

TRENDS in Cognitive Sciences

**Figure 1.** Examples of the stimuli used by Morgan *et al.* [3]. The elements are ‘Gabor patches’, sinusoidal gratings vigneted within a Gaussian window, laid out in a pseudo random manner. The orientation of each element is  $45 + G(\sigma)^\circ$ , where  $G$  is a pseudo random number obtained from a Gaussian distribution of mean 0 and standard deviation 1, and  $\sigma$  is equal to  $0^\circ$ ,  $2^\circ$  and  $4^\circ$  in (a), (b) and (c), respectively.

datum (percept) containing a definite number of speckles? No, we would say, because that is not how perception works.

#### Acknowledgements

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#### Book Review

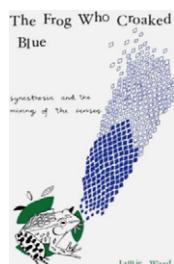
## Two complementary perspectives on synesthesia

**The Hidden Sense: Synesthesia in Art and Science** by Cretien van Campen, The MIT Press, 2008. US\$29.95, hbk (185 pp.) ISBN 978-0-262-22081-1

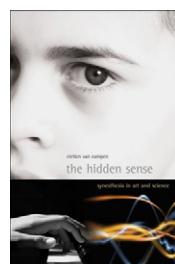
**The Frog who Croaked Blue: Synesthesia and the Mixing of the Senses** by Jamie Ward, Routledge, 2008. US\$16.69, pbk (174 pp.) ISBN 978-0-451-43014-2

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*The Hidden Sense* by Cretien Van Campen and *The Frog Who Croaked Blue* by Jamie Ward are the latest instalments in a rapidly growing series of scientific and popular writings on a fascinating condition known as synesthesia. People with synesthesia experience a melding of the senses in which ordinary everyday stimuli trigger conscious experiences that most people do not associate with those stimuli [1]. For instance, sounds can elicit experiences of colour (e.g. a frog’s



croak is blue), tastes can lead to tactile sensations and units of time (e.g. months, days and years) are seen as occupying spatial locations outside of the body.

The two books by Van Campen and Ward provide distinct yet complementary insights into synesthesia. Van Campen, a social scientist, considers the relation between synesthesia, science, art and culture. In tackling such a diverse range of topics, he inevitably transcends the available empirical evidence, yet his conclusions still provide valuable lessons for scientists and laypersons alike. Van Campen provides a

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myriad of descriptions of synaesthetes' subjective experiences that captivate the reader and make his book infinitely useful to those seeking to understand synaesthesia. Jamie Ward, a seasoned cognitive neuroscientist, takes the reader on an exciting tour of recent developments in cognitive neuroscientific studies of synaesthesia. However, Ward's book is much more than a catalogue of recent synaesthesia studies; it places synaesthesia in a much broader context of the fundamental principles of cognitive and brain function.

Despite their different flavours, both books explore two fundamental questions about synaesthesia. (i) How does synaesthetic perception relate to normal (non-synaesthetic) perception? And, (ii) does synaesthesia serve a function in those who experience this unusual form of perception? The answers, not surprisingly, depend on the book.

With regard to the relationship between synaesthetic and normal perception, Ward takes a relatively conservative view, basing his conclusions on three fundamental principles of brain function. These include: (i) that the brain is highly modular with specific brain areas specialized for processing different sensory information such as colour, shape and sound; (ii) that the brain combines sensory information, and this multisensory integration is a fundamental aspect of perception; and (iii) that sensory perception relies on spatial relationships, and that the brain has many different spatial maps for different types of sensory information. According to Ward, synaesthesia is 'deeply rooted' in these basic principles of brain function. Importantly, however, Ward suggests that synaesthetes differ from non-synaesthetes because they have greater interconnectivity between adjacent brain areas – an interconnectivity that unifies the senses to a greater extent in synaesthetes than in non-synaesthetes. Furthermore, according to Ward, synaesthetic experiences are often experienced in different spatial planes (i.e. in the mind's eye or 'out there' in space) because synaesthesia co-opts the various spatial maps the brain normally uses during perception. Thus, although based on similar principles, the patterns of brain connectivity differ between synaesthetes and non-synaesthetes. By contrast, Van Campen believes that there is, in fact, no sharp distinction between synaesthetes and non-synaesthetes. He suggests that everyone is a synaesthete but that many people are simply not aware of it. Based on a discovery of his own synaesthesia while listening to Vivaldi in a feverish state, Van Campen suggests that with sufficient self-exploration and self-awareness, we can all become aware of our hidden synaesthetic sense.

