Determining a Drug’s Properties: Medieval Experimental Protocols

MICHAEL McVAUGH

SUMMARY: Among Galenic texts attracting attention circa 1300 was De complexionibus, which described a crude protocol for determining the qualitative character and intensity of any given medicine. This caught the attention of physicians at Montpellier, where three generations of writers made it into a carefully structured test procedure for identifying by a via experimenti the nature of a drug’s effect on healthful function: they introduced a null point as the referent for their measurements, identified a range of contingent factors that had to be controlled for, and devised ways to standardize the sample being tested. Their protocol was certainly designed to be used, but in practice they seemed to have preferred an alternative via rationis that inferred the effect of a medicine from sensory attributes like taste and color, acknowledging that taste tests were coarser and less certain than a structured experimental procedure, but were easier and quicker to perform than the elaborate alternative.

KEYWORDS: Montpellier, Galen, experimentum, protocols, degree
Learned physicians in the Middle Ages had available to them a very large number of medicines, simple or compounded, that they could use to treat their patients. Some were widely known, some much less so, but even familiar medicines could exhibit variability depending on such things as their place of origin or their age. It was obviously of potential interest to these physicians to find some secure way of testing a particular medicine to confirm, or even discover, what its actual properties were. Thus it is not particularly surprising to find a program for testing medicines taking shape about 1300 in one of the first and most famous medical faculties, that of Montpellier in southern France. It emerged out of the faculty’s close study of Avicenna and the new Galenic literature just gaining strength in medical schools, which led them to devise, debate, and gradually refine a practical protocol for experimentally determining a drug’s effect on the human body. To what extent the protocol was actually put into effect is another matter.

I

Galen had laid particular emphasis on the power of medicines to act on the qualitative nature of the body (its complexion) through their own primary qualities of hot or cold (and dry or moist), a power that he discussed at length in his works *De complexionibus* and *De simplici medicina*. Knowing whether a specific medicine would heat or cool the body, and to what degree, was valuable if the physician wanted, say, to cool a fevered patient; but the medicine’s hotness or coldness was also linked in a more or less regular way to much more important specific physiological or clinical effects, like narrowing passages within the body (*constrictio*) or bringing local infections to a head (*maturatio*): an aperitive medicine, for example, capable of opening and loosening the body, was naturally hot and moist. Once the physician had determined the nature of the medical problem to be corrected, he might
administer a drug whose established primary quality of hot or cold, or higher-order physiological effect, would counteract the specific problem he had identified.

The emergent medical faculties of the thirteenth century encountered this system in two sources of Galenic medicine that they were just beginning to absorb. One was the works of Galen himself, circulating in recent Latin translations; a particular subset of these, today often referred to as “the new Galen,” proved to be of special interest to the faculties for a variety of reasons and gradually became the focus of scholastic commentaries.\textsuperscript{1} The other new source was the encyclopedic \textit{Canon of Medicine} of Avicenna, which was to a great extent a systematic compilation of Galenic medicine, often in paraphrases or quotations drawn immediately from Galen’s writings. In parallel translation from Arabic the two sources often sounded remarkably similar.

