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Perception: Ground of Empirical Objectivity

Abstract: Several types of objectivity are surveyed. The role of perception as a type of empirical objectivity, and as a source for more sophisticated types of objectivity that it itself does not realize, is discussed. Perceptual representation is distinguished from the sort of representation explained in terms of information theory. Perceiving is also distinguished from sensing. Some threads in the history of philosophy that have taken perception not to be a type or source of objectivity are discussed and criticized. Often inevitable limitations on the types of objectivity that perception can embody have been misconstrued as marks of subjectivity. Often perception has been mis-characterized in the interests of one or another philosophical ideology. The irony of this history is that the ultimate basis for the objectivity of the empirical sciences has commonly been miscast in the philosophical tradition.

Keywords: Perception, objectivity, perceptual constancy, representation

My topic is the objectivity of perception. I begin by surveying various kinds of objectivity. Then I discuss how perception realizes some of these kinds. Finally, I consider some limitations of perception. I try to explain why these limitations should not be taken to undermine the kinds of objectivity that perception in fact has. For the empirical sciences, perception is the ground and *sine qua non* of all other types of objectivity, even the types that perception cannot itself measure up to.

First, a brief survey of kinds of objectivity.[1]

The largest division is that between subject-matter types and representation-of-subject- matter types. The broadest, least restrictive example of a subject-matter type is the objectivity of all that is real, or all that exists, or all that has being. The contrast is with the purported, unreal "objects" of fantasy and delusion. Since such "objects" have no being, there is no genuine contrast class for the objective in this broadest sense.

Some subject-matter types of objectivity are more restrictive than the objectivity of everything that is. For example, it is common to count mind-independent

1 Most of what follows on types of objectivity is drawn from my *Origins of Objectivity* (Oxford University Press, 2010), chapter 2.

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aspects of the world as objective – and contrast them with mind-dependent aspects. Here and throughout, I exclude the mind of any deity from consideration. Mud, atoms, stars, and trees are mind-independent, hence objective on this categorization. Pains, beliefs, desires, and theories are non-objective on this categorization. In a sense, not all trees are mind-independent. Many are planned and planted.

To avoid this piece of awkwardness, let us take 'mind-independence' to mean 'constitutive mind-independence' – independence of mind for being the sort of thing it is. It is not a constitutive aspect of a tree that it be planned. Even with this restriction, quite a lot of things turn out to be mind-dependent, besides mental items themselves. Hammers are constitutively mind-dependent. What it is to be a hammer involves having some function or use, presumably for some being with a mind. Animals such as cats have minds constitutively. Something would not be a cat if it lacked a natural capacity for perception. On many views, colors are constitutively mind-dependent. For example, if colors are secondary qualities – dispositions in objects to produce certain sensations in a class of individuals –, then colors are constitutively mind-dependent. The constitutively-mind-independent type of subject-matter objectivity counts quite a lot of things non-objective: hammers, cats, nations, and perhaps colors. Such consequences are rarely recognized when people put forward notions of objectivity in terms of mind-independence.

A subject-matter type of objectivity that is more restrictive than the whole-real-world type and less restrictive than the constitutively-mind-independent type is the objectivity of things that are not themselves representational perspectives or states of consciousness. This type would include hammers, cats, colors, and nations as in themselves objective, but exclude beliefs, perceptions, pains, theories, and statutes.

I have cited three subject-matter types of objectivity. All are to be distinguished from representation-of-subject-matter types. Most uses of the term 'objective' apply to certain types of representation of a subject matter, rather than to subject matters themselves.

I divide representation-of-subject-matter types of objectivity into two large sub-classes – vertical types and horizontal types. The intuitive idea is that vertical types are characterized by a relatively direct representational relation to a subject matter. Horizontal types, by contrast, are characterized by types of representation or relations among representations.

The vertical relations to a subject matter are all aspects of or contributors to veridicality. Such relations as being true of, or accurate of, a subject matter are

aspects of veridicality. Referring to a subject matter is a contributor to veridicality. Being *veridical* – that is, being either accurate or true – is itself a vertical relation to a subject matter, by virtue of its dependence on these sorts of relations.

Different types of subject matters differentiate among types of vertical representation-of- subject-matter objectivity. For example, being true of a real subject matter, being true of a subject matter that is constitutively mind-independent, and being true of a subject matter that consists of things that are not themselves representational perspectives or states of consciousness are different types of vertical representation-of-subject-matter objectivity.

A stricter type of vertical objectivity is representation of laws or of certain structural invariances. This type loomed large in Kant's work and is central to modern physics.

The horizontal types of representation-of-subject-matter objectivity are a more varied lot. An example of horizontal objectivity is following a procedure that yields representations in a way that is independent of the whims of any particular individual. Following a set procedure in civil law counts as objective in this sense. Perhaps the central procedural type of objectivity in the history of philosophy, again emphasized by Kant, is representation that follows rational procedures, according to some canon or other.

