

This is the initial volume proposal. Some of the contributors/contributions have since changed. Volume in preparation and under contract with Oxford University Press.

Perception and Its Modalities

Dustin Stokes, Stephen Biggs, and Mohan Matthen
(Co-editors)

VOLUME OVERVIEW

Philosophers have traditionally relied on a modality-specific conception of sensory experience: all such experience is visual or auditory or tactual, etc., they have said. No sensory experience is of more than one of these kinds, they assume – there is no such thing as audio-visual experience, for example, except insofar as visual experience can take place in the same perceiving subject at the same time as auditory experience. Recent work in cognitive science and philosophy has begun to show that this assumption of exclusive modalities has severe limitations. In the proposed volume, a number of distinguished philosophers and cognitive scientists show why it is not useful to think of the sense-modalities as distinct and discrete in their operations. Many of them argue, moreover, that once this exclusivity is abandoned, there is no reason to think of the modalities as limited to some small number – five, as the tradition would have it. The volume works toward a new understanding of sense-modality.

One reason for insisting on discrete modalities has been that the receptive sense organs are *prima facie* different – Aristotle, for example, would have distinguished the eyes, the ears, the skin, the nose, and the tongue as the five sense-organs. Until at least the middle of 19th century, this consideration was thought to be decisive – there was no awareness of sensory processing in the brain – the early 19th century conception of brain processing was restricted to “associations of ideas” which were thought to be a post-sensory process. And until recently, sensory psychologists thought that the data emanating from these organs remained separate in the brain, at least in the early stages of data-processing. Philosophers, for their part, suggest that each of these sense-modalities produces consciousness (or qualia) of distinct kinds. They assume that visual awareness is easily distinguished from auditory awareness, for example – what it is like to see something is different from what it is like to hear something, and we are easily able to distinguish these forms of awareness.

All of these claims come under attack in the proposed contributions to this volume. Let’s start with Aristotle’s claim. It is, of course, true that the eyes can be distinguished from the nose. Nevertheless, many of these organs rely on multiple receptors, and the processing pathways associated with these receptors are often kept separate for at least some short distance. For instance, the eyes contain rod and (three types of) cone cells; touch relies on stretch, pain, and pressure receptors; olfaction on a variety of chemical receptors, and so on. So the criterion of distinct organs and distinct early processing pathways does not yield the five-fold distinction. Doubtless, there are ways around this difficulty, but the question is whether they are better than *ad hoc* ways to save an outmoded distinction. Receptor distinctness and organ distinctness receive different treatments, and sometimes different treatments in different modalities – there is seemingly no principled way of saying why. Thus, the distinct organs test fails to provide a principled and well-motivated way to distinguish modalities. The question is: why should we distinguish modalities in this manner when, quite clearly, receptor processing is not divisible into modalities in the manner proposed.

Similarly, let's think about the philosophical idea that modalities correspond to distinguishable kinds of awareness. Again, there are reasons to doubt that this is a useful basis for making a distinction. For one thing, think of the so-called McGurk effect. Here, the visual stimulus of looking at a speaker's lips sharply influences what is heard. So the auditory experience of *hearing* certain phonemes turns out to be the product, in part, of *seeing* those phonemes being uttered. There is nothing in auditory consciousness to indicate this mixing of information gained from separate modalities. Again, consider the "rubber hand illusion". Here a subject looks at a rubber-cast of a hand, while her own hand is hidden from her view. Both hands are stroked with a brush: thus, the subject can feel her hand being stroked, while at the same time seeing the rubber hand being stroked. At this point, the subject's capacity to locate the stimulus fails – she seems to *feel* the brush where the rubber hand actually is. However, she obviously receives no tactual stimulation from this inanimate object. Again this shows that what *feels* like a tactual stimulus is actually the result of visual stimulation. So though the distinctness-of-consciousness claim can still be upheld, its significance and utility have to be reassessed.

The considerations just advanced are mainly negative in their thrust. But there are more positive reasons to look at modality afresh. The senses inform us about the external world – that is, about the reality that doesn't reside in our minds alone. Now, given that the senses are conduits of information from this external world, why should they necessarily be kept separate? Of course, there might be architectural reasons that compel separation: at an elementary level, the eyes are anatomically and functionally different from the ears, and this by itself imposes a large degree of separation. Moreover, the data-streams that flow from the ears and the eyes are of necessity separate, at least initially. And the kinds of data that come from different kinds of receptor are subject to very different kinds of constraint, which suggests analysis by functionally distinct computational modules.

Notwithstanding these considerations, there are often strong reasons to merge sensory data-streams. This is especially evident in the case of flavour perception, which involves input from four distinct sources: orthonasal input generated by chemicals sniffed up the nose flowing over the nasal receptors in one direction, retronasal input generated by substances flowing over these same receptors in the opposite direction, input from the taste receptors in the tongue, and input from the trigeminal nerves of the face. These sources can be activated independently of one another or in sub-groups, but in flavour perception, all are active in ways that influence the others. Touch, again, has very complex inputs – there is not only a variety of receptors, as mentioned earlier, but touch is strongly influenced by the exploratory activity of the perceiver. And as already mentioned, vision operates with multiple receptor types – cones and rods. In all of these cases, the system is designed to use as much relevant information as is available, and is not restricted arbitrarily to the information that emanates from a single set of receptors.

More ephemeral cases are to be found in interactions of vision and taste. Tasteless dyed water seems to most observers to have a distinct taste dependent on colour (but not when they are blindfolded). A different kind of example involves cultural learning. A heart-

shape will look redder than a star-shape though both are coloured the same shade of orange. In these cases also, the system maximizes its employment of available information in order to arrive at the most accurate and well-informed report on how things are.

In some other cases, the interactions of the senses serve to inform us of predicative relations. In the ventriloquist effect, a sound is sharply localized in moving lips – the ventriloquist produces the sound with minimal lip and mouth action, but moves his dummy's mouth, with the effect that the sound is narrowly and irresistibly located in the dummy. Why is this? Not because vision provides information about *what* is said, but because social interactions demand that we know *who* is speaking. The visual information is thus integrated into the auditory perception of the voice stream.

Again, consider sensory substitution. This is a phenomenon first discovered by Paul Bach-y-Rita, who projected a video image via tactile stimulators on to subjects' backs. Thus, these subjects were able to feel on their backs an image isomorphic to that which normally falls on the retina. After a relatively small amount of practice, subjects were able to sense distinctively visual properties – notably perspective. Sensory substitution challenges many of the most firmly held principles of sense modality – it is hard even to answer the question, Are these subjects seeing or feeling the scene?

To summarize, then, there is a variety of theoretical issues surrounding the questions of modality and multimodality. The only other volume to explore these issues is Fiona Macpherson's *The Senses: Classical and Contemporary Perspectives* (OUP, forthcoming 2010). (Berg Publishers, Oxford has a collection entitled *The Sixth Sense Reader* (2010) – <http://www.bergpublishers.com/?tabid=5216> – that contains some relevant material, but it is pretty self-evidently aimed at a quite different audience, with different kinds of concerns.) Macpherson's volume is extremely valuable, but takes an approach different from ours. It reprints ten classic papers, and sets them off against eight new essays. The focus is on non-visual senses and on questions of demarcation raised by considering functional questions peculiar to those senses. While there is some overlap, Macpherson's volume is primarily motivated by considerations of the non-visual senses, and radiates from there to broad questions of what the senses do – questions that she and her contributors rightly think to have been unduly influenced by considerations peculiar to vision. Our primary focus is on multimodal integration and sensory substitution, which leads to investigations of a broad range of questions concerning how the senses, internal and external, function collectively and individually. We believe that the two volumes complement each other in certain ways, and that each is likely to provoke interest in the other.

