2012, *British Journal of Psychology*, *103*, 20-23

Redefining synaesthesia?

Roi Cohen Kadosh

Devin Blair Terhune

Department of Experimental Psychology

University of Oxford

In a thought-provoking paper Simner (2010) highlights and criticizes a number of assumptions concerning synaesthesia. She specifically takes issue with the following assumptions: 1) synaesthesia is strictly a sensory-perceptual phenomenon; 2) consistency of inducer-concurrent pairs is the gold-standard for establishing the authenticity of an individual's synaesthesia; and 3) synaesthesia is not heterogeneous. In the wake of this critique, Simner advances a working definition of synaesthesia as a *neurological hyper-association* that aims to be more inclusive of its variants. We are very sympathetic to Simner's approach and believe that it raises important points that will advance our understanding of synaesthesia. Below we supplement, and sometimes challenge, some of these ideas.

Synaesthesia as a 'Merging of the Senses'

Simner (2010) rejects the argument that synaesthesia is strictly a sensory-perceptual phenomenon and we are in complete agreement with her. It is interesting to note that many synaesthetic experiences are induced by cultural tools, such as letters, numbers, time units, which neurally develop later, and are evolutionarily newer. In our view, this division between sensory and non-sensory synaesthesia should guide our search for the origins of this condition. Might it be that synaesthetic experiences that involve sensory inducers or concurrents originate at a different developmental stage (e.g., infancy) than non-sensory synaesthetic experiences (e.g., early childhood, beginning of schooling)? Relatedly, different types of synaesthetic experience may result from different mechanisms such as disinhibition {Grossenbacher, 2001 #1290}, excessive connectivity {Bargary, 2008 #2409}, or lack of cortical specialization {Cohen Kadosh, 2009 #2380}.

It is more parsimonious, but probably wrong, to ascribe synaesthesia as a homogenous phenomenon that occurred due to single mechanism, such as excessive connectivity. In other

fields that examine atypical development, such as dyslexia or dyscalculia, it is clear that there are several subtypes with distinct neural and cognitive origins {Rubinsten, 2009 #2490}. The field of synaesthesia, which is relatively younger, still tries to push all the cases under one umbrella, as was unsuccessfully done in the past with other forms of atypical development {Butterworth, 1999 #1198}.

Consistency

Simner (2010) next refutes the test of consistency as the "gold standard" for demonstrating the genuineness of an individual's synaesthesia. She notes that widespread adoption of this criterion has led to the exclusion of a small subset of individuals, who otherwise report experiences suggestive of synaesthesia, from inclusion in various studies. It is clearly paramount to further investigate such individuals using functional neuroimaging. For instance, if a subset of grapheme-colour synaesthetes report experiencing colour when presented with graphemes, but display inconsistent pairings, they may still exhibit similar cortical activation patterns as 'consistent' synaesthetes. If this were found to be the case, there would be no reason for excluding them from empirical studies. The same conclusion is valid at the behavioural level; if these subjects exhibit behavioural response patterns (e.g., Stroop interference effects) displayed by other synaesthetes, and which are relatively independent of subjective strategy (Cohen Kadosh & Walsh, 2009), there is little ground for assuming that they are not synaesthetes. In either case, such individuals clearly require greater empirical attention. Simner should be praised for reminding us of how the manner by which we study a phenomenon often colours our conception of it. It is critical to not attribute certain characteristics reported by a *subset* of synaesthetes to *all* of them and to be mindful of considering features that may be artifactual of our research methods as principal characteristics of this condition.

The issue of consistency raises the further question of the status of transient episodes of synaesthesia. Grapheme-colour synaesthesia can be experimentally induced by posthypnotic suggestion (Cohen Kadosh, Henik, Catena, Walsh, & Fuentes, 2009) and different forms of synaesthesia are often spontaneously experienced following the ingestion of lysergic acid diethylamide (e.g., Grossenbacher, 1997). A better understanding of the commonalities and differences between these types of synaesthesia and congenital synaesthesia will advance our understanding of the origin and locus of the synaesthetic experience.

Heterogeneity

A central contention of Simner's (2010) paper is that certain features manifested by only a subset of synaesthetes have been erroneously attributed to all synaesthetes and/or interpreted as principal features of synaesthesia. Simner clearly demonstrates how certain features of synaesthesia widely regarding as fundamental (e.g., consistency) might only present in a subset of individuals with this condition. This represents an important reminder about the perils of generalizing from small samples (upon which the majority of synaesthesia research is based) and points to the strengths of large sample studies that are more sensitive to tapping individual differences in this population (e.g., Eagleman, 2010).

