

Observers, Objects, and the Embedded Eye; or, Seeing and Knowing in Ptolemy and Galen

*By Daryn Lehoux**

ABSTRACT

This essay explores the ways in which theories and entities are culturally and intellectually embedded in historical and disciplinary contexts by looking at the development of a set of related theories of perception that emerged in response to contemporary Sceptical criticisms of the very possibility of doing empirical science. At the same time, it attempts to bring into focus a puzzle about precisely how (and how deeply) seeing itself is conditioned.

A FEW YEARS AGO I was stumped for several days by this question: Why is it that when we look in a mirror, left and right get reversed, but up and down do not?¹ Like any good puzzle, once solved it may seem surprising that the question should have posed any problems at all. And yet it can be genuinely difficult if you've never thought it through before. Perhaps the trick to the question lies in the way the answer hides itself in the space just between optics and perception, between physics and psychology, between image and imagination.

Indeed, a newcomer's initial attempts to answer the question highlight an almost instinctive tendency to compartmentalize the different aspects of this single phenomenon under the auspices of different sciences: optics, physiology, psychology. In the second century A.D., when Ptolemy first faced this same question in his *Optics*—and imagine my surprise when I found this passage—he did not have the same problems I had in seeing an answer, partly because he was himself working in territory that only later would become liminalized, hiding in the boundary areas of the different modern sciences. To put it another way: Ptolemy does not have the same blind spots as I do. By this I do not mean to say that his science is more inclusive but, rather, that it moves over different ground and that the ways

* School of Arts, Histories, and Cultures, University of Manchester, Manchester, United Kingdom M13 9PL.

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¹ For this I can thank Kevin McNamee.

in which it does so are revealing: the concepts he takes for granted, the phenomena he seeks to explain, the tools he chooses, and the answers he is satisfied with—all these will shed light not only on Ptolemy's project, but also on the ways in which modern ideas of vision and perception are similarly *embedded*. Part of what I am driving at here is an idea that has been demarcated in different ways by different disciplines at different times, and aspects of it have been flagged by Ian Hacking, Nelson Goodman, Michel Foucault, and others: Any given way of framing questions of truth and falsity about the natural world is bound up in networks of relations and requires a background of standards, concepts, methods, tools, and objects against which truth and falsity can be judged.² This background is necessarily both highly complex and, under the normal constraints of day-to-day practice, invisible.

Partly because of historical, intellectual, and cultural currents, the second century A.D. Roman empire is particularly fruitful for the sciences, and it is here that we find two of the most sophisticated, prolific, and ultimately authoritative of ancient scientific authors: Ptolemy and Galen.³ Each of them, as it turns out, works on very different aspects of the phenomena of *seeing*: Ptolemy in mathematical optics and Galen in physiology. In pursuing their different ends, though, each of them needs to deal with the physics of vision and the mechanisms of perception.⁴ The sets of questions these pose are particularly interesting in that they, like the mirror puzzle, run up against the boundaries between the objective and the subjective, between the physics of the world, the makeup of the human body, and the idiosyncrasies of perception.

Why Ptolemy and Galen in particular? These are not two authors who commonly find themselves stood together for focused comparative analysis.⁵ There are several reasons that I do so here. One is that Galen and Ptolemy, exact contemporaries that they are, have investigative domains that are in one sense mirror images of each other, standing on either side of the eyeball, each probing its secrets and the relationships in which it is rooted, but from opposite ends of the pupil. Ptolemy is looking at the way visual lines move in the world at large, how they come to the eye itself, how they can be physically altered to create illusions and errors, and how such common illusions and errors of perception can be explained purely geometrically, in terms of the propagation of visual rays. His account of these phenomena is thorough, detailed, and rigorous. But he also knows that his explanation of vision is incomplete if he cannot give some account of what happens inside the

² Ian Hacking, *Representing and Intervening* (Cambridge: Cambridge Univ. Press, 1983), puts these issues under the umbrella of *styles of reasoning*; Nelson Goodman, *Ways of Worldmaking* (Indianapolis: Hackett, 1978), frames it as a question of *worlds*; Paul Feyerabend, *Against Method: Outline of an Anarchistic Theory of Knowledge* (London: Humanities, 1975), tries to locate it under the rubric of *incommensurability*; Michel Foucault, *Les mots et les choses: Un archéologie des sciences humaines* (Paris: Gallimard, 1966), refers to *epistemes*; and J. G. A. Pocock, *Virtue, Commerce, and History* (Cambridge: Cambridge Univ. Press, 1985), speaks of *discourses*.

³ On these "currents" see, e.g., Jutta Kollesch, "Galen und die Zweite Sophistik," in *Galen: Problems and Prospects*, ed. Vivian Nutton (London: Wellcome Institute for the History of Medicine, 1981); and Heinrich von Staden, "Galen and the 'Second Sophistic,'" in *Aristotle and After*, ed. Richard Sorabji (London: Institute of Classical Studies, 1997), pp. 33–54.

⁴ Throughout this essay, the careful reader will notice that "sensation" and "perception" are being used virtually synonymously. Neither Ptolemy nor Galen had access to Bertrand Russell's very influential distinction between sensation and perception in *The Analysis of Mind* (London: Allen & Unwin, 1921). Indeed, the kinds of psychological burdens that Russell is flagging in perception as interposing and imposing on sensation only become really problematized (and so only begin to need systematic explanation) with the advent of professional psychology in the nineteenth century.

⁵ There are a few exceptions, however: Anthony Long, "Ptolemy: Epistemology for the Scientist," in *The Criterion of Truth*, ed. Pamela Huby and Gordon Neal (Liverpool: Liverpool Univ. Press, 1989), pp. 151–178; Paola Manuli, "Claudio Tolomeo: Il criterio e il principio," *Rivista Critica di Storia della Filosofia*, 1981, 35:64–88; and Giorgio Cardona, "Tolomeo e Galeno," in *La filosofia ellenistica e la patristica cristiana dal III secolo A.C. al V secolo D.C.*, ed. Mario del Pra (Milan: Vallardi, 1975), pp. 229–249.

eye itself to produce the phenomena of vision that we experience. Standing on the outside, he knows he must make at least some effort to look in, if he is to give a full account of seeing. Contrariwise, Galen is carefully examining the structures in and behind the eye itself: how it is physically constituted, how it is connected to the rest of the organs, and what these various physical connections might mean for how we actually come to perceive anything. But he also knows that his explanation of vision is incomplete if he cannot give some account of what happens outside the eye itself to produce the phenomena of vision that we experience. Standing on the inside, he knows he must make at least some effort to look out if he is to give a full account of seeing. It is just at this point that each of our authors begins to get hazy in his account, as they look beyond their customary spheres, from their own side of the eye to the other's.

Now why should both Ptolemy and Galen care about giving such a full account of seeing? Ptolemy's predecessors in mathematical optics, for example, show no concern with what happens to visual information once it reaches the eye. But for Ptolemy, as for Galen—and this is where their different domains intersect—there are epistemological considerations that are ultimately at the foundation of the very methodologies they are employing: If we have no account of the relationship between sensation and the mind, how can we use the data of observation as a fundamental ingredient of what counts as *knowledge*? In order to open up a secure epistemological space for sensation to stand in, both Ptolemy and Galen go to some lengths to show that there are no serious or insurmountable impediments to the transmission of facts from the world at large to our minds via the senses in general and via sight in particular. That is, if we can understand how visual impressions come from the world into the mind, and we can show that such a transmission is secure (or at least that its insecurities are comprehensible and manageable), then we have a sound epistemological base on which an empiricism can rest. This grounding is all the more crucial, I will argue, in the Hellenistic philosophical context where several varieties of (sometimes very radical) Scepticism were leveling nontrivial objections to the reliability of sensory experience in general.

Related to this is the fact that for Galen and Ptolemy the ways in which they frame not only their own proper investigations, but also how they probe into each other's territory, will be conditioned by their intellectual resources and philosophical commitments.⁶ In both cases these commitments show a high degree of philosophical independence but at the same time a readiness to use the fruits of the rich Hellenistic intellectual milieu as both resources and grounding to solve very specific problems in the sciences, problems that only a working scientist would encounter so intimately.

Lastly, because they are the predominant figures in their respective fields in the Arabic

⁶ Both Galen and Ptolemy are often classed by modern readers as philosophical *eclectics*. Although the word is handy, it is not uncontroversial in this particular instance, and, at the very least, I would certainly not want "eclectic" to be understood as pejorative. On Galen's eclecticism see esp. Michael Frede, "On Galen's Epistemology," in *Galen*, ed. Nutton (cit. n. 3), pp. 65–86; R. J. Hankinson, "Galen's Philosophical Eclecticism," *Aufstieg und Niedergang der Römischen Welt*, 2nd Ser., 1992, 36(5):3505–3522; Pierluigi Donini, "Galeno e la filosofia," *ibid.*, pp. 3484–3505; and Heinrich von Staden, "Body, Soul, and Nerves: Epicurus, Herophilus, Erasistratus, the Stoics, and Galen," in *Psyche and Soma: Physicians and Metaphysicians on the Mind-Body Problem from Antiquity to the Enlightenment*, ed. John P. Wright and Paul Potter (Oxford: Clarendon, 2000), pp. 79–116. On Ptolemy's see Long, "Ptolemy"; and A. Mark Smith, *Ptolemy's Theory of Visual Perception: An English Translation of the Optics* (Transactions of the American Philosophical Society, 86[2]) (Philadelphia: American Philosophical Society, 1996), pp. 17–18. On eclecticism in general see, e.g., Donini, "The History of the Concept of Eclecticism," in *The Question of "Eclecticism"*, ed. J. M. Dillon and A. A. Long (Berkeley: Univ. California Press, 1988), pp. 15–33.

and European Middle Ages, both Ptolemy and Galen later stand as the quintessential authority figures against which early modern science (Copernicus, William Harvey) would see itself as struggling to emerge. We could tell a similar story about Aristotle's relation to Galileo in this context, but what Ptolemy and Galen share is a much stronger emphasis on, and control of, careful and systematic observation than we find in Aristotle. What we have in Ptolemy and Galen are fully fleshed out empirical methodologies, which show sophisticated attempts to control the vagaries inherent in observation through the improvement of observational techniques, through the understanding of where observational error can intrude, and through the careful minimizing of the effects of such error. On the epistemological front, they also agree on a crucial point: for them, the relationship between perception, objects, and ideas is not, in the first instance, one of *representation*. It is instead one of direct physical causation.⁷ The precise details of how this is so will be worked out in different ways by Ptolemy and Galen, but for each of them this line of causation is central to the grounding of experience.⁸

MECHANISMS OF SEEING

It is worth having a brief look at the ancient visual and perceptual theories that furnish the background against which Ptolemy's and Galen's investigations are framed. If we start from the eye itself and look outward, there are a number of competing accounts of how visual information comes from the world at large and into the eye. We should also keep in mind that the basic phenomena that get ancient optics off the ground are all based around how objects in the world appear to us and why.⁹ Why do objects appear smaller when farther away? Why do mirrors produce images? How do we perceive distance and shape?

