# Synaesthesia

## Is a common and harmless perceptual condition

PRACTICE, p 261

**David M Eagleman** assistant professor, Department of Neuroscience and Department of Psychiatry, Baylor College of Medicine, Houston, TX 77030, USA
eagleman@bcm.edu

**Competing interests:** None declared.

**Provenance and peer review:** Commissioned; not externally peer reviewed.

Cite this as: *BMJ* 2010;340:b4616
doi: 10.1136/bmj.b4616

**bmj.com**

**"One of the synaesthetes describes her world as a 'weaved cheesecloth of sound.' Another says that she became more aware of her condition when she heard an orchestra playing, saying, 'I didn't realise it was individual instruments. I thought there was some sort of coloured quilt.'"**
*BMJ* technical editor Sally Carter in a blog about a film on synaesthesia. http://blogs.bmj.com/bmj/

**For more blog extracts, see OBSERVATIONS, p 244**

Imagine a world of magenta Tuesdays, tastes that have shapes, and wavy green symphonies. At least 1% of otherwise normal people experience the world this way—in a harmless neurological condition called synaesthesia. In synaesthesia, stimulation of one sense triggers anomalous perceptual experiences.[1 2] For example, a voice or music may be not only heard but also seen, tasted, or felt as a touch. Synaesthesia is a fusion of different sensory perceptions: the feel of sandpaper might evoke an F sharp, a symphony might be experienced in blues and golds, or the concept of February might be experienced above the right shoulder. Synaesthetes are typically unaware that their experiences are unusual. In the linked article, a patient describes her journey with synaesthesia.[3]

Synaesthesia comes in many varieties, and a person can have several different types. Experiencing letters and numbers with colours or textures is an especially prevalent form (fig a)[4] that affects at least 1% of the population.[5] The woman in the patient's journey reports her first hand experience with this form of the condition,[3] known as "grapheme-colour" synaesthesia. Other common varieties include experiencing colours in response to sounds, or tastes in+ response to words.[1] Another very common form is spatial-sequence synaesthesia, in which a person perceives sequences (such as numberlines, years, or weekdays) as having a spatial three dimensional form.[6] For example, someone with this form of the condition may say that Monday is in front of them to the right, next to that is Tuesday, and so on, with specific locations to which they can point.

Synaesthetic perceptions are typically basic: people sense things like simple colours, shapes, or textures, rather than something pictorial or specific (for example, synaesthetes do not say, "This music evokes a vase of flowers on a restaurant table"). Moreover, the particular synaesthetic pairings (for example, number 3 is purple) are unique to each person. Synaesthetic perceptions are involuntary, automatic, and consistent over time.

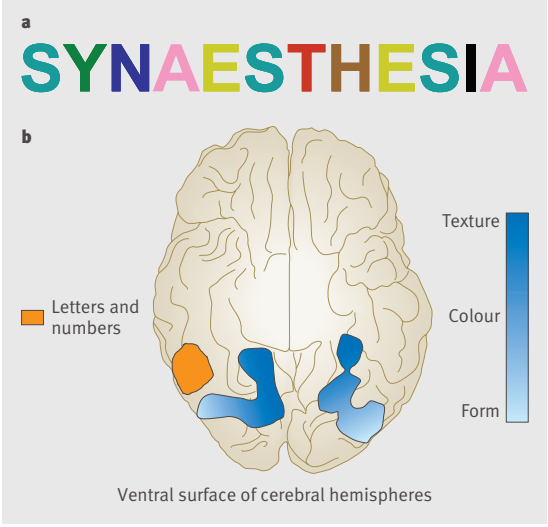
Synaesthetic experiences are not hallucinations. Synaesthetes do not think that their synaesthetic perceptions exist in the outside world—instead they are internal experiences (in "the mind's eye") and recognised as such.

