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Chapter 9

MUSIC AND CONCEPTS

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ABSTRACT

What does music convey to the mind that may possibly explain its powerful effect on human behavior? While it is already well known that music can convey emotions, there is little evidence that it can also communicate concepts. We will first describe the theoretical framework that needs to be taken into account when studying conceptual processing in music. We will then present recent results that have been interpreted as signs of conceptual processing in music: the effect of a sound or a musical context on the processing of a target word (and vice-versa) as well as a gating paradigm exploring the unfolding of familiarity in music listening.

These results are of interest in the discussion of whether separate neuronal networks or general cognitive resources are at work in processing concepts issued from different domains (e.g., language and music). Moreover, they are relevant to musical memory and the issue of a musical mental lexicon and the representations it may contain.

1. INTRODUCTION

The mermaids used their charming voices and songs to seduce sailors, forcing them to dive into the sea. Only Ulysses could defeat them asking to be attached to the main mast of his boat to avoid being enchanted by the mermaids' songs. In another Greek myth, Orpheus was also able, using only his lyre and voice, to charm the powerful gods of hell. These early myths suggest that, since the ancient times, human beings have been fascinated by the power of music. The whole human history insists on the importance of

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music for human beings, in religious and sacred rituals as well as in everyday life. Indeed, music is a very complex activity involving many aspects of human life. Among these, the communicative role is commonly considered as an important aim of music production and listening (Koelsch and Siebel, 2005), even if it is still not clear what kind of information music can communicate to the mind, and how. Even though research on music was mostly focused on the effects of music on emotional responses, but not on "objective" propositional and logic aspects as in language research, the question of whether music can communicate concepts has been raised (Koelsch et al., 2002).

This does not go without difficulties. For instance, when musical conceptualization is considered, it might be extremely difficult to disentangle this cognitive mechanism from linguistic processes, and consequently, in the cognitive science of music, the comparison between language and music is extremely difficult to assess. In this chapter, we propose a review of the literature concerning the communicative aspect of music, with an emphasis on experiments suggesting that, implicitly or explicitly, some information provided by music might evoke not only emotions but also concepts. We will start by describing the theoretical framework required to study conceptual processing in music.

2. The "Mish-Mash" of Concepts and Emotions in Music

In the theories of human knowledge, two modalities of knowledge of reality can be distinguished: the first one concerns the concrete aspect of things, in their singularity; and the second one which reaches the reality only through abstract determinations that can be generalized. The first modality characterizes the sensitive intuition and the second one the conceptualization (Ladrière, 2007). A concept refers to a general and abstract representation of reality. Although a concept is a cognitive unit of meaning, we will prefer here the term "concept" instead of "meaning" because the latter if often associated with semantics, while the former does not necessarily involve linguistic mediated representations.

Moreover, in addition to both intuition and conceptualization, each contact with reality leads to affects, feelings, and emotions. An emotion is a complex physiological, neurophysiological, and psychophysiological process, which involves basic mechanisms giving animals the ability to avoid harm/punishment and to seek valuable resources/reward in a particular situation.

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Human emotional processes comprise several cognitive, physiological, behavioral, and subjective components (Paul et al., 2005), which can be classically organized into three dimensions: a) emotional reactions (i.e., cognitive and autonomic processes), b) emotional expressions (e.g., facial and vocal expressions), and c) feelings (i.e., the subjective perception of emotions) (Damasio, 1999).

If we consider music as a human act of communication, such communication might arise via different pathways. The first one is the expressive power of music itself, through a complex organization of sounds.

The second one is the expression of emotions by musicians while playing music. Indeed they are able to express their feelings via musical performance/composition. In this case (which, for example, makes use of facial expressions or subtle rhythmic movements of the body), the communicative aspect of music is related to an affective attunement between participants through dynamic forms of vitality (Stern, 2009). Musical communication might also involve linguistic significance but will never be limited to that.

For instance, listening to the complex structure and dynamic of Debussy's "La mer", goes far beyond the word "sea". What is evoked here is the concept of sea, including the words "sea, waves, boats…" as well as images of the sea in a specific landscape, and the feeling of being at the edge of the beach. In this case, the elicited concept exceeds the verbal significance and includes much more feelings and images.

