

Selections: Binocular Convergence

Descartes, Rene. 1984. [1637] “Discourse and Essays: Optics.” *The Philosophical Writings of Descartes.*, vol. 1, eds John. Cottingham, Robert. Stoothoff, and Dugald. Murdoch. Cambridge: Cambridge University Press.

Discourse 6: Vision

-p.169 [The role of **tactile**, muscular sensations in perception]: “...when our eye or head is turned in some direction, our soul is informed of this by the change in the brain which is caused by the nerves embedded in the muscles used for these movements.”

-p.170 [Distance perceived by **focus**]: “The seeing of distance depends no more than does the seeing of position upon any images emitted from objects. Instead it depends in the first place on the shape of the body of the eye. For as we have said, for us to see things close to our eyes this shape must be slightly different from the shape which enables us to see things further away; and as we adjust the shape of the eye according to the distance of objects, we change a certain part of our brain in a manner that is ordained by nature to make our soul perceive this distance.”

-p.170 [Distance perceived by **binocular angle of convergence**]: “And this is done by a mental act which, though only a very simple act of the imagination, involves a kind of reasoning quite similar to that used by surveyors when they measure inaccessible places by means of two different vantage points.”

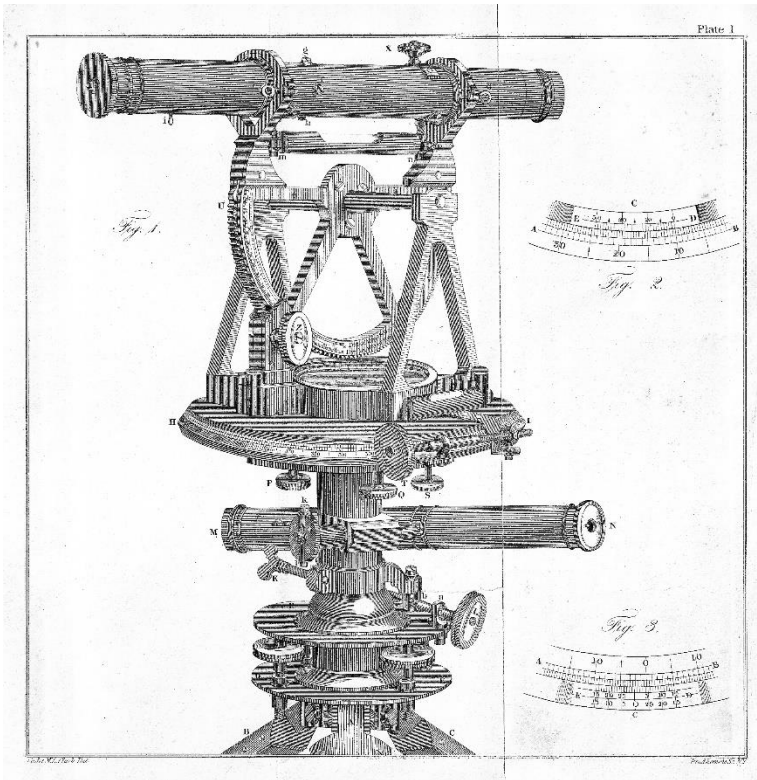


Figure 1 – 19th-Century Surveyor's Theodolite. As the sight pivots, its angle can be read off the upper base. Note the Vernier scale for increased accuracy (Figs. 2 and 3). Simpler versions were used in the 17th century when Descartes was writing.