⁷ Philosophers are wont to characterize representational accounts of perception in contrast to something called "common sense" realist accounts, but I think here they generally underestimate the common-sense nature of the representational accounts, which are, if anything, far more pervasive and deeply rooted (at least since Locke). See, e.g., Hilary Putnam, *The Threefold Cord* (New York: Columbia Univ. Press, 1999); and John Foster, *The Nature of Perception* (Oxford: Oxford Univ. Press, 2000).

⁸ Lorraine Daston and Kelley Wilder have pointed out to me that the line of argument here got a kind of second life in the nineteenth and twentieth centuries in debates about the nature of photography. These debates run on two different (if overlapping) planes: (1) Is photography representational or (merely) causal? If only causal, can it be art? (2) What is the nature and value of photographic evidence versus other kinds of evidence? Both of these issues put the question of human agency and mediation between object and image front and center (and situated at just the point where Scepticism would drive the wedge in for the ancient problem of perception). Much of the debate on photography (as Ted Cohen, "What's Special about Photography," *Monist*, 1988, 71:292–305, very rightly points out) sees the camera as implausibly autonomous (see also Joel Snyder and Neil Walsh Allen, "Photography, Vision, and Representation," *Critical Inquiry*, 1975, 2:143–169; contrast Kendall Walton, "Transparent Pictures: On the Nature of Photographic Realism," *ibid.*, 1984, 11:246–277). Take Bazin's very influential and highly provocative framing: "L'originalité de la photographie par rapport à la peinture réside donc dans son objectivité essentielle. Aussi bien, le groupe de lentilles qui constitue l'oeil photographique substitué à l'oeil humain s'appelle-t-il précisément 'l'objectif.' Pour la première fois, entre l'objet initial et sa représentation, rien ne s'interpose qu'un autre objet. Pour la première fois, une image du monde extérieur se forme automatiquement sans intervention créatrice de l'homme, selon un déterminisme rigoureux." André Bazin, "Ontologie de l'image photographique" (1945), rpt. in *Qu'est-ce que le cinéma?* (Paris: Éditions du Cerf, 1975), pp. 9–17. In philosophical aesthetics, this same line of thought led Roger Scruton ("Photography and Representation," *Crit. Inq.*, 1981, 7:577–603) and Walton to argue that photographs (being causal) were not *representations*, which seemed to many to mean that they could not be art. Attempts to salvage representation in photography (e.g., Donald Brook, "Painting, Photography, and Representation," *Journal of Aesthetics and Art Criticism*, 1983, 42:171–180—misreading Nelson Goodman, *Languages of Art* [Indianapolis: Hackett, 1968]) have unfortunately sometimes relied on interpreting "representation" linguistically (far too limiting!), a trap that Scruton thankfully avoids, as does Gregory Currie, "Photography, Painting, and Perception," *J. Aesthet. Art Crit.*, 1991, 49:23–29. Cohen is still, I think, the best way out of this whole quagmire. Here I cannot resist the urge to paraphrase the NRA: cameras do not shoot people; people shoot people.

⁹ See, e.g., A. Mark Smith, *Ptolemy and the Foundations of Ancient Mathematical Optics: A Source-Based Guided Study* (Transactions of the American Philosophical Society, 89[3]) (Philadelphia: American Philosophical Society,

Ancient optics is not about light; it is about vision. The modern idea that visual information is carried in the first instance by the action and movement of *light* has become so ingrained that it is often difficult for us to set this assumption aside and allow some room for the very foreign mechanisms of sight in ancient optics. Nevertheless, the movement of light as the primary mechanism of vision is not so obviously *given* in the visual phenomena themselves. In fact, this claim needs to be argued for at length in our earliest source for the idea, which is the Arabic writer Ibn al-Haytham. In antiquity light played some very different roles in seeing, and not every account of seeing seems even to have felt the need to invoke or explain the role of light in any detail. Perhaps the oddness of ancient light is seen most clearly in Aristotle, for whom light was nothing more than the actualization of the inherent (but passive) tendency of air to be transparent. That is: air (or water) is potentially, but not always, see-through. At night, the potential transparency is unactivated and the air is accordingly nontransparent, so we cannot see through it. Light is just the actualization of the air's potential transparency, which thus allows visual forms to pass. This is a very foreign idea indeed.

There is a different basic visual model on which virtually all ancient writers on *mathematical* optics agree. Unlike the modern model, where the eye *takes in* light and thence information, for ancient mathematical opticians the eye instead *sends out* some kind of radiative visual force that contacts objects in the world and somehow then passes information back to the eye. The details of this radiation vary from writer to writer, but the basic model is one of *extramission* out from the eye rather than *intromission* into the eye.¹⁰ This is not to say that everyone in antiquity who writes on vision in general is an extramissionist (a good many philosophers are definitely not) but that those who work in the field of mathematical optics do, for some reason, have a strong tendency to adopt this model.¹¹ In general, radiation that travels in straight lines does offer a clean way to mathematize vision—but why then choose radiation *out* rather than radiation *in*, which is presumably just as rectilinear?

In fact, there are several *empirical* phenomena that we know inclined some ancient authors to extramission. One is squinting: why is it that people with weak eyes can see better when they squint? On an intromissionist theory, squinting should reduce the amount of visual information able to enter the eye and so should decrease visual acuity rather than increasing it; but on the extramissionist theory, squinting has the (obvious!) effect of concentrating the visual rays in a smaller space, thus enabling better vision:

1999); Gérard Simon, *Le regard, l'être, et l'apparence dans l'optique de l'antiquité* (Paris: Éditions du Seuil, 1988); and David Lindberg, *Theories of Vision from al-Kindi to Kepler* (Chicago: Univ. Chicago Press, 1976).

¹⁰ To be sure, the ways in which the radiation passes this information back do usually depend on light as an actor, and this will complicate or at least qualify the use of the word "extramission." See Smith, *Ptolemy and the Foundations of Ancient Mathematical Optics*, p. 23f. Here and throughout, "radiation" is used in its root sense to refer only to things that travel in straight lines—i.e., as mathematical *rays*—rather than in the modern physical sense.

¹¹ The Epicureans are perhaps the most obvious example of philosophers who are not extramissionists, but Plato and Aristotle, as well as most of the Presocratics for whom we have any information, cannot be counted as extramissionists either. Nevertheless, Mary Beagon has pointed out to me that Democritus's explanation of the Evil Eye uses a kind of extramission of malign particles to account for the effect (something similar can be found in Plutarch, *Moralia* 680b–682b), although this is not an explanation of vision *per se*. See Mary Beagon, trans., *The Elder Pliny on the Human Animal: Natural History Book VII* (Oxford: Clarendon, 2005), p. 139f. For a good general overview of the different optical theories on offer in antiquity see the introduction to Smith, *Ptolemy and the Foundations of Ancient Mathematical Optics*. Finally, A. Mark Smith, "The Psychology of Visual Perception in Ptolemy's Optics," *Isis*, 1988, 79:188–207, questions Lindberg's idea that there was a distinct "philosophical tradition" in optics.

διὰ τί οἱ μύωπες συνάγοντες τὰ βλέφαρα ὀρώσιν; ἢ δι' ἀσθενείαν τῆς ὄψεως, ὥσπερ καὶ οἱ πρὸς τὰ πόρρω τὴν χεῖρα προσάγοντες, οὕτω καὶ τὰ βλέφαρα πρὸς τὰ ἐγγύς προστίθενται ὥσπερ χεῖρα; τοῦτο δὲ ποιοῦσιν, ἵνα ἀθροωτέρα ἢ ὄψις ἐξίη, δι' ἐλάττονος ἐξιούσα, καὶ μὴ εὐθύς ἐξ ἀναπεπταμένου ἐξιούσα διασπασθῆ.

Why is it that shortsighted people squint their eyes to see? Is it because of the weakness of their eyes, as in those who bring their hands up over their eyes when looking at something far off, and so bringing the eyelids together when looking at something close is like using the hand? They do this so that the vision they send out is more bunched up (because it is exiting through a smaller aperture) and not dispersed immediately out of a wide-open aperture.