This similarity was certainly true of their discussions of medicinal activity, extending down to matters of detail. At the end of \textit{De complexionibus} III Galen gave a number of rules that should be used by anyone wishing to determine the basic qualitative properties of a food or medicine (the simple alterative properties of hot and cold, dry and wet).\textsuperscript{2} It is apparent from his language here that he was imagining testing the medicine’s properties not against the relativized complexional medium or midpoint that he had brilliantly introduced into medical theory,\textsuperscript{3} but against particular illnesses in individuals, because most of his rules dealt with the way in which a medicine’s activity could be identified by its effect on complexional imbalances. His rules are not always entirely clear or concisely expressed, and they overlap to some extent, and when Avicenna took them up in \textit{Canon} II.1.2 he characteristically reformulated them with considerable care, expanded them, and even numbered them. Yet, built on Galen’s as they are, the Avicennan rules are of the same type, presuming that alterative medicines (hot and cold) are to be tested for their effectiveness on patients with particular illnesses.
Briefly, the refined Avicennan program is as follows. (1) The medicine should be free of any acquired quality, like artificial hotness or coldness. (2) A patient to whom the medicine is to be given should be suffering from one single illness, not a composite one. On the other hand, (3) a medicine should always be tested on two patients with contrary illnesses, so that if it helps both, the physician may distinguish its effect \textit{per se} from its effect \textit{per accidens}. (4) The strength of the medicine should be opposite in quality but equal in strength (\textit{potentia}) to the illness. (5 and 6) The action of the medicine should be observed repeatedly over a period of time, because effects \textit{per se} tend to be steady and lasting, whereas effects \textit{per accidens} can come and go. (7) Medicines should be tested on human subjects, not on animals.\textsuperscript{4} Of these seven rules, only the first and fourth are clearly stated by Galen, and most of the others are at best implicit in his works, while the seventh and perhaps the second seem purely Avicennan.

We might think of this Galenic-Avicennan program as one that was meant to test for a cure. As I interpret their discussions, their rules involve the testing of medicines not on healthy subjects but on patients; they are planning to assess or measure a medicine’s powers, its hotness or coldness, not against some midpoint of temperancy, but against the imbalanced temperature of a particular sick patient. To quote Avicenna,

\begin{quote}
the power that is in the medicine should be comparable to the strength of the disease to which it is opposed. For there are some medicines of which the heat is less than the coldness of some disease, so that it can scarcely act on it. . . . Therefore the test should be done on a weaker [disease] first, gradually progressing until the power of the medicine is known beyond any doubt.\textsuperscript{5}
\end{quote}
 Implicitly, therefore (neither Galen nor Avicenna actually says this outright), when you test a medicine, you should try administering it in illnesses of increasing severity, and when you finally arrive at a case where the medicine just restores the patient to temperancy—cures him you will have determined experimentally that the medicine is qualitatively opposite but equal in strength to the patient’s illness in this particular case. You will not, however, have determined a fact of general validity about that drug that can be directly applied to the treatment of the next patient who comes along, unless he is suffering from exactly the same illness, for the illness itself is what measures the strength of the drug. Since the idea of measuring medicinal activity against a temperate midpoint is missing in De complexionibus, it is not surprising that a system of measurement, of precise gradations of activity, does not figure there either. Galen developed such a complementary system fully in his later De simplici medicina. There, at the very end of book V (the conclusion of the work as it was known to the late thirteenth century), he explained how the strengths of the qualitative forces in medicines were to be measured, namely by distinguishing their relative effects on the healthy body over a scale of four degrees above a midpoint of temperancy. A temperate medicine with a complexion equal to the healthy body it was applied to would have no effect. One hot in the first degree would heat it, but the hotness would not be manifest to the sense, rather its effect would have to be recognized demonstratione ratiocinationis et dialetice. A medicine in the second degree would have a manifesta operatio; in the third, an operatio fortis; and in the fourth, an operatio in ultimo.\(^6\) His account of the scale makes no reference to its possible use in an experimental test of the sort he had laid out earlier in De complexionibus, however, and Avicenna followed Galen in describing the scale of measurable degrees in a section of the Canon (I.2.2.1.15) that was quite separate and far distant from his account of medicinal testing. Avicenna’s measures remained essentially the same as Galen’s, except for his
definition of the effect produced by a first-degree medicine, which had more practical relevance than Galen’s and was generally used by Latin physicians: “the first degree is that which . . . brings about in the body no perceptible qualitative effect . . . unless it is repeatedly administered.”

