"Trust No One But Yourself": William Gilbert's Use of Experiment and Rejection of Authority, Reconsidered

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One of the most important components of early modern science was the experiment. Advocates of the "new sciences" used experiments as indisputable evidence in controversies with their opponents and as powerful arguments against authoritative texts. Among the first early modern scientific works to systematically and successfully use experiments as parts of the central argumentation is William Gilbert's treatise De magnete *(1600), in which the author sought to present a completely new theory of magnetism as an explanation of phenomena on earth as well as of the movements of heavenly bodies. Gilbert goes to great lengths to persuade his readers of the innovation of his* nova et inaudita physiologia*. For this, however, it did not suffice to present a startling number of experiments and advocate empirical investigation. This contribution will shed light on the surprising literary and rhetorical tools employed in the* De magnete *in questions of authority, which aided Gilbert in presenting his powerful and highly successful "New Physiology."*

This special issue shows in all its contributions how early modern cosmology relied heavily on the concept of trust. Believing in authorities was fundamental, and any doubt in their expertise had to be justified carefully

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(Danneberg 2003, pp. 162–72; Blair 2006; Danneberg 2009). One important methodological approach that is often showcased as the crucial difference between pre-modern and modern science is empirical investigation. Advocates of the "new sciences" used experiments as powerful arguments against allegedly blind trust in authoritative texts. However, if we look at how experimental reports in the sixteenth and seventeenth centuries were employed in scientific argumentation, it becomes apparent that the experiment itself, the sole report of a trial and its results, was not always persuasive. By choosing a particular case study, a work that explicitly advocates experimental knowledge taking the place of mere trust in authoritative texts, the following contribution will show that the experiment alone was by no means enough to replace the vast space of authoritative book knowledge. Additional strategies were required. In our example, literary and rhetorical tools were employed in questions of authority alongside new empirical methods, creating a persuasive piece of argumentation.

In 1600, William Gilbert, president of the Royal College and Elizabeth I's private physician[1], published his treatise *De magnete magneticisque corporibus et de magno magnete tellure physiologia nova* [*New Physiology of the Lodestone and Other Magnetic Bodies and of the Great Magnet, the Earth*] (Gilbert 1600). In this work, the author analyzed the properties of magnetic bodies, such as the lodestone, a naturally magnetized form of iron ore, and he exposed a new theory of magnetic and electric phenomena. While numerous scholars from antiquity to the early modern era had already analyzed magnetic phenomena and their origin, extent, and consequences, Gilbert's monograph was presented to the reader as the first published systematic treatment of magnetism in one volume (Roller 1959, pp. 92–153; Pumfrey 1987; cf. Ugaglia 2006 for a differentiated view). Gilbert's examinations using spherical lodestones, which he called *terellae*, or "small earths," led him to base his explanations of magnetic phenomena on Earth on what he defined as the five magnetic *motiones*, "movements"—attraction, direction, variation, dip, and rotation (see Fig. 1; Roller 1959, pp. 154–62; Pumfrey 2002, pp. 136–58). Significant for this issue of early modern cosmology are the cosmological consequences of Gilbert's view on magnetic bodies and the magnetic earth: in the last of his six books on the lodestone, Gilbert explained how magnetism both rotated the Earth diurnally and magnetically stabilized its axis of rotation.

De magnete proved very influential. It laid the foundations for the understanding of magnetic properties and shaped the majority of knowledge on magnetism as well as on electrical forces until the nineteenth century (Zilsel 1941; Daujat 1945; Balmer 1956; Roller 1959; Hesse 1960a, 1960b;

1. For Gilbert's biography, see Roller 1959, pp. 50–91.

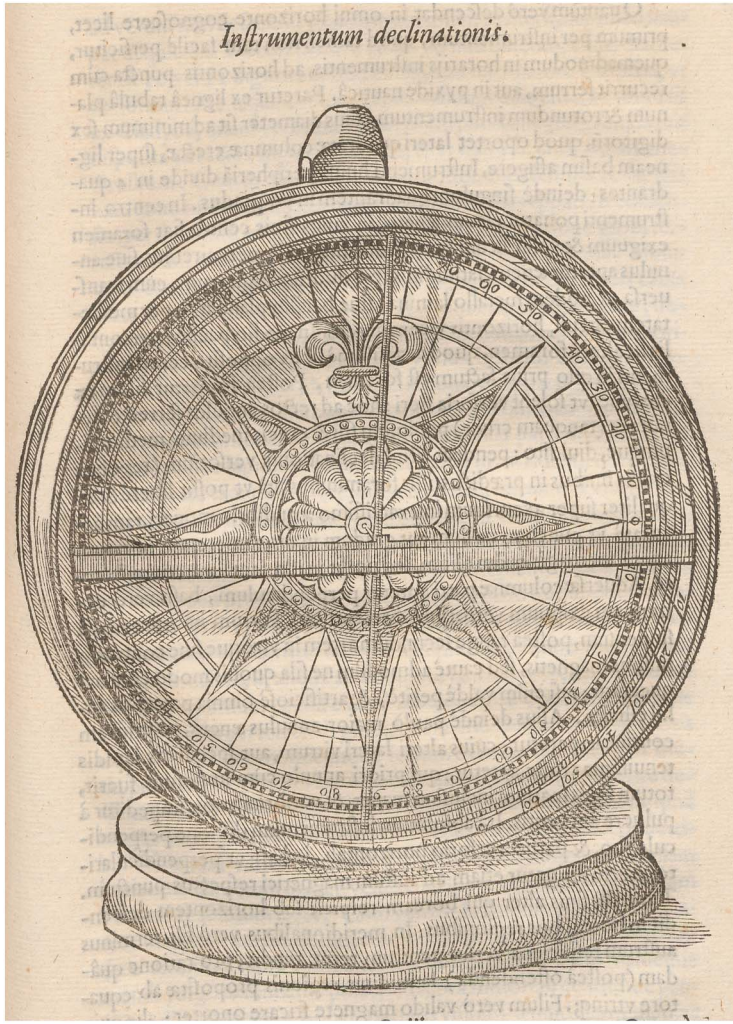


Figure 1. Image of a so-called inclinometer, an instrument measuring the magnetic dip, the angle of the compass needle with the horizontal line, invented by Robert Norman and included in the *De magnete*. Gilbert 1600, p. 185. ETH-Bibliothek Zürich, Rar 1253, https://doi.org/10.3931/e-rara-8370.

