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Making Sense of the Senses:

Individuating modalities in humans and other animals

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Abstract

How ought we differentiate the senses? For example, what distinguishes vision from audition from olfaction, and how many senses are there, exactly? I argue that these questions come in two versions. First, there is the traditional problem of individuating the senses in humans, which goes back to Aristotle's solution that we have five senses. Second, there is also an important question about what sensory modalities we ought to attribute to non-human animals, a version of the question that has been virtually ignored by philosophers. In this paper, I argue that modality ought to be construed as an "avenue into" an organism for information external to the nervous system. I examine a collection of seven proposed criteria found in the philosophical literature concerning the senses. Initially, the four criteria I support—physics, neurobiology, behavior, and dedication—are shown to be individually necessary and jointly sufficient. Next, three criteria—Aristotle's proper objects of sensation criterion, Grice's sensation or qualia criterion, and Nelkin's belief criterion—are considered and rejected. However, one overall goal of this paper is to show that there is interesting contemporary work left to be done on this

ancient philosophical question.

I

Introduction

One of the perhaps most striking phenomenological facts about the human perceptual experience of the world is that it seems to be divided up into modes. That is, our perceptions of the world are delivered to us in distinct classes, those of the separate sensory modalities: vision, hearing, touch, etc. When confronted with, say, a horse after a long ride on a hot summer's day, we experience vivid impressions of the animal in the form how it looks (large and brown), how it sounds (loud, heavy breathing), how it feels to the touch (hot and slick with sweat), how it smells, etc. That these different modes of experience are, well…different seems beyond question. The existence of separate sensory modalities would seem to be a brute fact about perception, if ever there was one.

The apparent "bruteness" of this fact of human experience might explain why, throughout history, philosophers and perceptual scientists have had relatively little about the nature of this difference. Yet, the apparent fact of this difference lay at the very foundation of philosophical and scientific questions about the senses. Its very centrality is what makes it simultaneously both a difficult and crucial question: Exactly what is it that distinguishes the senses from one another? Further, apparent bruteness should never be an excuse for lack of philosophical attentiveness.

The goal of the present essay is two-fold. First, I want bring attention to this under-explored topic; to bring together much of what little has already been written on it and, in doing so, to encourage others to take up the challenge it represents. Second, I also have my own proposal for answering the question. The answer is based on the criteria used in neuroethology, one of the sciences that daily confronts issues related to distinguishing, comparing and contrasting sensory modalities. Distinguishing the senses in a way useful to perceptual sciences—i.e., those sciences that study perception—requires knowledge of several factors, including the

categories of physics, as well as the neurobiology, evolutionary biology, and behavior of the organism whose senses are to be distinguished. On my account, to possess a genuine sensory modality is to possess appropriately wired-up sensory organs that are historically dedicated to facilitating behavior with respect to an identifiable physical class of energy. I suggest that the correct way to think about modality is best suggested by a definition of the term in Webster's Ninth New Collegiate Dictionary: “One of the main avenues of sensation (as vision).” Modality is an “avenue into” an organism. Question: what travels on an avenue? Answer: information about the physical state of the world exterior to the central nervous system (CNS). What constitutes an “avenue” itself? An evolutionary dedicated sensory organ that converts energy into nerve impulses and conveys those impulses to the CNS. This captures the original sense of the term: the different senses are different “modes” of perceptual interaction with the world.

With that as a preview of things to come, I will leave further discussion of my proposed answer to Sections II (where I discuss how to set up the problem of distinguishing the senses) and III (where I present my proposal in detail). Perhaps surprisingly, I will argue that the distinct experiential qualities of perception—the qualia—so central to the commonsense understanding of perception are simply non-starters for a scientific understanding. I draw a similar conclusion about the most venerable theory of the senses: Aristotle’s account of the senses in terms of the “proper objects of sensation.” In Section IV, I will turn my attention to these *prima facie* plausible proposals in order to show how they fail to provide a firm foundation for an empirically adequate account of sensory differentiation.

Both the Aristotelian and the qualia-based approaches are best thought of as representing commonsense or folk psychological accounts of the senses. While they may well be adequate for this purpose this is not my goal in this essay. To the contrary, I offer what might be termed a “thoroughly naturalized” approach to distinguishing the senses; one that proposes to make sense of the problem as it presents itself to the perceptual sciences. Therefore, one way of looking at what I do in this paper is to provide an eliminative materialist theory of the sensory differentiation as an alternative to more traditional, commonsense theories. To my knowledge,

the account I offer here is the first of its kind in the philosophical literature.

However, before proceeding to the answers, I need to explain a little more fully what is the *philosophical* question here. What is it about the question of how we ought to differentiate the senses from one another that should draw the interest of philosophers? Further, what is the philosophical payoff?

Let's get the somewhat facetious answer out of the way first. If one defines philosophical problems as those questions that actual philosophers find important enough to grapple with, then the issue of distinguishing the senses would seem to qualify as sufficiently philosophical. Although, as I note above, the topic has received relatively little philosophical interest, it has nonetheless drawn the interest of philosophers as varied as Aristotle, Paul Grice, David Armstrong, and Nelson Goodman, to name only a few. Introducing his take on the issue, John Heil (1983) observes that, "Regrettably, philosophers have had little to say about what distinguishes the senses from one another" (3). However, that situation may be changing, as evidenced by the recent papers of Lopes (2000), Noë (forthcoming), and Ross (unpublished).

The "philosophy-is-what-philosophers-do" answer is only as good as far as it goes. Surely, we can say more about the source of this interest. Turning again to Heil: "An explication of the senses, a determination of what constitutes a sensory mode must, it seems, occupy a position of central importance in any theory of perception" (ibid). Perceptual psychology (particularly psychophysics), sensory biology, neuroethology, and numerous other sciences make foundational use of the notion of separate senses without much discussion of the details. (Not surprisingly, the ecological psychologist J. J. Gibson (1966, 1979) is an exception to this blanket generalization.) Such sciences typically just <u>assume</u> the existence of different senses. One sees this reflected in the textbooks used in undergraduate psychology and neuroscience curricula. These textbooks are often divided up into chapters covering the various separate senses, but it is rare to see an explanation for what makes the separate senses separate. (Not that this is a feature unique to scientific theorizing. Philosophical theories of perception likewise tend to start from an unexplicated foundation of differentiated senses. Those that do explicate such a

foundation typically do so in terms of the approaches I will criticize in Section IV.)

I agree with Nelkin (1990): The question of differentiating the senses, “asks how we should define the senses so as to make them scientifically useful concepts. More metaphysically, [it] asks what is the real nature of the senses” (149, emphasis in original). That is, the issue engages philosophy of psychology in both of its emphases. To the extent that philosophy of psychology is a branch of philosophy of science, the notion of the senses as differentiated from one another is a core notion in perceptual sciences; a scientific assumption requiring philosophical justification. Of course, philosophy of psychology also has a foot in philosophy of mind, and Nelkin’s “more metaphysical” aspect of the issue invokes that connection. Part of what is required in spelling out this fundamental aspect of perception involves explicating exactly what sort of metaphysical entity a sensory modality is.

