

The senses as psychological kinds

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The distinction we make between five different senses is a universal one.¹ Rather than speaking of generically perceiving something, we talk of perceiving in one of five determinate ways: we see, hear, touch, smell, and taste things. In distinguishing determinate ways of perceiving things what are we distinguishing between? What, in other words, is a sense modality?² An answer to this question must tell us what constitutes a sense modality and so needs to do more than simply describe differences in virtue of which we can distinguish the perceptions of different senses. There are many such differences – the different perceptions involve different sense organs, sensitivity to different kinds of stimuli, the perception of different properties, and they involve different kinds of experiences – but which, if any, of these differences are the differences that really matter?³

1.

To say what is constitutive of a sense modality we need to say what all instances of perceiving something with a particular sense have in common in virtue of which they are instances of perceiving with that sense.³ Many philosophers suppose that there is an obvious answer to this question. In order to perceive something one must have an experience of it.⁴ Seeing something requires having a *visual* experience of it, hearing

¹ Or almost universal: it is possible that some cultures distinguish fewer than five senses (by grouping together two senses we distinguish), but I have not been able to find a description of any culture that distinguishes more than five senses (for the anthropology of the senses, see Howes 1991). In talking of the distinction we make between senses I am talking about the distinction we *actually* make (and have made for at least 2000 years) between five senses. There may be other distinctions that we could make or even ought to make; I am not talking about them.

² Throughout this chapter I use ‘sense modality’ to mean ‘sense modality as we commonly understand it’ and am agnostic about the nature of its referent. In other contexts ‘sense modality’ may be taken to refer to something specific – in physiology to anatomically individuated sensory transducers, for example. It doesn’t follow from the fact that common-sense and physiology use the same term that they are talking about the same kind of thing. And it doesn’t follow from the fact that science distinguishes more than five senses that common sense is mistaken: that depends on whether common sense and science are talking about the same kind of thing.

³ An account that failed to explain what all perceptions of a single sense have in common would not explain why we make a distinction between *five* senses.

⁴ This used to be accepted as an a priori truth; some philosophers now think (wrongly in my view) that phenomena such as blindsight show that it’s false.

something requires having an *auditory* experience of it, and so on. The different kinds of experiences involved in perceiving are what constitute perceiving with different senses. We *see* something just in case we perceive it in virtue of having a visual experience of it; *hear* something just in case we perceive it in virtue of having an auditory experience of it, and so on. To answer the question in this way is to give an *experiential account* of the senses.

Of course, such an account would be circular if the only explanation we could give of what makes an experience a visual experience is that it is the kind of experience involved in seeing things. A defender of the experiential account must suppose, therefore, that we can distinguish experiences into kinds corresponding to each of the senses simply in virtue of their character *as* experiences. That is, they must suppose that there is some property that is intrinsic to experiences that can explain the distinction, a property that is independent of how experiences are produced. *Non-experiential accounts*, by contrast, explain the distinction by appeal to the non-intrinsic properties of experiences.⁵

Although much of what we perceive about the things around us we perceive with more than one sense, we experience the world as unified. When we see and hear a car passing in the street we are aware of the car and its properties – its colour, how it sounds, where it is, how big it is, and so on; when we look at something that we hold in our hand we are aware of the object and its properties – its weight, shape, and colour. In both cases, we are aware of properties that are in fact perceived with different senses as properties of single object. Our perceptual system integrates information about the object that is picked up using different senses to produce a unified experience of the object as having those properties. To say that we experience the world as unified is just to say that when we perceive properties that are properties of a single object they are normally experienced as such, even when they are perceived with different senses.⁶

It is often remarked that perceptual experience is transparent. When we reflect introspectively on our experience, the only objects and properties to which we can attend are those objects and properties of which we are apparently aware in having the experience. As a consequence, just as the *world* seems unified in experience, so our

⁵ My labeling here is stipulative. Some strongly externalist accounts of experience end up in the non-experiential category because they take aspects of experiences to be constituted by mind-independent objects.

⁶ Since a perceptual system that integrates information about an object picked up with different senses is less likely to get things wrong about that object it is evolutionarily advantageous that our senses do this (see Lewkowicz and Kraebel 2004, and Bertelson and de Gelder 2004).

experience of the world seems unified to introspection. In shifting our attention between aspects of an experience that is produced by different senses, we are simply shifting attention between different properties of the objects of which we are apparently aware in having that experience. We cannot attend to a visual or auditory experience as such, only to the objects and properties that we visually and auditorily perceive (or apparently perceive).⁷ If that's right, then there is nothing of which we are aware solely on the basis of introspecting our experience which is sufficient to explain the distinction we make between different senses.⁸ That makes it doubtful that we can distinguish experiences into kinds corresponding to the senses on the basis of their character *as* experiences, and doubtful too that we can give an experiential account of the senses. It seems more plausible to suppose that in distinguishing experiences into kinds we are distinguishing between them on the basis of how they are produced.

Although our (unified) experience of objects and their properties is produced by the operation of different sensory mechanisms,⁹ this is not apparent to us in introspection.¹⁰ It is a fact that we can only discover by reflecting on what is involved in coming to be aware of objects and properties; that is, by reflecting on the different ways in which we come to perceive things.¹¹ In virtue of the fact that perception involves different perceptual mechanisms, there are various different causal conditions that have to be satisfied in order to perceive, and these vary for different properties. Some properties we perceive by, for example, looking at objects, others by touching objects, and so on. We can explain why we distinguish perceptions into perceptions of different senses by appeal to our understanding the connection between what we can perceive and the satisfaction of these different causal conditions associated with different perceptual mechanisms. The best explanation, therefore, of the distinction we make between

⁷ Here I am expressing a fundamental disagreement with Keeley who claims that "One of the perhaps most striking phenomenological facts about human perceptual experience of the world is that it seems to be divided into modes... The existence of separate sensory modalities would seem to be a brute fact about perception, if ever there was one" (2002, p.5). He doesn't say what features of experience he takes to support his claim.

⁸ I am assuming that we cannot explain the distinction in terms of the objects of experience for the simple reason that the very same objects and properties can be perceived with more than one sense. For the senses to be individuated in terms of their objects there would need to be one kind of object 'proper' to each sense. I discuss this in Nudds 2003, sec. 3.

⁹ I use the terms 'mechanism' and 'process' interchangeably.

¹⁰ For a discussion of the limits of introspection, see Martin 1997.

¹¹ This means that prior to having such a reflective understanding we can make no distinction between senses. The developmental evidence supports this claim (Yanix and Shatz 1988; O'Neill et al. 1992). For a discussion of whether chimpanzees have a reflective understanding of seeing, see Povinelli and Eddy 1996, and the debate between Tomasello et al, and Povinelli and Vonk in Hurley and Nudds 2006.

different kinds of experience – between visual experience and tactile experience, and so on – is in terms of a reflective understanding of the connection between experiences involved in the perception of certain kinds of objects and properties and the different ways we perceive those objects and properties – that is, in terms of the different ways those experiences were produced.

My suggestion, then, is that the most plausible explanation of the distinction we make between senses is that we distinguish perceptions into perceptions of different senses on the basis of a reflective understanding of how those perceptions were produced. In distinguishing perceptions in this way we are distinguishing between perceptions produced by different kinds of sensory mechanism, and so our concepts of the senses must be concepts of different kinds of sensory mechanism. This provides an answer to the question of what constitutes a sense modality. A sense modality just is a kind of sensory mechanism, and all instances of, say, *seeing* something are instances of seeing that thing in virtue of their having been produced by a single kind of sensory mechanism – the sensory mechanism of vision.

It might be objected that the distinction we make between different senses is a universal and common-sense one; it's a distinction made with only a vague and superficial understanding of the nature of our sensory mechanisms, by people who perhaps know little more than that seeing involves looking, touching involves contact, and so on. It's just not plausible, therefore, to think that in distinguishing different senses we are distinguishing between perceptions on the basis of the way that they were produced, nor that our concepts of the senses are concepts of these different kinds of sensory mechanism.

