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Sorana Corneanu, Koen Vermeir

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# The Art of Thinking

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*Sorana Corneanu and Koen Vermeir*

“Logic in the modern phrase is the Art of Thinking, a help or instrument of reason.” Thus wrote the Cambridge antiquarian Thomas Baker in his *Reflections upon Learning* (1699), an “Historical Account” of philosophy, conceived as an overview of the successes and failures of various ancients and moderns in each branch of learning.<sup>1</sup> The phrase ‘art of thinking’ had been made popular by the title of Antoine Arnauld and Pierre Nicole’s *La Logique, ou l’art de penser* (1662), also known as the Port Royal Logic.<sup>2</sup> In the hands of Baker and other authors reflecting on what it meant to be modern in the late seventeenth century, the phrase was used as a general name for logic or method that would apply equally well to the theories of Ramus, Bacon, Descartes, Malebranche, Locke, and even to that of Aristotle.

In this chapter we propose an approach to the history of early modern logic and method<sup>3</sup> that places our topic within the specific context of the late seventeenth-century debate over the relative worth of ancient and modern learning. This debate initiated a period of “intense self-reflection” in which both the literary and the scientific merits of the present were compared with those of the past—a process which subsequently helped fashion “the narrative of Enlightenment.”<sup>4</sup> We will show that logic, rebranded as ‘the art of thinking,’ was one of the core concerns of authors on both sides of the debate. We will be interested in the way their reflections, whether in support of Aristotelian or of the various brands of ‘modern’ logics, contributed to the construction of an image of philosophical modernity at the high point of the Scientific Revolution. This image was inherently polemical and pluralistic, as will emerge from the variety of canons and the diversity of positions on the ingredients of the art of thinking that we will identify in their writings. Yet it will also appear that the points of disagreement reveal an underlying consensus about the core features that the

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<sup>1</sup> Baker 1699: 51, A7<sup>r</sup>.

<sup>2</sup> A previous occurrence is in Gassendi 1658 (*ars bene cogitandi*). The Cartesians usually adopted the phrase. Gassendi also referred to logic as *ars disserendi*, which had a double pedigree: humanist-Ramist (Ong 1983:178-80; Jardine 1974: 26, 41) and scholastic (e.g., Coimbrans 1607: 54).

<sup>3</sup> Important overviews of these topics include: Gilbert 1963, L. Jardine 1974, L. Jardine 1988, N. Jardine 1988, Dear 1995, Dear 1998, Nuchelmans 1998, Serjeantson 2006, Capozzi and Roncaglia 2009, Roux 2011, Sgarbi 2013, Lu-Adler 2018.

<sup>4</sup> Edelstein 2010: 5 and chaps. 3 and 5; cf. Norman 2011, chap. 2.

logic relevant to the sciences needs to exhibit: both parties in the debate agreed that this logic would have to be the expression of the natural operations of the human mind, would ground the pursuit of the sciences and would be capable of leading the mind to the discovery of genuinely novel and valuable truths about the natural world. These, we will argue, are the points on which the debaters agreed to disagree. To them, these features were the labels that captured the gist of their philosophical modernity. The way they filled in these features, however, differed significantly from author to author.

## 1.1 The Art of Thinking and Philosophical Modernity

Thomas Baker, with whom we began this chapter, indicated that the late seventeenth-century *querelle des anciens et des modernes* was indeed the context for his work.<sup>5</sup> The *querelle* has been mainly studied by historians of literature, yet it is an equally significant moment in the history of science and philosophy: the “comparisons,” “parallels,” and “histories” of ancient and modern learning undertaken by its participants often encompassed the whole array of disciplines and were particularly interested in assessing the new science.<sup>6</sup> When they did so, the chapters devoted to logic (often also called ‘method’) served as fulcrums of the debate over the merits of ancient and modern natural philosophy. The art of thinking described the cognitive procedures apt to deliver the best results for all actions of the mind in all its endeavours, yet the crux of the debate was the art’s relevance to the philosophical study of nature. While almost everyone agreed on the value of the ancients’ contributions to rhetoric and poetry, the key issue that divided camps was the progress, or lack thereof, related to philosophy and the new sciences.

One early contribution to this debate came from Nicolas Poisson, the Oratorian priest and Cartesian propagandist, whose *Commentaire ou remarques sur la Méthode de René Descartes* (1670) included a “parallel” (or comparison) between “vulgar” (i.e., Aristotelian-Scholastic) and “recent” logicians. Among the latter were Raymond Lull, the humanist dialecticians (Lorenzo Valla, Rudolph Agricola, Juan Luis Vives, and Petrus Ramus), Francis Bacon, Thomas Hobbes, and, above all, René Descartes, whose logic was supplemented by those of Johannes Clauberg and the Port Royal authors. All of these new logics, Poisson claimed, agreed with the “great principle” behind Descartes’s method, identified as the conduct of reason and the formation of judgment.<sup>7</sup> Poisson’s was the type of position against which the Jesuit critic and historian René Rapin, “the chief

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<sup>5</sup> Baker 1699: A5<sup>v</sup>-A6<sup>r</sup>.

<sup>6</sup> See Lehner and Wendt 2017.

