Senses as capacities

Multisensory Research, 2020
https://doi.org/10.1163/22134808-bja10024

Casey O'Callaghan

Washington University in St. Louis

Philosophy Department, PNP Program

1 Brookings Drive

St. Louis, MO 63130

USA

casey.ocallaghan@wustl.edu

Abstract

This paper presents an account of the senses and what differentiates them that is compatible with richly multisensory perception and consciousness. According to this proposal, senses are ways of perceiving. Each sense is a subfaculty that comprises a collection of perceptual capacities. What each sense shares and what differentiates one sense from another is the manner in which those capacities are exercised. Each way of perceiving involves a distinct type of information gathering, individuated by the information it functions to extract and the medium from which it does so. This approach distinguishes the project of characterizing and differentiating senses from that of attributing experiences to sensory modalities. Perceptual experiences are episodes in which perceptual capacities are exercised. Conscious perceptual episodes may be ascribed to distinct sensory modalities, according to the manners in which perceptual capacities are deployed on an occasion. According to this account, senses are not exclusive. First, their capacities may overlap. Second, perceptual episodes, including conscious experiences, may belong to multiple senses. Indeed, some episodes require the joint use of several senses. In this account, subjects have only limited first-person knowledge of the senses they employ.

Keywords: the senses, sense individuation, perceptual capacities, multisensory perception

1 Skepticism about the senses

Common sense and theorizing about perception and the mind presuppose that humans possess multiple senses. Typically, we include vision, audition, touch, taste, and smell. Some count more or fewer senses. Taste and smell might collapse into one chemical sense; touch may fragment into thermoreception and mechanoreception. Moreover, we may possess senses beyond the familiar ones. Interoception also offers to multiply our inventory of senses. Nonetheless, among the familiar exteroceptive modalities of sensory perception, by means of which we become perceptually aware of things and features in the world independent from ourselves and our own experiences, received wisdom counts several distinct senses.

There are differences in focus. Psychologists and neuroscientists investigate sensory systems, processes, and performance. Philosophers theorize about sensory consciousness and experience. Non-specialists exploit senses as ways of finding out, getting around, and having a good time. But our having several senses is as close to a shared assumption as one finds in these areas. It structures folk, scientific, and philosophical approaches to the mind.

The shared view faces two substantial challenges. The first is that multisensory perception and consciousness challenge the independence of our senses. Recent work in psychophysics and neuroscience demonstrates that sensory systems interact extensively. This can cause surprising crossmodal perceptual illusions, such as ventriloquism, the McGurk effect, and the sound-induced flash. Such interactions are not merely causal or accidental. Conflict resolution and weighted recalibration sometimes cause illusions, but generally they enhance the coherence and the overall reliability of sense perception. Coordination among senses is part of perceptual functioning. Moreover, the joint use of the senses can extend their reach to reveal novel perceptible features, including intermodal identity, causality, and even qualities such as flavor. One upshot is that characteristics typically associated with one sense can rely on the influence of other senses, at a time or over time. Another is that features of a perceptual episode can outstrip those associated with each of the various senses. In these respects, even perceptual consciousness is richly—constitutively and irreducibly—multisensory. As a consequence, the boundaries between senses are not easily discerned.

Multisensory perception also has been used to challenge the distinctness of our senses. Sensory scientists, such as Shimojo and Shams (2001), argue that multisensory interactions, integration, and plasticity over time show that senses are not distinct modalities, understood as discrete information processing systems.[1] In philosophy, Speaks (2015, chapter 25) contends that multisensory consciousness challenges the claim that the senses are distinct experiential modalities, understood as phenomenal ways of being related to contents, akin to distinct attitudes. Tye (2003, 28) says distinct, phenomenologically bounded, sense-specific components of overall perceptual experience are "figments of philosophers' and psychologists' imaginations." O'Callaghan (2012, §6.2, 111–12) suggests that multisensory perception and consciousness make trouble for extant accounts of sense individuation. And the popular press is teeming with reports that multisensory phenomena—including synesthesia, taste–smell interactions in gastronomy, sensory prostheses, augmentation, and substitution—overturn traditional ideas about where one sense ends and another begins. Multisensory phenomena threaten the natural idea that we possess distinct senses.

There is a further complication. We lack a satisfactory account of what individuates senses. What makes something a sense? What differentiates one sense from another? In virtue of what do experiences belong to sensory modalities? The problem is not a shortage of candidates. Grice (1962) influentially distinguishes four types of criteria. These appeal, respectively, to the features perceived; to the physical medium or energy stimulating our sense organs; to internal processes and mechanisms; or to special introspectible character. However, Grice articulates serious obstacles for each, tentatively settling on a hybrid.[2] Nudds (2003) in turn spells out destructive objections to each specific criterion. Grice's hybrid does not escape. Despite numerous attempts, no consensus yet has been reached concerning how to differentiate senses, nor is any candidate a favorite. This means we cannot rely on accepted criteria to address the first challenge. And it compounds

[1] Notably, Fodor (1983) does not treat senses as wholly modular, in light of crossmodal phenomena such as the McGurk effect (see, especially, p. 47 and footnote 13). Instead, Fodor's domain-specific modules may span senses.

[2] Notably, multisensory cases play a key role in Grice's remarks. His central argument concerns a crossmodal conflict, in which sight and touch disagree about whether two coins have equal size (137ff.). Grice even advances as a relevant consideration a hypothetical description of an empirically possible crossmodal interaction (139–40).

skeptical worries raised by multisensory perception and consciousness.[3]

One response is despair. Nudds (2003) denies that senses are real psychological kinds that earn a place in mature theorizing. He says how we carve up senses is a matter of convention, an entrenched shared habit. If so, sensory taxonomy is answerable ultimately to pragmatic considerations. Speaks (2015, 173) echoes this.

Another response is pluralism. Some are pluralists about the types of senses that exist. Macpherson (2011), for instance, holds that each criterion proposed to individuate senses corresponds to a dimension in a complex multidimensional space into which fits each of many, many actual and possible senses. Distinct locations yield distinct senses. Others are pluralists about classificatory criteria. Fulkerson (2014b) maintains that complex, overlapping sensory systems may be differentiated in differing ways depending on one's explanatory purposes. In principle, one might appeal to receptors, to functions, or to experiences. Each is legitimate, carving senses differently depending on one's aims in a context. Matthen (2015) is a pluralist about concepts of senses. Sensory scientists and laypeople do not disagree about the nature of the senses. Instead, they employ distinct concepts, so their subject matter differs.

I am an optimist. Optimists hold out for a principled, informative account of the nature of the senses and of what differentiates them. The account I pursue here is designed to be compatible with richly multisensory perception and consciousness. It trades on the insights of conventionalists and pluralists. However, unlike

[3] A number of more specific criteria have been proposed. (i) Aristotle (*De Anima* II.vi–x) famously distinguishes senses by proper or special sensibles—colors, sounds, tastes, smells, warmth, and pressure. (ii) Grice (1962) appeals to the full range of features revealed by each of the respective senses. (iii) Heil (1983, chapter 1) relies on kinds of physical stimulation to sensory receptors and types of energy transduced—light, sound, heat, chemical, and mechanical. (iv) Keeley (2002) invokes evolutionarily dedicated sense organs. (v) Psychologists and neuroscientists delineate senses according to functionally or physiologically distinct systems responsible for sensory processing. (vi) Representationalists often appeal to differing contents associated with various senses. (vii) Clark (1993) and Rosenthal (2015) rely on quality spaces determined by patterns of discrimination distinctive to each sense. (viii) Peacocke (1983), Lopes (2000), and, ultimately, Grice (1962) himself, cite distinctive experiential character associated with each of the senses. While a full survey and assessment is beyond this paper's scope, as Nudds (2003) makes evident, each more specific criterion faces difficulties familiar from discussions of Grice's original four criteria.

conventionalists, it treats senses as psychologically real. And, unlike pluralists, it does not multiply senses, classification schemes, or concepts of senses.