A closely related family of types of objectivity comprises representation in impersonal terms, representation that is independent of first- or second-person pronouns, representation that is independent of demonstratives or indexicals, representation that is independent of individual attitudes or training. These are types of the objectivity of impersonality. Many specifications of laws have striven to be impersonal in some of these ways. The horizontal types can overlap.

A final type of horizontal objectivity is representation that accords with representation by others. Often the others are taken to follow some procedure – such as being rational or being scientific. The intersubjective versions of horizontal objectivity present straightforward contrasts with the subjectivity of idiosyncracy and the subjectivity of privacy.

Some broad points can be made about relations among the horizontal and vertical representation-of-subject-matter types of objectivity. Although many have championed inter- subjectivity as a central type of objectivity, philosophers have wisely tended to qualify intersubjectivity by placing some condition on the subjects to assure that intersubjectivity is not that of agreement among crazies. Kant took intersubjective objectivity to occur among subjects that follow rational or scientific procedures. Frege associated the communicable with law.

There is, of course, evidence that over the long run, a kind of efficiency, sometimes even group rationality, emerges from the aggregate actions of the

group. These are instances of the so-called wisdom of crowds.[2] I believe that if rationality, as opposed to efficiency or evolutionary success, is at issue, the individuals in a group must have basic rational competencies. Genuine rationality is not an aggregate upshot of efficient behavior of non-rational individuals.

The large point that I want to emphasize is that taking *vertical* representation-of-subject- matter types of objectivity to be constitutively more basic than horizontal ones is fundamental to a realist view of the world. Peirce defined truth as what rational procedures would lead to in the limit. Kant took following rational and/or scientific procedures to be what objective validity consists in – at least from what he called the transcendental point of view. These are idealist strategies. What I take to be the correct view is that rationality is to be understood partly in terms of being conducive to truth, given certain limitations of information and competence. Good scientific method should be understood partly in terms of truth or approximate truth. It must be method that can be expected to lead toward true or approximately true scientific theory. Statements of laws are often very far from being exactly and literally true, although such statements can serve many useful purposes. But representations of laws are ultimately to be judged by whether they describe, to some approximation, real lawful patterns in the world.

Of course, science must idealize. Few of our methods lead to precise truths. We are constantly finding limitations in our methods and both limitations and imprecision in our theories. But ultimately our procedures are evaluated by how well they describe reality.

Understanding reality in an illuminating way is the basic aim of science. Being veridical is the fundamental idealization that guides our conceptions of rational and scientific procedures.

So horizontal types of objectivity are to be understood as serving vertical types, given a realist attitude toward science and metaphysics. The primary norm for vertical types of objectivity is to be veridical-true or accurate. Veridicality is fidelity to subject matter. So the subject-matter types of objectivity provide the primary basis for assessing the objectivity of vertical representation-of-subject matter types. And as noted, the objectivity of horizontal representation-of-subject-matter types functions to serve vertical types. So subject-matter objectivity – essentially, what *is* – is in this sense fundamental.

There is a further sense in which the subject-matter types of objectivity are fundamental with respect to representation-of-subject-matter types. The contents

2 F. Galton, 'The Wisdom of Crowds', *Nature* 75 (1907), 450–451, http://galton.orf/essays/1900-1911/galton-1907-vox-populi.pdf; G. Gigerenzer and W. Gaissmeier, 'Heuristic Decision Making', *Annual Review of Psychology* 62 (2011), 451-482.

of representations and representational states, at least for empirically based representations, are determined to be what they are through interaction with their subject matters. The subject matters of such representations are partial determiners of the natures of our representations.[3] One can think, metaphorically, of the world's stamping itself – primarily through causal interactions – into the very contents of our representations.

I turn from these vertiginously general reflections to more specific points. I focus on ways in which perception is objective and on the role of *its* objectivity in the objectivity of more sophisticated types of representation.

To understand the role of perception in this welter of types of objectivity, it is crucial to distinguish perceiving from non-perceptual sensing. Sensing is an extremely broad phenomenon. Plants are *sensitive* to light and respond to it. I say that they do not *sense* anything, because they do not act and sensing serves action. Still, they are sensitive to the environment. Even laying aside the distinction between sensing and being sensitive, numerous organisms sense their environment without perceiving it. Bacteria sense light and swim away from it. Rotifers sense food through their cilia. Ticks sense warmth and crawl toward it.

No science explains these instances of sensing in terms of states that have conditions for being accurate. Sensing is causally based, statistically significant interaction with the environment that has a function for the organism. Relevant functions here are biological functions and functions associated with action. Fulfilling such functions are broadly, and in many cases richly, *practical* successes. We can speak of the accuracy of such sensing. But we are thereby describing nothing more than fulfillment of a practical function. In fulfilling a biological function, an organism or state contributes to fitness for survival long enough to mate. In fulfilling a function of an action – in reaching the action's target –, an organism commonly contributes to such fitness. Fulfilling such functions is not being accurate or inaccurate. Talk of these sensory states as being accurate or inaccurate is metaphorical.