For Galen, seeing is dependent on the extramission of a substance he calls psychic *pneuma*, and this extramission is manifest in the fact that when one eye is closed the other pupil widens (to allow passage to the *pneuma* whose extramission has been blocked at the closed eye).¹² Moreover, intromission is plagued in antiquity by many problems: How could the image of a mountain shrink to fit into our eye? How could the mountain shed so many images as to be viewable to any observer on any side? How could those images cohere in every direction so as to produce a true likeness of the object seen?¹³

And there are other, less familiar, phenomena that extramission can explain more credibly than an intromissionist account. Aristotle's theory of how rainbows are formed, for example, relies crucially on his belief that ordinary atmospheric air, under certain circumstances, can actually reflect sight. In making this point, he has recourse to an unusual fact—complete with all the characteristics of what I have elsewhere called a *trope*—which he narrates with a story:

ἀνακλωμένη μὲν οὖν ἡ ὄψις ἀπὸ πάντων φαίνεται τῶν λείων, τούτων δ' ἐστὶν καὶ ἄηρ καὶ ὕδωρ. γίγνεται δὲ ἀπὸ μὲν ἀέρος, ὅταν τύχη συνιστάμενος. διὰ δὲ τὴν τῆς ὄψεως ἀσθενείαν πολλάκις καὶ ἄνευ συστάσεως ποιεῖ ἀνάκλασιν, οἷόν ποτε συνέβαινε τιτι πάθος ἡρέμα καὶ οὐκ ὀξὺ βλέποντι· αἰεὶ γὰρ εἶδωλον ἐδόκει προηγεῖσθαι βαδίζοντι αὐτῷ, ἐξ ἐναντίας βλέπον πρὸς αὐτόν. τοῦτο δ' ἐπασχε διὰ τὸ τὴν ὄψιν ἀνακλαῖσθαι πρὸς αὐτόν· οὕτω γὰρ ἀσθενῆς ἦν καὶ λεπτὴ πάμπαν ὑπὸ τῆς ἀρρωστίας, ὥστ' ἔνοπτρον ἐγίγνετο καὶ ὁ πλησίον ἄηρ, καὶ οὐκ ἐδύνατο ἀπωθεῖν—ὡς ὁ πόρρω καὶ πυκνός· διόπερ αἱ τ' ἄκραι ἀνεσπασμένα φαίνονται ἐν τῇ θαλάττῃ, καὶ μεῖζω τὰ μεγέθη πάντων, ὅταν εὖροι πνέωσι, καὶ τὰ ἐν ταῖς ἀχλύσιν, οἷον καὶ ἥλιος καὶ ἄστρα ἀνίσχοντα καὶ δύνοντα μᾶλλον ἢ μεσουρανοῦντα.

It seems that vision is reflected by all things that are smooth, and both air and water can be counted in this class. This happens in the case of air when it is condensed, but also often because of weak vision it causes a reflection without being condensed. This was the case with a man who suffered blurry and weak vision: he always thought there was an image before him as he walked, seeing a reflection in front of himself. This happened because his vision was reflected back to himself, thus the weakness and utter feebleness caused by his ailment made even the nearby air act as a mirror, and his vision could not pass through it—just as is the case with distant and dense air. This is why at sea distant landing-sites appear greater in size whenever the southeast wind blows, as also in mist, and so also the sun and stars look bigger when rising and setting than when high overhead.¹⁴

¹² Pseudo-Aristotelian *Problems* 959a2f; and Galen, *De placitis Hippocratis et Platonis* (hereafter abbreviated as *De plac. Hipp. et Plat.*) 7.4.11f. Here and elsewhere, all translations into English are my own.

¹³ This last group of objections to intromission is conditioned by the fact that the main intromissionist theory available in antiquity was Epicurean, where what we perceive are films or images of atoms that peel off of objects in every direction. See esp. *De plac. Hipp. et Plat.* 7.7.8f.

¹⁴ Aristotle, *Metaphysica* 373a33f. Later commentaries on this passage identify the man as a certain Antipheron (Olympiodorus says he is from Tarentum, Alexander that he is from Oreus). Aristotle does elsewhere refer by name to a certain Antipheron of Oreus as being subject to a particular kind of madness that had him believing

That air will in itself be visible if it is sufficiently condensed is just taken as given here by Aristotle, as it is half a millennium later by Ptolemy, who compares it to the way that water, which is more condensed than ordinary atmospheric air, is itself visible rather than being completely transparent like ordinary atmospheric air.¹⁵ What is perhaps most interesting about Aristotle's use of the man who saw himself everywhere, though, is that it is very difficult to see how to make this phenomenon actually agree with the visual theory Aristotle himself proposes in other works.¹⁶ On Aristotle's fully worked out (and particularly idiosyncratic) account, seeing does not in any way involve the extramission of visual rays or the intromission of images or light. It is instead the direct perception of the medium (air or water) by the eye, where the medium has itself been changed by the colors of the objects in the world such that it has the same form as they do. A green cup looks like a green cup because the form of its matter (green, cup shaped) has altered the air between it and our eye in a green and cup-shaped way, and the air then presents these qualities to us directly. The self-seeing man has no place here.

In fact, any kind of reflection may present difficulties for Aristotle's theory of vision, but particular characteristics of the case of the self-seeing man show that Aristotle has pretty clearly borrowed someone else's example to make his point in this instance. The illusion he describes in fact makes sense *only*—as Galen pointed out quite forcefully—if one supposes, *contrary to Aristotle's own visual theory*, that the eye is sending out some force that, on encountering the resistance of the air, is then being bent back and trained on the subject himself, so that the man sees himself in the air before him, as in a mirror.¹⁷

I highlight these examples partly to show why extramission was so readily plausible in antiquity. Mathematical opticians do not always go to such lengths to justify their use of extramissionist theories, but it is nevertheless a historical fact that, within the mathematical optical tradition, extramission of visual rays is taken for granted by pretty much everyone, and this is not just instrumentalist window dressing. In Ptolemy's case, at least, it is underscored by a profound scientific realism.¹⁸ Ptolemy, modifying the visual ray theories of Euclid and Hero of Alexandria before him, adopts a theory of vision that has a continuous visual "flux" emanating from the eye out to the world at large.¹⁹ Sometimes, for the sake of mathematical or hermeneutic convenience, Ptolemy represents this plenistic conical flux as reducible to discrete and linear visual rays; but when push comes to shove he is deeply opposed to the discrete-ray model. His flux is a real physical plenum, though it is not possible, on the available evidence, to associate it clearly with any particular substance

phantasms were real (*De memoria et reminiscencia* 451a8) but says nothing there about his eyesight, poor or otherwise. Michael of Ephesus, in the eleventh or twelfth century A.D., explicitly tries to bridge the gap by pointing out that Aristotle's tale about the anonymous self-seeing man was really about the Antipheron of Oreus mentioned in the *De mem.* (*In parva naturalia commentaria* 17.30). Given the root meaning of the Greek name Antipheron ("one who goes in the opposite direction"), however, it is hard not to see the association with the man whose reflection accompanied him everywhere as apocryphal. On tropes in the sense I mean here see Daryn Lehoux, "Tropes, Facts, and Empiricism," *Perspectives on Science*, 2003, 11:326–345.

¹⁵ Ptolemy, *Optics* (hereafter abbreviated as *Opt.*) 2.9.

¹⁶ Aristotle, *De sensu* and *De anima*.

¹⁷ Galen's objection is at *De plac. Hipp. et Plat.* 7.7.10f.

¹⁸ A. Mark Smith, "The Physiological and Psychological Grounds of Ptolemy's Visual Theory: Some Methodological Considerations," *Journal of the Behavioral Sciences*, 1998, 34:231–246; Alexander Jones, "Ptolemy's Mathematical Models and Their Meaning," in *Mathematics and the Historian's Craft: The Kenneth O. May Lectures*, ed. Glen Van Brummelen and Michael Kinyon (New York: Springer, 2005), pp. 23–42; and Bernard R. Goldstein, "The Arabic Version of Ptolemy's Planetary Hypotheses," *Transactions of the American Philosophical Society*, 1967, 57:4–12.

¹⁹ Euclid's rays are discrete, and objects can fall between individual rays when they are small or distant enough. Ptolemy argues specifically against this theory, preferring a visual continuum.

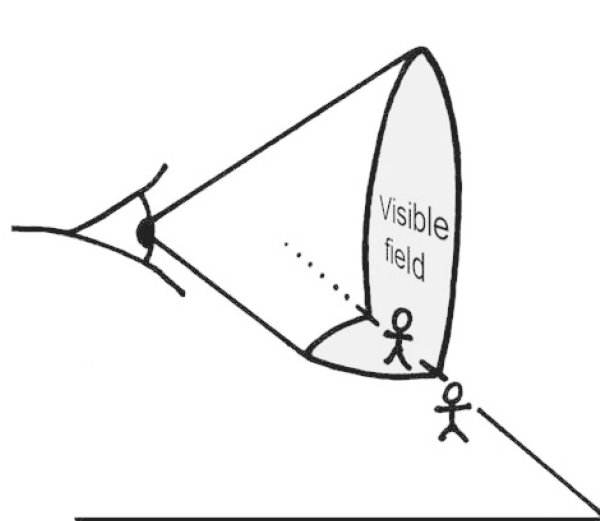


Figure 1. The visual cone.

with any degree of certainty.²⁰ He treats the center of the eye as a point source of this radiation, and the resulting emission forms a conical shape as it emanates forward and outward from the eye—a cone whose base is out in the world at large, whose apex is in the eye, and whose angle at the vertex is exactly equivalent to the breadth of the visual field of the observer (see Figure 1).

