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Problems with Rhubarb: Accommodating Experience in Aristotelian Theories of Science

Stefan Heßbrüggen-Walter
Higher School of Economics, Moscow
shessbru@hse.ru

Abstract

The paper examines controversies over the role of experience in the constitution of scientific knowledge in early modern Aristotelianism. While for Jacopo Zabarella, experience helps to confirm the results of demonstrative science, the Bologna Dominican Chrysostomo Javelli assumes that it also contributes to the discovery of new truths in what he calls 'beginning science'. Both thinkers use medical plants as a philosophical example. Javelli analyses the proposition 'rhubarb purges bile' as the conclusion of a yet unknown scientific proof. Zabarella uses instead hellebore, a plant that is found all over Europe, and defends the view that propositions about purgative powers of plants are based on their 'identity of substance', an identity that had become questionable with regard to rhubarb due to new empirical findings in the sixteenth century.

Keywords

experience – metaphysics – logic – Chrysostomo Javelli – Jacopo Zabarella – Thomas Aquinas – Jean Buridan – Giovanni Manardi – rhubarb – medical plant – principle

In 1586, Joachim Camerarius the Younger (not to be confused with his father, the humanist Joachim Camerarius) published a new edition of Pietro Andrea Mattioli's *De plantis epitome* and added in the process "new pictures and descriptions." The entry on rhubarb contains an illustration marked at the right-hand side with an asterisk, which leads the reader to a note (*appendix*) that

* Faculty of Philosophy, National Research University – Higher School of Economics, Russian Federation, 109028 Moscow, Chitrovski pereulok, building 2/8.

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states that the image was marked by the original author (Mattioli) as uncertain and that the editor (i.e., Camerarius himself) has nothing positive to add to this.[1] This is no surprise, as the early moderns were not in general agreement over what rhubarb may look like, because they were not sure what may count as rhubarb.[2]

At the same time, rhubarb may well be the most popular medical plant in the history of philosophy. It makes an appearance in the works of lots of prominent authors, including Thomas Aquinas, Buridan and then again in Boyle, Locke, and Hume (whereas the plant is conspicuously absent in Kant, with the exception of a letter to Herz from 1777, which discusses in excruciating detail Kant's own digestion, a topic with no obvious philosophical relevance).[3]

Why this fascination with rhubarb? And why is rhubarb topical for discussions concerning the role of experience in science? First of all, Aristotle himself creates a link between the concept of experience and therapeutic knowledge at the beginning of the *Metaphysics* (981a1 ff). More specifically, medieval philosophers like Aquinas and Buridan were interested in how to explain the causal efficacy of medicinal plants. The viewpoints of both philosophers differ, because they have different conceptions of what counts as a good explanation in natural philosophy. In the beginning of the sixteenth century, there is a decisive shift taking place in medical theories regarding this plant. The main problem is now how to bridge the apparent gap between what ancient authorities have to say on the plant and empirical evidence, which is constituted by rhubarb samples that have come to Italy.

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1 Cf. Pietro Andrea Mattioli, Joachim Camerarius, ed., *De plantis epitome utilissima Petri Andreae Matthioli novis Iconibus et Descriptionibus pluribus nunc primum diligenter aucta a Joachimo Camerario* (Frankfurt, 1586), 414: "De pictura Rhabarbari ab autore expressa tanquam adhuc incerta, nihil habeo quod affirmare queam." ("Regarding the image of rhubarb which is explicitly marked by the author [sc. Mattioli] as uncertain I [sc. Camerarius] do not have anything that I could add in the affirmative."). The illustration is available online: http://nbn-resolving.de/urn:nbn:de:hbz:061:2-20361-p0430-1.

2 Cf. Ernst H. L. Krause, "Untersuchungen über die Geschichte von *Rumex patientia*," *Beihefte zum Botanischen Centralblatt*, 24/2 (1909), 6–52, 17ff.

3 Cf. Robert Boyle, "Of the Origin of Forms," in: *Selected Philosophical Papers of Robert Boyle*, ed. M. A. Stewart (Indianapolis, 1991), 53–96, 68, John Locke, *An Essay concerning Human Understanding*, ed. P. H. Nidditch (Oxford, 1975), IV.III.25, 556, David Hume, *An Enquiry concerning Human Understanding*, ed. T. L. Beauchamp (Oxford, 1999), 6.4, 132, Immanuel Kant to Herz (letter 120), 20 August 1777, in: Immanuel Kant, Königlich Preußische (later Deutsche) Akademie der Wissenschaften (ed.), 1900-, *Kants gesammelte Schriften*, vol. 10 (Berlin, 1922), 212 f.

This paper is based on the assumption that this shift in the available evidence has left traces in philosophical theories about the role of experience in scientific argumentation.[4] Zabarella, for one, does use laxatives as a philosophical example. But he chooses a different plant, namely hellebore. That this may have been a conscious choice can best be explained by comparing Zabarella's views on medical plants with an author who continues the 'rhubarb tradition', Chrysostomo Javelli. Again, disagreements on what can or cannot be said about rhubarb (or hellebore) highlight philosophical differences with far-reaching consequences.

Zabarella's view of science is based on the premise that we have epistemic access to universals that allows us to generalise a series of observations (i.e., experience) in a process he calls *inductio*.[5] But grasping universals is a hit-or-miss affair: you either succeed or you do not. Experience has no special role to play in this process. It only serves to confirm findings that can equally well be argued for without any appeal to it.

Javelli's model of science (and thus by implication also of knowing rhubarb) is more complex. He agrees with Zabarella that experience can confirm the findings of our rational faculties. But he also allows for the possibility of a 'beginning science' (*scientia initiativa*), which contains proofs with merely probable premises and conclusions that are suggested by experience. Accordingly, for him experience is a constitutive precondition of the scientific enterprise.[6]

Javelli and Zabarella represent two rival camps in early modern philosophy of nature. Javelli belongs to those metaphysicians who are primarily interested

4 '*Experientia*' and '*experimentum*' were used in classical Latin to refer to "the knowledge gained by repeated trials, experimental knowledge, practice, experience" (Charlton T. Lewis, Charles Short, *A Latin Dictionary* (Oxford 1879), s.v. *experientia*) or "a proof, test, trial, experiment, experience" (ibid., s.v. *experimentum*). In the early modern period, experience was interpreted by Aristotelians either as repeated apprehension (Andreas, Suárez) or as apprehension of a complex fact (Cajetan, Javellus). Cf. Stefan Heßbrüggen-Walter, "Scientific Knowledge and the Metaphysics of Experience: The Debate in Early Modern Aristotelianism," in *Studia Neoaristotelica*, 10 (2013), 134–154, 136–139.

5 Throughout this paper I will only use the Latin term when referring to Zaberalla in order to emphasise that his understanding of *inductio* is not the same as our contemporary understanding of 'induction'.