An organism has perception only when it has states that are accurate or inaccurate, where having accuracy conditions is a real, non-metaphorical feature of the states' natures. Finding that having accuracy conditions is a feature of a state's nature is discovering that strong causal explanations appeal to states with accuracy conditions. In such cases accuracy is not merely a matter of biological functional success. Such success is constitutively a practical matter – being useful for survival long enough to reproduce, including fulfilling or contributing to

3 This point is a form of anti-individualism. For more on this matter, see my *Foundations of Mind* (Oxford: Oxford University Press, 2007), essays 4–10, and *Origins of Objectivity*, *op. cit.* chapter 3.

fulfilling biological functions of action and reaction for the animal or animal species. Accuracy in perception or belief is not constitutively a practical matter. A perceptual state can be accurate but practically deleterious, or practically useful but inaccurate.[4]

The term 'representation' is often used, even in science, in two importantly different ways. One way applies to all sensing, perceptual or not. The other way applies to a distinctively psychological capacity. This latter is the type of representation that underlies the main types of representation-of-subject-matter objectivity, vertical and horizontal.

To understand the former type of representation, one must first understand the basic idea of Shannon information theory, a theory of statistical correlation. State X provides (Shannon) information about state Y if X and Y are statistically correlated to some relevant degree.

Providing information is a symmetrical relation.[5] Clearly, providing information in this sense is not in any way equivalent to the sort of representation that we evaluate for veridicality.

Shannon information is a component element in applications of the term 'representation' that require meeting more conditions than providing information. These applications have been useful in understanding animal behavior. The conditions for state kind X's *informationally registering* state kind Y are (a) that state kinds X and Y are statistically correlated (provide information with respect to one another) to some significant degree; (b) that instances of Y commonly cause instances of state X; and (c) that such causal correlation is functional. Whereas the shadow cast by the sun off a rock statistically correlates with the direction of the sun and is caused by the sun's rays' hitting the rock from that direction, the causal correlation has no function. So there is no information registration. By contrast, a bacterium's sensing the light and a plant's sensitivity to

4 Similarly, of course, for a belief. Action that involves representation is a more complex matter. An agent's making his/her/its representation of the action's target veridical by acting in such a way as to satisfy the representation of the target is indeed both a representational success and a practical success. But there are always richer, more basic, practical norms and functions for each action, and richer, more basic types of practical success. These norms and functions are not fulfilled simply by the action's meeting whatever target it has. I believe that representational success in conation does not reduce to any of these richer types of practical success. Nor do these richer types reduce to conative representational success–acting so as to meet one's set (represented) target. These are, however, matters beyond the scope of this article.

5 C. Shannon, 'A Mathematical Theory of Communication', *Bell System Technical Journal* 27 (1948), 379-423; M. Mansuripur, *Introduction to Information Theory* (New York: Prentice Hall, 1987).

the light are not only caused by and statistically correlated with the light; this causal correlation is also functional. It is present in the world because it tends to enable bacteria to survive long enough to reproduce.[6] Thus it is said that the bacterium's sensory state represents light. It does so, but only in that it informationally registers light.

This information-registration use of the word 'representation' can seem to come close to being cognate with the use of 'representation' that figured in our discussion of objectivity. But it is not the same use. The distinction is marked in the explanatory practice of relevant sciences. No scientific theory of the sensing of food by a rotifer characterizes the sensory states in terms of their conditions for accuracy. The causal account is purely in physiological terms, or in terms of how aspects of proximal stimulation are weighted in such a way as to cause certain behavior.

The functional account is purely in terms of how the causal sensitivity to aspects of the environment contributes to the organism's biological success. Scientists sometimes attribute accurate perception to such organisms as rotifers – indeed to trees, because of their sensitivity to light. This is meta-patter, often with an advertising purpose. It is not straight-out science. No such patter figures in literal scientific explanation. Invocation of states with veridicality conditions is not needed or illuminating in causal explanations or functional explanations of a rotifer's behavior.

By contrast, there is a science of perceptual psychology whose primary aim is to explain the formation of accurate and illusory states. The science invokes such states in its causal explanations. It takes some causes and some effects as having conditions for accuracy as aspects of their natures – or as marking the kinds of states that figure in those explanations. Having conditions for veridicality (for accuracy or truth) is the hallmark of a representational state. So scientific practice and theory distinguish non-perceptual sensing from sensory perception. Non-perceptual sensing is a form of information registration, but not representation in the traditional sense. Sensory perception is not only information registration. It is a type of representation that has veridicality conditions, as an aspect of the causal-explanation-grounding natures of sensory perceptual states. Such

6 The notion of function explicated in this sentence is a slight simplification of what has become a standard notion of function in evolutionary biology. See L. Wright, 'Functions', *The Philosophical Review* 82 (1973), 139-168. The notion of function that I use in other contexts is broader. It includes representational functions, for example, as well as biological functions. However, in understanding information registration, the notion of biological function suffices.

states can be assessed, quite literally, for vertical objectivity with respect to a subject matter.