What follows is an account of the nature of the senses and of what differentiates them. Section 2 presents what I call the capacities account of the senses. Sections 3–5 describe what individuates distinct senses, including distinct token, determinate, and determinable senses. Section 6 confronts hard cases, including touch, flavour, and sensory substitution. Section 7 applies the account to multisensory perception, and section 8 addresses how to attribute episodes and experiences to sense modalities. Section 9 describes how this account captures the significance of the senses. Section 10 concludes.

2 The capacities account

Begin by distinguishing the project of characterizing and differentiating senses from that of ascribing experiences to sensory modalities. Considerations apposite one task do not always matter to the other. This paper first tackles characterizing and individuating senses, then turns to attributing experiences to sensory modalities.

The account of the senses I favor takes its lead from two insights. The first is due to Nudds (2003, 47, see also 44–9), who puts it plainly: "Senses are ways of perceiving." The other is due to Matthen (2015, 567), who says, "The senses constitute a group of information-gathering faculties." Putting them together, the senses comprise differing ways of gathering information.

Suppose that perception is or involves a type of psychological faculty. It is useful to understand a faculty as a collection of capacities. A sense is a modality of perception. So, a sense is a family of perceptual capacities. This is the core of the capacities account of the senses.

A capacity is akin to an ability, a capability, or a power. The important thing about capacities is that they are distinct from their exercises. Capacities are standing characteristics whose possession is a matter of potential or disposition, rather than current or actual activity. Exercises of capacities are occurrences or performances. They are episodes or events. So, for instance, you may have the capacity to pronounce

the longest word of the English language, even though you are not now uttering it, and even if you never encounter it. You have the capacity to hold your breath, even if you are breathing and never intend to stop. Capacity ascriptions thus are counterfactually sensitive. They concern what one could or would do under various conditions, whether or not those conditions obtain. Exercises of capacities are occasions in which a capacity is manifested or demonstrated. One task of empirical psychology is to test relevant subjunctives.

My discussion focuses on capacities a subject currently possesses, rather than ones a subject could come to possess in time with development or effort. This corresponds to Aristotle's distinction in *De Anima* between first actuality (capacity) and potentiality. Exercises or manifestations of such capacities correspond to Aristotle's second actuality. My account also relies on joining Aristotle's rejection in *Metaphysics* of the Megarian view that possessing a capacity requires its current exercise.

Perceptual capacities are psychological features of subjects. In the first instance, they are capacities to perceive things and features. For example, typical human beings have the capacity to perceive sounds and their pitch, timbre, and loudness when awake and in the presence of compression waves between 20 Hz and 20 kHz. A further inventory of what is perceptible might include ordinary objects, colors, shapes, rainbows, chords, speech, flavors, textures, faces, collisions, and causality. Some lists are more liberal, and some are more austere.

Perceiving requires being differentially sensitive to the presence things or features in one's environment (Lewis 1980). Differential sensitivity to a thing or feature requires the capacity to detect it or to register its presence. Responding to its presence is not enough, however, since one might respond to a range of distinct things in just the same way. For differential sensitivity, one needs to respond differently to a thing or feature from how one would respond to at least some others. For example, being differentially sensitive to an extended object requires distinguishing it from its surroundings and from other objects. To be differentially sensitive to a feature such as pitch requires responding differently to pitches from how one responds to other features, such as hues or sourness. Differential sensitivity to C♯ precludes responding uniformly to it and other features, including distinct determinate pitches.

Differential sensitivity is not enough to possess a perceptual capacity. The responsiveness of a low-level receptor or a feature-sensitive neuron does not suffice. Perceptual capacities must play the right role in a subject's psychology. A subject's thinking and acting must reflect differential sensitivity in the way that is characteristic of perception. For example, detecting and differentiating should enable making use of a target in attention, recognition, judgment, belief, memory, or imagination.

A capacity is individuated by what it is a capacity for, or to do; that is, by the circumstance that is the outcome of its successful exercise. The capacity to tie a shoelace is distinct from the capacity to fasten a button because the conditions for their successful exercises differ (even while they involve shared cognitive and manual capacities). Accordingly, we may individuate perceptual capacities in part according to their objects (see, for instance, Schellenberg 2018, chapter 2). Perceptual capacities differ when they target distinct objects or features. A difference in what two subjects can detect and differentiate, when it plays the right psychological role, means a difference in their perceptual capacities.[4]

Questions about what can be perceived are questions about what can be detected and what can be differentiated. Such capacities, which ground or constitute a capacity to perceive, count among perceptual capacities.

What use are perceptual capacities in theorizing? Aristotle said capacities are principles of change that explain activities. Capacities are powerful predictive and explanatory tools. This is true in science, in philosophy, and in day-to-day coping. Psychologists catalog capacities in order to describe, predict, and explain performance. Philosophers appeal to capacities in normative assessments. We all make use of capacities in planning and in deciding to hold ourselves and others accountable.

Appealing to a capacity to make a prediction requires specifying what is done when it is manifested. This means saying what is accomplished. What is the outcome of the capacity's successful exercise? More specific predictions require saying in what conditions the capacity is exercised. What are the circumstances that prompt or allow the relevant disposition to be realized? For example, you have the capacity to understand

[4]To be clear, distinct ranges of individuals or feature instances that a subject can detect and differentiate suffice for distinct capacities. I am not suggesting that each distinct particular individual or feature instance guarantees a distinct perceptual capacity.

the last word of this paper. In particular, you have the capacity to do so when awake, attentive, and presented with it in good light or quiet. Ascribing this capacity enables me to predict how things will be if you reach that word. You will grasp its content. You will comprehend it.

Notice that this does not explain much. It does rule out that the outcome was an accident. But, like dispositions, capacities and the conditions in which they are exercised add little in accounting for and illuminating why an outcome occurs or an accomplishment takes place. This is not the case if capacities themselves are inherently powerful features (Heil 2012), but it is best not to tie an account of the senses to a specific metaphysics of properties.

Explanation requires more. It requires saying how things are done. This means specifying the manner in which a capacity is exercised. How is the performance carried out? Doing so does help to explain an outcome or an accomplishment. Consider again the case of word understanding. You can understand this paper's last word. You might do so by reading it on the page. Or, you might do so by hearing me speak it aloud. You might encounter the Braille inscription, or you might see the American Sign Language gestures. Each involves a distinct way to exercise the capacity for understanding. Describing the manner in which you exercise the capacity for understanding helps to account for why you grasp the meaning when you do. Cummins (1983), who treats capacities as disposition types, says psychological explanations work by analyzing capacities into their subcapacities. Describing subcapacities helps explain performance. Doing so is one way to specify the way or manner in which a capacity is exercised.[5]

My proposal is that each sense is a collection of perceptual capacities. What each sense shares and what differs between senses is the manner in which perceptual capacities are exercised. Each sense is a bundle of perceptual capacities exercised in a distinctive manner.