I agree that it's implausible to think that in making the distinction between five senses we deploy detailed knowledge of, or a theory of, the mechanisms of perception; but distinguishing between perceptions on the basis of the kind of sensory mechanism that produces them doesn't require such knowledge, any more than making common-sense distinctions between animal species requires knowledge of evolutionary theory, or distinguishing between different kinds of metals requires knowledge of atomic theory. In all these cases we can use concepts which refer to different natural kinds without knowing what makes something an instance of the kind in question. This is because it is possible to give an account of what determines the reference of the concept independently of an account of what determines the concept's extension, and so give an

account of that in which possession of the concept consists that doesn't require knowledge of what makes something a member of the kind.¹²

In claiming that the senses are different kinds of sensory mechanism and that our concepts are concepts of kinds of sensory mechanism we need be committed to no more than that a similar explanation can be given of our concepts of different senses. There are two requirements that such an explanation must satisfy. Firstly, it must explain how the reference of our concepts of different senses is fixed independently of an account of what determines their extension; and secondly, it must show that the relevant sensory mechanisms exist and so determine the extension of the concepts. If either of these requirements is not met, then our common-sense distinction between five senses cannot be a distinction between kinds of sensory mechanism.¹³

Reference fixing requires an understanding of the casual dependence of perceptions on different ways of perceiving; that understanding may simply consist in the capacity to think of our perception of one kind of property as being produced differently to our perception of some other kind of property. Someone who understands the connection between perceiving different properties of things and looking at them, touching them, putting them in their mouth, and so on, has such a capacity. So, for example, we might think that the perception of an object is an instance of seeing it just in case it is produced as a result of the operation of the sensory mechanism that involves looking at the object; it is an instance of touching an object just in case it is produced as a result of the operation of the sensory mechanism that involves contacting the object with a part of our body, and so on. By grasping such principles we can refer to the different kinds of mechanism that enable us to perceive – the mechanism that involves looking, the mechanism that involves contact, and so on – without having detailed knowledge of the operations of those mechanisms, and without knowledge of what determines the extension of concepts of perceptions produced by these different mechanisms. The first requirement, then, can be met.

What about the second requirement? Here the question is, in large part, an empirical one: Does our perceptual system consist (in part) of five kinds of sensory mechanisms? If our concepts refer to kinds of perceptual mechanisms, then the

¹² I have in mind the kind of account suggested by Putnam (1975) and the view of kinds described by Millikan (2005).

¹³ Failure of reference doesn't itself show that our concepts are not natural-kind concepts, but does show that judgments involving those concepts are never true. If we have reasons to think the judgments can be true, then we have a reason to think the concepts are not natural-kind concepts. I argue below that we do have reasons to think the judgments can be true.

mechanisms must actually exist to be referred to by our concepts. What does that require? It requires that there exist a sensory mechanism corresponding to each of the ways we commonly distinguish perceptions: a mechanism which enables us to see, a mechanism which enables us to hear, and so on; and it requires that there is a single kind of mechanism that produces all (or most) of the perceptions that we commonly classify as being of a single sense: all (or most) of the perceptions we commonly classify as instances of seeing must be produced by a single kind of mechanism, all (or most) of those of hearing must be produced by a single kind of mechanism and so on. Since we actually make a distinction between, and have concepts of, five senses it must be possible to identify five perceptual mechanisms for these concepts to refer to:¹⁴ if there are five such mechanisms our concepts may refer to them; conversely, if there are not five such mechanisms, our concepts of the five senses cannot be concepts of kinds of perceptual mechanisms. Although appealing to kinds of perceptual mechanism in order to explain in what the distinction between senses consists doesn't require that we know a theory of the mechanisms of perception, it does require that such a theory would make a distinction between five kinds of perceptual mechanism.¹⁵ So the question we need to answer is this: does a theory of the mechanisms of perception distinguish five kinds of sensory mechanisms? A theory of the mechanisms of perception must explain the mechanisms that enable us to perceive things; such explanations are psychological; therefore a theory of the mechanisms of perception is a psychological theory of perception.¹⁶ The question we need to answer is therefore: Does a psychological theory of perception distinguish five kinds of perceptual mechanism or process? This is the question that I address in the remainder of this chapter.

2.

¹⁴ I am assuming that our common-sense distinction is correct; I discuss the possibility that it is mistaken – that there are not five senses *as we conceive them* below.

¹⁵ Whenever I talk of perceptual mechanisms I mean mechanisms that produce perceptions of the kind we commonly classify as perceptions of the five senses. Of course there may be other mechanisms which, on some understanding of what it is to perceive, count as perceptual – there may be a mechanism involved in proprioception, for example. They are irrelevant to the question I am discussing.

¹⁶ I am making the (relatively uncontroversial) assumption that our capacity to perceive is appropriately explained at the psychological level rather than at any lower level – that generalizations in a theory that explains how we perceive will quantify over psychological states and processes.

I have argued that the best explanation of our everyday classification of perceptions into perceptions of five different senses is that it reflects the underlying psychological organisation of our perceptual system. Such a suggestion is plausible only if our perceptual system has the appropriate organisation. One way to determine whether it does would be to simply consult a psychological theory of perception. Unfortunately there is, as yet, no such theory to consult. There are theories, or parts of theories, of some aspects of our perceptual system, but nothing like a complete theory.

How, then, should we proceed? In what follows I argue that even if we don't have a complete psychological theory of perception, we do know what form a theory that distinguishes five kinds of perceptual mechanisms would have. We know, too, what the empirical commitments of a theory of that form are. In advance of knowing a complete psychological theory of perception, therefore, we can attempt to determine whether the empirical commitments of a theory of the right form are met. Although we might never be in a position, prior to having a complete theory, to show that the commitments are met, we might find evidence that shows that they are not met; that is, we might find evidence that rules out the possibility of there being five kinds of sensory mechanism.

What form would a psychological theory of perception have? We postulate psychological mechanisms in order to explain the psychological capacities of an organism, like the capacity of an organism to perceive its environment. What form should the explanation of a psychological capacity have, and how in general can we explain such a capacity? It is commonly supposed that we can explain psychological capacities *functionally*. The most detailed philosophical account of functional explanation is Robert Cummins's and Jerry Fodor's (see especially Cummins (1983) and Fodor (1968) and see Fodor (1983)). In what follows I begin by giving a brief account of functional explanation, and then describe its empirical commitments.

According to Cummins, we can explain a complex *psychological* capacity in the same way that we explain any other *complex* capacity: by analysing it into simpler elements. There are two ways in which this can be done. We can give what he calls a *functional analysis* of the capacity itself; and we can give a *compositional analysis* of the system which has the capacity. Since what makes an explanation the explanation of the capacity of a particular system is that the system actually realises that capacity, an adequate explanation will often require both kinds of analysis. This sets an empirical constraint on the analysis of any capacity of a system: the analysing capacities must be shown to be

capacities of the system which has the capacity. This point should be noted; we will see that it has some important consequences.

Compositional analysis explains a system's possession of a capacity by decomposing the system into parts. The system's possession of the capacity is then explained "by appeal to the properties of [the system's] components and their mode of organisation" (Cummins 1983, p.15). Analysing a system in this way has an explanatory value "when we come to see that something having the kinds of components specified, organised in the way specified, is bound to have the target property" namely, the capacity that we want to explain (1983, p.17). Since the components we use to analyse a complex capacity will often themselves have capacities or properties which we want to explain, this process of analysis is recursive.

The functional analysis of a capacity consists in analysing it into a number of simpler or less problematic capacities in such a way that the organised activity of the analysing capacities amounts to the activity of the analysed capacity. This has explanatory value because we can come to see how a series of relatively simple capacities operating together in a certain way can together constitute very complicated capacities.

The functional analysis of a capacity is often a preliminary step to explaining how a system possesses that capacity. We begin by analysing the capacity into a number of simpler capacities, and then explain how some system realises or possesses the complex capacity by showing that various component parts of the system themselves realise or possess the simple capacities described by our analysis. Thus functional analysis goes together with compositional analysis when we show that the analysing capacities are capacities of components of the system.