ORGANS, INSTRUMENTS, AND ARTIFICE

In order to understand what Galen is doing with the eye and its vision, it is first necessary to come to grips with an important theoretical superstructure that guides his own seeing in many instances. For Galen, there is a very close link between the bodies of animals and their souls. It is not just that the soul is completely embodied and physical for Galen, but that the body can ultimately be defined as the proper *instrument* or *organ* of the soul (τὸ γὰρ σῶμα ταύτης [*sc.* τῆς ψυχῆς] ὄργανον).²¹ We can see this as the body's being the soul's tool for interacting with the world, and this in two directions: in terms of sensation and nutrition (internalizing) and in terms of communication and will (externalizing). Thus, says Galen, by means of *their* hands (which externalized their ideas as writing) and *our*

²⁰ Smith, "Psychology of Visual Perception in Ptolemy's Optics" (cit. n. 11), p. 196, wants to see the flux as Stoic *pneuma*, the same substance Galen will have emanating from the eye, but this relies on a chain of inference that is not nearly so solid as I would like: that Ptolemy's *virtus regitiva* can be identified as equivalent to the Stoic *hegemonikon* I am partial to accepting; but to move from there to the idea that Ptolemy's flux must therefore also be Stoic is to overburden the initial equivalence unduly. In discussing a dream I had, for example, I can easily use a phrase that is more or less equivalent to "my subconscious" without implying that I accept any other baggage of Freudian psychology (e.g., "my Oedipal complex").

²¹ Galen offers a magisterial argument for the physicality of the soul in *Quod animi mores corporis temperamenta sequuntur*, even though he is there and elsewhere cautious about *genuinely* committing to the idea. See Martino Menghi and Mario Vegetti, *Le passioni e gli errori del' anima* (Venice: Marsilio, 1984); R. J. Hankinson, "Galen's Anatomy of the Soul," *Phronesis*, 1991, 36:197–233; Von Staden, "Body, Soul, and Nerves" (cit. n. 6); and Teun Tieleman, "Galen's Psychology," in *Galen et la philosophie*, ed. Jonathan Barnes and Jacques Jouanna (Geneva: Hardt, 2003), pp. 131–169.

eyes (which are internalizing their writings as ideas), we can even now converse with Plato, Aristotle, and Hippocrates. To appreciate the thrust of the relationship between soul and body for Galen fully, we need to look a little closer at his use of the word I am translating as “instrument” or “organ,” ὄργανον. It is indeed the normal Greek word for a tool or instrument of the hammer or file type, but in medical writing it is commonly used more specifically to refer to the parts of the body that perform functions of various sorts, and it is from this meaning that we get our English word for bodily *organs*.²² As Galen defines it at *De methodo medendi* 1.6:

ὄργανον δὲ ὀνομάζω μέρος ζώου τελείας ἐνεργείας ἀπεργαστικόν, οἷον ὀφθαλμὸν ὄψεως καὶ γλῶτταν διαλέκτου καὶ σκέλη βαδίσεως·

I define *organ* as a part of an animal that is cause of a complete action, such as the eye for vision, the tongue for discourse, or the legs for walking.

Thus the body is the *organ* of the soul.

Where Galen’s use of the word gets particularly interesting is when he pushes the breadth of meaning inherent in the Greek word to nuance our understanding of the soul’s relationship to the body: in *De usu partium* 1.2 Galen is discussing the various weapons and faculties that animals have for their protection, and he asserts that people, although they may look to be vulnerable, are actually the best protected of all. For they have the *hand*, which can provide sharper and stronger armaments than any animal is provided with by Nature:

οὐκ οὖν γυμνὸς, οὐδ’ εὐτρωτός, οὐδ’ ἄοπλος, οὐδ’ ἀνυπόδετος ἄνθρωπος, ἀλλ’ ἔστι μὲν αὐτῷ θώραξ σιδηροῦς, ὅποτε βούλοιο, πάντων δερμάτων δυστρωτότερον ὄργανον, ἔστι δ’ ὑποδημάτων παντοῖον εἶδος, ἔστι δ’ ὄπλων, ἔστι δὲ καὶ σκεπασμάτων. οὐ γὰρ θώραξ μόνον, ἀλλὰ καὶ οἰκία καὶ τεῖχος καὶ πύργος ἀνθρώπου σκεπάσματα.

But man is neither naked, nor vulnerable, nor without protection, nor barefoot, for he can have an iron *thorax* whenever he wants, *an organ more protective than any skin*, and he has every kind of sandal, of weapon, and of armor. And not only does man have the *thorax*, but he also has houses, walls, and towers as protection.

Here we see a deliberate juxtaposition of the artifices of Nature and the artifices of man. The skin, an *organ* of animals, is compared *qua organ* to the *instruments* of warfare: armor, weapons, walls, towers.²³ Not only is this comparison an insight into Galen’s view of the state of nature as constant warfare between species and individuals, but it also shows how easily the concepts of bodily organ and man-made *technai* bleed into one another. This is further underscored by the fact that the improved *organ* he uses as an example straddles this same line between human artifact and the natural: “*thorax*” in Greek refers both to an armored breastplate (a human artifact) and to the (natural) part of the human body it covers. Indeed, Aristophanes plays on just this ambiguity in a passage in the *Wasps*.²⁴ The point here is *not* to take a McLuhian book-is-an-extension-of-the-eye position

²² ὄργανον is also the origin of the English *Organon*, which collectively refers to Aristotle’s logical books (where logic is conceived of as a basic *instrument* for doing philosophy), and hence by extension also Bacon’s *Novum organum*. On Galen’s definition of the word see Galen, *On the Usefulness of the Parts of the Body*, trans. Margaret Tallmadge May (Ithaca, N.Y.: Cornell Univ. Press, 1968), p. 67 n 3.

²³ David Langslow has reminded me here of how rich a source of metaphor warfare is in pathology, anatomy, and therapeutics.

²⁴ Aristophanes, *Wasps* 1190f.

but, rather, to underscore the fact that for Galen the bodily organs themselves are the products of the active and divine craftsmanship of capital-N Nature.

And this is where we can see one of the primary agendas that drives Galen's anatomical work in the *De usu partium* and elsewhere: by looking closely and intelligently at the structures and details of the body, we can see therein the wisdom of its creator. Nature—personified, active, wise—is credited with having created perfect instruments in animals.²⁵ Each part of the body shows the wisdom and the forethought of the creator, since each organ is so perfectly crafted for its function, and every organ is the best of all possible constitutions for the performance of that function.²⁶ This has two important implications: Galen, in approaching his anatomical observations, will be looking through a frame or a filter of functional-teleological implications that needs to see how each detail contributes with maximal utility toward some end; and he is frequently looking through his bodies at the creator—the physical is his window to the divine. But we need to be careful here: in making these two points, we are *not* saying that his vision is clouded, nor that the objects are transparent. Things are—as they should be—much more complicated than this.²⁷ To understand fully Galen's theory of how visual sensation comes into the eye, it is necessary to keep two related points in mind: the fact that the entire system was created by a wise, beneficent, personified Nature; and (partly derived from that) the bivalency inhering in Galen's use of the word “organ” itself.

For Galen, all sense perception and motor function rely in some manner on a physical substance, *pneuma*, in the nerves of the body.²⁸ Seeing happens because the optic nerve conducts *pneuma* from the brain to the eye: “The brain sends part of itself out to the crystal-like humor (the lens of the eye) to know how it (the lens) is being affected.”²⁹ This *pneuma* then passes through the various humors and structures of the eye itself to emerge from the pupil. But at this point Galen takes one of the standard ancient objections to extramission seriously: if vision is dependent on something that is physically sent out from the eye, how is it that it takes no time at all to see very distant objects like the stars, which we can see instantly upon opening our eyes?³⁰ Moreover, any *pneuma* extramitted would

²⁵ On Galen's definition(s) of Nature see esp. Jacques Jouanna, “La notion de nature chez Galien,” in *Galien et la philosophie*, ed. Barnes and Jouanna (cit. n. 21), pp. 229–268; and Fridolf Kudlien, “Galen's Religious Belief,” in *Galen*, ed. Nutton (cit. n. 3), pp. 117–130. See also Galen, *On the Usefulness of the Parts of the Body*, trans. May (cit. n. 22), p. 10f.; R. J. Hankinson, “Galen and the Best of All Possible Worlds,” *Classical Quarterly*, 1989, 39:206–227; and (albeit briefly) Vivian Nutton, *Ancient Medicine* (New York: Routledge, 2004), pp. 234–235. Jackie Pigeaud, “Les problèmes de la création chez Galien,” in *Galen und das hellenistische Erbe*, ed. J. Kollesch and D. Nickel (Stuttgart: Steiner, 1993), pp. 87–103, is tangentially useful. On divine providence with respect to vision in particular see *De usu partium* 10; and *De plac. Hipp. et Plat.* 7.5.13f.

²⁶ In using the word “constitution,” I want to underscore Galen's emphasis on the combination of the physical makeup of an organ, its particular balance of the elements, its geometrical shape, and the arrangement of its parts (cf. *De usu partium* 1.9).

²⁷ On the complex relationships between Galen's teleology and his materialism see P. N. Singer, “Levels of Explanation in Galen,” *Cl. Quart.*, 1997, 47:525–542; and Hankinson, “Galen and the Best of All Possible Worlds” (cit. n. 25). In many ways, the questions raised by this issue are profoundly relevant to any reading of *De usu partium* in particular, where Galen is very explicitly running between a hands-on detailed anatomical study, a teleological paean to a benign and wise creator, and, from time to time, a physical (elemental) explanation of the composition of organs and parts.

²⁸ The exact details of the precise role of *pneuma* are not always as clear as we might like, however. See Julius Rocca, *Galen on the Brain* (Leiden: Brill, 2003), p. 66; Leonard G. Wilson, “Erasistratus, Galen, and the Pneuma,” *Bulletin of the History of Medicine*, 1959, 33:293–314; G. E. R. Lloyd, *Revolutions of Wisdom* (Berkeley: Univ. California Press, 1987), p. 213; and Von Staden, “Body, Soul, and Nerves” (cit. n. 6).