Thus, when studying the communicative aspects of music, it is extremely difficult to separate the role of emotions (feelings), meanings (semantics, rhetoric, linguistic reference) and concepts (abstract verbal and non-verbal representations).

3. Emotions from Music: What We Know from Cognitive Sciences

(A) Emotions from Music

As pointed out by Peretz (2001), the neuropsychology of musical emotions is in its infancy. Nevertheless, it seems established that there is not a unique neuronal network activated for all types of musical emotions. Moreover, different music may evoke different autonomic reactions. For instance, sad excerpts seem to produce larger changes in heart rate, blood pressure, skin conductance, and temperature compared to excerpts that elicit

fear or happiness (Krumshansl, 1997). In the most extreme cases (e.g., rhythmic drumming) music can induce a state known as “trance”, which is characterized by a specific cognitive and emotional response with a strengthened theta electroencephalography activity and a complex modification of the content and structure of consciousness conveying the feeling to fully match with the rhythm as well as feelings of joy, happiness, or ecstasy (Vaitl et al., 2005).

Traditionally, according to empirical studies on more standard musical experiences, only two emotional dimensions have been frequently studied: arousal and valence/pleasantness (Smith and Ellsworth, 1985). However, several other dimensions may also to be considered (e.g., Reisenzein and Hofmann, 1990; Kissler et al., 2006). Using a multidimensional analysis of subjective scales of emotions to musical excerpts, Bigand et al. (2005) proposed three emotional dimensions of music perception: arousal, valence, and a third dimension related to “body posture and gestures” (p. 1130) or that tends “to contrast pieces that started with a melodic interval from those that started with a chord“ (p. 1128). These results are in agreement with the hypothesis of Canazza et al. (2001) who suggested that music would induce feelings within at least two dimensions: one related to the tempo, called “kinematic”, and one called “energy”, which would be related to the intensity or the attack time (Legato/Staccato). Thus, emotional perception to music would involve three main dimensions: arousal, valence, and a dimension related to movements.

Importantly, the aesthetic emotions are not the current life emotions. When, for instance, music is sad, the listener does not really become sad, but rather feels something which exemplifies the sadness (Livet, 2005). Indeed, in music, emotions never require a development of behavioral reactions, such as an escaping behavior, suggesting that musical emotions might just be “vectorial germs of our affective dimensions” (Livet, 2005).

(B) Towards Concepts in Music

According to Juslin (2001, pp. 309) “music might be viewed as a communication system in which composers code musical ideas in notation, performers recode from the notation to musical signal, and listeners recode from the acoustic signal to ideas”. Interestingly, Juslin used the term “ideas” instead of “emotions”, thus opening a possible link between abstract musical ideas (musical concepts) and the subjective component of emotions (feelings) to music. Similarly, following De Schoelzer (1947), a philosopher of music,

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who said that music constitutes "concrete ideas", it might be that composers code ideas in musical notation.

This point, in our view, is critical. Daniel C. Dennett, by inferring that every conscious knowledge is propositional in nature, pointed also to the relatedness between feelings and concepts. The simple fact that emotions can be described with not less than ten dimensions (Reisenzein and Hofmann, 1990) raises the questions of the relatedness between emotions and concepts, and/or of the validity of the categorization and classification of emotions. Thus, it is also not surprising to read statements that suggest the existence of consciously experienced abstract entities (concepts) in music, e.g., "emotional experience may correspond to the most abstract level of musical categorization" (Bigand et al., 2005, p 1130) or proposals that music conveys emotions indirectly via a linguistic mediation, that is, through combined elements according to rules with the function of generating and communicating a semantic or a propositional content (Coker, 1972).

Indeed, in a recent review of the research on the links between music and language, Patel (2008) claimed that the concepts communicated by music would belong to three categories: non-verbalizable concepts issued from the musical structure, concepts that may or may not be verbalizable from feelings, and verbalizable concepts from semantic associations (Patel, 2008).

4. Empirical Evidences of Conceptual Processing in Music

(A) Introduction

After this theoretical introduction of the links between music, concepts, and emotions, we will describe empirical evidences of a relation between music and concepts.