6 A more thorough discussion of Javelli's model of science in comparison to Suárez' can be found in Heßbrüggen-Walter, "Scientific Knowledge," 144–149. The notion of *scientia initiativa* is introduced in Chrysostomo Javelli, *In Omnibvs Metaphysicae libris quaesita testualia* (Venice, 1552), fol. 16v, but he also uses the term *scientia inductiva* (*Quaesita* , fol. 14v). Both terms are apparently interchangeable.

in the compatibility of their discipline with the basic tenets of Christian faith.[7] Zabarella may be counted among those who believed that the main task of the philosopher was to stay true to Aristotle's intentions regardless of how these may relate to Christian dogma.[8] For 'Christian metaphysicians', controversial topics like the immortality of the soul or the creation of the world belong to metaphysics. This has the interesting consequence that what remains for natural philosophy to explore, has no bearing on theological questions and can therefore be investigated without any dogmatic restrictions. 'Aristotelian literalists' believe that philosophers should strive to preserve the integrity of Aristotle's system regardless of how it fits in with the teachings of the church. Aristotle's natural philosophy may require corrections or additions, but its overall approach should not be watered down by making concessions to theology.[9]

Other readers of early modern Aristotelianism believed that it was the 'empiricist' approach of the 'literalists' that paved the way for a greater relevance of experience in science.[10] In order to assess the validity of this claim, it does not suffice to point to various uses of the term 'experience' in a given corpus.[11] The salient question is rather, why an author feels the necessity to appeal to experience in some of his arguments; moreover, various uses of experience must be related to the general methodological framework that guides the application of the concept. Only then is it possible to understand the evidential value accorded to experience and the goals pursued by appealing to it.

This approach addresses a major deficiency in Schmitt's interpretation. If Zabarella in his general methodology "does not have much to say which goes

7 Cf. Charles H. Lohr, "The Sixteenth-Century Transformation of the Aristotelian Natural Philosophy," in: Eckhard Keßler, Charles H. Lohr, and Walter Sparn, eds., *Aristotelismus und Renaissance: in memoriam Charles B. Schmitt* (Wiesbaden 1988), 89–99, 89 ff, who uses the debate between Pomponazzi and Javelli on the immortality of the soul to highlight the contrast between the two traditions.

8 Zabarella is not mentioned by Lohr. Nicholas Jardine, "Keeping Order in the School of Padua: Jacopo Zabarella and Francesco Piccolomini on the Offices of Philosophy," in: Daniel A. di Liscia, Eckhard Keßler, and Charlotte Methuen, eds., *Method and Order in Renaissance Philosophy of Nature* (Aldershot 1997), 183–209, 198, points out that Zabarella was in favour of a sharp separation between natural philosophy and metaphysics and insisted on the independence of natural philosophy from theological considerations.

9 Cf. Lohr, *Transformation*, 98 f.

10 The *locus classicus* of this approach is Charles B. Schmitt, "Experience and Experiment: A Comparison of Zabarella's View With Galileo's in De Motu," *Studies in the Renaissance*, 16 (1969), 80–138, recently revived by Marco Sgarbi, *The Aristotelian Tradition and the Rise of British Empiricism - Logic and Epistemology in the British Isles* (*1570–1689*) (Dordrecht, 2013), who does not address Lohr's concerns.

11 This is Schmitt's argumentative strategy, *Experience and Experiment*, 93 ff.

beyond the ancient and medieval commentaries,"[12] we must presume either that his approach in applying this methodology to phenomena does not transcend Aristotelian orthodoxy or that there are tensions between his methodology and its application, which must somehow be resolved. Palmieri seems to opt for the second horn of this dilemma, when he proposes to distinguish between two discordant authorial voices in Zabarella's natural philosophy, the 'commentator' and the 'scientist'.[13] This distinction seems to be overly hasty, however. It is in fact possible to read Zabarella in a way that renders him coherent, albeit less interesting to a historian of science. For such a reading, we must compare Zabarella's attitude towards experience with Javelli's rival account. If the argument developed here is convincing, it will provide additional evidence for Lohr's claim that those who wish to explore the conceptual resources for the advancement of experimental science should take into account what went on in the Dominican *Studium generale* in Bologna instead of focusing exclusively on the University of Padua.

A discussion of the issue of rhubarb fits this general agenda, because that plant is discussed in logical or metaphysical contexts that are intended to clarify central methodological presuppositions. So it can serve as a test case for a better understanding of the connection between method and its application, the concept of experience and its various uses in natural philosophy. This in turn requires a summary of medieval views of laxatives, so that we can show that on this topic, early modern Aristotelians had more to say than their medieval predecessors.

The Medieval Background: Thomas Aquinas and Buridan on Rhubarb

Aquinas discusses pharmaceuticals in his *De operationibus occultis naturae ad quendam militum* ('About the hidden effects of nature, written to some soldier'), a discussion that is particularly instructive, because it defends the view that medical plants have 'quasi-magical' qualities (similar to sacred relics).

In that text, Aquinas draws two distinctions that are relevant for understanding his views on the causal efficacy of medical plants like rhubarb. The first difference concerns changes caused by medical plants as compared to common changes in the sublunar sphere: The effect of medical plants on the human body

12 Ibid., 93.

13 Cf. Paolo Palmieri, "Science and Authority in Giacomo Zabarella," *History of Science*, 45 (2007), 404–427, 410.

defies any explanation according to the principles of the sublunar world, because the principles that are responsible for these actions cannot themselves be apprehended, for they are 'hidden' (*occultus*) from our sensory capacities. In this sense, they are 'preternatural', because they do not fit into the general explanatory scheme of natural changes, which explains changes in mixed bodies by reference to the proportion of the mixture of elements rather than celestial influences. But in another sense, these changes are called 'natural' by Aquinas, presumably because they all take place in the ordinary course of nature.[14] Usually, he tells us, changes of mixed bodies can be attributed to the proportion of elements in them.[15] But in some cases, as in the attraction between iron and a magnet or in the purgative force of a plant, such explanations fail.[16] In these cases, we must introduce a 'higher principle':

> It is therefore appropriate to explain such actions by higher principles. […] Higher agents that transcend the nature of the elements and mixed bodies are not only celestial bodies, but also separate substances.[17]

14 Cf. Thomas Aquinas, "De occultis operationibus naturae ad quendam militem," in: Thomas Aquinas, *Sancti Thomae de Aquino Opera omnia*, vol. 43 (Rome, 1975), 183–186, 183: "Quoniam in quibusdam naturalibus corporibus quedam naturales actiones apparent quarum principia maxime apprehendi non possunt, requisiuit a me vestra dilectio, ut quid super hiis michi uideatur uobis transcriberem." ("Since in some natural bodies natural actions take place the principles of which are completely hidden from apprehension, you asked me to please you by writing down for you what appears to me [sc. to be true] in these matters.")

15 Cf. ibid., 183: "Quecumque igitur actiones et motus elementatorum corporum sunt secundum proprietatem et virtutem elementorum ex quibus talia corpora componuntur, huiusmodi actiones et motus habent manifestam originem, de qua nulla emergit dubitatio." ("Any action or movement of a mixed body takes place according to the quality and virtue of the elements from which it is composed; such actions and movements have a manifest origin about which no doubt is possible.")

16 Cf. ibid., 183: "Sunt autem quedam huiusmodi corporum que a uirtutibus elementorum causari non possunt, puta quod magnes attrahit ferrum, et quod quedam medicine quosdam determinatos humores purgant et determinatis corporis partibus." ("But some such [sc. mixed] bodies cannot be caused by the virtues of the elements [sc. they are made of], like that the magnet attracts iron and that some pharmaceuticals purge determinate humours in determinate parts of the body.")

17 Ibid., fol. 213r f: "Oportet igitur tales actiones in altiora principia reducere. […] Superiora autem agentia, quae naturam elementorum et elementatorum excedunt sunt non solum corpora caelestia, sed etiam superiores substantiae separatae."

That all changes in nature are ultimately caused by a supralunar cause, namely the prime mover, is in this context irrelevant: the movement of a falling stone towards the earth must be explained by its proximate cause, the proportion of elements, and not its ultimate cause, the prime mover. Conversely, in a magnet attracting iron the 'occult' principle must be in some sense directly responsible for the occurrence of this movement.