In discussing this topic with colleagues, I have discovered a surprising amount of unrecognized disagreement between individuals. For example, some have strong intuitions that the problem of differentiating the senses is intimately tied up with qualitative experience, to the extent that a “non-conscious sensory modality” is seen as an oxymoron. To have a sense is to have a unique set of experiences—qualia—associated with that sense. However, others see the issue as much more related to the sorts of things in the world that can affect behavior, regardless of whether we are ever consciously aware of such influence. For example, they feel that we would be right to posit a human magnetic sense if people could be shown to behaviorally respond to magnetic stimuli in a systematic fashion whether we experience “magnetic qualia” or not. The first group holds that this could not be any more misguided. Still others I have talked with insist that the senses are strictly related to sensory organs; for example, refusing to accept the existence of a genuine “vestibular sense” until informed of the existence of the semicircular canals and associated cranial nerves and brainstem nuclei. “No organ, no sense” seems to be their rule.

As it turns out, these differing intuitions agree on Aristotle's classic five senses, so people tend not to notice their different intuitions. Such apparently widespread agreement reinforces the

strength with which these intuitions are held. After echoing the sentiment that the differentiation of the senses are “seldom been directly discussed,” Roxbee Cox (1970) goes on to diagnosis this curious condition by supposing that it may be “...due to the fact that certain answers have seemed to different people so obvious that they did not need to be supported by argument” (530). However, while different people agree there is no significant problem left to be solved, they respectively conceive of the solution in very different ways. The disagreement between individuals begins to become clear once we start considering potential senses in addition to Aristotle’s five, examples of which I'll be discussing below. What makes the problem of discriminating the senses philosophically interesting is that the intuitions here are fundamental (to an understanding of perception), relatively firm, and generally unrecognized by the people who hold them. When one finds a disagreement with these three qualities, it is a clarion call for philosophical inquiry.

That I will argue that qualia are not central to differentiating the senses indicates a philosophical payoff from the topic of this paper. The legitimacy of the concept of qualia in our scientific understanding of the mind is a matter of ongoing controversy. One line of argument might run thus:

> **P1:** Qualia are essential to the project of differentiating the senses; one cannot make sense of different senses except by reference to the qualitative character of perceptual experience.
>
> **P2:** Differentiating the senses is an essential component of any science of perception, such as perceptual psychology, cognitive science, or sensory biology.
>
> / **C:** Qualia are essential to science.

I fully accept P2. However, in offering my “qualia-free” account of sense differentiation, I will be attacking P1; an attack which, if successful, can only undermine one of the primary purposes for which qualia could be useful. However, if the account I defend here is wrong, and

qualia are essential to differentiating the senses, then this would represent a powerful, new argument for the scientific legitimacy, nay the scientific necessity, of qualia.

For these reasons, I suggest that it is clear that the problem of how to differentiate the sensory modalities is an interesting and important philosophical topic. I will return to the topic of philosophical implications in the final section, Section V. That said, assuming I have adequately justified the legitimacy of the topic, in the next section, I will consider how I will address the question and consider what form the answer should take.

II

How to think of the question and the form of its answer

Aristotle famously counted five human sensory modalities: vision, hearing, taste, smell, and touch. Since then, his list has been expanded to include such potentially novel modalities as proprioception (our sense of the relative location of our limbs) and the vestibular sense (the sense of one's orientation with respect to gravity). In addition, it has been suggested that some of Aristotle's senses should be subdivided, e.g., replacing touch with multiple modalities represented by the separate sensory systems found in the skin that are differentially responsive to temperature or degrees of mechanical pressure. So, Aristotle undercounted but by how many? Reviewing the human sensory literature, Rivlin & Gravelle (1984) claim that, “Five [is] obviously just not enough to account for the huge range of sensory possibilities of which the human species is capable; seventeen senses is probably a more accurate count” (17, my emphasis).

Lurking behind the empirical seeming question of how exactly many modalities there are, in fact, we find a philosophical question of how we ought to count them. By what criterion (or set of criteria) should we count individual senses? I believe it is wise to recognize two different versions of this problem. The first version I call “Aristotle's problem:” how many modalities do humans have and how ought we decide the issue? For example, what exactly is needed to say whether we have vestibular sense? This version of the problem is rather hoary, and I do not

believe I need to introduce it further.

The same problem arises again, in a slightly different guise, in animal sensory biology. When he counted five, Aristotle was writing not only of humans, but all animals. He not only counted a total of five human senses, he also thought there were a sum total of five senses to be found in the entire animal kingdom. However, just as we now think he undercounted the senses of humans, we also have good reason to believe that he underestimated the sensory skills of other species. The animal kingdom is full of all sorts of wonderful ways of detecting the world. Honeybees have visual capacities in the ultraviolet range (Von Frisch 1960). Certain snakes and boas use special pits below their eyes to sense infrared (Bullock & Cowles 1952). It has been proposed that certain fish, such as shad, can hear in the ultrasonic frequency range (Mann et al 1998), as can bats (Griffin & Galambos 1941).

While all these examples are interesting, one might argue that they are not genuinely different from human sensory capacities. If our ears or eyes, say, were built just a little different then we too could hear in the ultrasonic range or see in the infrared. Nonetheless, there are animals with sensory capacities that are extremely alien with respect to human capacities. Sharks are apparently capable of sensing magnetic fields (Kalmijn 1982, 1987). There are also animals—several species of fish, for example—that are capable of perceiving electricity (Keeley 1999, 2000).

Consider, for a moment, the star-nosed mole. Perhaps the most striking thing about this animal is the structure that gives the animal its name: an elaborate, fleshy, tendriled nose (Figure 1). Casual observation quickly reveals that its star-shaped nose is most likely a sensory organ. It constantly jabs its nose against the ground when exploring its environment. For the sensory biologist, a question arises: given that the nose is indeed a sensory organ, what sensory modality is being used? Is the nose a tactile receptor, a chemoreceptor, or perhaps even an electroreceptor? These questions have been a topic of recent debate in biology. In 1993, Gould and his colleagues at the Smithsonian Institution published experiments suggesting that the star-nosed mole uses its nose for electroreception. Others (Schlegel & Richard 1992) dispute this

claim, and the recent work of Catania (Catania & Kaas 1995; 1996) argues that the nose's modality is most likely tactile in nature.

Figure 1: A star-nosed mole. Assuming its fleshy, tendriled nose is a sensory organ of some type, what modality does it use?