[5]It is notable that Cummins's approach serves as an important precursor to the mechanistic explanation movement (Machamer et al. 2000). A mechanistic explanation is an even more specific description of the way or manner in which a capacity is exercised.

3 Ways of perceiving

Senses are families of perceptual capacities. Each sense is unified and distinguished by the way or manner in which those capacities are exercised or demonstrated. This calls for an account of sensory manners. What follows develops one such proposal.

Sensory manners must individuate senses at the right grain. The aim is to offer an account that captures two facts about sense perception. First, it is possible to deploy the same perceptual capacity in distinct manners. For instance, one can perceive shapes by vision or by touch. Second, it is possible to deploy distinct capacities in the same manner. One can perceive shapes and colors in vision, pitches and loudness in hearing, or texture and warmth in touch.

To individuate senses, Matthen (2015) appeals to the actions or exploratory activities involved in perceiving. These include opening and aiming one's eyes in looking; gripping and guiding one's hands in feeling a surface; sniffing around to get a whiff; orienting one's head to optimize spatial hearing; or savoring by chewing and swishing. O'Regan and Noë (2001) pursue a related approach. Each invokes activity types to differentiate the senses.

Differing exploratory activities do bring to light differing manners in which perceptual capacities are exercised. However, the class of information-gathering activities is vast and diverse. It lacks neat structure, and its joints are not clearly marked. Exploratory activities alone are too amorphous to deliver an account of sensory manners. We need to say more.

Perceiving is enabled by extracting information contained in a stimulus. Human beings extract information from various physical sources in part by means of receptors that respond selectively to each. These tuned receptors are distributed around our bodies, collected in our sense organs. We exercise perceptual capacities by doing things that enable us to detect and differentiate objects and features through the use of our sense organs. When we exercise perceptual capacities, we do so by behaving so as to facilitate information gathering. We explore, and we glean details about our surroundings.

Sense perception thus involves using a sense organ in order to detect and differentiate things and features

in the environment, thereby exploiting or taking advantage of its capacity to transduce and thus to help extract information contained in a medium or proximal stimulus. This is a way of gathering information. Call it sensory information gathering. Sensory information gathering is a kind of information-gathering activity. On a given occasion, sensory information gathering comprises a process by means of which perceptual capacities are exercised. The details of this process determine a very specific way or manner of exercising a perceptual capacity.

Sensory information gathering reveals what is distinctive about exercising perceptual capacities using the senses. However, the ways of exercising perceptual capacities it illuminates involve very specific processes. So, it does not yet individuate senses at the appropriate grain. That requires types of sensory information gathering.

What marks the types of sensory information gathering that individuate senses? Sensory information gathering activities have numerous features in virtue of which they belong to a variety of distinct types. For instance, each involves a sense organ, a kind of energy transduced, information extracted, things and features thereby discerned, and gross body movements. Specifying these types is an empirical task, subject to philosophical interrogation.

To make progress, suppose we understand a sense organ as a collection of receptor types. If so, a sense organ is a device that transduces energy of a specific sort. Unlike a biological organ, this does not require a cellular makeup or evolutionary history, so it allows for prosthetic sense organs (cf. Keeley 2002). Even so, it is best not to tie senses to specific sense organs, in light of sensory substitution (see §6). However, classifying information-gathering activities according to the sense organs they deploy helps show the way to what unifies and differentiates senses.

Sense organs carve sensory information-gathering activities at a relatively natural joint. Each sense organ transduces energy of a specific kind. This enables a perceiver to extract information about whatever range of distal features that medium contains. The use of a given sense organ even exhibits characteristic patterns of bodily movement, revealing shared forms of action and reaction, both simple and complex, that

facilitate selectively extracting specific kinds of information from the medium.

These features do not go together accidentally. They point to a joint function. The activity they characterize serves to extract, from a given medium of transmission or stimulating energy, information of a specific sort. That is the role the activity plays. That is its purpose. We may call this its information-extraction function. My claim is that this function individuates the relevant types of information gathering. Thus, it individuates sensory manners.

The proposal is that each sensory modality is a family of perceptual capacities. In particular, each is a collection of capacities exercised in a common manner. Sensory manners are aspects of exercises of perceptual capacities. According to the account I have described, sensory manners are types of information gathering. So, each capacity belonging to a sensory modality can be exercised by means of the same type of information-gathering activity. What marks the relevant type of activity or process is its information-extraction function, which is given by the variety of information it functions to extract and the medium from which it does so. Therefore, a sense is a bundle of perceptual capacities whose exercise involves a common sort of information gathering, individuated by the information it serves to extract from a particular medium.

4 Information-extraction functions

Several features of this framework are noteworthy. The foundation is that the medium and the information it encodes are independent from perceivers and their distinctive concerns. Perceivers' activities function selectively to extract such information, as shaped by their interests and means.

First, the medium is a kind of external stimulus that triggers peripheral sense receptors. Each type of medium is a natural kind, characterized by its respective physical science. Light is electromagnetic radiation in a given spectrum. Sound is a compression wave that propagates in a material such as air or water. Molecules are chemical kinds. Pressure is mechanical force. Temperature is molecular kinetic energy. Magnetism is a polarized field of current loops.

Second, a medium bears and transmits information. Information is reduced uncertainty, or increased

likelihood (Shannon 1948). A medium encodes information concerning things and features beyond sense receptors, outside the bodies of organisms. Light encodes information about illumination sources and reflectance properties of surfaces. Sound waves contain information about the intensity, periodicity, and durations of disturbances. Chemicals bear information about volatility, decay, poisonousness, and nutritiousness of things we sniff and ingest. Mechanical forces convey resistance, solidity, texture, and shape.

Third, its physical characteristics determine which information a medium does and does not encode. In a vacuum or in air, light transmits information about illumination sources because it travels mostly undisrupted. It carries information about surface reflectance because objects selectively filter differing wavelengths. It conveys rich detail about boundaries because its wavelength is tiny relative to macroscopic objects. It reveals motion at a distance because it travels quickly. Sound waves convey little about precise spatial boundaries due to their long wavelength in relation to ordinary object sizes—centimeters to tens of meters in the human audible range. They give no indication of illumination, and not much about rotting or decomposing. Chemicals in air are too slow to reveal motion at a distance. The medium thus constrains which information it encodes and transmits.

Fourth, information extraction is selective. Not all information encoded in a medium is extracted by perceivers. Some is no use, and some we lack tools to access. For instance, converting a stimulus to neural activity fails to record each physical property that encodes information. Transducing a signal thus filters it. The process is "lossy." Downstream processes are a further filter. Sensory and perceptual subcapacities discern, decode, and thereby extract information from what is transduced. Sensory processes select what is needed to detect and differentiate features of use, discarding the rest. So, on any occasion, the information extracted from a medium is a portion of what it encodes and transmits.

Fifth, information extraction can be modeled as a relation between a medium and the information extracted from it. This yields a function from each type of medium and the information it encodes to what can be extracted from it by a type of perceiver. The medium type determines which information it encodes in an environment, and the information extracted is a selection from that.