²⁹ ἀπέτεινεν οὖν ἑαυτοῦ τινα μοῖραν ὁ ἐγκέφαλος ἐπὶ τὸ κρυσταλλοειδὲς ὑγρὸν ἕνεκα τῆς γνώσεως τῶν κατ' αὐτὸ παθημάτων: *De usu partium* 8.6.

³⁰ He has something like this clearly in mind when he points out that alterations in atmospheric air, which is a continuum, should happen in an instant, ἐν ἀκαρεῖ χρόνῳ: *De plac. Hipp. et Plat.* 7.5.7.

have to become impossibly dilute as it reached out to distant and large objects. In order to get around these problems, Galen proposes a unique theory: rather than the extramitted *pneuma* running off in all directions and to an infinite distance, it instead needs only to reach to the exterior surface of the eye, where it impacts the atmospheric air that surrounds it. It then—and this is the rub—it then *alters* the atmospheric air and uses that air *as though it were an organ of the body*:

λείπεται οὖν ἔτι τὸν πέριξ ἀέρα τοιοῦτον ὄργανον ἡμῶν γίνεσθαι καθ' ὃν ὁρῶμεν χρόνον, ὅποῖον ἐν τῷ σώματι τὸ νεῦρον ὑπάρχει διὰ παντός.

What remains, then, is that for the duration of the time when we are seeing, the surrounding air becomes for us just the sort of *organ* that the nerve always is in the body.

A little later he elaborates with a mathematical analogy: “The brain is to the nerve [lit., ‘has the same ratio’] as the eye to the air.” He compares the action of the *pneuma* to that of the sun, which touches the upper atmosphere and is thus able to illuminate the entire air completely and instantaneously (but note that this comparison is *not* an explanation of the role of light in vision—this Galen omits to offer us). There is a second respect in which the *pneuma* is sun-like (ἡλιοειδής): it is, Galen tells us, “luminous” (αὐγοειδής; lit., “light-like”) or “fiery” (πυροειδής; lit., “fire-like”). He offers empirical evidence for the luminosity of visual *pneuma* by calling on the example of feline eyes. We are all familiar with the sometimes unsettling phenomenon of seeing a cat’s eyes fairly glowing in the dark, when nothing else is visible. We now would dismiss this phenomenon as only an *apparent* glow due to reflected light, but we cannot do quite the same with this “observable fact” that Galen offers us: if, he says, you get a sufficiently large cat—say, a lion or a leopard—and observe it in a darkened room, you can see not only its glowing eyes, *but also a circle of light shining on its nose whenever the leopard looks that way*.³¹ Moreover, the circle will be measurably smaller closer to the eyes and measurably larger toward the tip of the nose owing to the expansion and contraction of the visual cone (he even offers us a mathematical formula for relating the size of the circle to the distance from the eyes).

This particular example aside, Galen’s account of vision is, broadly speaking, based on Stoic (Chrysippean) models, although he importantly modifies the details of how perception itself occurs, criticizing the Stoic idea that the *pneuma* transmits information by encountering resistance, in the same way as a walking-stick might, and instead turning to the luminosity (light-like-ness) of visual *pneuma* as key.³²

Galen and Ptolemy agree that each sense will have one proper sensible that it perceives, although in the case of vision they will differ slightly. Galen, like Aristotle before him, thinks the proper sensible of sight is color, but Ptolemy qualifies this, arguing that although color is *per se* primarily and directly visible, it does not in itself provide all the visual cues we use. Indeed, for Ptolemy, seeing is seven-dimensional: we perceive not just color but also “corporeity,” size, shape, location, motion, and rest. These last six are perceived not by color alone (as Galen would have to have it) but, more specifically, by means of the boundaries between colors and any changes therein.³³

³¹ *De plac. Hipp. et Plat.* 7.5.5, 7.5.32, 7.4.18.

³² *De plac. Hipp. et Plat.* 7.5.41, 7.7.20. For the Chrysippean models see *Stoicorum veterum fragmenta* 2.232f.

³³ *Opt.* 2.7. I borrow the translation “corporeity” from Smith, *Ptolemy’s Theory of Visual Perception* (cit. n. 6), p. 71 n 1; he clarifies thus: “I have rendered *corpus* as ‘corporeity’ to indicate that it is not so much body as the fact that something is a body that is apprehended by sight.” Aristotle’s view that the proper sensible of sight is color appears at *De anima* 418a11–14.

NOT EVERY BLACK BOX IS A CAMERA OBSCURA

What happens in the eye itself to produce vision? Detailed as their own accounts are, in both Ptolemy and Galen there comes a point in the explanation where they defer to a common Hellenistic causal trope, which can essentially be summarized as “like affects like.” They invoke this explanation at just the point where we might want them to be considerably more specific about the details in the physical causal chain. It is not, however, that they are each looking for a quick and easy way of whitewashing their own ignorance of a (the?) crucial link in the causal chain that begins out in the world and ends in our conscious perception. We can see it instead as part of their shared intellectual heritage, their shared *world*, that they should be perfectly happy invoking what they each think of as a universal physical law (and here I am not using “law” carelessly) in order to secure the relationship between our perceptions and objects-at-large.³⁴ Rather than accusing them of black-boxing a link in that relationship by pointing to a mechanism that is really devoid of any clear empirical meaning, we should instead see them as invoking one of the most self-evident of ancient general laws as being, in fact, the most sensible mechanism for linking the two realms—and linking them in a way that is in principle error free. “Like affects like” may still be a black box, insofar as neither Ptolemy nor Galen (nor anyone else, to my knowledge) works out the precise physical mechanics of its efficacy. But it is a black box that sits in a blind spot, so to speak, and I am for the moment more interested in how the mechanism itself is used to bridge a gap in the causal chain than in the precise internal workings of the mechanism itself.

We saw earlier that, for Aristotle, light is just the state of the air’s transparency being active rather than simply potential. For Ptolemy, there is something else going on entirely, even if he still uses Aristotelian language to explain it. We might say that his understanding of light is not Aristotle’s but that it is still to some extent Aristotelian, borrowing language, categories, and tools of analysis from Aristotle to arrive at different ends.³⁵ Instead of talking about transparency, Ptolemy has light and the visual flux, the *visus*, interacting to produce vision, and when he comes to explain exactly how, he says it is as though light were *form* to color, which is as matter: “ut forme coloribus quoque ut yle.” But light is also itself physical, and it *falls on* the visible object (“cedit super eam”) in the same way as the visual flux does (“incidit super eam”), and the more of either, the better a thing is seen.³⁶

In understanding this position, we are severely hampered by the loss of Book I of the *Optics*, where (as Ptolemy tells us in Book II) he had explained all of this in detail. Nevertheless, we can work out some of the particulars from the summary he provides us, from his other works, and from how he handles particular puzzles in the rest of the *Optics*. Basically, light and color interact out in the world. The visual flux we send out is completely receptive (*passive* in an Aristotelian sense) and so cannot affect things in the world, but it can be affected by them because of something it has in common with light and color: it shares, to use the Aristotelian terminology, the same *genus* (“participat eis et in genere”). But the visual flux itself is multidimensional. It perceives color primarily, to be sure, but

³⁴ See Daryn Lehoux, “Laws of Nature and Natural Laws,” *Studies in History and Philosophy of Science*, 2006, 37:527–549, for my argument.

³⁵ Smith, “Psychology of Visual Perception in Ptolemy’s Optics” (cit. n. 11), p. 200f., has argued for a considerable borrowing of particular details of Ptolemy’s analysis from Aristotle, but—as in the case of Smith’s views on Stoic influence—I want to be more cautious.

³⁶ *Opt.* 2.16, 2.18 (“ex diuersitatibus quidem quantitatis uidetur res magis, quando plus incidit super eam claritas uisus, aut quando lumen plus cedit super eam”).

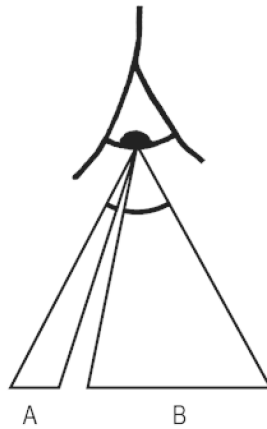


Figure 2. Line B, being larger, subtends a larger angle than line A.

it also perceives distance (apparently directly, through the length of the visual rays) and size (via visual angles). This perception of distance by length and size by angle is again framed in terms of an agreement of *genus*.³⁷ These different aspects of the visual flux are affected by the properties that are similar to—of the same *genus* as—them. Thus, for example, relative size is measured by the angle subtended by two objects, the larger subtending the greater angle when the objects are equidistant (see Figure 2).

The eyes themselves (like all the sense organs) always tell the truth about how they are affected. They are not in and of themselves a source of error. How they are affected may provide false information about the world, as in optical illusions or the bending of vision in reflection and refraction, but the senses themselves do not lie. The visual flux simply receives (*suscipiat*) the qualities in a manner that Ptolemy calls “straightforward,” *simpliciter*.³⁸

Galen gives us a slightly different fleshing out of the idea that properties and faculties must share particular similarities in order for veridical perception to occur. As in Ptolemy, something changes hands at the eyeball. Where for Ptolemy there is a stamping of *phantasia* somewhere in the eye by the passions of the visual flux, for Galen there is a passing of sensation from what we might call worldly or external *pneuma* to the internal, psychic *pneuma* that goes from the eyes to the brain. As for Ptolemy, the story is one of a continuous chain of causal linkages that hinges at one point on *likeness* as a mechanism in the transition of sensory impressions between the world and the body.