For the philosopher, the problem raised by this scientific controversy deals with the criteria to be applied in answering the question about what sense the star-nose mole is using. On what philosophical grounds should we decide which organisms possess which modalities? What kind of evidence would be required to make a decision? When scientists claim to have discovered a new sensory modality, what is the theoretical content of this claim? If philosophers have paid relatively little attention to Aristotle’s problem, they have almost completely ignored what I propose to call the “star-nose mole problem” (although it is not restricted to these organisms).

The above discussion gives some feel for what I take the question to be; however, before continuing, I should say a little more about my assumptions concerning the appropriate form of the answer. I introduced the topic by proposing that we should think of the sensory modalities as “avenues” into the organism for information about the physical state of the external world. Further, I draw the boundary at the edge of the CNS. At this point, three questions arise. First, why draw a boundary at all? Central to the concept of perception is that there is a duality: a perceiver and a perceived; some kind of psychological entity and that to which the psychological entity’s states are causally connected. Senses do not exist in vacuu; they are possessed by “sensers” and, at the most basic level of analysis, they act as some kind informational connection between the world and the psychological entity which possesses them. It would seem that a theory of perception must posit a boundary between the perceiver and the perceived. The concept of modality would then refer to the different ways in which information about the world crosses that boundary.

Second, if we must draw such a boundary, is it not necessarily arbitrary? Why draw the

boundary one place versus another? My answer is that drawing the boundary at the CNS is not arbitrary if we keep in mind my initial starting point: I am here presenting a concept of sensory modality that is useful to sciences that deal with human and animal perception.[1] Given an environment and some kind of psychological system under investigation—two things I am assuming here—a sensory modality is a potential mode by which information in the environment can pass through some boundary and enter into the psychological system. If we are materialists and believe that the central nervous system is somehow the locus of the mind, then it is not arbitrary to draw the boundary between the environment and the psychological system at the “world/CNS” junction.

Finally, I claim that the appropriate boundary surrounds the central nervous system and not the body in general. I do not have space to go into the example here, but I wish to leave open the possibility of “internal modalities,” for example, our sense of body position (proprioception) or our sense of thirst (which is mediated by blood osmotic pressure receptors connected to our hypothalamus). The point in these examples is that information about the world external to the CNS (in this case, the body) is passing across the conceptual boundary surrounding the CNS along a particular pathway that represents a mode of interaction different from other pathways.

III

Four proposed criteria for individuating the senses

So much for the preamble. In this section, I will survey the four criteria that I believe taken together constitute the best account of modality differentiation. These four criteria are, I propose, individually necessary and jointly sufficient. Throughout this section, I will discuss why each is a necessary component of a correct account, as well as what is insufficient about each taken on its own

(1) Physics: The external physical conditions upon which the senses depend. That is, we might distinguish the senses by reference to the physical qualities of their respective stimuli: vision is the detection of differences in electromagnetic

stimuli; olfaction is the detection of differences in concentrations of chemical stimuli.

Sensory systems operate by physiologically responding to different forms of energy in the environment. Independent of any psychological and biological concerns, physics provides us with an ontology of energy forms. According to our best physics, electromagnetic phenomena are just different from mechanical energy, both of which are different from chemical gradients, and so on. This ontology of energy forms gives us an initial foundation for a non-arbitrary differentiation of the senses.

In providing an ontology of possible forms of energy, what physics provides is the space of possible modalities. Whether any animal on earth makes use of a magnetic modality or not, the fact that physics identifies magnetism as a type of energy raises the possibility of a magnetic modality. However, while necessary, physics is not a sufficient criterion. By itself, physics tells us nothing about which modalities actually exist in either humans or other animals. Physics can give us magnetism as a form of energy, but in order for there to be a magnetic modality, there must be organisms capable of sensing this physical class of stimuli.

Finally, physics is also important because it indicates important connections between the modalities. Take the example of olfaction via the epithelial system, pheromone reception via the vomeronasal system, and gustation via the taste buds of the tongue (to be discussed in Section IV). Even if we come to decide that these should be treated as separate modalities, physics lets us see how they are nonetheless fundamentally related: they are all three forms of chemoreception, albeit they detect different classes of chemicals. Similarly, the reason that even deaf individuals can often sense the beat of loud dance music through their skin is that hearing and touch are both mechanoreceptive senses; responding to mechanical energy in the environment.

(2) Neurobiology: The character of the putative sense organs and their modes of connection with the brain.[2] For example, vision is what we do with

> our eyes; audition is what we do with our ears (or perhaps, to be more exact, our cochlea and associated auditory brain areas).

This would seem to be the additional “contribution of the organism” required by the discussion of (1). It also matches well with some of our naive notions of modality individuation; that is, we individuate our modalities in part on the basis of our sensory organs. However, as Armstrong (1968, 211-213) points out, individuating sense organs is itself no mean problem. Following a suggestion by Anthony Kenny, Armstrong suggests that sense organs are bodily structures that we actively use to gain information about the world, as when we open and move our eyes to see or cock our head to hear. However, he continues, this runs up against the problem that we do not actively move organs in all the putative cases of sense. For example, we do not do anything to gain vestibular information. It seems to be ever present (which might explain why Aristotle did not remark upon it). The use of an organ in active perception does not seem to be of help here.[3]

My suggestion is to follow sensory neurobiology and look for physiological, anatomical, and morphological characteristics to individuate sense organs. A legitimate sense organ, I suggest, has the following characteristics:

First, it has to be an organ that physiologically responds to a naturally occurring amount of physical stimulation.[4] If the organ in question is a genuinely magnetoreceptive organ, then it needs to respond to the presentation of appropriate amounts of magnetic stimulation.

Second, a sense organ needs to be innervated by neurons; in other words, something cannot be a sense organ unless it is “wired up” properly to the CNS. (Hence, the neurobiology criterion explicitly helps rule out vestigial sensory organs that no longer provide any information to the organism.)

Third, we need to be able to identify an “end organ” of some type; the neurons leading from the CNS to the putative sense organ need to end there. This is to discount as sensory organs the

second, third, fourth, etc., neurons in the chain leading from the sensory periphery. A sense organ must contain cells that respond to energy in the environment, not another nerve cell. Most legitimate sense organs feature morphologically distinct end organs, for example, the rods and cones of the eye, that are physically constituted so as to transduce some class of energy, say photons, into the electrochemical energy of neurons. However, some senses seem to make use of so-called “free nerve endings” without any identifiable end organ. But in these cases, the putative sensory cells still lie at the end of a chain of neurons leading to the CNS. In its usage here, the stress is on “end” rather than “organ”.

There is, of course, more to be said here, but suffice it to say, I think it is possible to deal with the issue of individuating sensory organs. I said above that this criterion “helps” deal with the problem of vestigial organs. However, it does not completely rule them out, which indicates the insufficiency of this criterion. It is possible to conceive of an end organ that seems to be appropriately wired up to the CNS, but which passes information onto to the CNS of which the animal never makes any use. To have a genuine modality, it is not enough to have an organ of a particular type wired up to the CNS, that organ has to allow you to do the right sorts of things. Hence, the next criterion.

