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Review

The development of aesthetic responses to music and their underlying neural and psychological mechanisms

S. Nieminen [a,b], E. Istók [a,b], E. Brattico [a,b], M. Tervaniemi [a,b] and M. Huotilainen [a,b,*]

[a] Cognitive Brain Research Unit, Institute of Behavioural Sciences, University of Helsinki, Finland
[b] Finnish Centre of Excellence in Interdisciplinary Music Research, University of Jyväskylä, Finland

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ABSTRACT

In the field of psychology, the first studies in experimental aesthetics were conducted approximately 140 years ago. Since then, research has mainly concentrated on aesthetic responses to visual art. Both the aesthetic experience of music and, especially, its development have received rather limited attention. Moreover, until now, very little attention has been paid to the investigation of the aesthetic experience of music using neuroscientific methods. Aesthetic experiences are multidimensional and include inter alia sensory, perceptual, affective, and cognitive components. Aesthetic processes are usually experienced as pleasing and rewarding and are, thus, important and valuable experiences for many people. Because of their multidimensional nature, these processes employ several brain areas. In the present review, we examine important psychological and neural mechanisms that are believed to contribute to the development of aesthetic experiences of music. We also discuss relevant research findings. With the present review, we wish to provoke further discussion and possible future investigations as we consider the investigation of aesthetic experiences to be important both scientifically and with respect to potential clinical applications.

1. Introduction

The Greek word 'aisthétikos' refers to perception through the senses (Urmson, 1990). Aesthetic perceptions are rather unique in the sense that they are usually experienced as very pleasing and are often related to the concept of beauty. However, it is difficult to describe the quality of one's own aesthetic experience and to delineate the many aspects of it. This difficulty, presumably, derives from the fact that an aesthetic experience is a multidimensional process composed of several components and stages, some of which are involuntary and implicit. An aesthetic experience originates from the perceptual, cognitive and affective analyses of a stimulus and leads to several outcomes, including aesthetic judgements (e.g., "This piece of art is beautiful."), aesthetic emotions (e.g., awe, nostalgia, and enjoyment), conscious liking or preference, and aesthetic taste (Brattico and Jacobsen, submitted for publication; Leder et al., 2004). Hence, both cognitive and affective responses are interconnected and constantly interacting as parts of the aesthetic processing (e.g., Baldwin, 1911; Leder et al., 2004; Neperud, 1988). This processing is further affected inter alia by

* *Corresponding author*. Cognitive Brain Research Unit, Institute of Behavioral Sciences, P.O.BOX 9 (Siltavuorenpenger 1 B), 00014 University of Helsinki, Helsinki, Finland.
E-mail address: minna.huotilainen@helsinki.fi (M. Huotilainen).
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previous experiences, knowledge, and personal features of the perceiver (Leder et al., 2004). Thus, a rather complex network of stimulus-, person-, and situation-related matters influences the nature of an aesthetic experience (Brattico and Jacobsen, submitted for publication; Jacobsen, 2006; Miell et al., 2005).

Although researchers have reached consensus on some psychological aspects contributing to aesthetic experiences, other questions have been left unresolved or, in some cases, somewhat neglected: from where do aesthetic experiences stem and how do they develop? Are there certain innate prerequisites in the peripheral and central nervous systems, similar to all individuals, that affect whether and how an event is processed in an aesthetic way? Which aspects of an aesthetic experience require cultural exposure, higher brain processes, and, hence, are subjected to more cultural and individual variation?