The second distinction concerns the regularity of changes caused by medical plants, on the one hand, and changes brought about by other healing agents, e.g. relics, on the other. A sick person seeking relief by touching a relic can never be sure that the desired effect really will take place as expected.[18] The purgative power of rhubarb is different: "[…] rhubarb always purges a determinate humour; this implies that such a process stems from some internal and permanent virtue in such a body [i.e., rhubarb]."[19]

Whenever supralunar influences manifest themselves irregularly, the 'occult' principle is the cause of their manifestation: 'Higher agents' do not modify the nature of a saint's bone. They intervene, when a believer touches the saint's bone at a given time. If 'higher agents' operated in the same manner in the case of rhubarb, this would mean that every purgation by rhubarb would be directly caused by some heavenly body or separate substance. Such an assumption is not parsimonious. Therefore, it makes more sense to presume that the essence of rhubarb is in some way transformed by 'higher agents', so that the supralunar influences do not shape the change itself, but the form that is conducive to this change. The purgative power of rhubarb itself is 'occult', because it depends on a principle that cannot be apprehended by the senses:

> The principles of forms of such corruptible bodies are celestial bodies which according to their advance or withdrawal [sc. from the center of the earth] cause generation and corruption in such lower [sc. bodies].[20]

According to Aquinas, then, the purgative power of rhubarb must be explained by some higher principle that cannot be apprehended by the senses. This supralunar influence transforms those properties of rhubarb that it would otherwise

18 Cf. ibid., 184: "[…] nec omnia mortuorum ossa apposita sanant egrotos." ("[…] not every contact with a dead person's bones heals the sick.")

19 Ibid.: " […] reubarbarum semper purgat determinatum humorem; unde relinquitur huiusmodi actionem prouenire ab aliqua virtute indita et permanente in corpore tali."

20 Ibid.: "[…] principia formarum huiusmodi corruptibilium corporum sunt celestia corpora, que diversimode se habentes secundum accessum et recessum ad generationem et corruptionem in hiis inferioribus causant."

possess on the basis of the mixture of the elements it contains. This transformation allows us to explain why rhubarb regularly purges a determinate humour in the human body. Still, this activity of rhubarb in the human body is 'preternatural', because it is not caused by the mere mixture of elements in the plant. At the same time, it is also 'natural', because its acticity is part of the normal 'course of nature'. Within an explanatory framework that is built on the behaviour of elements in mixed bodies, the activity of rhubarb in the human body remains, however, inexplicable.

It is not quite clear whether for Aquinas, there could be such a thing as a 'science of rhubarb'. Such a science could not be built on apprehension, because the principles governing the rhubarb's purgative power are 'occult'. But then, knowledge of inapprehensible principles is possible in metaphysics. But metaphysics is not concerned with the clarification of events in nature. Regardless of how this situation could be resolved, we can be sure that, if such a science should be possible, the proposition 'rhubarb purges bile' would figure in it as the conclusion of a syllogism relating it to the 'higher principles' that are its cause.

This is an important point, because it constitutes a clear difference from Buridan's views on rhubarb. For the latter, propositions like 'rhubarb purges bile' or 'magnets attract iron' are unprovable (*indemonstrabiles*). Unprovable general propositions are principles. So for Buridan the question of why rhubarb purges bile is a special case of the general problem of how we get to know such principles. The first step to such knowledge is experience: we may perceive repeatedly that rhubarb does in fact purge bile or that magnets attract iron. This experience is necessary, because the 'unaided' intellect cannot accept on its own that rhubarb purges bile.[21] Experience, however, does not in itself justify the general statement that rhubarb purges bile. So for Buridan the 'problem with rhubarb' is the problem of induction, that is, the question of how to turn experiential facts into universal truths.[22]

21 Cf. Jean Buridan, *In libros Posteriorum Analyticorum*, ed. H. Hubien (unpublished manuscript), consulted at: http://www.logicmuseum.com/wiki/Authors/Buridan/In_libros_posteriorum_analyticorum (last access: 28/03/2013), 2.11.3: "[...] quod omne rheubarbarum faciat choleram non statim concedit intellectus." ("The intellect does not accept immediately that all rhubarb purges bile.")

22 Cf. Jean Buridan, *Summulae de Dialectica*, ed. H. Hubien (unpublished manuscript), consulted at: http://www.logicmuseum.com/wiki/Authors/Buridan/Summulae_de_dialectica/ (last access: 28/03/2013), n. p.: "Sic enim scimus hoc indemonstrabile principium quod omnis ignis est calidus, et quod omnis magnes est ferri attractivus, et quod omne rheubarbarum est cholerae purgativum, et quod omne quod naturaliter fit fit ex subiecto praesupposito, et sic de multis aliis principiis indemonstrabilibus." ("For this is how we

First we formulate the statement "this rhubarb plant and that rhubarb plant purged bile."[23] If we memorize several such incidents, the judgement that a rhubarb plant before us will also purge bile is justified even though we do not have a direct perception of this effect. This is an experiential judgement, namely an inductive judgement with limited validity.[24] If no counter-examples are known, the intellect adds the clause "et sic de singulis" ('and thus for all particulars'), which justifies the universal principle that 'all rhubarb purges bile'.[25] It is important to recognize the essential limitation of this type of experientialism. Experiential input does not determine the outcome of the inductive process, because the intellect is autonomous in its decision as to whether or not the universal proposition 'all rhubarb purges bile' should be confirmed (this is why induction is not an 'inference with necessity'):

> If you have often seen that rhubarb purges bile and if you have memories of this and if you have never found a counter-example even though you have considered this several times, the intellect assents to the universal principle, not, however, because of a necessary inference, but because of its natural inclination to truth.[26]

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know the indemonstrable principle that every fire is hot, and that every magnet attracts iron, and that all rhubarb purges bile, and that everything that comes to be in nature comes to be from some preexisting subject, and so on for many other indemonstrable principles.," Jean Buridan, *Summulae de Dialectica*, trans. G. Klima (New Haven 2001), 396)

23 Buridan, *In lib. post. an.*, 2.20.3: "Hoc rheubarbarum purgabat choleram, et illud."

24 Cf. Buridan, *In lib. post. an.*, 2.11.3: "[…] si occurrit tibi alter ignis, quem tu non sentis, propter memoriam praeteritorum, iudicas illum esse calidum, et hoc est iam experimentale iudicium de non sensato." ("[…] if you encounter another fire, which you do not feel, you judge that it is hot because of your previous memories, and this is already an experiential judgment about a thing that has not been perceived.")

25 Cf. Buridan, *In lib. post. an.*, 2.20.3: "[…] intellectus supplet istam clausulam 'et sic de singulis', eo quod numquam vidit instantiam, licet consideravit in multis circumstantiis, nec apparet sibi ratio nec dissimilitudo quare debeat esse instantia, et tunc concludit universale principium." ("[…] the intellect supplies this clause 'and thus with regard to particulars' because it has never seen a counter example, although it has considered [sc. the content of the proposition] in differing circumstances, and there appears to be no reason or dissimilitude why there should be a counter-example, and then it infers the universal principle.")

26 Buridan, *In lib. post. an.*, 2.20.3: "Cum enim saepe tu vidisti rheubarbarum purgare choleram et de hoc memoriam habuisti, et quia in multis circumstantiis diversis <hoc> considerasti, numquam tamen invenisti instantiam, tunc intellectus, non propter necessariam consequentiam, sed solum ex naturali eius inclinatione ad verum, assentit universali principio."