<sup>7</sup> Poisson 1670: 4-12.

proponent of *ancienneté* in the reign of Louis XIV,”<sup>8</sup> reacted in his own polemical history of learning, the *Reflexions sur la philosophie ancienne et moderne* (1676). With regard to logic, Rapin’s concern was to establish Aristotle’s definitive contribution to the field of the “art of thinking and discoursing” and to dismiss the abortive modern attempts at reforming or discarding the Aristotelian legacy. His list of misguided moderns included Lull, the humanist dialecticians, Bacon and Descartes, as well as Girolamo Cardano, Jan Baptist van Helmont and Tommaso Campanella, but also the over-sophisticated Spanish Aristotelians. Instead, Rapin praised two moderns who furthered Aristotelian logic in an innovative way: Martinus Smiglecius, the Polish Jesuit, and Pierre Mousnier, the Grenoble physician who published the lectures on logic of his teacher, Honoré Fabri.<sup>9</sup>

The defense of the moderns took the form of *encomia* in the 1680s, with Charles Perrault’s recitation of his poem *Le Siècle de Louis XIV* at the Académie Française (1687) and the publication of Bernard Bovier de Fontenelle’s *Digression sur les Anciens et les Modernes* (1687). Fontenelle argued that while the ancients were still commendable in rhetoric, history and poetry, the moderns necessarily had the upper hand in the sciences, since the sciences were based on the *justesse du raisonnement*, exemplified best by the Cartesian *manière de raisonner*, an aptitude that was perfected over time, and thus allowed progress.<sup>10</sup> Fontenelle’s stance was echoed by Pierre Coste, the Protestant theologian and translator, in his *Discours sur la philosophie*, appended to the Cartesian Pierre Sylvain Régis’s *Cours entier de philosophie* (1691), the first part of which was devoted to “Logic, or the Art of Thinking.” Coste’s text was written in response to Rapin’s and was similarly designed as a history of philosophy.<sup>11</sup> Unlike Rapin’s, however, Coste’s aim was to show that philosophy had reached its highest perfection in modern times. Coste limited the list of moderns to Pierre Gassendi, Descartes, and the Cartesians, among whom the relevant logicians were Nicolas Malebranche and Régis himself.<sup>12</sup>

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<sup>8</sup> Levine 1991: 268.

<sup>9</sup> Rapin 1678: 117, 120-24.

<sup>10</sup> Fontenelle 1766: 280-90; cf. Coste 1691: n.p.; Wotton 1694: 154-6. For Fontenelle, physics, medicine, mathematics, metaphysics, but also religion and ethics are governed by reason, and therefore allow for progress, while rhetoric, history and poetry depend mostly on the vivacity of imagination.

<sup>11</sup> Piaia 2011: 9-11. Generally on early modern histories of philosophy relevant to science, see Levitin 2014. The relations (and extent of overlap) between early modern histories of philosophy and of logic and between philosophical and logical sectarian groupings are topics deserving further investigation, On philosophical sects, see Bellis’s chapter in this volume.

<sup>12</sup> Coste 1691: n.p.

In reaction to Fontenelle, Sir William Temple, the English statesman and essayist (and Jonathan Swift's patron<sup>13</sup>) wrote a "history of learning" meant to show that the moderns' claims to both novelty and superiority were misguided. Temple and the other defenders of the ancients admitted there were discoveries, yet questioned the idea of progress. As Temple put it, "whether either of these be modern discoveries, or derived from old Fountains, is disputed." Similarly, Rapin commented that Descartes' principles were "not altogether new" and that Aristotle's natural historical works contained "the first hints of the most part of the new discoveries, whereof Modern Philosophy boasts."<sup>14</sup> Temple's main respondent was William Wotton, a classical scholar, linguist, and historian, whose *Reflections upon Ancient and Modern Learning* (1694) was commissioned by the Royal Society as a reply to Temple's *Essay*. For Wotton, logic (the "art of thinking" or "of reasoning") was "the Foundation of all Knowledge" and its key feature was its capacity of leading to discoveries in the sciences. Wotton pitted the Baconian "Advancement of real Learning" against "the Art of Disputing, and making Syllogisms" of the schools. To illustrate modern achievements, Wotton singled out Bacon, Descartes, John Locke, and E.W. Tschirnhaus.<sup>15</sup> Similarly short lists of luminaries meant to exemplify the superiority of modern logic over Aristotelian-scholastic logic were put forward by Tschirnhaus himself, William Molyneux, and Jean le Clerc. These lists included Descartes, the Port Royal Logic, Malebranche, Locke, and Edme Mariotte.<sup>16</sup>

Wotton's work reached G.W. Leibniz via Thomas Burnett, who in 1697 summarized for him the new edition of the *Reflections*.<sup>17</sup> In the same year, Leibniz wrote a letter to Gabriel Wagner, in which both ancients and moderns were praised for their contributions to logic: Aristotle and Porphyry, Ramus and the Ramists, Cardano, Bacon, Descartes, Joachim Jungius, Vincent Placcius, and Johannes Felden—all of them had had something valuable to say about the "art of thinking," or the art of using the understanding in both discovery and judgment.<sup>18</sup> Leibniz's irenic goodwill toward ancients and moderns alike had its counterpart in the sceptical downgrading of both parties by Thomas Baker, whose historical account was meant to show the "Weakness of Humane Understanding" across its history, and thus the need for revelation. As far as logic was concerned,

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<sup>13</sup> Although officially a defender of the ancients, Swift (1891: 79) derided school logic, exemplified by Aristotle and Smiglecius.

<sup>14</sup> Temple 1909: 25; Rapin 1678: 69, 174-5.

<sup>15</sup> Wotton 1694: 154-6.

<sup>16</sup> Tschirnhaus 1695: "Praefatio," n.p.; Molyneux 1692: "To the Illustrious Royal Society," n.p.; Le Clerc 1692: "Ad lectorem," n.p.