> **(3) Behavior:** The ability to behaviorally discriminate between stimuli that differ only in terms of a particular physical energy type.

Part of what it means to have a modality is to be able to make behavioral discriminations within that modality. Once again, the suggestion of this individuating criterion generates further individuation requirements. To wit, how ought we individuate “behaviors?” For example, it seems odd to identify changing the timing of one's menstrual cycle (assuming one has a menstrual cycle) or tanning as a behavior. My plan here is simply to follow Dretske (1988) on this issue: “…behavior is endogenously produced movement, movement that has its causal origins within the system whose parts are moving” (2, emphasis in original). Tanning is

something that happens to a person, not something one does. (Although one often does behave in certain ways to either become tan or not, as when we walk into a tanning salon. However, the act of tanning itself is not properly thought of as a behavior per se, whereas walking is). To change the timing of one's hormonal cycles is not to produce a movement. On the other hand, pressing a button or vocalizing are paradigmatic behaviors.

According to this criterion, then, unique senses ought to have a unique behavioral signature. The science that is arguably most invested in the study of the relationship between behavior and the senses is the science of psychophysics. In his 1993 book, Sensory Qualities, Austen Clark wields the impressive conceptual and empirical framework of psychophysics to ground an account of qualitative appearances that is materialist in spirit and which answers a variety of philosophical questions concerning the nature of appearances. Furthermore, Clark proposes that psychophysics alone has the conceptual resources to individuate the sensory modalities. For this reason, I will now go into that proposal in some detail to show why the behavior criterion taken alone is insufficient to differentiate the senses.

Central to Clark's account is the psychophysical concept of “matching” (taken originally from Goodman 1977). “Matching” is the relation between two stimuli that differ physically but are nonetheless in principle indiscriminable from one another. For example, two color patches might reflect slightly different wavelengths of light, but differ so minutely that any human subject would report that the two patches are perceptually identical. Perhaps surprisingly, it turns out that the matching relation is non-transitive: Stimulus **A** may match stimulus **B**, and stimulus **B** match stimulus **C**, but stimulus **A** need not match stimulus **C**. Using this relationship, one can construct “matching spans” of stimuli in which each stimulus matches its immediate neighbors, but the ends of the spans are easily differentiable (Clark 1993, 79-84). For example, we can construct such matching spans for color, creating a series of stimuli that vary infinitesimally by wavelength from red to green, say. A given observer, when presented with any two adjacent elements from this series, will be unable in principle to discriminate them, even though she can clearly distinguish red from green (the ends of the matching span).

This is only a tiny fraction of the story Clark (1993) tells, but it is all we need to understand his proposal for individuating modalities (also taken from Goodman 1977):

> Facts about matching can individuate modalities. Sensations in a given modality are connected by the matching relation. From any sensation in the given modality, it is possible to reach any other by a sufficiently long series of matching steps.[5] Distinct modalities are not so connected. One can get from red to green by a long series of intermediaries, each matching its neighbors; but no such route links red to C-sharp. (140-141)

There are two problems with Clark's proposal. The first problem with this criterion is that, on this account of modality individuation, we get many more modalities than we might have otherwise thought. Clark's account would entail breaking up the modalities into many sub-modalities, for not only can you not get from red to C-sharp (thus demarcating vision from audition), you also cannot get from red to “moving left to right across the visual field” (or however motion sensations ought to be described), nor from C-sharp to “darn that's as loud as a 747 engine from 10 feet away” (or however auditory intensity sensations ought to be described).

Lacking the appropriate matching relationships, there is no reason to class the “color” and “motion” sub-modalities of vision as indeed both being sub-modalities <u>of vision</u>. We are left with an account that makes “color” and “motion” as distinct from one another as each is distinct from “pitch.” Such an account fails to provide the resources for grouping together as “the same modality” sensory qualities that we would intuitively group together. All Clark has shown us is how to individuate sub-modalities.

There is a second problem with relying on behavior and psychophysics: it attributes the wrong modalities to the wrong organisms. For example, using (3) alone, humans have an

electrical modality! Consider the following: we humans are easily capable of discriminating otherwise identical fully charged 9-volt batteries from “dead” ones, simply by sticking them to our tongues. Nine volts is more than enough electricity to stimulate the sensory cells of the tongue, which in turn makes it very easy to behaviorally discriminate the presence or absence of electricity. You could do all sorts of interesting psychophysical studies of human electrical sensation. Yet, it seems absurd to claim that humans have an electrical modality, at least not in the same sense we mean when we claim that electric eels and other electric fish have an electrical modality. Something more is needed than simply a capacity to behaviorally discriminate the presence or absence of a stimulus of a certain physical type. We need some acknowledgement of the function of the alleged sensory modality in the species under consideration.

> **(4) Dedication:** The evolutionary or developmental importance of the putative sense to the organism in question. For example, we ought not attribute an electrical modality to an individual unless electrical properties of the world are part of the normal environment of that individual.

Dedication, a concept taken from the science of neuroethology, is an attempt to make relevant what is biologically important to an organism. Just because a particular individual can behaviorally respond to a particular class of stimuli does not give us warrant to propose a modality for sensing that class of stimuli. In the example above, the reason why it is absurd to attribute an electrical modality to humans is that, as a species, we do not go around using this electrical capacity of our tongues to sense the electrical properties of the world. Electric fish, on the other hand, detect the electrical properties of their world all of the time. It allows them to navigate the nearly opaque water of the tropical waterways in which they live. It allows them to carry out a nocturnal lifestyle, which in turn gives them a fitness advantage over non-electroreceptive fish. And so on.

Neuroethologists, neurobiologists who study the evolution and neural basis of animal

behavior, draw a distinction between “detection” and “reception” that will be useful here. The suffix -detection is applied to any organism that is capable of responding, by any means, to the presence of a particular type of stimulation in the environment. The suffix -reception is reserved for those organisms that carry out such sensory discriminations through the use of a dedicated anatomical system of structures. So, they would say that whereas electric eels are capable of electroreception—they can behaviorally respond to electrical stimulation using structures that have specifically evolved to process electrical information about the world—at best, humans are capable of electrodetection. Using Millikan's (1984) useful terminology, it simply is not a proper function of the human tongue to detect electricity. By considering both the developmental history of an individual and the evolutionary history of its species, we can determine to what forms of energy in the world a putative sense organ has become dedicated.

