Consciousness and Cognition 61 (2018) 94–106

Contents lists available at ScienceDirect

Consciousness and Cognition

journal homepage: www.elsevier.com/locate/concog

Review article

# Music-colour synaesthesia: Concept, context and qualia

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ARTICLE INFO

*Keywords:*
Synaesthesia/synesthesia
Ideaesthesia
Concept
Music-colour/color
Chromesthesia
Qualia

ABSTRACT

This review provides a commentary on coloured-hearing arising on hearing music: music-colour synaesthesia. Although traditionally explained by the hyperconnectivity theory (Ramachandran & Hubbard, 2001a) and the disinhibited feedback theory (Grossenbacher & Lovelace, 2001) as a purely perceptual phenomenon, the review of eight coloured-hearing neuroimaging studies shows that it may not be assumed that these explanations are directly translatable to music-colour synaesthesia. The concept of 'ideaesthesia' (Nikolić, 2009) and the role of conceptual and semantic inducers challenge the likelihood of a single mechanism underlying the cause of synaesthesia and argue for a move away from a purely sensory to sensory explanation. Finally, music-colour synaesthesia forms a challenge for established philosophical theories and the position of synaesthesia is considered within the larger context of musical qualia.

## 1. Introduction

Synaesthesia is a relatively rare condition that manifests itself in approximately four percent of the population. It is a phenomenon that occurs automatically and, generally, with considerable consistency over time. It has been described as a 'union of the senses' (Cytowic, 1989, 2002; Marks, 1975; Motluk, 1994; Vernon, 1930) and, typically, arises as result of stimulation in one sense (an inducer) triggering a reaction in an unstimulated second sense (a concurrent). The most commonly examined form is grapheme-colour synaesthesia in which colours are experienced in response to digits or letters (Hubbard, 2007) although many other combinations exist: a sensation of colour may be elicited on hearing certain sounds, or in association with certain tastes, or by touch. Furthermore, although often described as a purely sensory to sensory phenomenon, it is also possible for inducers to be non-sensory in nature. For example, some common forms result in an experience of colours and spatial layouts in association with days of the week or calendar months; neither months, nor days of the week, can be described as delivering any sensory input, per se. This review provides a commentary in three parts on the existing literature that explores a form of synaesthesia also known as chromesthesia, or coloured hearing, that arises on hearing music. The first part of the review begins by considering the characteristics of music-colour synaesthesia and the commonalities between the synaesthetic experience and normal cross-modal perceptions in non-synaesthetes (Ward, Huckstep, & Tsakanikos, 2006a; Isbilen & Krumhansl, 2016). The second part of the review discusses the two main neurological hypotheses pertaining to the cause of synaesthesia: the hyperconnectivity theory (Ramachandran & Hubbard, 2001a) and the disinhibited feedback theory (Grossenbacher & Lovelace, 2001) followed by a discussion of the results of eight neuroimaging studies with a sound-colour focus. The final section explores how some types of music-colour synaesthesia provide further evidence in support of the importance of the role of conceptual and semantic inducers in synaesthesia, and the alternative theory of 'ideaesthesia' (Nikolić, 2009; Mroczko-Wąsowicz & Nikolić, 2014). The review concludes with a consideration of the challenge presented by synaesthesia to established philosophical theories and the position music-colour synaesthesia might occupy within the larger context of musical qualia.

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https://doi.org/10.1016/j.concog.2018.04.005
Received 27 November 2017; Received in revised form 9 April 2018; Accepted 10 April 2018