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ABOUT THE EDITORS

Stephen Biggs is a postdoctoral fellow in the Department of Philosophy at the University of Toronto. He works generally in the areas of metaphysics and philosophy of mind. Recent research includes work on phenomenal consciousness, representationalism, and modality. For more information (including cv and current research) see here: <http://www.stephenbiggs.com/Site/Main.html>

Mohan Matthen is Professor and Canada Research Chair in Philosophy, Perception, and Communication, in the Department of Philosophy at the University of Toronto. He works in the philosophy of perception and the philosophy of biology, and is currently researching issues concerning phenomenal content, audition, perceptual knowledge, and the relation between perception and memory. For more information (including cv and current research) see here: http://web.mac.com/mohanmatthen/Site/Mohan_Matthen.html

Dustin Stokes is Assistant Professor in the Department of Philosophy at the University of Toronto. He works generally in the areas of philosophy of mind and cognitive science. His current research concerns the cognitive penetrability of perceptual experience, relations between sense modalities, and the role of imagination and imagery in practical and theoretical reasoning. For more information (including cv and current research) see here: http://stokes.mentalpaint.net/Dustin_Stokes.html

For additional background information on the Senses Research Project, please see here: http://individual.utoronto.ca/sensesproject/The_Senses.html

ABOUT THE CONTRIBUTORS

*Research/institutional information for each contributor is included with chapter abstracts below.

Clare Batty

<http://www.uky.edu/~cebatt2/>

Tim Bayne

http://www.philosophy.ox.ac.uk/members/timothy_bayne

Jon Bird

<http://www.jonbird.info/>

Peter Carruthers

<http://www.philosophy.umd.edu/Faculty/pcarruthers/>

Roberto Casati

http://www.shadowes.org/wiki/index.php?title=Main_Page

Mazviita Chirimuuta

<http://bristol.academia.edu/MChirimuuta>

Andy Clark

<http://www.philosophy.ed.ac.uk/people/full-academic/andy-clark.html>

Ed Cooke

<http://www.ua.ac.be/main.aspx?c=ed.cooke>

Ophelia Deroy

<http://opheliaderoy.wordpress.com/>

Jerome Dokic

<http://j.dokic.free.fr/philo/>

Matthew Fulkerson

<http://sites.google.com/site/mtfulkerson/>

Benj Hellie

<http://individual.utoronto.ca/benj/>

Howard C. Hughes

<http://www.dartmouth.edu/~psych/people/faculty/hughes.html>

John Kulvicki

<http://www.dartmouth.edu/~phil/faculty/kulvicki.html>

Susanna Millar

susanna.millar@psy.ox.ac.uk

Fiona Macpherson

<http://www.gla.ac.uk/philosophy/ourstaff/fionamacpherson/>

Erik Myin

<http://www.ua.ac.be/main.aspx?c=erik.myin>

Matthew Nudds

<http://www.philosophy.ed.ac.uk/people/full-academic/mathew-nudds.html>

Casey O'Callaghan

<http://ocallaghan.rice.edu/>

Kevin O'Regan

<http://nivea.psych.univ-paris5.fr/>

Mark Paterson

http://geography.exeter.ac.uk/staff/index.php?web_id=Mark_Paterson

Vincent Picciuto

<http://www.terpconnect.umd.edu/~picciuto/>

Nicholas Shea

http://www.philosophy.ox.ac.uk/members/nicholas_shea

Barry C. Smith

<http://www.bbk.ac.uk/phil/staff/academics/bsmith>

Charles Spence

<http://www.neuroscience.ox.ac.uk/directory/charles-spence>

Karim Zahidi

<http://www.ua.ac.be/main.aspx?c=karim.zahidi>

BRIEF SECTION SUMMARIES AND CHAPTER ABSTRACTS

I. MODALITY AND MULTIMODALITY

Commonsense suggests that there are exactly five senses: vision, audition, olfaction, touch, and taste. Orthodoxy in both philosophy and science has largely followed. Recently, however, orthodoxy has begun to unravel. The main challenge begins with a philosophical question: What determines the categories: what individuates seeing as seeing, hearing as hearing, and so on? Philosophers have considered a number of (perhaps not exclusive) criteria, such as kinds of properties represented by perception, phenomenal character, type of stimulus, and neuro-anatomical structure. Exploring these potential criteria carefully has suggested that, whichever one chooses, maintaining orthodoxy is difficult. The difficulties become especially clear when one considers relevant developments in various sciences. Scientific investigation of “exotic” sensory capacities—for example, echolocation in bats, infrared sensation in pit vipers—suggests that not all senses map readily onto any of the traditional five. Similarly, investigations of interactions among the senses (i.e. *multimodal interaction*)—for example, the McGurk and the rubber hand effects—identify perceptual experiences that are not readily classified under any one of the traditional five.

Reactions to this challenge suggest two opposing positions, which we can call *commonsense realism* and *scepticism*. Commonsense realists defend orthodoxy, arguing that, despite the challenge, there are exactly five senses. Some commonsense realists claim that one of the familiar criteria for individuating the senses supports commonsense. Other commonsense realists grant that familiar standards may lead us away from the traditional five senses, but offer novel criteria that, they claim, deliver exactly the traditional five (Hellie; O’Regan). Sceptics reject orthodoxy, offering a range of alternative ways of thinking. Some sceptics maintain that the various cross-cutting criteria for individuating the senses should be determined and prioritized by appeal to theoretical utility, which likely will not align neatly with commonsense (Casati and Dokic). Other sceptics suggest that hard lines between the senses should be abandoned entirely, with the senses being taxonomized by differences in degree, not differences in kind (Macpherson).

In addition to the question of individuating the senses, orthodox thinking suggests that, however the senses are divided, one can be consciously aware of information from more than one sense simultaneously. For example, one can be simultaneously aware of both visual (e.g. colour, shape) and auditory (e.g. pitch, timbre) information regarding a cello. But one can again challenge orthodoxy and argue, contrariwise, that we can be

consciously aware of information from only a single sense modality at any given moment. That is, whereas orthodoxy holds that conscious awareness is informationally *multisensory*, the challenge holds that conscious awareness is informationally *unisensory* (Spence and Bayne).

1. The Nature and Number of Senses Actual and Possible

Fiona Macpherson (Senior Lecturer, Director of Postgraduate Studies, and Director of the [Centre for the Study of Perceptual Experience](#), University of Glasgow, UK; Co-director of the [Centre for the Study of the Senses](#), Institute of Philosophy, London)

Traditionally, it has been claimed that there are five senses. However, evidence from the sciences about the human body, brain and behaviour, and similar evidence about animals, suggests that there exist many more senses than five. In addition, recent evidence concerning sensory enhancement and augmentation suggests that we could create more senses still. But what makes a sense the sense that it is? What makes an instance of a sense a sense of vision, touch, taste, smell, hearing or some one of the many other types of senses? Indeed how many different types of senses could there be?