In sum, both Aquinas and Buridan agree that an explanation of the purgative powers of rhubarb is beyond the scope of explanation by its nature as a mixed body (or else Buridan should have treated 'rhubarb purges bile' as the conclusion of a proof that contains as its premises propositions about the proportion between the elements contained in the plant). Aquinas assumes that this calls for a 'supralunar' explanation that is based on the assumption that the essence of rhubarb is transformed by celestial influences. Buridan accepts the purgative power of rhubarb as an insight that can be legitimately generalised from a limited number of instances, because our intellect has a 'natural inclination for truth'. So a physician taking his cue from these two philosophers could justify choosing rhubarb as a purgative remedy by appealing either to 'supralunar' explanations that assimilate medicine to magic or to experience in combination with a 'medical intellect' and its natural inclination for truth. Which option is the right one would depend on whether 'rhubarb purges bile' should be interpreted as a conclusion capable of proof – leaving aside the caveats regarding the very possibility of such a science – or as a principle, presumably of medical science.

Both thinkers agree that the traditional model of mixed bodies is not capable of explaining the purgative power of rhubarb (or else Buridan should have introduced the proposition as a conclusion in natural philosophy rather than as an example for a principle known by the intellect). And both presume that we have a clear-cut concept of rhubarb. However, as the note added by Camerarius to his illustration of rhubarb shows, this assumption looked doubtful to medical writers at the end of the sixteenth century. But uncertainty about rhubarb had already spread at the beginning of that century.

Manardi's Challenge: Experiencing Rhubarb

In 1512 or 1513, three learned men, the physician Giovanni Manardi (or Manardo), his mentor Niccolo Leoniceno, and the young humanist Gian Giorgio Trissino sat together in the house of the Obizzi family in Ferrara and contemplated this very problem. The episode is recounted in Manardi's *Epistolae medicinales*, which was first published in 1521.[27] Pliny and Dioscorides had held that rhubarb

27 Cf. Giovanni Manardi, *Epistolarum medicinalium libri viginti* (Basel, 1549), Ep. 6.5, 72: "Meministi puto Leonicene vir doctißime, dum paulo antea quam huc venturus, Ferraria receßisssem, in Opizonium clariß. familiae domo, cum Ioanne Georgio Trissino [...] de variis simplicibus medicamentis loqueremur, in grandem nos [...] incidisse dubitationem, circa preciosißimam illam radicem, quam Rheon Graeci, Plinius rhecoma, vulgus

is an odourless plant. However, experience contradicts the wisdom of the ancients: the plant the three scholars had in front of them filled the room quickly with its scent. So either the ancients were proven wrong by experience or the plant commonly believed to be rhubarb was not identical with what Pliny and Dioscorides had held in their hands.[28]

Some years later, while serving as court physician to Ladislaus II., King of Hungary, Manardi met colleagues from Poland. He was first given a powder and, later on, an intact root that allegedly had come from India and was described as 'true rhubarb'. Manardi agreed with this assessment, as the plant parts were odourless. So, he concluded, the ancients had been right about the properties of rhubarb. But they had located it in the wrong region of the world, namely the Bosporus.[29] Manardi concludes his letter with the question whether the known

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rheum barbarum vocat: […]." ("Maybe, most learned Leoniceno, you remember that a short time before I came here, we met in the house of the very famous Obizzi family. There we had a conversation with Giovanni Georgio Trissino about various simple medicines which left us with substantial doubts regarding the very precious root which the Greeks call *rheon*, Pliny *rhecoma* and the vulgar *rheum barbarum*.") For the presumed date of the conversation cf. Bernardo Morsolin, *Gian Giorgio Trissino: monografia d'un gentiluomo letterato nel secolo 16°* (Florence, 1894), 48.

28 Cf. Manardi, *Epistolae*, Ep. 6.5, 72: "[…] quod videlicet Dioscorides et Plinius eam odore carere dicerent, re ipsa et experimento valde odoratam comprobantibus. Quod cum tu negares, radix in medium allata, thalamum in quo sedebamus statim odore replens, manifestum veritati praebuit testimonium, adeo ut necessario alterum concedendum videretur, vel falsa illos scripsisse, vel hanc non esse veram rheon." ("[…] whereas Dioscorides and Pliny said that it lacks odour, we could prove through the thing itself and experience that it had an intensive smell. Since you denied this, we dissolved the root in a liquid, and it instantly filled the room with its odour. This evidence for the truth [sc. that the tested plant smells] was clear. It forced us to concede that they [sc. Dioscorides and Pliny] wrote down a falsehood or that this plant [sc. before us] was not true *rheon*.")

29 Ibid.: "Tunc enim a Sigismundi regis Sarmatarum medicis didici, in eo bello, quod contra Moschos […] idem rex gesserat, repertum esse aliud rheon, communi quidem satis simile, sed penitus inodorum: cuius pulverem chirurgus quidam mihi dono dedit, quoniam radicen integram non haberet. Dedi posthac operam, ut radicem ipsam haberem: quod tandem tertio adhinc mense consequutus, ipsamque quantum valui diligenter rimatus, esse quam Plinius et Dioscorides pingunt dubio procul iudicavi. Affertur enim ex his quae supra Pontum, vel Bosphorum sunt regionibus, prope videlicet Rha flumen, radix nigra […] sine odore, calefaciens gustum et adstringens […]. Nec a Ponto, sed a extremis meridionalis indiae partibus ad nos vehitur, vimque purgatoriam non minorem agarico habet." ("At that time I learned from physicians of King Sigismund of the Samartians that in the war which this king fought with the Moscovites, a different *rheon* was found that is quite similar to the common [sc. form], but almost odourless. Their surgeon gave me a poweder as a gift, because he did not have the complete root. Afterwards I went to some trouble in

rhubarb from Turkey and the new root growing in India may belong to the same species.[30]

Manardi's report demonstrates both that the classification of plants depends on experience and that previous notions of rhubarb were inconsistent: rhubarb either is odourless or it does not grow in Turkey. So our 'rhubarb universal' is less stable than both Aquinas and Buridan had presumed. For Aquinas' position, this does not pose substantial problems. As he regarded the proposition 'rhubarb purges bile' as the conclusion of a scientific proof (if a 'science of rhubarb' is indeed possible), the question of what counts as rhubarb is secondary, if both plants have purgative powers caused by celestial agents.

For Buridan, the situation is more difficult: the truth of the proposition 'rhubarb purges bile' does not depend on having made appropriate experiences, but only on the natural inclination for truth to be found in the intellect. Manardi's report shows that physicians before his 'Indian discovery' had been wrong about rhubarb (in fact he himself had been wrong in 1512). Before the discovery, the following proof would have been true:

(1) All rhubarb looks like rhubarb, smells, and grows in Turkey.
(2) This plant looks like rhubarb, smells, and grows in Turkey.
(3) All rhubarb purges bile.
(4) This plant is rhubarb.
(5) This plant purges bile.

After Manardi's discovery, the following proof is correct:

(1') All rhubarb looks like rhubarb, is odourless, and grows in India.
(2') This plant looks like rhubarb, is odourless, and grows in India.
(3') All rhubarb purges bile.
(4') This plant is rhubarb.
(5') This plant purges bile.

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order to obtain the root itself, and I received it after three months. After I pulverised the root diligently I judged that this is without any doubt the plant described by Pliny and Dioscorides. The black and odourless root has an astringent and pungent taste and is imported from the region beyond the Bosporus, close to a river called Rha. [...] And it does not come to us from the Bosporus, but from some parts of southern India and its purgative power is not inferior to *agaricum*.")

30 Ibid., 73: "[...] an communis haec barbarica vulgo dicta, loco tantum, non etiam specie distet a Pontica." ("[...] whether the common [sc. form] which is usually called [sc. *rheum*] *barbarum* differs only with regard to the habitat or whether it is a different species.")