<sup>17</sup> Levine 1991: 88.

<sup>18</sup> Leibniz 2006: 375, 378-9, 382.

although Aristotle was to be commended for having perfected the “art of syllogizing,” and Bacon for laying open “the way of free thinking,” both attempts were futile, since both syllogism and induction were weak instruments of knowledge. The logics proposed by Ramus, Descartes, the Cartesians, and Tschirnhaus were equally inadequate, while the best part of the Port Royal Logic was simply borrowed from Aristotle.<sup>19</sup>

The various lists of modern authors of arts of thinking put forward during this debate are illustrated in the TABLE attached to this chapter. The table shows that, although some names appear more frequently than others, most notably Ramus, Bacon, Descartes, the Port Royal Logic, Malebranche, and Locke,<sup>20</sup> there was no agreement on a single canon. Alongside the plurality of canons, the table also makes clear the presence of what are, in the present-day, both canonical and non-canonical authors. From the point of view of the early modern actors, all of them were recognizable members of the modern field of logic. These lists are therefore apt to problematize the nineteenth-century canons that still dominate the current history of philosophy and science.

The early modern canons were the fruit of a process of historicization, since the understanding of what was modern was based on historical actors’ attitudes towards the past. This historicizing endeavour was highly polemical on all sides, resulting in various images of what it meant to be modern in relation to the tradition.<sup>21</sup> Attitudes varied from the triumphant image of a clean break with the past (as in Perrault), to the suggestion that the modern discoveries were “derived from old Fountains” (as in Temple), through middle positions on the points of convergence and divergence between ancients and moderns (as in Leibniz). These mirror precisely the types of attitudes to the relation between the Aristotelian tradition and the early modernity that the historiography of the Scientific Revolution has explored over the last century. The latter two have been the preferred directions of our most recent historiography, supplanting the former perspective. The overview here suggests that these directions were already the fruit of the self-reflexive capacity of the Scientific Revolution, of which the *querelle* was one of the more visible (and noisier) manifestations.

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<sup>19</sup> Baker 1699: A5<sup>v</sup>-A6<sup>r</sup>, A7<sup>r-v</sup>, 51-63.

<sup>20</sup> On the reception of Descartes and Locke as logicians, see Schuurman 2003; Savini 2004; Ariew 2014; Pécharman 2016.

<sup>21</sup> The *querelle* can be fruitfully compared with the earlier debates over the *novatores* in philosophy: Garber 2016 and Garber’s chapter in this volume.

In the rest of this chapter we will argue that the debate over logic played an important role in the construction of an image of philosophical modernity. Certainly, since the positions in the debate reflect a specific time frame, national bias, particular ideological positions, as well as personal agendas, they can hardly be taken as the definitive face of modernity itself. Nevertheless, what we can glean from the debate is the way historical actors constructed their own image of a modern art of thinking relevant to science: this art would be the reflection of a “natural logic” inherent in the human mind, it would ground the pursuit of the sciences and it would make scientific discovery possible—these were the core features that both sides of the debate recognized as part of the set of philosophical values characteristic of their own time. Even when defending the ancients, authors like Rapin agreed with the defenders of the moderns on these basic features of an art of thinking. However, we will also note that these widely recognized features were diversely qualified by the individual authors and supported by different historical sources. In addition, we will show that the historical sources themselves provided a plurality of views subsumed under these features.

## 1.2 The Features of the Art of Thinking

For the authors on both sides of the debate, an art of thinking reflecting the natural functioning of the human mind and grounding the pursuit of the sciences with a view to discovery was at the heart of their image of their own modernity. However, there was little consensus regarding not only the sources best representing these features, but also their precise content—while seemingly unitary *mots d'ordre*, the features covered a highly heterogeneous landscape. We will explore this heterogeneity both at the level of the debate and among the sources invoked by the participants in the debate.

### 1.2.1 The Focus on Mind

Reflecting their early modern sources, the participants in the debate conceived the art of thinking as an art that systematized the natural operations of the mind and directed its rules towards a useful end—in other words, as a practical, instrumental art.<sup>22</sup>

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<sup>22</sup> For this humanist notion of “art,” see Gilbert 1963, 11, 69; Jardine 1674, 41; Ong 1983, 179. Compared to the scholastic discussions of the status of logic as either a science or an art (Campanella 1637, 2-5; Smiglecius 1638, 80-92; Mousnier [Fabri] 1646, 136; Ariew 2014, 48-50), here the practical nature of the art is simply assumed. For the scholastic discussions of *logica naturalis*, *artificialis*, *docens* and *utens*, see Smiglecius 1638, 92-96; Mousnier [Fabri] 1646, 137; Lu-Adler 2018, 48-63.

The art of thinking was premised on the existence of a “natural logic,” seen as the inchoate form of the art. On both sides of the *querelle*, authors agreed that the art of thinking was simply an extension and clarification of structured procedures which the mind of man naturally employed in the acquisition of knowledge. An overview of this issue will nicely set the stage for our argument that both sides of the debate agreed on several essential features of the art of thinking, while describing them in different ways and ascribing them to different sources.

