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“眼睛是间暗室”：霍布斯的笛卡尔光学

“The Eye is a Darke Roome”: Hobbes’ Cartesian Optics

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摘　要：“最先为两门科学奠定基础的荣誉应归于我”，霍布斯在1646年如是写道，“一门是光学，另一门是自然正义。”对他来说，光学和政治是同一事业的两面：将人与世界和人与人之间的关系自然化。正是1637年凯内姆·迪格比交给霍布斯的笛卡尔《折光学》为他指明了道路：人的自然化需要视觉的物理化——正如开普勒在其光学中教导的那样——并从自然中剔除所有认知实体，如“可见种相和可理解种相”。1639年至1646年，霍布斯根据“杰出的笛卡尔先生的观点”撰写了三篇关于光学的专业性创新论文，最终在最关键的一点上却与其观点相左。笛卡尔认为要使“物质摆脱[所有]只属于精神存在的描述”，就需要一个精神的、非物质的实体来解释感官的物理效应。然而，霍布斯坚持认为，这样的解释可以且应该被物理地、机械地理解，因为“视觉就是判断本身。”

关键词：霍布斯　笛卡尔　凯内姆·迪格比　托马斯·怀特　沃尔特·华纳　早期现代光学　早期现代认识论　光学暗箱的历史

Abstract: I shall deserve the Reputation of having beene ye first to lay the grounds of two Sciences,” wrote Thomas Hobbes in 1646, “this of Optiques and yt other of natural Justice.” For him, optics and politics were two prongs of the same effort: to naturalize humans’ relations to their world and to each other. It was Descartes’ *Dioptrique*, handed to him by Kenelm Digby in 1637, that cleared for him the path: naturalizing humans required physicalizing vision – as Kepler taught in his own optics – and removing from nature of all cognitive entities such

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as “species visible and intelligible.” Between 1639 and 1646 Hobbes produced three professional, innovative treatises on optics founded upon “the opinion of the excellent Monsieur Des Cartes” but, finally, diverging from it in the most crucial point. For Descartes, ridding “Matter [of all] such Descriptions … as belong but to Spiritual Beings” required a spiritual, non-material entity to interpret the physical effects of the senses. Hobbes, however, insisted that the interpretation can and should be understood physically and mechanically, for “Vision is the judgement itself.

Key Words: Thomas Hobbes; René Descartes; Kenelm Digby; Thomas White; Walter Warner; Optics, early modern; Epistemology, Early modern; Camera Obscura, History

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I. “YE FIRST TO LAY THE GROUNDS OF TWO SCIENCES” – HOBBES’ DISCOVERY OF CARTESIAN OPTICS

1. “Renatus Des Cartes … His Booke of Dioptrikes” – Hobbes in Paris

“I shall deserve the Reputation of having beene ye first to lay the grounds of two Sciences,” Hobbes (1588-1679) would write in 1646, “this of Optiques ye most curious, and yt other of natural Justice.” [1] He did gain much reputation for the “science of natural justice” – his political philosophy, but for him, optics was as important. This paper is a study of Hobbes’ optics and its role in formulating his overall project: to merge, as his title has it, *The Elements of Law Natural and Politic*.

The story has a surprisingly clear starting point. Through most of 1636, Hobbes and his pupil William Cavendish (1617-1684)① stayed in Paris, concluding a grand tour through Europe (Hobbes’ third). The tour as a whole served to familiarize Hobbes with the new continental trends in natural philosophy and and was highlighted by a visit to Galileo in Florence. The Paris segment was an opportunity to make the acquaintance of a contingent of English *savants* who, for reasons of religious and political affiliations, spent the years of English turmoil (1640s-1650s) in and around the city and were respected and valued, if somewhat peripheral, members of the Mersenne Circle. Prominent amongst them was “the Noble Sir K. Digby” (1603-1665), whom his contemporaries saw, alongside “the Illustrious Des-Cartes” as the “two Grand Sages, then whom it may be the Sun never saw a more learned pair,” ②[2] and it is through Digby that Hobbes was introduced to Descartes’ new optics.

Digby and Hobbes were discussing issues of language and meaning, as documented in their earliest extant correspondence, from January the following year, where Digby related a trip he took to the convent at Loudun to visit its famously possessed nuns ③. [3, 4] He asked Hobbes whether his (Hobbes’) “work vpon

①Later to become the third earl of Devonshire, and not to be confused with his father William (1590-1628), the second earl of Devonshire, whom Hobbes accompanied in that earlier grand tour; his grandfather William (1552-1626), the first earl of Devonshire, who originally hired Hobbes as a tutor to his son; or their relative William (1593-1674), the first duke of Newcastle and later the husband of the great Margaret, and the patron of the scholarly circle described below. On the way Hobbes’ work was framed by the patronage of the Cavendish family see Sarasohn, “Thomas Hobbes and the Duke of Newcastle.”

②On Digby’s life see Petterson, *Sir Kenelm Digby*; Moshenska, *A Stain in the Blood*. For an overview of his natural philosophical interests see Dobbs, “Studies in the Natural Philosophy of Sir Kenelm Digby,” (Part I, Part II and Part II); Foster “Sir Kenelm Digby” (I and II). For his religious wavering see Moshenska, *A Stain in the Blood*, chapter 9; Janacek, “Catholic Natural Philosophy,” 91. On White’s life see Southgate, *Covetous of Truth*; Southgate, “White [alias Blacklo].” On the relations between science and Catholicism in the scientific revolution see Ashworth.

③The literature concerning the Loudun affair itself is vast; about the discourse that developed around it and its significance see Popkin, *History of Scepticism*, 184; Clark, *Vanities*, 142-3; *Thinking with Demons*, 174-5 (in which it is related to Descartes’ *mauvais génie*), 275; Stephens Demon Lovers, 5.On Hobbes-Digby correspondence concerning Loudun cf. Martinich, *Hobbes*, 9 Martinich, *Hobbes*: *A Biography*, 93-4. On the Loudun possession as a text see Clark, *Thinking with Demons*, 402.

the generall notions and apprehensions"(3, 42-3) could help explain his (Digby's) failure to communicate with the nuns. Digby was thus an early audience to Hobbes' intellectual turn: from primarily humanistic interests – a translation of Euripides; an essay on Tacitus; a treatise on rhetoric – Hobbes, already in his forties, was diverting his attention to an active attempt to apply the New Science to the study of "notions and apprehension." He was delving into a physical, naturalistic study of meaningful human engagement with their world and with each other.

It was in this contest that Digby "putt Monsieur des Cartes (whom Mydorge so much admireth) his book into [Hobbes'] hands." (3, 51)

The book was the three essays Descartes salvaged from the aborted *Le Monde* – , *Les Meteors* and *La Géométrie* – prefaced by *Discours de la Méthode*, and Hobbes mastered "Renatus Des Cartes … his booke of Dioptrikes" [5] so well, apparently almost all on his own①, that within two years he could write his own sophisticated, professional optical treatise, followed by two more in quick succession.

2. "Nothing other than light"– Descartes' Physicalized Optics

What Hobbes found in the *Dioptrique* was Descartes' elaboration of Johannes Kepler's (1571-1630) revolutionary optics②: [6] an analysis of vision as a purely physical process, in which the eye and "the inventions which serve to augment its power" are, in essence, one and the same. A full account of the novelty of this approach is beyond the scope of this paper, [7-9] but Descartes, who called Kepler "mon premier maître en optique," [10]was completely aware of it. He starts his First Discourse with the telescope and then turns to the *camera obscura* – Kepler's model of the eye – "a chamber … completely closed except for a single hole." He then invites his reader to view objects through "the eye of a dead animal" (Fig. 1), promising that having done that, one "cannot doubt that an entirely similar [image] is formed in the eye of a live man." [11]

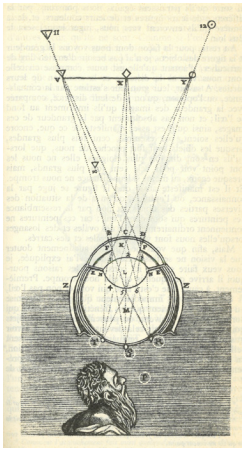

Fig. 1

In this optics, the eye is a *camera obscura*, because the agent of vision is *light*. There "is nothing other than light" passing from the object to the eye, especially not "all those small images flitting through the air, called *intentional species*, which worry the imagination of philosophers." (11, Discourse I, 68) There are no essentially cognitive relations between eye and object; there are no 'species', 'visual rays' or 'visible forms' travelling from object through the eye, informing the mind. This was "The demonstration … that great witt Renatus Des Cartes hath excellently sett downe in his booke of Dioptrikes" (5, 106) that most impressed his contemporaries. Digby hailed "Monsieur des Cartes [and] his great and heroyke attempts," (5, 275) in condemning the "schools" for their reliance on "hidden and inexplicable qualitis." (5, Preface) Descartes, he writes, was "the first … who hath published any conceptions of this nature, whereby to make the operations of sense intelligible," and he "agree[s] with him, as to allow motion alone to be sufficient to work sensation in vs." (5, 276)

Thomas White (1593-1676) – another Paris Englishman and a close personal and intellectual ally of Digby – would suggest some years later a mechanical theory of perception, akin to "that most acute Person, Renatus des Cartes," [12] in which "*Hearing* and *Sight* require a situation near the Brain … where Motion and Light may come to them more pure" and ridicule

①He used to complain that his Oxford education was almost exclusively Aristotelian (ODNB 27, 386), and there is no record of him taking any formal mathematical studies beyond the astronomy of his university curriculum.