Although synaesthesia was first described in *Nature* 126 years ago,[7] its study was hindered for almost a century from a lack of tests to verify the phenomenon. Synaesthesia can now be rigorously phenotyped thanks to simple diagnostic tests (www.synesthete.org).[8] Such tests use the fact that synaesthetes are consistent in their letter-colour matches over years, a feat that cannot be imitated by controls. In recent years, the authenticity and automaticity of synaesthesia have been confirmed by functional magnetic resonance imaging.[9]

Synaesthetic brains reflect crosstalk between normally separated brain areas, such that activity in one area kindles activity in another (fig b). Whether this crosstalk results from increased physical connectivity between areas or a slight imbalance of inhibition and excitation is unknown. Interestingly, synaesthesia clusters in families, and the patterns of inheritance suggest the possibility of a single dominant gene.[10 11] A large scale genetic study (a family linkage analysis) is currently mapping the gene(s) that correlate with coloured sequences (such as letters and numbers).[12] Understanding the genetic basis of synaesthesia should clarify the different neural hypotheses.

Synaesthetes do not seek medical help—nor should they—and they do not need support groups. They accept the reality presented to them, as we all do. (Analogously, we would not expect a colour blind person to suggest a support group for those with normal vision under the assumption that "seeing all those colours" must be troubling.)

Doctors, parents, and educators should all be aware of this condition to avoid showing misplaced concern when hearing a synaesthete's unusual description of the world. It is far too common for synaesthetes to be stigmatised as saying something "crazy" when they describe




(a) Representation of the colours evoked by individual letters in a word for a grapheme-colour synaesthete. (b) Synaesthesia seems to result from higher than normal crosstalk between neighbouring areas in the brain—in this case the nearby brain areas involved in graphemes (orange) and those involved in colour, texture, or form (shades of blue). Adapted from Eagleman and Goodale[4]

their perceptual experience—a point germane to why the patient described by Logsdail stopped talking about her synaesthesia for 25 years.

Given the high prevalence of synesthesia, doctors need to know about this phenomenon in case they mistake it for a peculiar type of cognitive fragmentation.


1 Cytowic RE, Eagleman DM. *Wednesday is indigo blue: discovering the brain of synesthesia*. MIT Press, 2009.
2 Robertson LC, Sagiv N, eds. *Synesthesia: perspectives from cognitive neuroscience.* Oxford University Press, 2004.
3 Logsdail S. Synaesthesia. *BMJ* 2009;339:b3191.
4 Eagleman DM, Goodale MA. Why color synesthesia involves more than color. *Trends Cogn Sci* 2009;13:288-92.
5 Simner J, Mulvenna C, Sagiv N, Tsakanikos E, Witherby SA, Fraser C, et al. Synaesthesia: the prevalence of atypical cross-modal experiences. *Perception* 2006;35:1024-33.
6 Eagleman DM. The objectification of overlearned sequences: a new view of spatial sequence synesthesia. *Cortex* 2009;45:1266-77.
7 Galton F. Visualized numerals. *Nature* 1880;21:252-6.
8 Eagleman DM, Kagan AD, Nelson SS, Sagaram D, Sarma AK. A standardized test battery for the study of synesthesia. *J Neurosci Methods* 2007;159:139-45.
9 Nunn JA, Gregory LJ, Brammer M, Williams SC, Parslow DM, Morgan MJ, et al. Functional magnetic resonance imaging of synesthesia: activation of V4/V8 by spoken words. *Nat Neurosci* 2002;5:371-5.
10 Ward J, Simner J. Is synaesthesia an X-linked dominant trait with lethality in males? *Perception* 2005;34:611-23.
11 Asher JE, Lamb JA, Brocklebank D, Cazier JB, Maestrini E, Addis L, et al. A whole-genome scan and fine-mapping linkage study of auditory-visual synesthesia reveals evidence of linkage to chromosomes 2q24, 5q33, 6p12, and 12p12. *Am J Hum Genet* 2009;84:279-85.
12 Nelson SN, Avidan N, Sarma AK, Tushe R, Milewicz DM, Lee K, et al. The genetics of colored sequence synesthesia: evidence of linkage to chromosome 16q and genetic heterogeneity for the condition. *Nature Precedings* 2009. http://dx.doi.org/10.1038/npre.2009.3987.1.