The first electrophysiological evidence showing that conceptual processing may not only occur with language but also with music perception was provided by Koelsch et al. (2004). The authors showed that ten seconds of music (i.e., the musical context) can influence the conceptual processing of a "target" word. Targets conceptually unrelated to the musical context showed a larger negativity of the Event-Related Potentials (ERPs) compared to related targets between 300 and 500 msec post-stimulus onset. This effect was interpreted as reflecting a modulation of the N400, a negative ERP component peaking around 400 msec post-stimulus onset (Kutas and Hillyard, 1980) known to be sensitive to conceptual processing (Fogelson et al., 2004;

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McPherson and Holcomb, 1999; Orgs et al., 2006; Van Petten and Rheinfelder, 1995). In a behavioral follow-up of Koelsch et al. study, Poulin-Charronnat et al. (2006) used musical contexts of approximately 12 sec. Participants were significantly faster in a lexical decision task to targets related to the musical context compared to unrelated targets. Importantly, these two studies could only indirectly conclude for conceptual processing during music perception because they found their effects during target words perception (with musical excerpts as contexts) but did not test the perception of target musical excerpts. Since the musical excerpts used in these studies were rather long (around 10 sec), it was very difficult to precisely know when the concept would emerge for each excerpt.

(B) Conceptual Relatedness Effects on Words and Sound Targets

In order to deal with this problem, Schön et al. (2009) used short musical excerpts as targets. Moreover, they used a particular type of music: concrete music. This choice was driven by the results from previous N400 studies of conceptual processing in the auditory domain using environmental sounds (Cummings et al., 2006; Orgs et al., 2006; Van Petten and Rheinfelder, 1995).

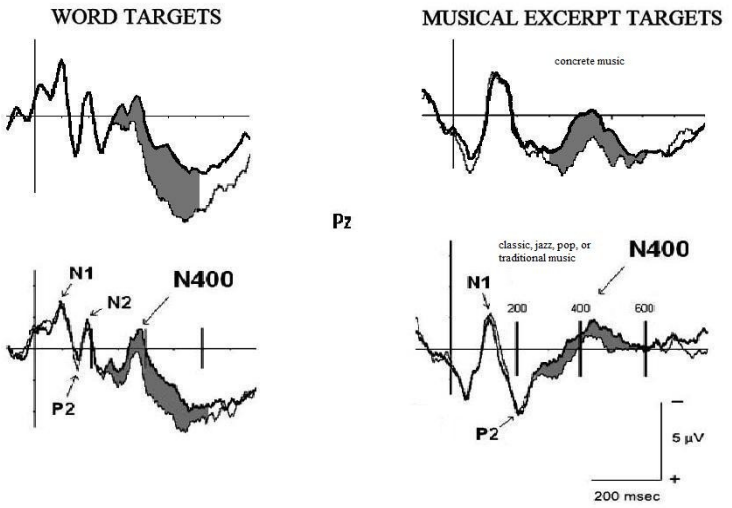

Figure 1. Grand-averaged ERPs at Pz to related (thin lines) and unrelated (thick lines) targets. Left panel: word targets; Right panel: musical excerpt targets; Upper panel: with concrete music (Schön et al., 2009); Lower panel:

with classic, jazz, pop, or traditional music (vertical unit: μV; horizontal unit: msec).

These studies found that the amplitude of the N400 to environmental sounds was reduced if the sources/causes of the sound, i.e. an object (e.g. a bottle, a cork, or a corkscrew) or an action (e.g., turning, pulling, opening) and the word or the picture presented before the sound (as context) were related. Although the aim of these studies was to investigate non-verbal conceptual processing, it cannot be excluded that the reported effects were in fact due to a verbal (i.e., semantic) relatedness (i.e., between the meaning of the word or the picture and the meaning of word label of the sound source, e.g., "bottle" or "opening").

Indeed, environmental sounds are strongly associated to labels. In order to minimize the likelihood of a labeling process, Schön et al. (2009) used sounds whereby the identification of a source "was highly unlikely". This type of sounds, called «acousmatic» sounds, is typically used in contemporary music such as "concrete music". Two experiments were conducted to test conceptual relatedness using excerpts of concrete music. In an Experiment 1, pairs of stimuli consisted in a sound (i.e., an excerpt of concrete music) followed by the presentation of a related or unrelated word. In an Experiment 2, a word was presented before a related or an unrelated sound. In these two experiments the N400 to the target (i.e., the second item of the pair) was always larger for unrelated compared to related pairs of stimuli (Figure 1). These results suggest that (non-environmental) musical sounds can convey non-verbal concepts.