②For background see Prins, "Kepler, Hobbes, and Medieval optics"; Giudice, "Optics in Hobbes's Natural Philosophy"; Giudice, "The Most Curious of Sciences."

the fact that “the Senses are believ’d to consist in a kind of *Spirituality* and *abstraction* from matter.” ①[13] Even those who disagreed understood and respected the move to eschew ‘species’ for physical accounts of perception. Walter Charleton (1619-1707), for example, rejected “the opinion of the excellent Monsieur Des Cartes ... especially such as affect the accommodation of Mechanick Maxims to the sensible operations of Nature.” [14] He called it the “pleasant violence [that] hath so ravisht the assent of most of the Students of Physiology, in the praesent Age.” But he understood full well the core of Descartes’ optics: “for Sensation in Common,” he explained, “He [Descartes] conceives it to be made, not by the mediation of Images, but of certain Motions,” (14, 151) and commended “the sage Digby” because “no other opinion [but Digby’s] could have been consistent to [Descartes’] Cardinal Scope of Solving all the Operations of Sense by Mechanick Principles.” (14, 152)

The great achievement that Descartes inherited from Kepler’s optics, developed and presented to his contemporaries, then, is “the accommodation of Mechanick Maxims” to the operations of the senses and expunging material nature of all cognitive, “spiritual” elements like species. The objects and the eye, in this optics, were passive termini in the causal process by which images are produced, and light itself was nothing but “a certain movement or action, very rapid and very lively, which passes toward our eye through the medium of the air and other transparent bodies.” (11, Discourse I, 67) Descartes’ first two Discourses in the *Dioptrique* are thus a mechanical analysis of light and refraction, and the Third is a short anatomical analysis of the eye as an optical instrument. In this account, “the crystalline humour,” for example, “causes almost the same refraction as glass or crystal.” (11, Discourse V, 84) Analyses like fig. 2 explain the perception of distance and diagrams like fig. 3 provide the precise empirical implications of understanding refraction and reflection along the lines of the “movement of a ball or of a rock thrown in the air is deflected by those bodies it encounters.” (11, Discourse I, 70) The core of the treatise, however – the Fourth Discourse “Of the Senses in General” and the Sixth Discourse “Of Vision” – remains a promissory note. Descartes does not have a developed answer to the query left by Kepler – how the image on the retina becomes visual *knowledge* – “how the mind, located in the brain, … receive[s] impressions of external objects through the mediation of the nerves.” (11, Discourse IV, 87)

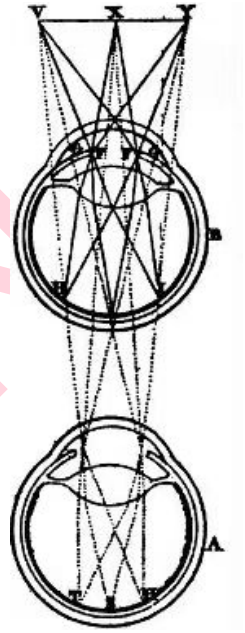

Fig. 2

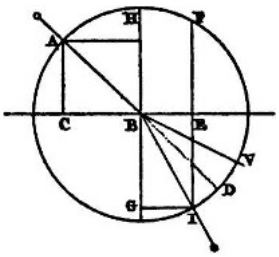

Fig. 3

It is clear to Descartes that it is a process of physical “mediation” and that the material makeup of the nerves is the key to understanding it: they are comprised of

> membranes … originating in those that enclose the brain [which] are like little tubes divided in many branches … spreading …

①Liber II, Lectio XVIII in White’s original Latin Instituionum has two Section 6, which the English translator corrected.

> throughout the members [like the] veins and the arteries … in each of these small tubes [are] many … separate little fibers independent of each other; and finally the animal spirits, which are like a very subtle wind or air which, coming from the chambers or concavities in the brain, flows away by these same tubes throughout the muscles. (11, Discourse IV, 87-8)

This three-partite structure – external tubes, threads, spirits – allows Descartes to explain how the same nerves deliver sensations to the brain and motions from it. The spirits operate pneumatically, "expanding [the different muscles] more or less … according to the various ways that the brain distributes them." The spirits also serve to keep the "tubes … always inflated and held open" so that the internal fibers can freely vibrate like "a very taut cord." In the case of the eye (Fig. 4), the optical nerve delivers the motions from the points on the retina where light fell – "light being nothing but a movement or an action" – and maps them on the appropriate segments of the brain. The coordination of these motions into a coherent image is done in "a certain small gland which is found about the center of these concavities" – the pineal gland which perform, mechanically, the task of the old "common sense." (11, Discourse V, 100)

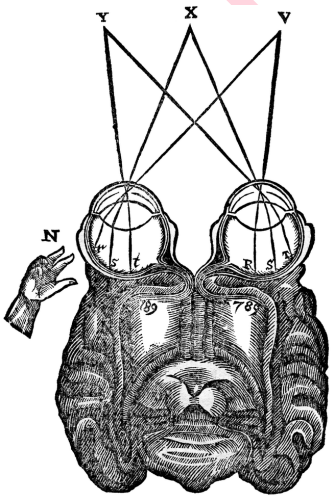

Fig. 4

What Hobbes finds in the *Dioptrique's* analysis of the motion of light and the creation of images is thus an ambitious exercise in physicalizing perception and naturalizing the place of humans in their world. He also finds where Descartes, at this rather early period, drew its limits of naturalization. The image, in Descartes' optics, has to pass "through the mediation of the brain," because, crucially, "it is the mind which senses, not the eye." (11, Discourse VI, 108, and similarly in Discourse VI, 87) Even the simplest tasks of observation, like determining "the apparent size of objects" (11, Discourse VI, 111) or "the location of [a] point" (11, Discourse VI, 106) require "judging." The eye is only a receptacle of the effects of a causal process, not its interpreter, and interpretation is necessary for the image to become knowledge; the causal effect does not declare its meaning and needs to be deciphered. Descartes' physicalized, materialized perception requires an immaterial interpreter – the soul.

II. "ACTIONS OF EXTERNALL THINGS UPON THE ANIMAL SPIRITS" – NATURALIZING HUMANS AT THE CAVENDISH CIRCLE

1. "Understanding is a Motion … by the Action of the Brayne" – the Short Tract

Exactly 40 years later, almost ninety years of age, Hobbes would recall his introduction to natural philosophy along these very lines:

> [in 1631-4] in Paris … was the stage of his life that Hobbes [he is writing in the third person] began to study the natural sciences. When he realised that science depends entirely on the nature and variety of movement, he began to concentrate primarily of what motion lies behind the operation of our senses, intellect, dreams and other qualities of animal[①]. [15]

①Anno Christi 1631 revocatus est in familiam comitissae Devoniae ut filium suum comitem Devoniae, natum annos 13, in literis instrueret; quern etiam circiter tnennium post comitatus est in Galliam et Italiam, studiorum ejus et itinerum rector. Dum moraretur Parisiis, principia scientiae naturalis investigare coepit. Quae cum in natura et varietate motuum contineri sciret, quaesivit inprimis qualis motus is esse posset qui efficit sensionem, intellectum, phantasmata, aliasque proprietates animalium, cogitatis suis cum reverendo patre Marino Mersenno, ordinis Minimorum, in omni genere philosophiae versatissimo viroque optimo, quotidie communicatis. (Aubry, *Brief Lives*, 397).

The great challenge facing contemporary natural philosophy – which in the 1630s, for Hobbes, was *ipso facto* mechanical philosophy – was its application to the world of meaning: “our senses, intellect, dreams.”

