

Theory of Vision

LPS 243
Fall 2015 - Winter 2016

In this course, we'll survey the development of thinking on vision from ancient and medieval times, through the Scientific Revolution and the early modern period, to the rise of experimental psychology in the 19th century, and into the present day. Vision theory, and the theory of perception more generally, is obviously of central importance to epistemology. It also presents a particularly vivid case history in the evolving relations between (what we now think of as) science and (what we now think of as) philosophy. For most of the history, these two weren't clearly, or often even vaguely, distinguished, so tracing how there came to be a separate, distinctively philosophical inquiry into vision and perception may illuminate unexpected features of contemporary philosophical thought.

The default requirement for those taking the course for a grade (other than S/U, which involves only reading and attendance) is three short papers (750-1250 words) due at the beginning of class in the 4th week, 7th week, and 10th week. Each paper should isolate one localized point within one of the readings and offer some analysis and/or critique. (For many, the most difficult part of the exercise is finding a topic of the right size and a thesis to match. All little-paper writers are strongly encouraged to email me their topic and thesis, or even better, a draft introductory paragraph, for discussion well before the due date.) Other options are open to negotiation.

I assume everyone has access to copies of

Lindberg, *Theories of Vision from Al-Kindi to Kepler*.

Berkeley, *New Theory of Vision*.

Reid, *Inquiry into the Human Mind on the Principles of Common Sense*.

Hatfield, *Perception and Cognition*.

Schwartz, ed., *Perception*.

The rest of the assigned readings are available on the course EEE web site. Copies of these three books are kept in Schatz's office for perusal:

Atherton, *Berkeley's Revolution in Vision*.

Nichols, *Thomas Reid's Theory of Perception*.

Palmer, *Vision Science*.

Pastore, *Selective History of Theories of Visual Perception 1650-1950*, is also useful for background reading. This and other books listed in the extra reading can be borrowed from me.

Please come to the first meeting prepared to discuss the reading in Topic 1.

Topics

1. Ancient and early medieval theories

Lindberg, 'The background: ancient theories of vision', chapter 1 of his *Theories of Vision*.

Lindberg, '[The intromission-extramission controversy in Islamic visual theory: Alkindi vs. Avicenna](#)'.

Lindberg, 'Alhazen and the new intromission theory of vision', chapter 4 of his *Theories of Vision*, pp. 58-67.

Extra reading:

Lindberg, 'Al-Kindi's critique of Euclid's theory of vision', chapter 2 of his *Theories of Vision*.

Lindberg, 'Galenists and Aristotelians in Islam', chapter 3 of his *Theories of Vision*.

The high point of theorizing about vision between the ancients and the early modern period came in the work of the medieval Islamic scholar, Ibn al-Haytham or Alhazen (born in Basra in 965, d. in Cairo in 1040). (We caught a glimpse last time of his critique of earlier extramission theories.)

2. Alhazen

Lindberg, 'Alhazen and the new intromission theory of vision', chapter 4 of his *Theories of Vision*, pp. 67-86.

Sabra, '[Sensation and inference in Alhazen's theory of visual perception](#)'.

Hatfield and Epstein, 'The sensory core and the medieval foundations of early modern perceptual theory', pp. 358-368.

3. Kepler

Lindberg, 'Johannes Kepler and the theory of the retinal image', chapter 9 of his *Theories of Vision*, pp. 185-208.

Straker, '[Kepler, Tycho, and the "Optical Part of Astronomy": the genesis of Kepler's theory of pinhole images](#)'.

Hatfield and Epstein, 'The sensory core and the medieval foundations of early modern perceptual theory', pp. 368-372.

Extra reading:

Lindberg, '[The theory of pinhole images from antiquity to the 13th century](#)'.

