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Book Review

Bruno, N. and Pavani, F. (2018). *Perception: A Multisensory Perspective*. Oxford University Press, Oxford, 368 pp., ISBN: 9780198725022

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1. Introduction

I cannot be the only one out there teaching undergraduate courses on multisensory perception who has long wished that there was a book that one could recommend as course material to one's students. The problem has always been that the majority of volumes on perception have tended to deal with just one sense, and that, of course, has primarily always been vision (see Hutmacher, 2019, on the long history of visual dominance in research practice).

Those interested in the study of audition have long been well serviced by Brian Moore's (1977/2012) *An Introduction to the Psychology of Hearing* (Moore, 2012). Touch too has its dedicated volumes including everything from Katz's (1925/1989) impressive *The World of Touch*, through to Gallace and Spence's (2014) more recent *In Touch with the Future*: *The Sense of Touch from Cognitive Neuroscience to Virtual Reality*. In truth, though, the level of many of these works devoted to a single sense tends more to graduate-level upward than really being appropriate for an undergraduate multisensory course.

While it may well be the case that more of our brain is given over to the processing of visual inputs than to any other modality (e.g., Felleman and van Essen, 1991; see Gallace *et al.*, 2012, on a variety of metrics regarding the relative importance of the various senses), one might equally want to prioritize

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touch, given the skin's role as our largest sense, weighing in at something like 16–18% of body mass (Montagu, 1971). Indeed, according to J. L. Taylor (1921, p. 157) writing almost a century ago: '*The greatest sense in our body is our touch sense. It is probably the chief sense in the processes of sleeping and waking*; *it gives us our knowledge of depth or thickness and form*; *we feel, we love and hate, are touchy and are touched, through the touch corpuscles of our skin*'. Then again, what about olfaction? Surely it deserves a look-in, or should that be a sniff (defined as drawing up air audibly through the nose in order to detect a smell). Far more of our genes are given over to the coding of olfactory receptors than for any other sense, perhaps hinting at this sense's former importance (e.g., Axel, 1995; Buck and Axel, 1991; Glusman *et al.*, 2001). Indeed, while long neglected, there has been something of a resurgence of interest in the sense of smell recently.

According to an intriguing article published in *Science* by John McGann (2017), the olfactory cortex was deliberately minimized in size by early neuropsychologists in order to make space for the frontal lobes — the seat of higher reason. The sense of smell, or olfaction, by contrast, was considered one of the lower 'animal' senses. As part of what one might think of as this olfactory revival, the range of smells that we can apparently discriminate has recently increased from a widely-cited but merely speculative 10 000 up to more than a trillion (Bushdid *et al.*, 2014). However, the latter astronomical figure has not, it should be noted, been unquestioningly accepted by everyone (e.g., Gerkin and Castro, 2015).

When combined with the fact that many of us are exquisitely sensitive to certain odours, being able in some cases to detect the equivalent of parts per trillion of biologically-relevant unsafe molecules, such as, for example, 2,4,6-trichloroanisol (or TCA for short; Buser *et al.*, 1982). This is the compound that gives rise to the distinctive 'cork taint' in wine. At least it does for the majority of people. I myself am completely (and blissfully) anosmic, or 'smell-blind', to this particular molecule that has spoiled many a good bottle of wine (see Spence, 2017). Such feats of olfactory sensitivity, then, parallel the sensitivity of the retina to a single photon of light, that I seem to remember vaguely being taught about in my own early lectures on Vision, sorry I mean Perception, as a student in Oxford back in the late 1980s. In fact, research published in 2016 finally provided empirical support for what had been no more than a plausible theoretical conjecture (see Tinsley *et al.*, 2016).

2. From Textbooks Covering Multiple Senses to the First Multisensory Perception Book

Typically, those traditional sensation- and perception-type books that cover different senses in different chapters never really get to grips with the way

in which the senses interact. This would certainly be one of the criticism of Barlow and Mollon's (1982) authoritative early edited volume, *The Senses*. The second edition (2019) of Schwartz and Krantz's *Sensation and Perception* illustrates the typical structure of undergraduate textbooks in this area, with a couple of introductory chapters on the research method, followed by chapters 3–9 essentially dedicated to vision. Thereafter, chapters 10–13 are dedicated to hearing, followed by one chapter on touch and pain, and ending up with a solitary chapter on olfaction and taste.