Hobbes was not alone in this pursuit. The intellectual context in which his curiosity was directed in this way is quite well documented in a manuscript discovered by Ferdinand Tönnies in the late 19th century and published by him as *Short Tract on First Principles* ① . Found among Hobbes’ papers and in a hand that appeared his, Tøennies assumed that it was Hobbes’, but after a century of debate Timothy Raylor and Noel Malcolm demonstrated that the *Short Tract* was authored, rather, by Robert Payne in 1636, the year of Hobbes’ and Digby’s correspondence② . [16, 17]

Payne was the Cavendish family’s chaplain at their residence at the Welbeck Abbey and Hobbes’ mentor in mathematics.(17, 92-3) Welbeck (together with Bolsover) was the main meeting place for ‘The Cavendish Circle’ – a group of scholars patronaged by William Cavendish (Hobbes’ employer’s cousin) and curated to a large degree by his brother Charles (1594-1654), whose understanding of the new natural philosophy was more sophisticated. [18] The most renowned of the circle was the poet and playwright Ben Jonson (1592-1637), who was Hobbes’ acquaintance from the late 1620, and Walter Warner (1563-1643), to whom we will return shortly, was its expert on theoretical and experimental optics.

Raylor and Malcolm show that the *Short Tract* is a rather strained attempt to synthesize the different beliefs circulating in the Cavendish Circle, which undoubtedly included some of Hobbes’ views. It is written in a quasi-Euclidean form that, Raylor shows, Payne adopted from texts by Galileo and Castelli he was translating (16, 32-3) – three parts, each beginning with numbered “Principles” followed by “Conclusions” and “Corollaries.” The enforced orderliness, however, hardly hides the sometimes rather sharp inconsistencies, e.g., between expressions like “it appears that colour is Light diversified by the species of diverse bodyes” in Section Two, [19] whereas in Section Three “Light, Colour, Heat, and other proper obiects of sense … are nothing but the severall Actions of Externall things upon the Animal Spirits, by severall Organs” (19, 3.3, 206)

Yet if the answers are inconsistent, the questions are not. The *Short Tract* reveals that the Cavendish Circle was primarily engaged in the same project that Hobbes finds at his other – Paris – milieu – the submission of humans to natural philosophy, a bold attempt to relate and physicalize “sense and motion,” (19, 3.1, 204) and the tracts’ inconsistencies reflect the inherent difficulties of this project. For Payne (and the Welbeck thinkers he apparently represents) ‘modern’ natural philosophy means the philosophy of matter in motion, and they particularly stress motion. As this stress follows Hobbes’s interpretation of the mechanical philosophy, [20] it suggests that his views are represented in the *Short Tract*. Accordingly, the challenge set in the *Short Tract* is to directly relate the motion of objects to the meaningful motion of subjects; to account for animal and human behavior in terms motions, all the way to the soul itself, with which the tract concludes:

> There are but two discerning facultyes, in generall, of the Soul; sense and understanding. The Animal Spirits are not moved but by the Species, or by the brayne qualifyed; The former of those motions is the Act of Sense … the later, the Act of understanding. (19, Conc. 10, 210)

Turning the two “Facultyes … of the soul” into kinds of motion was a radical move – the *Short*

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①Tøennies added it as Appendix I to his edition of Hobbes’ *Elements of Law* (193-210), and that is the text consulted here, ascribing it to Robert Payne for the reasons explained below.

②Raylor provides a comprehensive account of the debate about the authorship and Malcolm adds an account of the relations between Hobbes and Payne and their place in the Cavendish circle. See also Shapiro, “Kinematic Optics,” 164 (FN 94) for the questions of dating authorship. Concerning the way Hobbes’ work was framed by the patronage of the Cavendish family see Sarasohn, “Thomas Hobbes and the Duke of Newcastle.”

Tract claims that "sense is a motion" (19, Conc. 5, 208) and "Understanding is a Motion … by the Action of the brayne" (19, Conc. 6, 208) – it will take another fifteen years before White would discuss knowledge and memory in terms of "stroaks" applied by light and transformed in the brain. (13, Bk. II, L. XX 104)

But with the reference to "Species" this concluding paragraph also marks the limits of the Welbeck version of the naturalization project: Payne and his interlocutors remain loyal the fundamental assumption that perception is an authentic relation between the world and the perceiving organ. In traditional optics, "all those small images flitting through the air, called *intentional species*," that Descartes and his disciples would ridicule, explained and warranted our ability to conceive things from afar: *species* were replications, *re-presentations* of the objects from which they originate, meaningful entities that *in-formed* the mind of these objects. This is exactly the way Payne understands them:

> Every Agent that worketh on a distant Patient, totcheth it, eyther by the Medium, or by somewhat issueing from it self, which thing so issueing lett be call'd Species. (19, 2.1, 197)

"Agents send out their species continually" (19, 2.5, 199) and the species retain their original form to represent the agents at a distance:

> Hence it appears that colour is Light diversified by the species of diverse bodyes; which Species, as the bodyes from which they come, are different. (19, 2.7 (Corollary), 200)

With all their effort to apply the mechanistic principles to understanding humans, then, Payne and his discussants in the Cavendish Circle still take for granted that perception is a fundamentally cognitive relation. In the words of Boyle, Payne could not help endowing "Matter [with] such Descriptions to, as belong but to Spiritual Beings." ①21

The need to resort to this "corporeal occult quality," (5, Preface) as Digby would term species and its cognates, in order to explain action at a distance in general and perception in particular, does not imply that Payne was relinquishing the project of physicalizing perception. In fact, he tried hard to give the concept of species a mechanical interpretation, claiming that "the Act of Sense is Motion of the Animal Spirits, by the Species of the externall object" (19, Conc. 5, (italics added)) and "Species are moved locally." (19, 2.8, 200) He makes a point to stress that "Species move not in an Instant," (19, 2.8, 201) and attempts a materialist answer, adopted from Lucretius②, 22–24 to the question "If bodyes continually send out so many substantiall species, how can they subsist without supply?"

> as Fyery bodyes, which send out most Species, are manifestly and sensiblely supplyed with fuell: so other bodyes, sending out fewer, may have a supply of Nutriment, by converting other bodyes or Species adjacent, into themselves. (19, 2.8, 201)

The concept of species is an efficient one. It allows Payne to speculate about causes of various phenomena of action at a distance, such as magnetism:

> There is betweene Species Conveniency, and disconveniency, by which the Agents whence they issue, attrude and repell one the other … Hence Loadestone attracts Steale. For the Species of the Loadestone meeting with the Species of the Steale in the medium, do so fortify their motion by Conveniency with them. (19, 2.9, 202-3)

But what gives species the required explanatory power, what makes them account for *individuated* action at a distance, is exactly the teleological and cognitive assumptions built into the concept and the mechanistic philosophy eliminated from natural philosophy. "Species of diverse bodyes" can inform the subject of "the bodyes from which they come,"

①*Works*, Vol. 6: 167.

②The literature on Lucretius and its place in early modern science and philosophy is vast. Among recent contributions, c.f., Johnson and Wilson, "Lucretius and the History of Science" in: Gillespie and Hardie (eds), *Cambridge Companion to Lucretius*, 131-148; Ford, "Lucretius in Early Modern France", in: Gillespie and Hardie, 227-241; For its place in the circle of Mersenne and Gassendi c.f. Darmon, *Philosophie Épicurienne*; Fisher, Pierre Gassendi's Philosophy and Science.

because they are replications of the object, essentially suitable for the mind to conceive: they are “*Visible species*.” (19, 2.6-7, 200)

2. “Visio Refracta” – Walter Warner’s Optics

“Visible species” signals the exact point where the Cavendish Circle’s version of the project of naturalizing human and physicalizing perception reaches its limits. These bounds are set by the excruciating difficulty to do away with the instinctive, rarely explicated assumption that perception is an essentially teleological and cognitive process, in which object and mind are genuinely related to each other through the sense organ. The clearest expression of this conundrum is to be found, tellingly, in the most technical and professional product of the group: the optics of Walter Warner, their acknowledged optical expert①. (3, 29; 34)

Mersenne – according to Hobbes, with his encouragement②, [25, 26] – gave Warner an opportunity to demonstrate this expertise, publishing his *Problema ad Tabvlas Refractionvm, as Opticae Liber Sextus* of his (Mersenne’s) *Universae Geometriae* of 1644, in which Hobbes’ optics is *Liber Septimus*③. [27] Warner responded with an impressive mathematical analysis of empirical observations of refraction. Mathematically and empirically, Warner’s treatise is indeed state-of-the-art, and it concludes with the greatest achievement of contemporary mathematical-experimental optics, the sine law: “in refracted vision, the sines of the angles of incidence are proportional to the sines of the corresponding angles of refraction” (Fig. 5)④. [27] Absent, however, is the fundamental insight of the new optics: Warner’s is law of vision, not of light.