Kepler (1571-1630) represents the early days of the Scientific Revolution (starting roughly with Copernicus in 1543, ending roughly with Newton in 1687). In reaction, Descartes (1596-1650) initiates the early modern period in philosophy. Of his writings below on vision, only the brief excerpt from the sixth replies was published during Descartes' lifetime. The *Treatise on Man* was projected as part of a three-part work, along with *The World (Treatise on Light)* and a third section on the soul that was apparently never completed. Descartes learned of Galileo's condemnation by the Inquisition as he was revising the work, and decided he would prefer not to publish: 'I would not for all the world want a discourse to issue from me that contained the least word of which the Church would disapprove, and so that I would prefer to suppress it than to have it appear in a mangled form' (letter to Mersenne, November 1633).

4. Descartes I

Descartes, [Optics](#), pp. 91-113.

Descartes, *Treatise on Man*, pp. [49-68](#), [77-100](#).

There are a lot of pages here -- just read to get a feel for what Descartes is up to. And in the *Treatise* selection, but you needn't knock yourself out studying all the footnotes.

Extra reading:

Hall, '[The physiology of Descartes](#)'.

Hatfield, '[Descartes' physiology and its relation to his psychology](#)'.

Hall describes Descartes' physiology as 'derivative' on theories of his predecessors. Hatfield largely agrees, but emphasizes that 'his innovation, which was truly radical, came in his reliance on mechanical categories alone in explaining how bodily functions are performed' (p. 341).

Pastore, '[Descartes](#)', chapter 2 of *Selective History of Theories of Visual Perception*.

Pastore gives a helpful overview.

5. Descartes II

Descartes, '[Sixth Replies](#)', pp. 294-296.

Hatfield and Epstein, 'The sensory core', pp. 372-378.

Hatfield, '[Natural geometry in Descartes and Kepler](#)'.

Extra reading:

Hatfield, '[On natural geometry and seeing distance in Descartes](#)'.

This paper covers much of the same ground as 'Natural geometry in Descartes and Kepler', so it might helpful to switch back and forth.

Mauil, '[Cartesian optics and the geometrization of nature](#)'.

Wolf-Devine, '[Descartes on Seeing](#), pp. 84-88.

The most innovative and influential early modern vision theorist was the Good Bishop Berkeley.

6. Berkeley I

Seeing distance --

Berkeley, *New Theory of Vision*, §§1-51.

Pitcher, '[Berkeley, chapter II](#)'.

Atherton, *Berkeley's Revolution in Vision*, pp. [68-72](#), [77-87](#).

Extra reading:

Goldstein, '[Sensation and Perception](#)', pp. 227-242.

Palmer, *Vision Science*, chapter 5.

Goldstein and Palmer summarize some of the contemporary science on distance vision.

Winkler, '[Berkeley](#)', pp. 149-161.

This is Winkler's take on the distinction between immediate and mediate perception.

7. Berkeley II

Degenaar, *Molyneux's Problem*, pp. [17-23](#), [53-56](#).

Berkeley, [*The Theory of Vision ... Vindicated*](#), §71.

Seeing size --

Berkeley, *New Theory of Vision*, §§52-87.

Pitcher, [Berkeley](#), pp. 34-41.

Atherton, [Berkeley's Revolution](#), pp. 108-127.

Extra reading:

Goldstein, [Sensation and Perception](#), pp. 243-248.

Palmer, [Vision Science](#), 315-322.

Goldstein and Palmer give a contemporary take on size perception.

Judith Thompson, 'Molyneux's problem'.

This is the paper noted by Pitcher.

Atherton, *Berkeley's Revolution*, chapter 7.

Atherton explores the case of the microscope in §§79-87.

George, '[James Jurin awakens Hume from his dogmatic slumber with a short tract on visual acuity](#)'.

George traces some interesting history and science of 'minimum visibilia'.

For the curious ...

Palmer, *Vision*, pp. 322-323.

Goldstein, *Sensation and Perception*, pp. 252-253.

Plug and Ross, '[Historical review](#)' (of the moon illusion).

Ross and Plug, '[Conclusions and conundrums](#)'.