Notice how, according to such a themed (not to mention visually dominant; see Hutmacher, 2019) unisensory approach, object recognition is treated as essentially a visual problem whereas speech perception, naturally enough, is seen as belonging squarely in the auditory section (which is where it also appears in Moore's book). According to such organizational frameworks, there is no real recognition that vision, specifically lip movements, or even gesture, might play a key role in communication, as discussed in Soto-Faraco *et al.*'s (2019), recently published volume, *Multisensory Interactions in the Real World*. I have just reviewed the latter book for this very journal (see Spence, in press).

What attempts there have been in this space, namely sensation- and perception-type text books that have deigned to consider multisensory interaction, are either now long since out of date (e.g., Roberts', 2002, *Signals and Perception*: *The Fundamentals of Human Sensation*) or else too advanced for even the most advanced of undergraduates. Other works tend to be too focused on a particular methodological approach, such as the neurophysiological approach championed by Stein and Meredith's beautifully illustrated *The Merging of the Senses* published in 1993. Meanwhile, the many edited books (e.g., Bremner, Lewkowicz and Spence, 2012; Calvert *et al.*, 2004; Sathian and Ramachandran, 2020; Stein, 2012) and special issues dedicated to the exploding interest in the topic multisensory perception (e.g., Murray and Wallace, 2012), due to the contributions from many unconnected authors, typically tend to involve scattered coverage in what can best be described as an eclectic range of didactic styles.

While there have been rumours circulating for a number of years that various members of the International Multisensory Research Forum (IMRF) were about to step up to the challenge of delivering a contemporary coverage of the field, this has seemingly come to naught. Perhaps the challenge of keeping up with such a rapidly developing field is too much for most. *Perception*: *A Multisensory Perspective*, the book by Nicola Bruno and Francesco Pavani, promises to fill this gap. Professor Pavani was the lead organizer of the memorable 6th IMRF meeting in Rovereto, Italy in 2005 (https://imrf.info/wp_imrf/past-meetings/). The subject matter of this volume covers a broad range of topics in the world of multisensory perception, with

a focus on behavioural data from neurologically-normal adult humans. Those interested more specifically in the development of multisensory perception would be best advised to look elsewhere (e.g., at one of the edited volumes that have been published on this topic; Bremner *et al.*, 2012; Lewkowicz and Lickliter, 1994). Bruno and Pavani include chapters on synaesthesia and cross-modal correspondences, on the perception of one's own body, perception for action, object perception and recognition, flavour perception, space, time, and attention and learning. Connections to the relevant cognitive neuroscience are embedded in the text but discussion is kept, from my perspective at least, mercifully brief.

The book itself comes in at a weighty 350 pages, and is amply, engagingly, not to mention colourfully, illustrated throughout. Multisensory illusions, including everything from the ventriloquism effect, the rubber hand illusion and its variants, the Pinocchio illusion, the Ames Room, and the lesser-known Japanese Illusion (see Zampini *et al.*, 2005) play a prominent role in this work.

A version of this book first appeared in Italian back in 2010. At that time, Bruno and Pavani were accompanied on the author list by a third author, my colleague Prof. Max Zampini. The latter's absence from the spine of the English version, published eight years later, hints at the major rewrite that was occasioned by the opportunity to deliver an English-language edition of this work. The remaining authors suggest that writing the English edition began in earnest in 2015. As they themselves note in their Introduction, the field has been moving forward so fast that keeping up with the literature is no mean feat. No sooner had a new chapter been completed than the last one needed updating to account for some of the latest findings emerging in journals such as *Multisensory Research*.

While there is plenty of talk of phenomenology throughout the text, one thing that was little mentioned was the meta-cognitive experiences that may be associated with the conditions of sensory incongruency that are so often used in the laboratory research on multisensory perception. While C. V. Jackson's (1953) classic steaming whistling kettle study of ventriloquism rightly gets a mention, I, for one, missed any discussion of the discombobulation experienced by a number of Jackson's subjects, as described in the discussion of the paper (see Deroy *et al.*, 2016, for a review; see also Spence, 2015). At the same time, however, the authors inject a healthy degree of scepticism when needed, as when discussing Guarniero's first-person account of what it is like to use a sensory substitution system such as the TVSS (Guarniero, 1974, 1977) — see *Box 4.2. A first person account of 'seeing' with one's skin* (pp. 133–134). That Guarniero was a PhD in the Philosophy of Perception at the time he was writing is presumably germane to one's interpretation of his theoretically-relevant claims.