There is a double thrust to the claim about natural logic. On the one hand, it signals the importance of the operations of the mind for the grounding of logic, whether in the form of the three “Aristotelian” operations of simple apprehension, judgment, and reasoning (to which ordering is sometimes added as a fourth operation), or in that of the two Ciceronian operations of invention and judgment.<sup>23</sup> These models are indeed recognizable in the sources of the late seventeenth-century debate. The former structures most late Scholastic logics, as well as Gassendi’s logic, the Port Royal Logic and, in its wake, all of the Cartesian logics; while the latter forms the ground of Ramus’s dialectic and of Bacon’s “new logic.”<sup>24</sup>

On the other hand, the notion of natural logic rests on the identification of specific logical procedures with which man naturally is endowed. For instance, Leibniz thought that “the art of thinking must first be sought by using as models examples of good thinking,” and that such examples were to be found among both ancients and moderns, whether in the form of Bacon’s “art of experimenting” or in Aristotelian syllogistic.<sup>25</sup> Rapin took syllogism alone to be the “most consonant to the usual manner of reasoning.”<sup>26</sup> By contrast, Coste and Poisson associated the natural manner of reasoning with Descartes’s method, which “simply advises us that these rules are in us.”<sup>27</sup> This echoes a position frequently found in their sources: for Ramus, the rules of invention and judgment were natural operations of the mind; for Bacon, the mind of man naturally followed the path of induction if it could remain untainted by “idols”; Descartes thought that intuition and

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<sup>23</sup> For the “Aristotelian” operations (in fact a Thomist legacy), see Rapin 1678, 118; Coste 1691, n.p.; Baker 1699, 52; for the Ciceronian operations, see Leibniz 2006, 375-79.

<sup>24</sup> Ariew 2014, 43-57, 157-65; L. Jardine 1974, 31-34.

<sup>25</sup> Leibniz 2006, 378-9, 383.

<sup>26</sup> Rapin 1678, 109.

<sup>27</sup> Poisson 1670, 15-16; Coste 1691, n.p.

deduction were activities proceeding from the innate “light of reason”; and for Locke, the understanding had a “native Faculty” for perceiving the agreement or disagreement of ideas.<sup>28</sup>

A consequence of the notion of natural logic is the question of the legitimacy of artificial logic, or the *art* of thinking. The Port Royal Logic’s threefold answer to this question is a good indication of early modern attitudes: one thing this art ensures is the right use of reason; a second is the knowledge and prevention of error; a third is the knowledge of our minds.<sup>29</sup> The first use is relevant to the focus on discovery, to which we will return below. Here we will dwell on the other two uses (in reversed order).

The art of thinking was bound up with the aim of acquiring knowledge of the human mind. This is indeed part and parcel of the modern sources: in *De augmentis scientiarum*, Bacon discussed logic as part of his doctrine concerning the use and objects of the faculties of the human soul; Descartes inserted an account of the human mind in the Twelfth Rule of the *Regulae*; Malebranche structured his *Recherche* according to the faculties and passions of the mind; and Locke presented his *Essay* as a natural historical investigation of the understanding.<sup>30</sup> The noteworthy fact here is that the scope of mind relevant to logic became wider than intellect alone: the imagination, memory, passions, as well as the body itself became involved in the art of thinking. The imagination could be relevant negatively, as the faculty at work, together with the passions and the bodily spirits, in the vices of the mind that the art of thinking was supposed to remedy (as in Bacon, Malebranche or Locke);<sup>31</sup> or positively, either as the faculty partly responsible for the logical acts (as in Hobbes and Gassendi),<sup>32</sup> or as an aid to logical thinking (as in Descartes, Malebranche, or Tschirnhaus).<sup>33</sup> Memory could feature as an aid to natural history (as in Bacon), or as an aid to inference (as in Clauberg).<sup>34</sup> Moreover, the complex faculty of *ingenium* also became involved in the logical life of the mind.<sup>35</sup>

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<sup>28</sup> Ramus 1555, 2; Bacon, SEH IV, 140, OFB XI, 197; Descartes, AT X, 368, 371-3, 383, CSM I, 14, 16, 22; Locke 1975, 671. See also Campanella 1637, 11; Mariotte 1678, 168; Arnauld and Nicole 1996, 9, 23; Malebranche 1980, 437; Régis 1691, 48; Tschirnhaus 1695, 53, 294.

<sup>29</sup> Arnauld and Nicole 1996, 23.

<sup>30</sup> Bacon, SEH IV 405ff; Descartes, AT X 411-17, CSM I 39-43; Locke 1975, 44. See also Mariotte 1678, 202-32.

<sup>31</sup> Bacon, OFB XI 79-109, OFB IV 21-32; Malebranche 1980, bks. 1-2, 4-5; Locke 1975, 715; Locke 2000, 237-50.

<sup>32</sup> Hobbes 1656, 36-7; Gassendi 1658, 92.

<sup>33</sup> Descartes, AT X 388, 416, 438, CSM I 25, 43, 56; Malebranche 1980, 419ff; Tschirnhaus 1695, 280-86.

<sup>34</sup> Bacon, OFB XI 215ff; Clauberg 1691, 813-14.

<sup>35</sup> See Ariew, in press. On the complexities of early modern *ingenium*, see Marr et al. 2019.