Sabra, '[Psychology versus mathematics: Ptolemy and Alhazen on the moon illusion](#)'

These sources give an overview of historical and contemporary thinking on the moon illusion (plus a little added tidbit on Alhazen for his fans).

Degenaar, *Molyneux's Problem: Three centuries of discussion on the Perception of Forms*.

Morgan, *Molyneux's Question: Vision, Touch and the Philosophy of Perception*.

Gallagher, '[Neurons and neotates: reflections on the Molyneux problem](#)'.

Held et al, '[The newly sighted fail to match seen with felt](#)'.

Streri and Gentaz, 'Cross-modal recognition of shapes from hand to eyes in human newborns'.

These two books survey the development of thought on Molyneux's problem. The final three papers give a contemporary perspective.

8. Berkeley III

Seeing situation --

Berkeley, *New Theory of Vision*, §§88-120.

[Theory of Vision Vindicated](#), §§49-57.

Pitcher, [Berkeley](#), pp. 42-48.

Atherton, [Berkeley's Revolution](#), pp. 140-157.

The next episode of the sensory core --

Hatfield and Epstein, 'The sensory core', pp. 378-385.

9. Berkeley IV

Visibles ≠ tangibles --

Berkeley, *New Theory of Vision*, §§121-159.

Pitcher, [Berkeley](#), pp. 48-61.

Atherton, *Berkeley's Revolution*, pp. [183-201](#).

Extra reading:

Atherton, *Berkeley's Revolution*, pp. 201-207.

Atherton discusses Berkeley's account of the objects of geometry.

Atherton, *Berkeley's Revolution*, pp. 215-229.

Atherton explores the relations between the *New Theory* and Berkeley's immaterialism.

Atherton, '[Berkeley's theory of vision and its reception](#)'.

In the first section of this paper, Atherton gives an illuminating account of the relationship between *New Theory of Vision* and *Theory of Vision Vindicated*.

After Berkeley, we all know, comes Hume and the threat of skepticism. Kant reacts with a new way of doing philosophy, as a transcendental inquiry distinct from empirical science. Reid reacts with a version of proto-naturalism. ('[Naturalism and common sense](#)' (Hume and Reid) gives an overview of Reid's naturalistic method, contrasted with Hume's empiricism.) We'll examine how he applies this method to the theory of vision.

10. Reid I

Reid, *Inquiry into the Human Mind*, §§II.2 (on sensation), V.3 (on natural signs), 5-6 (on extension), VI.1-13 (on seeing).

Extra reading:

Reid, *Inquiry*, §§VI.14-16.

It's only with regret that we skip over these discussions of the eyes of brutes and of the cause and treatment of 'squint' (strabismus or cross-eyes).

11. Reid II

Reid, *Inquiry*, §§VI.17, 20-23.

Grandi, '[Distance and direction in Reid's theory of vision](#)'.

Extra reading:

Palmer, *Vision*, pp. 206-210.

This shows how close Reid was to stereopsis.

Angell, '[The geometry of visibles](#)'.

Belot, '[Remarks on the geometry of visibles](#)'.

Grandi, '[Thomas Reid's geometry of visibles and the parallel postulate](#)'.

Grandi examines the detail of Reid's geometric investigations and argues that he should not be understood as having discovered non-Euclidean geometry (because he didn't understand that the parallel postulate is independent of the incidence axioms).

12. Reid III

Reid, *Essays on the Intellectual Powers of Man*, §II.5 ([on perception](#)), pp. 139-141 ([on Berkeley's New Theory](#)), pp. 36-38 and §§16 ([on sensation](#)), [21](#) ([on acquired perception](#)).

Van Cleve, '[The geometry of visibles](#)', chapter 6 of his *Problems from Reid*.

Extra reading:

Nichols, '[Visual perception](#)', chapter 4 of his *Thomas Reid's Theory of Perception*.

Weldon, '[Direct realism and visual distortion](#)'.

Grandi, '[Reid's direct realism about vision](#)'.

13. Reid IV

Copenhaver, '[A realism for Reid: mediated but direct](#)'.