Philosophers have proposed different criteria to answer this question: the representational criterion, the phenomenal character criterion, the proximal stimulus criterion, the sense-organ criterion. It is typically thought that these are competing criteria for individuating the senses. However, in this paper, I will argue that they needn't be competing. Indeed, I will argue that one only needs to hold that they are competing if one has a view of the senses as discrete, rather different from each other and relatively few in number. If one gives up this view, which I believe one should once one takes into account the evidence mentioned above, then one can use the criteria in tandem to provide a fine-grained taxonomy of all actual and possible senses that captures all the relevant properties of the senses that are of interest to us. According to this taxonomy the differences between the senses is a matter of degree rather than a difference of kind and in fact there could be an infinite number of (possible) senses.

I will then proceed to elaborate on this taxonomy. I will consider the version of each criterion that should be adopted. I will consider the relationships between the actual and possible senses and reflect on their similarities and differences. I will also consider the status and nature of the traditional five senses within this taxonomy. I will consider how one might use this taxonomy to enumerate novel senses that don't exist. Finally, I will consider which of these possible senses one could create in humans through sensory substitution or extension by taking into account the essential features of each sense.

2. Sensory Acts and Evidentials

Benj Hellie (Associate Professor of Philosophy, University of Toronto)

Since Grice's early work on the senses, evidence has been mounting that familiar approaches to distinguishing the senses—e.g. by an associated organ, by the information they impart, "phenomenally"—cannot succeed; so I advance an unfamiliar approach. I distinguish perceptual states (seeing, hearing) from perceptual acts (looking, listening), and individuate the senses by appeal to kinds of perceptual act. There are at least five "perceptual evidentials": 'look', 'feel', 'smell', 'taste', and 'sound'. The meaning of 'o looks F' is roughly 'going by looking, o is F'. These five perceptual evidentials track five maximally determinable kinds of perceptual act: looking, feeling, smelling, tasting, and "sounding". I will argue, moreover, that there are only five perceptual evidential, and hence only five kinds of perceptual act, and hence only five senses. This discussion dovetails with a more general thesis I advance, that conscious experiences are actions: our direct access to perceptual acts would explain their registration in language; our lack of direct access to perceptual states would explain the failure of state-based approaches.

3. Individuating the Senses: A Sensorimotor Approach

J. Kevin O'Regan (Director, Laboratory for the Psychology of Perception, Centre for National Scientific Research, Paris)

Traditional approaches attempting to individuate the senses base their distinctions on either (i) the properties of objects that can be ascertained by the sense, (ii) the characteristics of the sensations involved, (iii) differences in the stimulations that give rise to the sensations, or finally (iv) the sensory organ involved.

The sensorimotor approach takes a different tack, by considering the feel associated with a sensation not as something that is received by an observer, but as an activity in which an observer is engaged. From this point of view, distinguishing sensations (and therefore, in my view, distinguishing sense modalities) becomes a question of distinguishing the sensorimotor skills that are engaged when one is sensing in different sense modalities. For example, blinking and eye movements produce dramatic changes in sensory input when we see, but they have no effect when we hear or smell or touch. Moving backwards and forwards produces changes in intensity when we hear, but changes governed by quite different laws, namely expanding and contracting flow-fields, when we see.

Taking this philosophical stance has implications for empirical research. Among others, it suggests new ways of explaining anthropological and psychophysical data on color. It opens the door to research on sensory substitution and makes predictions about what kind of mental experiences will seem to humans as having "something it's like".

4. Distinguishing the Commonsense Senses

Roberto Casati (*Senior Researcher, National Centre of Scientific Research, France and Member of [Jean-Nicod](#) Institute, Paris*)

Jerome Dokic (*Professor at [École des Hautes Études en Sciences Sociales](#), Paris and Member of [Jean-Nicod](#) Institute, Paris*)

What characterizations are available for distinguishing sense modalities? Commonsense offers at least two. “Coarse” characterizations allow for a distinction between, say, commonsense hearing and commonsense vision, but not for a distinction between, say, vision-for-action and vision-for-recognition. “Fine” characterizations allow for distinctions within traditional modalities, and thus, can allow the distinction between vision-for-action and vision-for-recognition. These commonsense characterizations presuppose that the sense modalities are natural kinds, and thus, sense concepts can be improved. Commonsense, however, does not provide the only possible characterizations for distinguishing the sense modalities. Alternative, theory-based characterizations, may dispose with commonsense altogether.

We shall investigate whether we can live with two or even several characterizations for distinguishing the senses. To see how, we should look at actual uses of the sense concepts. For instance, a noun such as 'vision' can be used as an umbrella term for track keeping purposes—in the face of theoretical change, it is not preposterous to say that Descartes was studying vision. We shall also see how sense concepts can be used to bridge disciplines (for example, the study of artificial vision and of biological vision), and as heuristics (rough, imperfect, but still quite usable) for making empirical discoveries about the senses possible. This investigation reveals the roles commonsense can play in helping us to understand non-commonsense classifications.

5. Is consciousness multisensory?

Charles Spence (*Professor of Experimental Psychology, University Lecturer in Experimental Psychology, Head of the Crossmodal Research Laboratory, University of Oxford*)

Tim Bayne (*University Lecturer in Philosophy of Mind, University of Oxford, and Fellow of St. Catherine's College*)

As James (James 1890/1981: 219) pointed out, “consciousness is of a teeming multiplicity of objects and relations.” But does consciousness draw on multiple

modalities at a single time? The claim that humans can only be aware of a single modality (or channel) of information at any one time flies in the face of what most psychologists and philosophers currently appear to believe. However, we argue that a surprisingly large body of empirical evidence supports the single channel view.

We begin by clarifying the single channel model. It might be thought that in order to give some content to the thesis one needs an account of the senses. Although there is some truth to this claim, it is possible to make a significant degree of progress in evaluating arguments for and against the single channel model by working within an intuitive account of the divisions between the modalities. (The chemical senses might provide a problem here though, for unless we have a good grip on where the borders between different chemical senses lie it might be difficult to evaluate potential counter-examples.) Another question that needs to be addressed in clarifying the claim is concerned with what it means for multiple modalities to be simultaneously present in consciousness. Does this require only that multiple modalities be represented within a single specious present, or does it require that multiple modalities are concurrently represented in experience? We will adopt the latter view.

We then turn to an examination of the evidential status of the single channel model. We begin with first-person evidence—the evidence from introspection. One question here is just how counterintuitive people find the single-channel model. We suspect that both naïve and sophisticated introspectors find it highly counter-intuitive, although we are unsure about this. A second question is whether introspection is likely to be well-placed to address the plausibility of the single-channel model. We suggest that it is not. In fact, there are good reasons to think that introspection is likely to be particularly unreliable when it comes to determining whether certain conscious states are simultaneous or sequential. In light of this, our approach will be a third-person one.

At first glance, the evidence would appear to favour a multi-channel view of consciousness. After all, there are many multisensory interactions: contexts in which input in one sensory modality alters or modulates content in another. Perhaps the most famous of these is the McGurk effect, in which the auditory experience of the phoneme a person is uttering is modulated by visual information of their lip movements (McGurk & McDonald, 1976). But from the fact that there are profound multisensory influences on perception and on awareness (Calvert, Spence, & Stein, 2004; Chen, Yeh, & Spence, submitted; van Ee et al., 2009) one should not necessarily jump to the conclusion that awareness itself is a multisensory construct, for it is possible that the influence of one modality on another takes places ‘outside’ of consciousness, and that what we really have are multisensory influences on unisensory awareness.