II

Avicenna’s Canon began to be quoted in Latin medical works with increasing frequency from the 1230s on, and it was the likely source for the first testing protocol I have seen in a thirteenth-century text, Peter of Spain’s commentary on Isaac’s Diete universales, where it is attached abruptly to the end of a series of questiones on the nature of experimentum: its last rule is certainly Avicennan rather than Galenic. Of the preconditions for what Peter calls the via experimenti, he says:

The first is that the medicine should be kept free from every [accidental] complexional quality; the second is that the patient taking it should be suffering from the illness to which the medicine is appropriate; the third is that it should be given by itself; the fourth is that it should be of a degree opposite to the illness; the fifth, that we should try it not just once but repeatedly; the sixth is that it should be given to the right subject, so that we should try it on a man and not on an ass.

By the second half of the century, their study of the Canon had prepared European physicians to tackle the works of Galen himself, with all their diffuseness and obscurity, and by the 1270s or 1280s the Paris master Jean de Saint-Amand was epitomizing Galen’s own works for his students—including De complexionibus, from which he helpfully condensed the Galenic rules for testing a medicine’s quality:
The foods and medicines to be given should be free from any foreign quality . . . ; they should be given to bodies of a simple single complexion . . . ; a distinction must be made between their action *per se* and their action *per accidens* . . . ; the strength of the medicine should correspond to the strength of the state of the body.\textsuperscript{10}

But I know of no evidence that these procedures were yet anything more than quotations from authorities; to this point, no Latin author that I am aware of was actually speaking of putting them into practice.

It does not seem as though the masters in the Montpellier faculty were immediately attracted by questions of medical testing, or of degrees, as they began to study *De complexionibus* and *De simplici medicina* as part of the “new Galen” in the last quarter of the thirteenth century. The questions raised on the latter work by one such master, Bernard de Angarra (teaching there perhaps 1300–1320), survive in the form of a student’s notes, and it is obvious that what interested Bernard involved how, qualitatively, the body and its members were affected by medicines *already* known to be hot or cold. The problems involved in deciding what a medicine’s complexion was, or measuring its potential effect on a patient, were never raised at all there.\textsuperscript{11}

What redirected their interests was Arnau de Vilanova’s *Aphorismi de gradibus*, composed at Montpellier in the mid-1290s. Arnau’s treatise said very little about practical matters, although it did pass on the more specific definitions of degree measurement, including an Avicennan definition of the first degree: “to alter the body noticeably after repeated application, without harming function.”\textsuperscript{12} Its principal concern was simply to lay out an abstract system derived from the Arab philosopher Alkindi that would allow a physician to compute the intensity of the primary qualities of a compound medicine based on the intensities of the simple medicines that were combined in it. Since those intensities were
presumed to be already established, the power of the system meant that the intensity of the compound followed automatically, and it is not surprising that Arnau did not raise the question of testing his results.

Arnau was enthusiastic about his system for calculating qualitative intensity in a compound, and referred to it repeatedly in his later writings. It must soon have become a subject of much discussion among the other masters in the faculty. In 1303, two years after Arnau had left Montpellier to defend himself at Rome against charges of religious heterodoxy, his colleague and probable rival at the school, Bernard de Gordon, produced his own rather different *Tractatus de gradibus*, different in its evident concern for placing the discussion on a practical foundation. Bernard began his little treatise by recognizing the frustration (*amaritudo*) involved in trying to pursue a science of medicinal degrees in compounds, given the need to base it not on reason but on actual experiential knowledge of the properties of simple medicines, something that medical authorities insisted would require the efforts of a thousand men for a thousand years. But there was a way to escape this frustration, he went on: It lay in following a five-part testing program for medicines, a *via experimenti* of his devising that was grounded, he declared, in Galenic principles. To determine a medicine’s degree of qualitative intensity, (1) a sample of the medicine needed to be tested free of any accidental property (one should not test pepper that had just been chilled in the snow). (2) It had to be a pure sample, not admixed with something else. (3) Its effect had to be observed on a temperate or qualitatively neutral body; or (4), if its effect were to be observed on a distempered body, let us say hot, this could be done only if the medicine were of a roughly equal and opposite (cold) distemperancy. (5) Finally, It was essential to distinguish an effect that a medicine might exhibit *per accidens* from one that it possessed *per se*, since it was only the latter “that persists and has the same result over and over.”
experimental technique back to Galen’s *De complexionibus* and *De simplici medicina*, and indeed his first and fifth rules were restatements of rules given by Galen in *De complexionibus*. But he had thought seriously enough about them to recognize that Galen’s procedure needed refinement, for his second rule added a new twist when it declared that the specimen to be tested must be not only temperate (his first rule) but pure and uncontaminated; Galen and Avicenna may have assumed that this should be the case, but neither made it explicit.