Hopkins, '[Thomas Reid on Molyneux's problem](#)'.

Van Cleve, '[Molyneux's question](#)', chapter 8 of his *Problems from Reid*.

Extra reading:

Reid, *Inquiry*, §§V.2, 4-6.

Here Reid discusses hardness and the primary/secondary distinction.

Nichols, '[Answering Molyneux](#)', chapter 9 of his *Thomas Reid's Theory of Perception*.

14. Reid V

Copenhaver, '[Thomas Reid on acquired perception](#)'.

Van Cleve, '[Acquired perception](#)', chapter 5 of *Problems from Reid*.

Extra reading:

Van Cleve, 'Reid's theory of perception'.

This is the paper that introduces the example of the wife and the car keys.

Reid's distinction between sensation and perception was a crucial step in the history of vision theory. It's also worth noting that his idea of perception as involving the acquisition of information, e.g., that the object exists, foreshadows both belief-acquisition theories of perception among philosophers (Pitcher's *Perception* is leading example) and information-processing models of perception among vision scientists (see Marr, below).

With the likes of Berkeley and Reid, we've seen thinkers classified, then and now, as 'philosophers' playing an important role in the study of vision in the 18th century. It's often claimed that psychology as a whole, and the theory of vision with it, only broke free of philosophy to become a 'science' in the late 19th century, with the founding of Wundt's laboratory 1879. (Palmer ([Vision Science, pp. 48-50](#)) characterizes Wundt's 'structuralism' as the descendent of the theory of ideas.) Hatfield debunks this origin story in 'Psychology, philosophy, and cognitive science: reflections on the history and philosophy of experimental psychology', pp. 409-416. (See also Hatfield's three papers from the 1990s in the extra reading.)

One particularly salient event in the early 19th century was Wheatstone's discovery of stereopsis. It remains a mystery why this came so late. Crone (in the extra reading) blames Locke and Berkeley.

Helmholtz brings us to the early 20th century.

Extra Reading:

Helmholtz, [Treatise on Physiological Optics](#), volume III, pp. 1-36.

Hatfield, *The Natural and the Normative*, pp. [171-179](#), [195-208](#).

Extra Extra reading:

Palmer, [Vision, pp. 55-59](#).

Palmer's sketch of Helmholtz.

Goldstein, [Sensation and Perception, pp. 234-242](#).

Palmer, [Vision Science, pp. 206-216](#).

Goldstein and Palmer describe stereopsis.

Hatfield, 'Psychology, philosophy, and cognitive science: reflections on the history and philosophy of experimental psychology'.

In this paper, Hatfield also examines the rise and fall of behaviorism in psychology and the relation of psychology to neuroscience, cognitive science, etc.

Hatfield, [the rest of chapter 5 of *The Natural and the Normative*](#).

Crone, '[The history of stereoscopy](#)'.

Hatfield, '[Psychology as a natural science in the 18th century](#)'.

Hatfield, '[Remaking the science of the mind: psychology as natural science](#)'.

Hatfield, '[Wundt and psychology as science: disciplinary transformations](#)'.

The last three papers fill in the origin story sketched in 'Psychology, philosophy, cognitive science'.

Two aspects of Helmholtz's view reverberate in the subsequent discussion: the atomistic understanding of sensation (one nerve-one sensation) and his appeal to unconscious inference. The Gestaltists reject the first; the second is a theme that extends to some contemporary theories.

15. **Gestalt psychology**

Koffka, [Principles of Gestalt Psychology](#), pp. 75-98.

Here Koffka raises the iconic question -- why do things look as they do? -- and sets the stage for gestalt innovations.

Köhler, '[Some tasks of gestalt psychology](#)'.

Spelke et al, '[The development of object perception](#)', pp. 297-314.

The developmentalists suggest that gestalt principles aren't decisive in infant perception of object boundaries.

Extra reading:

Goldstein, [Sensation and Perception](#), pp. 100-108.