Fodor suggests that psychological explanations employ just this methodology; such explanations, he says,

have characteristically exhibited two phases that, although they may be simultaneous in point of history, are nevertheless distinguishable in point of logic...in the first phase of psychological explanation, the primary concern is with determining the functional character of the states and processes involved in the etiology of behaviour...The second phase...has to do with the specification of those biochemical systems that do, in fact, exhibit the functional characteristics enumerated by the phase-one theories. (Fodor 1968, pp.107-9.)

Although functional analysis often goes together with compositional it doesn't always do so. Sometimes we can analyse the capacity of a system into other capacities which are capacities of the system as a whole, and not capacities of any of its components.

Consider, for example, the capacity of a cook to bake a cake. Such a capacity can be analysed into a (sequence of) simpler capacities – to break eggs, to follow instructions, to mix ingredients together, and so on – which are not capacities of some part of the cook, they are just capacities that the cook has; capacities, we might say, of the whole cook.

We could provide an explanation of the capacity of the cook to bake a cake by providing a functional analysis of the capacity, but not a compositional analysis of the cook.

In practice, when we attempt to explain the capacity of a system we often need to analyse the complex capacity of the system into simpler capacities of the system as a whole before attempting any compositional analysis of these capacities. It will often be possible to analyse the complex capacity of a system in different ways and, since the different analyses will have different implications for the structure of the system which instantiates them, it will be important to distinguish these analyses when we come to explain the instantiation of a capacity by a particular system. The same capacity might, for example, be the product of two distinct and simpler capacities of the system as a whole, or it might be a single complex capacity of the system – we need to know which before attempting to provide any further compositional analysis.

A concrete example is provided by a class of distributed networks which are commonly used for simulations of cognition. Such networks are set up so as to have a particular steady state function – to produce a certain kind of output given a certain input – but the network can also 'learn' to produce a particular output given a particular input. We can analyse the complex capacity of this system into two simpler capacities – to produce a steady output and to learn – which are both capacities of the whole system or network, not of components of it. Yet the same complex capacity could be implemented by a system having two distinct components each possessing a simpler capacity (see Shallice 1988, p252).

If it is to be explanatory of a system's possession of a capacity the functional analysis of the capacity must terminate in capacities which we can show are instantiated by the system. Since there will usually be more than one way in which a capacity can be analysed, what makes an analysis an explanation of the capacity of a particular system is that the system instantiates the analysing capacities. If the system doesn't instantiate the

capacities described by our analysis then we will not have explained how this particular system has the capacity. In order to substantiate the claim that we have provided an analysis of some capacity of, say, the human brain, we need to show that our analysis is in fact instantiated by the brain. This requirement is what sets an empirical constraint on correct analysis. If, for example, we analysed some complex capacity into two simpler, and distinct, capacities of the whole system, we would look for evidence that these capacities are in fact independently instantiated by the system, and our claim to have provided an analysis will be undermined if we cannot show the analysing capacities to be independently instantiated.

This method of explanation can be used both to explain the operation of a complex capacity and the possession of that capacity by a system. We can think of the psychological capacities of an organism as complex capacities instantiated by them, and so can use this combination of functional and componential analysis to explain the operation and instantiation of the psychological capacities of an organism.

A complete functional explanation of some capacity of a system has the form of a hierarchy of levels. The top level is simply a description of the capacity to be explained; an analysis of this capacity constitutes the next level down, and each of the lower levels in turn provides an analysis of the level above. Each analysis of a higher level capacity is constrained by the requirement that the components of the analysis actually be instantiated by the system. If we cannot show that the lower level description is a description of capacities of components of the system then we have a reason to reject it as an explanation.

3.

Suppose that psychological capacities can be given functional explanations. Then a necessary condition for there being five kinds of sensory mechanism is that a functional explanation of our capacity to perceive distinguishes independently identifiable sub-functions, each of which functions in such a way that it can be plausibly identified with the operation of one of the senses.

Even in the absence of a functional explanation of our capacity to perceive, we know what form such an explanation would take were it to analyse the capacity to perceive into five distinct sensory capacities. Given that the capacities of an empirically

adequate analysis must be instantiated, we know too what structures or mechanisms the brain must instantiate for such an analysis to be correct.

That means that, in advance of having a complete functional explanation of our capacity to perceive, we can look for evidence either that the brain does or does not have the relevant structures or mechanisms. Such evidence would constitute evidence for or against the existence of five kinds of sensory mechanism independently of having a complete functional explanation. Evidence of this kind might never be such that we could confidently say, in advance of a complete explanation, that there were five kinds of sensory mechanism; but it might convince us that there were not five such capacities.

Isn't it just obvious that there are five such capacities? After all, we can use each of our five senses independently of the others – we can perceive something by seeing or by hearing alone without perceiving it with any other sense. Doesn't that suggest that, prior to any componential analysis, an initial *functional* analysis of our capacity to perceive should distinguish five independent sub-capacities, one corresponding to each sense? And therefore that all we should expect from further analysis of these capacities is an explanation of *how* each of them is actually instantiated by mechanisms in the brain?

However intuitively obvious it might seem, it doesn't follow from the fact that we can use each of our senses independently of the others that a functional explanation will produce an analysis into five sub-capacities. Distinct capacities that normally operate together may realise distinct functions; whether or not they do so depends on their overall functional organisation. Therefore, each independently usable sense may not be a single capacity but instead be instantiated by a number of distinct capacities operating together. And there may functionally significant interdependencies between the capacities that instantiate what we normally regard as distinct senses, interdependencies that in normal circumstances we don't notice.

To see this, consider the example of vision. A capacity is individuated by its functional role, its function being to map types of input onto types of output in a certain way.¹⁷ If a capacity is an input-output mapping, then to claim that a sensory modality is instantiated by a single capacity is to claim that there is some mapping of input states onto output states of the brain which instantiates it. We will have identified such a capacity when we have identified its inputs and its outputs and the relation between

¹⁷ Cummins says that “to ascribe a function to something is to ascribe a capacity to it that is singled out by its role in an analysis of some capacity of a containing system”, and that “X has a disposition to d if X would manifest d were a certain range of events to occur. To explain a disposition is to explain why d comes about when precipitating conditions occur”. A disposition is the same as a capacity for Cummins, see p.195 n.1.

them; two capacities will be identical only if they map the same kind of inputs onto the same kind of outputs in the same way. If vision is a single capacity then it must consist of some single mapping of inputs onto outputs. If there exists no one kind of input, or no unique kind of output, then vision would not be a single kind of capacity. Evidence against such uniqueness would be evidence against the claim that vision is a single capacity.

Marr, in his discussion of the function of vision (a function whose hypothetical workings he goes on to describe in detail) takes the *input* to the visual capacity to be fairly obvious:

A process may be thought of as a mapping of one representation onto another, and in the case of human vision, the initial representation is in no doubt – it consists of arrays of image intensity values as detected by the photoreceptors of the retina (1982, p.32).¹⁸

Whatever the output of vision may be, the input must be the light that is detected by the retina. We might think that something similar is true of the other senses; it is fairly easy to distinguish anatomically different sensory ‘transducers’ – those parts of the body – the sense organs – which are sensitive to various different kinds of stimuli and hence detect different kinds of information about the physical world. All the information we have about the world comes to us thanks to the operation of these transducers, so we know that the input to whatever perceptual capacities we have can be no more than what is detected by them; and each of them can be used independently of the others. It might seem safe, then, to infer from this that the input of each of the different sensory capacities is just what is detected by each sense organ – in the case of vision, arrays of light intensity values. But we want to know whether there is a *single* capacity corresponding to each transducer, and that depends in part on how the transducer itself functions.

The retina contains neurones which are sensitive to different features of the visual array, and – a fact “that is often not appreciated”¹⁹ – projections from the

¹⁸ Marr talks of processes where I talk of capacities; the difference is not important from the point of view of my argument.