Yet his other rules suggest that Bernard (and perhaps his Montpellier colleagues) was rethinking the possible goals of medicinal testing. It will be remarked that Bernard’s fourth rule is another one that is essentially identical to ones found in the Galenic and Avicennan lists, in that it is designed to identify a medicine’s ability to cure a particular case of illness. But his third rule is quite different, and new. It is designed to measure a medicine’s absolute qualitative nature against a universal standard: our pure sample of medicine is to be applied to a temperate object, and the measurable result will indicate an inherent property of that medicine, its quality and intensity, which it will then exhibit when applied to a distempered patient. This is of course the datum that was the necessary starting point for the calculations of the new *scientia de gradibus* that allowed the compounding of new medicines of given degree. And Bernard was certainly expecting his procedure to be extended to new and unfamiliar medicines, for he added a sixth rule to his first five as a precautionary measure: “When we want to test a certain medicine on the human body, we should first test it on birds and then on dumb animals and then in hospitals and then on lesser brethren [*in hospitalibus et postea in fratribus minoribus*] and so on in turn, because it might kill if perhaps it were poisonous.”*¹⁶* This is not an experimental object that Galen had ever envisaged—or, for that matter, Avicenna, whose seventh rule it actually contradicts.
Three years after Bernard had finished his little *Tractatus*, Arnau de Vilanova came back to Montpellier, this time not to teach but to finish up some of his medical writings, including a broad survey of medical theory that he had promised to King Jaume of Aragon, the *Speculum medicine*; writing this work seems to have taken up most of the years 1307–8. It is likely that he found his school still buzzing with discussions of medicinal activity, which would help explain why he ended up devoting over half of the *Speculum* to that subject alone. This was in effect a separate treatise that analyzed the nature of complexioned things and their action and interaction, and tried to answer such basic questions as: What different levels of qualitative activity are possessed by simple bodies? When simples are combined, do the properties of the ingredients persist usefully in the compound? May a compound have more than one property of its own?

Not surprisingly, the question of how a physician can determine a medicine’s active properties, simple or compound, comes up at an early stage in the *Speculum*’s analysis; nor is it surprising, given Bernard’s treatise (and Avicenna’s before Bernard’s), that Arnau should have decided to offer some rules to guide an experimental test of this sort. What is remarkable is the coherence and comprehensiveness of the procedure that Arnau has suddenly come up with, especially since there was nothing like it in his earlier *Aphorismi*. He approaches it systematically, explaining that when we want to use *experimentum* to determine what the immediate effect of a given medicine is on the human body, there are a number of conditions to observe *in experiendo* so as to avoid error, conditions that govern every aspect of the procedure, including the subject on whom the medicine is being tested, the quality of the drug being tested, its dosage, and the manner of its application.17