The crux for Buridan's method would be that (1) and (1') cannot both be true. Therefore, the extension of the term 'rhubarb' in (3) and (3') would not be the same. So there are in fact two interpretations of the principle 'all rhubarb purges bile' that are mutually incompatible. Before Manardi's discovery (3) would have been self-evident (this is after all the reason why Buridan used it as an example for explaining his views on induction). But this is no longer the case, which raises serious questions about the reliability of the intellect in deciding on the truth of principles on its own.

1534, a decade after Manardi's *Epistolae*, Chrysostomo Javelli published his *In omnibus metaphysicae libris quaesita*, in which he took up both the role of experience in knowledge and the topos of 'rhubarb purges bile'.[31] There, he classifies this proposition as the conclusion of a scientific proof that we may not yet have. In order to prove this conclusion we must investigate the plant itself and find out how it works on the human body.[32]

As far as principles are concerned, Javelli disagrees with Buridan: the intellect does not decide on its own whether or not a principle is true, but requires experiential input. In order to justify that the intellect joins two concepts in a proposition, we cannot appeal to some mysterious faculty that admits only true judgements. A natural inclination for truth is deficient, because it cannot help us to find out whether the referent of a subject term and the referent of a predicate term do stand in the relation stated in the proposition combining subject term and object term. Or, to put it more simply: Whether rhubarb purges bile cannot be found out by apprehending rhubarb and apprehending the purgation of bile in isolation.[33] Instead, we must find out whether the relation between subject term and predicate corresponds to a mind-independent fact:

31 For a more detailed account of Javelli's notion of experience cf. Heßbrüggen-Walter, *Scientific Knowledge*, 137–144.

32 Cf. Javelli, *Quaesita*, fol. 14 v: "Reubarbarum purgat choleram non habetur scientia, nisi deducatur a principiis intrinsecis, et cognoscatur virtus, a qua talis effectus procedit." ("That rhubarb purges bile is not known scientifically, unless it is deduced from intrinsical principles and the power that produces such an effect is known.")

33 Cf. Javelli, *Quaesita*, fol. 14 v: "Nam oportet assignare aliquod motivum, et determinativum intellectus ad formandam hanc universalem propositionem. Reubarbarum purgat choleram, [...] Hoc autem motivum, et determinativum non potest esse sola notitia terminorum incomplexa, quum ut incomplexa non magis determinat intellectum ad hanc complexionem quam ad illam. ("It is necessary to assign some moving and determining reason to the formation of this universal proposition 'rhubarb purges bile', [...] This moving and determining reason cannot only consist in a non-complex awareness terms, because this non-complex awareness does not determine the intellect [sc. to accept] this complex [sc. of terms] rather than that [sc. complex].")

> As experience shows, we do not know how to form a complex principle, even when we are aware of the terms, unless we perceive that these terms are connected to one another in reality.[34]

This insight is crucial, because it explains why Javelli can distinguish two functions of experience in relation to scientific knowledge. It can either help us find new knowledge or help us in confirming and teaching existing knowledge. So for Javelli, 'experiential induction' can have a heuristic function, namely the formulation of merely probable, but general statements about a natural kind and its particulars.[35] In the light of Manardi's findings, we may add that even the question of whether something that lies before us really is rhubarb, depends on facts about this plant, namely whether or not it smells and where it grows. Apprehension of a root does not help us in determining what it is. Why else should Manardi require the assistance of his mentor Leoniceno to find out whether common rhubarb and the Indian variety he had discovered belong to the same natural kind?

Zabarella on Plants, Principles, and Experience

Zabarella's views on laxatives and experience are developed in his commentary on Aristotle's *Posterior Analytics* and his *De Methodis*.[36] We can memorise effects apparent in various individuals belonging to the same species. From these recollections we form an experience. Then the intellect takes over and forms on its own the universal principle that 'all particulars of this species have purgative force'.[37] This is an application of the 'resolutive method': the argu-

34 Javelli, *Quaesita*, fol. 15 r: "Nam experimur, quod habentes notitiam terminorum, nisi cognoscamus sensu tales terminos coniungi in re, nescimus formare principium complexum, [...]."

35 Cf. ibid.: "Dicemus ergo experimentum non esse generativum scientiae, sed inductivum, et confirmativum, [...] sed non principaliter, [...]." ("So we say that experience does not cause knowledge, but it paves the way [sc. to knowledge] and confirms [sc. it], but not as its main cause, [...].")

36 This is the passage deemed by Schmitt to be lacking in originality. See above, footnote 11.

37 Cf. Giacomo Zabarella, *Opera logica: Praefatio Ioannis Lvdovici Havvenrevteri* [...] (Cologne, 1597), col. 1269: "[...] colligit Aristoteles fieri ex sensu memoriam, ex memoria vero, quae saepe fiat eiusdem rei, experientiam; quandoquidem multae numero memoriae unam experientiam constituunt: verba autem illa 'quae plerumque eiusdem fit' non sunt intelligenda de eodem secundum numerum, sed secundum speciem; [...] memoria plurium singularium eiusdem speciei unam experientiam facit, ex qua inquit Aristoteles

ment proceeds *a posterioribus ad priora*, from what is known by the senses to its principles. More precisely, the argument is an *inductio*, because the principle to be found is implicitly contained in the experience the argument is based upon. According to Zabarella's terminology, *inductio* progresses 'from one thing to the same thing', it is a *processus ab eodem ad idem*.[38] Knowledge of a principle that is found by *inductio* is knowledge that is based only on the *lumen proprium* of the intellect: Whenever we encounter a human individual, we know immediately not only that this individual is a biped, but also that the general principle 'man is a biped' is true. It is important to see that the intellect alone is responsible for this generalisation, which is an effect of its *lumen proprium* (or, as Buridan would say, a 'natural inclination for truth').[39] The *lumen proprium* can achieve this feat, because in confronting different particulars we know immediately that they share a common nature (Zabarella calls this 'identity of substance' *convenientia substantialis*):

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oriri universale in intellectu, quod artis, et scientiae principium est: […]." ("Aristotle states that memory comes from sense, experience comes from memorising the same thing repeatedly; but although many memories constitute one experience, the words [sc. in Aristotle] 'that comes from many [sc. memories] of the same [sc. thing]' should not be understood as denoting numerical identity, but the identity of [sc. belonging to] the same kind; memory of many particulars of the same kind constitutes one experience, from which, as Aristotle says, the universal is generated that is the principle of art and science: […].")

38 Cf. ibid., col. 270: "[…] universale enim a singulari reipsa non distinguitur, sed ratione solum; […] ideo inductio est processus ab eodem ad idem; […]," ("[…] the universal is not distinct from the particular as a [sc. separate] thing, but it is distinct only in reason; […] hence *inductio* progresses from one thing to the same thing; […].")

39 Cf. ibid., col. 269: "[…] inductione non inveniuntur nisi illa principia, quae sunt nota secundum naturam, et levi egent comprobatione: […] notum secundum naturam illud dicitur, quod sensile est. eiusmodi autem sunt non ea solum, quae singularia sunt, sed ea quoque universalia, quorum singularia sensu percipi possunt, […] haec propositio, homo est bipes, dicitur nota secundum naturam, quia quocunque individuo homine oblato statim cognoscit sensus eum esse bipedem, haec autem iure vocantur nota secundum naturam: quia proprio lumine cognoscuntur, […]." ("[…] by an *inductio* we only find those principles which are known following nature and can easily be proven: a thing is said to be 'known by nature', if it is accessible to sense. This is true not only for particulars, but also for universals of particulars that can be perceived, […] the proposition 'man is a biped' is said to be 'known following nature', because sense cognises that a man is a biped as soon as it is confronted with an individual man. These [sc. propositions] are justly called 'known following nature', because they are known by the proper light [sc. of the intellect]."")