¹⁹ Milner and Goodale 1995, p.3. Physiological and anatomical studies have distinguished several distinct classes of retinal ganglion cells each of which appears to be involved in the analysis of a different aspect of the visual scene. The cells form two channels of information which remain partially segregated through higher cortical regions (see Cowey 1979). Recently, a similar

neurones in the retina travel to a number of different targets in the brain. So, that the retinal image is the input to a single capacity, rather than that different properties of the image are inputs to distinct capacities, is an assumption which may turn out to be false. It is possible that we could find evidence that there are several kinds of visual output, which would be evidence that there is not a single input-output mapping for vision. That would suggest that vision is not a single capacity. The same may be true of the other sense organs: empirical investigation of their function is required to determine whether or not it is.

If it doesn't follow from the fact that we can use each sense independently of the others that there are five kinds of sensory capacity, then what would be evidence for the existence of five such capacities? If the correct analysis of our capacity to perceive analyses it into five distinct capacities, one of which is a single visual capacity, then we should expect to find a visual capacity instantiated in the brain as a single kind of mapping of inputs onto outputs. If, on the other hand, our visual capacity is analysed into two distinct parallel capacities, then we should expect to find it instantiated as two distinct input-output mappings in the brain. The existence of two such visual capacities would undermine the identification of our everyday concepts of the senses – in particular that of vision – with concepts of kinds of psychological capacity.

Even before we have a complete psychological theory of perception we can look for evidence that there is a single visual capacity instantiated by the brain, so here we have a clear example of how we might actually go about deciding whether our concepts of the senses are natural kind concepts. Evidence for or against the claim that the senses are natural kinds will therefore take the form of evidence that the brain does or does not instantiate distinct sensory capacities, or distinct kinds of input-output mappings.

4.

Suppose that we find evidence that there is not a single input-output mapping for vision. That would seem to be enough to undermine the claim that there is a single visual capacity, and so undermine any identification of our concept of vision with the concept of a natural kind. The question is not, however, quite so clear cut. I have been supposing that psychological capacities can be explained functionally, and have described

neuronal specialisation has been found in the auditory cortex of non-human primates (Romanski 1999a,b); I discuss this below.

what kind of evidence would show that a functional explanation of perception would undermine an identification of our concepts of the five senses with psychological capacities.

But the question of whether we can explain the capacity of some system functionally is not itself trivial: it depends, in part, on the kind of structure the system has. An adequate functional explanation is one whose analysing capacities can be shown to be instantiated by components of the system. If the organisation of the system whose capacities we are attempting to explain doesn't have a componential structure it will not be possible to show that a functional analysis is instantiated by the system – there would be no components of the system to instantiate the relevant capacities. Given that this structural organisation is a necessary condition for functional explanation, evidence that some system doesn't instantiate a particular capacity is not necessarily evidence that the system lacks that capacity: it may show instead that the system lacks the kind of structure that makes functional explanation appropriate.

According to the model of functional explanation that I have described we can explain a psychological capacity by analysing it into sub-capacities; and we can show that the analysis is the correct analysis of the capacity of a particular thing or system by showing that the analysing capacities are capacities of parts or components of the system, that they are instantiated by components of the system. Suppose, for example, that we analyse the complex capacity of some system into two parallel capacities each of which are capacities of the system as a whole. To show that this analysis is correct we would need to show that both capacities are in fact instantiated by the system in the way described by our analysis. That means the system must be shown to instantiate two independent capacities (together with any component capacities we postulate in further analysing these capacities). If two capacities of the system are independent of one another then, since component capacities are, in turn, individuated in terms of their role in the analysis, each set of their component capacities must themselves be independent of one another. So, in order to show that such an analysis is the correct analysis of the capacity of the particular system that we are attempting to explain we need to show that the system has components which instantiate those capacities in the way described by the analysis. If the analysing capacities are not instantiated then we cannot claim to have provided an analysis of the capacity of this particular system: although we might have provided an analysis of the capacity, and so given an explanation of how some arbitrary system could have this capacity, we would not have explained how this particular system

actually has the capacity. If we can't show that the system really instantiates two independent capacities, then our analysis will not be the correct explanation of the capacity of this system. This kind of procedure is described by Fodor:

having arrived at a ... theory of the kinds of operations performed by the mechanisms that are causally responsible for behaviour, one then "looks inside" to see whether or not the nervous system does in fact contain parts capable of performing the alleged functions... The physiological psychologist's task of determining what, if any, organisation into subsystems the nervous system of an organism exhibits is precisely the problem of determining whether the nervous system has subsystems whose functional characteristics correspond with those required by antecedently plausible psychological theories...it is clear that a psychological theory that attributes to an organism a state of process that the organism has no physiological process capable of realising is ipso facto incorrect...If no such mechanisms exist, then the [analysis of that capacity] is the wrong model for the functional organisation [of that capacity] (1968, pp.109-110).

If the nervous system doesn't have subsystems that correspond to our theory, then the theory doesn't provide an explanation of the psychological capacity or associated behaviour. Therefore if the model of functional explanation is to be applicable to the various psychological capacities – capacities like vision and memory – that we ordinarily attribute to people, then the system which instantiates these capacities – the human nervous system and brain – must have a certain kind of structure, it must have what Fodor calls a 'modular' structure: that is, it's various distinct capacities must be implemented by collections of sub-components – parts of the nervous system and brain – which are themselves independent of one another.²⁰ Were the brain to lack this kind of modular structure then we could not explain its capacities functionally because there

²⁰ For Fodor (who introduced the term in his 1983 book) a module is actually a sub-component with a special set of properties: "A module is, inter alia, an informationally encapsulated computational system – an inference making mechanism whose access to background information is constrained by general features of cognitive architecture, hence relatively rigidly and relatively permanently constrained" (1990, pp.200-1). The term 'modular' is now often used to describe functionally specialised sub-component structures which lack these properties; such structures are modular in a weaker sense than Fodor's.

would be no way to determine empirically which of two alternative analyses of the same psychological capacity was correct.

Given the empirical commitments of this form of psychological explanation, and in advance of a complete explanation of perception, evidence against the existence of five sensory capacities corresponding to the five senses will be equivocal. On the one hand, we could take it to be evidence that the correct functional explanation of the senses will not in fact distinguish five sensory capacities; on the other hand, we could take it as evidence that the human nervous system and brain lacks the kind of modular structure required for this model of psychological explanation to apply to it.

5.

Functional explanation of the form I have described sets a very strong constraint on explanation. Psychologists can and do construct explanations of people's psychological capacities, and they do so by constructing models of how those capacities are realised in the brain. Such explanations often distinguish capacities at one level even when they are produced by the operations of sub-capacities which are not entirely distinct at a lower level. If that's so then, in practice at least, psychologists don't necessarily individuate analysing capacities by their role in the analysis of higher level capacities, since they may also play a role in the analysis of other capacities that we distinguish at the higher level. In effect we can see functional explanation as placing too strong a constraint on adequate explanation – a constraint that has the effect of making it too easy to find evidence against a proposed explanation of a capacity. Couldn't there be other, less demanding ways of empirically determining which of two (or more) alternative analyses of a psychological capacity is a correct analysis of the capacity of the brain? If our model of psychological explanation is to be consistent with psychological practice, then we need to weaken the instantiation requirement on adequate explanation, and hence raise the level of evidence required to show that a particular analysis is not instantiated by a system. What form should this model of explanation take, and what kind of evidence do psychologists in practise appeal to in providing an analysis of a particular psychological capacity? The best way to answer these questions is to consider a concrete example: the explanation of memory. I've simplified it somewhat, to make the point more clearly.