To consider a concrete example, there are at least three different things that can stimulate a vertebrate eye: 1) photons, 2) mechanical distortion (as when you press the eyeball with a finger), and 3) a properly inserted stimulating electrode (as in a neurophysiological experiment). These are quite clearly three different forms of energy (electromagnetic, mechanical, and electrical, respectively) to which the eye qua sensory organ is physiologically responsive (satisfying criteria (1) & (2)). All three types of stimulation can elicit behavior as required by criterion (3). What makes the eye part of a visual system, but not properly thought of as a mechanosensory or stimulating-electrode-receptive system, is the evolutionary history of those vertebrates that have eyes. It is in virtue of the light-receptive properties of eyes (and not their mechanoreceptive or electrode-receptive properties) that eyes have been maintained in the population. It is this history that determines to what sense a putative sense organ is dedicated. Dedication, in turn, allows us to distinguish which animals genuinely possess a given sensory modality from those who have figured out a way of using some other sense to make occasional inferences about the world.

At this point, I can finally address an account that has likely bothered some readers by its absence in the preceding discussion: ecological psychology. In his 1966 book, The Senses

Considered as Perceptual Systems, J.J. Gibson offered a characterization of the senses at odds with preceding and subsequent accounts in psychology (see also Gibson 1979; Noë (forthcoming) also defends a Gibsonian account of the senses). As Heil (1983, 10-11) points out, Gibson does not directly address what I'm calling Aristotle's and the Star-nosed mole problems, but such an account seems implicit in his work (and I will rely on Heil's explication here). According to Heil, "Gibson's fundamental notion is that perceiving is the picking up of information about the world made available to the perceiver by various sorts of physical stimulation" (10). The notion of "information" is critical to the Gibsonian account, and it is at the crux of why I part company with them. Gibsonians hold that it makes sense to attribute a sensory modality to any organism that can act on structured stimuli of a particular physical regardless of how that information is obtained by the organism. Take the case of a blind person equipped with a video camera and mechanism that converts the visual image into an isomorphic pattern of vibrating pins placed against the skin, as in the 1970s experiments with "tactile visual substitution systems" (TVSS) made famous by the work of Bach-y-Rita (1972). On the ecological psychology account, therefore, it makes sense to say that TVSS-equipped persons can see (albeit poorly)—that they have a visual modality.

However, given what I just said about the distinction between detection and reception, it should be clear why I disagree here. A TVSS-equipped, but otherwise blind, individual is capable of visual-detection, not visual-reception. Such persons should no more be said to have a visual modality than all of us should be said to have an electrical modality just because we can detect electricity with our tongues. It is true that they are getting visual information about the world, but they are getting that information via their tactile modality. Giving a blind person a TVSS system does not give them a modality they did not have before. Rather, it allows them to make more rich use of the modalities they already have. (Therefore, all this is not to say that say that there is anything wrong with sensory substitution systems. Research in this area is important and valuable. I am trying to make a conceptual point here.) To the extent that ecological psychology fails to draw this distinction, it does not give us an adequate account of

the senses.

The distinction at play here is that between the content of the senses and the mode of perceptual interaction between the organism and the world. Sensory modality is not simply an issue of what things in the external world can become the content of an individual’s psychological states, but rather the mode by which that content comes into the organism. It may well be the case that a blind person can come to have every propositional attitude a sighted person has. But such an individual is still blind; he lacks the modality of vision. He has one less different modality from that of typical members of his species. He has just cleverly jerry rigged a sensory system dedicated to the reception of mechanical distortion (his skin) into one capable of providing him with generally reliable information about the electromagnetic spectrum. However, his perceptual mode of interaction with the “visual world” is tactile.

What this example shows is that there is more that we may wish to learn about perception than simply what modalities are at play. However, an understanding of modalities will help us understand an important way in which a TVSS-equipped blind person and others differ perceptually: one (the blind person) lacks a sensory system dedicated to the perception of electromagnetic stimuli that another person (a sighted one) has. One lacks a modality that the other one has, just as the electric fish possesses a modality (electroreception) that humans lack, although, thanks to our ingenuity, we can sometimes obtain information about the electrical world. Indeed, it is an understanding of modality that allows us to say why certain individuals need to be equipped with TVSS systems in the first place!

IV

Three criteria to be rejected

In the preceding section, I argued for the four criteria that I believe are necessary to differentiate the senses. However, there are other criteria that have been proposed, although on my account they are misapplied to Aristotle’s and the Star nosed mole problems. Nonetheless, they are worth considering in some detail, if only because they have a great deal of intuitive

plausibility. Therefore, in this section, I will consider three additional proposed criteria.

In perhaps the twentieth century's most cited discussion of Aristotle's problem, H. P. Grice (1962/1989) discusses a set of four criteria for distinguishing the senses: proper objects, sensation, neurobiology, and physics. However, the bulk of Grice's paper is not spent arguing for the adequacy of these four criteria, but rather discussing the relationship between the first two:

> **(5) The proper objects of sensation:** The special features detectable by the operation of the senses; that is, by “ the differing features that we become aware of by means of [the senses]” (250). For example, through vision, we become aware of colors; through audition, we become aware of degrees of loudness.
>
> **(6) Sensation:** “It might be suggested that two senses, for example seeing and smelling, are to be distinguished by the special introspectible character of the experiences of seeing and smelling; that is, disregarding the differences between the characteristics we learn about by sight and smell, we are entitled to say that seeing is itself different in character from smelling” (250, my emphasis).

Grice's first criterion (our (5)) is perhaps the most venerable approach to the issues at hand. This is the account to be found in Aristotle's De Anima, bk. ii.[6] Aristotle points out that there are qualities, such as color, which are perceived by only a single sense. These are the “proper objects” of these senses; “the things to which the very being of each sense is naturally related” (Sorabji 1971, 56). Aristotle goes on to contrast the proper objects with the “common sensibles”—number, shape, magnitude, motion, rest, etc.—which are qualities that are sensible

by more than a single modality. Therefore, on this account, one first identifies the formal objects that are proper to only one sense, and based on that list, we can derive a classification of the senses related to those objects.

In a sense, Aristotle’s criterion can be seen as a primitive version of the physics criterion (1) in that a proper object account draws a strong connection between the categories of physics and those of our phenomenology. The categories of Aristotelian physics are the categories of our commonsense, folk physics. Of course, it is always open to us to reinterpret Aristotle's account in light of contemporary physics and argue, for instance, that “wavelength of electromagnetic energy” and not “color” is the true proper object of vision. However, such a reinterpretation represents such a significant change to the commonsense nature of Aristotle's original proposal that it seems appropriate to identify it as a different proposal.[7]

Grice's second criterion (our (6)) proposes to individuate modalities by reference to the “the special introspectible character,” or what might be more commonly referred to as the distinct sensations or qualia associated with each given sensory modality.[8] Since the senses each have their own unique experiential quality, we can use these unique experienced qualities to differentiate the senses. Therefore, the second criterion would have us catalogue the different experiences we have, sorting them in terms of similarities and differences, and end up with several sets of related experiences that are the different modalities: the visual experiences, the olfactory experiences, the auditory experiences, etc.

