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Guest editorial essay: Special issue

New insights into multisensory perception

This special issue on "Advances in Multisensory Perception" reflects just some of the interesting work that was presented at the 7th annual International Multisensory Research Forum (IMRF) held in Dublin, Ireland. Research into multisensory perception has grown exponentially in the last decade, and the annual IMRF meeting offers the opportunity for dialogue and collaboration among scientists from various disciplinary backgrounds to explore the intricate relationship between the sensory modalities.

When we perceive the world around us, our phenomenological experience is not of disjointed sensory sensations but is instead of a coherent multisensory world, where sounds, smells, tastes, lights, and touches amalgamate. What we perceive or where we perceive it to be located in space is a product of inputs from different sensory modalities that combine, substitute, or integrate. In turn, these inputs are further modulated by learning and by more cognitive or top – down effects including previous knowledge, attention, and the task at hand. Although it is important to understand the intricate workings of each of the sensory systems (and this is perhaps conducted better in isolation), the challenge for researchers interested in perception is to elucidate the processes involved in how the senses combine to result in a coherent percept of our world. This will be best achieved by combining different disciplinary approaches to the problem, eg from single- or multi-unit physiology, to neuroimaging, psychophysics, experimental psychology, computational neuroscience, and statistical modeling. The IMRF meeting encourages such interdisciplinary collaboration and this special issue reflects just a snapshot of these different approaches. It seems clear that no single discipline will provide all the clues to the workings of multisensory perceptual systems and that a 'multimodal' approach seems more likely to succeed.

In this special issue we attempted to include such diversity in approaches, partly to allow the reader to appreciate the extent of the issues pertaining to multisensory perception, but also to highlight some of the more recent advances at each stage in perception. We have ordered the reports to reflect advances in multisensory perception from more bottom – up physiological approaches through to perceptual learning, and more higher-level perception of events, space, objects, and finally social perception of self and others. We hope the reader finds this organisation helpful with regard to appreciating the issues specific to each of these perceptual domains.

In a neuroanatomical study, Hackett and colleagues report evidence for multisensory inputs in monkey auditory cortex. Specifically, they found that the belt area receives input from somatosensory areas, as well as multisensory areas. In contrast, the auditory core area receives no input from somatosensory areas, and only sparse input from multisensory regions. As a further development of how different sensory inputs merge in the superior colliculus in the cat, Rowland and colleagues present a computational model which takes into account the main reported findings in the literature such as the effect that multisensory enhancement is attenuated when cortical areas such as AES are deactivated.

Next, our reports move from advances at the neural level of multisensory processing to advances in human multisensory perception. First, Seitz and colleagues try to elucidate the processes involved in learning associations between multisensory events. They report evidence that statistical regularities and associations between visual and auditory stimuli are implicitly learned, and this crossmodal learning seems to occur in parallel and independently of learning in individual sensory modalities. How stimuli from across modalities are grouped together and the nature of rules of these groupings was explored by Harrar and Harris for visual, tactile, and visual – tactile stimuli using an apparent-motion scheme (ie ternes). While the rules of grouping were similar across the three modality conditions, they were not identical, suggesting modality-specific but nevertheless similar grouping mechanisms operating across the senses.

Durgin and Gigone investigated multisensory aspects of the perception of speed. They found that determining the speed of visual flow is more efficient when one is walking than when standing still. This finding speaks to research on spatial updating as well as research conducted into passive versus active perception of space surrounding us. There seems to be a consistent story that active perception is more optimal, not just in spatial perception but also in object perception.

The following four papers explore factors affecting multisensory spatial perception. First, Bolognini et al report that partially congruent visual cues presented at threshold levels of detection can enhance the localisation of auditory events. Importantly, the authors show that, in contrast to suprathreshold incongruent visual cues, near-threshold signals do not capture auditory cues. Thus, this is further evidence for inverse effectiveness in spatial localisation for multisensory cues. Relatedly, Hartnagel et al found that the spatial reference frame for auditory – visual fusion is neither eye-centred nor head-centred, but seemingly half-way in between the two, even when there are no allocentric or egocentric cues available. The Santangelo and Spence, and the Königs, Knöll and Bremmer papers deal with factors affecting localisation of peripheral tactile and auditory stimuli, respectively. Santangelo and Spence found that exogenous orienting to peripheral tactile events during a visual task can occur, but that this orienting is affected by the demands of the visual task and is thus not consistently automatic. Seemingly, OKN can affect auditory localisation. According to Königs and her colleagues, auditory mislocalisation has similar but not identical characteristics to that of visual mislocalisation. Interestingly, this finding is inconsistent with a supramodal spatial representation across eye movements.

Advances in multisensory object recognition are described in the following two papers. First, Lacey et al provide a timely review of the literature on visual, tactile, and crossmodal object recognition. In particular, they focus their discussion on evidence for sensory-specific object representations versus representations based on combined information from visual and tactile senses. If object representations are unisensory, then crossmodal recognition is likely to be mediated through visual imagery. However, much evidence is also in favour of a representation that combines spatial information from both vision and touch. Indeed, this representation explains such findings that information is combined optimally across the senses for robust recognition. In this regard, Helbig and Ernst provide evidence for top – down influences in multisensory object perception. They found that knowledge about object unity (ie that two sensory signals correspond to the same object) can lead to fusion of the signals even when the two signals are spatially incongruent.

Our special issue closes with a couple of papers that explore multisensory influences in, what we refer to as, social perception. Our ability to understand the intentions, attentions, and social goals of others is the result of a combination of sensory inputs. Everdell et al investigated eye gaze patterns of observers who were asked to report the spoken sentence of an actor. They found that eye gazes were predominately distributed on the right-hand side of the talker's face, especially for dynamic faces. These eye-gaze patterns seemed more related to observers' preferences for gazing at a particular side of the talker's face rather than optimal speech recognition performance, although it remains possible that performance differences may emerge in more degraded speech patterns.

In a further exploration of the 'rubber-arm' illusion, Pavani and Zampini provide evidence that this illusion works well for video images of one's own arm that are veridical or enlarged but not when they are reduced. This finding may reflect representations of body schema that are more geared up for body growth than shrinkage per se.

Finally, we would like to thank all of these authors for their interesting contributions to this special issue. We believe that this issue captures the diversity of the current issues in multisensory perception, and we look forward to reading further developments in this rapidly growing research field in the future.

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