We know that memory is the capacity to store certain kinds of information; we don't know what kind of information is stored in what way, nor do we know how it is

stored. If we want an explanation of our memory capacity then we must begin by attempting to characterise the capacity to remember in detail. On the face of it there is more than one way to characterise a person's capacity to remember things. We might characterise it as a single, general purpose capacity which can be used to remember any kind of information; or as consisting of several distinct capacities to remember different kinds of information: the capacity to remember the way to get into the centre of town may be a different capacity to the capacity to remember how to perform a mathematical calculation, or to remember the date of one's birthday, or to remember the smell of a flower. An explanation of memory must begin, therefore, with the most detailed description that we can give of a normal person's capacity to remember. The content of such a description may be far from obvious; as Churchland comments, what the mind is doing "even described at the level of input-output functions of the system – is not an observational matter, to be read off simply by looking at the behaving organism. Rather, it is a deeply theoretical matter. Some initial theory is essential to get the whole enterprise going..."²¹ The theory here will take the form of hypotheses about the role of memory in various kinds of behaviour. That is, we hypothesise psychological capacities which are responsible for people's behaviour. The capacities we hypothesise must be sufficiently complex to account for whatever behavioural abilities people are shown to possess. Producing this kind of description is likely to involve a certain amount of empirical investigation: we need to experiment, to test people, and so on, in order to determine what they can do. Once we have discovered what people can do – what they can remember and in what circumstances – and produced an analysis of their capacity, we can attempt to locate the mechanisms which instantiate the capacities postulated by our analysis.

I have suggested that failing to find such mechanisms does not show that the analysis of the particular capacity we are attempting to explain is incorrect; it may simply be that the capacity is instantiated by a system which lacks the required kind of structure. How, then, do psychologists determine whether an analysis – a theory of memory – is correct?

When constructing an account of people's capacity to remember – a psychological theory or model of memory – psychologists don't just use evidence of what people can do, they use evidence of what they can't do: their theories are often based on studies of the abilities of people with brain damage. By studying what

²¹ Churchland 1989, p.374; and see Fodor 1968, Ch.3.

capacities remain intact in the absence of others – by looking at how capacities dissociate when the brain is damaged – it is possible to learn about the structure of the intact capacity. Shallice provides a succinct explanation of the kind of methodology employed:

The importance of dissociations stems from an inferential asymmetry between associations and dissociations, if observed impairments faithfully reflect damage to an underlying modular system. If one patient shows an association between two types of deficit and a second shows a dissociation, with one of the abilities being preserved, then a simple explanation of the overall pattern exists. The observed dissociation can be presumed to arise from a lesion that has affected only one side of a functional line of cleavage in the modular system; the association is presumed to result from a lesion that has crossed this line.²²

In fact it is more important to look for double, rather than single, dissociations between two abilities. Two abilities are doubly dissociated if each one can be impaired without the other being so. This suggests that different underlying psychological capacities or mechanisms are required for the two abilities. A double dissociation is more significant than a single dissociation because a single dissociation is compatible with the possibility that the same capacities underlie the two abilities, but that the impaired ability simply taxes those capacities more heavily (and so stops working first, or works much less well, when they are damaged).

This approach has proved useful for understanding the mechanisms of memory.²³ In some people with damaged brains, memory impairment – amnesia – occurs as a circumscribed disorder, without any cognitive impairment. Although we tend to think of memory as a single capacity to remember things, the study of people with amnesia has provided evidence for distinguishing two kinds of memory: short and long term memory. People with amnesia can remember things for short periods of time, but not for longer periods. One psychologist of memory concludes that such results “suggest a distinction between at least two kinds of memory” (Squire 1989, p.504) – or two kinds of capacity: the capacity to remember things for short periods of time, and the capacity to remember things for longer periods of time. People with amnesia are in fact often able to learn

²² Shallice 1988, p.35. This methodological approach is relatively recent and interest in it has greatly increased over the past 25 years or so. Shallice’s book is an excellent discussion of its theoretical underpinnings. Note that Shallice is using ‘modular’ in a weaker sense than Fodor.

²³ Some of the relevant evidence is summarised in Squire 1989.

things – they are often able to learn how to perform certain motor, perceptual, and cognitive tasks. They can, in other words, still remember some kinds of things for longer periods of time, which suggests that we should distinguish different kinds of long term memory. It is this kind of evidence psychologists appeal to in attempting to characterise a particular psychological capacity that they want to explain; it's evidence that, in the case of memory, appears to show that what we thought of as a unitary capacity is in fact the joint operation of distinct capacities.

Although this evidence suggests that we need distinguish different kinds of memory it is possible that the kind of fragmentation of capacities revealed by amnesia has no functional significance and does not reflect the underlying structure of the mechanisms of memory. In order to show that the analysis is correct we need to show that these different capacities are in fact instantiated by the brain; if we are not able to do so, we would have to go back and revise our initial characterisation. But do they need to be instantiated, in the way required by functional analysis, by a strongly modular structure? No, because there are other kinds of brain structure which would produce the patterns of dissociation which count as evidence of distinct capacities of the system.²⁴ Suppose, for example, that each of two sub-capacities can function effectively without the other, but that there is some interaction between them. The interaction might be such that, for example, the two capacities are not able to produce conflicting outputs. According to the model of functional explanation, such interactions would rule out viewing these sub-capacities as components of distinct higher-level capacities, and yet in the situation in which one of these sub-capacities is damaged, the other may continue to function more or less normally. In that case it may be appropriate to treat each sub-capacity as a component in two different higher-level capacities. Our decision to treat these sub-capacities as distinct from one another may depend on whether we can specify the functions of each of the capacities of which they are part independently of one another. Evidence from a higher level – relating damage to a particular structure to changes in a subject's behaviour, for example – may lead us to treat components that interact at a lower level as distinct. Alternatively, suppose that two capacities are realised in overlapping areas of the brain. One capacity A might require regions X and Z of the cortex, and another capacity B might require regions Y and Z. Higher-level evidence

²⁴ For further discussion, see Shallice 1988, Ch.11. Farah (1994) discusses several dissociations that she argues could be explained in terms of damage to a non-modular system. The interpretation of the sensory dissociations that I describe below in terms of damage to a modular or functionally specialized system is supported by anatomical evidence that is absent in the cases Farah describes

might lead us to count X and Y as contributing to the function of two independent capacities, even though they are not realised independently of one another. Despite interactions, we would still regard A and B as distinct.²⁵

We should view the relation between a single sub-capacity and the rest of the system in which it is embedded as on a continuum. Our decision as to whether to treat two capacities as genuinely distinct or not will be determined by the extent to which the operation of a sub-capacity depends on outputs of other sub-capacities of the system of which it is a part, and how they relate to the state of the rest of the system. There may be certain relations between sub-capacities which are of far greater importance to the operation of the capacity than others; we can group together and distinguish components on the basis of the strength or importance of the connections between them. For as long as all the components of a capacity have strong connections to one another, and weak connections to the components of other capacities, we can view the components as genuinely instantiating that capacity and the capacity as genuinely distinct from others.

It is possible, then, to say when some proposed analysis of a capacity has a genuine functional significance even when the system whose capacity we are attempting to explain lacks a strongly modular structure. The difference between this approach – explanation in terms of functional specialisation – and functional explanation is that it allows that there is explanatory value to an analysis which shows how complex capacities can emerge from the interaction of functionally specialised components, even when we cannot precisely characterise the function of those components and the contribution they make to the system as a whole, and even when they don't stand in the very tight relationships to the analysed capacity required by functional analysis. This approach still makes an empirical assumption, namely that the brain has functionally specialised regions rather than having a general homogenous form, but there is ample evidence – from anatomical and functional-imaging studies, for example – to support this assumption.

6.

I have been describing what would be evidence for and against the claim that the human perceptual system consists of five kinds of psychological mechanism, and have suggested

²⁵ Overlapping or shared cortical areas doesn't entail the existence of a single function. Two distinct processes can overlap, and may do so when areas of the cortex contain differently sensitive neurons. So what may seem like an 'obvious' shared input to e.g. vision or audition, can in fact be an input to more than one process or function.

that philosophical accounts of psychological explanation – which view psychological explanation as a form of functional explanation – have an implausibly high a standard of empirical adequacy. When we look at examples of actual explanations we find that, in practice, psychologists treat as distinct capacities that are instantiated by components that are not entirely independent of one another, for as long as they have evidence that those capacities form part of functionally specialised subsystems. Given the structure of the brain and nervous system, this weaker model of functional explanation is an appropriate model for explaining human psychological capacities and the human perceptual system. The question of whether the human perceptual system consists of five kinds of psychological mechanism is, therefore, the question of whether the brain instantiates five functionally specialised perceptual capacities corresponding to each of the senses.