Palmer, *Vision Science*, pp. [255-266](#), [398-407](#).

Goldstein and Palmer on gestalt principles.

Helmoltz's notion of 'unconscious inference' has lasted longer than his atomism, but first comes the radical Gibson, who rejects the idea that the optical information stands in need of supplementation of any kind.

16. **Direct Perception: Gibson**

Gibson, *The Senses Considered as Perceptual Systems, The Ecological Approach to Vision*, and 'A theory of direct visual perception', excerpts in the Schwartz anthology.

Fodor and Pylyshyn, '[How direct is visual perception?](#)', pp. 167-196.

Gibson, '[The causes of deficient perception](#)', chapter 14 of *The Senses Considered as Perceptual Systems*, pp. 287-288, 303-308, 318.

Extra reading:

The rest of Gibson, 'The causes of deficient perception'.

The rest of Fodor and Pylyshyn, 'How direct is visual perception?'.

Turvey et al, 'Ecological laws of perceiving and acting: in reply to Fodor and Pylyshyn'.

Goldstein, [Sensation and Perception](#), chapter 7.

Palmer, [Vision Science](#), pp. 53-55.

Schwartz, *Vision*, pp. 137-142.

Next come the neo-Helmholtzians.

17. **Inferentialism: Rock**

Ullman, '[Against direct perception](#)', §§1-4.

This is really a continuation of #16.

Rock, 'Inference in perception'.

Hatfield, 'Perception as unconscious inference'.

Extra reading:

Rock, [The Logic of Perception](#), chapters 1 and 2.

Gregory, '[Perceptions as hypotheses](#)'.

Palmer, [Vision Science](#), pp. 80-85.

Schwartz, 'Perceptual inference', chapter 3 of his *Vision*, and pp. 137-142.

Schwartz argues that the debate between direct perception and the inferentialists is ill-formed, and gives a Gibsonian response to Fodor and Pylyshyn.

Finally, a very influential approach inspired by work in computer vision.

18. Information Processing: Marr

Marr, [Vision](#), pp. 3-53.

Palmer, [Vision Science](#), 171-182, 202-203.

Marr gives an overview. Palmer gives a sense of how this project plays out at the very first stage -- the primal sketch -- and an introduction to the 2½D sketch.

Extra reading:

Marr, *Vision*, the rest of the book, especially pp. 41-53 (on the primal sketch), [99-116 \(on stereopsis\)](#), [264-269 \(on the 2.5D sketch\)](#), and [chapter 5 \(on the 3D model\)](#).

Palmer, *Vision Science*, pp. [70-73](#), [85-92 \(an overview of Marr's project\)](#), [206-217 \(on stereopsis\)](#), [202-203 \(on the 2.5D sketch\)](#), [351-354](#), [396-397 \(on the 3D model\)](#).

19. Assessments of Gibson, Rock and Marr I

Ullman, '[Against direct perception](#)', §5.

Churchland, 'Is the visual system as smart as it looks?'

Bickle, '[Marr and reductionism](#)'.

Bechtel and Shagrir, '[The non-redundant contributions of Marr's three levels of analysis for explaining information-processing mechanisms](#)'.

Anderson, '[Can computational goals inform theories of vision?](#)'

Warren, '[Does this computational theory solve the right problem?](#)'

Extra reading:

Hatfield, 'Representation and constraints: the inverse problem and the structure of space'.

Hatfield, 'On perceptual constancy'.

Hatfield, 'Color perception and neural encoding'.

In these papers, Hatfield challenges the prevailing task analyses for both spatial and color vision.

20. **Assessments of Gibson, Rock and Marr II**

Kosslyn and Hatfield, '[Representation without symbol systems](#)', pp. 1037-1041.

Hatfield, 'Representation and content in some (actual) theories of perception'.

Epstein, '"Why do things look as they do?" What Koffka might have said to Gibson, Marr and Rock'.

Extra reading:

Hatfield, *Perception and Cognition*, pp. vii-ix, 43-47.

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