Hearing Colours and Tasting Words:

The Psychology of Synaesthesia

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Figure 1. *The days of the week seen by synaesthete IB.*

Like most people, I take for granted that what I see with my eyes and hear with my ears comes from things I encounter in the outside world. When I hear a buzzing noise, for example, and see a small striped object with wings, I assume it is because I have crossed the path of a bee, who is making his presence known to me via my senses of sight and sound. However, as a psychologist I know that what I hear, see, taste, smell and feel is simply a response to activity in particular areas of my brains. Usually this activity is triggered by an external source with the relevant properties (e.g., a buzzing bee), although neurologists have known for many years that this need not be the case. The Canadian brain surgeon Wilder Penfield (1891–1976) applied mild electric currents to exposed areas of patients' brains during surgery. When Penfield probed certain locations, his patients – who were awake during the procedure – reported sensations of smell, sight, touch etc., that had no source in the local vicinity.

Penfield's research, and that of others after him, tells us that it is possible to experience sensations in our five senses without the usual external triggers, and this is precisely what happens to individuals with the genetically inherited condition of synaesthesia. People with synaesthesia experience certain sensations (e.g., of taste, of sound, of colour) when engaged in activities that do not usually trigger that response in non-synaesthetic people. For example, synaesthetes may see colours when reading words, letters or numbers (Ward, Simner & Auyeung, 2004). These colours are seen either externally (e.g., superimposed on the typeface of the written word) or as a strong and overwhelming experience of colour in the mind's eye. Alternatively, a person with synaesthesia might feel shapes of different sizes and textures in response to the flavour of the food they taste. For patient S, reported by Cytowic (1993), the taste of chicken was a pointed 3D figure, and the taste of mint chocolate felt like a dozen smooth columns brushing at his fingertips. Crucially, all these sensations were as real and immediate as any other genuine tactile experience. Synaesthete JIW (Ward & Simner, 2003) experiences tastes in response to words (e.g., the word 'profit' tastes of unripe oranges and the word 'jail' tastes of cold hard bacon). Others still may see shapes and colours triggered by music, or have a sensation of smell when they experience physical touch. The aim of my research is to understand the psychological and developmental basis of synaesthesia and what, if anything, this might tell us about the ordinary functioning of memory and cognition.

The initial question for any study of synaesthesia is how to determine that these reported experiences are genuine. Although cases of synaesthesia have been described in the literature for over 100 years (e.g., Calkins, 1895), it is only relatively recently that systematic psychological and neurological procedures have been able to provide objective evidence for the validity of their claims. Evidence for the genuineness of synaesthetes' reports comes in two principle forms. First, initial support derives from the fact that people with synaesthesia tend to report the same pairings of trigger and response across years, and even decades. Hence, if the letter 'c' is yellow, or if Tuesdays are green (see Figures 1 & 2), this will usually have been true since childhood, and will tend to be the case for the entire length of the synaesthete's life. This means that synaesthetes are hugely consistent over time in their reports, even though their memories may be no better than the average person. To test this, we examined the consistency of synaesthete JIW (who experiences tastes in response to words; e.g., 'profit' = oranges; 'jail' = bacon). We gave a list of words to both JIW and to a set of non-synaesthete control subjects. JIW was asked to state his taste for each word, and controls were asked to invent a taste association for each. In order to show that JIW was significantly more consistent than controls in his associations, we 'stacked the deck' against him in a number of ways. JIW's list contained over 1000 words, which we retested after 5 months, in a surprise re-test. The controls' list was only 88 words long, and retested after just 2 weeks. Notwithstanding these less demanding conditions, controls were only 18% consistent in their responses. In contrast, JIW was almost 100% consistent, even though other tests of his memory showed he had no more than an average memory span. In other words, although JIW does not have a superior memory, his reports of word–taste