(B) Conceptual Relatedness Effects on Words and Musical Targets

While Koelsch et al. (2004) and Poulin-Charronnat et al. (2006) did not test musical excerpts as targets, Schön et al. (2009) only used musical sounds of a particular music genre (concrete music). Moreover, since target sounds mostly consisted in single (isolated) sounds, this was more an extension of previous research on environmental sounds than on music.

Therefore, we decided to study conceptual relatedness effects using musical excerpts as targets. In order, to reduce the temporal uncertainty of the conceptual processing that arises from the use of "long" duration musical targets, as in Koelsch et al. (2004), we used short excerpts of only one second. The aim of a first experiment (Experiment 1) was to replicate Koelsch et al. findings using short excerpts of one second duration as context. The aim of Experiment 2 was to study the influence of a linguistic context on the

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conceptual processing of target musical excerpts (Daltrozzo and Schön, 2009a). In these experiments, we recorded behavioral and electrophysiological responses while participants were presented 50 related and 50 unrelated pairs (context/target). Experiments 1 and 2 showed a larger N400 component to targets following a conceptually unrelated compared to a related context (Figure 1).

The data of Experiment 1 confirmed that the processing of words is influenced by its conceptual relatedness with a musical context even if the duration of this context is only 1 sec. The Experiment 2, showing a N400 effect with musical targets, suggests that music may also convey concepts. This interpretation assumes that concepts can be carried by emotional feelings to music. We proposed that the conceptual relatedness effects reported in the two experiments were due to a matching between the concepts carried by emotional feelings to the excerpt timbre and the musical structure and the concepts elicited by the word.

(C) The Automaticity of Conceptual Processing with Music

The literature on N400 studies designed to test conceptual relatedness effect is strongly focused on the question of the automaticity of the cognitive mechanisms responsible for the N400 effect. Several authors reported an N400 effect (e.g., between related and unrelated pairs) that depends on the level of attention (e.g. Brown and Hagoort, 1993; Matsumoto et al., 2005; Ruz et al., 2003), while others supported the view of automatic underlying processes (Anderson and Holcomb, 1995; Dehaene et al., 2001; Kiefer and Brendel, 2006; Misra and Holcomb, 2003; Reiss and Hoffman, 2006; Stenberg et al., 2000).

Thus, we decided to study whether the conceptual relatedness effect found with the N400 (Daltrozzo and Schön, 2009a) was due to automatic or controlled mechanisms. This led us to test another sample of participants with the same material but with a different task (Daltrozzo and Schön, 2009b). Compared to the explicit relatedness judgment task (RJT) used in Daltrozzo and Schön (2009a), we used a more implicit task (a lexical decision task, LDT) wherein the musical excerpt was followed by related or unrelated words (or pseudo-words). A relatedness effect on the N400 was also found with this implicit task (LDT). However, the size of the effect was only about one third of the size found with the explicit task (RJT). These data suggest that the processing of concepts conveyed by music is partly controlled (i.e. dependent on the level of attention) and partly automatic.

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(D) Music Familiarity and Conceptual Processing

These two studies, together with Koelsch et al. (2004) and Poulin-Charronnat et al. (2006) confirmed that music conveys concepts and further suggests that conceptual processing occurs while a musical excerpt is being heard. This conclusion led us to ask if evidence could be found that musical concepts (often referred to as "musical meaning" in the literature, see above) would emerge and be processed during the recognition of a familiar music from long term memory.

More precisely, we decided to test whether the emergence of familiarity to a melody (i.e., the beginning of the recognition process) may trigger or co-occur with the processing of the concept(s) conveyed by this melody (e.g., ideas due to the musical structure, emotional feelings, or semantic associations) (Daltrozzo et al., 2009). Perhaps the feeling of familiarity with a melody could reactivate concepts carried either by the melody itself or by the full musical piece it belongs to.

This was tested with ERP recordings while participants were presented with highly familiar and less familiar melodies within a gating paradigm. In this paradigm, a musical excerpt is presented several times. At the first presentation (or "gate"), the first tones (e.g., the first 3 tones) of an excerpt are presented. A judgment of familiarity with the presented stimulus is requested. At each new gate, one tone is added (e.g., the first 4 tones at the 2nd gate, the first 5 tones at the 3rd gate, etc…). The ERP individually time-locked to a tone of the melody called "Familiarity Emergence Point" (Dalla Bella et al., 2003), showed a larger fronto-central negativity for highly familiar compared to less familiar melodies between 200 and 500 ms with a peak latency around 400 ms. This latency and the sensitivity to the degree of familiarity/conceptual information led us to interpret this component as a N400. We proposed that the feeling of familiarity with a musical excerpt could be accompanied by the processing of other mechanisms at the conceptual level that were at the origin of the modulation of the N400.