The book helpfully contains a number of boxed sections to explain some of the more intriguing and important findings and concepts. The authors manage to set the work at a consistent, intelligent, and appropriate level for undergraduate-level readers upward throughout. Importantly, all five of the major senses get a look-in along with vestibular, proprioceptive, and kinaesthetic senses. Perhaps intriguingly, every topic/chapter is taken from a multisensory standpoint. That is, there is no attempt to first break perception down into its separate sensory components, as done, for example, in Roberts' volume, mentioned earlier. There, the multisensory chapter, written by yours truly only comes in after each of the senses have been introduced separately, hence being delegated to one of the latter sections of the book (see Spence, 2002).

The early chapter on action helps ground this work in the history of multisensory research, detailing the seminal work of J. J. Gibson and others working on the topic of prism adaptation. The point is also made early on that perception is an active process, again linked to Gibson's (1962) classic cookie cutter experiment. (Long gone are the days when one could get into the pages of a top science journal such as *Psychological Review* with nothing more than a few cookie cutters from the kitchen!)

One danger that perhaps comes from jumping straight into the multisensory is that one misses out on some of the relevant theorizing that has been developed within the unisensory research framework. As a case in point, it is surprising that the momentous contribution of Anne Treisman to our understanding of feature binding in vision is not mentioned once. True, the majority of this work has been conducted in a unisensory context. Yet there must surely be relevant insights for the crossmodal binding problem (see Spence and Frings, in press, for a recent review and consideration of how Anne Treisman's approach might be extended to the multisensory case). (There is, it is true, one reference to Treisman in the book but that turns out to be Oxford University's Michel Treisman rather than his ex-wife!).

For instance, Treisman and Souther (1985) long ago highlighted the fact that feature absence does not pop out (searching for an O amongst Qs) whereas the presence of a unique feature (a Q amongst Os, does). It would seem to me that this unimodal visual finding would provide the most relevant explanation for Delwiche *et al.*'s (2000) observation that people struggle to identify the tasteless distractor in/amongst a mouthful of taste distractor gel pieces as described in the *Perceiving food* chapter (see Bruno and Pavani, pp. 148–149).

One of the other possible blindspots is any consideration of perceptual load (e.g., Forster and Spence, 2018; Lavie, 1995, 2005; Murphy *et al.*, 2017a, b; Rees *et al.*, 2001). It can be argued that resolution of the question of when attention modulates multisensory integration can only really be resolved with

reference to the load-based account of attentional selection (see also Soto-Faraco *et al.*, 2019, on this theme).

On the plus side, having introduced the various themes, Bruno and Pavani then take the opportunity to make connections between the sometimes disparate material that is covered in various chapters. So, for example, given the two chapters dealing with synaesthesia and flavour perception, Bruno and Pavani take the opportunity to reference discussion of the possibility that we are all synaesthetic in the world to tasty smells, such as when we describe vanilla as smelling sweet (Stevenson and Boakes, 2004; Stevenson and Tomiczek, 2007). Auvray and Spence's (2008; see also Deroy and Spence, 2013) discussion of why such an analogy does not really make sense is deftly covered in *Box 6.1*: *Is flavour a universal form of synaesthesia?* (Bruno and Pavani, p. 159).

Now, while the *Perceiving food* chapter does emphasise the important distinction between flavour expectations and flavour experience, one potentially important distinction that is not mentioned, excepting in the text of Fig. 5.2 (see Bruno and Pavani, p. 140), is between orthonasal and retronasal smell. While the two terms are referenced in one of the figures, the reader is not really ever properly introduced to the important similarities and differences between what some refer to as the two senses of smell (e.g., Pierce and Halpern, 1996; Rozin, 1982).

What is more, the suggestion that oral-somatosensory tactile stimulation is responsible for the oral referral to the mouth, and the subsequent suggestion that oral referral is actually nothing special as far as multisensory phenomena are concerned while plausible, and suggested previously in the literature (e.g., see Marks, 1991), are both wrong, at least in my opinion. On the one hand, elegant oral psychophysics research from the laboratories of Dick Stevenson in Australia, and Juyin Lim from Oregon State University on the West Coast of the States suggest that localization phenomena depend on attentional capture by salient oral stimuli instead (see Spence, 2016, for a review). What is more, while ventriloquism in the mouth is a catchy metaphor for what is going on in the case of oral referral, it misses the key point about the phenomenology. Note here only how in the case of ventriloquism, the ventriloquist's voice still sounds like their voice once it has been mislocalized toward the agitated lips of his (or her) dummy. By contrast, when olfactory cues are mislocalized into the oral cavity they are no longer experienced as smells, but rather as tastes. As such, one can think of the case of 'oral referral' as unlike any other kind of multisensory effect documented previous in the higher spatial senses (see Spence, 2016; Spence *et al.*, 2015).