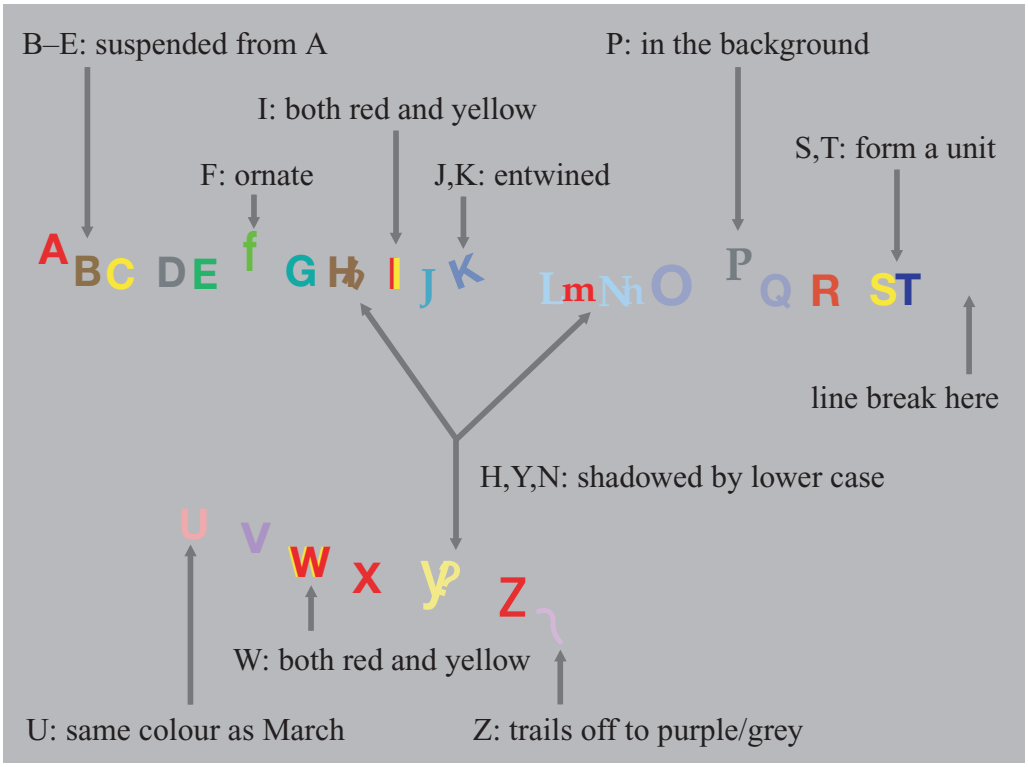

Figure 2. *The alphabet seen by synaesthete AD.*

associations remain consistent over time, and it is this consistency that lends support for the genuineness of his claims.

The second principle measure of genuineness has revolutionised the field of synaesthesia research since it allows us to show that the reports of synaesthetes are not only genuine, but neurological in basis. David Parslow and colleagues (see also Nunn, Gregory, Brammer et al., 2002) have performed fMRI brain imaging of synaesthete JIW and shown bilateral activation of the primary gustatory cortex in response to words. Put simply, the taste centres in JIW's brain 'light up' when he hears words. This activation tells us not only that his experiences are genuine, but that they are perceptual in nature. In other words, the colours/sounds/tastes/shapes etc. reported by synaesthetes *feel the same* as sensations perceived by you or me from objects in the outside world. Of course for people with synaesthesia, this comes as no real surprise: they have been telling us as much for the last 100 years, although the unusual phenomenology of their reports has often led them to be met with disbelief.

What then might cause these sensations in the 1 in 2000 people who experience synaesthesia? It appears that the condition is genetically inherited, since it can be traced through family trees. Interestingly, although synaesthesia itself is heritable, the precise manifestation can vary within a single family. Hence, a mother who sees colours for letters and numbers may have a daughter who sees shapes for music and a son who tastes words. We know, too, that the condition is linked to the X-chromosome, since it passes from mothers to children of both sexes, but from father only to their daughters. Finally, we have shown evidence of influences *in addition to* genetic inheritance, from a case of female monozygotic (single egg) identical twins, of which only one has synaesthesia. This suggests that synaesthesia developed after conception, once the twins had already become separated in the womb.

After a hiatus of almost 70 years, psychologists have returned to synaesthesia for what it can tell us about the nature of human perception and cognition. While modern cognitive research methods have opened the door for a renewed systematic examination, the field still lacks any deep understanding of the principles and mechanisms that underlie the condition. What synaesthesia does show, however, is that the experiences that we assume come to us from the outside world, are in fact very much located within the confines of our own brains, and can be triggered in ways that do not require a corresponding encounter in the world around us.

For more information about synaesthesia, log on to the web site www.psychol.ucl.ac.uk/jamie.ward/synaesthesia.htm for FAQs, and follow the links to the UK synaesthesia association.

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