Westfall 1971, pp. 25–8; Heilbron 1979, pp. 169–79; Freudenthal 1983; Pumfrey 1987, 2000, 2002). Apart from its ground-breaking scientific content on magnetic properties, *De magnete* presented intriguing strategies of deconstructing and constructing authority, which will be the focus of this

contribution. Two distinct and interconnected features made the monograph an outstanding natural philosophical work at the time of its publication: (1) Gilbert used numerous experiments as part of his reasoning, most of which were supposedly carried out by himself over decades of thorough investigation. (2) At the same time, from the outset of his work, the royal physician criticized mindless belief in authorities, rejected book knowledge in general and advocated a new, empirical approach toward understanding the cosmos. That he himself did not, and in fact could not, adhere to this very high standard in the *Magnes* has been shown by several historians of science (Pumfrey 1987, pp. 14–22).[2] This article will not repeat the importance of the treatise's scientific features, making it a seminal contribution to early modern science, but will focus on the wider argument of the work—the beginning of a wholly new chapter in natural history. Gilbert goes about constructing this argument by employing important rhetorical devices in addition to scientific ones. This might be surprising if we read Gilbert's stylistic statement in the preface, claiming that he did not employ excessive rhetorical ornament in his work.[3] Strategies of persuasion, however, encompass far more than rhetorical figures and grand style, and Gilbert's work shows how a text written in large parts in technical Latin and an impersonal tone can still make use of two rhetorical modes of persuasion, which will be presented in the following chapters: *logos*, the rational argument, and *ethos*, the self-fashioning of the author.

1. Logos: Gilbert's Use of Experiment

Experimental science was only slowly developing at the beginning of the seventeenth century. Experiment reports were often used to reinforce an argument, consisting of other strategies of persuasion, most commonly the use of written authorities. They did not represent the sole proof (Dear 1985, 1991, 2006). A considerable part of the reasoning can even be considered as adhering not exclusively to logic or factual evidence. Instead, we can look at and analyze the use of a device that early modern natural philosophers applied when writing a piece of persuasive text, which modern scholarship has sometimes ignored: the system of rhetoric. Ancient and Renaissance rhetoric, as it had been taught to almost every natural philosopher of the time, was regularly employed to persuade the audience in a form which was more than familiar to the *res publica litteraria* (Serjeantson

2. On Gilbert's appropriation of Leonardo Garzoni's work see Garzoni (2005); Ugaglia (2006); Sander (2020, pp. 804–39).

3. Gilbert 1600, fol. [iii]^{r}: "Nec huic operi ullum eloquentiae fucum aut verborum ornatum attulimus." ("And in this work we have not employed any of the disguises of grandiloquence or rhetorical flourish"). Hereinafter, all translations from Gilbert's *De magnete* are my own.

2006; Mack 2011; Luggin 2021). In Gilbert's treatise, empirical knowledge and material aspects played a crucial role, and the author described his many trials with *terellae* and iron needles and presented detailed discussions of instruments such as the compass or the inclinometer (see Fig. 1). The importance of the composition of his text, the "literary constitution and function" (Dear 1991, p. 163) of his demonstrations show us that Gilbert artfully combined empirical investigation and knowledge gained from objects with rhetorical strategies.

If we search for a place of experimental knowledge to analyze its employment against the background of ancient rhetoric, we can interpret it as an example of "non-artistic proof" according to Aristotelian rhetoric. In contrast to artfully created arguments according to the devices of rhetoric, such as syllogisms, enthymeme, signs, or examples (Arist. *Rhet.* 1.2.2 [Aristotle 1959]; Lausberg 2008, pp. 193–235), these non-artistic proofs are not invented or influenced as much by the author but form external evidence. Other examples for such external proof were laws, contracts, or witnesses, which could all be employed within an argument as evidence implied to be objective because it was seemingly formed outside the realm of influence of the author (Arist. *Rhet.* 1.2.2; Lausberg 2008, pp. 191–93). Still, non-artistic proofs did not speak for themselves, but they had to be implemented into reasoning with careful deliberation. The importance of a law, or the relevance of a contract, or the statements of a witness were shaped by the *rhetor*, or author, to adhere to his or her case. This holds true also for the use of empirical knowledge in early modern scientific argumentation, and specifically Gilbert's work. An experiment without explanation of the circumstances or exposition of the significance of its results did not have much persuasive power (Dear 1991, 2006). As a consequence, in many cases experiments were interwoven with mathematical demonstration or with a careful narration of the circumstances of its execution, which, in the way of an *ekphrasis*, could be long, engaging, and include surprising elements (e.g., in Kepler's *Astronomia nova*. See Gingerich 1989, pp. 61–9; Voelkel 2001, pp. 111–54; Wootton 2015, pp. 262–68; Luggin 2021). When employing an experiment within his reasoning, an early modern scientist could also make use of witnesses. They were to play a large role in presenting reliable, trustworthy, and empirical knowledge (Lausberg 2008, pp. 191–93; Shapin and Schaffer 1985; Lackey and Sosa 2006; on Gilbert see Cunningham 2001). A careful contextualization and interpretation of the empirical evidence and its consequences for the case at hand seems to generally have been necessary for an experiment report to be persuasive.

William Gilbert's work also shows strategies to employ these proofs in an appropriate way in his reasoning. However, his employment of experimental knowledge is slightly different than the cases just mentioned, and

from other contemporary scientific works, as we will see now. *De magnete* presents numerous experiments as part of the argumentation. This is announced in the full title of the work: *De magnete magneticisque corporibus et de magno magnete tellure physiologia nova plurimis et argumentis et experimentis demonstrata* [*New Physiology of the Lodestone and Other Magnetic Bodies and of the Great Magnet, the Earth, Demonstrated in Numerous Arguments and Experiments*]. While the emphasis on novelty is not exactly extraordinary in the natural philosophy of the time (Thorndike 1951; Cohen 2010, p. 252), the seemingly overwhelming number of *experimenta* reported in the *De magnete* has no parallel in the works of contemporaries. Gilbert's predecessors had also made use of experiments but described several dozen at most (Wootton 2015, pp. 327–32; Pumfrey 2002, pp. 109–10). The sheer number of allegedly original empirical knowledge presented—more than two hundred instances—did make an impression on his readers, no matter if Gilbert did really perform all of them himself. Not all these descriptions of empirical knowledge amounted to experiments in the modern sense: many instances simply state the conclusions drawn from empirical investigations, which were not always described. *Experimenta*, for the natural philosopher at the eve of the seventeenth century, not only comprised the actual experimental practice but also experience in the wider sense (Cohen 1985, p. 133; Dear 2006). For Gilbert, it also encompassed the knowledge gained from this experience, and he specifically combined his empirical knowledge (*experimenta*) with solid demonstration (*argumentis*) in both his title and preface (Gilbert 1600, fol. ii^{r}). As experimental practice and its systematic employment in scientific reasoning was still a novelty at the time, Gilbert's readers did not specifically consider the distinction between the actual practice and the knowledge gained from experience. The persuasive force of *De magnete*'s novel empirical approach was not hindered by it: Gilbert's work was from the beginning characterized most of all as a work embodying the new method of presenting empirical knowledge as the most important evidence.