Sixth, sensory information gathering has an information-extraction function when it functions to extract information from a medium. Its information-extraction function is characterized by the type of information it serves to extract and the medium from which it does so. Two broad notions of function are relevant, and the account is neutral between them. According to one, to have a function is to play a role in a system. For instance, a watch mainspring drives the barrel and powers the movement. According to the other, to have a function is to have a purpose or a goal. For instance, a watch tells time. So, to perform a function is to play a role or to serve an aim. Thus, for a type of activity or process to have a given information-extraction function is for it to play the role or to serve the aim of extracting from a certain medium information of a given sort. By design, in this account, activities and processes that constitute sensory information gathering play the role and serve the aim of extracting information from a medium, in the context of enabling the exercise of perceptual capacities.

Seventh, specific activities and processes that belong to such a type must serve to extract a common variety of information from the same medium. We have seen that the physical characteristics of a medium jointly encode information about a range of features. Transduction yields neural activity that also jointly encodes some of that information. Activities and processes that enable gathering information about a given feature from a certain medium therefore cannot help but enable gathering information about other such features. For instance, extracting information about reflectances requires an activity that also enables extracting information about edges, boundaries, and motion. Gathering information about pitch means gathering information about intensity. That information is entangled during encoding and transduction. Garg et al. (2019) report that even single neurons in the primate primary visual cortex (V1) code for both color and orientation.

Finally, attributing an information-extraction function requires empirical work. Which information a type of activity or process serves to extract from a medium mostly is a question for the perception sciences. Detailed accounts describe the distal sources, local cues, and means by which information is extracted. Nonetheless, it is an empirically necessary condition on being differentially sensitive to the presence of things and features in one's environment that it is possible to extract information about them that is contained

in a medium or stimulus. So, evidence for capacities to detect and differentiate is evidence for information extraction.

5 How many senses?

Questions about numbers of senses turn on questions about perceptual capacities and the manners in which they are exercised. In considering cases, one first needs to be clear what is being counted.

A *token sense*, such as my particular sense of vision, as distinct from yours, is a bundle of perceptual capacities instantiated by a perceiver.[6] Its possessor can exercise each such capacity in a common way or manner—that is, by means of an activity or process involving the same kind of sensory information gathering. Since it is individuated by its information-extraction function, each such activity type serves to extract from a specific medium a particular variety of information.

A *determinate sense*, such as human vision, as distinct from bonobo vision, is a determinate collection of perceptual capacities. It may characterize a range of perceivers. Senses can be understood as more or less determinate. Human vision and bonobo vision are more determinate senses than primate vision. Human vision just like mine is still more determinate. Capacities that constitute a single determinate sense share a sensory manner. Each can be exercised by means of a type of information-gathering activity that functions to extract a specific range of information from a medium. How the medium encodes information and how receptors transduce it constrain which information an activity can function to extract. Equipment, needs, skills, and interests shape the rest.

A *determinable sense*, such as vision, whether human or honeybee, encompasses a range of determinate senses that involve a common type of way of perceiving. A determinable type of sense modality is marked by information-gathering activities that serve to extract information from among what is encoded in a particular medium. The most determinable type of sensory modality still recognizable as such is just all those senses that serve to extract information encoded in the same kind of medium.

[6]Note that what Macpherson (2011) labels, "token senses," are determinate senses in my accounting, rather than token senses.

6 Hard cases

This approach to characterizing and differentiating sense modalities illuminates disputes about difficult cases. In hard cases, it is unclear to which sensory modality certain capacities belong. According to the capacities account, disagreement turns on predictable differences in how to specify ways or manners of perceiving. However, the account sketched here offers tools and guidance to make progress with tough cases. What follows samples how the account handles key hard cases.

6.1 Grice's four-eyed creature

Grice asks if a creature with two pairs of eyes would have two senses of vision or two distinct kinds of sense modality. Grice says the verdict depends on what it is like to perceive using each set of eyes. If the creatures reported, "there's all the difference in the world," between perceiving with one set and perceiving with the other, we should be prepared to say they possess two kinds of sense rather than one (1962, 146).

The interesting question about Grice's creatures is not whether they have one sense of vision and some other kind of sense. It is whether their two token senses are one or two determinates of the determinable sense, vision.

Start with the prior question. Why does the creature instantiate two bundles of vision-like capacities rather than just one? This question is especially pressing if the capacities are exercised in the same way or manner.

First, suppose Grice's creatures are differentially sensitive to just the same things and features using each set of eyes, as Grice suggests—he says they perceive blue and round with each. And suppose they use each set in the same way to enable this. If so, the capacities exercised using each set of eyes match. What makes this two sets of capacities rather than one?

Suppose each set of eyes is controlled separately from the other set, and that each set can target different parts of the surroundings. And suppose that, while information from each eye in a pair is integrated to ground unified awareness, as in, say, stereopsis or binocular fusion, information is not integrated in that way

between the two pairs.

If so, my view entails that the creatures possess two token visual senses of the same determinate type, while typical humans possess one token. The bundle of capacities is instantiated twice: any single capacity can have distinct independent exercises; capacities from distinct instances do not depend on each other like capacities from the same bundle instance; and some key capacities otherwise are missing from the union of the collections—for instance, the capacity to extract information about depth from paired retinal arrays, or to resolve binocular rivalry.

Counting two token senses agrees with Grice. As described, however, I disagree with Grice's other verdict. Each distinct token is a sense of vision, rather than some other distinct kind of sense. Each instantiates the same determinate collection of perceptual capacities, exercised in the same manner. According to the capacities account I have presented, a mere phenomenological difference does not by itself suffice for possessing senses of different types (cf. Ross 2001). Thus, the four-eyed creatures possess a second sense of vision, where typical humans have one.

Alternatively, suppose Grice's creatures can perceive distinct sorts of things and features using each pair of eyes. If differences in phenomenal character require differences in what seems to be perceived, Grice's claim that the phenomenology differs requires this description. If so, they do not deploy the same set of perceptual capacities using each. Thus, they possess at least one novel determinate sense.

However, this does not imply that one sense is not visual, since the capacities associated with each sense may be deployed in the same sort of manner. If, as Grice maintains, the organ is an eye-like structure that enables perception by extracting information from the light, then each rightly counts as a visual sense.

In either description, Grice's four-eyed creature has two distinct token visual senses. This case illustrates why it is important to distinguish token, determinate, and determinable senses.

6.2 Smell, taste, and flavor

Smell and taste rely on extracting chemical information. Therefore, according to the account described here, each belongs to a single determinable type of chemical sensory modality. However, human smell and

taste are distinct determinate senses. Each is a distinct collection of perceptual capacities, employed in a distinctive sensory manner.

Gustation serves to disclose the nutritive value of substances we ingest. It relies on the use of our tongues, taking advantage of taste buds' capacity to transduce and thus to enable extraction of information about sweetness, sourness, saltiness, bitterness, and umami from soluble molecules and ions. Olfaction plays a different role. It reveals attractive and repellent aspects of our surroundings by means of musky, pungent, putrid, minty, camphor, or floral odors. It relies on sensitivity to a dizzying range of airborne, volatile chemical compounds that make their way into our noses. This vector does not require direct contact with the source. Thus, smell and taste are distinct bundles of perceptual capacities, exercised by means of differing types of sensory information gathering. Each involves a distinct information-extraction function. So, smell and taste are distinct determinate senses that belong to a common determinable.