> By considering the identity of substance of several individuals, the intellect produces a universal. If for example someone sees that hellebore purges the black bile in Socrates and sees the same afterwards in Plato and in several other men, he is said to have experienced [sc. that hellebore purges the black bile], because he can produce these recollections. And from this experience he builds in the intellect this universal: all hellebore purges the black bile; [...].[40]

It is important to see that this model leaves no space for what Javelli calls 'beginning science': As long as our cognition of principles is in the 'beginning' stage, it is not science, because experience is concerned with several particulars, not with universals. As soon as our cognition of principles deserves to be called 'science', it is no more 'beginning', because the intellect has grasped the identity of substance in all particulars of the species.[41] So if Zabarella says that "from experience or from the universal itself, a principle of art or science is generated,"[42] this does not mean that experience as such provides awareness of universals – far from that. Experience contains data that allow the intellect on its own to quantify over all tokens of a given species. The model is by and large identical to what Buridan proposes – with the only difference that generalisations of the intellect are primarily based on shared natures of individuals within a given species.

In this context, it is telling that Zabarella introduces a new species into the philosophical herb garden: and importantly, hellebore can be found all over Europe.[43] To assert that hellebore plants share a common nature that can be apprehended by the intellect sounds as plausible as our capability to apprehend

40 Ibid., col. 1269f: "[…] considerans enim intellectus substantialem convenientiam pluriorum individuorum, facit universale, ut aliquis, qui vidit in Socrate helleborum purgasse atram bilem, deinde idem vidit in Platone, et in pluribus aliis hominibus, horum memoriam servans dicitur expertus esse, et ex hac experientia format in intellectu hoc universale: omne helleborum purgat atram bilem; […]."

41 Ibid.: "[…] principia scientiarum et artium sunt universalia, experientia vero est rerum singularium […]." ("Principles of sciences and arts are universal, experience however relates to particulars […].")

42 Ibid., col. 1270: "[…] ex experientia vero seu ex ipso universali fit principium artis, et scientiae." ("[…] but the principle of an art and a science comes from experience, that is from the universal itself.")

43 Cf. W. Wissner, H. Kating, "Botanische und phytochemische Untersuchungen an den europäischen und kleinasiatischen Arten der Gattung Helleborus – I. Zur Verbreitung, Morphologie, Anatomie und Kultur der Helleborus-Arten," *Planta Medica*, 26 (2009), 128–143.

humans as bipeds. For some of Zabarella's readers, the same assertion with regard to rhubarb might have sounded preposterous: even experts in the field could not agree on whether or not rhubarb is odourless or whether pictorial representations of the plant are reliable. The fact that we can err about the identity of natural kinds speaks against the ability of the intellect to discern them on its own and favours Javelli's position that in order to know a principle we always need prior experiences of facts corroborating the proposition to be examined – experiences that were readily available for hellebore, but were severely lacking in the case of rhubarb.

This is a disturbing result. If experience can only help us know explicitly what we knew implicitly beforehand, there is not much leeway for experience to correct our implicit knowledge. In theory, the situation described by Manardi should therefore be impossible: apprehension of rhubarb particulars should convey some awareness of their substantial identity, thereby providing means to prove scientifically what we can know about rhubarb. If this way is barred (and Manardi's lively report shows clearly that the world does not work the way Zabarella wants it to), there does not seem to be any productive role for experience in Zabarella's natural philosophy.[44]

But there is also another problem: as far as medical plants are concerned, physicians should only consider their capabilities to preserve or restore health, whereas the natural philosopher searches for complete knowledge of plants as natural bodies. Therefore, the investigation of plants as plants is for Zabarella no legitimate part of medicine.[45] The episode reported by Manardi thus shows

44 Cf. Heikki Mikkeli, "The Foundation of an Autonomous Natural Philosophy: Zabarella on the Classification of Arts and Sciences," in Di Liscia et al., *Method and Order*, 211–228, 215: "This scientific ideal Zabarella presents is profoundly different from the modern view of a scientist making new discoveries. In his opinion, science can be 'new' only in a very restricted sense; the work of a scientist is more like correcting the mistakes and filling the gaps in a ready-made Aristotelian world system."

45 Cf. Giacomo Zabarella, *De rebus naturalibus libri XXX* (Frankfurt, 1617), col. 129: "[…] vires enim et proprietates plantarum medicinales cognoscendae sunt et a Medico et a philosopho naturali, diversis tamen scopis; Medicus eas considerat, dum sibi proponit sanitatem recuperandam, vel conservandam; philosophus autem naturalis eas inquirit, ut plenam habeat cognitionem plantarum, quae sunt species corporis naturalis, […]." ("[…] the powers and properties of medical plants must be known by the physician and the natural philosopher, but for different reasons; the physician considers them in order to regain or preserve health; the natural philosopher concerns himself with them in order to know plants as a species of the natural body, […]." How exactly Zabarella conceptualises the relation between natural philosophy and medicine and how he interacted with practitioners of the medical art is a thorny question: cf. Mikkeli, *Classification*, 221ff, Jardine, *Keeping Order*, 204ff, Baker, *Jelly*, 2.

a lack of botanical knowledge that, according to Zabarella, falls into the province of natural philosophy proper. But unless we manage to get an intellectual grasp of rhubarb universals, there is nothing meaningful to say about this plant. This is awkward, because if the physician depends on the natural philosopher for a correct descriptive account of medicinal plants in order to use them for the curing of the sick, Zabarella's failure to incorporate a meaningful account of experience in his natural philosophy prevents the incorporation of experience in the application of natural philosophical insights to the healing of patients, in the realm of medicine.[46]

Once again, the comparison between Javelli and Zabarella is instructive. Javelli introduces 'beginning science' as a transitional state between complete lack of knowledge and perfect (i.e., apodictic) knowledge. For Zabarella, there either is or there is not explicit awareness of universals. This means that an essential stage in finding new knowledge about the world, namely statements regarding 'probable causes' (or in today's language: hypotheses) play no role in Zabarella's model of science. Yet, this does not mean that experience is completely irrelevant in his natural philosophy. But it has only one of the two functions envisaged by Javelli: it does not help us find new knowledge, but is only useful for confirming what we already know about nature.

Zabarella on Experience and Confirmation

At least in some passages, the wording itself makes abundantly clear that confirmation is the main role that experience has to play in Zabarella's philosophy of nature; as when he tells us that perceiving similarities between objects is easier than perceiving their differences, "is something we experience daily, too."[47] Or when he says that the assertion that mixed bodies move in a simple line according to their predominant element is 'also' (*quoque*) confirmed by experience.[48] Similarly, he states that the claim that clouds and rain are produced in the middle region of the sublunar atmosphere is "also proven by experience."[49]

46 For Zabarella, both art (medicine) and science (natural philosophy) are based on universals. See above, fn. 36.

47 Zabarella, *De rebus naturalibus*, col. 1065: "idque etiam quotidie experimur, [...]."

48 Cf. ibid., col. 370.

49 The claim is stated ibid., col. 552, which is wrongly numbered as col. 556. The reference to experience is made in col. 554: "[...] possumus autem etiam per experientiam id, quod diximus, comprobare." ("[...] we can also by experience prove again what we have said.")