Gilbert made clear from the very beginning of his text the crucial role of his use of empirical knowledge: The preface, one of the most important places for a programmatic statement in early modern books (Enenkel 2015, pp. 1–53; 521–90), underlines his use of *experimenta* repeatedly, calling attention to it and stressing the deficiency of book knowledge or the disadvantages of faulty experiments (Gilbert 1600, esp. fol. ii^{r}–iii^{v}). Here, Gilbert explains his method of deliberately using what he calls "certain experiments" and "validated arguments" to obtain stronger reasoning:

> Since in uncovering hidden phenomena and investigating the secret causes of things, stronger conclusions arise from certain experiments

> and validated arguments than from probable conjectures and the beliefs of common speculators [...]. (Gilbert 1600, fol. ii^{r})[4]

In attacking *coniectura probabiliora* carried out by common philosophers, Gilbert reprimanded the philosophy taught at English universities at the time, including his former professors, who, in his view, placed too much value on written authorities and too little on empirical knowledge (Zilsel 1941, pp. 26–7). He argued against exclusive book knowledge, addressing his intended readership who should rise above such blind trust in authority, toward a new kind of philosophy:

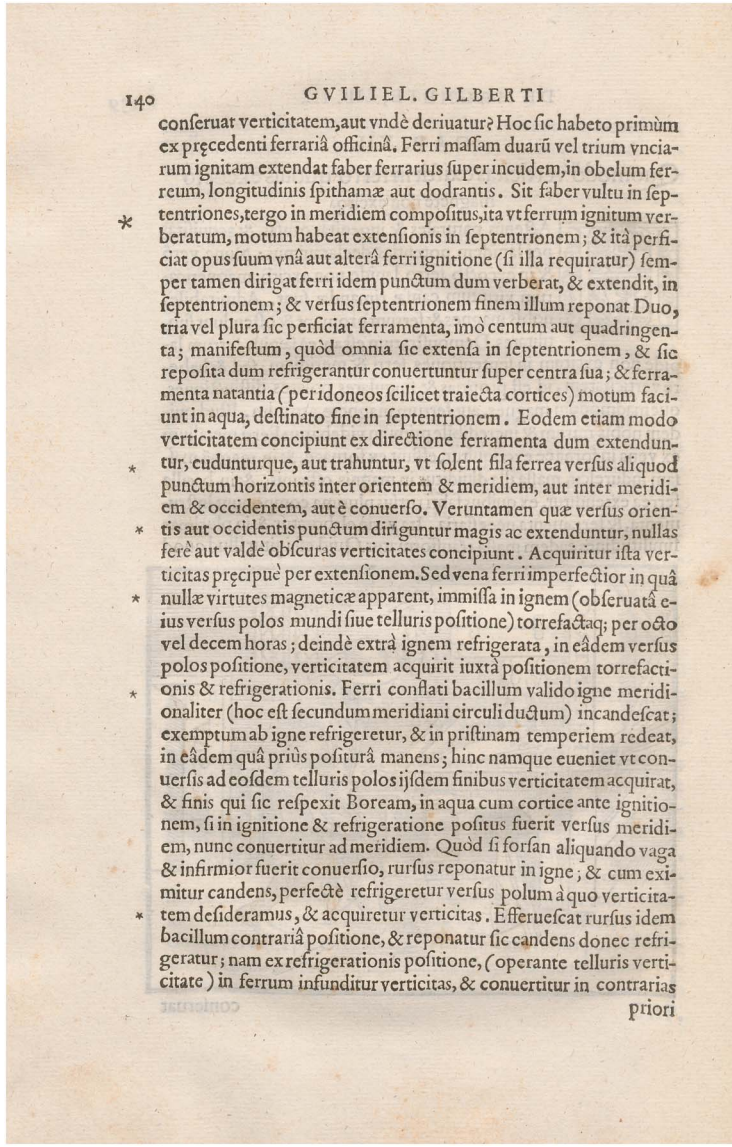
> But I have dedicated these foundations of magnetism, a new manner of philosophizing, to you alone, who truly philosophize, noble-minded men, who inquire knowledge not only in books but also in the things themselves. (Gilbert 1600, fol. ii^{v})[5]

Given the high number of *experimenta* detailed in the book, it would have been almost impossible for Gilbert to present what we would come to know as fairly standard experiment reports of the seventeenth century: long, detailed narrations of one certain operation with considerable context, e.g., in event-like reports of the Royal Society in the second half of the century (Shapin and Schaffer 1985; Dear 2006). Instead, Gilbert presented varied forms of experience, from longer reports of his trials to short statements of his conclusions only. To get his readers to trust his operations, even if he did not always give them the context of the actual practice, the author made use of additional strategies to support his claims, which were not linked to scientific evidence, but to his presentation of it in his book. These were not meant to replace some lack of evidence, but to reinforce his proofs.

Apart from the persuasive force of the sheer number of *experimenta* presented, Gilbert introduced a completely new tool to emphasize his use of empirical knowledge and, at the same time, strengthen the methodical significance of these *experimenta*. Throughout his book, he marked every one of his original experimental procedures, be they larger set-ups or smaller trials, in a special way, with asterisks in the margin. The size of the mark, a small or large asterisk, was determined by the importance of the respective operation, as the author explains in the preface (see Fig. 2;

4. "Cum in arcanis inveniendis, et abditis rerum causis perqiurendis, ab experimentis certioribus, et argumentis demonstratis, validiores existant rationes, quam a probabilibus coniecturis, et vulgo philosophantium placitis [...]." (Gilbert 1600, fol. ii^{v})

5. "Sed vobis tantum vere philosophantibus, viris ingenuis, qui non ex libris solum, sed ex rebus ipsis scientiam quaeritis, fundamenta ista magnetica commendavi, novo philosophandi genere."



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conſeruat verticitatem,aut vndè deriuatur? Hoc ſic habeto primùm ex præcedenti ferrariâ officinâ. Ferri maſſam duarũ vel trium vnciarum ignitam extendat faber ferrarius ſuper incudem,in obelum ferreum, longitudinis ſpithamæ aut dodrantis. Sit faber vultu in ſeptentriones,tergo in meridiem compoſitus,ita vt ferrum ignitum verberatum, motum habeat extenſionis in ſeptentrionem; & ità perficiat opus ſuum vnâ aut alterâ ferri ignitione (ſi illa requiratur) ſemper tamen dirigat ferri idem punctum dum verberat, & extendit, in ſeptentrionem; & verſus ſeptentrionem finem illum reponat Duo, tria vel plura ſic perficiat ferramenta, imò centum aut quadringenta; manifeſtum, quòd omnia ſic extenſa in ſeptentrionem, & ſic repoſita dum refrigerantur conuertuntur ſuper centra ſua; & ferramenta natantia (peridoneos ſcilicet traiecta cortices) motum faciunt in aqua, deſtinato fine in ſeptentrionem. Eodem etiam modo verticitatem concipiunt ex directione ferramenta dum extenduntur, euduntur que, aut trahuntur, vt ſolent fila ferrea verſus aliquod punctum horizontis inter orientem & meridiem, aut inter meridiem & occidentem, aut è conuerſo. Veruntamen quæ verſus orientis aut occidentis punctum diriguntur magis ac extenduntur, nullas ferè aut valdè obſcuras verticitates concipiunt. Acquiritur iſta verticitas præcipuè per extenſionem. Sed vena ferri imperfectior in quâ nullæ virtutes magneticæ apparent, immiſſa in ignem (obſeruatâ eius verſus polos mundi ſiue telluris poſitione) torrefactaq; per octo vel decem horas; deindè extrà ignem refrigerata, in eâdem verſus polos poſitione, verticitatem acquirit iuxtà poſitionem torrefactionis & refrigerationis. Ferri conflati bacillum valido igne meridionaliter (hoc eſt ſecundum meridiani circuli ductum) incandeſcat; exemptum ab igne refrigeretur, & in priſtinam temperiem redeat, in eâdem quâ priùs poſiturâ manens; hinc namque eueniet vt conuerſis ad eoſdem telluris polos ijſdem finibus verticitatem acquirat, & finis qui ſic reſpexit Boream, in aqua cum cortice ante ignitionem, ſi in ignitione & refrigeratione poſitus fuerit verſus meridiem, nunc conuertitur ad meridiem. Quòd ſi forſan aliquando vaga & infirmior fuerit conuerſio, rurſus reponatur in igne; & cum eximitur candens, perfectè refrigeretur verſus polum à quo verticitatem deſideramus, & acquiretur verticitas. Efferueſcat rurſus idem bacillum contrariâ poſitione, & reponatur ſic candens donec refrigeratur; nam ex refrigerationis poſitione, (operante telluris verticitate) in ferrum infunditur verticitas, & conuertitur in contrarias