Turning from the case against the single channel model to the case in favour of it, we will review evidence from a range of behavioural paradigms that support the claim that consciousness is modality-specific:

Perceptual rivalry data suggests that perceptual switches in a person’s awareness of a bistable figure in vision is unrelated to the switching of their perceptual state when listening to an ambiguous stream of auditory stimuli (Hupé, Joffo, &

Pressnitzer, 2008). This null effect is observed even when the stimuli are presented in spatiotemporal correspondence. By contrast, evidence suggests that there is some association between perceptual switches taking place when people view multiple ambiguous figures in vision at the same time.

Crossmodal perceptual grouping: While influential early research suggested that the perceptual grouping vs. segregation taking place in one sensory modality influenced the likelihood that the stimuli in another simultaneously presented modality would be grouped vs. segregated (O’Leary & Rhodes, 1984), researchers have subsequently criticized this result on the grounds that it may simply reflect response bias (see Vroomen & de Gelder, 2000; Spence et al., 2007)

Amodal apparent motion: Many studies have attempted to provide evidence of amodal apparent motion. To date, no study has provided any convincing support for the phenomenon of crossmodal apparent motion (e.g., Allen & Kolers, 1981; Huddleston et al., 2009; Sanabria et al., 2005). Meanwhile, others have failed to provide any evidence in support of the existence of amodal temporal rhythms (e.g., Guttman et al., 2006), and some have argued that this will never be found. Therefore, despite more than 70 years of research, no one has been able to provide any support for the notion of intersensory Gestalten (see Gilbert, 1939; Spence & Chen, in press).

Numerosity judgments: The span of attention (as measured by performance on numerosity judgment tasks) is around 4 items in vision and 2-3 items in touch. If awareness were multisensory then one might expect there to be separate spans, thus giving rise to a total of 7. However, the results suggest that this is not the case (Gallace, Tan, & Spence, 2007).

We argue that while there is undoubtedly multisensory information processing going on in brain it is likely that awareness switches from one modality to another. At this point there are deep links with the dual-task literature, which we plan to explore.

In the final section of the chapter we examine some of the questions raised by the single channel model (assuming that it is true). One issue here is what might explain the truth of the single channel model. Is it true because consciousness has a very limited capacity— one that necessarily restricts it to a single modality, or does the truth of the single channel model have more to do with the structure of modalities than the bandwidth of consciousness as such?

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II. INTERACTION AND INTEGRATION

The philosophy and science of perception has largely studied each sense independently of the others, which reflects the philosophical presupposition that the senses (whether five or more) are deeply discrete. Although there may be good reasons for this division of labour and the corresponding presupposition, various considerations support a more integrated approach. Some perceptual experiences (e.g. flavour experiences) appear to be inherently, thoroughly multimodal, which suggests that they cannot be studied by investigating any one sense. Insofar as traditional methods for individuating the senses fail to allow such experiences, moreover, their existence suggests the need for new ways of individuating the senses (Smith and Deroy). Cross-modal illusions suggest, moreover, that the senses interact in ways that will be revealed only if the senses are studied together. Such illusions (especially in conjunction with other empirical findings) also suggest that the content of experience is sometimes (perhaps quite often) multimodal (O'Callaghan). Even investigations of senses that are often thought to be single, discrete senses (especially touch and taste) suggest the need for a more holistic approach. One might wonder, for example, whether touch is a single sense (and, if so, by what criterion) or is it inherently multimodal, including elements of, for example, distinct senses of passive touch, active touch, and thermal perception (Fulkerson)? Further problematizing the independent pursuit of each sense, there are cases where a perceived object is not represented by any single sense (vision, audition, etc), and thus, some perceptual experiences, and the objects they represent, are arguably *amodal* (Nudds). Finally, since

some supposedly distinct senses provide similar information—touch and vision, for example, both provide spatial information—one wonders whether each modality has its own frame of reference or, instead, there is a single spatial frame of reference that crosscuts various senses (Millar).

Taken together, these considerations suggest, most obviously, a methodological prescription: the senses should not be studied in isolation, at least not exclusively. This methodological suggestion, however, is not the only upshot of considering sensory interaction and integration. Such consideration, once again, calls into question any individuation-criteria that result in entirely discrete senses, let alone exactly five discrete senses. And even if some plausible criteria yield discrete senses, in the face of, for example, pervasive multimodal experiences, one wonders whether such criteria are useful.

6. What Counts as Touch?

Matthew Fulkerson (Postdoctoral Fellow, Philosophy, University of British Columbia)

While touch is typically included among the major senses—along with sight, hearing, smell, and taste—there is reason to wonder whether touch is actually a single sense. Unlike the other senses, touch seems to have a number of distinct constituent elements that may be considered separate (though interacting) sensory systems. We can see the problem more clearly by considering some examples. Thermal perception, for instance, is typically included as part of touch. We experience hot and cold through our skin when we grasp objects, but this awareness is actually mediated by a unique physiological channel largely separate from discriminative touch. Many pains present similar issues. We experience pains through our skin and bodily surfaces, but pains also involve a largely independent system from that which codes for discriminative touch. And finally, prehension or grasping actions also seem to be a central part of touch, as they very often allow us to experience complex shapes and other properties of extended objects. But the movements involved in grasping involve motor systems that seem separate from those involved in surface sensory awareness. Since these sensory systems are in some ways as distinct from one another as are the systems for, say, vision and audition, one wonders what counts as touch.

At present there are no principled views on what ought to count as part of touch. This is largely because there are no widely accepted criteria for sensory individuation. That is, it remains a very difficult philosophical project to say what counts as a single sensory modality in general, much less for the complexities involved in touch. In this paper, I put forward a proposal for what counts as touch, one that could easily generalize to the other sensory modalities. I begin with the observation that the sensory modalities assign features to entities in the world (including our bodies). I next argue that these assignments are structured; they occur in particular ways that can be measured and described. Finally, I show that appealing to this structure offers a robust means of characterizing touch

experiences: those constituent systems that contribute to the structured representation of object features count as touch, those that do not should be considered separate. According to this criterion, thermal perception and prehension count as part of touch, but pains and tingles and itches do not (or, rather, the former are part of one kind of touch, the latter part of another).

7. Multimodality in Perception: Conflict, Content, and Phenomenology

Casey O'Callaghan (Assistant Professor of Philosophy, Rice University)

Theorizing about perception and perceptual experience once was driven primarily by attention to vision. More recently, philosophers and cognitive scientists have investigated perceptual modalities other than vision. In addition to theories of vision, theories of audition, taste, and smell have been proposed. Despite investigating multiple senses, this work risks remaining unimodal in one striking respect: much of it involves investigating the modalities in isolation or in abstraction from each other. Such investigation can be successful if perception in each of the various senses is explanatorily independent from the others—that the senses are discrete, encapsulated "channels of awareness". However, both recent empirical work on multimodal processing, including crossmodal biases, interactions, and recalibrations, and recent philosophical work on the unity of perceptual consciousness and multimodal illusions, suggests that senses are not discrete, encapsulated channels of awareness, which is to say, perception is richly multimodal. Despite these discoveries, little detailed conceptual work has been done to distinguish theoretically significant ways in which perceptual processes and experiences are multimodal, and arguments intended to overturn traditional unimodal or modality-specific accounts remain underdeveloped.