If our everyday concept of seeing is the concept of a kind of perceptual mechanism, then our capacity to see must be instantiated by a single kind of psychological process. Evidence that vision is instantiated by a single process will be evidence that there is a single functionally significant process whose operation enables us to see. In fact, there is evidence that suggests this isn't the case.

The primate visual system comprises a large number of anatomically distinct visual areas, each of which appears to process information about different aspects of the visual scene. Different areas are specialised for processing information about colour, motion, pattern, form, depth, and various other attributes (evidence for their function comes from a number of sources including, for example, deficits following brain damage, evidence of selective responsiveness of neurons in the area, and functional brain imaging (Zeki 1993). There are many interconnections between these areas, amongst which two significant pathways – a dorsal pathway and a ventral pathway – have been indentified.²⁶ The primary visual cortex (to which the majority of neurons from the retina ultimately project) makes a different contribution to each pathway so that although its destruction completely deprives 'ventral' neurons of visual input, 'dorsal' neurons remain responsive. They do so in virtue of the role played by subcortical visual areas in the dorsal, but not the ventral pathway. The different cortical and subcortical areas involved in the two pathways suggests the *dual-stream hypothesis*: the hypothesis that these two anatomically distinct pathways implement distinct and relatively functionally independent psychological processes. Strongest support for this hypothesis comes from

²⁶ The dorsal pathway links the primary visual cortex through the middle temporal area to the posterior parietal lobe, and the ventral pathway which links the primary visual cortex, through area V4, to the inferotemporal region.

neuropsychological studies of subjects with brain damage. The cases are relatively well known, and I shall describe them only briefly.²⁷

Cortical blindness is the result of bilateral lesions in the occipital lobe of the brain involving the primary visual cortex. These lesions mean that although the eyes and optic nerve could function normally, subjects cannot see objects in their blind field. We might expect damage to the primary visual cortex to produce complete deafferentation from the retina, but some cortically blind subjects are able to respond to visual stimuli. This phenomenon has become known as blindsight. Subjects with blindsight are unable to report the presence or nature of objects presented in their blind field and so are often said to be visually unaware of such objects. Their residual visual capacity can only be detected when they are placed in forced choice situations, in which they are encouraged to make a response, either by moving their eyes or by reaching or pointing, to a target object that they deny they can see. They are able to discriminate and localise such objects at levels well above chance.

A similar dissociation between awareness and action is found in some subjects with visual agnosia. Subjects with apperceptive agnosia are not blind, but are unable to perceive or recognise objects; they can detect visual features and have good acuity, but don't experience features as surfaces or as grouped into objects, and so cannot perceive shapes nor recognise objects.²⁸ One such subject, DF, suffered damage to her visual cortex following carbon monoxide poisoning. As a result she was unable to recognise everyday objects and faces, couldn't identify simple shapes, and had subnormal colour perception. She couldn't judge or use her fingers to show how big objects were or in which orientations. Despite these substantial visual impairments, she was normally accurate when object orientation and size were used to guide an action. Although she couldn't judge when objects were the same or different in shape, when she had to pick up an object she adjusted her fingers to grip it optimally; and when she had to post a card through a slot her movements were fluid and accurate, even though she could not match

²⁷ That they function relatively independently of one another was first suggested by studies of brain-lesioned monkeys. This led to a distinction between a 'what' and a 'where' function – one stream functions to compute information about objects' size and shape, the other – dorsal stream – to compute information about its spatial location. The neuropsychological studies I describe below have been taken to show that the distinction should not be understood in terms of the different kinds of information computed by each stream, but the use to which the information is put. Not a 'what' stream and a 'where' stream, but 'vision for judgment' and 'vision for action'.

²⁸ Associative agnosics, in contrast, can perceive objects normally, but are unable to attach a name to them. For more details, see Farah 1994. The dissociation between vision and action is associated only with apperceptive agnosia.

the orientation of the slot with another.²⁹ As with blindsighted subjects, although she lacks visual awareness of properties of objects, DF is able to use visual information about those properties to guide her actions.

Subjects with optic ataxia – typically following damage to the posterior parietal cortex – have visuo-motor deficits, and are unable to reach accurately for visually presented objects or to accurately grasp an object between finger and thumb or orient a card correctly for posting through a slot. They are nonetheless able to make accurate perceptual reports of the location and orientation of visually presented objects, and they can accurately indicate the size of an object with their fingers or rotate a slot to match the orientation of one presented to them. Their difficulty in reaching towards and grasping objects cannot, therefore, be explained in terms of their lacking perceptual awareness of the relevant properties of objects. Nor do they simply have a motor deficit since they can perform non-visually-guided actions normally; they can, for example, reach to places on their own body with normal accuracy. Although the exact form of deficit produced by optic ataxia varies from subject to subject it is best explained in terms of an underlying deficit in a visuo-motor system – that is, a system that functions to produce visually guided actions – that can be damaged at different points.³⁰ Subjects with optic ataxia have intact visual perception, but an impaired ability to use visual information to guide their action, and therefore show a dissociation between perception and action which is the reverse of that found in subjects with blindsight or agnosia.

In these neuropsychological cases, selective damage to the visual system affecting only one of the two visual pathways produces a visual dissociation. Damage to the ventral pathway leaves subjects unable to perceive visually presented objects, but able to use visual information about those objects in guiding their actions; damage to the dorsal stream leaves subjects able to perceive objects, but apparently unable to use visual information to guide actions directed towards objects they can see. This pattern of dissociation supports the hypothesis that the two visual pathways implement functionally independent processes: one which enables subjects to use visual information to guide object directed actions, and the other which enables the visual perception of objects required for subjects to make judgements about them, form intentions to act on them, and to select and discriminate amongst them.

²⁹ See Milner and Goodale 1995. Perenin and Rosetti (1996) describe a blindsight patient who was asked to post a card through a slot and grasp blocks in the blind field. Although the subject lacked awareness (couldn't report, denied seeing, etc.) their posting was accurate and grasping appropriate for the object.

³⁰ Milner and Goodale 1995, pp. 92ff.

The problem this poses for the view that in distinguishing the senses we are distinguishing between kinds of sensory mechanism is that there isn't a *single* mechanism of vision corresponding to our concept of seeing. The evidence I have described suggests that there are at least two distinct mechanisms or processes involved in vision. If there are two mechanisms then our common-sense concept of vision fails to refer to a single kind of mechanism; that is, it fails to refer.³¹ And if there are two mechanisms, then appealing to perceptual mechanisms will not answer the constitutive question – it won't tell us what all instances of visual perceiving have in common in virtue of which they are instances of seeing.

It might be objected that although the evidence I have described shows that there is more than one visual process, it doesn't show that our common sense concept of vision fails to refer to a single process. The evidence shows a dissociation between the visual process implemented in the ventral stream which produces conscious perceptions, and the visual process implemented in the dorsal stream which controls action. If the reference of our concept of vision is fixed in the way I described above, in terms of the causal process that plays a role in producing our perceptions of certain kinds of features of objects, then our concept will refer to the process which plays a role in producing our conscious perceptions; that is, the process implemented in the ventral stream alone. That there is a distinct process which controls action doesn't show that in thinking about the process which produces perception we don't successfully refer to a single psychological process.