priori

Figure 2. A page of chapter 12 of Book III of the *De magnete*, showing Gilbert's usage of small and big asterisks to mark his *experimenta*, according to importance. Gilbert 1600, p. 140. ETH-Bibliothek Zürich, Rar 1253, https://doi.org/10.3931/e-rara-8370.

Gilbert 1600, fol. ii^{v}). This practice is very peculiar and is, to my knowledge, not found in any similar scientific work of the time. It was a visual representation of the author's empirical evidence, of his knowledge, and of all his original findings. The picture thus painted of Gilbert's excessive use of experimental knowledge was presumably even larger than the actual experimental practice standing behind it. Gilbert did not report only his own empirical knowledge but also numerous reports of other scholars' investigations. As was common practice, he repeated and adapted a number of experiments, including some providing significant new knowledge, from earlier works, such as Girolamo Cardano's *De subtilitate* (1550), Giambattista della Porta's *Magia naturalis* (1558), and Robert Norman's *The Newe Attractive* (1581) (Gilbert 1600, pp. 2, 7–8, 107, 161–62, 169; Zilsel 1941; Henry 2001). However, Gilbert did not mark these instances with an asterisk, as only original knowledge was recorded in this way. He also marked many additional things as *inventa et experimenta* so that his empirical evidence would seem even greater. This includes deliberations on why he used a *terrella* for his experimental trials and how to make one (Gilbert 1600, pp. 12–13); and general or more specific statements about conclusion drawn from empirical knowledge, not the actual practice itself (e.g., Gilbert 1600, p. 51). With more than two hundred asterisks spread over the 240 pages of *De magnete*, the picture for the reader was clearly meant to be one of extensive, unprecedented empirical knowledge and practice.

Another aspect of this strategy of putting asterisks in the margins brings us back to the question of authority: This display of the author's *inventa et experimenta* through marginalia did not show only his empirical knowledge, but it also served to replace (other) authorities. Traditionally, the reader would have found mentions of Aristotle, Paracelsus, Girolamo Cardano, and others in the margins, next to passages quoting or paraphrasing their opinions. It appears that Gilbert refused to continue this established practice and banned these authorities from the margins, seemingly replacing them with his own original knowledge.

That this practice of marking experiments and conclusions with asterisks is peculiar is confirmed if we look at its reception. Later scholars did not adopt this method, nor do the asterisks appear in later, unauthorized editions of *De magnete* itself (see Gilbert 1628, 1629). It seems as if either publishers or printers did not understand Gilbert's strategy or that they did not think it necessary to repeat it.

The form of *experimenta* reported by Gilbert is equally intriguing: After an introductory book on the lodestone in general, Gilbert discusses the properties of magnetic bodies and their "natural movements" in Books II to V. These contain the bulk of the author's experimental knowledge.

Some operations are decidedly brief and concise. As has been mentioned, they do not always form full experimental reports but often simply state the most important steps of an operation or even merely idealized results without any details about the experimental practice supposedly standing behind it. As Gilbert arranged these short reports and conclusions predominantly one after the other, forming chains of four, five, or more, this does not retract from the persuasive force of his *experimenta* (e.g., Gilbert 1600, pp. 139–42; see also Fig. 3). What Gilbert's accounts sometimes lack in detail, they make up for with this strategy using the force of numbers, again, presenting, if not always particularized, but always substantial empirical knowledge.

Some of the experimental reports are accompanied by methodological musings on the achievement and use of empirical knowledge in general, ranging from abstract criticism of book knowledge to concrete guidelines and instructions (Georgescu 2013). In Book III, for example, Gilbert criticized natural philosophers, in this instance particularly Giambattista della Porta, who used experiments, but, because of their problematic methods, reached and defended the wrong conclusions:

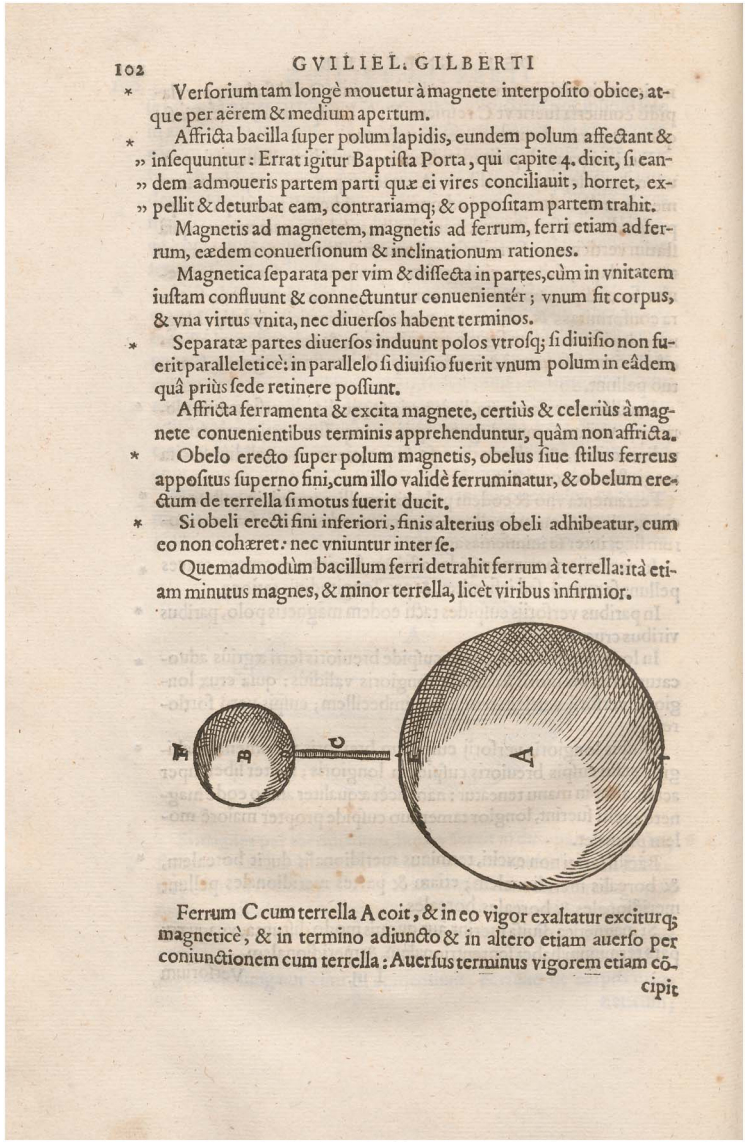
> But inquirers of nature should beware that they will not be further deceived by their own carelessly observed experiments and will not confuse the republic of letters with mistakes and foolery. (Gilbert 1600, p. 143)[6]