This article aims to fill these gaps and to provide a framework for understanding perception as robustly multimodal. It proceeds in three stages. First, it argues that (i) subpersonal perceptual processes cannot adequately be explained in terms of modality-specific processes and mere causal interactions, and (ii) the multi-modal recalibrations that lead to cross-modal illusions demonstrate a shared grasp upon common sources of sensory stimulation. This way of thinking provides a useful, if controversial, way to understand multimodality of perceptual processes. Next, using this conception, it presents and defends an argument for multimodal perceptual content based on correctness conditions and illusions under circumstances of multimodal interaction. Finally, it defends the claim that perceptual phenomenality is multimodal in the robust sense that it cannot exhaustively be characterized in modality-specific terms and that experiences associated with different senses share phenomenal features. This account explains how richly connected senses make possible new varieties of experience that are absent under discrete sense modalities.

8. Seeing What We Hear: Amodal Perception and the Senses

Matthew Nudds (*Senior Lecturer, School of Philosophy, University of Edinburgh, Scotland*)

Much of our perception of objects involves more than one sense modality – we hear the sound made by something that we can see, for example. In such cases it's not that we see an object and hear an object and then *judge* that what we see is the same as what we hear; rather, the fact that it is a single object that we see and hear is *perceptually* apparent to us: a single object is presented to us via two or more different senses. Since this singularity is perceptual but not received through any specific sense modality, we can say that an object perceived in this way is perceived 'amodally'.

The suggestion that some perception is amodal, in this sense, is also supported by a number of inter-sensory interactions, where what is perceived with one sense modality changes what is perceived with another. The best explanation of these interactions is that the perceptual system treats information picked up by different senses as information concerning a single object. Although some perception is amodal, the experiences associated with the non-visual senses are modality specific in the sense that we can exhaustively characterise these experiences in terms of objects or features that are perceptible with only a single sense. For example, we can characterise auditory experiences in terms of sounds, and olfactory experiences in terms of smells. This generates the following problem: how can there be amodally perceived objects the perception of which involves modality specific experiences?

In this chapter I attempt to solve the problem of amodal perception for the case of auditory experience. In the first part of the chapter I set out the problem and consider, and reject, solutions to it that involve either denying the amodal nature of some perception or the modality specific character of non-visual experiences. In the second part of the chapter I develop an account of auditory experience and, in particular, an account of the connection between experiencing sounds and perceiving the objects that produced the sounds. I use this account to explain how we perceive the sources of sounds in virtue of experiencing the sounds they produce in a way that can account for the fact that we perceive the sources of sounds amodally. In the third part of the chapter, I use the account of auditory experience to explain the inter-sensory interactions described in the first part of the chapter. I show that some interactions involve changes in the experiences involved and others changes in the apparent object perceived, and explain how my account of auditory experience can accommodate both kinds of case. Finally, I argue that understanding the relation between the non-visual experiences and their amodal objects is central to any account of the nature of non-visual perception, and that the pattern of explanation sketched for the auditory case can be generalised to form the basis of a general account of non-visual perception.

9. Flavour and Perceptual Abilities: Individuating the Senses in a Cross-modal Context

Barry C. Smith (*Professor of Philosophy, University of London-Birkbeck and Director of the Institute of Philosophy, School of Advanced Study, London*)

Ophelia Deroy (*Lecturer, University of Paris*)

Difficulties in individuating the senses can be traced to two problems: first, sensory modalities are understood as ‘ways’ of experiencing and are aligned with perceptual states or occurrences; second, cases of multi-sensory integration and cross-modal effects are often ignored or mis-described. Taking flavour as a key example, we argue that none of the existing criteria in terms of introspectible characters, sensory organs, proper objects, or selective deficits succeed in taking flavour into account, or offer a plausible account of the other senses. Thus, flavour helps to illustrate the mistaken ‘balkanisation’ of the senses, and where the real challenge lies. In a context where the ‘merging of the senses’ is the rule rather than the exception, should we give up on the notion of distinct senses? Such an ‘amodal’ view is no more satisfactory than traditional ‘modal’ views. Instead, we argue that the notion of a sense should be maintained, but redesigned in terms of perceptual abilities that are irreducible to sub-personal sensory capacities and task/stimuli specific. We show how this notion relates to J.J. Gibson’s insights, and illuminates the case of flavour, as well as the other more classical cases of vision and audition.

10. Spatial coding, the Senses and Ockham’s Razor: Findings from Touch and Vision

Susanna Millar (*Professor Emeritus, Department of Experimental Psychology, University of Oxford*)

One of my main research interests is how we make sense of the space(s) around us, and how the diverse senses relate to that process. One issue here is whether the diverse senses correspond to distinct spatial frames of reference or whether we have a single frame. Ockham’s Razor supports the single-frame view. Many results, however, are commonly interpreted as supporting the latter. One such result finds that subjects display a strong bias for egocentric frames of reference when performing certain spatial tasks using active touch, but not when performing the same tasks using vision. Prima facie such results suggest that active touch and vision involve distinct frames of reference, and thus, supports the distinct-frames view.

This result, however, can be explained in a way that is consistent with the single-frame view. Perhaps active touch and vision are simply biased toward different reference cues. I support this theory by using different test conditions. In one such experiment subjects

perform active touch tasks similar to those used in standard experiments except that external reference cues are used. The results on touch then look the same as those in the original experiments on vision. Moreover, using body-based cues in vision produces results that resemble those of the previous touch studies. These results are consistent with the view that touch and vision are biased toward different reference cues but nonetheless involve a single frame of reference. Consider another example. Experiments in the 1970s suggested that the relation of crossmodal to intramodal tests with vision and touch differ between shape and length tasks. Neurophysiological studies showed later, however, that visual shape recognition is served by ventral neural streams, whereas dorsal streams function in spatial tasks. Still later, touch-sensitive cells were found in the visual shape area. Recent studies also suggest indirect connections between ventral and dorsal neural networks. The same shape illusion that occurs in touch as well as in vision shows some effect of the difference in input, but they share the discrepant shape features that produce the illusion in both modalities. Accordingly, results that are commonly taken to support the distinct-frames view for active touch and vision do not. Given Ockham's Razor, therefore, one should endorse the single frame view.

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III. CHALLENGES TO TRADITIONS

Considering the diversity of experience also illuminates theorizing about the senses. One can explore this diversity either within a standard sense modality or outside of standard senses altogether. Within vision, for example, one finds several distinct phenomena (descriptive vision versus motor-guiding vision, recognition versus awareness), which are known to be distinct because psychological and neurological studies have shown them to be dissociable. Thinking about this intra-modal diversity suggests a more complex picture than commonsense, philosophy, or science initially presumes (Hughes). Outside of the standard senses, one can explore the many kinds of experience that importantly resemble standard perceptual experiences (visual, auditory, etc.) but are not typically counted as perceptual/sensory experiences. Arguably, for example, we experience numerosity, grammaticality, and agency—certainly we detect relevant properties fairly automatically and independent of doxastic commitments. Considering these “cognitive senses” not only suggests, once again, that the orthodox five are too few, but also, may provide insight into the standard senses (Shea). Similarly, we experience our own mental states, introspecting, for example, the *feeling of knowing*. This sort of *inner sense* may present yet another challenge to standard theories of the senses, since it may be a legitimate sense that is

neither explained nor suitably categorized along the standard lines (Picciuto and Carruthers).