While these two criteria appear independent of one another, one of the central goals of Grice's paper is to argue that they are not: Any attempt to make suggestion (5) [a proper object account—work leads to difficulties which seem soluble only if we bring in suggestion (6)—a sensation account, and suggestion (6) in its turn involves difficulties which seem avoidable only by adopting suggestion (5) (Grice, p. 259). I do not wish to regurgitate Grice's clear, and in my opinion correct, arguments for the interdependence of these criteria. However, let me present enough of one half of it—the dependence of (5) on (6)—to give a flavor.

Grice begins by following the suggestion of the proper objects criterion. He identifies a

series of perceptual features of the world that are independent of the agent, for example color, pitch, temperature, etc. This then allows us to individuate the senses using this list, without any reference to the way such features are experienced by a perceiver. At this point, a problem arises: “According to [the proper object criterion], certain properties are listed as visual properties, certain others as tactual properties, and so forth; and to say that color is a visual property would seem to amount to no more than saying that color is a member of a group of properties the others of which are… [sic]. This leaves membership of the group as an apparently arbitrary matter” (255). That is to say, relying on the proper objects of sense does not tell us by virtue of what these properties are the proper objects of vision, whereas those properties are the proper objects of touch. Of course, the obvious thing that classes these properties together is that we see the visual ones, and tactually feel the tactile ones. But to invoke this feature is to revert to the sensation criterion.

A second problem with the proper objects criterion is that it breaks down once you try to put it into practice. That color is a proper object of vision seems uncontroversial. But is warmth a proper object of the tactile sense? This seems correct until we realize that one can occasionally see the temperature of objects, as when the blacksmith sees that the red glowing metal bar on the floor next to the furnace is hot. The clear response to this worry is to draw a distinction between directly sensing temperature (as the tactile sense does) and inferring temperature (as we sometimes do with our visual senses). The proper objects of a sense are those that it directly senses. However, Grice demonstrates over several pages (251-255) that we cannot make sense of this suggested distinction without cashing out the notion of “directness” in terms of having a particular qualitative experience, e.g., directly sensing warmth is to experience a sensation of warmth, something you get through the tactile sense and never through the visual sense. Once again, criterion (5) only makes sense by invoking criterion (6).

Given the above arguments, the cogency of criterion (5) rests on the foundation provided by criterion (6). How firm is this foundation? Grice argues that any account of the senses in terms of experiential character of sensation in turn rests on an account in terms of proper objects. I

want to take a different tack. I would like to accept that a proper object account rests on an account of sensation, but argue that we should not use the experiential character of sensation to differentiate the senses. Both proper objects and sensations are non-starters when it comes to solving the star-nosed mole and Aristotle's problems.[9]

What is wrong with using the experiential character of sensation as a criterion for individuating the senses? There are two problems with this approach. First, while potentially useful for solving Aristotle's problem, it is less clear what use it is in solving the star-nosed mole problem. Do we have to believe in the existence of electrical qualia, say, before we can sensibly talk of an electrical modality in electric eels or decide whether the star-nose mole has an electrical modality? Relying on the character of experience to differentiate the senses of non-human animals runs straight into what Allen & Bekoff (1997, 53) call the “other-species-of-mind problem.” It seems to require that we be able to answer Nagel (1974) type questions concerning what it is like to be an electric eel or star-nosed mole. This point echoes one made by Coady (1974): “Further difficulties will arise for a Gricean view from the fact that we commonly attribute sight, touch, hearing, etc. to dumb animals and here we not only make no use of [the sensation criterion] but there seems to be no way in which we could” (111).

Of course, there is never a guarantee that philosophical analysis will make science easy (or even possible), and we might just have to accept that science cannot answer the star-nosed mole problem until it has overcome the worries raised by Nagel. However, I think there are other reasons for rejecting criterion (2) that renders Nagel mute on the issue at hand. Grice's proposal runs into problems even with humans, because there is reason to believe that there are apparently legitimate sensory modalities that lack a special introspectible character altogether.

Consider the case of the vomeronasal system. Admittedly, there is still controversy as to whether humans possess this modality, but over the past decade or so evidence in its favor has begun to mount. Furthermore, if we in fact possess this system, two things about it are striking: first, it plays a significant role in human behavior; and, second, we experience no sensations associated with this modality—there is no “special introspectible character” here, hence no basis

to individuate this modality from any other. It would appear to be a modality without concomitant sensory experiences.

In almost all vertebrates investigated, airborne chemicals are detected by multiple anatomical systems. One is the well-known system involving the olfactory epithelium within the nasal cavity containing chemosensory cells that project to the olfactory bulb. In humans, this is the system responsible for our variety of smell and taste experiences.[10] In most animals, this system is primarily responsible for the detection and evaluation of food.

There is a second system, however, that is primarily social in function. The vomeronasal organ is located in a pair of pits on either side of the nasal septum. The vomeronasal system is primarily responsible for detecting pheromones, which in turn have been shown to play a central role in reproductive behavior (Powers & Winans (1975), Meredith & Burghardt (1978), Halpern (1987)). For example, animals with lesioned vomeronasal organs typically exhibit greatly reduced sexual behavior. Similarly, artificially stimulating this organ and the nuclei to which it projects generally produces sexual behaviors in the animal so manipulated, even in the absence of appropriate conspecifics.[11]

Do humans have a vomeronasal system? The textbook answer has traditionally been that while this system is present in human fetuses, it disappears during normal development (Crosby & Humphrey 1938). In recent years, however, this received wisdom has been called into question (Taylor 1994). In terms of anatomy—contrary to the textbooks—vomeronasal pits are present in most adult humans (Johnson et al 1985). Furthermore, the pits are innervated by sensory neurons (Takami et al 1993).

Behaviorally, there is a growing list of findings in humans that closely resemble behaviors carried out by the vomeronasal system in other species. This combined with the fact that these behaviors seem to have no conscious correlates, suggests the presence of a non-conscious modality in humans. First, there is the phenomenon whereby women living together, say in single-sex dormitories, synchronize their menstrual cycles (McClintock 1971).[12] It is not clear by what sensory mechanism this happens, but a functional vomeronasal system is clearly a

strong candidate, based on what has been seen in other animals. Second, it has been reported that individuals can detect the gender of another based on smelling the breath alone. Some women are apparently able to identify the gender of a breather with an accuracy of 95 percent (Rivlin & Gravelle 1984, 154)! Finally, clinicians have observed that damage to the nerves in the nasal region is often, but not always, associated with a loss of interest in sex. (However, because medical students have typically been taught that humans do not even have a vomeronasal organ, nobody has pursued a study of naturally occurring lesions to the vomeronasal vs. olfactory epithelial systems in humans. Therefore, to my knowledge, no attempt has been made to try to tease apart the functions of these two systems, as has been done in non-human animals.)