The art of thinking was also bound up with the project of guiding, regulating, and improving the human mind, a project usually designated within the *querelle* by the Cartesian label of an “art of forming judgment,” adopted not only by Poisson or Coste, but also by Rapin.<sup>36</sup> Indeed, this definition of the aim of logic was present not only in the “new” logics among their sources, but also in some of the Aristotelian ones.<sup>37</sup> From the perspective of the former, the key ingredient of logic as a corrective art was a specific conception of error, seen as a result of the malfunctioning or even viciousness of the faculties of the mind—an idea captured by what Poisson and Baker called the “weakness of the understanding.”<sup>38</sup> Error in this sense could take the form of Bacon’s “idols” or of Descartes’s childhood prejudices.<sup>39</sup> Various combinations of these two models characterize the account of error in Clauberg, the Port Royal Logic, Mariotte, Tschirnhaus, Malebranche, and Locke.<sup>40</sup> In all these sources, one task of logic was to overcome error, in the sense of repairing the faulty functioning of the mental faculties. Logic thus became part of a general practice of the good life. In some places, the medical metaphor of curing the diseases of the mind (*medicina mentis*) was explicitly used and the interdependence with the medicine of the body was also thematized (as in Bacon, Clauberg, Malebranche, and Tschirnhaus).<sup>41</sup> Yet, while this was mostly a ‘modern’ development, a comparable approach to error can be found in an Aristotelian logic (Fabri).<sup>42</sup> In principle, this approach, which treats error as intrinsic to the mind and thus invests logic with a curative role, is in stark contrast with the traditional view of error as a breach of formal validity, and therefore as extrinsic to the mind (with the consequence that logic is seen as an instrument that aids thought, but is not part of it). However, in practice, both types of error were treated side-by-side in some non-Aristotelian logics (Hobbes, Gassendi, and the Port Royal Logic).<sup>43</sup> This was possibly a consequence of the move towards redefining the ‘instrumentality’ of logic: the idea of ‘instrument’ itself was redefined to mean ‘intrinsic’ to the mind, but for some authors the term continued to carry with it the sense of ‘extrinsic’, too.

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<sup>36</sup> Poisson 1670, 16; Coste 1691, n.p.; Rapin 1678, 98-9. For the Cartesian label itself, see Cassan 2015.

<sup>37</sup> Smiglecius 1638, 49-58; Jungius 1641, 1; Mousnier [Fabri] 1646, 50-51 (but with reference to the modern Galileo), 134-35.

<sup>38</sup> Poisson 1670, 4; Baker 1699, 51.

<sup>39</sup> Bacon, OFB XI 79-109; Descartes AT VIII A, 35-7, CSM I, 218-20.

<sup>40</sup> Clauberg 1691, 769-78; Arnauld and Nicole 1996, 5-9, 48-53; Mariotte 1678, 202-25, 232-4; Malebranche 1980, bk. 2, part 2; Locke 1975, 706-19; Locke 2000; Tschirnhaus 1695, 177-183.

<sup>41</sup> Bacon, OFB XII 229-73, OFB XI 427-29, SEH III 832; Clauberg 1691, 250, 771; Malebranche 1980, bk. 2, part 1; Tschirnhaus 1695, 217-20. See Savini 2004; Van Peursen 1993.

<sup>42</sup> Mousnier [Fabri] 1646, 45-48.

<sup>43</sup> Hobbes 1656, 41-47; Gassendi 1658, 96-97, 119-20; Arnauld and Nicole 1996, III.19-20. In the late seventeenth-century debate, at least one voice insisted on the crucial importance of formal error: Leibniz 2006, 378-79.

We have so far looked at the way both debaters and their sources attributed to logic an instrumental role relative to the human mind and noted the variety of positions behind this feature; we will now pass on to logic's relevance to the practice of the sciences and will be similarly interested in the diverse landscape of this theme.

### 1.2.2 The Focus on Scientific Practice

Rapin noted that the modern philosophers were “more addicted to Natural Philosophy than Logic,” while Wotton openly lauded the wide applicability of the new art of reasoning, as seen in “the late inquiries into physical, metaphysical, and mathematical matters.”<sup>44</sup> With regard to the Port Royal Logic in particular, Poisson praised its “appropriate application of the rules of logic by means of history, morals, physics, and metaphysics,” while Baker complained that “Arnauld's instances are taken from other Sciences, and suppose men to be wise already.”<sup>45</sup> Again, both sides agree on the applicability of the art of thinking, although they evaluate it differently. Two main issues are at stake here. One is the totalizing, universal nature of the art; in other words, the way it was seen to relate to the other sciences. The other has to do with the relationship between the rules of logic and the examples accompanying them.

The former issue recalls the traditional designation of logic as the “art of arts and science of sciences.”<sup>46</sup> The idea is present among the earliest sources used in the debate. It was the hallmark of Ramus's philosophy, for instance, to turn dialectic into a super-science or method that, by dividing and ordering all knowledge with the help of the famous Ramist trees,<sup>47</sup> could organize an architecture of the disciplines—which in turn was the root of the encyclopaedias and systems developed by later Ramists, such as Johann Heinrich Alsted, Clemens Timpler, and Bartholomäus Keckermann.<sup>48</sup> The totalizing tendency is also visible in both Bacon and Descartes, although their grand aim was no longer the teaching and organization, but rather the production of knowledge.<sup>49</sup> Their respective logics were presented as the ground and sap of their trees of knowledge.<sup>50</sup> However, each of them was exemplified by a particular science: Bacon's art of inquiry took the form

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<sup>44</sup> Rapin 1678, 122; Wotton 1694, 155.

<sup>45</sup> Poisson 1670, 13; Baker 1699, 60.

<sup>46</sup> Peter of Spain's phrase: L. Jardine 1974, 30; Ong 1983, 182.

<sup>47</sup> Ramus started with methodizing the traditional liberal arts but continued to increase its scope, in the end also including religion. See Ong 1983 for an introduction to Ramus's method.

<sup>48</sup> Hotson 2007, chap. 4.