Sometimes it is suggested that flavor perception is a novel modality distinct from taste and smell (Macpherson 2011; Matthen 2015). According to the capacities approach, flavor perception need not be regarded as the work of a new sense modality. While it involves perceiving a novel feature type, and thus a new perceptual capacity, it does not implicate a wholly novel sensory manner distinct from those that mark taste and smell. Perceiving flavors, such as the mintiness of mint ice cream, is not a sui generis sensory way of exercising perceptual capacities. Savoring a wine's flavor deploys no distinct manipulable sense organ beyond the tongue, the mouth, and the nose. It exploits no new form of sensory transduction, and it relies only on information extracted through other means. Flavor perception makes use of multiple sense organs, the coordinated use of several sensory systems, and perceptual capacities jointly exercised in differing sensory manners. So, flavor perception is a multisensory perceptual capacity.

Smell and taste illustrate why it is important that distinct determinate senses, comprising distinct perceptual capacities, may rely on extracting information from the same type of medium. Flavor shows why novel perceptual capacities do not require novel sensory modalities.

6.3 Touch

Touch is tricky. Touch includes distinct determinable types of senses. Common usage recognizes a lot of variety, including active, passive, and affective touch. Focus on haptic touch. This means tactually discerning things and attributes independent from oneself, through contact, by means of forces, vibrations, and motion.

Even haptic touch is a difficult case. Active touch involves several receptor types and distinct pathways for stimulation of each kind, including mechanical forces, heat, and chemical irritation. For instance, human skin houses four types of mechanoreceptors, used to discern form, roughness, stretch, slip, and vibration. Thermoreception relies on distinct receptors for warming and cooling. All of these receptors are distributed over the body, rather than in some local cluster.

Mechanical and thermal touch rely on differing ways to exercise a perceptual capacity. Mechanoreception extracts information from mechanical forces, while thermoreception extracts information from heat. Distinct kinds of energy suffice for distinct sorts of information-extraction function. Thus, according to this paper's account, mechanical and thermal touch belong to distinct determinable types of sensory modality.

Determinates of haptic mechanoreception include senses that comprise capacities to discern extended objects, substances, and their size, shape, texture, hardness, force, and movement (see de Vignemont and Massin 2015). Thermoreception, however, requires capacities that can be exercised by means of an activity or process that functions to extract information from patterns of thermal transfer, such as sensitivity to hot and cold (for helpful refinement, see Gray 2013).

Touch is a hard case because all of its recognized forms involve perceptual capacities exercised through skin contact. It lacks a well-defined sense organ, and its receptors are comingled. Both mechanoreception and thermoreception target features of things that touch the body, and they make use of observably similar patterns of movement and exploration. Moreover, haptic and thermal features often are bound to a common tangible object. So, the activities and targets suggest a single sense.

Nonetheless, distinct ways of perceiving can target common objects, and feature binding can occur across senses (O'Callaghan 2014; cf. Fulkerson, 2014). The kinds of activities required to do so reflect close

coordination between senses, rather than the work of one sense. Still, haptic and thermal touch are not just superficially similar. At least in humans, their aims are closely aligned.

The affinities between haptic and thermal touch disguise the deeper difference. According to the capacities account I have described, thermal touch is a distinct determinable sense from haptic touch not just because it does not reveal the same type of feature, but because it extracts information from the environment in such a dissimilar manner. Touch therefore shows that how many senses we count can be revised in light of empirical discoveries, background theoretical considerations, and appreciating multisensory perception. Our perceptual capacities and the manners in which we exercise them are open to scientific and philosophical illumination.

Haptic and thermal touch illustrate that distinct perceptual capacities exercised by means of superficially similar activities nevertheless may belong to distinct determinable senses. The capacities account captures this by invoking a distinct type of information-extraction function for each of the respective activities.

6.4 Sensory substitution

Sensory substitution devices enable distinct determinate forms of perception that employ familiar human senses. One technique bypasses a natural sense organ with a device that stimulates another. Tactile visual sensory substitution (TVSS) is a familiar example (Bach-y-Rita 1967). It uses a head-mounted camera attached to a vibrotactile array that stimulates the skin. Over time, this enables subjects to discern objects, shapes, position, and motion at a distance in a way similar to vision. Another system, the vOICe, uses cameras to transcode information about a visible scene into sound.

One central question about sensory substitution is whether it enables perception associated with the substituted sensory modality. For instance, does TVSS make seeing possible? In this paper's account, it is plausible that TVSS enables a form of vision. Using TVSS, subjects exercise typical visual capacities in a manner sufficient for seeing.

The TVSS device has a head-mounted camera used by its wearer to explore and investigate the facing scene. Practiced subjects can detect and differentiate objects and spatial features at a distance. They em-

ploy the device like eyes to gather information, taking advantage of its photoreceptors and their capacity to transduce light. This enables information about distant features that is encoded in the light to be extracted. The activity serves that role. Its information-extraction function is visual, as individuated by the sort of information it serves to extract and the medium from which it does so. TVSS enables its users to perceive in a visual manner. It is impoverished compared with typical human vision, but TVSS users have a determinate sense of vision.

Nevertheless, TVSS is distinctive because it implicates the sense of touch (the vOICe implicates audition). Perception using TVSS relies on mechanoreceptors, and it exploits their capacity to transduce information from vibrations. But it does not involve the body and the skin in the exploratory patterns characteristic of haptic touch. Moreover, it extracts a very different variety of information from what vibrations typically encode. And it does not manifest the customary haptic capacities to detect and differentiate attributes of extended objects and substances that make contact with the body. Thus, in its fluent use, the capacities on display and the information-gathering activity by means of which they are exercised differ from those of touch. TVSS therefore recruits an intact sense of touch to replace typical human vision. According to the capacities account I have described, accomplished TVSS users have an atypical determinate form of vision whose employment makes use of the organ of touch.

Sensory substitution illustrates that possessing a certain type of sense modality does not rely on the usual biology. According to the capacities account I have described, what matters is having the relevant perceptual capacities and being able to exercise them by means of an activity that serves to extract the needed information from a specific medium.

6.5 Augmentation

Sensory augmentation uses technology to extend sense perception. Actual forms supplement existing token senses to add to their capacities. For instance, you might be fit with a device, such as a cochlear implant, to detect frequencies outside your current range, or above human range. This alters your determinate sense of hearing by adding to your auditory perceptual capacities, or to the typical human stock.

Hypothetical forms promise a wholly new way of perceiving. You might acquire a magnetic sense that enables you to perceive orientation with respect to Earth's polar magnetic field, enhancing your navigation skills.[7] This would secure a way of exercising perceptual capacities most humans lack. David Eagleman provocatively suggests we might develop a weather sense, a stock market sense, or a Twitter sense if hooked up to the relevant data feed. This raises challenging questions about the limits of sensory augmentation that are beyond this paper's scope. Nonetheless, the capacities account shows what is at stake.[8]

Sensory augmentation illustrates that a determinate sense may be extended to encompass additional capacities, by enabling a perceiver to extract further information from a medium, and that new determinable senses could stem from having means to extract information from a wholly novel source.

6.6 Alien senses

Non-human senses can be familiar or unfamiliar. Bunnies discern frequency and localize sounds far better than we do. Honeybees detect ultraviolet light. Bunnies and bees have capacities humans lack, but they still hear and see. Since they gather information about similar things and features from the same type of medium, familiar senses of non-human animals are distinct determinates of determinable senses humans possess.