# Home based cardiac rehabilitation

## An effective way of widening access to preventative services

HOMER SYKES/ALAMY

**RESEARCH, p 249**

**Alexander M Clark** associate professor, Faculty of Nursing, University of Alberta, Edmonton, AB, Canada T6G 2G3
alex.clark@ualberta.ca

**Competing interests:** The author has completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare: (1) No financial support for the submitted work from anyone other than his employer; (2) No financial relationships with commercial entities that might have an interest in the submitted work; (3) No spouse, partner, or children with relationships with commercial entities that might have an interest in the submitted work; (4) No non-financial interests that may be relevant to the submitted work.

**Provenance and peer review:** Commissioned; not externally peer reviewed.

**Cite this as:** *BMJ* 2010;340:b5510
doi: 10.1136/bmj.b5510

In the linked systematic review, Dalal and colleagues assess the effect of home based cardiac rehabilitation on mortality and morbidity, health related quality of life, and modifiable cardiac risk factors in patients with coronary heart disease.[1] They found that home based cardiac rehabilitation was as effective and efficient as centre based rehabilitation at reducing mortality and cardiac events; improving risk factors such as exercise capacity, systolic blood pressure, and total cholesterol; and increasing health related quality of life. This finding is consistent with another recent meta-analysis,[2] which found that home based programmes provided by "telehealth" show promise in reducing mortality and can lead to clinically significant benefits in cholesterol, blood pressure, and prevalence of smoking.[2] As with centre based programmes,[3 4] a variety of home based programmes can improve health and quality of life outcomes in suitable patients.

Providing programmes in the patient's home makes sense because of what is needed for risk factor reduction. To improve morbidity and mortality, health behaviours must be sustained for at least two years.[4] Home based programmes can provide support for these behaviours longer than the usual two to three months offered by hospital based cardiac rehabilitation, the most common type of centre based rehabilitation.

However, centre based programmes have several potential advantages. Some patients prefer the reassurance and perceived safety offered by a clinical setting. They also provide more face to face access to health professionals from different disciplines, opportunities to do supervised group-based exercise, and contact with other patients. For patients with more complicated or chronic health needs, specialists from centres can design tailored programmes. Yet, the greater centralisation needed to provide these types of programmes is often accompanied by lower access, relatively weak links to general practice and the local areas in which patients try to sustain healthier lifestyles over the long term.[5]

The home is the most natural place to situate long term support for secondary prevention because it provides constancy, familiarity, and family support. Home based programmes are important because the large population with established coronary heart disease has high levels of modifiable risk factors but is difficult to reach with centralised programmes.[6 7] Uptake of hospital based programmes is consistently lower in groups most in need of support for risk factor reduction, including women, elderly people, people in different ethnic groups, and people of low socioeconomic status.[6] Ensuring access to centre based services is more challenging in large countries. Even in high income countries with universal and free access to cardiac rehabilitation, such as Australia and Canada, rural populations have limited access to centre based programmes. Home based programmes overcome many of the most common barriers to participation in these populations and settings.

Despite the potential of home based programmes, they do have important differences that may influence their effectiveness. Some home based interventions, notably those based on the *Heart Manual*,[8] have a more substantial theoretical basis and require clinical providers to be trained to a more advanced level. Language, health literacy, ethnicity, and cultural appropriateness are further local considerations that must be tackled when developing a home based programme. Where possible, new home based programmes should draw on established models but adapt them to local populations and needs.

Dalal and colleagues' analysis is not without weaknesses.[1] Patients in the trials were younger, healthier, and likely to be wealthier than patients in clinical practice. However, this is the case with most trials of secondary prevention programmes,[3 4] and the overall quality of the analysis is strengthened because the trials included were of moderate quality. Just under half of the home based programmes included were "exercise only" interventions, but for more than a decade it has been recommended that secondary prevention services be multifactorial—most now include physical activity, smoking cessation, diet and weight, and psychosocial health elements. The authors do not adequately explore how the characteristics of the home