Simner rightly acknowledges individual differences among synaesthetes and briefly describes the principal differences between lower and higher synaesthetes and between associator and projector synaesthetes as important variables that require greater attention. Although there is accumulating evidence for these subtypes (Dixon, Smilek, & Merikle, 2004; Hubbard, Arman, Ramachandran, & Boynton, 2005; Rouw & Scholte, 2010), but see {Ward, 2007 #2424}), it is imperative that

caution be exerted before they are interpreted as reflecting discrete subtypes as opposed to occupying different positions along a continuum. That is, it is necessary to consider whether the lower-higher and associator-projector dimensions are categorical (i.e., reflecting distinct subtypes) or dimensional (i.e., existing along a continuum). These are empirical questions that can be resolved but will require large samples of synaesthetes. Similarly, given that synaesthetes and non-synaesthetes exhibit some similarities in letter-colour and other associations {Rich, 2005 #2011}{Cohen Kadosh, 2007 #2248}{Ward, 2006 #2121}{Simner, 2005 #2122}, it may be worthwhile to consider where non-synaesthetes fall on the aforementioned dimensions, specifically whether they are more proximal to one or another subtype (or position) or whether variability among non-synaesthetes is largely orthogonal to that observed among synaesthetes.

Defining synaesthesia

In shining light upon the various assumptions in the literature, Simner (2010) advances a working definition of synaesthesia as a *neurological hyper-association* that aims to be more inclusive of its variants. We believe this is a worthwhile exercise, but wonder whether she arrives at a definition that is overly inclusive. As an example of this over-inclusiveness, Simner concludes by asserting that synaesthesia "is characterized by the pairing of a particular triggering stimulus with a particular resultant experience" (p. 24). It is readily apparent that this description is overly inclusive insofar as it also encompasses a wide variety of processes that are distinct from synaesthesia (e.g., cross-modal interactions, a variety of forms of learning).

Another, more troublesome issue in defining synaesthesia biologically, is that it is still unclear what will be the dependent variable. For example shall we look for changes in gray matter volume, white matter, or brain activity? What the direction of these changes should be (i.e.,

increased or decreased brain activation)? Individual differences among synaesthetes also introduce a challenge. Moreover, different people with different type of synaesthesia, or even with the same type of synaesthesia might show different markers resultant from their different aetiologies (hyper-connectivity, disinhibition, lack of cortical specialization, changes in gamma band/oscillations). A further problem is that the connection between brain and behaviour is sometimes not as straightforward {Wilkinson, 2004 #1583}. While we are sympathetic to Simner's approach, we think that we need to gain a better understanding of the cognitive, developmental, and neural bases of synaesthesia before defining it biologically. Notwithstanding this point, Simner's ideas are likely to advance our knowledge and to make another step toward a possible biological definition of synaesthesia in the future.

References

Cohen Kadosh, R., Henik, A., Catena, A., Walsh, V., & Fuentes, L. J. (2009). Induced cross-modal synaesthetic experience without abnormal neuronal connections. *Psychological Science, 20*, 258-265.

Dixon, M. J., Smilek, D., & Merikle, P. M. (2004). Not all synaesthetes are created equal: Projector versus associator synaesthetes. *Cognitive, Affective and Behavioral Neuroscience, 4*, 335-343.

Eagleman, D. M. (2010). *What has large-scale analysis taught us?* Paper presented at the 5th Meeting of the UK Synaesthesia Association.

Grossenbacher, P. G. (1997). Perception and sensory information in synaesthetic experience. In S. Baron-Cohen & J. E. Harrison (Eds.), *Synaesthesia: Classic and contemporary readings* (pp. 148-172). Oxford: Blackwell

Hubbard, E. M., Arman, A. C., Ramachandran, V. S., & Boynton, G. M. (2005). Individual differences among grapheme-color synesthetes: Brain-behavior correlations. *Neuron, 45*, 975-985.

Rouw, R., & Scholte, H. S. (2010). Neural basis of individual differences in synesthetic experiences. *Journal of Neuroscience, 30*, 6205-6213.

Shergill, S. S., Brammer, M. J., Fukuda, R., Williams, S. C., Murray, R. M., & McGuire, P. K. (2003). Engagement of brain areas implicated in processing inner speech in people with auditory hallucinations. *British Journal of Psychiatry, 182*, 525-531.

Simner, J. (2010). Defining synaesthesia. *British Journal of Psychology*.

Ward, J., Jonas, C., Dienes, Z., & Seth, A. (2010). Grapheme-colour synaesthesia improves detection of embedded shapes, but without pre-attentive 'pop-out' of synaesthetic colour. *Proceedings of the Royal Society B: Biological Sciences, 277*, 1021-1026.

2012, *British Journal of Psychology*, *103*, 20-23