11. The Diversity of Visual Experience: Looking, Seeing and Looking Without Seeing

Howard C. Hughes (Professor, Department of Psychology and Brain Sciences, Dartmouth University)

In everyday parlance, the meaning of the verb ‘to see’ is clear: it means ‘to perceive by eye’. However, experimental studies of human visual experience make it clear that there exists a wide variety of visual experiences. Here we explore some of those variations, which include dissociations between recognition and awareness, detection and recognition, conscious and unconscious, and the visual control of cognition versus the visual control of action. We consider these dissociations in both neurologically intact and neurologically compromised individuals. The resulting analysis illustrates a wide variety of visual experiences that not only are possible, but that are rather routine occurrences.

12. The Cognitive Senses

Nicholas Shea (Senior Research Fellow, Somerville College Research Fellow, Faculty of Philosophy James Martin 21st Century School and Wellcome Centre for Neuroethics, University of Oxford)

Accounts of the senses can be tested and challenged by broadening our perspective away from the paradigm perceptual senses: seeing, hearing, touching, etc. We have other means for detecting objects in the world and their properties, which are less readily thought of as perceptual. Here are some examples of properties that we are able to detect relatively directly:

- causal relations, e.g. when one object caused another to move
- when a sentence is ungrammatical
- the approximate number of items in a large array of objects
- the exact number of items in a small array of objects
- when an object is likely to be an agent

Our detection of these properties resembles our detection of colours, sounds, and other traditional targets of the senses in at least two respects. First, we often detect these properties automatically. Second, which properties we detect is at least partially independent of our other beliefs. Our detection of these properties doubtless involves inferences over mental representations, but not inferences that we are aware of at the personal level. This similarity with the traditional senses suggests that there may be an

under-appreciated psychological category, the *cognitive senses*, covering a variety of capacities for direct receptivity to the world which differ systematically from the paradigm senses. Carey argues for the existence of such a category, which she calls core cognition (*The Origin of Concepts*, 2009, O.U.P.).

Other considerations, however, count against there the cognitive senses being a genuine psychological category. First, the deliverances of the cognitive senses are typically less phenomenologically salient than the colours, sounds, and textures of the perceptual senses. Second, the deliverances of the cognitive senses have a different epistemic status. When I see a red cube, say, there are various subpersonal information processing steps that precede formation of that perceptual representation, but none is at the personal level. By contrast, the cognitive senses seem to operate on the basis of prior perceptual representations: I hear a sentence and then detect that it is ungrammatical, or I see the array of objects and then form an analogue magnitude representation of their numerosity.

By way of investigating whether the cognitive senses really are a genuine psychological category, this paper will address four more specific questions:

1. Do the cognitive senses require consciously-represented properties as input?
2. Do the cognitive senses operate at the personal level, in the sense that the subject can always make available some epistemic basis on which the output representation was deployed? – e.g. features of the visible objects, when they are seen as agents.
3. Does the operation of the cognitive senses issue in applications of concepts, that is, representations that are only meaningfully deployed as a component of representations with semantically-significant constituent structure?
4. Can subjects differentiate between the reliable operation of a cognitive sense and brute guessing, for example via an associated feeling or intuition of accuracy?

13. Inner Sense

Vincent Picciuto (PhD Student, Department of Philosophy, University of Maryland, College Park)

Peter Carruthers (Professor, Department of Philosophy, and Associate Member, Neuroscience and Cognitive Science Program, University of Maryland, College Park)

Many philosophers have proposed the existence of an inner sense or senses, designed to provide us with reliable access to our own mental states (Locke, 1690; Armstrong, 1968; Lycan, 1987; Nichols and Stich, 2003; Goldman, 2006). Some of these authors (e.g. Goldman) have even proposed that there are dedicated sensory transducers associated with inner sense, much as there are with our traditional senses (at least, according to one common method of sense individuation). Inner sense should not, however, be confused with our interoceptive and proprioceptive senses (if they are properly described as such),

which give us access to such bodily phenomena as pain, warmth, touch, our own physical movements, our own heartbeat, “butterflies” in our stomach, and so forth. For these senses issue in first-order representations of states and properties of the body. Inner sense, in contrast, is inherently metarepresentational: it is thought to issue in awareness of our own *mental* states. In consequence, it might less misleadingly be called “higher-order sense” or “metarepresentational sense”. The term “inner sense” has stuck, however, and is widely used; so we, too, propose to employ it.

One of us has offered extended critiques of traditional inner sense theories, both in respect of their alleged role in accounting for our awareness of our own perceptual states (Carruthers, 2000) and our awareness of our own propositional attitudes (Carruthers, forthcoming). In brief, we think that the increasing evidence supporting “global workspace” or “global broadcasting” accounts of the architecture of the mind (Baars, 1988, 2002; Dehaene et al., 2003, 2006) renders inner sense theories otiose. For attended and globally broadcast perceptual representations will perforce be accessible as input to all of the main conceptual systems of the mind, including the mindreading faculty, in which case self-attribution should be almost trivial. Moreover, there is no good evidence supporting the alleged systems for monitoring our own attitudes, whereas there are multiple strands of evidence that count against them. In the first part of the chapter we briefly review these arguments, before we move on to discuss more subtle variants on the idea of inner sense.

A candidate inner sense that has been investigated by psychologists is “feeling of knowing”. We discuss these feelings, as well as epistemic emotions such as surprise and uncertainty. In each case it seems that we find nonconceptual representations (of the same general sort that might be delivered by our regular senses like vision) that target underlying mental states. Feelings of knowing seem to give us nonconceptual access to states of knowing or remembering. Surprise seems to give us nonconceptual access to a conflict between the contents of current perception and prior belief. And uncertainty seems to give us nonconceptual access to our low degree of belief about something. In each case it is possible to wonder whether the experiences in question can properly be thought of as involving *a sense* (in this case a higher-order or “inner” sense) and whether any extant view of sense individuation is best suited to account for such a sense. (See Nudds, 2004, for useful summary.)

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IV. SENSORY SUBSTITUTION

Since Paul Bach-y-Rita's pioneering research in the middle of the last century, philosophers and scientists have been increasingly interested in sensory substitution. Bach-y-Rita developed these technologies largely for clinical reasons (treatment of sensory disabilities). Exploring these technologies, nonetheless, has been theoretically fruitful, providing, for example, powerful evidence for neural plasticity. More importantly for our purposes, exploring sensory substitution technologies has problematized various aspects of traditional theorizing about the senses. Consider, for example, the finding from studies of Tactile Vision Sensory Substitution (TVSS) that information from one modality is apparently transferred to another modality. This transference could be explained in a number of ways: perhaps modalities are altered through TVSS; perhaps different systems (visual, tactile, etc.) produce neural representations that are modality-neutral and thus readily transferable to other systems without modification; perhaps there is a non-modality specific system of representation at work (Paterson and Chirimuuta).