What underlies this difference in types of scientific explanation? The broad answer is that perceptual states are products of perceptual constancies, whereas mere non-perceptual sensory states – or mere informational registrational states – are not. A perceptual constancy is, roughly, a capacity to perceptually represent the same environmental property or relation *as* that property or relation, despite significant variation in proximal stimulation. For example, a perceptual state that represents a surface as a certain shade of green can, within limits, represent the surface as being that shade of green, despite significant variation in illumination of the surface (say, variation between white and red illumination). Difference in illumination has a huge effect on proximal stimulation. A system with color constancy can filter out differences in illumination and respond to the surface reflectance – roughly, the color – itself. Similarly a perceptual state that represents a surface as circular can do so whether the surface appears head-on or at a considerable slant. Again, representation as of a given environmental property succeeds despite significant variation in proximal stimulation. Sensory states in rotifers and snails show no such perceptual constancies.

Within a given perceptual system, in the formation of perceptual states, there is always some change-over from the immediate effects of proximal stimulation – which are non-perceptual, sensory, information-registrational states – to perceptual states. It can be a delicate matter to specify when such change-over occurs, and to motivate such specification. One must allow for vagueness in specifying a boundary. Still, the practice of the science does show fairly consistent agreement on what states are perceptual representations of the environment and what states are either immediate registrations of the proximal stimulus or subsequent filtered registrations of patterns in the proximal stimulus. The non-perceptual registrational states provide more information about the initial proximal stimulus array than about the environment. They remain merely informational-registration states. Perceptual systems, however, at some stages of processing, generate perceptual states that are embedded in perceptual constancies, and that are capable of being accurate or inaccurate, as an aspect of the basic kinds of states that they are.

Detailed accounts of why the science draws these distinctions in specific cases are complex and beyond the scope of this paper. But there are at least two key differences.

One is that perceptual contancies tend to fit a perceptual state to attributes in the distal environment. Invariances in sensory registration do not. They fit a state only to more or less abstract aspects of the proximal stimulation (for vision,

the light array just as it strikes the retina – the retinal image). The pre-perceptual registrations fit well with features in the retinal image, but poorly with the counterpart attributes in the physical environment, even when instances of those attributes are distal causes of features of retinal image.

For example, the registration of a contour in the retinal image (the array of light just as it strikes the retinal receptors) fits that contour very well. But although it in fact came from a specific contour in the distal physical environment, it is in itself consistent with a nearly infinite number of possible contours that could have produced that very same retinal image contour, all differing in their shape, length, and exact orientation in three-dimensional space. At the stages of processing in which a retinal image contour is being merely information-registered, nothing distinguishes the contour in the distal environment that is the actual cause from the nearly infinite array of other possible environmental contours that are consistent with that contour in the retinal image. At later stages of processing, states are produced that present the orientation, shape, and length of a contour in three-dimensional space. The science assumes that visual perception represents entities in the distal environment, not entities in the retinal image. Those are the entities that make a perception accurate or not. So the science distinguishes perceptual representation of three-dimensional contours (say, of branches in the distal environment) from sensory registration of two-dimensional contours in the retinal image. The latter registration is not taken by the science to be accurate or inaccurate.

Of course, even the non-perceptual information registrations function to aid action and reaction to aspects of the distal environment. Functional explanation of information registrations very frequently connects non-perceptual sensory states to aspects of the distal environment. But until science postulates relevance to the distal environment in its specification of sensory kinds embedded in the science's causal explanations, there is no postulation of perceptual states. Such specifications occur when sensory systems show perceptual constancies.

A secondary difference between pre-perceptual and perceptual sensory states concerns the role of perception in action. In animals that have perception in a given modality, pre-perceptual registrations that lead up to perceptual representations do not have the systematic role in action that perceptual representations do. Of course, if one stopped a perceptual process before it got to a perception, an animal would have to act on the information it had. But a systematic account of action by animals that have perception will normally take action to be guided by perception, not by those pre-perceptual registrations. A detailed ac-

count of the role of perception in action can help distinguish constancies or invariances among sensory registrations that are not perceptual from invariances that are part of genuinely perceptual constancies in the same modality.

Since perception is the most primitive type of representational state, the most primitive type of state whose nature admits evaluation for veridicality, perception is the most primitive state that can be counted objective. Accurate perceptions have vertical, representation-of-subject-matter objectivity. Since information registration is not, in itself, a type of representation that marks mentality, information registration cannot, in itself, qualify as either subjective or objective in any representation-of-subject-matter sense.

