MODERNIZING VISION

My starting point is the various ways in which vision and the techniques and discourses surrounding it have been periodized historically. It is interesting that so many attempts to theorize vision and visuality are wedded to models that emphasize a continuous and overarching Western visual tradition. Obviously at times it is strategically necessary to map out and pose the outlines of a dominant Western speculative or scopic tradition of vision that is continuous or in some sense effective, for instance, from Plato to the present, or from the Quattrocento into the twentieth century, or to whenever. My concern is not so much to argue against these models, which have their own usefulness, but rather to insist there are some important discontinuities that such hegemonic constructions have prevented from coming into view. The specific account that interests me here, one that has become almost ubiquitous and continues to be developed in a variety of forms, is that the emergence of photography and cinema in the nineteenth century is a fulfillment of a long unfolding of technological and/or ideological development in the West in which the camera obscura evolves into the photographic camera. Implied is that at each step in this evolution the same essential presuppositions about an observer's relation to the world are in place. One could name a dozen or more books on the history of film or photography in whose first chapter appears the obligatory seventeenth-century engraving depicting a camera obscura, as a kind of inaugural or incipient form on a long evolutionary ladder.

These models of continuity are used in the service of both,

for lack of better terms, the right and the left. On the one hand are those who pose an account of ever-increasing progress toward verisimilitude in representation, in which Renaissance perspective and photography are part of the same quest for a fully objective equivalent of "natural vision." On the other are those who see, for example, the camera obscura and cinema as bound up in a single enduring apparatus of power, elaborated over several centuries, that continues to define and regulate the status of an observer.

What I want to do are essentially two related things: (1) to briefly and very generally articulate the camera obscura model of vision in terms of its historical specificity, and (2) to suggest how that model collapsed in the early nineteenth century—in the 1820s and 1830s—when it was displaced by radically different notions of what an observer was and of what constituted vision. So if later in the nineteenth century cinema or photography seem to invite formal comparisons with the camera obscura, or if Marx, Freud, Bergson, and others refer to it, it is within a social, cultural, and scientific milieu in which there had already been a profound rupture with the conditions of vision presupposed by this device.

For at least two thousand years it has been known that, when light passes through a small hole into a dark, enclosed interior, an inverted image will appear on the wall opposite the hole. Thinkers as remote from each other as Euclid, Aristotle, Roger Bacon, and Leonardo noted this phenomenon and speculated in various ways how it might or might not be analogous to the functioning of human vision.

But it is crucial to make a distinction between the empirical fact that an image can be produced in this way (something that continues to be as true now as it was in antiquity) and the camera obscura as a socially constructed artifact. For the camera obscura was not simply an inert and neutral piece of equipment

or a set of technical premises to be tinkered upon and improved over the years; rather, it was embedded in a much larger and denser organization of knowledge and of the observing subject. If we want to be historical about it, we must recognize how for nearly two hundred years, from the late 1500s to the end of the 1700s, the structural and optical principles of the camera obscura coalesced into a dominant paradigm through which was described the status and possibilities of an observer.

It became a model, obviously elaborated in a variety of ways, for how observation leads to truthful inferences about an external world. It was an era when the camera obscura was simultaneously and inseparably a central epistemological figure within a discursive order, as in Descartes's *Dioptrics,* Locke's *Essay on Human Understanding,* and Leibniz's critique of Locke, *and* occupied a major position within an arrangement of technical and cultural practices, for example in the work of Kepler and Newton. As a complex technique of power, it was a means of legislating for an observer what constituted perceptual "truth," and it delineated a fixed set of relations to which an observer was made subject.

What I will argue is that very early on in the nineteenth century the camera obscura collapses as a model for an observer and for the functioning of human vision. There is a profound shift in the way in which an observer is described, figured, and posited in science, philosophy, and in new techniques and practices of vision. Here I want briefly and very sketchily to indicate a few important features of this shift.