## 2. Characteristics and commonalities

### 2.1. The characteristics of music-colour synaesthesia

The umbrella term 'music-colour synaesthesia' or simply 'coloured-hearing' has been applied to the experience of colour elicited on hearing sounds. There are several different types of music-colour synaesthesia which manifest in quite different ways and might include not just the experience of colours, but also of textures, shapes and spatial landscapes (Eagleman & Goodale, 2009). Peacock (1985) broadly classified four groups of 'inducers' related to compositional style, timbre, tonality, and pitch (or tone). These may be further differentiated to include relationships between colour per individual composer, colour and certain keys, and colour occurring from differing harmonic progressions (Vernon, 1930). It is not uncommon for synaesthetes to experience combinations of these different types, and the idiosyncratic nature of the condition frequently results in individual synaesthetes disagreeing about the colours and imagery associated with musical inducers: one synaesthete may consider B minor to be the colour of sunlight on a window pane, yet for another B minor is sea green. Examples of the different types of music-colour synaesthesia experienced are given by GS, the subject of Mills, Boteler, and Larcombe's (2003) study. Her experiences encompass shapes, texture, and movement, in addition to colours. GS reports big blocks of dark colours in response to heavy metal music, and displeasing combinations of colours to music that she does not like. GS does not possess absolute pitch but found that higher pitches would be accompanied by lighter colours and lower pitches by darker colours. GS also explained that different instruments, or combinations of instruments, would produce different colours and patterns, and that the same note played at the same pitch but on a different instrument would result in a different colour. Musical intervals, tonality and themes created landscapes that she referred to as maps, and the tempo of the music would dictate the speed at which the maps moved. GS commented that she often found the maps easier to follow than standard musical notation.

### 2.2. Normal cross-modal associations

Although there is a uniqueness to the visual and/or spatial phenomenon synaesthetes experience on hearing music, some commonalities with cross-modal associations in non-synaesthetes have been identified (Ward, 2013). For example, in the general population the visualised size and location of pitches has been shown to be associated with certain auditory characteristics: higher pitches tend to be associated with an elevated spatial position and a smaller size, and lower pitches with a lower space and a larger size (Marks, 1987, 2004; Gallace & Spence, 2006; Walker et al., 2010; Ward et al., 2006a). Ward et al. (2006a) posits that although there are differences between synaesthetes and non-synaesthetes in respect of automaticity, consistency and specificity of colour selections, both groups do appear to employ similar pitch mapping with regard to pitch-lightness. Tsiounta, Staniland, and Patera (2013) also found that non-synaesthetic people appeared to use comparable mental processes to make associations between colours and music, and to make similar pairings at a conceptual level. The study examined the correlations that people from different cultures and backgrounds made between colour and music. Twenty different music genres were presented to participants and then twenty different themes from movies and television soundtracks. In each case participants were required to select a colour from a pallet that they thought was best associated with the track they were hearing. The results demonstrated a level of common association in some genres between colour and music in non-synaesthetic people.

### 2.3. Role of emotion

Similarly, a level of common association has been demonstrated between emotion and music, and emotion and colour (Palmer, Schloss, Xu, and Prado-León, 2013; Palmer, Langlois, & Schloss, 2016). Palmer's studies were carried out with non-synaesthetes and demonstrated an association between major keys and more saturated, yellow, and brighter colours, and an association between minor keys and darker, bluer, less saturated colours. In addition, emotional ratings of the colours and the musical excerpts showed a correlation between the emotional state and the musical excerpts, and emotional state to the colours, suggesting that music to colour associations might be mediated by emotion in the general population.

Isbilen & Krumhansl (2016) carried out further studies to test this hypothesis including in their study musicians, non-musicians, absolute pitch possessors, and music-colour synaesthetes. Using the preludes from Bach's Well Tempered Clavier, musical excerpts were presented in each of the major and minor keys and in a diverse range of styles. The study comprised three experiments. Experiment 1 required participants to choose from a pallet of eight colours and to match them to excerpts heard from 24 preludes. From the colour choices made, it was found that the preludes could be grouped together in terms of tempo, key, pitch height and attack rate. In Experiment 2, participants were asked to rate the colours on an emotional scale, and in Experiment 3, they were asked to rate the preludes they heard on the same emotional scale. The results of Experiments 2 and 3 were then combined and it was found that the music-colour associations observed in Experiment 1 could be predicted by the colour-emotion rating given in Experiment 2, and the music-emotion rating given in Experiment 3. The possession of synaesthesia or absolute pitch was shown to have very little effect on the actual colours chosen for each of the musical excerpts, but it might be reasonable to expect that music that elicits a strong emotional response may be more likely to induce synaesthesia than music that does not (Marks, 2004). Such results suggest that there may be similarities on a general level in the way that people conceptualise emotions associated with music and those associated with colours. The conceptual meaning of music may vary with its emotional (Cutsforth, 1925; Marks, 2004) which in some forms of music-colour synaesthesia may also be represented by a corresponding change in colour.

Although the studies above lend support to the hypotheses that synaesthesia may rely on normal cross-modal associations (Marks,