In the current paper, we will review the psychological and neuropsychological literature focussing on music as an artistic input. This focus aims to fill the gap in the empirical field of aesthetics, which has historically devoted the largest attention to figurative arts at the expense of all performing arts, such as music, dance, opera, and theatre (Hargreaves and Castell, 1987). From the first empirical investigations by Gustav Theodor Fechner (1876) concerning aesthetic judgements, the investigation of aesthetic experiences in experimental psychology has mainly been a discipline of visual perception (Jacobsen and Höfel, 2001; Jacobsen et al., 2006; Leder et al., 2004). Several influential ideas and theories have been proposed on the basis of this research tradition. Berlyne (1971) suggested that positive aesthetic emotions, such as pleasure or enjoyment, depend on the amount of arousal elicited by a stimulus with medium arousal potential being maximally preferred. Subsequently, a significant amount of research has concentrated on the relationship between the different variables of stimuli (e.g., complexity, familiarity, and predictability) and various measures of the aesthetic response such as the degree to which one likes and/or finds the experience interesting and the level of subjective familiarity (Hargreaves, 1986). The results have revealed, for example, the effects of novelty, complexity and predictability on the aesthetic emotions of interest and enjoyment (Silvia, 2005) as well as, quite often, an increase in preference due to familiarity. A recent model by Reber et al. (2004) also takes into account person-related matters, proposing that aesthetic experiences emerge from the interaction of stimulus properties and cognitive and affective processes of the perceiver. The main premise behind this model is that aesthetic pleasure is due to the perceiver's fluent stimulus processing of a certain stimulus enabled by objective stimulus features (e.g., symmetry, clarity, the amount of information) interacting with the subjective and personal characteristics of the perceiver (e.g., familiarity, implicit knowledge of stimulus-governing rules). Processing fluency is experienced as positive and, therefore, results in more favourable judgements. Another recent information-processing model by Leder et al. (2004) focuses on aesthetic experiences as they relate to contemporary abstract visual art. The model represents different processing stages as well as important variables that determine the aesthetic experience. This aesthetic processing has two major outcomes, namely, aesthetic judgements and aesthetic emotions. Visual artworks are first analyzed perceptually, after which both the perceiver's implicit and explicit knowledge modify the subjective aesthetic experience. In the final evaluation stage, the success of the preceded information processing is assessed and leads to an aesthetic emotion.

In sum, the majority of the theories and models referred to above are concentrated on the visual arts. Unfortunately, only very few developmental models of the aesthetic experiences of visual art have been introduced to date (see e.g., Parsons, 1976). In the neurosciences of music, any attention to the aesthetic experience is quite recent (Müller et al., 2010; Brattico and Jacobsen, submitted for publication; Kornysheva et al., 2009). However, aesthetic responses to music, such as judging a song as beautiful or enjoying a live performance, are important and frequent events in contemporary society, in which music is universally present (Dutton, 2002) from infancy onwards and, in some cases, even during the pre-natal period. For example, infants display an intense interest in music, as evidenced by various head-turning experiments (Trehub, 2003), in which the aesthetic responses to music seem to activate the motor system of the listener (Patel, 2008). Often it is very easy to see that an infant, a child, or an adult enjoys the music she hears when she starts to sway, tap, or otherwise move to the music. This interaction between the sound and the movement appears to develop early, and it is fundamental to music processing throughout one's life (Phillips-Silver and Trainor, 2007), serving, possibly, the function of sharing aesthetic and emotional judgements of music with others.

A very recent model of the aesthetic experience of music introduced by Brattico and Jacobsen (submitted for publication) contributes to the field by focussing on the aesthetic processing of music so that it takes into account the motor activity and the neuropsychological aspects. The model is intended not only to describe aesthetic responses occurring in a concert hall when listening to classical music but also to include those aesthetic experiences elicited by listening to or performing any kind of music in any situation. The model further considers external and internal contextual factors such as mood, attention, and previous musical training, and it integrates neuro-imaging evidence for a mental and neural chronometry of aesthetic processes. The initial processing stages consist of perceptual analysis and cross-modal integration. These stages are accompanied by core 'liking' or sensory valence, which attributes pleasant or unpleasant connotations to sounds (possibly through fast subcortical routes), by arousal, and by other discrete emotion categories that are quickly processed, perhaps, by exploiting neural pathways evolved initially for simple animal vocalizations and human voices. Physiological changes and the induction of motor activity accompany these aesthetic processes. The subsequent stages involving higher brain structures and voluntary inter-modal processes (such as retrieval from long-term memory of schematic musical knowledge) include aesthetic judgement, aesthetic emotions (such as joy or awe), and a conscious liking or preference. These aesthetic processes initiate a feedback and feedforward loop, aiding the formation of musical taste. This loop appears most active in the adolescent years. The mental and brain mechanisms