The vertical objectivity of perception is narrower than that of veridicality with respect to any subject matter that is real. Our conscious sensations are real. The classical British empiricists took objects of perception to be our own conscious sensations. Perceptual psychology firmly rejects this position. The entities that perception represents are entities in the subject's body or in the physical environment. These entities are either constitutively mind-independent, or at least not themselves representational perspectives. Perception is vertically objective inasmuch as it veridically represents entities that are not themselves representational or otherwise mental.[7]

Perceptual constancies, as understood in perceptual psychology, comprise the key phenomenon that, at the most primitive level, distinguishes representation that can be literally evaluated for accuracy from information registration that cannot be. Being embedded in a perceptual constancy is, I think, a necessary and sufficient condition for an accurate perceptual state to have this vertical, representation-of-subject-matter type of objectivity. It should be noted that perceptual constancies exhibit a primitive form of horizontal objectivity. They are capacities to represent a given attribute or particular on different occasions despite substantial differences in proximal stimulation. Substantial differences in proximal stimulation correlate with substantial differences in representational perspective. Embedded in perceptual capacities is, necessarily I think, an ability to cut through local, idiosyncratic aspects of a proximal stimulus situation to center on aspects of a distal stimulus that remain constant across perspectives. Thus there are antecedents to structurally invariant and impersonal types of horizontal objectivity in the perceptual constancies. Since most perceptual constancies track

7 I think that although we consciously sense our pains, we do not strictly perceive them. Our awareness of the felt quality of pain does not exhibit perceptual constancies. We may, however, perceptually attribute bodily locations to them.

lawlike patterns that are constant across variations in perspective on the patterns, the perceptual constancies even bear an implicit relation to types of objectivity that represent laws.

Of course, perceptions do not represent laws. Constitutively, they function to represent particulars, that are in fact localized in space and time. Obviously, perceptions do not count as objective on the conception that takes objectivity to be veridical representation of law. They are not in themselves science.

The history of philosophy has undergone a run of philosophical claims to the effect that perception is not objective, full stop. Threads in Descartes suggest that he thought that perception is fundamentally misleading regarding the real nature of the world. Leibniz took ordinary perception to be confused and indistinct. Sometimes, in both cases, ordinary perception seems to be portrayed as a hindrance rather than a help to science. Perception needed to be corrected and transcended by a natural philosophy that amounted to a metaphysics. As mentioned, the British empiricists assimilated perception to awareness of one's own sensations – a paradigmatically subjective enterprise. They made this mistake because they wanted to take perception as a foundation for knowledge that could resist scepticism and because they thought that the only way to resist scepticism was to postulate an infallible foundation. Of course, perception is not infallible. So there was no place in their account for genuine perception.

Kant is sometimes cited as holding that representation of laws is the only true type of objectivity, thus excluding perception from the realm of the objective. Frege is sometimes taken to locate objectivity purely in laws and structures, again excluding any representation that is as particular-bound as perception is.

These construals of Kant and Frege are, I think, mistaken. Kant was the father of several modern uses of the term 'objective'. He certainly regarded representation of laws and necessities as a paradigmatically important type of objectivity, for scientific cognition. But he clearly and explicitly counted empirical intuition – ordinary perception – as objectively valid and objectively real.[8] Kant denied objectivity to sensation, not to perception. Similarly, Frege contrasted structural objectivity only with incommunicable "intuitions" (misinterpreting Kant). He

8 I. Kant, *Critique of Pure Reason*, P. Guyer and A. Wood trans. (Cambridge: Cambridge University Press, 1998), B376–377. Kant's uses of the term 'empirical intuition' ('*empirische Anschaung*') correspond reasonably well with modern uses of the term 'perception' (that is, 'sensory perception').

counted singular thoughts based on perception as synthetic aposteriori truths, thus as vertically objective.[9]

There are, however, major threads in both traditional rationalism and traditional empiricism that do suggest, quite amazingly, that perception is not a source of objectivity. It is true that relevant authors often suggest only that perception is not a source of some favored type of objectivity, which science clearly does aspire to and that perception clearly does not attain.

But there is the thread in the rationalist tradition that perception is actually a hindrance to understanding the world, as opposed to navigating it. And there is the thread in the empiricist tradition that "perception" – or what the tradition substitutes into the role of perception – is in itself subjective, in not getting beyond the contents of the perceiver's own mind.

Although most of us are beyond being tempted by the traditional Empiricist view of perception as primarily a connection to our own sensations or ideas, it is hard to understate what a pernicious effect this view has had on the history of philosophy. The view gives an account of knowledge that leaves genuine perception completely out of the picture. The view starts with *sensa* and urges inferring things about the physical world from such *sensa*.

By contrast, perception represents the physical world directly – not by way of representing anything other than the physical world. Perceptual representations – that is, instances of specific types of perceptual states — are formed through complex, largely automatic processing that is, of course, fallible. Such processing is not the sort of propositional, intellectual inference postulated by traditional models of reasoning and knowledge. Ironically, there is no place in the Empiricist view for genuine perception.

This omission shows up not only in Locke, Berkeley, and Hume. It infects the work of Russell, Moore, early Carnap, Quine, mid-career Sellars, and Davidson. For many of these philosophers, genuine representation – capable of veridicality – begins with propositional attitudes. It begins with beliefs and other states on which propositional reasoning can operate. These philosophers maintained this benighted position because they lacked a clear-sighted view of perception. And they rightly regarded mere sensing, or sensation, as something that cannot be

9 G. Frege, *Foundations of Arithmetic*, J. Austin trans. (Evanston, Illinois: Northwestern University Press, 1968), sections 3, 12, 26. For discussion of this matter, see my 'Frege on Apriority', in P. Boghossian and C. Peacocke eds., *New Directions on the A Priori* (Oxford University Press, 2000); reprinted in my *Truth Thought Reason; Essays on Frege* (Oxford: Oxford University Press, 2005).

evaluated for veridicality. As a consequence, they postulated a direct transition from sensations to empirical beliefs, leaving out perception altogether.