Other senses are alien to us. A shark's capacity to navigate and find prey using magnetic and electrical fields reveals a novel electromagnetic sense. The distinctive way sharks perceive is an unfamiliar determinable type of sense. Its determinate forms are fixed by the capacities they exercise in that foreign electromagnetically sensitive manner. Extraterrestrial aliens could have senses of a sort wholly novel to Earth. Such senses require wholly alien ways or manners of perceiving.

What about echolocating bats and dolphins? According to the capacities approach, each has a sense of

[7] Maybe you would not need a new sense organ. Wang et al. (2019) report electroencephalographic (EEG) evidence (alpha-event-related desynchronization) that human brains are differentially sensitive to the local orientation of Earth's magnetic field.

[8] "Can we create new senses for humans?" (TED talk, March 2015, URL = `https://youtu.be/4c1lqFXHvqI`). It would be challenging to implement appropriate information-gathering activities and processes that served to extract such information and thus to enable the exercise of corresponding perceptual capacities that become integrated in our existing perceptual repertoire. Thus, it would be a surprise for Eagleman's examples to qualify as genuine modalities of sense perception.

hearing, comprising auditory perceptual capacities. But the determinate collections of auditory capacities bats and dolphins possess are in certain respects far more extensive (and overlap more with vision), while the information-gathering activities by which they wield them are more interactive (like using a flashlight), when compared with typical human hearing.

Alien senses of non-human creatures illustrate that it is important to distinguish distinctive determinate senses of a familiar determinable form from wholly novel determinable senses.

6.7 Synopsis

According to the capacities account, a sense is a bundle of perceptual capacities. Each distinct bundle shares a common sensory manner. A sensory manner is a sort of information gathering activity. As developed here, each such activity type is marked by the information it serves to extract from a given medium.

This approach to the senses is realist. Sense individuation turns on genuine physical and psychological commonalities and differences, not just pragmatic interests. It answers to the perceptual capacities a perceiver possesses and to the distinctive ways in which those capacities are exercised. It offers a univocal way to differentiate distinct token, determinate, or determinable senses.

It is a strength of the capacities approach I have described that it provides resources to characterize and help resolve key hard cases. And it offers defensible verdicts.

7 Multisensory perception

How does this approach handle multisensory perception and consciousness? Understanding distinct senses as capacities organized by the manners in which they are exercised offers taxonomic payoff in characterizing multisensory phenomena.

In the first place, the account illuminates what makes a perceptual capacity unisensory or multisensory. Start with sensible features. A *proper sensible* is a feature accessible with just one sense. Accordingly, it is a feature targeted by a perceptual capacity that can be deployed in only one sensory manner. For instance, for typical humans, pitch is perceptible only by means of an information gathering activity that functions

to extract information about distal events and features encoded in sound waves. This approach allows for multiple proper sensibles of one sense. These are distinct proper sensibles accessible in a common sensory manner, none of which is perceptible by means of any other sense.

A *common sensible* is accessible with multiple senses. It is a feature targeted by a perceptual capacity that can be deployed in more than one sensory manner. For instance, shape and motion are perceptible not only through an activity type that involves the use of the eyes but also though a type of activity that implicates the skin and mechanoreception. Each has a distinct information-gathering function, corresponding to the extraction of information from light and from mechanical forces, respectively.

Ascribing a perceptual capacity for the purpose of predicting and explaining performance involves specifying what is accomplished, in what conditions, and in which manner. The senses are bundles of capacities individuated by a common way or manner of perceiving. This enables us to characterize what makes a perceptual capacity unisensory, unimodal, or multisensory.

Say that a *unisensory*, or *sense-specific*, *perceptual capacity* is one that can be exercised in only one sensory manner. For instance, there is only one relevant sort of manner in which one can detect and differentiate a proper sensible, such as pitch. However, unisensory capacities need not be limited to those targeting proper sensibles. Multiple object tracking, for example, is unisensory if it is only exercised visually.

A *unimodal capacity*, as I understand it, is one for which an exercise can occur in a single manner. By this I mean that, like a unisensory capacity, one sensory manner exists per token exercise; however, in contrast with a unisensory or sense-specific capacity, a unimodal capacity can be deployed in distinct ways. Thus, a unimodal capacity may belong to multiple senses. For example, the capacity perceive a common sensible, such as texture, may be deployed separately in vision and in touch.[9]

Turn now to forms of perception that involve multiple senses. A *multisensory capacity*, in this choice of terminology, is one that can be deployed multisensorily, or in a way that relies on more than one sensory

[9]It is more common to label such capacities *amodal*. However, this elides the distinction between a capacity that can be exercised in distinct sensory manners and a capacity that cannot be exercised in any specific sensory manner. 'Amodal' may be reserved for capacities of the latter type.

manner. A capacity that can be exercised using one sense at a time nonetheless may also be exercised in a way that jointly employs more than one sensory manner. This is the case when a subject perceptually identifies an object or feature discerned using distinct senses, or when a subject is perceptually sensitive to an intermodal spatial, temporal, or causal relation. For example, you can perceive identity, space, time, and causality with just one sense, but you also can perceive novel intermodal instances of such features by using several senses in coordination. These are critical cases that have been used to diagnose genuinely multisensory capacities because they rely on the joint use of multiple senses.

A *novel*, or *distinctive*, *multisensory capacity* is one that cannot be exercised originally using one sense at a time, or by means of a single sensory manner. Flavor and balance perception are examples. Flavor and balance are accessible only multisensorily. Perceiving such novel features relies on the joint use of multiple senses. Each relies on information extracted from several distinct sources. Each is distinctively, ineliminably multisensory.

Therefore, according to the capacities account of the senses, possessing multisensory perceptual capacities is compatible with having genuinely distinct senses. What is more, in this account, multisensory capacities require distinct senses. That is because multisensory capacities require for their exercise multiple ways or manners of sensory information gathering, engaged jointly. That is, they rely on activities of distinct types that function in different ways to enable us to extract information about distal features from a medium. Such complex activities serve to extend our perceptual capacities.

This account has two noteworthy consequences. The first is that the senses are not exclusive. It is possible for a perceptual capacity to belong to more than one token, determinate, or determinable sense. For instance, the capacity to detect and differentiate motion is part of human vision and audition. The second is that the senses are not exhaustive. By this I mean that not every perceptual capacity must belong to some individual sensory modality or another. Some novel perceptual capacities require for their exercise the joint use of several senses. Possessing such a capacity relies on coordination among senses.

8 Experiences

What about perceptual experiences? Senses are bundles of perceptual capacities. Experiences are not capacities. In virtue of what do perceptual experiences belong to sensory modalities? Multisensory phenomena have been said to pose special trouble here (Tye 2003; Speaks 2015). How do we pry apart experiences that constitutively involve multiple senses?

The capacities account enables us to ascribe perceptual episodes to sensory modalities. And it does so in a way that is compatible with richly multisensory perception and consciousness.

Perceptual episodes are events or occurrences that involve the exercise of one or more perceptual capacities. Perceptual experiences are phenomenally conscious perceptual episodes. They are perceptual episodes in which a subject instantiates phenomenal character.