We can recognize that many of these rules are anticipated to a certain extent in Bernard’s *Tractatus*, but in the *Speculum* they are much more carefully and thoughtfully developed. Arnau
explains that the experimental subject must be human, not of another species, since medicines act differently on different species. (Bernard, it will be remembered, had proposed beginning by testing on birds and animals.) The subject must be of an *optima dispositio* that can represent the nature of normal humanity, someone temperate and healthy, middling in his physical type and in his diet, for otherwise his responses to a medicine cannot be taken as representative of that medicine’s activity. The second rule establishes that the activity has to be related to a defined or unit quantity of the medicine, its *prima dosis*—Bernard did not raise this point among his rules, and we will come back to it later. The third bears on the quality of the medicine, or, as we might be tempted to say, its purity, for the medicine to be tested must be entirely free of any extraneous property, untainted by qualitative contamination or association with anything else, fresh and uncorrupted by age or other deterioration, so that it will still possess its own inherent activity and can be “applied to the body in the perfection and purity that is characteristic of its species.”18 Fourth, the manner of its administration has to be controlled: some medicines demonstrate their properties only if given in powdered form, others have to be given in larger pieces, still others whole; some things have to be given by mouth, others in an enema, and so forth. A particular medicine always has to be given in a particular way, specific to it, and therefore when it is being tested it must be administered in precisely that same way; similarly (this is Arnau’s fifth rule), natural agents take different periods of time to act, and therefore the observation of a medicine’s activity has to be made over a defined period of time. For his sixth, final, condition he repeats the point made by Bernard, following Galen, that it is essential to distinguish a medicine’s effect made *per se* from an accidental one; and he advises that one can distinguish them by recognizing that an accidental effect occurs not consistently but infrequently (Galen’s point), and that it often
occurs when the drug is distant from the body, for drugs that act \textit{per se} are in direct contact with the body.

Arnau outlines his ideal test procedure in the early part of his discussion and then turns his attention to other things, but he comes back to it later on, explaining how it reveals a medicine’s direct effects on the body (\textit{operatio}) to the physician.\footnote{Those immediately observable effects may be those of its primary qualities (making the body hotter or colder) but they may well be instead its secondary qualities, particular actions that are very obvious in a specific clinical context—purging a particular humor, perhaps, or numbing the patient’s senses. From these immediate effects that the medicines reveal directly to us we can then infer the primary qualities that lie behind them. In the form in which Galen first conceived his procedure, he seems to have imagined it as testing directly for a medicine’s primary quality, but for Arnau (and probably his contemporaries as well)\footnote{\footnote{Indeed, Arnau concludes his account with a series of tables listing the secondary qualities that the physician would encounter distributed within medicines and explaining from what primary quality they arose: for example, fortifying, repercussive, thickening, and stupefactive medicines would all indicate to him the dominance of coldness within them, even though he might not observe the coldness directly.}} the properties of drugs that were directly apparent to the physician, and most important to medicine, were those of higher order. Indeed, Arnau concludes his account with a series of tables listing the secondary qualities that the physician would encounter distributed within medicines and explaining from what primary quality they arose: for example, fortifying, repercussive, thickening, and stupefactive medicines would all indicate to him the dominance of coldness within them, even though he might not observe the coldness directly.}

Here let us recapitulate the novel elements in Arnau’s protocol, this procedure for testing medicines. It differs from the classical (Galenic) procedure because it does not confuse testing how close a medicine’s properties will come to curing a particular patient’s illness with testing to determine what we might call the absolute character of the medicine: if you like, it distinguishes testing drugs from trying cures. Bernard de Gordon’s procedure had begun to distinguish these two test aims, of course, and Arnau’s rules have much in common with Bernard’s; where Arnau’s differ is largely in
their thoughtful exploration and clarification of Bernard’s perceptions. Bernard had said simply that medicines had to be tested on a *corpori humano temperato*; Arnau tried to specify exactly what that had to entail. Bernard’s insistence on the purity of the medicine to be tested had been limited to the statement that the medicine had to be *homogenea non heterogenea*; Arnau examined the many ways in which a medicine could fall short of purity, not just by admixture with other substances but by decay and deterioration as well. And of course Arnau’s insistence that a medicine to be tested had to be administered experimentally in the same way that it would be given in practice is not something that seems to have struck Bernard; nor, as we will see, did Bernard fully recognize the importance of controlling dosage in testing a medicine. Still, the continuities between the two certainly allow the reader to wonder whether Arnau’s account might be summarizing a progressively sophisticated appreciation of how one might test medicines that had been evolving in the faculty and of which Bernard’s *Tractatus* had been an early expression, five years before. But the details of the account in the *Speculum* may perfectly well have originated with Arnau, especially given the care with which each of his six conditions was thought through.

