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Comment

Signification and significance: Music, brain, and culture Comment on "Towards a neural basis of processing musical semantics" by S. Koelsch

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It is important to mention that in his pioneering work on neural correlates of musical semantics or meaning Stefan Koelsch [12] avoids the "language of emotion trap" by not reducing research on musical semantics to research on music and emotions (cf. [10]). He distinguishes extra-, intra-musical and musicogenic meaning. "Musicogenic" is used in interpreting "musical meaning" in the sense of significance, the value of music. Extra-musical meaning is related to N400 whereas N5 to intra-musical meaning. Event-related potentials such as N400, music closure positive shift for phrase boundaries (MCPS; cf. [11,15]) or P600 [17] indicate shared neural networks involved in common processing of language and music (cf. also [5]). N5, it is claimed, is an indicator for neural activities specific to processing (intra-)musical meaning. Furthermore, Koelsch intends to set up a conceptual framework for research on musical meaning. This comment focuses on the aspect of using sign theory for setting up a conceptual framework for research on the semantics of language and music considering the problem of connecting research in the humanities and social sciences to research in the brain and cognitive sciences.

'Musical meaning' has been one of the major research topics in the history of Western music research in particular in musicology and philosophy. It has been associated with ethics and aesthetics. Music as a 'language of emotion' and a medium of expressing inner feelings as a related topic was introduced in the eighteenth century. 'Music' became a fine art being distinguished from 'music' as a discipline of mathematical or scientific research in the quadrivium of the liberal arts or acoustics (cf. for details e.g. [20]).

Today, foundational music research strives for a theory of music as a part of a scientific theory of mind and as such is an enterprise of cognitive science of or the neurosciences of music. Explanatory goal of a theory of music is music as such or in modern terms the "music faculty". Research on "musical meaning" belongs to the domain of a theory of music and is part of foundational research on music.

Stefan Koelsch's [12] and Aniruddh Patel's [16] pioneering work in cognitive neuroscience tackles with the problem of musical meaning and meaning in language explicitly in a comparative way. It must be regarded as foundational research in musicology and a contribution to a theory of music too. Moreover, Patel [16] proposes a research program based on a comparative approach to music and language. Both Koelsch and Patel refer to semiotics/semantics or semiology as a broader conceptual framework for research in cognitive neuroscience on musical meaning. In particular,

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Patel [16] expects that "music–language studies might also suggest ways of bridging the current divide between the sciences and the humanities".

Patel addresses the hardest problem to be solved in research on meaning in general because meaning is not only an individual but also a socio-cultural phenomenon based on social interaction.

Koelsch's concept of musicogenic meaning – but also the concepts of intra- and extra-musical meaning (cf. [12, p. 15]) – seems to indicate that "musical meaning" is grounded in social interaction.

Unfortunately individualism [19] is methodologically the main approach of cognitive science and neuroscience to mind and brain. A fortiori research in cognitive neuroscience of music focuses on music processing by single minds or brains. By contrast the humanities and social sciences deal with "group minds", culture or social interaction.

In research on meaning naturally the question arises how to link research on socio-cultural phenomena like language and music to brain research. From a (cognitive) neuroscience perspective one can conceive of socio-cultural phenomena as products of collective brain processes. For example, the neuroscientist Wolf Singer [18] remarks that since the phenomena elaborated within the humanities are nothing but products of those collective brain processes that underlie cultural evolution, it should be possible to bring together descriptive systems which trace back brain functions to material components with those that deal with products of individual and collective brain processes. Taking this remark into consideration two questions arise: How can research on socio-cultural and mental phenomena be linked? How can research on mental phenomena and brain function be linked? Socio-cultural processes must be linked to mental processes and these to brain processes. A conceptual framework which provides a terminology to make theory-guided experimental research results comparable and that allows for linking socio-cultural research, cognitive science and neuroscience is needed. To view language and music as sign processes might bridge the gap and provide such a framework. Patel [16] explicitly refers to semiology in the study of musical meaning. Stefan Koelsch's "musical semantics" or theory of musical meaning might be interpreted referring to sign processes – to semiosis. Considered in this way his distinction of semantic processing in musicogenic, extra- and intra-musical meaning might be more generally viewed as signification involved in sign processes. To conceive of "musical meaning" as sign processes and signification encompasses Patel's [16] semiotic proposal too. Furthermore, signification allows to study collective and individual sign processes carried out by interpretative (bio)physical devices. For individuals significance of music is often expressed as "being touched" or "being moved" and is related to socio-cultural values. Again this relates to Koelsch's concept of musicogenic meaning.

To focus on the (human) brain as an interpretative sign-using system [6–8] and to conceive of music and language as sign processes of interacting brains seems a possibility to link the sciences and humanities within a research program on language–music and to tackle with the riddle of (musical) meaning. In discussing extra-musical meaning Koelsch [12] refers to Charles Sanders Peirce's semiotics. Patel [16] takes Jean-Jacques Nattiez' semiology into account invoking the binary relation "– stands for . . . " of the classical sign definition.

To my mind Charles W. Morris' semiotics [14] provides the best starting point for a general conceptual framework and terminology to investigate (musical) meaning as process and to link the humanities, social sciences and (natural) sciences – in particular computational modeling in cognitive science on one hand and biology, i.e. neurosciences and ethology, on the other. Morris' semiotics allows for grounding signification and significance in research on action–perception and motor theories of mind [1,4,9].

Briefly, for Charles W. Morris' semiotics encompasses syntax, semantics, and pragmatics. Signification is part of a sign process and significance links these processes to social and individual values as behavioral preferences. According to him [14] following George Herbert Mead [13] signification is a "complex behavioral process in the natural world" and is rooted in actions and motor behavior of organisms, i.e. for humans in social interaction and gestures [13,14]. This opens a way to relate semiotics to research on action–perception loops and schema theory and in particular to social schema theory [1,2], which addresses the problem of how to connect brain research on processing mechanisms of individual brains and brain functions to sign processing of socially interacting brains, i.e. research on language and music, within a computational and evolutionary framework [3].

To summarize, Stefan Koelsch, his colleagues and Aniruddh Patel do pioneering work for a theory of music and research on "musical meaning". Nevertheless, this research on "musical semantics" within comparative cognitive neuroscience of language–music needs to be linked closer to the humanities and social sciences. To achieve this goal comparative language–music studies in cognitive neuroscience are to be complemented by a) a conceptual "semiotics" framework focusing on sign processes rooted in motor behavior and social interaction, b) cognitive neuroscience research on pragmatics and discourse understanding, c) incremental computational modeling of interacting (bio)physical

systems carrying out sign processes, and d) (neuro)ethological research on the evolution of brain structures and mechanisms for sign processing.

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