Such a *confutatio* of others' opinions is almost always either preceded or followed immediately by Gilbert's own experimental report on the matter. In this instance, della Porta had declared and supposedly shown in an experiment that rubbing iron with a diamond would turn it magnetic. That *adamas* should influence the magnetic properties of iron had already been laid out by Pliny the Elder (XXXVII, 14 [Pliny the Elder 1906]) and repeated by later scholars (Roller 1959, pp. 25–6).[7] Detecting errors in della Porta's method of experimentation, Gilbert set out to falsify the former's conclusion:

> This [della Porta's observation] in fact, would be contrary to our magnetic rules. Therefore, I repeated the experiment myself using seventy-five diamonds, in presence of many witnesses, [...] with the

6. "Sed caveant naturalium rerum scrutatores, ne illi suis experimentis male observatis amplius decipiantur, et literariam rem publicam erroribus et ineptis perturbent."

7. It is, however, unclear which mineral Pliny and other ancient writers meant when speaking of *adamas*. Several substances are probably subsumed under this term. Early modern writers mostly interpreted the ancient text as meaning what they now knew as (mostly uncut) diamonds, see Dana 1837, pp. 331–32.



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* Verſorium tam longè mouetur à magnete interpoſito obice, atque per aërem & medium apertum.

* Affricta bacilla ſuper polum lapidis, eundem polum affectant & » inſequuntur: Errat igitur Baptiſta Porta, qui capite 4. dicit, ſi ean- » dem admoueris partem parti quæ ei vires conciliauit, horret, ex- » pellit & deturbat eam, contrariamq; & oppoſitam partem trahit.

Magnetis ad magnetem, magnetis ad ferrum, ferri etiam ad ferrum, eædem conuerſionum & inclinationum rationes.

Magnetica ſeparata per vim & diſſecta in partes, cùm in vnitatem iuſtam confluunt & connectuntur conuenienter; vnum fit corpus, & vna virtus vnita, nec diuerſos habent terminos.

* Separatæ partes diuerſos induunt polos vtroſq; ſi diuiſio non fuerit paralleleticè: in parallelo ſi diuiſio fuerit vnum polum in eâdem quâ priùs ſede retinere poſſunt.

Affricta ferramenta & excita magnete, certiùs & celeriùs à magnete conuenientibus terminis apprehenduntur, quàm non affricta.

* Obelo erecto ſuper polum magnetis, obelus ſiue ſtilus ferreus appoſitus ſuperno fini, cum illo validè ferruminatur, & obelum erectum de terrella ſi motus fuerit ducit.

* Si obeli erecti fini inferiori, finis alterius obeli adhibeatur, cum eo non cohæret: nec vniuntur inter ſe.

Quemadmodùm bacillum ferri detrahit ferrum à terrella: ità etiam minutus magnes, & minor terrella, licèt viribus infirmior.

Ferrum C cum terrella A coit, & in eo vigor exaltatur exciturq; magneticè, & in termino adiuncto & in altero etiam auerſo per coniunctionem cum terrella: Auerſus terminus vigorem etiam cõcipit

Figure 3. An example of cumulative empiric evidence: Gilbert mentioning one finding or experiment after the other and marking them with asterisks. Gilbert 1600, p. 102. ETH-Bibliothek Zürich, Rar 1253, https://doi.org/10.3931/e-rara-8370.

> utmost care [...]. It was, however, never granted me to observe this. (Gilbert 1600, p. 143)[8]

Through this particular refutation of della Porta's experiment, the confirmation of the author's own expertly achieved evidence, and the general methodological criticism of his predecessors, Gilbert's conclusions should seem all the more persuasive to the reader. In this particular case, the use of witnesses as an additional means of making experiments persuasive is especially highlighted. Something else becomes evident here: Gilbert replicated an experiment of della Porta's and allegedly repeated it seventy-five times. Conversely, some of his reports testify to Gilbert's efforts of making his own experiments replicable. Time and again, he commented on particular conditions that are vital to the outcome of the experiment and gave the reader clear instructions on what to do and what to avoid. This virtue of reliability through repetition would in the course of the century soon become a crucial point of the new experimental method (Dear 1991, p. 162; Cunningham 2001; Schickore 2010; Steinle 2016).

Gilbert goes to great lengths to show his mastery of all the operations discussed, even though he provided numerous experimental reports, which do not reveal the identity or character of the person designing and conducting the investigation. Most reports in the *De magnete* are delivered in an impersonal, descriptive, or prescriptive style. An example of a short prescriptive report can be found in Chapter 2 of Book II, which treats the attraction of amber. Here, Gilbert directly addressed the reader, providing instructions for how to perform the experiment, as shown by the two imperative verbs:

> Now in order clearly to understand by experience how such attraction takes place, and what those substances may be that so attract other bodies [...], *make yourself* a rotating needle of any sort of metal, three or four fingers long, pretty light, and poised on a sharp point after the manner of a magnetic pointer. *Bring* near to one end of it a piece of amber or a lightly rubbed gem, polished and shining: at once the instrument revolves. (Gilbert 1600, pp. 48–49; Fig. 5; my emphasis)[9]

8. "Hoc quidem contrarium esset regulis nostris magneticis. Ob eamque causam periculum nos fecimus septuaginta adamantibus praestantibus, coram multis testibus, [...] arte accuratissima [...]. Nunquam tamen hoc cernere licebat."

9. "Sed ut poteris manifeste experiri quomodo talis sit attractio, et quae sint illae materiae, quae alia sic alliciunt corpora, [...] fac tibi versorium ex quovis metallo, longitudinis trium vel quatuor digitorum, satis leve supra acum suam, more indicis magnetici,

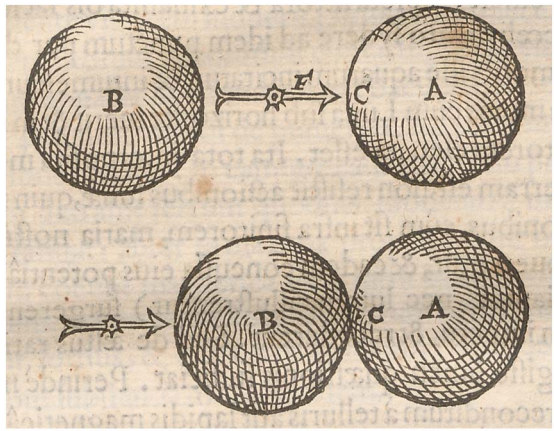

Figure 4. One of Gilbert's experiments in Book II concerns the phenomenon of verticity, the tendency of a needle toward the North or South poles of a *terella*. If an iron needle is placed between a lodestone (A) and an iron sphere (B; above), it tends toward the pole of the lodestone with more force than if it were placed next to both the iron sphere and the lodestone. Gilbert 1600, p. 85. ETH-Bibliothek Zürich, Rar 1253, https://doi.org/10.3931/e-rara-8370.