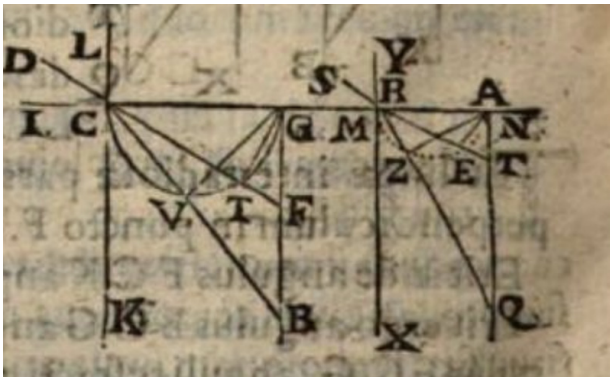


Fig. 5

As well versed as Warner was in the technical side of current optics, then, he was oblivious to the metaphysical and epistemological turn taken by Kepler and adopted by Descartes, and remained loyal to the teleology of traditional optics. Refraction, the basic optical process, is predicated for him on the relation between the eye and the object, which he makes clear with his very first definition: “vision engaging [adminiculo] one eye will be called *singular*; both eyes – *united*.”⑤ [27] Warner’s treatise is about *visio refracta* and *visio recta*, and light is never mentioned.

This is the reason for the excitement that Hobbes expresses about Descartes’ optics throughout his own optical tracts. “Renatus Des Cartes … his booke of Dioptrikes,” that he received from Digby, liberated him from “oculus imaginarium,” (27, 550) “*visio refracta*,” and “*Visible species*.” It presented him with a clear path forward for the project of naturalizing humans. This is the project he first encountered at Welbeck with Pine, Warner and Charles Cavendish, but the version of the project Hobbes found in Paris of the late 1630s with Digby, White, and Mersenne, was bolstered by Kepler and Descartes’ light optics, and Hobbes recognizes the change and immediately

①Hobbes discusses him, e.g. in a letter to William Cavendish on 15/25 August 1635 and again in 29 August/ 9 September, where he writes: “For the optiques I know Mr Warner and Mr Mydorge are as able men as any in Europe” (Hobbes, Correspondence I, 29; 34)

②Hobbes had to answer an accusation that he plagiarized Warner, and answered: “I never had sight of any of Mr. Warn. papers in all my life but that of Vision by Refraction (which by his approbation I carryed with me to Paris, and caused it to be printed under his own name, at the end of Mersennus his *Cogitata Physico-Mathematica*, which you may have there seen).” Hobbes, *Six Lessons*, 59. See also Prins, “Ward’s Polemic with Hobbes.”

③Mersenne’s ascription, on p. 548, reads as follows: “Dum illum amici singularis tractatum expetabis, accipe duos alios tractatus eruditissimos Clarissimorum Anglorum, primum nempe Gualteri Vverneri; secundum viri nobilis, subtiliffimique Philofophi D. Hobs.”

④Warner, *Opticae Liber Sextus*, Theorema VIII, 564: “in visione refracta, sinus angulorum incidentiæ, sinibus angulorum refractorum incidciitiis respondentium proportionales sunt.”

⑤Warner, *Opticae Liber Sextus*, Def. I, 549: “visio, quae vnius oculi adminiculo sit, singularis, quae vtriusque, coniugata, vocetur.”

embraces it. His own *Opticae Liber Septimus* in Mersenne's collection, celebrates the Keplerian-Cartesian insight by beginning, after explaining that action and passion are different aspects of local motion, with "vision is the passion produced in the seer by the action of a luminous or illuminated object."① [28]

III. "WHAT MOTION LIES BEHIND THE OPERATION OF OUR SENSES" – HOBBES' OPTICS

This, then, is what Hobbes would recollect in his autobiography, all these decades later. It is the moment of apprehension that the road to naturalization of humans leads through the new, physicalized optics; through understanding "what motion lies behind the operation of our senses." Befitting his excitement, he put this idea into immediate practice, producing his own *Tractatus Opticus* in 1639 ② , [29](1, MS 6796 ff. 193-266) followed in 1640 by the more formal treatise that was published in 1644 as the "Liber Septimus Opticae," ③ [30] and in 1646 he penned *A Minute and First Draught of the Optiques*.(1, MS 3360, 1-193) All three are mostly mathematical and technical, but from his first *Tractatus Opticus* and then throughout his optical work, Hobbes makes a point to stress the great new insight, "the hypothesis proposed by Descartes in the first book of [his] Dioptrics," that

> Those imaginary incorporeal flying entities of the Aristotelians which they call visible species are nothing but words ④ . (29, par. 10 (151))

1. "The Eye is a Darke Roome" – The Optical Tracts

Hobbes' optical thoughts receive their mature and final form in the *Minute Draught* ⑤ . [31] Though scribed in a beautiful hand and dedicated to "the right honourable the Marquise of Newcastle" (Cavendish), the Minute Draft was never published (Part II of the text, translated to Latin and modified, was incorporated into de Homine) ⑥ . [32, 33] It is unclear why, since it contains some truly original

①Hobbes *Opticae Liber Septimus*, Hyp. 2, in Mersenne, *Universae Geometriae*, 567: "Vifio est passio producta in vidente per actioncm obiecti lucidi vel illuminati."

②Harley MS 6796 ff. 193-266 and *Thomas Hobbes: Tractatus Opticus*, Franco Alessio (ed.) in: *Rivista Critica di Storia della Filosofia* 18.2 (1963): 147-228. The treatise is also known as Hobbes' *Latin Optical Manuscript* and often referred to in the literature as *Tractatus Opticus II* because his what is known as *Tractatus Opticus I*, written apparently in 1640-1, was published earlier, as "liber septimus: Opticae" in Mersenne's 1644 *Universae geometriae* (see below).

③On page 548 Mersenne credits the treatise to the "fecundum viri nobilis subtilisimique Philofophi D. Hobs" (the first is Walter Warner who wrote Book Six).

④*Thomas Hobbes: Tractatus Opticus*, par. 10 (151): "consideremus hyposthesim quam Cartesio propositam, tractatu primo Dioptricorum de volucribus quibusdam imaginibus incorporeis quas appellant species visibiles nihil nisi verba."

⑤On Hobbes' optics as example of his methodological conviction see Giudice, Franco, "Optics in Hobbes's Natural Philosophy," *Hobbes Studies* 29 (2016): 86-102. For the Role of Hobbes and in particular the *Opticae* in the development of Mersenne's optics see Cozzoli, Daniele, "The Development of Mersenne's Optics," *Perspectives on Science* 18 (2010): 9-25, and Dear, Peter, *Mersenne and the Learning of the Schools*, Ithaca: Cornell University Press (1988), esp. 206-8. On his theory of light and its relations to Descartes' see: Shapiro, Alan E., "Kinematic Optics: A Study of the Wave Theory of Light in the Seventeenth Century," *Archive for the History of Exact Sciences* 11 (1973), esp. 143-171. Shapiro's analysis is very comprehensive and technically accurate, but it is forward-looking, searching for an idea of wave front to satisfy Shapiro's criterion for "a proper wave theory" of light (p. 160) and pays little attention to the change wrought on optics and its general implications by Kepler designating light as the agent of vision. The most detailed and accurate account of Hobbes' optics and its relations to his moral and political theory is provided by Malet in "The Power of Images." Malet's technical analysis of Hobbes' optical treatises, especially the "Minute Draft," is impeccable, and he covers in much more details than we did issues like Hobbes' account of the perception of distance. But like most interpreters, Malet takes Hobbes' science and in general and his optics in particular as an instantiation of pre-conceived philosophical beliefs and methods, rather than a source of philosophical worries and dilemmas. The *camera obscura*, crucial to our analysis, is not mentioned by him.