While the science is admittedly controversial here, the possibility of a human vomeronasal system stands as a potentially interesting case of a modality without a special introspectible experiential character. Women who can guess the gender of breath do not report that they experience “male” vs. “female” qualia associated with the breaths. Indeed, subjects are generally surprised to be informed that they are so good at distinguishing the smells. Gender detection via the putative vomeronasal sense seems akin to an olfactory version of blindsight (Weiskrantz 1986). And if it is a modality that lacks qualia, then criterion (6) cannot even begin to distinguish this modality from others. Consider also that the vomeronasal system may not be the only sensation-lacking modality. If there were two or more such modalities, the second criterion would not give us the resources for distinguishing them.

Many will no doubt be surprised by the above arguments that the differentiation of the senses is independent of any appeal to the experiences associated with the senses. A commentator an early version of this paper, put it this way: “Much of the bad press over qualia is well-deserved; but if there is one place experiential qualities have a safe home, I would've thought it would be with the sense modalities.”[13] In response, I should say that experiential qualities do have a safe home in the modalities. Much of what we experience, we experience through the senses. (Although not all. Some of our experiences are non-modal; for example, the

experience of generalized anxiety and what I like to call the “eureka quale”—that distinctive feeling we have when something suddenly makes sense.) My argument here is not that there is no such thing as sensory experience, but rather that we should not use those experiences to differentiate the senses. Experience is often associated with the senses, but its nature does not define the difference between the individual senses.[14]

For a final argument against the relevancy of experience to differentiating the senses, consider the following thought experiment suggested by Nelkin (1990):

> Consider the following two sorts of cases. (a) Suppose there were people whose eyes seemed to be in working order. When their eyes are appropriately stimulated, they have all the ‘wrong’ sensations (i.e., sensations quite different from ordinary human beings), but all of their beliefs about the world track ours almost exactly and they have the same success in getting about in the world that we do. (b) Suppose again people whose eyes seem to be in working order. When their eyes are stimulated, they have just the sorts of sensations we would expect them to have but they have all the wrong beliefs, such that they fail to believe that there are colours, they run into objects and so forth. It seems natural to call the first people sighted and the second people blind. This result is magnified if we think that the first sort have no sensations but the right beliefs while the second have the ‘right’ sensations but no beliefs. It would seem that beliefs are essential to the sightedness-blindness distinction in a way that sensations are not. (158)

The upshot of Nelkin’s argument is that what we consciously experience tells us less about the senses than what we profess to believe through our behavior. Nelkin then provides us with a third criterion for individuating the senses.

(7) Belief: The content of our mental representations can be used to differentiate our senses. Presumably, this criterion is not restricted to belief alone and can include all the propositional attitudes.

This criterion is not so much false as it is vague. The idea here is that we can individuate the senses once we individuate mental content. Unfortunately, as any look at the recent philosophical journals will reveal, this move would seem to put us back at square one. The individuation of content—be it wide or narrow, conceptual or non-conceptual, implicit or explicit—is far from a settled matter. Should the individuation of content be based on a criterion of behavior (as Nelkin argues) or some evolutionary criterion akin to the above discussion of dedication (as teleosemanticists such as Millikan or Dretske suggest) or on something internal to the psychological agent (ala sensation)... or some combination of such criteria?

Instead of developing a full-blown theory of belief, I feel it will be more fruitful to keep our eye on the ball and stick to the star nosed mole and Aristotle’s problems. I will leave it to others to decide whether the account of sense modality differentiation I propose here just is an account of content individuation. Since what I say here is in general agreement with what I say about content in Keeley (1999), I suspect that it is. However, whether the reader agrees will depend greatly on what theory of content you endorse. If what I say here is not consistent with a given theory of content then my response will be that to such an extent that such an account of content is true, differentiating modalities is not a matter of content.[15]

V

Implications: What senses do humans and others have?

The proof, they say, is in the pudding, and I should conclude by showing how my account deals with some actual cases and spell out its philosophical implications. First, let us consider Aristotle's problem. On my account, vision, hearing, touch, smell and taste come out as

different senses. Each involves sensory organs dedicated to the detection of a different class of physical stimulation. If future science pans out as I have described it above, humans should be said to have a vomeronasal modality as well. We also have a vestibular sense (based in the semicircular canals in our heads) as well as a proprioceptive system (based in the stretch receptors in our skeletal muscles).

At the same time, on my account, humans should not be said to have an electric sense because we have as yet discovered no organ that is dedicated to the processing of electrical information in our environment. As noted above, we can access electrical information through our tongues, but only by electrically stimulating sensory systems that are normally responsive to other physical properties; physical properties that are part of the normal human sensory environment. On the other hand, electric fish, sharks, skates and rays should be said to have an electrical sensory modality, as these organisms have organs that have evolved specifically to process biologically meaningful electrical stimuli in their environment (see Keeley (1999) for more).

What about the star-nosed mole? On the account given here, the nose of a star-nosed mole would seem to be best thought of as mediating a tactile sense. While it is true sensory cells in the nose of this animal can be stimulated by the presentation of electricity, as with the case of the human tongue, we realize that this fact does not settle the issue. All sensory cells, when blasted with enough electricity can be made to respond. The question is whether there is any reason to believe that the amount of electricity required to stimulate the nose of a star-nosed mole is within the range that would make it likely that their noses had evolved this ability. Is the detection of electricity a proper function of star-nose mole noses? To date, such evidence has not been forthcoming. On the other hand, the work of Ken Catania (Catania & Kaas 1995, 1996) indicates that these same sensory cells are responsive to tactile stimulation and furthermore that the range of mechanical stimulation required falls within an ecologically plausible range. With such a nose, a star-nose mole is able to make all sorts of useful sensory discriminations of the texture, motion and shape of objects that it places its nose upon. What’s more, Catania has done

careful comparative studies indicating that the sensory end organs on the nose of the star-nose mole are likely modified versions of the tactile sensing end organs found in related species of moles, which in turn are modified versions of the basic tactile sensing end organs found in most mammals, including humans. All of these discoveries point to the conclusion that the nose of a star-nose mole is properly thought of as a tactile sensor.

The sort of story told about the star-nosed mole can be used as a template in the cases of all putative sensory modalities in non-human animals. If, for example, one wishes to argue for the presence of a magnetic sense in migratory birds or an electrical sense in the platypus or color vision in dogs then the same set of evidence needs to be collected. One must characterize the target of the sense in physical terms (What range of magnetic stimulation? Exactly what electrical properties? Etc.) One must demonstrate via the organisms’ behavior that the organisms in question can make use of the alleged sense. One must find a sensory organ that can transduce this information from the environment to the CNS of the organism. Finally, one must demonstrate that this organ has the evolutionary or developmental function to carry out such sensory transductions. Only if you do all four of these things can you properly talk of the animal as having the sense in question.