Descriptive accounts in an impersonal style could be equally short, as the following example shows, detailing the phenomenon of verticity, the tendency of a needle toward the North or South poles of a *terella*:

> Let A be a spherical lodestone, B an iron sphere, F a needle between the two bodies, with its point magnetized by the pole C. In the other figure let A be a spherical lodestone, C the pole, B an iron sphere, where the needle tends through the iron sphere to the pole of the lodestone, C. The needle thus placed between lodestone and the iron sphere vibrates more forcibly toward the pole of the terrella because the loadstone imparts instantaneous verticity to the opposite sphere. (Gilbert 1600, p. 85; Fig. 4)[10]

cuius alteri fini appone succinum, vel lapillum leniter fricatum, nitidum et politum, nam illico versorium convertit se."

10. "A terella, B globus ferreus, F versorium inter duo corpora, cuius cuspis excita fuit polo C. In altera figura A terrella, C polus, B globus ferreus, ubi versorium tendit per globum ferreum versus C polum terrellae. Sic versorium positum inter terrellam et globum ferreum firmius vibratur in polum terellae: quia magnes immittit verticitatem subitaneam in globum adversum."

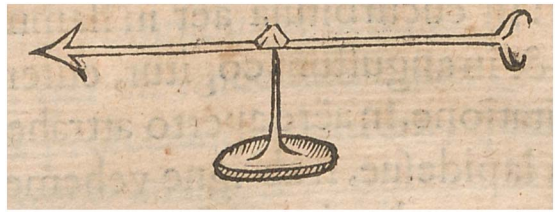

Figure 5. A *versorium*, an instrument used by Gilbert in many of his experiments to determine magnetic as well as electric attraction. A metallic, preferably iron, needle poised on a sharp point, so that it can rotate freely and display magnetic or electric forces. Gilbert 1600, p. 49. ETH-Bibliothek Zürich, Rar 1253, https://doi.org/10.3931/e-rara-8370.

This impersonal or prescriptive style of presentation as well as the shortness of many reports could in many cases conceal the identity of the experimenter. Still, if we consider the latter example, it becomes clear that the outcome of this setup and the conclusions drawn from it were very much determined by the experimenter, Gilbert, himself. His observations were not quantitative, and they relied upon numerous external conditions, which are not always transparent from his short reports. What is more, even though Gilbert included prescriptive accounts and urged the reader to repeat his *experimenta* in the preface (Gilbert 1600, fol. iii^{r}), because of the style of his reports and the many details left out, for numerous cases in *De magnete* an actual repetition of the experimental practice would have been difficult. This raises the question regarding how the author could still establish enough trustworthiness in all his operations.

Apart from the size of experimental knowledge depicted, the visualization through asterisks, the explicit methodological musings, and refutation of authorities, another strategy of persuasion was of crucial importance in establishing this trust: Gilbert's many personal statements about his laborious search for truth through empirical investigation, which we can find in the paratexts, but also preceding or following the experimental reports, in other words, the self-fashioning of the author.

2. Ethos, or Constructing Oneself as the Sole Authority

From the preface and first chapters of the *De magnete*, one characteristic of the work related to the emphasis on empirical investigation becomes clear at once: Gilbert's rejection of authorities and book knowledge. Relying on one's conclusions in the written word alone is the biggest crime imaginable to him:

> [...] in such a vast sea of books, by which the minds of the studious are harassed and wearied; silly books by which common people and impertinent scholars are intoxicated, speak deliriously, are inflated; they create a literary commotion and claim to be philosophers, physicians, mathematicians, astrologers, all the while ignoring and scorning genuinely learned men. (Gilbert 1600, fol. ii^{v})[11]

Gilbert criticizes the opinions of classical thinkers, such as peripatetic philosophers, Pliny the Elder, Ptolemy, Galen, as well as more recent ones, such as Paracelsus, Marsilio Ficino and other Neo-Platonists, Julius Caesar Scaliger, Francesco Maurolico, Girolamo Cardano, and many more. At the very beginning of his work, he entitled the first chapter of the first book *Veterum et recentiorum scripta de magnete* [...], *opiniones variae et vanitates* ("Writings of ancients and moderns on the lodestone [...], different opinions and delusions"; Gilbert 1600, pp. 1–8.). This dismissal of the *auctoritas* of both ancient and recent writers, and the rejection of the *argumentum ab auctoritate* are harsh indeed, but definitely not unique for that time. Similar positions could be found in some contemporary scholarly accounts. Thus, Francesco Patrizi and Giordano Bruno likewise criticized authoritative texts to present and promote their views (Vasoli 1989; Blum 2012; Akopyan 2019). Gilbert, it seems, modeled his own ideas on such bold undertakings and suggested that the old textual authorities ought to be replaced with an innovative *physiologia nova*. The title "New Physiology" might even be an analogy to similar claims of innovation by natural philosophers, such as Bruno, who called his new knowledge system "new philosophy" (Knox 2018), or Patrizi, who wrote *inter alia* a *Nova de universis philosophia* (Akopyan 2019). While such endeavors seem to reinforce the claim that ancient authorities and rhetorical argumentation are simply replaced by empirical knowledge in early modern times, the picture is more complex.

More often than not, the traditional ancient, medieval, and contemporary authorities constituted the basis for new scientific undertakings. New hypotheses and discoveries were commonly presented as being predominantly in line with the authoritative worldview, simply adding a novel nuance to it. Another strategy frequently employed was to criticize not the leading authority—Aristotle or Galen or Ptolemy—but later scholars disseminating distorted knowledge. This possibility of expressing tentative critique against authorities in early modern times was also employed by

11. "[...] in tam vasto librorum oceano, quibus studiosorum ingenia perturbantur, fatiganturque; quibus ineptioribus, vulgus et homines importunissimi inebriantur, deliriant, inflantur, et tumultus faciunt literarios, seque philosophos, medicos, mathematicos, astrologos profitentur, et viros doctos negligunt, contemnuntque."

Galileo ([1632] 1998, vol. 1, 54; see Danneberg 2009, pp. 330–49; De Angelis 2010). The *argumentum ab auctoritate* itself usually still held power (Blair 2006; Danneberg 2003, pp. 162–72; Danneberg 2009).