⑥One can find segments on optics in quite a few of Hobbes' works: *The Elements of Law Natural and Politic, Ferdinand Tönnies* (ed.), London: Simpkin and Marshall (1889), chap. I; *Critique du De Mundo de Thomas White*, Jean Jacquot and Harold W. Jones (eds.), Paris: Vrin (1973), chap. ix; *Leviathan*, Noel Malcolm (ed.), Oxford: *The Clarendon Edition of the Works of Thomas Hobbes*, (3 vols, 2012), vol. 2, chap. I; *De corpore*, in: William Molesworth (ed.), *Thomae Hobbes Malmesburiensis Opera Philosophica* I (5 vols., London: John Bohn, 1839–1845): chaps xxiv and xxvii.

analyses, including Hobbes’ clearest and most explicit formulation (in English) of the fundamental insight – “the true principle of this doctrine” that “Mons. des Cartes… hath sett forthe,”

namely that the Images of objects are in the Fancie and that they fly not through the aire, under the empty name of Species intentionales but are made in the braine by the operation of the objects themselves. (1, MS 3360 ff74r-v)

Even more exciting, the *Minute Draught* comprises the most concise and accurate summary of Kepler’s fundamental claim – in a clearer form than Kepler or Descartes had ever provided – the claim on which the project of physicalizing the senses and instrumentalizing the eye was based:

> The eye is a darke roome into which ye light comes at a little hole, which is called ye Apple of ye Eye, onely there is [this] difference, that ye matter of ye Eye consisting of divers humors or liquors, and those of divers figures, causeth ye beames of light which in ye aire, or in any medium of one and ye same matter, would be straign to become crooked and as it were broken, at ye entrance of euery new matter, and therefore the beames are said to bee refracted. (1, f12r)

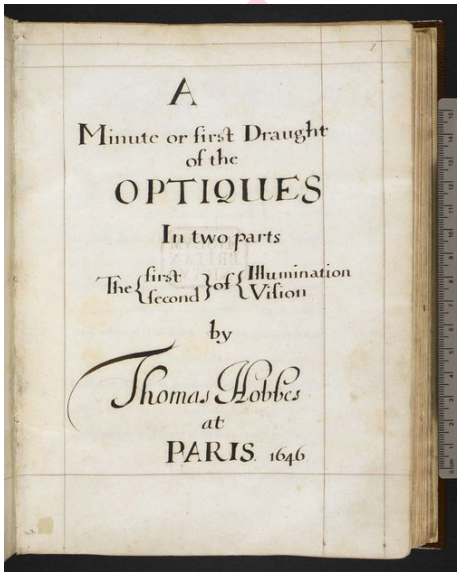


Fig. 6

The eye is “a darke roome” – a *camera obscura* – not just by analogy but in reality, “onely … that ye matter of ye Eye consist[s] of divers humors or liquor.” And in this flesh-and-blood *camera obscura* only “*beames of light*” feature, undergoing a complex process that “straign[s]” them “to become crooked and as it were broken.” There is nothing teleological or essentially veritable in vision. “Species intentionales” is just an “empty name” and “the Images of objects … fly not through the aire” from the objects. They “are in the Fancie.” Images are entities created by the mind from the light arriving through the eye. Vision is an arduous physical process of mediation, an idea that Hobbes knows to attribute to Kepler: “This manner of radiation was at first propounded by Kepler and since generally received, and is ye Very truth.” ① (1, f81r)

The acuity and methodological sophistication of Hobbes’ arguments are truly admirable, especially considering how late in life he taught himself optics and in what short a span. The *Minute Draught* includes technical analyses of core optical phenomena beyond reflection and refraction, captured by the table of contents on Fig. 7. His “Chap. 8th – illumination of an opacous bodie in a dark roome through a hole” provides a good example:

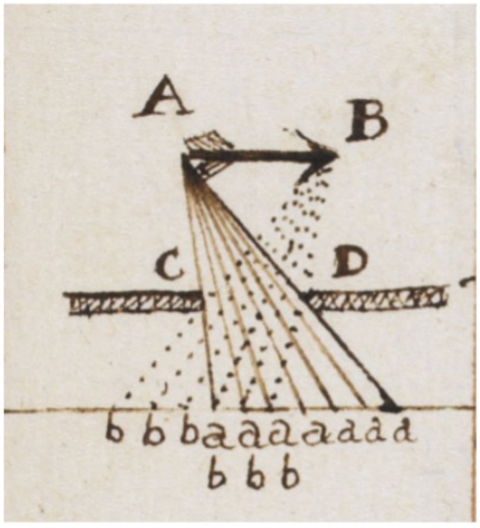


Fig. 7

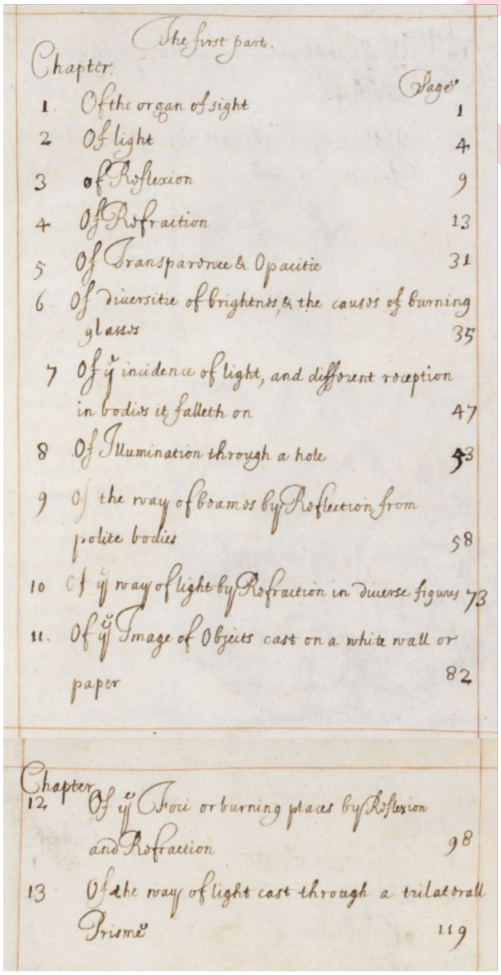
①Hobbes does not mention Kepler in the *Tractatus Opticus* or the *Liber Septimus*, but Mersenne, who wrote the first five books of the *Optica* in his *Universae geometriae*, quotes Kepler’s work quite extensively. On page 506, for example, he writes: “It is established by Kepler that the surface is either refracted of reflected by the perpendicular to the seen object, according to the distance of the object from both eyes” (“A Keplero statuitur in perpendiculari ex re visa insuperficiem sive refringentem, sive repercutientem, quatenus Distantia punctorum *rei visae* per binos oculos”).

If wee suppose a roome bee so close shutt, as there is no admittance of light, but at one hole, and that so little as to give entrance to a small imperceptible beame, the illumination will bee imperceptible, butt if it were possible that at the least hole, the illumination should bee sufficient whatsoever were illuminate without the roome, and opposite to the hole, would bee represented most perfectly within the roome upon a paper or white wall, butt inverted… This would, bee most accurate and mathematically distinct in case the hole were a mathematicall point, Butt because that cannot bee, and because the hole (through which the illumination at least must be sensible) must bee of a considerable greatnesse, there must also bee confusion in such pictures. (1, f32r-v)

This is of course an account of the pinhole image – the phenomenon enabling the *camera obscura* and the basis of Kepler's insight that "the eye is a darke roome." Hobbes is clear about the theoretical and mathematical analysis of the phenomenon (Fig. 8), and also recounts some of its practical aspects, e.g., the trade-off between clarity and illumination:

as there is the more confusion by how much the hole is greater, so also there be more brightnes, and by consequence the whole Object the more visible, though the pieces there of will not bee so distinguished one from another. (1, ff32v-34r)

Other effects, less dramatic and less pertinent to the new, physicalized optics, Hobbes analyses using the tools of traditional mathematical optics, with corresponding geometrical diagrams like Fig. 9. But Hobbes does not limit himself to geometrical analysis and attempts to interprets the diagrams in terms of his own version of Descartes' theory of light – a vibration in the medium caused by the expansion and dilation of the lucid body. Some of the physical interpretations are more compelling than others, but his conviction that they are necessary never wavers:


The first part.

Chapter. Page.