<sup>49</sup> Note that this totalizing tendency was not always fully realized; Fontenelle, for instance, distinguished between disciplines ruled by imagination and others ruled by reason (see note 10 above).

<sup>50</sup> Bacon, OFB XI 191; Descartes, AT IXB 13-14, CSM I 186. See also Malebranche 1980, 408-9; Tschirnhaus 1695, 295.

of the progress of inductive natural history from particulars to general natures, while Descartes described early on a universal science, or method, the best exemplification of which was provided by mathematics.<sup>51</sup> Now, whether the art was really only exemplified or in fact generated by the specific disciplines is a question that is directly related to our second issue: the relationship between logical rules and examples. The question here becomes, do the examples illustrate or do they generate the rules?

The notion that the examples generate the rules was present in Ramus's dialectic and grounded the idea of natural logic. His students had to derive topical and syllogistic rules from instances of the use of reasoning found in poets, philosophers, and mathematicians. Locke's project was stronger yet—his natural history of the understanding was culled from the activity of the mind in all areas of knowledge, including the natural philosophical, the moral, and the theological. In contrast, the examples in the Cartesian logics, mostly deriving from the experimental and mathematical sciences of the day (Port Royal Logic, Malebranche, and Tschirnhaus), but also, to some extent, from the domains of rhetoric, morals, and metaphysics (Port Royal Logic), were usually illustrative of the Cartesian rules of method. However, they were also presented as contributions to the development of the sciences themselves.<sup>52</sup> In reply, Mariotte erased the illustrative function of the examples, which he turned into "methodological indications" that guide research in the natural sciences.<sup>53</sup>

In sum, for the participants in the *querelle* and the sources they referred to, the art of thinking was the fruit of a cross-fertilization between logic and the sciences that paid special attention to the practice of the sciences. Attitudes varied, however, as to the reach of logic in this process. Echoing the various positions in their sources, our authors did not reach consensus on whether logic was to be seen as the ground or substance of general systems of knowledge, or as the methodological backbone of particular sciences.

### 1.2.3 The Focus on Discovery

The question of discovery lay at the heart of the image of modernity that emerged from the *querelle*. Naturally so, since it was a debate about the value of novelty. It was also a polemical question, since it involved an evaluation of the procedures that were apt (or not) to secure discovery in the

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<sup>51</sup> Bacon, OFB XI 191; Descartes AT X 374-78, CSM I 17-19.

<sup>52</sup> Arnauld and Nicole 1996, 15-16.

<sup>53</sup> Roux 2011, 67-68.

sciences.<sup>54</sup> However, what was meant by discovery, how it stood in relation to the ideal of demonstration, and what procedures were identified as the legitimate ones, varied widely.

'Discovery' in the general vocabulary of the time might refer to the discovery of phenomena (such as the circulation of the blood) or to technological inventions (such as the telescope). In a more restricted sense, it can stand for: a) the discovery of conclusions or theorems (by means of deduction from principles); b) the discovery of principles (the premises of demonstrations); or c) the discovery of arguments (the topics of the logical-rhetorical tradition). All of these senses are derived from the Aristotelian tradition, and in all cases, discovery is tightly connected with demonstration. Sense (a) is the very substance of demonstration and encapsulates the desideratum of certainty or *scientia*; a desideratum of both ancients and moderns, whether in its syllogistic or mathematical guise. The sense (b) refers to the route of discovery prior to demonstration, whereby the principles on which demonstrations depend are themselves established. This is the crux of the modern attack on traditional methods, insofar as they were seen to inhibit this sort of "discovery." Sense (c) is mostly associated with the procedures of the dialectical *inventio* in the humanist tradition; however, Bacon used topical discovery, in a reinterpreted form, to serve the discovery of principles (which had also been the Aristotelian use of the logical topics).<sup>55</sup> In this way, the third sense is subsumed under the second.

Senses (b) and (a) (the discovery of principles and that of conclusions/theorems) form a tandem that was traditionally represented as the pairs of analysis-synthesis or of resolution-composition. These pairings echoed a variety of procedures, with different ancestries. They could refer to the ascending and descending routes between effects and causes in Aristotelian syllogistic (coupled with the epistemic routes between what is 'better known to us' and what is 'better known to nature'). Or they might evoke the mathematical procedure by which one traces backward from the posited unknown to a known principle, and then onward from the principles (axioms) to the theorems. The pairings might also reference the upward and downward routes between genera and species in scholastic metaphysical definition; or, finally, the compositive and de-compositive moves between wholes and parts in metaphysics. In the former two cases (the syllogistic and the mathematical procedures), analysis/resolution stands for the route from

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<sup>54</sup> Poisson 1670, 12-13; Rapin 1678, 98-99; Coste 1691, n.p.; Molyneux 1692, n.p.; Wotton 1694, 157; Baker 1699, 56; Temple 1909, 25-26.