The basic idea is that psychic *pneuma* can be affected by worldly *pneuma* because they are the same kind of thing, and their affectations can thus pass from the one to the other in a simple and uncomplicated manner. We have already said that Galen’s account of vision involves the interaction of psychic *pneuma* with worldly *pneuma* and the use of that worldly *pneuma* as an organ of the body. So how, then, is the transition made between the worldly *pneuma* and our psychic *pneuma*? “In a word,” says Galen, “like shakes hands with like,” ἐνὶ δὲ λόγῳ τὸ ὅμοιον τῷ ὁμοίῳ γινώριμον, or elsewhere, “like comes into communal effect with like,” τῷ γὰρ ὁμοίῳ τὸ ὅμοιον εἰς τὴν τῶν παθημάτων ἀφικ-

³⁷ *Opt.* 2.23 (quotation), 2.63.

³⁸ See Ptolemy, *On the Criterion and Hegemonikon* (hereafter abbreviated as *Crit.*) 10.3, 11.1; and *Opt.* 2.23.

νεῖται κοινωνίαν.³⁹ The eyes perceive light because they are the “most light-like” of the organs (ἀγγοειδέστατος). This “light-like-ness” is the “luminosity” I referred to above as the fundamental property of visual *pneuma* that enables sight. *Pneuma* is said to be ἀγγο-ειδής (“light-like,” “luminous”), πυρο-ειδής (“fire-like”), and ἡλιο-ειδής (“sun-like”), each adjective here being a compound of the word εἶδος, “form” or “kind.” It is telling that Galen’s description of the powers of all of the senses are couched in terms of their sharing an εἶδος with their objects: touch is earth-like (γεώδης), hearing air-like (ἀεροειδής), and smell vapor-like (ἀτμοειδής).⁴⁰ Even the very relationship between the brain and the nerves is underscored by their sharing a form: Galen says that “the nerves are homo-εἶδος in substance with the brain,” ὁμοειδὲς δὲ καὶ κατὰ τὴν οὐσίαν τὸ νεῦρον ὑπάρχον τῷ ἐγκεφάλῳ.⁴¹

“Likeness” thus stands for Galen as the fundamental mechanism underlying sense perception. More importantly, though, it is *likeness*, form sharing, that bridges the juncture between the two discrete systems, between internal and external, between psychic and worldly *pneuma*. So, too, for Ptolemy, it was form sharing (*genus* sharing) that bridged the gap between the colors that exist in the world at large and the visual flux being extruded by the eye, to allow those colors into our perceptive system.

Finally, given the translation history of Ptolemy’s *Optics* (the only text we have is a Latin translation of a lost Arabic translation of a lost Greek original, with a possible Syriac intermediary between the Greek and the Arabic, even), we should not put too much weight on the use of particular words but, rather, focus on the ideas they express. Nevertheless, it may be worth pointing out that the word used in the Latin of Ptolemy’s *Optics* to describe the relationship of “likeness” that links our sense organs and the visual realm, “*genus*,” is the word normally used in Latin to translate the Greek γένος rather than the Greek word that Galen uses, εἶδος, which is usually rendered as “*species*” in Latin.⁴² If “*genus*” in the text of the *Optics* translates a lost original γένος, then we have a situation where Ptolemy (γένος) and Galen (εἶδος) are both borrowing terminology from the language of logical classification, where “*genus*” and “*species*” are simply different levels of classification, not so much opposite as relative. On the other hand, it may be worth mentioning that there is at least one extant instance of εἶδος → *genus*, so it is also (just) possible that Ptolemy may even have been using terminology identical to Galen’s in the original Greek.⁴³

EPISTEMOLOGIES OF SEEING

The epistemological problems with vision and with the senses in general were pushed most firmly and persistently by the Sceptics (Pyrrhonian Sceptics in particular).⁴⁴ Problems with

³⁹ *De usu partium* 8.6; and *De plac. Hipp. et Plat.* 7.6.10. “Shakes hands with” is an admittedly imperfect rendering of a very difficult sense to translate. The adjective by itself means “well known,” “familiar.”

⁴⁰ *De plac. Hipp. et Plat.* 7.5.42–44. Taste may appear to be a slight exception here, where its εἶδος has to do with receptivity to certain *properties* of its objects rather than to the objects themselves; so, instead of being “food-like,” it is said to be moist and “sponge-like” (σπογγοειδής). This is elaborated on a little later (7.6.22), where Galen explains that the objects of taste are moist, from which we can see that the moistness of the organ of taste is again in a like-to-like correspondence with its objects.

⁴¹ *De plac. Hipp. et Plat.* 7.5.13.

⁴² See Georgius Goetz, *Thesaurus glossarum emendatarum* (Leipzig: Teubner, 1899).

⁴³ Among the Greek words that Cicero renders as “*genus*” in his translation of Plato’s *Timaeus* is the Greek εἶδος (Cic. *Tim.* 21 = Pl. *Tim.* 35a).

⁴⁴ Pyrrhonism is the stronger of the two ancient varieties of Scepticism, the other being Academic Scepticism (the school to which Cicero and Plutarch subscribed), which, although worried about the reliability of the senses, did not take it as proven that they told us nothing about the world.

knowledge and sensory experience stand at the very heart of Pyrrhonism. Sextus Empiricus, our best source for Pyrrhonism and likely a contemporary of both Galen and Ptolemy, takes the strong Sceptical position that physical objects are simply not apprehensible. In support of this, he offers a series of traditional arguments (called “ways” or “modes”) that stand at the origins of Scepticism and that take clear aim at the senses in particular.⁴⁵ Take eyes, for example. People, dogs, and dragonflies all have different kinds of eyes, so surely colors are differently perceived by each species. How do we decide whose perception apprehends the object truly? Even within the same species, individuals have different constitutions (which for Sextus means different humoral balances). One man is thin, another fat, so that things must appear different to the differently constituted bodies of one person versus another. One person gets pleasure or pain from very different things than another person does, which further shows that the same bodies in the world affect different individuals differently. Does any of them have access to the real object? Even our own senses disagree with each other about the nature of individual objects. Paintings feel flat but can look like they have depth. Perfume smells nice but tastes awful. In any case, how do we know our five senses are even sufficient to be affected by all the properties of an object? (Comparing ourselves with dogs, whose noses and ears are so very much better than ours, is telling here.) Our senses also seem differently affected when we are in different states: waking or sleeping, intoxicated or sober, healthy or sick. So, too, objects appear differently in different circumstances: columns look narrow at one end when seen from below but symmetrical when viewed from the middle. A lamp looks bright at night but dim in the sunlight. Horn looks black on a goat, but its shavings appear white. When are the senses grasping the reality of the object?

For Ptolemy, as for many of his contemporaries, part of the way around this was to reduce the problem of the senses to a problem of *judgment*.⁴⁶ Just as a magistrate listens to the disclosure of evidence in order to decide the facts of a case (maybe better: “the goings on,” ἡ πράξις) by means of law and precedent, all with an aim to promoting social harmony, so the mind that investigates the world must use sense perception in order to adjudge what is (τὸ ὄν) by means of dialectic, all with an aim to finding the truth. Ptolemy maps the parallel thus.⁴⁷

	Investigating a legal case	Investigating the world
1. Point at issue	facts of case, ἡ πράξις	what is, τὸ ὄν
2. Instrument	disclosure of evidence	sense perception
3. Agent	the magistrate	the mind, ὁ νοῦς
4. Means	law	dialectic, ὁ λόγος, διαλέγειν
5. Goal	social harmony	truth, ἡ ἀλήθεια

⁴⁵ See e.g., *Pyrrhoniae hypotyposes* 3.38f., 1.35f. The word for “apprehensible” Sextus uses is καταληπτόν, “graspable,” which is a technical term in Hellenistic epistemology that is often used to refer to perception but also included cognitive “grasping” (perhaps in a similar way to how the English “I see” also means “I understand”). The “modes” are collected and discussed most fully in Julia Annas and Jonathan Barnes, *The Modes of Scepticism* (Cambridge: Cambridge Univ. Press, 1985).

⁴⁶ For the centrality of the *criterion* in Hellenistic epistemology, and its relation to debates between dogmatic schools and Sceptics, see Long, “Ptolemy” (cit. n. 5).

⁴⁷ Long, “Ptolemy,” notes that some of Ptolemy’s categories are shared by another of the second century’s great intellects, Sextus Empiricus—specifically, the middle three categories of *instrument*, *agent*, and *means* (although Sextus may be using category [4], *means*, with a slightly different emphasis than Ptolemy does). Long sees the two accounts as virtually identical, but Sextus’s use of the *application of sense impressions*, ἡ προσβολὴ τῆς φαντασίας, in slot (4), where Ptolemy talks of *dialectic* as the *means by which* the intellect judges, is more clearly rooted in a particular set of debates centered on Stoicism. There are family resemblances between the two accounts, but it is difficult to see how exactly to map Sextus’s version onto Ptolemy’s very precisely.

Here Ptolemy's model is partly rooted in his fundamentally mathematical conception of science, and his account is saturated with mathematical terminology. He says that we can conceive of categories (1), (3), and (5) in this table as the *terms* (ὄροι) in a mathematical proportion, with (2) and (4) standing as the *ratio* or the (mathematical) *means* (διάστημα καὶ μεσότητες), which arrange things according to the relationships (διαδόσεις) between the extreme terms of the proportion (τὰ ἄκρα).⁴⁸ The nuances here are technical, but the basic idea is that sense perception mediates between *what is* and the mind in the same way as dialectic mediates between the mind and the truth. But it also implies that the mediation is not the kind of mediation that filters or represents—or even that misrepresents—but is instead fixed, direct, and rigid. It brings the two terms together into a particular relationship and is in fact the very substance of their interrelation.