1. Of the organ of sight 1
2. Of light 4
3. of Reflexion 9
4. Of Refraction 13
5. Of Transparence & Opacitie 31
6. Of diversitie of brightenes, & the causes of burning glasses 35
7. Of ye incidence of light, and different reception in bodies it falleth on 47
8. Of Illumination through a hole 53
9. Of the way of beames by Reflection from polite bodies 58
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11. Of ye Image of Objects cast on a white wall or paper 82

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12. Of ye Foci or burning places by Reflexion and Refraction 98
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Fig. 8

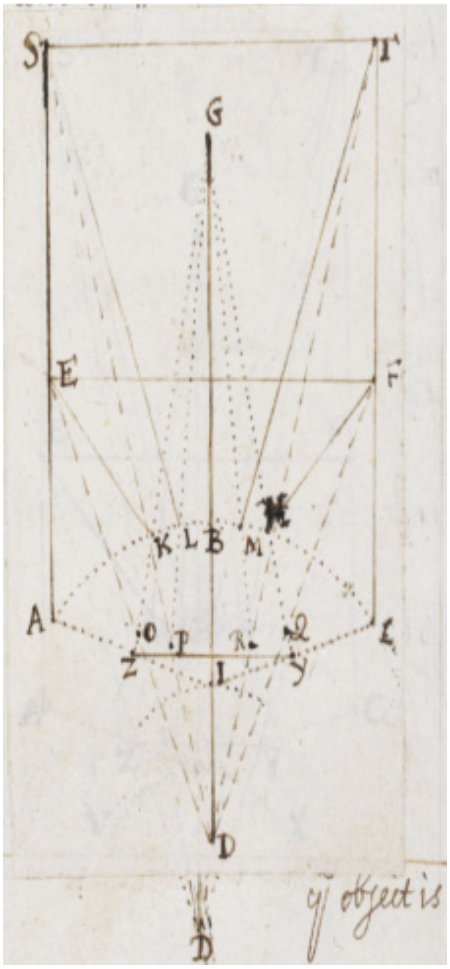

Fig. 9

> Vittelio, who brought to this busines of ye Optiques as much Geometry as could be brought tooke into Consideration nothing att all of ye Causes of vision, … So that though he taught much Geometry in his Optiques, yet he thought not, butt tooke for already known all that is properly called Optiques. But [the] principle [e.g.] that each point of ye object appears in ye perpendicular Drawn from it to ye Glasses is as generally false as hee hath made it generally true. (1, f155v)

Wrong physical accounts of light and vision, or failing to provide any, lead to mistaken mathematical optics. And the most important aspect of these physical accounts is that they substantiate “the true principle” that Hobbes learned from Descartes, namely – that nature does not speak to us:

> To conclude, I shall do like those that build a new house, where an old one stood before that is to say, carry away the rubbish. And first, Away goes the old Opinion, that the shewss (which they call Species) of all objects are in all places, and all the babble de extramitendo & intramittendo, for those species are nothing butt fancie, made by the light proceeding directly or by repercussion or refraction made from the object to ye eye, and so moving the braine and other parts within. (1, f192r)

2. “Vision in generall is yt fancie” – the disappearance of the image.

In a convert’s zeal, Hobbes takes the insight that “species are nothing butt fancie” a step further than Kepler and Descartes, and refuses to treat the image as a physical entity: “[there] is nothing without us really which we call an image or colour” he would stress in the *Elements of Law*. (32, 1.2.4, 4) For Kepler and Descartes, the idea that *the image* had a physical existence independent from the perceiver was a fundamental insight, a necessary step in freeing the new optics from “all the babble de extramitendo & intramittendo.” For Kepler, the image is the subject matter of optics, and he offers a clear idea of what the image, physically, *is*: a “picture [that] consists of as many pairs of cones as there are points in the object. [34] The eye and the mind are only receptors of this physical entity: “Vision is produced,” he explains, just “when the opaque screen of the eye is painted.” ①(6, 41–42) When Descartes discusses “this picture,” that “in being so transmitted into our head, always retains some resemblance to the objects from which it proceeds,” (11, Discourse VI, 101) and when he discusses the difficulty to assign truth or error to a physical clock [35]– it is Kepler’s idea of the image as an independent physical entity that he adopts.

Fig. 10 illustrates that Hobbes has no qualms about the role Kepler assigned to the retina or with Descartes’ analysis of its mechanical function in collecting the rays of light and transporting them to the optic nerve. He has no problem accepting the image as a transient stage of the optical process, but he does not find this stage a particularly interesting point of stress. Quite the opposite: the lingo of “picture … transmitted into our heads” sounds

Fig. 10

①Kepler, *Ad Vittleionem*, 41-42: “Amplectamur ergo veram sententiam … et irrefutabilibus experimentis stabilitam, a Sole scilicet, et a coloribus Sole illustratis, defluere species consimiles, ipsoque fluxu attenuari, donec in medium quacunque ratione opacum incidant, ibique suum fontem depingant: Fierique visionem ..., cum opacus oculi paries hoc modo pingitur, confusum, cum confunduntur ibi picturae variorum colorum, distinctam, cum non confunduntur.

to him dangerously similar to that of "imaginary incorporeal flying entities [that] the Aristotelians … call visible species" and that Descartes taught "are nothing but words. "[①](29, par. 10 (151))

Kepler's naturalization of perception was predicated on turning optics from a theory of vision to a theory of the creation of images by light. Hobbes eagerly accepts almost everything of the ensuing optics, technically and epistemologically, but he is still a humanist: his interest is not in a natural philosophy of light and image, but in a natural philosophy of *humans*. His optics, then, returns to be a theory of vision – even as it becomes a causal, material theory – and it involves a living viewer and a living eye at each phase:

> Vision in generall is yt fancie wch is caused in any living creature by ye action of a lucid or illuminated body upon ye organ of sight (that is to say ye eye) and braine and hearte with ye parts between and one continued substance and by the reaction of ye Organ outward. (1, ff73r)

It is important to stress both sides of Hobbes' version of the project of naturalization: his optics is a theory of vision, and vision needs a viewer, but the viewer has to be submitted to the same matter-in-motion analysis that applies to every aspect of nature and every stage of the optical process:

> Some objects are visible by their owne action only and those are called Lucid objects, such as is ye Sun, or a candle or a gloworme, some …, as ye moone or a wall [are] opaceous bodies, and these are visible only when they are by lucid bodies illuminated. … The Sunne (for example) presseth every way round about upon ye aire, or other medium that toucheth it, which aire must therefore every way recoile, by which it follows that at ye very same time, ye aire which is next again behind … & so by consequence at ye same instant ye Sunne swelleth or presseth; ye aire also which toucheth ye eye preseth upon it, and ye parts thereoff inward presse on upon another to the … Retina, which being of the same substance with ye optique Nerve, and with the braine, ye motion or pressure is continued to ye braine and by communication of arteries to ye heart. … Objects which of their owne nature have not that motion by which is engendered light, become visible by reflection of the motion of lucid bodies. (1, ff7v-9r)

Hobbes is naturalizing humans and physicalizing perception, and – unlike Kepler and Descartes – he does not privilege the retina and the image impressed upon it: "the said image or colour is but an apparition unto us of that motion, agitation, or alteration, which the object worketh in the brain or spirits." (32, 1.2.4, 4) The optical process as a whole is a series of vibrations and pulses, and the "Retina … being of the same substance with ye optique Nerve," just passes these motions along, through the brain to the heart. Hobbes has no patience even for the transformations of motions that Descartes hypothesizes between the retina, the nerves, the pineal gland, and the brain. For Hobbes, all motions are the same. In the *Element of Law* he goes as far as to make the retina part of the optic nerve: "the interior coat of the eye is nothing else but a piece of the optic nerve, and therefore the motion is still continued thereby into the brain, and by resistance or reaction of the brain, is also a rebound in the optic nerve again." (32, 1.2.8, 6) The retina is nothing but the extremity of the nerve, and the image just is the external motions, continuing to the brain.

Hobbes' optics is a severe, spartan reduction of perception to motion, and his analysis of light is structured to support this stance:

> the lucid [body] swells and then contracts many times, or [we could say] that it has a perpetual *systole* and *diastole* … that we observe in every lucid body and call scintillation[②].

Light is a "scintillation" through the medium – which may as well be air, just as Hobbes read in

①*Thomas Hobbes: Tractatus Opticus*, par. 10 (151): "consideremus hyposthesim quam Cartesio propositam, tractatu primo Dioptricorum de volucribus quibusdam imaginibus incorporeis quas appellant species visibiles nihil nisi verba."