There are two replies that can be made to this objection.³² First, the objection supposes that we think of vision simply as the process that produces conscious perceptions of things, and not more generally as the process that produces conscious perceptions of things and which enables us to act successfully on things that we can see. But it's not clear that we do think of vision in that narrower way. Suppose that you pick up an object that you can see. If you were asked why you moved your hand to that place (the place the object was) you are likely to say that it was because that is where you saw the object to be. It may not have been a conscious perception that guided your action to that place but, nonetheless, you appeal to vision in explaining your action. If that's right

³¹ The situation is similar to the jadeite/nephrite case that Putnam describes (1975, p. 241). In effect a presupposition of our reference fixing – that the majority of the things we refer to belong to a single kind – fails.

³² A third kind of response challenges the idea that the experiential states involved in perception are distinct from those involved in the control of action. For an example of such a challenge, see Nudds forthcoming.

then we don't think of vision simply as the process that produces conscious perception, and so our reference fixing procedures don't pick out only the visual process implemented in the ventral stream.

Second, the objection – even if successful – cannot provide a general method for defending a natural-kinds account of the senses since it applies only to the case of vision, and yet the psychological structure of the visual system that undermines the claim that vision is not a single capacity is not unique to vision; it reflects a general organisational principle of the human brain. The processes which instantiate the other senses are similarly modular and task-dependent in organisation and we are likely to find that they are not instantiated by a single psychological mechanism. Just this is true for the only other sense that has been studied in any detail: auditory perception.

The functional organisation of the auditory system is far less well understood than that of the visual system; however, just as the existence of a number of circumscribed and specific visual deficits provides evidence for modularity in vision so a number of similarly circumscribed hearing deficits provide similar evidence for the modularity of the auditory system. These deficits include, for example, cortical deafness – deafness caused by damage to the brain rather than the ears; pure word deafness – which is an inability to understand spoken words despite intact hearing, speech production, and reading ability; auditory agnosia – the auditory analogue of visual apperceptive agnosia; and phonagnosia – which is an impaired ability to recognise familiar voices. Since the modules could all be subcomponents of a single processing stream a modular structure alone is not inconsistent with the existence a single auditory processing system, but three kinds of evidence suggests that these modules are organised into at least two functionally independent systems. The evidence is anatomical (from non-human primates), neuropsychological,³³ and from functional imaging data.

Neurophysiological studies of non-human primates have described distinct projections from areas of the auditory cortex which respond to different auditory information, along dorsal and ventral pathways (Romanski et al. 1999a, b). One of the pathways responds to auditory spatial information, the other to non-spatial information; this suggests that they implement different processes. The suggestion is supported by functional imaging studies. A number of imaging studies, using fMRI and PET, have attempted to determine the extent to which sound identification and sound localisation

³³ The deficits may be double-dissociated, which suggests that they should be explained in terms of damage to a functionally specialised or modular system (see Polster, 1998).

involve different neural pathways. In one such study (Alain et al 2001) subjects had either to say whether two sounds appeared to come from the same or different locations, or whether they had the same pitch. Different brain areas, corresponding to the pathways identified anatomically, are activated for the two different tasks. The authors conclude that the neural systems involved in identifying and localising auditory objects are functionally and neuroanatomically segregated.³⁴ These results have been reproduced in a number of similar studies.³⁵

Subjects with normal hearing can effortlessly recognise a wide range of environmental sounds – such as the sounds produced by dropped objects, by poured liquids, and by animals – and are often able to localise the source of such sounds on the basis of hearing them. Subjects with auditory agnosia have adequate hearing but are unable to recognise familiar sounds and so are unable, for example, to match a sound to a picture of the kind of object that makes the sound. Although it often occurs together with other auditory deficits, auditory agnosia can occur as a circumscribed disorder. Subjects with spatial hearing deficits may be unable to localise the source of a sound or perceive its motion, and so unable to indicate the position on their head corresponding to the apparent location of a sound played over headphones, or the direction – right-to-left or left-to-right – in which the source appears to move.³⁶ Several case studies have described subjects who are able to perceive the location and movement of the source of sounds, but have severe auditory agnosia and so cannot recognise the sounds, and others who are unable to localise sound sources or perceive movement, but have a normal ability to recognise sounds.³⁷ The deficits are the result of lesions localised the parts of the brain corresponding to the two anatomically identified pathways. The double-dissociation is consistent with the evidence from functional imaging, and suggests that the processes that subservise auditory recognition and auditory spatial perception can function independently of one another. This suggests that, as in the case of vision, the

³⁴ Meander 2001 describes an fMRI study to determine whether auditory information relevant to recognition and localisation are processed by distinct neural populations. They found that differences in patterns of activation were apparent in passive listening tests, suggesting that the difference is not due to motor aspects of the task, but rather corresponds to “an organisational principle of the human auditory cortex”.

³⁵ A recent survey of 36 imaging studies (Arnott et al. 2004) found that the results were consistent with the two-systems model of auditory organisation in humans.

³⁶ The apparent location and movement of sound sources in the azimuthal plane can be varied by changing the inter-aural time difference of the sound when played over headphones.

³⁷ For example, Clark et al. (2000) describe four patients with localised brain lesions, two of whom have normal auditory localisation and motion detection, but severe impairment of auditory sound recognition. Their visual perception was normal.

auditory system comprises at least two independent functionally specialised capacities,³⁸ one of which is involved in sound recognition and the other in the localisation of sound sources.³⁹

This functional organisation undermines the claim that auditory perception involves the operation of a single perceptual mechanism, and so undermines the suggestion that in distinguishing the senses we are distinguishing between kinds of sensory mechanism. There isn't a single auditory mechanism corresponding to our everyday concept of hearing; there are at least two distinct mechanisms. Therefore our common-sense concept fails to refer. Since both auditory processes contribute to the conscious perception of sounds and their sources – each process enables us to perceive different features of sound sources – the reply I considered to the visual case – that only one of the two processes enables us to perceive and so only one is the reference of our common-sense concept – cannot be made here.

Although I have only considered two senses, the general pattern that emerges suggests that the psychological organisation of the perceptual system in general just doesn't correspond to the distinction we make between five senses. In both cases what we regard as a single sense is implemented in distinct psychological mechanisms. In addition to this fractioning or splitting of mechanisms *within* a sense, evidence is emerging of a great deal of interaction *between* the processes that implement distinct senses.⁴⁰ Such multi- or inter-sensory processes play a role in explaining the unified nature of our experience that I described above, and are responsible for illusions such as the McGurk effect (McGurk and MacDonald 1976). I hope to discuss of the implications of these interactions – both for an account of the distinction between senses and for perception more generally – on another occasion, but it is worth pointing out

³⁸ There may be more than two. Ducommun et al. (2002) describe a patient with circumscribed cortical motion deafness but intact ability to localise sound sources, suggesting that the mechanisms underlying these capacities are distinct. Their data “support the existence of highly specialised and partially overlapping processing networks for both sound localisation and sound motion perception” (p.86).

³⁹ The two systems in auditory perception are widely described as implementing ‘what’ and ‘where’ processes that are distinct in virtue of computing different kinds of *information* about sound sources; although the initial characterizations of the two systems in vision was similarly in terms of ‘what’ and ‘where’ (as informationally distinct) they are better characterized as a vision-for-action system and a vision-for-perception system, where both systems may process the same kind of information (both, for example, process spatial information) but each has a different *function*. I know of no attempts to distinguish in audition the role of spatial information in guiding action from the role of spatial information in perception.

⁴⁰ Two recent collections presenting some of this evidence are Spence and Driver 2004, and Calvert, Spence and Stein 2004.

that the existence of psychological mechanisms that play a role in producing our perceptions and which are inter-sensory is further evidence against the suggestion that the senses are psychological kinds. It's not just that a psychological theory of perception distinguishes more sensory processes than we commonly distinguish senses, it distinguishes processes in a way that cross-cuts our common-sense distinction.

I have described evidence that two senses – vision and audition – are not realised by single processes, but that perceptions that we commonly categorise as of a single sense may in fact be produced by the operation of two (or more) processes. That, I think, undermines the suggestion that the senses are natural kinds – it undermines the suggestion that the distinction we actually make between different senses tracks a natural distinction between kinds of psychological processes,⁴¹ and it shows that we cannot appeal to the psychological processes involved in perception to answer the question with which I began: What do all instances of seeing have in common in virtue of which they are instances of seeing? Whatever it is they have in common – whatever it is that makes a *visual* perception a *visual* perception – it is not that they are produced by a single kind of sensory mechanism.