DISCUSSION

If the definition of concepts refer to abstract determinations that can be generalized, we can conclude from the experiments cited in this review that music communicates not only emotions but also concepts. The main evidence for this, is the presence of a N400 response: a) to a word unrelated to a musical context, and b) to a musical excerpt unrelated to a word context.

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What is less clear is whether the concepts conveyed by music are always supported by language (i.e. related to a linguistic or semantic process). Indeed, both priming experiments described above made use of words as targets or context, and hence might not fully disentangle relatedness based on semantic (linguistic) meaning from relatedness due to non-verbal concepts. However, the gating experiment pointed to the possibility of conceptual processing (related to the feeling of familiarity) during music listening only. Schön et al. (2009) proposed a model to explain the perception of sounds at the conceptual level. We proposed the existence of amodal conceptual representations as a link between concepts evoked by sounds, emotions (sound lexicon), and concepts evoked by words (with a semantic level). More work needs to be done, for instance, with priming paradigms, by using short excerpts of music as context or target, asking for instance the subjects to minimize internal verbalization while performing the task.

A major challenge when studying music and emotional/conceptual processing is related to the nature of the question itself. When we listen to a musical piece during a concert, we may experience simultaneously emotions (e.g., from rhythmic movements or various affective attunements with the performer), verbal thoughts (i.e., giving a meaning to the music), visual mentation, or abstract sensations conveying for instance concepts. Within this complexity, experimental cognitive neurosciences, with the aim to find neurobiological correlates, try to dissociate what would be an emotion, a meaning, or a concept. Since even philosophy defines emotions, feelings, and concepts with great difficulty, it is also not surprising that neurosciences use these notions without much questioning, reducing and simplifying them, possibly leading to experimental and epistemological artifacts. For instance, the small amount of musical emotions often reported in the literature (e.g., Juslin, 2001) are studied: a) without any differentiation between everyday life and aesthetic emotions, b) using an huge reduction of the variety of emotions (for a wider variety, see Descartes, 1649) c) while neglecting that each emotion takes place within a mood state and a life context that may modify its impact.

Another challenge when working on meaning, concepts, and emotions in music is that little attention is paid to the level of consciousness while listening to music. If we discard the hypnotic state induced by some musical experiences, we may distinguish 3 levels of conscious experiences: verbal reflexive experience, non-verbal reflexive experience, and pre-reflexive experience (Stern, 2009). It might be that musical experience elicits together meaning, concepts, and emotions during these 3 levels of consciousness. For instance, aesthetic emotions would occur mainly during a pre-reflexive

experience while perception of meaning would occur through a verbal reflexive one.

Finally, to understand the complexity of the problem discussed in this paper (music and conceptual processing), we need to take into account the work on intentionality, namely the property of mental phenomena of being mandatorily directed upon an object (real or not). The word "intentionality" implies, according to Brentano and Husserl, that consciousness is always a consciousness of something (Fisette and Poirier, 2000). Two modalities of this kind of intentionality might be distinguished: one concerning concrete objects, which are immediately understood, and one concerning concrete objects understood through abstract determinations separated from their concrete basis. The concept is, in this latter case, the mediation allowing to understand and point to a reality through an element of generality, what Ladrière (2007) calls concepts of "assimilative intentionality". From the classical psycho-linguistic point of view of cognitive sciences, the N400 component is related to the linguistic meaning. Other N400 theories suggest that this component is developed in the brain not only when meaning is processed, but also when the act of intentionality towards a new object occurs (Piotrovski, 2009): the less familiar the object, the larger the N400. Because, for unfamiliar objects, many cognitive resources are required to elicit the intentional act. Linguistic meaning perception would reflect only a particular kind of activation of an intentional act. We may assume that the N400 might be a marker of the processing of concepts of "assimilative intentionality", and may be a neurophysiological correlate of an amodal representation system.

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