Exercising a perceptual capacity requires doing so in some way or manner. Therefore, perceptual episodes belong to types corresponding to the manners in which subjects manifest perceptual capacities. For instance, an episode is auditory just in case it involves exercising capacities in the manner characteristic of audition—that is, by means of an information-gathering activity with the function to extract from pressure waves information about features such as sounds, pitch, timbre, loudness, duration, and location. Manner, and thus modality, is an attribute or aspect of a perceptual episode. This provides a scheme for attributing experiences to sensory modalities. Accordingly, a typical human subject perceives auditorily, visually, tactually, olfactorily, or gustatorily.

Multisensory perception is no special obstacle. Most perceptual episodes involve exercising perceptual capacities in several sensory manners. Each such episode belongs to several sensory modalities. For instance, watching a movie typically involves episodes that are both visual and auditory. The noteworthy consequence is that, like the senses themselves, the modalities of a perceptual episode are not exclusive. Belonging to one sensory modality does not preclude belonging to another. Being visual does not rule out being auditory.

Here, there is a taxonomic payoff in characterizing perceptual episodes. A *unisensory episode* involves the exercise of perceptual capacities in just one sensory manner. Touching a rough surface in darkness and

silence may be an example. A *multisensory episode* is one in which perceptual capacities are deployed in more than one sensory manner.

It is theoretically fruitful to add a further distinction. A *minimally multisensory episode* is one that involves the exercise of perceptual capacities in more than one sensory manner but in which each of the capacities exercised is unimodal, relying on no more than one sensory manner. On the other hand, a *richly multisensory episode* involves deploying a multisensory capacity and relying for its exercise on more than one sensory manner.

What about parts of perceptual episodes or experiences? It is common to say that perceptual experiences comprise co-conscious components of the various sensory modalities. This may be used to justify focusing on a single sense, such as vision alone (see, for example, Siegel 2010, 19–21). However, if experiences are conscious episodes, then experiences are events. As such, experiences need not apportion neatly into parts, each of which itself is a conscious episode that belongs to a single modality (Tye 2003, chapter 1).

My view is that we should forget about carving up perceptual episodes and analyzing them in terms of individual sense-specific parts. Nevertheless, it is intuitive to think that seeing a cardinal is a proper part of my current conscious experience. We can address the intuition by saying what it is for features, including phenomenal features, to be *associated with* a given sense modality on an occasion. The features of a particular episode that are associated with a given sensory modality include just those that a corresponding unimodal episode could have under equivalent stimulation, where a unimodal episode is one that belongs to a given sensory modality but that does not belong to any other sensory modality. For illustration, suppose that right now you are having a complex multisensory experience. The features of your current experience that are associated with vision include just those that a corresponding unisensory visual experience—one that is visual but not auditory, tactual, gustatory, or olfactory—would have under equivalent sensory stimulation. And so on for each sense. So, we can say that a feature, such as phenomenal character instantiated in consciously perceiving scarlet, is associated with vision, while denying that conscious episodes decompose to yield a neat visual part.

This has a further taxonomic payoff. A *minimally multisensory experience* is innocuous. It is a conscious episode whose features are exhausted by those associated with each of the respective sensory modalities, plus those that accrue thanks to mere co-consciousness. A *richly multisensory experience* is more interesting. It is a conscious episode whose features are not exhausted by those associated with each of the respective senses, plus those that accrue thanks to mere co-consciousness. Consciously perceiving a novel intermodal feature, such as identity, simultaneity, causality, or flavor, is an example of a richly multisensory perceptual experience.

This leads to a final significant consequence. The approach I have described does not require that every feature of a perceptual episode, including its phenomenal features, on each occasion must be associated with some sensory modality or another. The senses are not exhaustive in this way. Accordingly, not all phenomenal character is sense specific, even allowing for whatever stems from simple unity of consciousness. This approach therefore enables us to reject the exhaustiveness of the senses, understood as experiential modalities.

The capacities approach to characterizing and differentiating the senses thus accommodates even richly multisensory forms of perception and consciousness. Multisensory perception and consciousness are compatible with distinguishing distinct senses, attributing perceptual episodes to sensory modalities, and associating features of episodes with specific senses. The key is to reject the exclusiveness and exhaustiveness of the senses. When we take the right approach to individuating the senses, multisensory phenomena do not pose trouble for the project of differentiating distinct senses. In fact, a proper understanding of the senses illuminates the nature and the purpose of multisensory phenomena.

9 The significance of the senses

Nudds (2003) says that an account of the senses should address their significance. What explanatory gain stems from distinguishing distinct senses? With the capacities approach now in view, let us revisit why it is valuable to differentiate distinct senses. Why does it matter that we possess distinct senses rather than just

a long list of perceptual capacities? The account I have described captures six reasons why distinct senses matter.

First, there are vastly different ways to exercise the same perceptual capacity and noteworthy similarities in how subjects exercise distinct capacities. An account that explains why has advantages in economy and generality. Sensory manners capture important aspects of the grain of the sensory landscape.

Second, each sense reveals a certain range of features that serves a perceiver's specific needs. Each sensory manner enables perceivers to extract the requisite information. For example, if you want to find ripe tomatoes on tangled vines, exploring with your eyes to extract information about colors, shapes, and extended objects from the light is a good strategy. On the other hand, to find your lost phone, it is better to call it and use your ears, taking advantage of their capacity to transduce and thus enable information about spatial location to be extracted from pressure waves. Taste and smell serve a host of critical needs concerning nutrition and harm avoidance by means of their chemical sensitivities. The account described explains how differing forms of sense perception enable creatures to meet differing kinds of needs.

Third, multiple ways of perceiving can enhance your epistemic position. Using different ways of gathering information expands your view, and it gives you another angle. It provides information about new things and features, and it offers further information about things and features perceived in other ways. Making use of multiple information sources thus helps you to be not just more comprehensive but also more accurate and more reliable. Sense perception works better with multiple ways of exercising perceptual capacities. This can accrue to your epistemic standing.

Fourth, just as possessing multiple senses has practical benefits, being able to exercise perceptual capacities in multiple ways proves useful. For instance, redundancy improves resilience. Distinct sorts of information gathering can target the same things and features. So, a perceiver can still function without one or more ways of exercising perceptual capacities. Flexibility also helps. In planning and acting, it is good to be able to mine several information sources.

Fifth, according to this account, distinct senses provide valuable third-person information about what

and how someone else has perceived. For example, if I tell you that Edith has seen the Rubik's Cube, rather than just that she has perceived it, then you are in a position to know what other sorts of features she is likely to have perceived, such as its pattern of colored stickers, and also why she perceived those features rather than its weight or its characteristic *tchk*ing sound. This in turn enables you to attribute to Edith corresponding experiences and beliefs, and it gives you good reasons for doing so.

Sixth, distinct sensory manners can be employed jointly, rather than independently and in parallel, to extend one's perceptual capacities. Employing distinct information-gathering activities in coordination is a novel, complex form of activity. It enables the exercise of perceptual capacities that otherwise could be deployed only separately. It does so because it enables perceivers to extract information about features that is encoded jointly by distinct sources. Subjects thereby can detect and differentiate novel intermodal instances of features such as rhythm and causality and novel types of features such as flavors and balance. The capacities account thus explains why sense perception can do more when distinct ways of perceiving are used in coordination.

The capacities approach therefore is able to capture and elucidate the significance of the senses.

10 Conclusions

According to the account described, senses are families of perceptual capacities. These include capacities to detect and differentiate things and features in one's environment. Senses are differentiated by a distinctive way or manner of exercising perceptual capacities. Sensory manners are information-gathering activity types. Each is individuated by an information-extraction function, determined by the sort of information the activity serves to extract and the medium from which it does so.