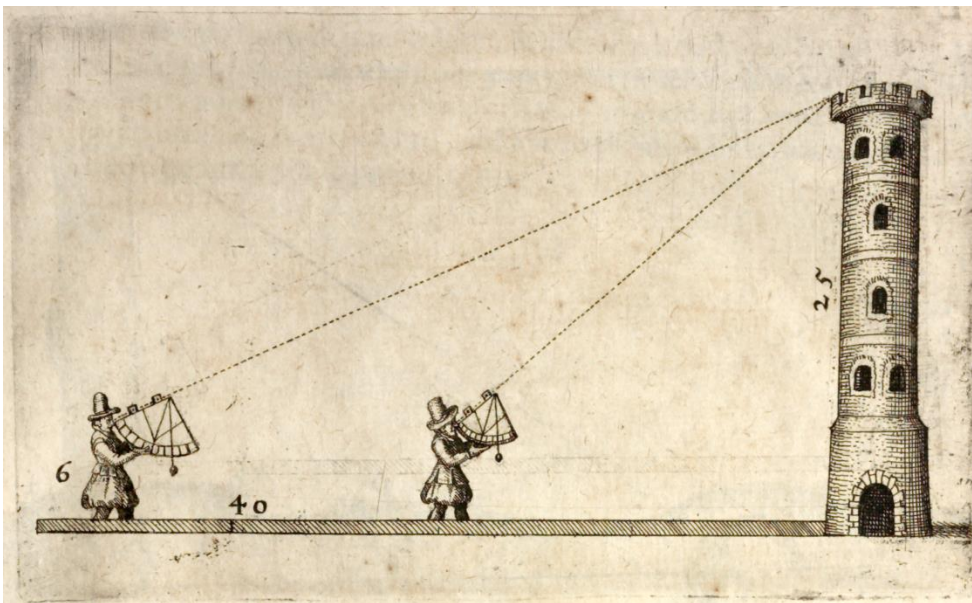


Figure 2 – 17th-Century Surveyors measuring height from a distance. The same trigonometric principles could apply to measuring the distance of the tower. Robert Fludd, *Utriusque Cosmi Majoris Scilicet Et Minoris Metaphysica Atque Technica Historia*, Francofurti: Oppenheimii 1617, 103.

-p.171 [The role of **time, memory /imagination** in the *immediate* perception of distance]: "...we may have already from another source an image of an object's size, or its position, or the distinctness of its shape and colours, or merely the strength of the light coming from it; and this may enable us to imagine its distance, if not actually to see it."

-p.172 [Sight as potentially **deceptive theatre**]: "...it is the soul which sees, and not the eye; and it does not see directly, but only by means of the brain. That is why madmen and those who are asleep often see, or think they see, various objects which are nevertheless not before their eyes: namely, certain vapours disturb the brain and arrange those parts normally engaged in vision exactly as they would be if these objects were present."

-p.173 [Depth perception is **unreliable**]: "It must also be noted that all our methods for recognizing distance are highly unreliable. For the shape of the eye undergoes hardly any perceptible variation when the object is more than four or five feet away [ditto for binocular angle of convergence]"

Molyneux, William and Edmond Halley. 1692 *Dioptrica Nova, A Treatise of Dioptricks in Two Parts*. London: Printed for Benj. Tooke.

[Prop. XXVIII](#): The manner of Plain Vision with the naked Eye is expounded.

Tab. 25. F. 1. a b c is an Object, i k l e m is the Globe of the Eye, furnish'd with all its Coats and Humors; But in this Figure we have only expressed the Crystalline Humour g o h, as being Principally concern'd in Forming the Image on the Fund of the Eye.

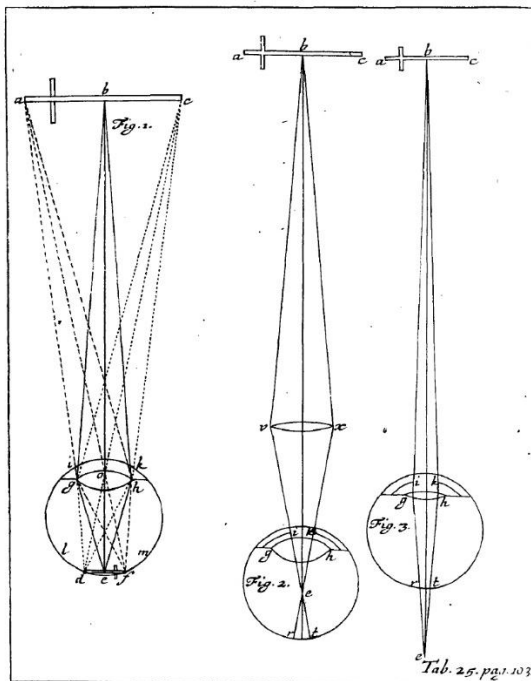


Figure 3 – Molyneux, Table 25

Prop. XXVIII /Sec-1: From each Point in the Object we may Conceive Rays flowing on the Pupil of the Eye i k; as here from the middle Point b, there proceed the Rays b g, b o, b h; These by means of the Coats and Humours of the Eye, and especially by the Chrystalline Humour g h, are refracted and brought together on the Retina or Fund of the Eye in the Point e, and there the Point b is represented. For we may conceive the Crystalline Humour g h as it were a Convex-glass, in the Hole a Dark Chamber i l m k, and that d e f is the Distinct Base of this Glass. What is here said of the Point b, and its Representation at e, may be understood of all the other Points in the Object, as of a and c and their Representations at f and d.