In other passages, this function of experience is less obvious, but it can be unearthed by reading carefully. One such example concerns the function of the *humor vitreus* in vision.[50]

Early modern theorists of vision distinguished three different humours in the eye: the aqueous humour in front, next to it the crystalline humour, and, at its rear, the vitreous humour.[51] Zabarella argues against Galen's thesis that the function of the vitreous humour is to nourish the crystalline humour that is responsible for vision. As Tawrin Baker points out, Zabarella's views in this matter are highly original.[52] Moreover, the text suggests strongly that in this case this new theory is based on experience and that these experiences were made in the anatomical theatre.[53] So this passage seems to substantiate the view that experience has a role in obtaining new insights into nature. But a close analysis of Zabarella's exposition shows that it follows his general methodological framework. First, the truth of an assumption is proven without any appeal to experience. Afterwards, experiential findings can be used to confirm this newly acquired truth.

Zabarella believes that the vitreous humour serves as a 'barrier' between the 'rear wall' of the eye cavity (i.e., the retina) and the crystalline humour.[54] If this barrier were inexistent, light that passes through the crystalline humour would be reflected from the retina back to the crystalline humour. But since parts of the 'rear wall' of the eye are 'blackish' (*subniger*), the crystalline humour would be 'filled' (*imbutus*) with coloured reflections from inside the eye mixed with light from the outside. Hence the existence and 'blocking function' of the vitreous humour is a necessary requirement of vision.[55]

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50 Cf. ibid., col. 902 f. The following account is heavily indebted to Tawrin Baker, "Why All This Jelly? Jacopo Zabarella and Hieronymus Fabricius ab Aquapendente on the Usefulness of the Vitreous Humor," an unpublished paper that provides invaluable background information on Zabarella's general theory of vision.

51 Cf. ibid., 3ff.

52 Cf. ibid., 2.

53 Cf. ibid., 9.

54 Cf. Zabarella, *De rebus naturalibus*, col. 902: "[...] nisi aliquis alius humor in parte posteriore inter tunicas, et crystallinum intercessisset, lumen illud ad tunicas in illa parte pervenisset, [...]." ("[...] unless some other humour intervened between the retina and the crystalline [sc. humour], light would reach the tunica in this part [sc. of the eye], [...]." For reasons of clarity I will use in the main text the term 'retina' and preserve in quotations Zabarella's usage of *tunica*.

55 Cf. ibid.: "[...] et quum soleat lumen a solidis corporibus reflecti fuisse iterum reflexum a tunicis ad crystallinum una cum colore tunicarum, est autem secunda tunica colorata colore subnigro, ideo imbutus fuisset perpetuo crystallinus colore illo, quod quidem visioni maximum impedimentum attulisset; [...] fuit ergo necessarium, ut inter tunicas et

This argument is not and cannot be based on experience, because it contains a statement of necessity, whereas truths that are based on experience can only be contingent. Instead, we must read Zabarella as exploring the counterfactual question of what would happen, if such a barrier were absent. Zabarella asks how the eye *must be* structured for vision to be possible rather than how the eye *is* structured, so that vision is possible.

The transition to the confirmative argument drawn from experience is textually ambiguous. Zabarella closes his 'counterfactual argument' with the statement that "[...] this [sc. serving as a barrier] is without doubt the function (*officium*) of the vitreous humour."[56] The next sentence begins with the phrase "for experience teaches" (*nam experientia docet*).[57] This can either mean that the vitreous humour functions without doubt as barrier, because this is what experience teaches. Or it can mean that no doubt is possible about the function of the vitreous humour, because this function is confirmed by experience. If the first reading is correct, the previous 'counterfactual argument' will be superfluous, because it does not appeal to experience. The second reading explains why there are two arguments; it is moreover in agreement with our general thesis that in Zabarella, experience can be used to confirm truths we know, but it cannot serve as the sole justification for newly gained insights.

But what exactly does experience teach? Zabarella describes the light cone that can be seen when light falls through a burning glass. If an object is put into the cone, the illuminated area is inversely proportional to its distance from the glass. In the focal point, the illuminated area reaches its minimum. At the same time, the light is so 'united and powerful' (*unitum et validum*) that the object can burn up. If the object is moved beyond the focal point, no more light can reach it. Zabarella's explanation for this is that its power has been 'exhausted' (*exinanitus*).[58] The same mechanisms are at work in the eye: Zabarella empha-

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crystallinum in posteriore oculi parte humor vitreus poneretur [...] ne ab earum [sc. tunicarum] colore crystallinus per reflexionem luminis coloraretur: [...]." ("[...] and since usually light is reflected from solid bodies, it is again reflected from the *tunica* towards the crystalline humour and has the colour of the *tunica*. However, the second *tunica* is blackish, therefore the crystalline humour would always be filled with this colour which would pose a very grave obstacle to vision; it is therefore necessary that between the *tunicae* and the crystalline humour the vitreous humour is positioned, so that the crystalline humour cannot be coloured by the reflection of light [sc. from the *tunicae*].")

56 Ibid.: "hoc est absque dubio vitrei humoris officium; [...]."

57 Ibid.

58 Cf. ibid., col. 902–903: "[...] nam experientia docet, lumen transiens per vitrum aliquod cavum [...] permeans ultra vitrum in quadam certa ab eo distantia facere conum, in cuius extremitate intensissimum lumen apparet, [...] nempe si in illa certa distantia ponatur

sises that he himself has observed (apparently in an anatomy theatre) that the crystalline humour in the eye behaves like a burning glass, when a candle is lit beside it. This effect is reinforced by a bulge facing the retina ensuring that the focus of the light cone produced by the crystalline humour lies within the area filled by the vitreous humour, so that light coming in 'exhausts itself', before it can reach the retina and be reflected.[59]

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corpus aliquod solidum, id quod angulus impingat; nam si propinquius vitreo; at si paulatim removeatur, minuetur continue, donec ad minimam superficiei illuminatae quantitatem perveniat, ideo in illa minima quantitate ita est unitum et validum illud lumen, ut etiam accendat, et urat, quoniam ibi desinit conus, et angulus a concursu radiorum productus: ideo si adhuc magis removeatur corpus illud, nullum amplius lumen ab illo vitro ad ipsum pervenit, sed est exinanitum, quia quum ad conum, et ad acumen tendat, non praetergreditur quoddam determinatum punctum: [...]." ("[...] for experience teaches that light that goes through a caved glass as soon as it has passed it produces in some distance from it [sc. the glass] a cone. At the end of the cone a very intense light appears [...] for when some solid body is placed at this determinate distance, it is within the angle [sc. of the cone] and nearer to the glass; if it is a bit removed, the light diminishes continuously, until it reaches the minimal surface area; therefore the light is to such an extent 'united and strong' in this minimal area that it burns and heats the body. If it leaves the cone at this place and the angle that is produced by the light beams and if it is then further removed, no light from the glass reaches the body, it [sc. the light] is 'exhausted', because if it moves from the cone to the point [sc. the focal point, S. H.-W.], but it cannot transcend this determinate point [...]." In *De motu gravium et levium* (in *De rebus naturalibus*, col. 333 ff), Zabarella asserts that the velocity of natural bodies peeks at the end of their movement. If the movement of light is in this sense natural, this may explain, why the power of light is most intense in the focal point and why at the same time it cannot move beyond it.