And this interrelation is the essence of perception. Perception is not only the action of objects in the world on the senses, nor is it only the appearance of ideas in the mind. It instead arises as an interaction between those two systems: “per relationem et ratiocinationem inter illas factam et id quod diuiditur et procedit a uirtute regitiua,” where “relatio et ratiocinatio” may be best translated as “response and reckoning.”⁴⁹

What the mind receives, though, are not the actual changes in the sense organs but something else, something called φαντασία, images. Where the senses touch the world, Ptolemy tells us, the *phantasia* are impressions (lit., “pressings,” “molds,” not “representations”), which then pass sensation on to the mind.⁵⁰ But the picture he offers is one of continuous and unbroken contact, *touching*, from the mind out to the world at large. What the mind judges are not just the raw sensory impressions, though, but also the objects in the world that are the causes of those impressions—and it is here that both error and error correction can occur. Error, however, does not come about because the judging faculty is inherently faulty (Ptolemy tell us its *criterion* for judging is infallible), but because it may be affected by impressions that for one reason or another are misleading. The senses always tell the truth about how they are affected, but those affections may still not accurately represent the true nature of the objects of those perceptions, or they may be of such a sort as to distract the judgment itself, tricking it into privileging inappropriate and misleading sources of information, as when it judges distance primarily (and inappropriately) by relative coloring or size and so is fooled by the kind of *trompe l'oeil* painting Sextus was worried about. This is essentially a problem of using part of the visual faculty to judge aspects that are not of its proper *genus*: as color for distance, or distance by visual angle.⁵¹ Nevertheless,

⁴⁸ Recall that Galen had also used a metaphor from proportion theory to compare the relationship between the brain and psychic *pneuma* to that between the eye and worldly *pneuma*: *De plac. Hipp. et Plat.* 7.5.32. Although similar in kind to Ptolemy's analogy, it differs insofar as it breaks down Ptolemy's categories 1–3 differently, inserting two intermediary objects between 1 and 3, and Galen does not reify their relationship in the same way as Ptolemy does.

⁴⁹ *Opt.* 2.22.

⁵⁰ *Crit.* 8, 2.4. On the Stoic understanding of *phantasia* see Anthony Long, “Stoic Psychology,” in *The Cambridge History of Hellenistic Philosophy*, ed. Keimpe Algra et al. (Cambridge: Cambridge Univ. Press, 1999), pp. 560–584, on pp. 572–580. Long uses “impression” as his translation of “*phantasia*” produced by sensation but does in other contexts offer “representation” as another translation, which could be seen as conflicting with my nonrepresentational reading of Ptolemy if it could be shown that Ptolemy is using “*phantasia*” in a strictly Stoic sense. Unfortunately, “*phantasia*” itself is a common term in Hellenistic accounts of perception, and Ptolemy's use of it is gray enough not to allow us to decide to what extent he may be committing to a Stoic view in particular here. Finally, I am not certain that “*phantasia*” as a blanket term in Stoicism for something like “the objects of thought” would be precluded from sometimes being representational (as in memory) and sometimes being nonrepresentational (as in perception).

⁵¹ *Crit.* 9.6 (on the infallibility of the *criterion* for judging), 11; and *Opt.* 2.84f., 2.126f.

if we can understand what kinds of sense impressions create what kinds of images, and what kinds of objects create what kinds of sense impressions, the *hegemonikon* will be able to work out, via the faculty of judgment, what the natures of objects really are, insofar as is possible.⁵² It does this in two ways: by comparing experiences from other senses or from the same sense at different times or under different circumstances; and by reflecting on the sensation through a process of reductive comparison (προσβιβάζειν) and uncovering (ἀνευρίσκειν). This process helps us not only to know what to do with conflicting or confusing perceptions when they *do* arise but also to recognize when the senses are reporting in a clear and uncorrupted manner so that we can simply accept their reports as being, “within the limits of human ability, most infallible,” which reports the mind receives “with a miraculous, almost incredible power.”⁵³ This, then, is the trick: learning to know when and how the senses can be fooled and to know how they should be corrected or more carefully examined. This makes empiricism a learned, skilled practice and, at the same time, *the essential tool* in the acquisition of true knowledge.

Galen does not problematize the relationship between the mind and sense perception to quite the same degree. Where for Ptolemy the mind judges *what is* by subjecting the evidence presented for it (sense impressions) to dialectic, Galen seems to be happy having the sense impressions carried by *pneuma* into the physical home of the ruling part of the soul—called the *hegemonikon*, following Stoic terminology—which he (like Ptolemy) locates in the brain. Physically running the chain of perception into where he knows the *hegemonikon* is located is, it seems, enough for Galen to be satisfied.⁵⁴ So long as we are not overly hasty in drawing conclusions from the senses—for example, thinking that we have seen Dion off in the distance when it was really Theon—there should be no problem.⁵⁵ But note that this is not so much a problem of hasty assent to *any* sensory impressions so much as to the judgment of relatively complex phenomena as being true. It is not that we thought we saw Dion but we were hallucinating, only that the perception of the man we did see, Theon, was misattributed.

In Ptolemy’s discussion, the problem of misattribution seems to happen at a more fundamental level. When he does offer examples of misjudgments, they are not just that the man we saw was not the man we thought we saw, but more on the order that the man we thought we saw was actually a realistic painting of a man or some such thing. This is a deeper problem than Galen wants to face, and it cuts a little closer to the heart of the Sceptical assaults that both Ptolemy’s and Galen’s empiricisms were buttressing themselves against. It is not just that we could be misled as to details; we could be misled as to the true natures of the things in the world. Nevertheless, Galen could certainly respond that his no-hasty-judgments rule would still allow him to work out the difference between the painting and the man, just as Ptolemy recommends cross-referencing any sensory experience with other experiences to determine the truth.

⁵² As Smith has remarked, “it would be fair to say that Ptolemy’s ulterior purpose in the *Optics* as a whole is to correct such misjudgments by explaining them away”: Smith, *Ptolemy and the Foundations of Ancient Mathematical Optics* (cit. n. 9), p. 40. There is a lovely ambiguity in this regard at *Opt.* 2.83: “we should draw distinctions between illusions . . . in order that we can solve doubts that come up in investigations *de scientia optitorum*.” Does this mean that we can solve doubts that come up in investigations *concerning* the science of optics or that we can solve doubts that come up in investigations *by means of* the science of optics?

⁵³ *Crit.* 10.5–6; and *Opt.* 2.73.

⁵⁴ The precise correspondence between *pneuma* and consciousness is left open in Galen. Nevertheless, it is clear that consciousness depends on *pneuma* and intelligence on the quality of the *pneuma*: *De usu partium* 7.13.

⁵⁵ Galen, *De animi cuiuslibet peccatorum dignotione et curatione* 6.

GROUNDING EMPIRICISM

For both Ptolemy and Galen, then, the problem is the same, and the answers are overlapping. The overarching question is this: How do you justify a scientific methodology that relies so very deeply on empiricism in the face of the radical Hellenistic Sceptical assaults on the reliability of sensory experience?

The answers for both of them rely on the development of tight causal chains that run without interruption from the objects of the world into the mind itself. Those objects physically affect the senses, which in turn interact with internal physical mechanisms, which in turn physically affect the mind. The chain is unbroken and error free, insofar as perceptual error is not caused by the senses misinforming us of how they have been affected but, rather, by the mind misjudging what that affectation implies about the nature of the object that caused the sensation. Even this talk of “misinforming” and “implication” is in a sense misleading, insofar as it takes a particularly modern perspective for granted: the idea that in the first instance we have *experiences* that we take to *represent* the world in a certain way. Neither Ptolemy nor Galen is a representationalist in this sense.⁵⁶ Instead, they give us not so much sense impressions as sense *reactions*. Both Ptolemy and Galen can be seen in this light to espouse causal versions of what modern philosophers call *direct realism* with regard to perception: we perceive real objects in the world immediately and directly.⁵⁷ Ptolemy adds, in his discussion of the *criterion*, that we then make representational (language-rooted) judgments about *what is*, but for him the perceptions themselves are nonrepresentational.

In both Ptolemy and Galen, the chain of causation relies at critical junctures on the invocation of the law of “like affects like” as the primary mechanism for how the material of the world can be trusted to affect our internal states in nonrandom ways through the senses. But this is not to put phenomenological brackets around the relationship between the senses and the world in an attempt to avoid questions about the exact nature of the relationship between the visual flux and color or between internal and external *pneuma*. It is instead to appeal to what both Ptolemy and Galen take to be a basic law about how the universe works: “like affects like” looks to be a law of nature in Hellenistic philosophy—and one that neither Ptolemy nor Galen is worried about the truth of. It may look like a black box to us, but they clearly see it as an *explanans*, not as an *explanandum*-on-hold.

Finally, we should notice the centrality of experience to both Ptolemy and Galen. Sense perception is for Ptolemy *prior* to thought in actualization: we experience before we can think. And animals, which are lower than us, can experience but not think.⁵⁸ True, the seat of the *hegemonikon* is the principle cause of living well and so *above* the senses in that respect, but, Ptolemy tells us, the senses come a close second. And in the acquisition of true knowledge, although the mind is the primary agent, the senses are absolutely indispensable as *the* source of evidence.

⁵⁶ Ptolemy is explicit that judgment, insofar as it uses language, is representational, but sense perception itself is causal.

⁵⁷ For accounts of this position see, e.g., P. F. Strawson, “Perception and Its Objects,” in *Perception and Identity: Essays Presented to A. J. Ayer, with His Replies*, ed. G. F. Macdonald (Ithaca, N.Y.: Cornell Univ. Press, 1979), pp. 41–60; and Putnam, *Threefold Cord* (cit. n. 7), although why Putnam claims that a causal account of perception should be “wholly incompatible” with what he calls natural realism is opaque to me, unless it rests on his (unwarranted) assumption that causal theories are sense-data theories (pp. 12, 22)—here contrast Fred Dretske, “Perception,” in *Cambridge Dictionary of Philosophy*, ed. Robert Audi (Cambridge: Cambridge Univ. Press, 1995), p. 657. In a different tradition, but making at least sympathetic points, see James J. Gibson, *The Senses Considered as Perceptual Systems* (Boston: Houghton-Mifflin, 1966).