Prop. XXVIII /Sec-2: And as in a dark Chamber, that has a Hole furnish'd with a Convex-glass, if the Paper, that is to receive the Image in the Distinct Base, be either nigher to, or farther from the Glass, than its due distance, the Representation thereon is confused; For then the Radious Pencils do not exactly determine with their Apices on the Paper; But those from one Point are mixt and confused with those from the Adjacent Points: so in [Page 104](#) the Case of Plain Vision, 'tis requisite that the Pencils should exactly determine their Apices at d, e, f, on the Retina, or else Vision is not Distinct.

'Tis therefore contrived by the Most Wise and Omnipotent Framer of the Eye, That it should have a Power of adapting it self in some Measure to Nigh and Distant Objects. For they require different Conformations of the Eye; Because the Rays proceeding from the Luminous Points of Nigh Objects do more Diverge, than those from more Remote Objects.

But whether this variety of Conformation consist in the Crystallines approaching nigher to, or removing farther from the Retina; Or in the Crystallines assuming a different Convexity, sometimes greater, sometimes less, according as is requisite, I leave to the scrutiny of others, and particularly of the curious Anatomist.

[Prop. XXXI](#): Concerning the Apparent Place of Objects seen through Convex-glasses.

Prop. XXXI/ Sec-1: In Plain Vision the Estimate we make of the Distance. of Objects (especially when so far removed, that the Interval between our two Eyes, bears no sensible Proportion thereto; or when look'd upon with one Eye only) is rather the Act of our Judgment, than of Sense; and acquired by Exercise and a Faculty of comparing, rather than Natural. For Distance of it self, is not to be perceived; for 'tis a Line (or a Length) presented to our Eye with its End towards us, which must therefore be only a Point, and that is Invisible. Wherefore Distance is chiefly perceived by means of Interjacent Bodies, as by the Earth, Mountains, Hills, Fields, Trees, Houses, &c. Or by the Estimate we make of the Comparative Magnitude of Bodies, or of their Faint Colours, &c. These I say are the Chief Means of apprehending the Distance of Objects, that are considerably Remote. But as to nigh Objects, to whose Distance the Interval of the Eyes bears a sensible Proportion, their Distance is perceived by the turn of the Eyes, or by the Angle of the Optick Axes. (*Gregorii Opt. Promot.* Prop. XXVIII.) This was the Opinion of the Antients, Alhazen, Vitellio, &c. And tho the Ingenious Jesuit Tacquet (*Opt. Lib. I.*

Prop. II.) disapprove thereof, and Objects against it a New Notion of Gassendus (of a Man's seeing only with one Eye at a Time one and the same Object) yet this Notion of Gassendus being absolutely False (as I could Demonstrate, were it not beside my Present Purpose, but I refer to the 7th Chap. of the 2d Part.) it makes nothing against this Opinion.

Porterfield, William. 1759. *A Treatise on the Eye, the Manner and Phænomena of Vision*. Edinburgh: G. Hamilton and J. Balfour [1759].

Bk.5 §3, p.388: The *second* most universal, and frequently the most sure Mean we have for judging of the Distance of Objects, is the Angle made by the optic Axes at that Part of the Object on which our Eyes are fixed: For our two Eyes are like two different Stations in Longimetry, by the Assistance of which Distances are taken, as hath been already explained at some Length.

Berkeley, George. 1709. *An Essay Towards a New Theory of Vision*. Dublin: Aaron Rhames for Jeremy Pepyat. From the 1732 edition republished by *Classics in the History of Psychology*, <https://psychclassics.yorku.ca/Berkeley/vision.htm>

12. But those lines and angles, by means whereof some men pretend to explain the perception of distance, are themselves not at all perceived, nor are they in truth ever thought of by those unskilful in optics. I appeal to anyone's experience whether upon sight of an object he computes its distance by the bigness of the angle made by the meeting of the two optic axes? Or whether he ever thinks of the greater or lesser divergency of the rays, which arrive from any point to his pupil? Everyone is himself the best judge of what he perceives, and what not. in vain shall any man tell me various ideas of distance, so long as I myself am conscious of no such thing.