Sensorily perceiving involves exercising perceptual capacities in some such manner. Perceptual episodes belong to types that correspond to the manners in which perceptual capacities are exercised. It is important that such types are not exclusive. Attributing an episode to one sensory modality does not preclude attributing it to another.

Experiences are phenomenally conscious episodes. They are episodes in which a subject instantiates phenomenal character. Experiences may be ascribed to sensory modalities according to the manners in which perceptual capacities are exercised. According to this account, phenomenal features do not play an essential role in individuating senses or in attributing experiences to sensory modalities. Modality is not a fundamental determinant of phenomenal character. Modality is not an experientially basic category.

Boundaries between senses thus need not be evident just in examining phenomenology. Subjects may have only limited knowledge of the senses with which they perceive on any occasion. Moreover, not every feature of a perceptual episode, including its phenomenal features, must be associated with one sense or another. In this respect, not all perceptual experience is modality specific. Individual senses are not exhaustive.

According to this account, perceptual processes associated with distinct senses can interact extensively, and some perceptual capacities may require coordination and cooperation among senses. Moreover, some forms of perceptual consciousness may be constitutively and ineliminably multisensory. So, it comports with the science and the philosophy of multisensory perception and consciousness.

This framework distinguishes the project of characterizing and differentiating senses from that of attributing perceptual episodes and experiences to sense modalities. It provides a principled, informative account of the senses according to which typical human subjects and other creatures possess multiple senses, and it is compatible with richly multisensory perception and consciousness. Multisensory perception and consciousness do not challenge the distinctness of our senses, but we ought to reject their independence.[10]

[10]Many thanks to Austin Andrews, Jake Beck, Jonathan Cohen, Carl Craver, Matt Fulkerson, John Heil, Kathryn Lindeman, Peter Ross, Susanna Schellenberg, and Barry C. Smith for invaluable conversations and insightful written comments. Audiences and hosts at the Institute of Philosophy, Glasgow, Illinois State, UCSD, Jerusalem, Texas, NYU, Rutgers, SSPP, Notre Dame, and Miami asked sharp questions that helped me to improve this paper. The editors and anonymous referees offered constructive critical feedback that shaped the final version. This paper develops, revises, and extends ideas from O'Callaghan (2019, chapter 6).

References

Aristotle (1984). *The Complete Works of Aristotle: The Revised Oxford Translation*. Princeton University Press, Princeton, NJ.

Bach-y-Rita, P. (1967). Sensory plasticity: Applications in a vision substitution system. *Acta Neurologica Scandinavica*, 43:417–426.

Clark, A. (1993). *Sensory Qualities*. Clarendon Press, Oxford.

Cummins, R. (1983). *The Nature of Psychological Explanation*. MIT Press, Cambridge, MA.

de Vignemont, F. and Massin, O. (2015). Touch. In Matthen, M., editor, *Oxford Handbook of Philosophy of Perception*, chapter 16, pages 294–313. Oxford University Press, Oxford.

Fodor, J. A. (1983). *The Modularity of Mind*. MIT Press, Cambridge, MA.

Fulkerson, M. (2014a). *The First Sense: A Philosophical Study of Human Touch*. MIT Press, Cambridge, MA.

Fulkerson, M. (2014b). Rethinking the senses and their interactions: the case for sensory pluralism. *Frontiers in Psychology*, 5(1426):1–14.

Garg, A. K., Li, P., Rashid, M. S., and Callaway, E. M. (2019). Color and orientation are jointly coded and spatially organized in primate primary visual cortex. *Science*, 364(6447):1275–1279.

Gray, R. (2013). What do our experiences of heat and cold represent? *Philosophical Studies*, 166(S1):131–151.

Grice, H. P. (1962). Some remarks about the senses. In Butler, R. J., editor, *Analytical Philosophy: First Series*, pages 133–153. Blackwell, Oxford.

Heil, J. (1983). *Perception and Cognition*. University of California Press, Berkeley, CA.

Heil, J. (2012). *The Universe as We Find It*. Oxford University Press, Oxford.

Keeley, B. L. (2002). Making sense of the senses: individuating modalities in humans and other animals. *Journal of Philosophy*, 99(1):5–28.

Lewis, D. (1980). Veridical hallucination and prosthetic vision. *The Australasian Journal of Philosophy*, 58:239–249.

Lopes, D. M. M. (2000). What is it like to see with your ears? The representational theory of mind. *Philosophy and Phenomenological Research*, 60(2):439–453.

Machamer, P., Darden, L., and Craver, C. F. (2000). Thinking about mechanisms. *Philosophy of Science*, 67(1):1–25.

Macpherson, F. (2011). Taxonomising the senses. *Philosophical Studies*, 153(1):123–142.

Matthen, M. (2015). The individuation of the senses. In Matthen, M., editor, *The Oxford Handbook of Philosophy of Perception*, pages 567–586. Oxford University Press, Oxford.

Nudds, M. (2003). The significance of the senses. *Proceedings of the Aristotelian Society*, 104(1):31–51.

O'Callaghan, C. (2012). Perception and multimodality. In Margolis, E., Samuels, R., and Stich, S., editors, *Oxford Handbook of Philosophy of Cognitive Science*, pages 92–117. Oxford University Press, Oxford.

O'Callaghan, C. (2014). Intermodal binding awareness. In Bennett, D. J. and Hill, C. S., editors, *Sensory Integration and the Unity of Consciousness*, pages 73–103. MIT Press, Cambridge, MA.

O'Callaghan, C. (2019). *A Multisensory Philosophy of Perception*. Oxford University Press, Oxford.

O'Regan, J. K. and Noë, A. (2001). A sensorimotor account of vision and visual consciousness. *Behavioral and Brain Sciences*, 24:939–1031.

Peacocke, C. (1983). *Sense and Content*. Clarendon Press, Oxford.

Rosenthal, D. (2015). Quality spaces and sensory modalities. In Coates, P. and Coleman, S., editors, *Phenomenal Qualities: Sense, Perception, and Consciousness*, pages 33–65. Oxford University Press, Oxford.

Ross, P. W. (2001). *Qualia* and the senses. *The Philosophical Quarterly*, 51(205):495–511.

Schellenberg, S. (2018). *The Unity of Perception*. Oxford University Press, Oxford.

Shannon, C. E. (1948). A mathematical theory of communication. *The Bell System Technical Journal*, XXVII(3):379–423, 623–656.

Shimojo, S. and Shams, L. (2001). Sensory modalities are not separate modalities: plasticity and interactions. *Current Opinion in Neurobiology*, 11:505–509.

Siegel, S. (2010). Do experiences have contents? In Nanay, B., editor, *Perceiving the World*, chapter 12, pages 333–368. Oxford University Press, Oxford.

Speaks, J. (2015). *The Phenomenal and the Representational*. Oxford University Press, Oxford.

Tye, M. (2003). *Consciousness and Persons: Unity and Identity*. MIT Press, Cambridge, MA.

Wang, C. X., Hilburn, I. A., Wu, D.-A., Mizuhara, Y., Cousté, C. P., Abrahams, J. N. H., Bernstein, S. E., Matani, A., Shimojo, S., and Kirschvink, J. L. (2019). Transduction of the geomagnetic field as evidenced from alpha-band activity in the human brain. *eNeuro*, 6(2).