First, a bit more about the camera obscura in the seventeenth and eighteenth centuries. Above all, whether in the work of scientists or artists, empiricists or rationalists, it was an apparatus that guaranteed access to an objective truth about the world. It assumed importance as a model both for the observation of empirical phenomenon and for reflective introspection and self-observation. In Locke, for example, the camera is a

means of spatially visualizing the position of an observing subject.[1] The image of the room in Locke takes on a special significance, referring to what it meant in the seventeenth century to be *in camera,* that is, within the chambers of a judge or person of title.[2] Thus he adds onto the observer's passive role a more authoritative and juridical function to guarantee and to police the correspondence between exterior world and interior representation and to exclude anything disorderly or unruly.

Richard Rorty has pointed to Locke and Descartes as key figures in establishing this conception of the human mind as "an inner space in which clear and distinct ideas passed in review before an inner Eye . . . an inner space in which perceptual sensations were themselves the objects of quasi-observation."[3] For Descartes, the camera obscura was a demonstration of how an observer can know the world "uniquely by perception of the mind." The secure positioning of the self with this empty interior space was a precondition for knowing the outer world. Its enclosedness, its darkness, its categorical separation from an exterior incarnates Descartes's announcement in the Third Meditation, "I will now shut my eyes, I shall stop my ears, I shall disregard my senses."[4] If part of Descartes's method implied a need to escape the uncertainties of mere human vision, the camera obscura is compatible with his quest to found knowledge on a purely objective view of the world. The aperture of the camera corresponds to a single mathematically definable point from which the world could be logically deduced and re-presented. Founded on laws of nature—that is, geometrical optics—the camera provided an infallible vantage point on the world. Sensory evidence that depended in any way on the body was rejected in favor of the representations of this mechanical and monocular apparatus, whose authenticity was placed beyond doubt.

Monocular, not binocular. A single eye, not two. Until the nineteenth century, binocular disparity, the fact that we see a

slightly different image with each eye, was never seriously addressed as a central issue. It was ignored or minimized as a problem, for it implied the inadmissible physiological and anatomical operation of human vision. A monocular model, on the other hand, precluded the difficult problem of having to reconcile the dissimilar and therefore provisional and tentative images presented to each eye. Monocularity, like perspective and geometrical optics, was one of the Renaissance codes through which a visual world is constructed according to systematized constants, and from which any inconsistencies and irregularities are banished to insure the formation of a homogeneous, unified, and fully legible space.

Finally to wind up this extremely compressed outline, it should also be suggested how closely the camera obscura is bound up with a metaphysic of interiority. It is a figure for the observer who is nominally a free sovereign individual but who is also a privatized isolated subject enclosed in a quasi-domestic space separated from a public exterior world. It defined an observer who was subjected to an inflexible set of positions and divisions. The visual world could be appropriated by an autonomous subject but only as a private unitary consciousness detached from any active relation with an exterior. The monadic viewpoint of the individual is legitimized by the camera obscura, but his or her sensory experience is subordinated to an external and pre-given world of objective truth.

What is striking is the suddenness and thoroughness with which this paradigm collapses in the early nineteenth century and gives way to a diverse set of fundamentally different models of human vision. I want to discuss one crucial dimension of this shift, the insertion of a new term into discourses and practices of vision: the human body, a term whose exclusion was one of the foundations of classical theories of vision and optics as I have just suggested. One of the most telling signs of the new centrality of the

body in vision is Goethe's *Theory of Colours,* published in 1810, which I have discussed at length elsewhere.[5] This is a work crucial not for its polemic with Newton over the composition of light but for its articulation of a model of subjective vision in which the body is introduced in all its physiological density as the ground on which vision is possible. In Goethe we find an image of a newly productive observer whose body has a range of capacities to generate visual experience; it is a question of visual experience that does not refer or correspond to anything external to the observing subject. Goethe is concerned mainly with the experiences associated with the retinal afterimage and its chromatic transformations. But he is only the first of many researchers who become preoccupied with the afterimage in the 1820s and 1830s throughout Europe. Their collective study defined how vision was an irreducible amalgam of physiological processes and external stimulation, and dramatized the productive role played by the body in vision.