Thus Galen’s reflections on the nature of medicinal action led Montpellier physicians to pursue two quite different programs after 1300. On the one hand, his scale of four numerical degrees to measure the power of a simple drug to heat or cool, sketched out in *De simplici medicina*, was the basis for the elaborate systems they constructed in order to compute the degree of a medicine compounded from several such simples, systems *de gradibus* with a history that has long attracted the attention of historians. On the other hand, as we have just seen, his concern in *De complexionibus* to determine the effectiveness of medicines induced them to devise test procedures that would allow them to identify securely what kind of immediate effect a medicine had on the body. For all that these two
programs grew simultaneously out of a common body of Galenic material, they dealt with entirely independent issues and had almost no relevance to each other. The calculated degree of a compound medicine was typically fractional and could not be accurately measured—tested—by Galen’s four simple sensory stages; it remained a theoretical construct. The powers that were most important for a physician to be able to identify in a drug were often not its primary qualities of hotness or coldness but its higher-order powers that acted in various specific ways—opening passages in the body, for example, expelling humors, or consolidating wounds—to which Galen’s degrees did not apply. How the physician might choose to calculate the degree of a compound medicine was perfectly irrelevant to him as he tried to make that identification.

III

Arnau’s thoughtfulness is further evidenced by the way he imbedded this way of determining the property or quality of a medicine in a wider analytical framework, one that went back to Galen’s discussion of medical testing in De simplici medicina. There Galen had distinguished (not entirely clearly) between two ways of determining medicinal properties, one a via experimenti and the other a via rationis, a distinction that Avicenna characteristically tried to clarify in the Canon. Bernard de Gordon ignored Avicenna’s reformulation, however, and instead went directly back to Galen: he understood Galen’s via experimenti to describe his own favored approach, one that directly observed a medicine’s effect on the body, and he identified the via rationis with a method that he believed Galen had rejected, that of inferring a medicine’s properties by observing its subtlety or its density, its color or taste or smell. Galen did in fact attack examples of such reasoning early in De simplici medicina II, as logically unsound, but inference from taste was not among the procedures that he objected to
there, and in book IV of that work he himself developed taste as an alternative index to the
determination of qualitative nature, rational rather than experimental:

   We can determine it by either of two methods, one by sense [direct observation] and the other
   by reason [logical inference from taste]. Determination by sense involves recognizing it
   through the medicine’s activity, while determination by reason draws on the very substance of
   these medicines.\textsuperscript{24}

For Galen, the material nature of the medicine—roughly, subtle or dense—determined how finely it
could be divided, and fineness of division was the physical factor that had as its consequences both
whether it heated and what kind of effect it had on the human senses.\textsuperscript{25} As explained further by
Avicenna, hotness and coldness were necessarily determined by material nature, but the sensations
were less trustworthy indicators: testing is normally done “by taste, not because it is necessary but
because it is usual; and after taste by odor, and after both of these by color—but color is not really
satisfactory.”\textsuperscript{26}

Arnau paid thoughtful attention to this part of Galen’s work, more perhaps than Bernard had
done. In the \textit{Speculum}, Arnau found a role for both ways of testing a medicine’s properties. The \textit{via rationis}
is valuable because it allows the physician to start with something immediately apparent, the
body’s direct sensory perception of or response to a drug’s active power, which is of course not at all
the same thing as its effect on complexion and health. The latter effect, which may not be immediately
recognizable to the physician observer, is what the \textit{via experimenti} allows him more laboriously to
identify; nevertheless, both kinds of effects derive ultimately from the medicine’s complexion, from its
hotness or coldness. Arnau follows the Galenic-Avicennan account of the \textit{via rationis} broadly, but in
reverse, explaining how noting a drug’s material character (density or subtlety) or studying its taste (he
accepts that the other sensory responses are less satisfactory) gives the physician a way to infer its complexional nature by a kind of “logical” process, arriving at the (complexional) cause from the way it can be inferred to be producing the (sensory) effect: hotness produces sweetness or unctuousness or saltiness, coldness produces sourness or sharpness or stipticity.