More recently, philosophers and scientists have begun using sensory substitution technologies with the explicit goal of developing and honing new theories of perception. Some of these investigations explore whether full (phenomenological) substitution is possible for one or another sense (Clark and Bird). Others explore whether senses can be "morphed". Suppose that one sense, say touch, substitutes for another sense, say vision, such that structural features of "touch" begin to resemble those of vision quite closely and experiences of "touch" begin to *feel like* ordinary visual experiences. This morphing suggests that the identity conditions for a sense modality are dynamic, not static, as tradition presumes (Myin, Cooke, and Zahidi).

14. Philosophies of Sensory Substitution: The Case of the Seeing Tongue

Mark Paterson (*Lecturer in Human Geography, University of Exeter*)

Mazviita Chirimuuta (*Visiting Fellow, Department of Philosophy, University of Bristol*)

Since 1692, Molyneux's question to John Locke has been a focus for the discussion of perception in philosophy and psychology. Molyneux asked Locke whether a congenitally blind person who could distinguish globes from cubes by touch would be able to distinguish them by sight immediately upon gaining sight. In this paper we introduce a methodological question inspired by Molyneux. Can a conceptual framework developed to theorise one sense modality generalise to others? This methodological issue is pertinent to much work on the senses. Vision has traditionally been the paradigmatic sense, the one invoked to illustrate ideas in the philosophy of perception, such as the externality and spatiality of the perceived world. But if such ideas are not translatable across modalities, then the visuocentric bias of the theory undermines its claims of generality.

We approach this "meta-Molyneux" question by discussing work in the technology of sensory substitution. Paul Bach-y-Rita has experimented since the 1960s with his TVSS (Tactile-Visual Sensory Substitution) technologies which transcode optical information onto the surface of the tongue (e.g. Bach-y-Rita et al 1998) and the back (Bach-y-Rita 1969). This provides constantly updated low density information as a means of visual guidance for the blind. Reports of such sensory substitution demonstrate that information gleaned by one sense modality is partially translatable to another sense modality. But such transference is only possible due to brain plasticity (Sampaio et al. 2001). This suggests that both modalities are altered in the process of transference. So what is peculiar to one sense—a pattern of neural representations, say—may have to be modified to render it accessible to the other sense, and the substituted sense itself undergoes reorganisation.

This raises a series of issues related to the "meta-Molyneux" question. Previous philosophical accounts of the senses have assumed that the presence in perception of a spatial field, or of bodily awareness, is a stable characteristic of sensory modalities, the former being associated with vision, the latter with touch (Martin 1992; O'Shaughnessy 1989). Findings of the plasticity of neural systems underlying sensory performance are a challenge to this assumption. It appears that haptic awareness becomes more "spatial" and less "corporeal" given the experience of optically driven tactile stimulation in TVSS. That is to say, through cortical reorganisation, tactile perceptions are experienced as arranged in an external spatial field, a characteristic once thought to be the hallmark of vision. Given evidence that neuronal properties in sensory systems are sensitive to recent stimulus history, and undergo plasticity in the light of experience (e.g. David 2004), it should not be presumed that profound alterations in sensory processing can only be the result of advanced sensory-substitution technologies. We conclude that because of the plasticity of sensory systems, philosophical frameworks used to characterise sense

modalities will have to be more fluid than previously expected, accommodating not only the potential for one sense modality to substitute for another, but also implications for spatial perception.

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15. Sensory Substitution as Experimental Philosophy

Jon Bird (Research Fellow, [Pervasive Interaction Lab](#), Open University)

Andy Clark (Professor of Philosophy and Chair in Logic and Metaphysics at the University of Edinburgh, Scotland)

Sensory substitution devices provide, via one sensory modality (the *substituting* modality), access to information that is ordinarily experienced through another sensory modality (the *substituted* modality). The possibility and conditions of sensory substitution have been thought to play a role in a variety of arguments, both philosophical and cognitive scientific in nature. One complex of arguments concerns the individuation of the senses, another concerns so-called 'sensorimotor models' of conscious experience, and a third concerns practical design issues affecting attempts to build devices that extend or transform human perceptual contact with the world.

We shall argue that confronting these design issues in an ongoing cycle of design and testing affords a powerful tool for philosophers to test and tune their ideas in this domain. This is a kind of ‘experimental philosophy’. Under this umbrella, we report the results of our recent speculative research project that brought together philosophers, engineers, and experts in human computer interaction, using this work as a lens through which to reencounter the philosophical issues that are mentioned above.

Finally, we extend our discussion to consider the nature, scope and limits of sensory substitutions, focusing on three core issues. First, is full qualitative substitution possible? Second, are there differences among substituted modalities that render some substitutions more effective than others? Third, what does work on sensory substitution really tell us about the nature of sense perception, and about the relations between perception, cognition, and action?

16. Morphing Senses: A Dynamic View of Sensory Modalities

Erik Myin (Professor and Director of the Centre for Philosophical Psychology, University of Antwerp)

Ed Cooke (Researcher, Centre for Philosophical Psychology, University of Antwerp)

Karim Zahidi (Lecturer, Centre for Philosophical Psychology, University of Antwerp)

What if sound was acquired through sound receptors in the nose by means of a motoric process similar to sniffing? Further, what if sound acquired the broadly affective role that smell seems to play, and what if the sounds began to relate to each other in the way that smells relate to other smells? We will argue that, contrary to what is assumed in many philosophical contexts, changes in structural features of a sense modality—which include the properties of the stimuli, the motor acts that facilitate experience, and how the experiences function in the overall system—*will* lead the phenomenal character of the experience of sound, say, to become much like that of, say, olfaction. We will argue that consequently, even given a phenomenological standard for sense-individuation, structural features can decide how we identify modalities. Accordingly, senses *can* be morphed.

We will supplement our a priori considerations by turning to two types of empirical cases of sensory transformation: sensory substitution and the evolutionary emergence of different sense modalities out of one more generic modality. These cases, so we will argue, support our case that morphing is possible, and that the identity of a sense modality is essentially dynamical: depending on changes in its structural features.

Such a view has been challenged in particular with respect to sensory substitution. It has been claimed, for example, that perception with a sensory substitution device such as Bach-y-Rita’s Tactile-to-Visual-Substitution-System remains essentially tactile. We will

argue that a proper developmental understanding of a sensorimotor view on the sense modalities answers these worries.

This leads us to what we call a *differentiation view* of sensory modalities. According to the differentiation view, sensory modalities should not be distinguished, as has been traditionally done, by uniquely defining singular features such as stimulus, sensory organ or phenomenal quality. It is these features taken together and conceived dynamically that best characterize the modalities, which can be conceived as different elaborations on a more generic modality. Moreover, degree of difference of structural features is what underlies phenomenal difference. What is called vision may, in fact, depending on the dynamical context of the perceiver assume a role in many structures, and have many distinct characteristic phenomenal feels: as phenomenology would suggest.

Features such as sensory organ or the nature of the stimulus which have traditionally been used as binary criteria can be reinterpreted in terms of *stabilizing factors*, which, in most, but not all, circumstances, counteract “flow” from one modality into another, and which keep the range of variation within a modality within familial limits. The proposed view of the modalities allows one to understand, not only what distinguishes the senses, and the variety within each, but also why it is (often) useful to speak of each as a unity.