Although we are talking about scientists, what is in question here is the discovery of the "visionary" capacities of the body, and we miss the significance of this research if we don't recall some of its strange intensity and exhilaration. For what was often involved was the experience of staring directly into the sun, of sunlight searing itself onto the body, palpably disturbing it into a proliferation of incandescent color. Three of the most celebrated students of vision of this period went blind or permanently damaged their eyesight by repeatedly staring at the sun: David Brewster, who invented the kaleidoscope and stereoscope; Joseph Plateau, who studied the so-called persistence of vision; and Gustav Fechner, one of the founders of modern quantitative psychology. Fechner's biography provides an account of the almost addictive fascination with which he persisted in this activity. At the same time in the late 1830s and early 1840s we have the visual expression of these attempts in the late paintings of Turner, in which there is that piercing confrontation of

eye and sun, paintings in which the strictures that previously had mediated and regulated vision are abandoned. Nothing now protects or distances the observer from the seductive and sensual brilliance of the sun. The symbolic confines of the camera obscura have crumbled.

Obviously afterimages have been noted and recorded since antiquity, but they had always been outside or on the margins of the domain of optics. They were considered illusions—deceptive, spectral, and unreal. In the early nineteenth century such experiences that previously had been an expression of the frailty and the unreliability of the body now constituted the positivity of vision. But perhaps more importantly, the privileging of the body as a visual producer began to collapse the distinction between inner and outer upon which the camera obscura depended. Once the objects of vision are coextensive with one's own body, vision becomes dislocated and depositioned onto a single immanent plane. The bipolar setup vanishes. Thirdly, subjective vision is found to be distinctly temporal, an unfolding of processes within the body, thus undoing notions of a direct correspondence between perception and object. By the 1820s, then, we effectively have a model of autonomous vision.

The subjective vision that endowed the observer with a new perceptual autonomy and productivity was simultaneously the result of the observer having been made into a subject of new knowledge, of new techniques of power. And the terrain on which these two interrelated observers emerged in the nineteenth century was the science of physiology. From 1820 through the 1840s it was very unlike the specialized science that it later became; it had then no formal institutional identity and came into being as the accumulated work of disconnected individuals from diverse branches of learning. In common was the excitement and wonderment at the body, which now appeared like a new continent to be mapped, explored, and mastered, with new re-

cesses and mechanisms uncovered for the first time. But the real importance of physiology lay in the fact that it became the arena for new types of epistemological reflection that depended on new knowledge about the eye and processes of vision. Physiology at this moment of the nineteenth century is one of those sciences that stand for the rupture that Foucault poses between the eighteenth and nineteenth centuries, in which man emerges as a being in whom the transcendent is mapped onto the empirical.[6] It was the discovery that knowledge was conditioned by the physical and anatomical structure and functioning of the body, and in particular of the eyes. At the same time, as Georges Canguilhem has noted, for the new sciences in the nineteenth century the body was *a priori* a productive body: it existed to be set to work.[7]

Even in the early 1820s the study of afterimages quickly became the object of a more rigorous and *quantitative* scientific research throughout Europe. Studied was the persistence and modulation of afterimages: how long they lasted, what changes they went through, and under what conditions. But instead of recording afterimages in terms of the lived time of the body as Goethe had generally done, they were studied as part of a comprehensive quantification of the irritability of the eye. Researchers timed how long it took the eye to become fatigued, how long dilation and contraction of the pupil took, and measured the strength of eye movements. They examined convergence and accommodation in binocular vision and the relation of image to retinal curvature.

The physical surface of the eye itself became a field of statistical information: the retina was demarcated in terms of how color changes hue depending on where it strikes the eye. Also measured were the extent of the area of visibility, of peripheral vision, the distinction between direct and indirect vision, and the location of the blind spot. Classical optics, which had studied the transparency of mechanical optical systems, gave way to

a mapping of the human eye as an opaque territory with varying zones of efficiency and aptitude and specific parameters of normal and pathological vision. Some of the most celebrated of these experiments were Joseph Plateau's calculation, in the 1830s, of the average duration of an afterimage, or persistence of vision, which was about one-third of a second, and later, Helmholtz's measurement of the speed of nerve transmission, which astounded people by how slow it was, about ninety feet per second. Both statistics heightened the sense of a temporal disjunction between perception and its object *and* suggested new possibilities of intervening externally in the process of vision.