Helmholtz, the father of modern perceptual psychology, did not make these mistakes. He distinguished non-perceptual sensing from perception, and saw in perceptual constancies a structural element that could support the idea that perception is objective. But he was so concerned to distinguish sensing from perceiving that he insisted that perceiving is a mere manipulation of signs. The obvious iconic aspects of perception, for which there is now massive empirical evidence, were largely ignored, at least in Helmholtz's official glosses on perception.[10]

Pylyshyn is a modern day follower in this regard.[11] Picture and map-like aspects of perception, grounded in isomorphisms between neural populations and the spatial world, beginning with the two-dimensional proximal stimulus array, are the basis for the format of spatial representation in vision and touch.[12] Helmholtz's determination to avoid the mistake of the Empiricists – the mistake of assimilating perception to sensation – led to an overly abstract view of perception.

Paradoxically, traditional Rationalists are less guilty than traditional Empricists of distorting what perception is. However, they tended to underplay perception's role in science because they thought that Aristotelian common sense, based on perception, yielded a distorted view of the world of fundamental physics. I think that they were right in having some inkling of the enormous gulf between the world that perception and common sense give us, on one hand, and the world that fundamental physics gives us, on the other. But up through Leibniz, traditional rationalists tended to overrate how far they could get in understanding the world through armchair metaphysical reasoning and to underrate how central perception is to arriving at a scientific understanding of the world.

Newton and Kant were the first to recognize the basic, if unsharp, distinction between science and metaphysics. Their drawing this distinction was revolutionary. Leibniz's complaints about Newton's *Principia* and Hegel's, Schelling's, Bradley's, Royce's post-Kantian idealist metaphysics, unconstrained by science, show that the distinction that Newton and Kant insisted upon did not go down easily. However, gradually but decisively, their conception of natural science as an experimental, observation-grounded enterprise has long since won the day.

The Rationalists' concerns about perception are, however, not all wayward. Those concerns are, I think, worth addressing from our current perspective. That

10 H. von Helmholtz, *Handbuch der Physiologischen Optik* (Leipzig: Voss, 1867).

11 Z. Pylyshyn, *Seeing and Visualizing* (Cambridge, Mass.: MIT Press, 2003).

12 T. Burge, 'Iconic Representation: Maps, Pictures, and Perception', in S. Wuppuluri and F. Doria eds. *The Map and the Territory* (Cham, Switzerland: Springer, 2018).

perspective has the advantage of a powerful science of perception, a meta-understanding of science that is largely free from armchair metaphysics, and a consequent recognition that perception is the necessary starting point for natural science.

One limiting fact about perception is that each perceptual system evolved to serve the needs of specific types of animals. Dolphins and bats use echolocation to locate objects. Spiders can locate and even identify specific shapes that are associated with prey, predators, and mates, by feeling the ripple effects of movement in their webs. Dogs and dolphins have hearing ranges that are different from ours. Many fish use tactile perception of water currents, whereas others use electrical signals, to locate prey. We lack these capacities, but have a versatile and acute visual system. Even with respect to vision, we are not pre-eminent among terrestrial animals in all respects. Hawks can see with more acuity at greater distances than we can.

A common lightheaded response to these facts has been to suggest that this dependence on the perceptual equipment of one's species makes perception non-objective. The response is lightheaded inasmuch as it sets an impossible ideal for the objectivity of perception. Perception is inevitably from a finite, limited perspective. It cannot represent all features of the world. We are limited receptacles. When the world stamps its features into our representation, it cannot do so in all detail. One should not confuse selectivity with subjectivity. Our perceptual intake is inevitably selective. It is selective because it was selected for through long interaction with the environment. It does not follow that it is not objective within its species-dependent domains.

There are, of course, important types of objectivity that perception cannot realize – the objectivity of representation of laws or structures *per se*, the objectivity of demonstrative- and indexical-free representation, and so on. What it can provide is the objectivity of approximately veridical representation of certain constitutively mind-independent or perspective-independent aspects of the world. Approximately accurate perceptual representation grounds more general, even law-like, representation. Perception also grounds the empirical objectivity of intersubjectivity. Perceptual systems and perceptual representations are broadly similar within species. In fact, our visual system is broadly similar to the visual systems of nearly all mammals. Given that we humans have similar perceptual systems and are able to conceptualize our perceptions and express such conceptualizations in language, and given that we are often in a position to recognize and correct each others' perceptual mistakes, we have a common basis for communicating results of observations and for checking one another's reports against independent perceptions of similar environmental conditions.

