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Familial patterns and the origins of individual differences in synaesthesia

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Abstract

The term synaesthesia has been applied to a range of different sensory-perceptual and cognitive experiences, yet how these experiences are related to each other is not well understood. Not only are there disparate types of synaesthesia, but even within types there are vast individual differences in the way that stimuli induce synaesthesia and in the subjective synaesthetic experience. An investigation of the inheritance patterns of different types of synaesthesia is likely to elucidate whether a single underlying mechanism can explain all types. This study is the first to systematically survey all types of synaesthesia within a familial framework. We recruited 53 synaesthetes and 42% of these probands reported a first-degree relative with synaesthesia. We then directly contacted as many first-degree relatives as possible and collected complete data on synaesthetic status for all family members for 17 families. We found that different types of synaesthesia can occur within the same family and that the qualitative

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nature of the experience can differ between family members. Our findings strongly indicate that various types of synaesthesia are fundamentally related at the genetic level, but that the explicit associations and the individual differences between synaesthetes are influenced by other factors. Synaesthesia thus provides a good model to explore the interplay of all these factors in the development of cognitive traits in general.

Keywords: Synaesthesia; Synesthesia; Individual differences; Inheritance; Familiality; Genetics; Experience; Intrinsic developmental variation; linguistic–colour; Sex; Male lethality; Twins

1. Introduction

Synaesthesia has been defined as the experience of involuntary sensory cross-activation whereby the presentation of a particular stimulus elicits a secondary sensory-perceptual experience (Baron-Cohen, Wyke, & Binnie, 1987; Cytowic, 1989, 1997). This definition has been extended to include a number of more cognitive categories, both for the inducing stimulus and the concurrent synaesthetic experience. The term 'synaesthesia' has been applied to a wide range of quite disparate phenomena (Baron-Cohen et al., 1987; Cytowic, 1989, 1997; Marks, 1975). These include forms acquired after optical injury of some sort (Armel & Ramachandran, 1999), patterns of information integration in multisensory perception (Gallace & Spence, 2006), temporary forms induced by hallucinogens such as mescaline or lysergic acid diethylamide (LSD) (Cytowic, 1989; Nichols, 2004) and an apparently hereditary form that has been called idiopathic or developmental synaesthesia (Ward & Mattingley, 2005). There are, in turn, many different forms of the latter, most of which are described within the sensory-perceptual domains but are not strictly restricted to these domains (Dixon, Smilek, Cudahy, & Merikle, 2000; Jansari, Spiller, & Redfern, 2005). The most common and best-studied forms of synaesthesia involve the association of colour with linguistic stimuli such as letters, numbers, or words (Baron-Cohen, Harrison, Goldstein, & Wyke, 1993). We use the term linguistic–colour synaesthesia to describe such phenomena. This can occur as 'coloured hearing', where sounds, including spoken phonemes or words induce a colour percept or 'coloured reading' where visually presented letters or numerals induce an associated colour. In fact, the concept of an inducer is often sufficient to elicit a concurrent experience (Dixon et al., 2000). There are many additional phenomena to which the term synaesthesia has been applied, including for example, the induction of tastes by words (Ward & Simner, 2003), the induction of touch by vision (Blakemore, Bristow, Bird, Frith, & Ward, 2005), the induction of shapes by tastes (Cytowic, 1993), the personification of numbers (Simner & Holstein, 2007; Smilek, Callejas, Dixon, & Merikle, 2007) and experiencing numbers or units of time in spatial arrangement (Dixon, Callejas, Smilek, & Merikle, 2006). To date, it is unknown how these different types of synaesthesia relate to each other (Sagiv, Simner, Collins, Butterworth, & Ward, 2005). Reports of individual synaesthetes with more than one type of synaesthesia (e.g., Simner & Hubbard, 2006) support the view that the different types are