Clearly this study of the eye in terms of reaction time and thresholds of fatigue and stimulation was not unrelated to increasing demand for knowledge about the adaptation of a human subject to productive tasks in which optimum attention span was indispensable for the rationalization of human labor. The economic need for rapid coordination of hand and eye in performing repetitive actions required accurate knowledge of human optical and sensory capacities. In the context of new industrial models of factory production the problem of visual inattention was a serious one. But what developed was a notion of vision that was fundamentally quantitative, in which the terms constituting the relation between perception and object became abstract, interchangeable, and nonvisual. One of the most paradoxical figures of the nineteenth century is Gustav Fechner, whose delirious and even mystical experiences with solar afterimages led to his mathematization of perception, in which he established a functional relation between stimulus and sensation.[8] Sensory perception was given a measurable magnitude solely in terms of the known and controllable magnitudes of external stimulation. Vision became studied in terms of abstract measurable regularities, and Fechner's famous equations were to be one of the foundations of modern stimulus-response psychology.

Another dimension of the collective achievement of phys-

iology in the first half of the nineteenth century was the gradual parcelization and division of the body into increasingly separate and specific systems and functions. Especially important were the localization of brain and nerve functions, and the distinction between sensory nerves and motor nerves. Finally, by 1826 it was determined that sensory nerves were of five distinct types, corresponding to the five senses. All of this produced a new "truth" about the body which some have linked to the so-called "separation of the senses" in the nineteenth century, and to the idea that the specialization of labor was homologous to a specialization of sight and of a heightened autonomous vision, something that Fredric Jameson develops briefly but provocatively in *The Political Unconscious.*[9] I believe, however, that such a homology doesn't take account of how thoroughly vision was reconceived in the earlier nineteenth century. It still seems to pose observation as the act of a unified subject looking out onto a world that is the object of his or her sight, only that, because the objects of the world have become reified and commodified, vision in a sense becomes conscious of itself as sheer looking.

But in the first major scientific theorization of the separation of the senses, there is a much more decisive break with the classical observer; and what is at stake is not simply the heightening or isolating of the optical but rather a notion of an observer for whom vision is conceived without any necessary connection to the act of looking at all. The work in question is the research of the German physiologist Johannes Müller, the single most important theorist of vision in the first half of the nineteenth century.[10] In his study of the physiology of the senses, Müller makes a comprehensive statement on the subdivision and specialization of the human sensory apparatus; his fame was due to his theorization of that specialization: the so-called "doctrine of specific nerve energies." It was a theory in many ways as important to the nineteenth century as the Molyneux problem was to the eighteenth century. It was the foundation of

Helmholtz's *Optics,* which dominated the second half of the 1800s; in science, philosophy, and psychology it was widely propounded, debated, and denounced even into the early twentieth century. (Also, I believe Marx was paraphrasing this work when he discussed the separation of the senses in his *1844 Manuscripts.*[11]) In short, this is a major way in which an observer was figured in the nineteenth century, a way in which a certain "truth" about sight was depicted.

The theory was based on the discovery that the nerves of the different senses were physiologically distinct. It asserted quite simply—and this is what marks its epistemological scandal—that a uniform cause (e.g., electricity) would generate utterly different sensations from one kind of nerve to another. Electricity applied to the optic nerve produces the experience of light, applied to the skin the sensation of touch. Conversely, Müller shows that a variety of different causes will produce the *same* sensation in a given sensory nerve; in other words, he describes a fundamentally arbitrary relation between stimulus and sensation. It is a description of a body with an innate capacity, one might even say a transcendental faculty, to *misperceive,* of an eye that renders differences equivalent.