59 Cf. Zabarella, *De rebus naturalibus*, col. 903: "[...] ego igitur in oculorum sectione vidi crystallinum ab aliis humoribus separatum, cui quum accensa candelula apponeretur, totus fiebat lucidus, et splendens tanquam candelae lumine imbutus ob suam perspicuitatem, et trans totam crystallini substantiam meabat lumen, et in posteriore crystallini parte transibat in conum, et in acumen, non multo post intimam crystallini gibbositatem, ita ut acumen illud, et linearum concursus parum distaret a crystallino, imo ipsum fere attingere videretur; ideo certum est, illius coni acumen exinaniri in humore vitreo, qui magnam habet profunditatem, ideoque ad posteriores tunicas pervenire non posse." ("I myself have seen in a dissection of eyes the crystalline humour separate from the other humours [sc. in the eye]. As a burning candle was brought near it, it became bright and shining. Being transparent it was shining and seemed to be filled with the light of the candle. Light pervaded the crystalline substance completely. In the rear it was bundled into a cone and a point not far behind the inner bulge of the crystalline [sc. humour], so that this point and the bundle of light rays were placed at a tiny distance from the crystalline [sc. humour]. It [sc. the bundle] seemed to almost touch it; therefore it is certain that the

In this sense, then, experience can indeed confirm that the functional organisation of the eye follows the requirements stated in the previous argument. The vitreous humour functions as a 'barrier' between the crystalline humour and the retina. But this insight can only serve to resolve eventual doubts about the validity of the 'counterfactual argument'. But it does not and cannot serve as an independent proof about the function of the vitreous humour.

Conclusion

The medievals disagreed on whether the proposition that 'all rhubarb purges bile' is in need of supranatural demonstration (Aquinas) or was an unprovable principle based on observables (Buridan). In Aquinas, experience apparently has no role in explaining the efficacy of medical plants. For Buridan, experience can be articulated in judgements and generalised by an intellect with a natural inclination for truth. Both thinkers, however, share the premise that we have a firm grasp of what rhubarb is. Manardi's discussion shows that previous assumptions about rhubarb may have been misguided. Javelli's arguments are not touched by this insight, because he regards 'rhubarb purges bile' as the conclusion of a scientific proof, so we must investigate what rhubarb is and what its effects are on the human body. The process of investigation is called 'beginning science'. This notion is missing in Zabarella's model of science: the 'beginning' of an investigation is not science. And science can not 'begin'. It either is there, or it isn't, because the intellect either does or does not grasp the 'identity of natures' in a series of individuals of a species. The only remaining function of experience is then the confirmation of what the philosopher has found out before without relying on experience for his results.

The physicians' puzzle about rhubarb throws doubt on the central premise of both Zabarella's methodology and its application to problems in natural philosophy: we are not always able to isolate a universal from a number of given apprehensions or experiences, because the notion of a natural kind is less stable than what is required for an intellect that relies only on its *lumen proprium* to assert the *convenientia substantialis* of a series of particulars. It may make more sense to assert a role for experience not only in confirmative, but also in 'beginning science'. Instead, Zabarella finds an easy way out. He remains faithful to the custom of invoking laxatives as examples when he discusses experience,

topmost point of this cone is exhausted in the vitreous humour that has a large width, and thus [sc. the light] cannot reach the posterior *tunicae*.")

but instead of using the controversial and exotic rhubarb, he refers to a well-known natural kind, hellebore, which grows all over Europe.

But if proof in natural philosophy cannot rely on arguments from experience and if experience can only be used to confirm what we already know, the question remains as to why there are references to experience in natural philosophy at all: what is the function of experience in Zabarella's own terms? A first hint is contained in a passage from *De rebus naturalibus* in which Zabarella silently equates experience and 'example' (*exemplum*).[60] For Zabarella, an example is an 'imperfect *inductio*'. However, it is not imperfect, because it is incomplete. On the contrary, examples contain an element that is not part of a perfect *inductio*: In a perfect *inductio*, the mind progresses from a number of particulars to the universal and then 'comes to rest' (*conquiescit*). Examples contain an additional step: the application of the newly grasped universal to other particulars that did not belong to the original set, from which the *inductio* started.[61] So

60 See ibid., col. 1069f, where Zabarella asks about the sequence in which we perceive properties of a material object and contends that in perceiving an object that we already know (i.e., in the case of *cognitio habitualis*) we perceive first its specific properties before taking in those aspects of the object it shares with other members of the same genus. He then discusses an argument for his view that can be found in Scotus: "Ad hanc demonstrandum non potest efficacius argumentum adduci, quam illud, quod primum a Scoto allatum est: […]." ("In order to prove this there is no more convincing argument than the one that was first asserted by Scotus […]."). Scotus' general point can also be confirmed by corresponding experience: "[…] et hoc experientia manifeste comprobatur; […]." ("[…] this is also clearly proven by experience; […]."). But Scotists were wrong regarding the scope of their argument believing that it concerned the first perception of an unknown object: "[…] adeo Scotistae dum huiusmodi *exemplo* [emphasis mine] et argumento praedicto utuntur, non animadvertunt se decipi, quum putent se probare de prima nostra originali cognitione, probetur tamen non de originali, sed solum de illa, quae fit ex habitu antea contracto: […]."; ("[…] when Scotists use such an *example* and the quoted argument, they do not realise that they deceive themselves, when they believe that their proof relates to our first original cognition, even though it relates not to our original [sc. cognition] but only to that [sc. cognition] that is caused by a habit that we have acquired before: […]."). Here, Zabarella implicitly divides the previous text in two sections, an *argumentum* and an *exemplum*. But there is only one passage in the previous text that does not belong to the *argumentum* and can therefore be identified as the *exemplum*: it is the passage that is concerned with the experience of the concrete cases substantiating the *argumentum*. So '*experientia*' and '*exemplum*' seem to be interchangeable terms for the same thing.

61 Cf. Zabarella, *Opera logicae*, col. 95: "Exemplum autem est inductio imperfecta, ut Aristoteles docuit in secundo libro Priorum Analyticorum, et ab inductione in eo differt, quod inductio a singularibus ad universale progrediens in ipso universali conquiescit: at exemplum a singularibus transiens ad universale non desinit in universali, sed ab eo

maybe experience serves primarily didactic aims: A reader may more easily understand the relation between some particulars of a species and universal propositions about this species, if, after a rational proof has been presented, the same relation is demonstrated by using other particulars of the same species.[62]

In order to demonstrate this conclusively, it would be necessary to examine all references to experience in Zabarella's natural philosophy so as to find out whether this model of 'experience as example' is applicable to all of them. Regardless of such a comprehensive analysis, the arguments presented here justify the claim that there is no need to separate Zabarella's methodology from its application to natural philosophy. But then we must accept that Zabarella's application of this methodology to natural philosophy was less audacious than some of his readers have wanted it to be.

A proper assessment of the role of experience in Zabarella depends essentially on the way we manage to relate his thought to other debates of his day, instead of merely reconstructing his views in isolation. In Javelli, we find not only the explicit distinction between 'beginning science' and 'confirmative science', but also a general model of scientific knowledge based on the indispensability of experience. Charles Lohr has been right: Dominican views on methodology and natural philosophy in sixteenth-century Italy do indeed deserve further study.

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descendit ad aliud singulare simile primis: [...]." ("An example however is an imperfect *inductio*, as Aristotle teaches in the second book of *An. Pr*. It differs from an *inductio* in that an *inductio* progresses from particulars to the universal and comes to rest in this universal: but an example that moves from particulars to the universal does not stop there. It descends to another particular that is similar to the first [sc. particulars].")

62 Paolo Rossi articulates this hypothesis in "Aristotelici e 'moderni': le ipotesi e la natura," in: Luigi Olivieri, ed., *Aristotelismo veneto e scienza moderna* (Padua, 1983), 125–154, 146, but he does not relate it to Zabarella's own methodological account of examples.