13. Since, therefore, those angles and lines are not themselves perceived by sight, it follows from sect. 10 that the mind doth not by them judge of the distance of objects.

14. The truth of this assertion will be yet farther evident to anyone that considers those lines and angles have no real existence in nature, being only an hypothesis framed by the mathematicians, and by them introduced into optics, that they might treat of that science in a geometrical way.

...[In the next passage, Berkeley's wording is somewhat confusing, so I have added clarification in square brackets]

49. But if we take a close and accurate view of things, it must be acknowledged that we never see and feel one and the same object. That which is seen is one thing, and that which is felt is another. If the visible figure and extension be not the same with the tangible figure and extension, we are not to infer that one and the same thing has divers extensions. The true consequence is that the objects of sight and touch are two distinct

things. It may perhaps require some thought rightly to conceive this distinction. And the difficulty seems not a little increased, because the combination of visible ideas hath constantly the same name [“vision”] as the combination of tangible ideas wherewith it is connected: which doth of necessity arise from the use and end of language.

50. In order therefore to treat accurately and unconfusedly of vision [i.e. perception which unites the visual and tactile], we must bear in mind that there are two sorts of objects apprehended by the eye [i.e. in visual perception], the one primarily and immediately [the retinal image], the other [tactile representations] secondarily and by intervention of the former. Those of the first sort [retinal pictures] neither are, nor appear to be, without the mind, or at any distance off; they may indeed grow greater or smaller, more confused, or more clear, or more faint, but they do not, cannot approach or recede from us. Whenever we say an object is at a distance, whenever we say it draws near, or goes farther off, we must always mean it of the latter sort [tactile], which properly belong to the touch, and are not so truly perceived as suggested by the eye in like manner as thoughts by the ear.

51. No sooner do we hear the words of a familiar language pronounced in our ears, but the ideas corresponding thereto present themselves to our minds: in the very same instant the sound and the meaning enter the understanding: so closely are they united that it is not in our power to keep out the one, except we exclude the other also. We even act in all respects as if we heard the very thoughts themselves. So likewise the secondary objects [tactile representations], or those which are only suggested by sight, do often more strongly affect us, and are more regarded than the proper objects of that sense; along with which they enter into the mind, and with which they have a far more strict connexion, than ideas have with words. Hence it is we find it so difficult to discriminate between the immediate [image on the retina] and mediate [memory of the tactile] objects of sight [perception], and are so prone to attribute to the former what belongs only to the latter. They are, as it were, most closely twisted, blended, and incorporated together. And the prejudice is confirmed and riveted in our thoughts by a long tract of time, by the use of language, and want of reflexion. However, I believe anyone that shall attentively consider what we have already said, and shall say, upon this subject before we have done (especially if he pursue it in his own thoughts) may be able to deliver himself from that prejudice. Sure I am it is worth some attention, to whoever would understand the true nature of vision.

Reid, Thomas. [1764] 1769. *An Inquiry into the Human Mind, on the Principles of Common Sense*. Edinburgh : A. Kincaid & J. Bell.

Chapter VI, 22. Of the signs by which we learn to perceive distance from the eye

309-10: A ship requires a different trim for every variation in the direction and strength of the wind; and—if I may be allowed to borrow that word—the eyes require a different trim for every degree of light and for every variation (within certain limits) in the distance of the object. The eyes are trimmed for a particular object by contracting certain muscles and relaxing others, as the ship is trimmed for a particular wind by pulling some

ropes and slackening others. The sailor learns the trim of his ship, as we learn the trim of our eyes, by experience. Although a ship is the noblest machine that human skill can boast, it is far inferior to the eye in this respect: it requires skill and ingenuity to navigate a ship; and a sailor must know which ropes to pull and which to slacken to make her right for a particular wind; whereas one needs no skill or ingenuity to see by the eye, because such superior wisdom has gone into its structure and workings. Even the part of vision that is acquired by experience is attained by idiots: we don't need to know which muscles to contract and which to relax to make the eye right for a particular distance of the object. But although we aren't conscious of the motions we make in order to make the eyes right for the distance of the object, we are conscious of the effort involved in producing those motions; and they are probably accompanied by some sensation that we don't attend to any more than we do to other sensations