⁵⁸ *Crit.* 9.2. We can also experience when we are not thinking.

Galen's corpus is littered with appeals to experience, and the two most common accusations he levels at the targets of his invective are either that his opponents cannot think straight or that they have missed the empirical evidence that is before them. Experience is one of the fundamental cornerstones of knowledge: "I have thought it best to guard against nothing so carefully in argument as against positing something that contradicts what is clearly observed," ἤξιουν τε μηδὲν οὕτω φυλάττεσθαι κατὰ τὸν λογὸν ὡς τὸ τοῖς ἐναργῶς φαινομένοις ἐναντία τίθεσθαι.⁵⁹ And the methodology Galen outlines for determining the location of the *hegemonikon* itself is what he calls the "demonstrative method," ἡ ἀποδεικτικὴ μέθοδος, translated (perhaps not unjustly) by Phillip de Lacy and by Teun Tieleman as "the scientific method."⁶⁰ For the details of this methodology Galen refers us to a treatise of his on the subject, unfortunately no longer extant, but we can work out the general approach by looking at how he applies this method in the solution to physiological problems. For example, in attempting to determine where in the human body the governing part of the soul is physically located, his technique is highly (though not only) empirical: he looks for physical structures in the body that could be responsible for the kinds of activities the soul is supposed to perform (namely, sensation and motion, for which he credits the nerves), and he then looks to see which organ is physically connected to the greatest number of these structures. "Everything," he tells us, "which falls outside of this path is superfluous and misleading," ταύτης τῆς ὁδοῦ πᾶν ὅ τι περ ἂν ἔξω πίπτῃ, περιττόν τ' ἐστὶ καὶ ἀλλότριον.⁶¹ Like Ptolemy, he sets the *hegemonikon* in the brain. And, like Ptolemy, he sets up vision as the highest of the senses—though for very different reasons. For Galen it is because of the very great volume of *pneuma* used in vision (shown by the physical size of the nerves that lead to the eyes), whereas for Ptolemy it has to do with the physical location of the eyes as the sense nearest to the brain. There is also the general *topos* they share with their contemporaries, as with many moderns, that just unreflectively sees vision as *the* paradigm for the senses in general.

Whether all of this provides for either of them a bulletproof antidote to Scepticism is still an open question. What is clear is that both Ptolemy and Galen felt the need to work out in some detail what they saw as a solid epistemological footing for experience in general, and for vision in particular, in order to ground each of their investigations. They both did this by running tight causal chains from the world into the brain. And Galen, at least, seems to have thought he had succeeded in diffusing Scepticism: in the autobiographical *Prognosis*, he recounts a memorable incident that happened to him while preparing to dissect a pig in front of an audience of philosophers. Galen launched into a description of the very delicate and careful anatomical demonstration in which he would lead the philosophers, explaining how he would show them that there was a very fine pair of nerves, one on either side of the larynx and each as thin as hairs, that were responsible for vocalization. If these were cut, it would leave the animal speechless. Here, to Galen's horror, the philosopher Alexander interrupted him:

τοῦτο πρῶτον· ἂν σοι συγχωρηθεῖν τοῖς διὰ τῶν αἰσθήσεων φαινομένοις πιστεύειν ἡμᾶς δεῖν;

But first, must we concede to you this point: that the evidence of the senses is trustworthy?⁶²

⁵⁹ *De plac. Hipp. et Plat.* 2.1.1.

⁶⁰ To be fair, it is not *our* scientific method, but it can be argued that it is *a* scientific method. For the translation see Phillip de Lacy in Galen, *De plac. Hipp. et Plat.*; and Teun Tieleman, *Galen and Chrysippus: Argument and Refutation in the De Placitis Books II–III* (Utrecht: Dept. Philosophy, Utrecht Univ., 1992).

⁶¹ *De plac. Hipp. et Plat.* 2.3.8.

⁶² Galen, *Prognosis* 98.5.

Galen's response was simply to storm out of the room, his parting shot to say that he would not have come had he known that the ἀγροικοπυρρώνειοι were going to be there. The insult he coined? A compound of "Pyrrhonians" and "boors."

APPENDIX
LEMMA TO THE MIRROR PROBLEM

Not everyone is immediately happy that the mirror problem has a straightforward solution. Standard answers run the problem back to the psychology of bilateral symmetry and the relativity of left and right as directions versus up and down as absolutes, but, as the physicist Brendan Quine forced me to see, this is not quite the whole story. Quine's objection runs as follows: Imagine you are looking in a mirror, holding an apple in your right hand. Now imagine someone standing where the mirror is and photographing you. When you look at the photograph taken from the mirror's point of view, the apple will be in your right hand in the photo, which is (in an absolute sense) on the opposite side to where the apple appears in the mirror, as in Figure 3. The apple appears to be in the wrong hand in the mirror, but when it appears in the right hand in the photograph, it has also switched sides in an absolute sense relative to the mirror image. In order to reproduce the mirror image, we need to turn the photograph 180° horizontally and look through it (imagine holding it up to the light or that it is a photographic slide). *What we do not do*, Quine points out, *is turn the photograph 180° vertically*. Does this not mean that there is something more going on than just "it looks like it is in the wrong hand only because you project right and left into the mirror image"? Are up and down not *more* absolute here?

My answer is this: yes and no. The real villain in the piece has a good deal to do with how we move around in the world—namely, on a horizontal plane. The reason the photograph needs to be turned horizontally to reproduce mirror conditions has to do with how the photographer oriented herself relative to the viewer in the first place and, accordingly, how we develop and then hold photographs to reproduce the image "correctly." Imagine the photographer initially standing beside you as you prepared the experiment. Before taking the photo, she had to stand between you and the mirror *and turn around 180° horizontally* in order to see you and the apple. It is *this* process that the horizontal inverting of the

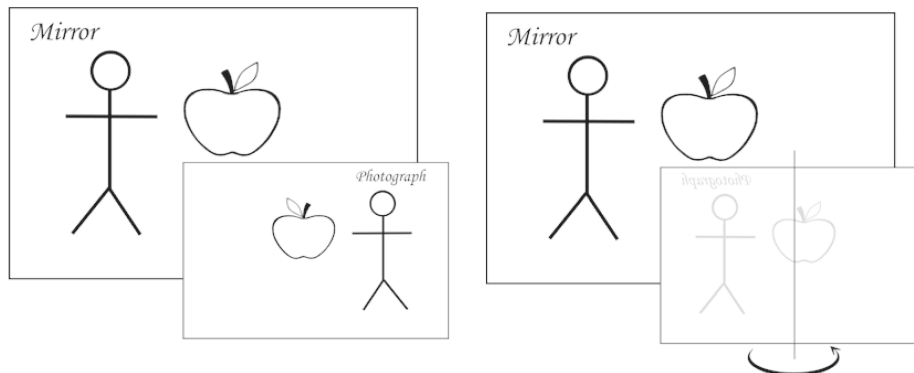


Figure 3. Switching sides only relatively—or is there something absolute going on? Why is the vertical axis privileged so that we have to rotate a photograph around it in particular in order to recreate mirror conditions?

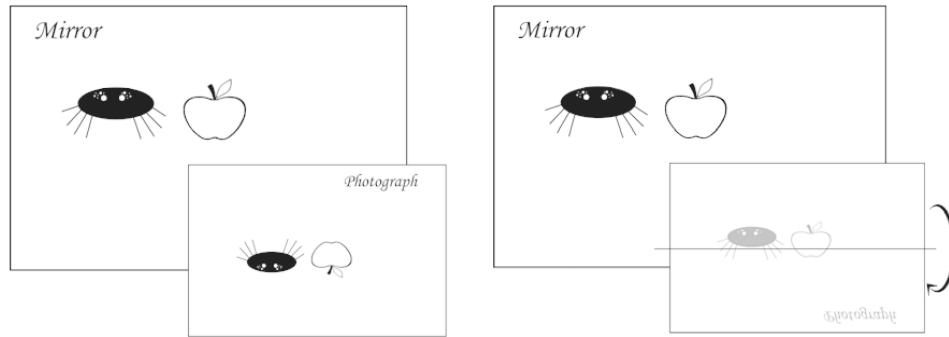


Figure 4. Spiders in a beach ball would hold the photograph differently (because of their different axis of rotation) in order to reproduce the conditions of initial observation. Thus left and right become absolute and up and down relative. Now the mirror puzzle must be reworded: *Why do up and down get reversed in a mirror, but left and right do not?*

photograph is meant to compensate for. Had we been, say, spiders living on the inside surface of a beach ball, the situation could have been completely different, insofar as the photographer spider could have (or likely would have) walked to the opposite side of the beach ball by going *up* along a meridian rather than around the equator, so to speak. When she arrived opposite you, her right side and your right side would both be absolutely in the same direction (pointing east, say), but her head would be pointing down and yours up. In such a world it would be natural to hold photographs upside-down rather than as we do, rightside-left, in order to reproduce the conditions of initial observation. (I suppose that this would also apply to flagellum-propelled animals in open water, among other creatures real or imagined.) Thus left and right become the absolutes and up and down are inverted, and the mirror problem requires a reciprocal wording to our version. Finally, in order to produce the mirror image, we have to turn the photograph 180° vertically and project through it, rather than 180° horizontally as we needed to do in the human case (see Figure 4).