Moreover, the aspects of the physical environment that perceptual systems were selected to represent include some of the most fundamental features of the world. Most perceptual systems are dominantly focused on spatial and temporal aspects of the world. Every animal must deal with distance and direction, size and shape, motion and duration, cycles and intervals.

Perceptual representation of such attributes is crude and certainly does not hint at the deeper fine-structure of space-time. Perception provides only ego-centric, indexically-based, local, highly macro maps of space and time. These do not have the perspective-independent objectivity that physics strives for. What perception does provide is approximately accurate representation within its domain. Mammalian vision has turned out to be rich enough to provide the basis for a science that goes vastly beyond what perception provides.

Although we got to our science primarily through vision, we can plausibly speculate that other species might use other types of signals – auditory or electrical signals for example – to come to scientific results regarding space-time that are similar to our own. If the signals were rich enough and the non-human scientists were intelligent enough, I see no bar to their acquiring comparable science by non-visual means.

The point about not confusing selectivity with subjectivity applies not only at the level of differences among species, but also at the level of differences among individual perceivers.

There have been recurrent rejections, even within science, of expert observation as a ground for objective scientific representation.[13] One ground for such strange resistance is that expert observation is not common enough to be objective. Certainly, if a single individual made uncheckable observations, they would be useless for science. But experts' observations can be shared, because expertise can be taught. As a nearly general rule, experts do not differ from non- experts in that they utilize fundamentally different ranges of perceptual attributives. They and their perceptual systems utilize shape, size, color, texture, motion, body, face attributives – as do the perceptual systems of non-experts. Rather, experts notice and remember things that non-experts do not notice or remember. And their perception may be sharper and more differentiated, on key cues, through applications of attention. This sort of selectivity expands the range of useable information provided by perception, rather than contracts it.

Another limitation of perception is its imperfect acuity. This is the limitation that Leibniz focused on. Leibniz' concern has been echoed, for example by Eddington and by Sellars, with recurrent reminders about how our lack of perfect

13 L. Daston and P. Galison, *Objectivity* (New York: Zone Books, 2007).

acuity produces a different image of the world than the image produced by basic physics. Sometimes this line is accompanied with an ontological bias. It is said that physical bodies that we see appear to be solid, but actually they are groups of particles with large stretches of space between them. They are not solid at all. Or we see some surfaces as smooth, but microscopically all surfaces are jagged landscapes of fast- moving particles. So we do not see the world as it is.

This line hinges on assuming that the representations of solidity and smoothness when applied to macro bodies are to be understood as micro-physics might understand them.

Perceptual attributives for solidity and smoothness have approximately veridical applications in the macro domain. These applications are not pre-empted by the micro-physical. A macro surface is smooth on a scale that distinguishes it from surfaces with macro-large peaks and valleys. The spatial patterns and spatial contrasts that vision distinguishes are real. They just should not be expected to ground immediate insight into scales of the world that are too small, or too large, for the limited acuity of vision. Limited acuity is another form of selectivity. Selectivity is not the subjectivity of non-veridical representation.

Of course, a pervasive limitation of perception is that it is subject to error. Error really is contrary to the most primitive type of objective representation: veridical representation. Perception cannot realize the ideal of traditional empiricism–infallibility. In fact, perception is subject to *brute* error – error that occurs despite no misuse of perception and no malfunction in operations of the perceptual system. This limitation is an inevitable result of the causal dependence of perception on distal antecedents. Perceptual states are formed on the basis of proximal stimulation. If a system is given a certain proximal stimulus, then assuming that the antecedent and concurrent states of the psychology are held constant, and bracketing noise, it will produce a specific perceptual representation. The same proximal stimuli can be produced by different distal stimuli. When the distal stimulus is non-standard – not the type of stimulus that gave the perceptual state its representational content –, the system will produce a misperception. Susceptibility to brute error is an inevitable fact of life for any perceptual system.

Noise is another, indeed pervasive, source of error. Noise results from interferences in perceptual processing that derive from the imperfections of any physical system. In fact, for scalar properties – such as distance, size, shape, speed, and color, as distinguished from yes-no properties – such as ordinal depth –, *most* perceptions are slightly inaccurate. But within ranges of normal operation, mammalian visual systems are close to being as optimal with respect to accuracy as physical limitations, such as noise and imperfect resolution, allow.

Susceptibility to error should not be overrated as a limitation on the sorts of objectivity that perception can provide. Many errors in observation are not strictly perceptual errors. They are errors of bias or of over-interpreting what perception provides. The attributives employed in perception form a relatively limited range. Visual perception inhumans, for example, has attributives for shapes and other spatial properties or relations, textures, colors, lightness, motion, body, faces, and probably a few other generic types of attributives, including perhaps some functional attributes like *prey*.