7.

The senses are not sensory mechanisms, but does it follow that they are not natural kinds: couldn't they be a different – non-psychological – kind of kind? Might they not, for example, be kinds of sense organ, or kinds of (neuro-)anatomical structure, or mechanisms individuated in terms of their sensitivity to different kinds of energy or stimuli? The answer, I think, is no.

Kinds of anatomical structure are individuated relative to a theory of anatomy, and in general such a theory will make distinctions – in terms of structures of nerves and so on – that are more fine-grained than those made by psychological theories. Anatomical structures may be grouped into larger structures in virtue of their functional organisation; these larger structures are then individuated in terms of the theory that describes their functional organisation. It follows that if the senses are not psychological kinds then they are not anatomical kinds either. Psychological theories group together

⁴¹ Of course, psychologists describe the processes as *visual* processes and auditory processes, but that is just because they both play a role in producing perceptions which common-sense labels as visual and auditory. Independently of the fact that we commonly distinguish five senses, the psychological organisation of our perceptual system wouldn't give us grounds for distinguishing five kinds of sense.

anatomical structures in virtue of their functional organisation. If two processes are psychologically distinct, then they will be instantiated by distinct groupings of anatomical structures; conversely, evidence that two processes are not anatomically distinct would be evidence that the processes are not distinct at the psychological level. There are not five kinds of psychological mechanism therefore there are not five kinds of anatomical structure either; and the argument that the senses are not kinds of psychological mechanism entails that the senses are not kinds of anatomical structure.

There are well-known and decisive objections to the idea that the senses might be kinds of sense organ. These objections point out that there can be no explanation of why we distinguish five kinds of sense organ which is independent of the fact that we distinguish five kinds of sense modality,⁴² and hence that appealing to kinds of sense organ will not explain why we distinguish five senses. The very same objection can be made to the suggestion that in distinguishing senses we are distinguishing perceptions that are produced by different kinds of stimuli. Although the perceptions we distinguish are brought about by processes that involve sensitivity to different kinds of stimuli, there can be no explanation of why we distinguish five senses in terms of the stimuli that bring them about. Different kinds of stimuli produce perceptions we commonly think of as perceptions of a single sense, and the same kind of stimulus can produce perceptions that we commonly think of as of different senses. Light shades into heat, sound waves into felt vibrations, smell into taste, and so on.

There is a reason for thinking that if the senses are natural kinds then they must be psychological kinds. If our concepts of the senses are natural-kind concepts then their references will be fixed in terms of how our perceptions are brought about. An account of how our perceptions are brought about will be an account that explains those perceptions; an account that explains perceptions will be a psychological account.⁴³ If, therefore, we distinguish the perceptions of different senses in terms of the way they were brought about then we are distinguishing them in terms of the kinds of psychological mechanisms or process that produced them. So if our concepts of the five senses are natural-kind concepts, then they are concepts of kinds of psychological mechanisms; and if the senses are not kinds of psychological mechanisms then they are not natural kinds.

⁴² See, for example, Roxbee-Cox 1970, p.533.

⁴³ Explanations must capture significant generalizations and generalizations across perceptual states will be at the psychological level; a perceptual state is also a physical state, but a physical explanation of a perceptual state will be too specific to explain the occurrence of a kind of perceptual state: the perceptual state could occur even if the physical state did not.

I have argued that, for the two senses that I have examined at least, a necessary condition for their being natural kinds is not met, and hence our concepts of those senses do not refer to natural kinds. This conclusion follows because there are not five kinds of sensory mechanism corresponding to our common-sense concepts of five senses. Whatever those common-sense concepts are concepts of, they cannot be concepts of kinds of sensory mechanism, and so are not natural kind concepts.

It might be objected that this conclusion only follows if our common-sense distinction is correct and we really do have five senses. What reason is there to conclude from the fact that there are not five sensory mechanisms that our concepts are not natural kind concepts rather than that our common-sense distinction is mistaken? Doesn't the psychological evidence show that in fact we have more than five senses?

Our folk-scientific concepts are often wrong. The situation with respect to our common-sense concepts of the senses would be the same as that with respect to many other common-sense distinctions or classifications. In these other cases, if we discover that our concepts don't correspond to natural kinds, we revise our concepts. When it was discovered that jade and nephrite, instances of which we treated as being of the same kind, are in fact of different kinds, we didn't conclude that our concepts were not concepts of kinds of minerals, but that we were mistaken. If we thought that, then we would be adopting an error theory of the senses. We make a distinction between five senses, but the distinction we make is wrong.

In the case of the five senses, I think it's more plausible to think that our concepts are not concepts of natural kinds than that the distinction is mistaken. This is for two reasons. Firstly, the initial reason for claiming that our concepts might be concepts of natural kinds is that, if true, it explains the distinction we make between different senses. But if there are no natural kinds corresponding to our concepts, then the claim doesn't explain the distinction, and that reason is undermined. To maintain an error-theory of the senses, we need some additional reason for thinking that our common-sense concepts are (failed) natural kind concepts.

The second, and more decisive, reason is that our concepts of the five senses are common-sense folk psychological concepts, as central as any to our understanding of ourselves and others. For most, if not all, folk psychological states, being in a state of

one kind, rather than another, matters; it has some explanatory significance, often because being in that kind of state has consequences for one's behaviour – one's judgements and actions. In giving an account of folk psychological states, in saying what makes them different from one another, we aim to spell out these consequences; in giving an account of what is characteristic of different kinds of psychological states we must give an account of their explanatory significance. It is plausible to think that concepts of these different states are part of our folk psychological repertoire of concepts *because* of the explanatory significance being in one rather than another such state has.

Now the problem with an error-theory of some common-sense folk-psychological concept or distinction is that it rules out the possibility of giving any account of the explanatory significance of the concept or distinction. This is because concepts which fail to refer cannot feature in true explanations; the concept of vision fails to refer, so that someone sees something cannot be explanatory of any of their subsequent behaviour. If we think that the fact that someone sees something is explanatory, and if in general we think that the distinction we make between different senses has an explanatory significance then, we should reject an error-theory of the senses.⁴⁴

So where does that leave my attempt to say what a sense modality is? There are, I think, a number of options. First, my suggestion that in distinguishing perceptions into the perceptions of different senses we are distinguishing them on the basis of how they were produced could be rejected. That suggestion depended in part on the idea that experience is transparent to introspection. If that is wrong then perhaps there are differences in the character of the experiences involved in the perceptions of different senses. Or it might be suggested that two experiences can differ in their phenomenological character without differing in the objects and properties to which we can attend in introspecting them. Grice held such a view, and suggested that the senses can be distinguished by appeal to the special character of our experience which 'resists both inspection and description' (Grice 1967, p.259).

Alternatively, we might hold on to the idea that the senses are psychological mechanisms and adopt kind of moderate error-theory. Common-sense is right in distinguishing perceptions on the basis of how they were produced, but wrong in making

⁴⁴ In Nudds 2003 I argue from the need to give an account of the significance of our concepts of different senses to a more anthropocentric account of the nature of the senses.

the distinctions as it does. This suggestion takes seriously the idea that common-sense psychology is a kind of proto-scientific psychology, liable to revision in the light of empirical discoveries.

Or we could accept that in distinguishing different perceptions we are distinguishing them on the basis of how they were produced, but to give up on the idea that we can explain or give an account of the different ways that perceptions are produced that is independent of our practice of making the distinction. According to this approach, all visual perceptions are produced in the same way and different ways of perceiving are individuated relative to a social practice of explaining and understanding behaviour. On this view a sense modality is what might be called a *social* kind rather than a *natural* kind. Such an account may provide the best account of what a sense modality, as we commonly understand it, actually is.⁴⁵

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⁴⁵ I attempt to outline and defend a view of this kind in Nudds 2003.

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