V. WHAT WE PERCEIVE

The previous four sections offer a rich variety of novel conceptual and empirical challenges to theorizing the senses. Many more traditional questions in the philosophy of perception, nonetheless, remain unresolved. The classic metaphysical and epistemological problems of perception, for example, are especially contentious, even if often combined with and constrained by empirical research. Several such questions concern the objects of perception. What kind of thing, when we perceive, do we perceive? Will this question receive the same answer for distinct sense modalities? How should we analyze the features represented by experience in different modalities—for example, colours for vision and sounds for audition? Most importantly, should these be analyzed the same way?

For most of the last century, the dominant strategy when approaching these (and other) questions in the philosophy of perception has been to secure a theory of vision first, and then generalize that theory to the other senses. So, for example, one uses some method to determine something about the objects of visual perception (e.g. whether they are physical objects, spatial regions, or something else entirely) and then applies one’s conclusions about vision or at least that method (whatever it may be) to the remaining

senses. Recent work, however, challenges this sort of generalization from vision. A current debate about audition, for example, concerns whether sounds should be explained in the same way that colours are for vision. Reacting to this challenge, one might argue that a dispositionalist account allows for a unified treatment: sounds, like colours as reflectance properties, are dispositions to vibrate (Kulvicki). Distinct challenges are presented by chemical senses, especially olfaction. At first glance, it may seem clear that smell, unlike vision, does not represent an object or a sensory individual. However, given both recent trends towards object-based models among olfactory scientists, and the possible theoretical advantages of an object-based account of olfaction, “odour objects” may be worth serious consideration (Batty).

17. Sound Stability: Duration, Perceived Duration and Perception’s Duration

John Kulvicki (Assistant Professor, Department of Philosophy, Dartmouth University)

Recent work on sounds divides over the extent to which it treats sounds and colors as on a par. A number of authors suggest a unified treatment (Kulvicki 2008, Pasnau 2009, Cohen 2010) while others suggest that sounds are quite distinct from colors (Casati & Dokic 1994, 2005, forthcoming, O’Callaghan 2007, Sorensen 2007, 2010). Since no one thinks that sounds simply *are* colors, there are naturally a number of dimensions along which accounts of color and sound can be (dis)unified. This paper focuses on whether sounds and colors can both be understood as qualities/dispositions. Recent trends suggest that sounds are better conceived as events than qualities or dispositions. Some recent work challenges the advantages claimed for such event views (Kulvicki 2008, Cohen 2010) and I propose an account of sounds as dispositions of objects to vibrate. This is very similar to reflectance physicalist accounts of color. (Cohen endorses neither the account of sounds proposed nor the account of color on which it is modeled. Pasnau (2009) suggests that both colors and sounds should be understood as events, not qualities or dispositions.)

Insisting that sounds are stable properties of objects requires handling intuitions that seem to suggest sounds last only moments, and are thus better modeled as events than stable dispositions. One way to handle these intuitions is to distinguish the duration for which something is perceived and the perceived duration of the thing and note that intuitions that sounds have durations might be confused with the fact that hearing episodes have durations. So, I hear the bell for 30 seconds, even though the bell has its sound—a disposition to vibrate in certain ways—all the time, just as colors exist even when conditions prevent their being seen.

In a forthcoming paper, Roberto Casati and Jerome Dokic raise a new objection to this defense of a stable disposition view. They suggest that any such view needs to distinguish not just dispositions to vibrate from hearing episodes, but also from what they call “occurrent sounds”. “You set the tuning fork in motion. It vibrates for thirty

seconds. But then, after ten seconds, you get bored and block your ears with your hands.” (Casati & Dokic, forthcoming) There are three things: the hearing episode, the audible vibration or occurrent sound, and the disposition to vibrate, but “Occurrent unheard sounds are invisible to the dispositional account.” This paper responds to their worry, by showing how, in general (not just in the case of sounds), one ought to distinguish the duration of a perceptible event, the duration of the perception of it, and the perceived duration of such an event.

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18. Olfactory Objects

Clare Batty (Assistant Professor of Philosophy, University of Kentucky)

Much of the philosophical work on perception has focused on vision. Recently, however, philosophers have begun to correct this ‘tunnel vision’ by considering other modalities. Nevertheless, relatively little has been written about the chemical senses—olfaction and gustation. The focus of this paper is olfaction. In light of new physiological and psychophysical research on olfaction, I consider whether olfactory experience is object-based.

Much of the literature on visual perception, and more recently on auditory perception, presupposes the object-based model of perception. This model, in turn, presupposes widely accepted principles of perceptual organization that allow for object individuation and recognition. Mere feature-extraction is not enough for object perception. Object individuation involves *grouping* of perceptual features. An experience that presents objects parses the scene before the perceiver, providing information about the *edges* or *boundaries* of sensory individuals. In turn, perceptual grouping allows for *figure-ground segregation* and the ability for a perceiver to distinguish objects not only from each other, but also from their background. Object recognition draws on features of object individuation and involves principles of *tracking*, *persistence* and *amodal completion*. Sensory individuals can be tracked across space and time, survive change to their

apparent properties and are perceived to continue uninterrupted behind other occluding objects. Vision and audition each meet these conditions on object individuation and object recognition, albeit along different dimensions. Visual features are packaged in space, and we are able to individuate and recognize visual objects due to their spatial characteristics. Audible features, while presented in space, are parsed largely in terms of their temporal characteristics.

Olfactory experience, in contrast, does not seem overtly object-based. Unlike visual experience, olfactory experience doesn't seem to present individuals that correspond to ordinary material objects. Like the auditory case, olfactory features seem disengaged from ordinary material objects; yet, unlike auditory experience these features are not obviously presented in space, nor do they appear to have temporal boundaries. Despite this, olfactory scientists have begun to favor an object-based approach to analyzing olfactory perception. Driving this approach is dissatisfaction with the traditional stimulus-response model of olfactory processing. On this approach, olfactory processing involves mere feature extraction and, in turn, an analysis of olfactory experience involves uncovering how the particular features of a chemical stimulus are represented in experience. But many researchers now hold that olfactory experience is largely synthetic—i.e., the various properties of the stimulus produce an irreducible experience, one in which the various features of the stimulus are not distinguishable. Much of what we encounter with our noses are chemical mixtures. The stimulus that gives rise to the experience of what we call the coffee smell, for example, is such a mixture. As we know, sniffing coffee provides us with a unique kind of olfactory experience; but it is not one where we are able to discriminate the over 800 compounds that constitute the coffee odour. As a result, it is now thought that our resulting experience is a function of the pattern of receptor output definitive of that odorant stimulus. These patterns of stimulation constitute “olfactory objects”. On the emerging object-recognition model of olfaction, then, our olfactory experience presents the odour object “coffee”.

In this paper, I explore the claim that these odour objects constitute sensory individuals. It isn't obvious—at least at the outset—whether they meet the widely accepted principles of object individuation and recognition at work in the visual and auditory cases. Among the general issues I consider, then, is whether these traditional principles form necessary, or simply sufficient, conditions on object perception. As we see, at the very least, considering the object-recognition model of olfaction challenges us to look more closely at well-entrenched models of object perception. But the payoff of doing so is high. We not only learn something about a modality that philosophers have historically neglected; by asking new questions and challenging old assumptions, we also further our understanding of perception in general.