Here we obviously have a testing procedure of another sort, “rational” rather than “experimental,” and Arnau stressed that there are rules that govern this procedure too. Coarseness and heaviness make it hard for a substance to heat, fine division makes it easier; thus in order to exclude doubt or some extraneous factor from contributing to the judgment, substances should all be tasted in the same form. But it is a procedure that gives rise to problems with the certitudo of its conclusions. Some substances have no taste; others are too solid to mix with salival moisture and thereby produce a taste; some are made up of constituents (like the rind and pulp of fruit) that are differently accessible to taste, or of which one has a taste that overpowers and conceals that of the other. Furthermore, these conclusions will vary from place to place: the drugs of some species affect individuals differently in different regions. Here the way out is to relate drugs in every region to a temperate individual in that region, and to refer all other medicines there to that local standard.

After discussing the two procedures separately, Arnau concluded by summarizing for the reader their relative advantages and disadvantages in a very illuminating passage:

In order to determine the primary and secondary powers of medicines, it is necessary for the physician to use each of these testing methods. . . . They differ in two ways. First, in the instruments that they employ, for the physician can make the test by taste on his own body, with his own taste, while the other test is made on another subject, because although the physician himself may have a temperate body, he ought not to expose himself to unknown and
doubtful effects for fear of injury, because he is an agent of the public good; a wise physician is of more value to the community than middling or lesser figures. Second, [they differ] in the character of the information they yield, for the information arrived at by taste [the via rationis] is only probable, leading to a judgment that leaves the mind uneasy when objections are raised against it, while the information arrived at by the second route [the via experimenti] is virtually assured, because of the certainty that can be had in such things. [Sometimes] it is necessary for the physician to obtain some information about the nature of a drug, at least general and approximate, for example when it is in widespread use in a land that he comes into; when asked, he should be able to offer advice about its use to worried patients, which he cannot readily do unless he turns to taste (assuming that he is unfamiliar with the drug that is in question), and he should not trust to the taste of others if it is in widespread use. On the other hand, sometimes it is necessary for him to have certainty about the medicine, for example when it is not commonly used as a food or as a seasoning, and if there is no immediate need to use it, it is appropriate that he test its effect on a healthy body according to the rules and cautions that have been laid down.28

The two procedures are thus complementary. The via rationis is quick and safe but gives only a rough result; the via experimenti gives an exact answer but is time-consuming and may involve some risks for the experimental subject. It is for the physician to decide which protocol, which method of testing, is more appropriate in the given circumstances.29

The general history of the words experimentum and experientia in the Middle Ages is not a part of this article, but we can at least reflect briefly on the way they are being used at this one particular place and time, Montpellier circa 1300. The terms via rationis and via experimenti were so named by
Gerard of Cremona in his translations of Galen and Avicenna in the 1170s or so, and from that time on they were effectively set in stone for Latin medical students who tried to apply these two methods of testing. Yet once in a while Gerard has Avicenna (and Galen) use not the noun, *experimentum*, but the corresponding verb, *experiri*, thereby focusing attention on the *act* of “experimenting” rather than on its product. And when we look closely at our Montpellier authors, we find them using the verb much more frequently than the noun when they describe the “experimental” situation, speaking not just of *experimenta* but saying *experiri*, *experimur*, *experitur*. This practice implies that at such moments they are imagining themselves as agents, visualizing the process that will yield *experientie* or *experimenta*. The process is so real to them that occasionally they even personify the agent: he becomes the *experiens*, even the *experimentator*. In this restricted setting the verb and noun should probably be translated not with an automatic “experiment,” but with “observe” or “observation,” all across a broad spectrum of situations. At one end, there are observations that approach experimentation in that they are deliberately constructed and controlled by the prior application of test protocols (as in Bernard’s sixth rule: “when we want to test [*experiri*] a medicine on the human body,” he declares, “we should first test it [experiri] on birds”). At the other end of the spectrum, there are the observations that are produced out of conscious awareness of particular circumstances or distinctive contexts (Arnau declares in his *Speculum* that “here among us we observe [experimur] that cabbage which grows in cold and dry places . . . is earthy and styptic, but in hot and moist ones . . . it is very moist”; “we often observe [experimur] that in some people the skin just reddens when it is rubbed with a brush, but in others it begins to itch”). Gianna Pomata has noted the fact that *observatio* itself lacked in the Middle Ages the sense of noticing or remarking, that instead it was routinely used to mean “conforming to” or
“observing,” as with rules or traditions—but given the way in which they used the term *experiri*, the Montpellier writers did not really need *observare*.32