His most exhaustive demonstration concerns the sense of sight, and he concludes that the observer's experience of light has no necessary connection with any actual light. Müller enumerates the agencies capable of producing the sensation of light. "The sensations of light and color are produced wherever parts of the retina are excited 1) by mechanical influences, such as pressure, a blow or concussion 2) by electricity 3) by chemical agents, such as narcotics, digitalis 4) by the stimulus of the blood in a state of congestion."[12] Then last on his list, almost begrudgingly, he adds that luminous images also can be produced by "the undulations and emanation which by their action on the eye are called light."

Again the camera obscura model is made irrelevant. The

experience of light becomes severed from any stable point of reference or from any source or origin around which a world could be constituted and apprehended. And of course the very independent identity of light had already been undermined as a new wave theory of light became part of a science of electro-magnetic phenomena.

Sight here has been separated and specialized certainly, but it no longer resembles any classical models. The theory of specific nerve energies presents the outlines of a visual modernity in which the "referential illusion" is unsparingly laid bare. The very absence of referentiality is the ground on which new instrumental techniques will construct for an observer a new "real" world. It is a question of a perceiver whose very empirical nature renders identities unstable and mobile, and for whom sensations are interchangeable. And remember, this is roughly 1830. In effect, the doctrine of specific nerve energies redefines vision as a capacity for being affected by sensations that have no necessary link to a referent, thus threatening any coherent system of meaning. Müller's theory was potentially so nihilistic that it is no wonder that Helmholtz and others, who accepted its empirical premises, were impelled to invent theories of cognition and signification which concealed its uncompromising cultural implications. But what was at stake and seemed so threatening was not just a new form of epistemological skepticism about the unreliability of the senses but a positive reorganization of perception and its objects. The issue was not just how does one know what is real, but that new forms of the real were being fabricated and a new truth about the capacities of a human subject was being articulated in these terms.

The theory of specific nerve energies eradicated distinctions between internal and external sensation, so that interiority was drained of the meanings it once had for a classical observer, or

for the model of the camera obscura. In his supposedly empirical description of the human sensory apparatus, Müller presents the subject not as a unitary "tabula rasa," but as a composite structure on which a wide range of techniques and forces could produce a manifold of experiences that are all equally "reality." If John Ruskin proposed reclaiming the "innocence of the eye," this was about as innocent as one could get. The observer is simultaneously the object of knowledge and the object of procedures of stimulation and normalization, which have the essential capacity *to produce experience for the subject.* Ironically the notions of the reflex arc and reflex action, which in the seventeenth century referred to vision and the optics of reflection, begin to become the centerpiece of an emerging technology of the subject, culminating in the work of Pavlov.

In his account of the relation between stimulus and sensation, Müller suggests not an orderly and legislative functioning of the senses, but rather their receptivity to calculated management and derangement. Émile Dubois-Reymond, a colleague of Helmholtz, seriously pursued the possibility of electrically cross-connecting nerves, enabling the eye to see sounds and the ear to hear colors, well before Rimbaud. It must be emphasized that Müller's research and that of psychophysics in the nineteenth century is inseparable from the resources made available by contemporary work in electricity and chemistry. Some of the empirical evidence by Müller had been available since antiquity, or was in the domain of common-sense knowledge. However, what is new is the extraordinary privilege given to a complex of electro-physical techniques. What constitutes "sensation" is dramatically expanded and transformed, and it has little in common with how it was discussed in the eighteenth century. The adjacency of Müller's doctrine of specific nerve energies to the technology of nineteenth-century modernity is made particularly clear by Helmholtz:

Nerves in the human body have been accurately compared to telegraph wires. Such a wire conducts one single kind of electric current and no other; it may be stronger, it may be weaker, it may move in either direction; it has no other qualitative differences. Nevertheless, according to the different kinds of apparatus with which we provide its terminations, we can send telegraphic dispatches, ring bells, explode mines, decompose water, move magnets, magnetize iron, develop light, and so on. The same thing with our nerves. *The condition of excitement which can be produced in them, and is conducted by them, is . . . everywhere the same.*[13]

Far from the specialization of the senses, Helmholtz is explicit about the body's indifference to the sources of its experience and of its capacity for multiple connections with other agencies and machines. The perceiver here becomes a neutral conduit, one kind of relay among others to allow optimum conditions of circulation and exchangeability, whether it be of commodities, energy, capital, images, or information.