②Hobbes, *Liber Septimus Opticae*, Prop. I, 570: "Hoc autem idem est ac si diceremus totum lucidum tumescere, et iterum se contrahere altemis vicibus, sive habere perpetuam *systolem* et *diastolem*.…quam in omni corpore lucido observamus et appellamus scintillationem, nihil aliud esse quam hanc systolem et diastolem."Also in *Opera Omnia Latine* V, 218;

Descartes’ *Dioptrique*: “a certain movement or action, very rapid and very lively, which passes toward our eye through the medium of the air and other transparent bodies.” (11, Discourse I, , 67)

3. “Worse than any paradox” – Hobbes’ Cartesian epiphany

Hobbes’ radicalization of Descartes’ “true principle” underscores the sense of epiphany he expresses concerning the insights of Descartes’ optics. His own optical tracts, starting with the *Tractatus Opticus*, mark the moment he recognizes the assumption that still ties the Cavendish Circle to tradition, eschews it, and embraces the radical version of human naturalization – the full physicalization that the new optics supported ①. [20, 36] Payne’s assumption of an authentic, transparent relation between object and mind – expressed with the reference to “Visible species” – is the “rubbish” that Hobbes feels liberated from by Descartes’ insight that “visible species are nothing but words.” It gives him permission, as it is, to strip nature of any quasi-cognitive entities and proceed with a fully mechanistic account of humans, their relations to the world, and their relations to each other. His first full attempt to expand the naturalizing project into politics – the *Elements of Law* of 1640 – commences by celebrating this new insight yet again:

> the introduction of species visible and intelligible … passing to and fro from the object, is worse than any paradox, as being a plain impossibility②. [37, 38]

IV. “HOW YE SOULE SHOULD GIVE SUCH JUDGEMENT?” – THE SCOPE OF THE NATURALIZATION PROJECT

1. “Rene Descartes was not correct” – Hobbes’ departure

The spartan ontological attitude reflected in Hobbes’ rejection the independence of the image which is genuine, and it makes him stress that the light beam itself is nothing but a mathematical representation:

> That which ordinarily is called a beame of ye Sunne … light, in not therefore anything that flyth through ye aire to ones Eye and therefore is to bee considered without respect to the matter of ye object, or of the medium (that is to say) and mathematicall quantity only. (1, f9r)

This demand for parsimony is at the heart of his analysis of vision as a continuous mechanical process – perception is nothing but motion, and it always the same kind of motion, even if different objects and organs are involved:

> So to present a definition of vision I say that it is a reaction of the heart through the brain, the optic nerve, and the fleshy part of the Retina, against the outward flow from the action of the lucid or illuminated body propagated through the transparent medium to the eye, and through the eye, the retina, the optical nerve and the brain to the heart③. (29, 206)

Hobbes’ light, as we already saw, is a vibration in the medium; that much he owed to Descartes. The latter did not want to accept Hobbes’ vibration hypothesis as a legitimate version of his own, and had no sympathy to the idea that this vibration is caused by the “*systole* and *diastole*” of the luminous body, and this theoretical difference in natural philosophy reflects Hobbes metaphysical divergence from the teachings of his adopted mentor. Hobbes’ approach to perception is ‘hyper-mechanistic’ – vision is nothing but countermotion; mechanical reaction to the external

①For the relations and differences between Hobbes’ and Descartes’ optics see Shapiro, “Kinematic Optics,” 167; Brandt, Frithiof: *Thomas Hobbes’ Mechanical Conception of Nature*. Vaughn Maxwell & Annie Fausbøll (Copenhagen and London, 1928).

②Hobbes, *Elements of Law* 2.4, 3-4. In writing that “Although［Hobbes’ optical］works were written in the 1640s, Hobbes conceived the main principles of his optics early in the 1630s,” Prins misses this crucial point. Prins, Jan, “Hobbes on Light and Vision,” in Sorell, Tom (ed.) *The Cambridge Companion to Hobbes*, 129. For the differences between Hobbes and Descartes see also Jesseph, “Optics, First Philosophy, and Natural Philosophy.”

③Hobbes, *Tractatus Opticus*, 206: “Ut itaque Visionis definitionem exhibeamus dico eam esse reactionem a Corde per cerebrum & nervum opticum et Retinae crassitiem versus externa procreatum ab actione corporis Lucidi sive illuminati propagata per medium diapahnum ad oculum et per oculm, Retinam, nervum opticum cerebrumque usque ad Cor. Visio ergo quae *revera* motus est extorsum in sentiente apparenter est imago obiecti irradiantis constans ex luce vel colore figurato extra sentiens.”

pressure that is light:

> because in all action there is reaction, or resistance, The pressure is no lesse back again outwards from the heart to the braine and by the optique nerve to the Retina [①]. (1, f8r)

Hobbes seems to conflate the mechanical image of bouncing billiard balls and the Aristotelian idea that motion implies a medium, hence resistance. He also does not consider the idea that the reaction should be equivalent to the action – or else he would have had to explain why that reactive motion does not simply make its way back to the original luminous body. But even if he did not yet fully hone these mechanical principles, Hobbes is completely consistent in applying them to perception: "Vision, then, is actually an outward-thrusting motion of the senses, appearing as the image of the radiant body [as if this image is] perceived from the outside." [②] (29, 206) This is what it means that the image is but a "fancie." A full, earnest commitment to Descartes' matter-in-motion ontology entails, in Hobbes' analysis, that the image is not a true physical entity, extended in place and time and resting on the retina to be observed and interpreted. It is only experienced as being outside and independent of us only because it consists of this reactive, outward motion:

> species, image, color, lumen, and so forth are parts of the image; they are not – if we would like to speak accurately – the seen entities, or the visual objects. It is, rather, the act of vision itself, which in reality consists only of the reaction, or outwards motion of the internal parts of seeing, from which the image is produced so it appears as if it is outside [③]. (29, 206)

It is hard not to be impressed by this turn of philosophical phrase: the image and its parts "are not the seen entities [but] rather the act of vision itself." But beyond demonstrating Hobbes' admirable literary skills, this epithet of ontological frugality, which would have made many 20th century philosophers proud, declares his point of departure from Kepler and Descartes. For them, the independence of the image from the perceiver was a crucial insight. For him, the 'image' was not the object of vision but its product:

> it should be said about visual knowledge that, properly speaking, the image is the visual entity, not the known entity [④]. (29, 206-7)

Hobbes is happy to credit Descartes with this line of thought:

> all of [those who "have enquired of the place of the Image"] (except onely Monsieur des Cartes now of late) supposed light and colour, that is to say the appearance of objects which is nothing butt our fancy, to bee some accident in the object itself, and so they sought the place of that which hath no place …They ought therefore to have enquired not of the place of the Image, but of the apparent or seeming place of the object itselfe. (1, ff73v-74r)

But at this very point of the argument he takes the most drastic leave from his mentor:

> Rene Descartes was *not correct*, in saying in p. 29 of *Dioptriques* "we already know well enough that it is the soul that senses, not the body." [⑤] (29, 207)

Without an image, there is no need for an interpreter, and with no need for interpreter, there

①Hobbes, *A Minute Draught*, f8r. On the history and context of the idea of that action necessitate equivalent reaction see Home, Roderick W.: "The Third Law in Newto's Mechanics," *The British Journal for the History of Science* 4.1 (1968): 39-51.

②Hobbes, *Tractatus Opticus*, 206: "Ut itaque Visionis definitionem exhibeamus dico eam esse reactionem a Corde per cerebrum & nervum opticum et Retinae crassitiem versus externa procreatum ab actione corporis Lucidi sive illuminati propagata per medium diapahnum ad oculum et per oculm, Retinam, nervum opticum cerebrumque usque ad Cor. Visio ergo quae *revera* motus est extorsum in sentiente apparenter est imago obiecti irradiantis constans ex luce vel colore figurato extra sentiens."

③Hobbes, *Tractatus Opticus*, 206: "*species, imago, color , lumen*, et quaecunque sunt imaginis partes, non sunt, si accurate loqui velimus, res visae, aut objecta visus, sed ipse actus visionis, qui consistit ręaliter in sola reactione sive motu partium internatum videntis propagato extrosum, ex quo efficitur vt mouentis imago appareat extra."

④Hobbes, *Tractatus Opticus*, 206-7: "Eodem modo loquendum de cognitione per visionem, est enim imago res visae proprie loquendo non res cognitio."

⑤Hobbes, *Tractatus Opticus*, 207 (Italics to "not correct" added): "non ergo recte dicit Renatus des Cartes in Dioptricis pag. 29. *Jam dudum satis scimus animam esse quae sentit, non autem corpus*."

is no place for the soul.

2. “Vision is the judgement itselfe” – Interpretation without the Soul

The reference to the soul reveals the gravity of the debate: it touches upon the deepest convictions about humans’ place in the world.