<sup>55</sup> Bacon, SEH IV 413-27; Jardine 1988; Rossi 2013. There is also a scholastic tradition of discussions of the topics, which informs Jungius 1641, bk. V; Clauberg 1691, II, 844ff; both are cited by Placcius 1689, 13, who is cited by Leibniz 2006, 376-78.

particulars/effects/complexes to universals/causes/simples, and synthesis/composition for the reverse—which are the senses in which these terms were generally used in the early modern discussions of method. However, the question whether the syllogistic and the mathematical varieties of the procedures were identical or not was a matter of intense debate.<sup>56</sup>

Let us note now the variety of positions on the relation between discovery and demonstration and the various ways in which this pair was connected with the tandems of analysis-synthesis and invention-judgment. Some of the sources worked with a neat separation between the two stages of analysis/discovery and synthesis/demonstration (Port Royal Logic, Mariotte, Régis).<sup>57</sup> Sometimes discovery was seen to require a combination of analysis and synthesis, although it was itself firmly distinguished from demonstration/synthesis (Hobbes);<sup>58</sup> other times analysis constituted a procedure that ensured both discovery and demonstrative certainty, while synthesis disappeared from view (Malebranche, Tschirnhaus).<sup>59</sup> Some held that discovery should carry with it the force of demonstration, even if the procedures of invention and judgment were kept separate (Bacon);<sup>60</sup> others thought that analysis and synthesis served both invention and judgment (Gassendi).<sup>61</sup> For still others (Locke), discovery and demonstration were closely coupled in the domain of mathematics, but severed in that of natural philosophy, where discovery (of particulars rather than principles) was possible only through natural history, while demonstration was unavailable.<sup>62</sup>

As for the procedures apt to secure discovery and demonstration in the sciences, the debate was over the authority of syllogism versus that of alternative procedures, such as the Baconian inductive natural history, the Helmontian chemical trials, or the Cartesian mathematical method. The general modern rhetoric against syllogism reduced it to the basis of a culture of mere disputation and speculation, without any use for discovery.<sup>63</sup> Yet, there were defenders of the syllogism among the advocates of both ancients and moderns. In some early modern quarters, the

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<sup>56</sup> Gilbert 1963, 31-35, 81-92; L. Jardine 1974, 29, 39-40, 249-50; Gaukroger 2002, 74-77.

<sup>57</sup> Arnauld and Nicole 1996, IV.2-3; Mariotte 1678, II.ii-iii; Régis 1691, 40, 54.

<sup>58</sup> Hobbes 1656, 48-58.

<sup>59</sup> Malebranche 1980, bk. 6; Tschirnhaus 1695, 73-91.

<sup>60</sup> Bacon, OFB XI 97-8, 109-11, 163, SEH IV 428.

<sup>61</sup> Gassendi 1658, I, 120-23.

<sup>62</sup> Locke 1975, 548-50, 643-45 and Anstey 2011, chap. 4; but see Locke 2000, 234-37 and Anstey 2011, chap. 7, for Locke's late views.

<sup>63</sup> Poussin 1670, 12; Coste 1691, n.p.; Wotton 1694, 155-7; Molyneux 1692, n.p.—echoing Van Helmont 1648; Bacon, SEH IV 410-12, 428-29; Descartes, AT X 363, CSM I 11, AT IXB 13, CSM I 186, AT VI 17, CSM I 119; Locke 1975, 601.

sylogism was conceived as a method for the discovery of principles.<sup>64</sup> More frequently, though, syllogism was seen to offer demonstrative power, either on its own or via mutual reinforcement with mathematical demonstration. While early in the century the certainty of mathematics was defended on the ground that it was possible to translate mathematical into syllogistic demonstration, the syllogism itself came to be legitimized via the idea that it encapsulated mathematical certainty and represented, as Rapin put it, the “Geometrical Method of Demonstration.”<sup>65</sup> However, many of those who embraced the mathematical model of demonstration disengaged it from syllogistic demonstration. The ordering of one’s reasoning starting from evident principles (axioms or definitions) and proceeding to certain conclusions in a linear model of deduction became the norm for Hobbes, Descartes, the Port Royal Logic, and Mariotte.<sup>66</sup> Yet, while Descartes repudiated the syllogism, Hobbes and the Port Royal authors still allowed it a place in their logics.<sup>67</sup>

Concerning the procedures for the scientific discovery of principles, we will note, again, a wide variety of positions in the sources of the *querelle*. The identification of induction as a route towards knowledge of first principles is present in various ways in the Aristotelian logical context (e.g., Smiglecius, Jungius).<sup>68</sup> Bacon put forward what could be called an experimental-logical analysis, in which the logical resolution was continuous with the chymical “solution” (*solutio* or *separatio*) of composites into their fundamental elements (a physical variant of the decomposition of wholes into parts). This *solutio* took the form of an eliminative induction supported at every step by natural and experimental histories arranged in tables.<sup>69</sup> For Mariotte, the experimental and the mathematical models of analysis were combined, since observation and induction were partly conceived as problem-solving procedures that needed the aid of mathematics.<sup>70</sup>

The other major type of logical analysis followed the mathematical model. Of particular interest here is the notion that discovery modelled on geometry proceeds “from the simple to the

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<sup>64</sup> Jardine 1974, 54-58; Gaukroger 2002, 20-24.

<sup>65</sup> Rapin 1678, 109, 121, 193-4—echoing Felden 1642, 3-6; Mousnier [Fabri] 1646, 63, 131-32 (Fabri organizes his Aristotelian logic itself as a mathematical demonstrative science). See Gilbert 1963, 87-92; Dear 1995, 31-41; and Miller’s chapter in this volume.

<sup>66</sup> Hobbes 1656, 59-64, Descartes, AT X 366-70, CSM I 13-15; Arnauld and Nicole 1996, 239-40 (who borrow their rules for definitions, axioms and demonstrations from Pascal 2000, 155-6); Mariotte 1678, 181-97.

<sup>67</sup> Hobbes 1656, 33-40; Arnauld and Nicole 1996, III. See further the literature cited in note 3 above and Anstey (ed.) 2017.