A closer look at the *De magnete* shows us Gilbert's relationship with authorities as somewhat more differentiated than the tone of the preface might suggest. The very end of the author's preface includes an attempt to redeem ancient writers, at least to some extent, as they stem from a distant world and had a different background and knowledge:

> Those ancient men, almost the first parents of philosophy, Aristotle, Theophrastus, Ptolemy, Hippocrates, Galen, should ever be honoured as those, from whom knowledge descended to later generations; but our era brought forth and to light many things which they would have gladly embraced had they still been among us. (Gilbert 1600, fol. iii^{r})[12]

Naturally, even scholars as bold as Gilbert had to ground their findings in already established knowledge. Lengthy parts of the *De magnete* are centered around the findings of his predecessors, the first book even creating a short historical overview of such investigations. Numerous properties of the lodestone described within the work were taken from Petrus Peregrinus' thirteenth century *Epistola de magnete* (Balmer 1956, pp. 243–77). Gilbert heavily used text on nautical problems and instruments to solve them, e.g., Robert Norman's *New Attractive*, sometimes openly acknowledging this debt to them, other times silently (Zilsel 1941; Pumfrey 2002, pp. 173–81; Cohen 2010, pp. 149–250). Additionally, Gilbert's theories sometimes depend on the opinions and systems of those schools he criticized. This concerns mostly notions and concepts, where he makes use of Peripatetic theories as well as Paracelsian and even Neo-Platonic thinking (Zilsel 1941, pp. 3–7; Freudenthal 1983; Henry 2001).

Even considering these limitations and Gilbert's dependence on ancient, medieval, and early modern thinkers, the explicit rejection of authority and especially the condemnation of the scholastics of the universities and all those who trust in book knowledge alone is striking. He essentially ridiculed written knowledge, celebrated the new age and its innovations, and stated that he laid his trust only in empirical investigations, largely his own demonstrations and experiments. These statements do not reflect Gilbert's scientific work in full, as he does quite naturally

12. "Priscis illis et quasi primis philosophiae parentibus Aristoteli, Theophrasto, Ptolemaeo, Hippocrati, Galeno suus semper honos tribuatur, a quibus dimanavit sapientia ad posteros; sed aetas nostra plurima detexit et in lucem attulit, quae illi etiam si viverent libenter amplecterentur."

depend on the knowledge of others but represent his rhetorical aims to construct a persuasive image: Apart from employing persuasive non-artistic proof in the form of *experimenta*, the Royal physician also exercised great effort to use another mode of persuasion according to Aristotelian rhetoric, which gained importance in sixteenth- and seventeenth-century natural philosophy: *ethos* (Arist. *Rhet.* 1.2.4; 2.12–17 [Aristotle 1959]) or the self-fashioning of the scientist (Dear 1985, 1991, p. 162; Luggin 2021). To make their hypotheses, beliefs, and conclusions persuasive, early modern scholars—similar to modern ones, for that matter—had to do more than skillfully formulate strong arguments. Not only the case at hand, the scientific problem, had to be presented as artfully as possible, it became more and more important to also promote the person behind the cause, the natural philosopher, his character, and reputation. Stressing the flawless character of the scientist also elevated the value of his work, as it built trust in the reader in the author's professional competence on the one hand and his faithfulness on the other. How could someone presented as an honest, moral, and hard-working person show the reader anything else than what he thought of as the truth of the matter? The credibility of the scientist thus depended to a large extent also on the display of his *ethos*, something which was clear to an early modern author after his usually extensive rhetorical training (Lausberg 2008, p. 141; Steel 2009, p. 81).

The spectrum of possibilities for self-fashioning at the time ranged from stressing one's personal and professional integrity and virtues or giving the appearance of neutrality and objectivity to the promise of presenting something wondrous and not heard or seen before (Jardine 1991; Serjeantson 2006, pp. 147–48). Apart from extra-textual possibilities, such as the network of the scientist, his patrons, his general social and political status, the role of scientific academies and societies, and the book market, there were plenty of places inside an early modern work to construct one's *ethos*: title pages, paratexts, images, and charts, as well as the main text. In an analogy to the *exordium* of ancient speeches, paratexts—the preface, letter to the reader, prefatory poems, an introduction—were the ideal place for this (Kennedy 1994, pp. 58–9; Lausberg 2008, p. 141; Vermij 2011). Early modern natural philosophers used the opportunities to present themselves as competent, reliable, hard-working, virtuous scholars, sometimes putting themselves in a tradition of authoritative scientists, other times juxtaposing their own accomplishments to those of earlier scholars (Steel 2009, p. 81). Many titles of early modern scientific works speak of the virtues, knowledge, or dignity of its authors, qualities that are repeated in congratulatory or panegyric poetry written by colleagues, patrons, friends, and dignitaries at the beginning of the works, testifying to the scientific, political, and social network of the author, showing their

symbolic capital and thus presenting them as competent and trustworthy (Enenkel 2015; Luggin 2021).

Gilbert consequently combined his presentation of empirical, seemingly objective knowledge, with an effort to display himself as a competent, trustworthy, and reliable natural philosopher, who spared neither trouble nor expense to uncover the secrets of nature. One element of this self-representation could be the dedication of the book to a powerful patron (Bossuyt et al. 2008). Interestingly, Gilbert's work does not have a dedication—and as physician of Queen Elizabeth and President of the College of Physicians it should not have been too difficult to obtain a dedicatee. The *De magnete* also does not contain panegyric prefatory poetry as was customary at the time (Enenkel 2015). It is presented as a simple, straightforward, technical work, with an unadorned title page, a preface by the author, and a letter of commendation by Gilbert's student Edward Wright. One can speculate about the reasons for this lack of common paratexts: did Gilbert want to break with another tradition? Did he not want to mention other scholars besides himself?

In a quote already analyzed above, Gilbert speaks of his ideal readers as the sole dedicatees (*Sed vobis tantum vere philosophantibus* [...] *fundamenta ista magnetica commendavi*, Gilbert 1600, fol. ii^{v}). Several pages later, at the end of the first chapter of Book I, the author harshly criticized contemporary scholars, who only paraphrased or even misused the works of others, using the names and power of patrons to influence their unsuspecting readers (Gilbert 1600, p. 8).

As his own book does not contain a dedicatory letter to a patron but instead a letter recommending himself, written by a colleague and student of his, we can argue that Gilbert aimed to turn the usual hierarchy around, breaking with just another literary tradition. It seems that he decided not to make use of the common practice of dedication, patronage, and panegyric paratexts, not to include topical paratextual instruments into his innovatively presented physiology. Instead, Gilbert put his readers and, most of all himself, again into the center of attention, without adopting the practices of eulogy, which could have made him suspect of using the same techniques as those adhering to authorial book knowledge and scholastic speculation. As Gilbert aimed to make his *De magnete* a sharp caesura in natural philosophy, he might have chosen to deviate from his forerunners in terms of presenting his work as well as his *ethos*.