3. Problematic Proofreading

If I have a criticism with the book it is that the work is let down by a lack of proofreading. A number of the in-text citations are either incomplete or incorrect. Some authors have the spelling of their name changed from the main text to the reference list and index. First names appear as surnames, and first names occasionally make an appearance where they have no reason to be. For instance, the citation of Kubovy and Minhong (2014) should actually be to Kubovy and Yu (2012). My name is misspelled as Spencel (p. 222) and reference in the text to Spence (2015) (p. 124) reveals no associated reference. The year of the relevant reference in the reference list is, in this case, incorrectly reported as 2016. Meanwhile, Burnett (p. 292) is misspelled as Burnet (p. 187, Practical 7.1). MacDonald, of McGurk and MacDonald (1976) fame becomes McDonald (p. 225). There are also an inordinate number of periods scattered through the index that should not be there [15 that I counted in the letter 'V' section alone (p. 340), not to mention in the main text itself, see p. 231].

In one of the generally excellent figures (see Fig. 3.2 in Bruno and Pavani, p. 60), the 'Eyes Snup' label should presumably be 'Eyes Closed'. One might also question the didactic benefits of including a picture of a hunk of parmesan as one of the work's presumably expensive colour images (see Fig. 5.1, p. 139). The blue-steak picture that appears on p. 153 is actually from my lab and does not appear in Wheatley (1973) as erroneously suggested in the associated figure caption. Meanwhile, the caption itself incorrectly has one of the pages of text as the volume number. The illustration for the Japanese Illusion in Fig. 7.3 (p. 188) also looks familiar, though is unattributed. I have used it myself previously, and suspect that it may actually come from Burnett's (1904) paper.

Those in charge of publishing always seem to struggle with formatting references where page numbering starts afresh, with each issue as for *Scientific American*, and when page numbers do not run contiguously. This leads to errors with referencing Wheatley's work and also with one of the classic studies on the visual dominance over taste and flavour perception by DuBose *et al.* (1980). Wheatley becomes Weathley in the text at several points on p. 153. Ray Klein becomes Kline (p. 220), while Vibell *et al.* become Vibell (p. 201). Shankar is missed from the citation on p. 152, while the citation of Stramer *et al.* (2009) referred to on p. 261 should actually be Störmer *et al.*

While, in the grand scheme of things, such details do not matter, the sheer number of errors, both obvious and more subtle ended up distracting me from what is otherwise a broad, accessible, interesting, and contemporary coverage of perception in all of its multisensory glory. That said, I freely admit to being more pedantic in this regard than most, as anyone who has been unlucky enough to have me as the editor for their paper will know all too well!

On occasion, secondary sources are referenced rather than the original work. For instance, the original discussion of the addition of a golden colour to margarine first appeared in Masurovsky (1939) rather than the secondary source (Packard, 1957), cited in the main text. Given my own interest in the Italian Futurists (Spence, 2017; Spence and Youssef, 2018), and the authors' base in Northern Italy, also the home of the Futurist movement, I was glad to see some discussion of their work, and even a dedicated box on the Futurist Dinner party (pp. 142–144). However, as a reader, I felt that it would have been helpful for the authors to have referred to the English version of *The Futurist Cookbook*, published by Penguin in 2014 (see Marinetti, 1932/2014), and not just the out-of-print Italian original.

4. Conclusions

Despite these minor quibbles (what some might see as no more than nit-picking anyway), I would say that overall *Perception*: *A Multisensory Perspective* represents a valiant attempt by Nicola Bruno and Francesco Pavani to make the exciting topic of multisensory perception accessible to a non-expert audience without ever getting too bogged down in the psychophysics of sensation and perception. The foregrounding of multisensory illusions, and the link to art, helps ensure that this book retains the reader's interest throughout. The authors have, then, succeeded admirably in their stated aim of providing an engaging overview of multisensory perception research for the non-specialist while at the same time still managing to maintain the interest of the multisensory scientist. I, for one, will be using a number of the demonstrations in class, while also rummaging around in the university library for a few intriguing articles cited in the text that I had not come across before.

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