<sup>68</sup> Clucas 2010; Sgarbi 2013, 121-26, 134-36.

<sup>69</sup> Bacon, OFB XI 215-453 (*solutio* at 254-55).

<sup>70</sup> Mariotte 1678, 118, 124-6. See further the literature cited in note 3 above.

complex,” a phrase repeated by Rapin, Fontenelle, and Coste.<sup>71</sup> The source of this phrase is the third of the four rules of method formulated by Descartes in his *Discourse*—the so-called rule of order, which is preceded by the rules of evidence and division, and followed by the rule of enumeration.<sup>72</sup> The four rules were adopted (whether as such or augmented with material from the *Regulae*) as the substance of analysis, understood as mathematical problem-solving, by all of the Cartesian logics. Yet, different positions on the relation between the “simple” and the “complex” resulted in different accounts of analysis. On one, epistemic reading, Cartesian analysis as summarized by the four rules proceeded from particulars to general principles (and was thus a variant of “orthodox” analysis, ascending from the “complex” to the “simple”), and needed to be complemented by the geometrical demonstrative method of synthesis (Port Royal Logic, Régis).<sup>73</sup> On a second, ontic reading, there was the idea that what was at stake was the positing of “relations” (*rappports*) or “links” between objects, the natural order of which needed to be discovered. One could do so simply by “comparing” the objects, and it was best in this sense to begin with the “simplest” objects and relations and gradually proceed to the more “complex.” In this sense, analysis was self-sufficient, as it became a form of demonstration (Malebranche, Tschirnhaus).<sup>74</sup>

In sum, “analysis” was a fluid, sometimes equivocal notion, the fruit of an accretion of different traditions. We have also noted the plurality of views on demonstration and on the relations between discovery and demonstration. The complications of this picture were however concealed under the pervasive (sometimes triumphant) talk of “discovery,” which the participants in the debate saw as one key feature of the modern art of thinking. We have seen the same heterogeneity underlying the other two features, which pertain to the way the art of thinking was seen as instrumental towards both the human mind and the practice of the sciences.

### 1.3 Conclusion

Our approach in this chapter has been to look at how the conception of a modern art of thinking was forged during a debate occurring at the turn of the seventeenth century, in which the question of modernity occupied pride of place. During this debate, the art of thinking was constructed either in continuity with classical thinking or as a break with the past; but in either case, logic was enlisted in a wider discussion about the value and novelty of philosophy and the new sciences.

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<sup>71</sup> Rapin 1678, 122; Coste 1691, n.p.; Fontenelle 1752, 238.

<sup>72</sup> Descartes, AT VI 18-19, CSM I 120.

<sup>73</sup> Arnauld and Nicole 1996, 237-8 (yet the authors also point out that the four rules in fact hold for all methods, not only analysis); Régis 1691, 55.

<sup>74</sup> Malebranche 1980, 433, 438; Tschirnhaus 1695, 85-86. See Lennon 2000; Van Peursen 1993.

We have discussed the attitudes of the participants in this debate and analysed their early modern sources by taking the perspective of the *querelle* as a starting point. This is by no means the only possible perspective on the art of thinking, of course, and it should be acknowledged that the participants in the *querelle* were biased and sometimes unreliable observers. Nevertheless, this perspective serves our central aim, which is to show how early modern logics, as variously interpreted and re-interpreted, played a role in the late seventeenth-century construction of modernity as a 'philosophical' or 'scientific' modernity. On a historiographical level, our approach also exemplifies the fact that any analysis is premised on a starting point that it needs to acknowledge.

The picture of the modern art of thinking was created during this key self-reflexive episode, at the apex of the Scientific Revolution, and exhibited both unity and diversity. The unity was a function of the common features we have identified in the writings of the participants in the debate: the art of thinking was seen as an expression of a 'natural logic' as well as a potential guide and remedy to a malfunctioning mind; as a ground of the sciences, whether universally so or not; and as a route to discovery in the sciences. The latter two are features that we, today, generally recognize as part of our own scientific modernity, while the former is being re-explored right now in 21st-century terms.<sup>75</sup> But there was also marked diversity to the picture. This is clear from the plurality of the canons described in the first section, as well as from the heterogeneity of the general features of the art of thinking discussed in the second section. From this perspective, the early modern art of thinking was a multi-faceted, polemical construct, which reflected the multi-directional effort the historical actors undertook in order to describe their own modernity.

The Scientific Revolution itself has been interpreted, in one recent historiographic reconstruction, as a similarly dynamic, polemical and inescapably diverse process.<sup>76</sup> Thus, under both its unitary and its heterogeneous aspects, our account of the early modern debate over the art of thinking mirrors and underpins this perspective on the Scientific Revolution. On a more reflexive level, concerning the relationship between the 'new science' of the seventeenth century and its Aristotelian past, we see that the main historiographic positions today seem to replicate positions already found within the early modern debate.<sup>77</sup> In sum, the *querelle* is a privileged historical

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<sup>75</sup> Houdé and Tzourio-Mazoyer 2003

<sup>76</sup> See Garber 2016

<sup>77</sup> The historiography, especially in the history of philosophy, has tended to focus on continuities or on discontinuities, questioning or confirming the revolutionary nature of the Scientific Revolution (e.g. Barker

moment, which illuminates the many facets both of the historical actors' self-understanding and of our own historiographical choices.

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and Ariew 1991). Another strand, especially in the history of science, has deconstructed the very idea of a Scientific Revolution (e.g. Shapin 1996).