A pirated second edition of Gilbert's work, printed in 1628, used the traditional construction of *ethos* through a beautifully adorned title page and added poetry lauding the author (Gilbert 1628; see Fig. 6). Additionally, this edition did not include Gilbert's system of asterisks, even though it maintained Gilbert's reference to and explanation of it in the preface

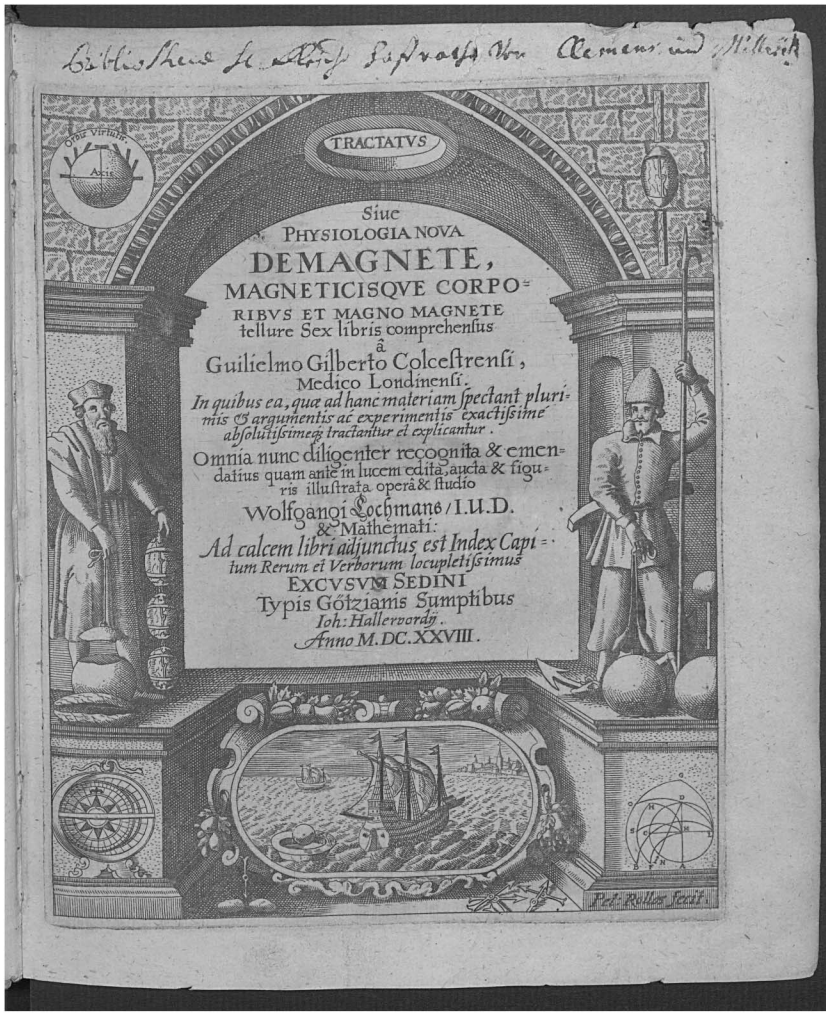

Figure 6. Title page of the second, pirated edition of Gilbert's *De magnete*, here called *Tractatus sive physiologia nova*, edited by Wolfgang Lochmann and printed with an intricate engraving, showing illustrations from the monograph as well as highlighting the close connection with navigation. Gilbert 1628. Universitätsbibliothek Erfurt, 13 – Np. 8° 01053.

(fol. A1^{v}), but it provided marginal notes summarizing the content of paragraphs and chapters. While Gilbert himself deliberately did not make use of these common devices, we can speculate that by the end of the 1620s his work had been established as an authority on magnetism as well as on empirical investigation, so the publisher saw no need to refuse the traditional means of constructing his *ethos*, essentially contradicting the author's original intention.

What Gilbert did to present himself as an expert scientist, instead of using patronage and authority through paratext, was time and again, throughout the entire work, to underline his arduous, time-consuming, as well as expensive work over many years to obtain the conclusions he could safely present as reliable and verifiable hypotheses and results. The two-and-a-half-page preface alone is full of self-fashioning that stated how Gilbert had with great care worked day and night on his research, and that he experimented daily, so that he would make new, outstanding, and unprecedented findings (Gilbert 1600, fol. Ii^{r}).[13] He strove to make sure that his readers would see how many investigations he conducted himself and how much effort, sleep, and money it all cost him, and that he did not present anything in his book that he had not himself investigated over and over (Gilbert 1600, fol. Ii^{v}).[14]

Throughout the text, Gilbert continued to make explicit statements and presented his knowledge, experiments, and conclusions, showing his efforts in providing precise, trustworthy information on the physical, technical, and cosmological aspects of magnetism. This is underlined by his strategy to frequently not acknowledge his debt whenever he adopted information, methods, or conclusions from other scholars. This certainly was in line with Gilbert's strategy of constructing his *ethos* as the new authority on magnetism, while largely rejecting the opinion of others.

3. Trust No One but Gilbert

We can conclude that Gilbert's attempts at persuasion, at deconstructing old and installing new authority, used a threefold strategy. First, he mentioned as many *experimenta* as possible as cumulative evidence, highlighting them in a completely new strategy with asterisks throughout the work and

13. "In magnetis viribus perquirendis […] diutinam multamque curam adhibuimus. Neque hunc nostrum laborem inertem, et infrugiferum invenimus; cum nobis quotidie experiendo, novae et inauditae proprietates elucerent".

14. "Videant tamen experimentorum et inventorum […] magnam frequentiam: quae multis nostris curis, vigiliis, et impensis eruta et demonstrata sunt; nihil enim in istis libris depromptum, quod non exploratum, saepissimeque actum et transactum apud nos fuerit".

using other strategies to make them more persuasive—emphasizing the frequency of experiments, of repetition of the same trial, generalizing events, providing instructions for replications or adaptations, or mentioning methodological issues. These are important strategies to make the use of experiments within argumentation effective as numerous attempts over the seventeenth century would show. The isolated instance of one empirical investigation could thus qualify as a statement of truth and not simply a description of one particular occurrence (Dear 1985, 1991, p. 162). Though the impersonal style of many of Gilbert's accounts deprived the reader of details of the operation, or could prevent repetition of the practice, this did not detract from the force of the work's display of substantial and unprecedented empirical knowledge (Cunningham 2001).

Secondly, Gilbert fashioned himself as a hardworking, devoted scientist, who spared neither effort nor trouble to get to the secrets lying behind things thus far hidden. Reading his work, the reader is confronted with this presentation of the scholar's *ethos* repeatedly, from the title page, the unusual paratexts, and the recurrent mentions in the preface to numerous passages within Gilbert's text. Even though he delivered many experiments in an impersonal style, the author made it a point that the reader would never forget who instructed him on the properties of magnets and why his instructor was qualified to do so. He did so, however, in a way which must have been surprising to his readers, considering his rejection of traditional paratextual strategies. Gilbert showed his awareness of the rhetorical devices that were usually employed in paratexts, but he did not himself make use of them to distance himself even more from previous authorities and contemporary scholars. The exceptional way of marking experiments with asterisks, which has no apparent parallel in earlier or contemporary writing, also served as a rejection of textual authorities. In his effort to replace textbook knowledge with empirical knowledge, this was just another innovative device to deconstruct authorities.

Finally, Gilbert dismissed written authorities, ancient, medieval, and, most harshly, contemporary, and those who trust them implicitly. He purposely concealed the influence of other scholars on his reasoning and his dependence on both Aristotelian and Neo-Platonic thinking. Instead, he presented not only a "new way of philosophizing," but also a new authority on magnetism. All these efforts should ultimately convince his readers to place their trust solely in one person, the author of the *physiologia nova*.

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