Those are the scientific implications of my account; what of the philosophical ones? If the account that I have presented here is plausible, then it represents a strong, naturalized alternative to the more commonsense approaches to the issues typically favored by philosophers. For the purposes of the perceptual sciences, at least, distinguishing the senses from one another is not a matter of such folk scientific entities as the proper objects of sensation or some specific qualitative feel of conscious perceptual experience. Strictly speaking, this is not to say that qualia do not exist, but rather that they do not have a role to play in this particular scientific story, however useful they may (or may not) be to our folk understanding of ourselves. Defenders of qualia need to look elsewhere for scientific legitimacy.

If you are unconvinced with the positive story that I have told here, I hope to have at least convinced you that there are interesting philosophical and scientific questions yet to be answered

concerning the differentiation of the senses in humans and other animals. At the same time, I believe I have shown that some of the more intuitive reasons for dividing up our senses run into problems, particularly when it comes to such potentially novel senses as proprioception and the vomeronasal sense, not to mention those of such exotic animals as star nosed moles and electric fish. The principled extension of common sense concepts into novel domains is a long-standing project in philosophy. I hope that this paper has shown that there is still interesting contemporary work to be done on ancient problems.

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Notes

1. Since I am primarily concerned with psychology and biology, I will not be discussing here the modalities of artifacts, as might be useful when discussing robots and their similarities and differences with animals. However, that said, I believe it should be possible to translate the account I give here into an account amenable to artifacts, assuming we can find adequate translations in artifact-language for the neurobiology and dedication criteria.

2. Some of the felicitous wording of criteria 2 & 3 are due to Coady's (1974) commentary on Grice. Also see Coady's paper for an extended discussion of the importance of the behavior criterion.

3. Coady (1974) takes a far stronger line: “...I cannot see how we should ever accept anything

as a kind of sensory experience if it were open to no voluntary control or supervision at all (112). While I think he is correct to criticise Grice for not recognizing a role for behavior in individuating the senses, Coady tries to use this criterion to usurp the role of all others. The justification Coady gives in defense of the above claim seems merely to be an intuition-based stipulation, but in the discussion of criterion (3), I will address the arguments of others for the sufficiency of behavior for Aristotle’s problem.

4. It must to respond to a naturally occurring degree of physical stimulation. The reason for this additional lemma will be discussed under criterion (4), dedication, below.

5. Keep in mind that “any” here quantifies over a single individual or species, and not over the entire space of possible or actual modalities. Perhaps to be more accurate, Clark should say, “From any sensation in the given modality of a given individual or species…” Thanks to Eric Saidel (personal communication) for pointing this out.

6. According to Richard Sorabji's reading of Aristotle, whose 1971 paper I follow closely in this discussion.

7. At this point, I should mention two relatively recent approaches offered by Roxbee Cox (1970) and Sanford (1976) that are suggested improvements on Aristotle’s “proper object” account. Both are attempts to spell out an account of the senses based on the content of perception; spelled out in terms of either “key features” (Roxbee Cox) or “primary objects” (Sanford) of perception. My response to both of these suggestions is that to the extent that they avoid Grice’s attempt to show that they necessarily collapse into a sensation-based account (and I will outline my problems with sensation below) they either (a) are better described in terms of the physics criterion that I accept or (b) the fall prey to the worries I raise about a belief-based criterion (7) below.

8. Grice does not use the terms “proper objects of sensation” or “sensation” or “qualia” in his discussion of the senses. However, what he says about each position seems to line up well with the common uses of these terms, so for pedagogical reasons, and to place Grice's discussion in a broader context, I will use these terms to identify his criteria.

9. In addition to Grice, Leon (1988) also argues for a sensation-based approach to differentiating the senses. However, he is mainly concerned to counter the criticisms of Grice and to distinguish his account from belief-based approaches (discussed as criterion (7), below). He does not address the issues I raise here. Lopes (2000) also endorses criterion (6), but see Footnote 15 below.

10. Contrary to popular wisdom, we do most of our tasting through our noses. The taste buds in our mouths have a relatively impoverished palate of tastes: sweet, sour, salty, and bitter. It is

the olfactory system that gives food its amazing array of flavors; a fact revealed when a cold or flu takes our nose out of the equation and food becomes extremely bland. For example, it has been reported that with the nose blocked, most people find it impossible to distinguish a piece of apple from a piece of raw potato. Both are faintly sweet and crunchy, that is all (Milne & Milne 1962, 141).

11. In many species, there is a still third olfactory system, also apparently for detecting pheromones: the nervus terminalis. Made up of bare nerve endings in the nasal epithelium, this system is technically difficult to study, and to my knowledge, nobody has even begun to investigate whether humans possess it. It is not clear whether currently available techniques are capable of detecting this system in humans. In any case, we cannot rule out a role for this system in human behavior. For more on the nervus terminalis, see Butler & Hodos (1996, 34).

12. However, as Eric Saidel (personal communication) has pointed out, synchronization of menstrual cycles hardly qualifies as a “behavior” in the sense discussed above. Nonetheless, given that the menstrual cycle is primarily controlled by the central nervous system, this finding suggests that vomeronasal information may be getting into the brain somehow.

13. Tom Polger made this comment at the 1999 Society for Philosophy and Psychology meeting in Palo Alto, California.

14. For reasons of space, one issue I have not discussed here is the assumption that the senses are “fairly discrete systems,” as Leon (1988, 245, fn 1) puts it. It is common to assume that the different senses are significantly separate and independent of one another. Indeed, this assumption motivates the questions discussed here. To my knowledge, this ubiquitous assumption has received even less attention in the philosophical literature than the star nosed mole and Aristotle’s problems; a curious observation given the existence of empirical phenomena that raise questions about it. I am thinking here of synesthesia (Cytowic 1989, 1993) and the McGurk effect (McGurk & McDonald 1976). In the neurological condition synesthesia, the proper objects of one sense result in experiences in more than one modality, e.g. “colored-hearing.” In the McGurk effect, normal humans will literally hear the same auditory speech stimulus differently depending on what they see (lips movements of one sort versus another). It is not clear what affect such interaction between senses has on the story I am telling here. Unfortunately, to fully explore the issue would require another paper.

15. Recently, Lopes (2000) has argued that “Representational theories of mind cannot individuate the sense modalities in a principled manner” (439). He takes as his target Dretske’s (1995) theory of content. While Lopes endorses a sensation-based account, he does not actively argue for it, concentrating his attention on showing the inadequacies of Dretske’s position with

respect to the senses. At best, he seems to ignore the possibility of unconscious sensory modalities. At worst, he rules them out by stipulation: “...what it is like to perceive in one sense modality is different from what it is like to perceive in others—each has a unique ‘phenomenal character’—and this is a fact which any theory of perception must take account” (ibid). My disagreement with this claim should be clear from the discussion of criterion (6) above. (Cf. Dretske’s (2000) response to Lopes. Also, Ross (unpublished) defends an intentionalist account of differentiating the senses that builds on the kind of approach Dretske takes.)

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