It is crucial to realize that Hobbes’ objection does not stem from pre-determined ontological positions: he fully adopts Descartes’ matter-in-motion ontology, and none of his arguments concerns the makeup of the soul. What Hobbes is not willing to allow is the intervention of *any* non-physical entity in the process of perception. As far as he is concerned, Descartes is betraying the very line of reasoning that he had inherited from him and for which he gained such “a high opinion of his intellect,” namely: that the way to naturalizing humans is by thoroughly physicalizing the senses. It is *the body* that sees, and Descartes’ own arguments make the allusion to the soul vacuous:

> as *he* demonstrates… we cannot suppose that the soul itself perceives the image produced in the brain “without there being other eyes in the brain,” and by the same argument it can be argued that the motion of the brain cannot be sensed by the soul without the soul having other eyes with which the brain is intuited [intueatur]①. (29, 208)

Descartes argued that ‘the eye of the mind’ is an absurd idea②, (11, Discourse VI, 101) so he should simply accept that

> the entity itself [that is – the animal or the person] is moved by the irradiation, and that very motion is vision. Hence it should not be doubted that what sees is in fact the body. [11]

“That very motion is vision” – seeing just is motion. It does not need a soul to interpret it, and Hobbes finds the quasi-empirical arguments that Descartes provides for the requirement that the visual data be interpretated simply weak:

> nor does he argue correctly in suggesting that “we see that when the mind is distracted by extasy or deep contemplation, the whole body remains without sensation although very many objects touch it.” In fact it is not necessary that this stupor, either of contemplation, of sickness, or of madness, consists in diversion of the soul rather than in the motion of the spirits, of the brain, or of the heart, produced by something else when these [bodily] parts are rendered less mobile by external objects; and as everyone knows, even if the souls of animals are destroyed by those [external objects], it is still possible for other parts to have the dispositions and motions that the animal requires to be an animal; those disposition and motion that when removed the sensible soul no longer exists③. (29, 207-8)

Descartes argument from distraction is a *petitio principii*: if we can understand sensation bodily, we can also understand “stupor” as a bodily phenomenon. The project is to understands humans naturally, that is, as much as possible – as animals – and since animal perception does not entail a soul, neither does human:

> Hence if the soul of animals senses, their body [also] senses. And since a man in sensing is an animal, then by the same reasoning, if a man’s soul senses, his body senses, hence when he [Descartes] says “it is the soul that

①Hobbes, *Tractatus Opticus*, 208 (italics added): “Praeterea si supponere velimus animam cognoscere ipsam imaginem in cerebro effectam, qua ratione is negat pag. 51 id fieri posse, *nisi sint rursus alii oculi in cerebro*, eadem negari potest motum cerebri sentiri ab anima, nisi anima habeat alios oculos quibus cerebrum intueatur, vel ipsa sit res per irradiationem mota, et ille ipse motus sit visio.”

②Descartes, *Optics*, Discourse VI,101: “We must not hold that it is by means of this resemblance that the picture causes us to perceive the objects, as if there were yet other eyes in our brain with which we could apprehend it.”

③Hobbes, *Tractatus Opticus*, 207-8: “neque recte arguit, adiiciens *Videmus enim tum cum anima extasi vel forti aliqua contemlplatione diuertitur totum corpus sine sensu remanere quamquam plurima sint obiecta quae ipsum tangant.* Non enim necesse est vt stupor ille contemplantium, vel aegrotantium, vel Phreneticorum consistat in diuersione animae, sed in motu spirituum vel cerebri vel cordis aliunde producto propter quem partes illae redduntur minus mobiles ab obiectis externis; neque enim si animae brutorum, cum ipsis pereant, id quod omnes credunt, possibile est ipsas aliud esse praeter ipsas partes ita dispositas et motas prout animal requirit ut sit animal; qua dispositione et motu sublatis anima sensibilis non amplius existit.”

senses" it does not follow that "not the body;" indeed (whether he likes it or not), the two [propositions] are contradictory ①. (29, 208)

Some years later, White – himself a firm believer in the immortal soul – would a similar "appeal to other Animals, in which there's frankly denied to be a Soul independent of the Body." [39] No 17th century scholar could truly afford to doubt to the existence of the soul, but for those committed to naturalized epistemology, it had no place in sensation.

Hobbes rejects the role Descartes assigns to the soul in the interpretation of sensation, but that is not because he thinks that such interpretation is not required. To the contrary: he is so committed to the idea that visual data are not self-evident or self-explanatory, that he understands even visual illusions as products of learning, memory and judgement. Linear perspective is a good example, and Hobbes' explanation is worth quoting in full because it answers a mystery long troubling historian of art – how were the geometrical rules of perspective discovered (by Brunelleschi). With a window or a mirror, suggests Hobbes:

> The representing of a figure in perspective is nothing else butt tracing upon a plaine those lynes which the sides of ye figure make in ye plaine which is interposeds between it and ye eye, and by consequence it is ye section a pyramide or cone. And therefore if a man erect between this eye and ye object a plaine glasse or other transparent body and devide ye same into many equall figures as Rectangles Squares, Triangles or Hexagons, having his paper on which hee will draw his perspective, devided in ye same manner, number or proportion, hee has no more to doe butt to observe where ye several lines passeeth throuogh ye Glasse, and marke ye same in ye correspondent places of ye paper. The same hee may also doe by reflection in a looking glasse by ye same divisions, when ye figure stands behind him. (1, ff108r-v)

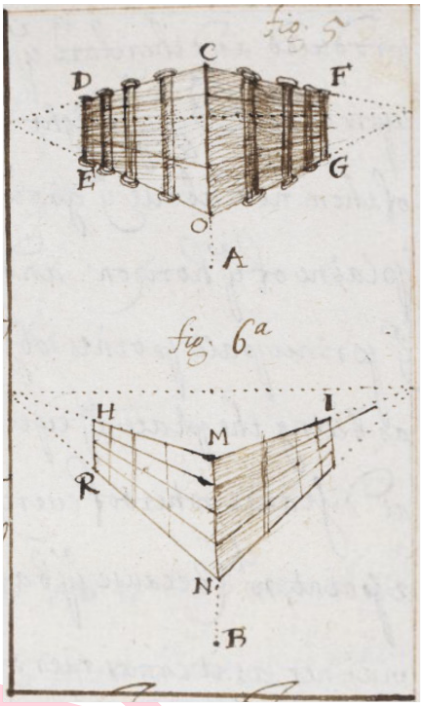

Fig. 11

Given that linear perspective replicates the true geometrical proportions produced by the optical cone on a flat surface, it is tempting to think that we actually 'see' the three-dimensional space on the two-dimensional canvas. We may think that it is *the eye* that is deceived, because the geometry provided by the perspective painting mimics what it usually perceives from the object. But this is not the case, argues Hobbes:

> to judge of perspective, a man has need of Experience in ye Originall appearance of objects and a steady fancy, as also of some glasse or Tube to putt before his eyes, whereby ye naturall Judgement of ye eye may be confounded. (1, ff114v-115r)

Judgement – interpretation – is the faculty being deceived by the products of linear perspective, and training is required for judgment to be susceptible to this particular type of visual deception:

> ye Reason why those figures generally have an apparent difference from their figures

①Hobbes, *Tractatus Opticus*, 208: "Si ergo bestiae anima sentit, corpus eius sentit. Eadem autem ratione sentit homo qua sentit bestia, si ergo anima hominis sentit, corpus eius sentit, neque ergo oportuit cum dixisset *Animam esse quae sentit*, adiicere illa verba non autem corpus; haec enim illis (velit nolit ille) contradictoria sunt."

made in ye playne of perspectice is this. That when wee have in memory ye Originalls whch they are made to represent, y plaine itself is not (to speake properly) seene, butt ye Originall remembered, and ye memory thereof maintained by the proporsions of ye lines drawne, which proportions are ye same wee see them in ye originall. (1, ff114v-115r)

The eye observing the two-dimensional canvas provides nothing but a representation of a two-dimensional plain. It is memory that creates the illusion:

> So that when wee behold a perspective and acknowledge nott anything it represents butt itself, then is ye fancie of ye beholder, Vision, namely ye vision of ye plaine, Butt when wee conceyve by it a Gallery, Landskip, or other thing represented by it, then it ye fancy of the beholder to be called memorie, though that memorie bee raised and confirmed by the lines drawne on ye plaine. (1, ff114v-115r)

Descartes’ mistake, according to Hobbes, is not in assuming that all sensation requires interpretation. The mistake – which Descartes shares with tradition – is in assuming that this interpretation can only be carried our by an immaterial soul; that “ye Soule residing in the head upon ye Stirring of certaine partes of the braine by certaine fibres of ye opticq nerve, [gives] Judgement.” This is an empirically weak assumption because it “is hard to bee conceived in respect wee can with no glasses perceive any likely hood of such fibres in ye said nerve.” We do not have good enough lenses to observe the physical relations that Descartes surmised between the eye and the brain, the supposed seat of the soul. But more importantly, it is a weak assumption metaphysically and logically: there is no way to make sense of

> how ye Soule should give such Judgement before Vision, and for judging it after Vision, tis in vain, for vision is the judgement itselfe. (1, ff76v-77r)

Physical and material, vision just is interpretation. It requires no immaterial soul.

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