The collapse of the camera obscura as a model for the status of an observer was part of a much larger process of modernization, even as the camera obscura itself was an element of an earlier modernity. By the early 1800s, however, the rigidity of the camera obscura, its linear optical system, its fixed positions, its categorical distinction between inside and outside, its identification of perception and object, were all too inflexible and unwieldy for the needs of the new century. A more mobile, usable, and productive observer was needed in both discourse and practice—to be adequate to new uses of the body and to a vast proliferation of equally mobile and exchangeable signs and images. Modernization entailed a decoding and deterritorialization of vision.

What I've been trying to do is give some sense of how radical was the reconfiguration of vision by 1840. If our problem is

vision and modernity we must look first at these early decades, not to modernist painting in the 1870s and 1880s. A new type of observer was formed then, and not one that we can see figured in paintings or prints. We've been trained to assume that an observer will always leave visible tracks, that is, will be identifiable in terms of images. But here it's a question of an observer who takes shape in other, grayer practices and discourses, and whose immense legacy will be all the industries of the image and the spectacle in the twentieth century. The body which had been a neutral or invisible term in vision now was the thickness from which knowledge of vision was derived. This opacity or carnal density of the observer loomed so suddenly into view that its full consequences and effects could not be immediately realized. But it was this ongoing articulation of vision as nonveridical, as lodged in the body, that was a *condition of possibility* both for the artistic experimentation of modernism and for new forms of domination, for what Foucault calls the "technology of individuals."[14] Inseparable from the technologies of domination and of the spectacle in the later nineteenth and twentieth century were of course film and photography. Paradoxically, the increasing hegemony of these two techniques helped recreate the myths that vision was incorporeal, veridical, and "realistic." But if cinema and photography seemed to reincarnate the camera obscura, it was only as a mirage of a transparent set of relations that modernity had already overthrown.

Notes

1. John Locke, *An Essay Concerning Human Understanding* (New York: Dover Publications, 1959), vol. 2, xi, 17.
2. Ibid., vol. 2, iii, 1.
3. Richard Rorty, *Philosophy and the Mirror of Nature* (Princeton: Princeton University Press, 1979), pp. 49-50.
4. René Descartes, *The Philosophical Writings of Descartes*, trans. John Cottingham

et al. (Cambridge: Cambridge University Press, 1984), vol. 2, p. 24.

5. Johann Wolfgang von Goethe, *Theory of Colours*, trans. Charles Lock Eastlake (Cambridge, Mass.: The MIT Press, 1970). See my "Techniques of the Observer," *October*, no. 45 (Summer 1988).

6. Michel Foucault, *The Order of Things* (New York: Pantheon Books, 1971), pp. 318-320.

7. Georges Canguilhem, "Qu'est-ce que le psychologie," in his *Etudes d'histoire et de philosophie des sciences*, 5th ed. (Paris: J. Vrin, 1983), pp. 377-378.

8. See Gustav Fechner, *Elements of Psychophysics*, trans. Helmut E. Adler (New York: Holt, Rinehart and Winston, 1966).

9. Fredric Jameson, *The Political Unconscious: Narrative as a Socially Symbolic Act* (Ithaca, N.Y.: Cornell University Press, 1981), pp. 62-64.

10. See Johannes Müller, *Handbuch der Physiologie des Menschen* (Coblenz: Holscher, 1838); *Elements of Physiologie*, trans. William Baly (London: Taylor and Walton, 1848).

11. See Karl Marx, *The Economic and Philosophic Manuscripts of 1844*, ed. Dirk J. Struik, trans. Martin Milligan (New York: International Publishers, 1964), pp. 140-141.

12. Müller, p. 1064.

13. Hermann von Helmholtz, *On the Sensations of Tone as a Physiological Basis for the Theory of Music*, 2nd ed., trans. Alexander J. Ellis (New York: Dover Publications, 1954), pp. 148-149.

14. Michel Foucault, *Discipline and Punish: The Birth of the Prison*, trans. Alan Sheridan (New York: Vintage Books, 1975), p. 225.