What about the function(s) of synaesthesia? Here again the answers differ from book to book. Ward considers this question from an evolutionary perspective and concludes that synaesthesia ultimately serves to enhance memory. Ward highlights several synaesthetes who have been shown to use their synaesthesia to improve their memory performance and also points to one of his own studies showing that synaesthetes outperform non-synaesthetes on several types of memory tasks. He suggests that heightened memory abilities would clearly confer an evolution-

ary advantage, thus propagating a putative synaesthesia gene in the population. Ward's take on synaesthesia, which he elegantly outlines in *The Frog Who Croaked Blue*, has been shaped by his extensive expertise in neuroscience. Van Campen formed his ideas concerning the function of synaesthesia based more on direct observation of the synaesthetes themselves (or indirectly by reading historical accounts of synaesthetic artists). His observations lead him to conclude that synaesthesia has multiple functions, including a hedonic function of extracting pleasure from synaesthetic experiences, a creative function of facilitating artistic expression and finally a cognitive function of generating unique meaningful gestalts (pp. 158–159). The insights of synaesthesia outlined by Ward and Van Campen mirror their distinct academic backgrounds. Ward's take on synaesthesia adheres to the principles of neuroscience, whereas Van Campen's take on synaesthesia has echoes of the theosophist's quest for universal principles and correspondences within nature and art.

Our own evaluation of the authors' responses to these questions is that both make salient contributions to our understanding of synaesthesia. That said, in some respects Van Campen goes a little too far and perhaps Ward does not go far enough. In our view, Van Campen goes too far in concluding that everyone is a synaesthete and that many people just do not know it yet. As researchers, we have been aware of the various aspects of synaesthesia for quite a few years, and have even been afflicted by bouts of 'synaesthesia envy' but, sadly, neither of us has been able to pass through the door that affords us a first-hand experience of the colourful world of synaesthesia. Admittedly, Van Campen could argue that we are simply not yet sufficiently self-aware to tap into our hidden sense. However, after consideration of the evidence, we are inclined to agree with Ward's assessment that synaesthetes do differ from non-synaesthetes in their brain organization and we believe that this difference is not likely to be bridged by any amount of self-awareness. Whereas Van Campen perhaps goes too far, Ward in some ways does not go far enough. In addressing the function of synaesthesia, he under appreciates that synaesthesia is fundamentally a process by which the synaesthete makes meaningful sense of his or her world. For a synaesthete, seven follows six, it is smaller than eight and is fundamentally yellow. As one synaesthete put it, a seven without colour was 'like a square circle, it just doesn't make any sense'. One way in which some synaesthetes code the meaning of numbers is by mentally using space to represent their sequential aspect. For other synaesthetes the fact that eight and nine have different colours, might be a way to help differentiate these otherwise very similar forms and concepts – a process that might aid memory. Importantly, space and colour are an intrinsic aspect of the meaning of numbers. As such, a quintessential function of synaesthesia might be that it adds meaning to the objects in the synaesthete's world – a crucial role of synaesthesia recognized by Van Campen.

In summary, we think both of these books will be an interesting and illuminating read for synaesthesia

researchers, students and lay readers who are interested in learning more about synesthesia. The two books, shaped by the different forms of expertise possessed by the two authors, complement one another and afford a synergy of understanding for those who have the pleasure to read these important contributions.

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