Perceivers can learn to group various bodies by their shapes or characteristic motions. Such groupings utilize more specific attributives – attributives for bodies with specific characteristic shapes and motions. The shapes or motions can be those that trees, cars, toothbrushes, aardvarks, or even X-Ray machines typically have. Of course, it does not follow that perceptual attributives have contents like tree, car, toothbrush, aardvark, or X-Ray machine. Perception lacks the resources to distinguish natural kinds from bodies with the characteristic shapes, colors, and motions that certain natural kinds have (such as bodies with the shape, color, and motion of tigers). Perception cannot respond to many types of artifactual function – like the functions of X-Ray machines. Perception tends to concern itself with surfaces, bodies, shapes, spatial relations, temporal relations, colors, textures, motions, and so on. But it can group so as to apply attributives that are approximately extensionally equivalent with such attributives as those listed just above.

There is some evidence, still disputed, that human visual perception has attributives whose content attributes being a causal event, and being an action. The list will probably be extended on empirical grounds. But it will remain limited in comparison to the range of concepts that language and science provide us.

Most of the kinds, properties, and relations that we think about are not attributed in perception. Many errors of observation involve over-interpreting what perception in fact yields.

On the basis of these perceptual attributions, the errors connect perceived properties erroneously with properties that are not strictly perceptually indicated or attributed. For example, one might correctly perceive a body as having a specific shape (that is in fact typical of X-ray machines) and mistakenly take the body to be an X-ray machine. Obviously, such errors are not the fault of perception. They are errors of inference or in other transitions between perception and thought.

Similarly, errors that derive from expecting perception to provide veridical information beyond its natural domain of application are not perceptual errors.

Human visual perception does not yield accurate information about ordinal depth of surfaces beyond about 200 or 300 yards.

Similarly, visual perception is not fitted to yield accurate representation of the movement or size of distant heavenly bodies. The view, held before early modern astronomy, that the stars are fixed and relatively small derived, I think, from an inference, not a misperception. Given lack of normal cues to the distance and size of a perceived object, the perceptual system is likely to go non-committal about distance and size. Traditional errors about the distance and size of heavenly bodies probably stemmed from inference, not from perception itself.

The familiar errors of bias are again rarely the fault of perception itself, though such errors can affect perceptual attention and hence perceptual groupings. Much work in social psychology that is supposed to show that bias commonly affects perception itself rests on poor methodology and will not stand. Of course, errors that derive from malfunctions – errors caused by cataracts or lesions, for example – do not reflect on perception *per se*.

The main failure in perception to achieve approximate accuracy is brute error. Although there is nothing intrinsic to perception that guarantees that it is even reliable, much less infallible, our actual perceptual systems – specifically our visual system – are, as noted, amazingly approximately accurate, within their proper domain of operation. An important area of research in perceptual psychology has grown up in the last ten or fifteen years that develops this point with great rigor. The idea of the research is to state a function of a given perceptual task, for example, to correctly estimate the speed and direction of visible motion at relatively close distances. Then, known natural limitations of acuity and noise in the system are factored in. A normative optimality theorem is then proved. The theorem states the theoretical limit of accuracy, given such natural limitations. Finally, human visual performance is experimentally compared, in ordinary conditions, to the limit of optimal performance. In cases studied so far, human visual performance is near optimal. One can expect similar results for other species.[14]Neither accuracy nor reliable accuracy is selected for *per se* in evolution.

14 C. Blakemore, 'The Range and Scope of Binocular Depth Discrimination in Man', *Journal of Physiology* 211 (1970), 599–622; W. Geisler, J. Perry, B. Super, and D. Gallogly, 'Edge Co-occurrence in Natural Images Predicts Contour Grouping Performance', *Vision Research* 41 (2001), 711–724; D. D'Antona, J. Perry, and W. Geisler, 'Humans Make Efficient Use of Natural Image Statistics', *Journal of Vision* 13 (2013), 1–13; J. Burge and W. Geisler, 'Optimal Disparity Estimation in Natural Stereo Images', *Journal of Vision* 14 (2014), 1–18; S. Gepshtein and I. Tyukin, 'Optimal Measurement of Visual Motion Across Spatial and Temporal Scales', in M. Favorskaya and L. Jain eds., *Computer Vision in Advanced Control Systems Using Conventional and Intelligent Paradigms* (Berlin: Springer-Verlag, 2014).

But reliable approximate accuracy is useful enough for fitness enough of the time that it is a characteristic of many perception-action packages that *have* been selected for. Our visual systems have had a long time to become the near optimal organs of representation that they have become. The non- perceptual sensory systems from which our perceptual systems evolved used that time well.

My conclusion is so simple that it should not have needed stating. Perhaps you will think that it really *did not* need stating. Despite the risk of having wasted your time, I hope that you think this. Here is the conclusion anyway. Perception is a primitive but powerful source of certain types of objectivity – pre-eminently, approximately veridical representation of a fairly large but restricted range of environmental subject matter. Perception's providing this type of objectivity undergirds, in empirical science, the achievement of types of objectivity that perception itself can never achieve. It is a striking fact about the history of philosophy that perception has been ignored or denigrated. It has not consistently been recognized and honored as a basis for our achieving objectivity in understanding and explaining the world. I trust that it will occupy such a place more securely in the future.

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