IV

We saw above that in his *Speculum medicine* Arnau de Vilanova included in the conditions for his *via experimenti* the requirement that a standard measured dose be employed in testing drugs, a requirement that Bernard de Gordon had not made much of. Arnau’s recognition that a specific quantity of a drug had a specific effect on the body goes back to his theorizing about medicinal degrees. In his *Aphorismi de gradibus* he had accepted Alkindi’s view of the ways in which drugs of two different degrees combined to produce a third, but he had modified it by accepting the philosopher-physician Averroes’ criticism that the relative weights of the drugs also contributed to the result. Arnau concluded that medicines of a given degree manifested the effect of that degree only when they were given in a quantity specific to that degree, a *prima quantitas*, and he gave a few examples in showing how this affected calculations: the *prima quantitas* of pepper, hot in the fourth degree, was one drachm; that of sandalwood, hot in the second, was two drachms. A temperate medicine, which did not produce any effect, naturally had no *prima quantitas*. All this fitted well with the understanding of *minima naturalia* in contemporary natural philosophy.33

As we have seen, the *Aphorismi* said nothing about testing its predictions, in which the relative weights of the ingredients were understood to play a part, but it was natural that, once physicians thought about it, they should incorporate weight relations into their thoughts about experimental testing. But they entered slowly. Bernard did not build them into the experimental protocol he sketched out early in his *Tractatus*; acknowledging the universal principle that “every natural power requires a
quantity of medicine sufficient for it to act," he brought up the concept of the prima quantitas in a much later part of the work instead, purely as an adjunct to the calculatorial process. In contrast, a few years later, for Arnau in the Speculum, it had become part of the protocol: indeed, in that work he actually went further than he had in the Aphorismi, and made the general pronouncement that the prima quantitas of every fourth-degree medicine was one drachm; of every third-degree medicine, one and a half drachms; of every second-degree, two; and of every first-degree, three—adding that for a food to act as a medicine, its prima quantitas had to be measured in ounces rather than drachms.

Arnau de Vilanova and Bernard de Gordon between them made Montpellier a medical center for intellectual exploration and debate in the years around 1300, and to a lesser extent the tradition was carried on in the next generation of the faculty, in particular in the person of Jordan de Turre. Jordan is already recorded as a master there in 1313, a master of arts as well as a master of medicine, and quite conceivably had been trained at that very school. Four years later he prepared a collection of useful recipes for his son Jean, “starting out in practice.” Taken in combination, his academic degrees and his offspring suggest that he might have been born circa 1270 and studied at some point during the later 1290s. If all this is true, his medical training would have coincided with the years when Arnau and Bernard were particularly active and would have exposed him directly to their conviction that testing and measurement were the keys to understanding the effects of drugs.

That Jordan absorbed that conviction is apparent in an exceptionally ambitious work that he finished in 1326, midway in his career, drawn up “ad utilitatem studentium medicine, maxime in studio Montispessulani, et ad informationem Johanni filii nostri”—more a contribution to medical discussion at Montpellier, however, than another vademecum for his son. The work is titled De adinventione graduum in medicinis simplicibus et compositis, and it is a study quite as elaborate as Arnau’s
Aphorismi de gradibus: it thoroughly examines the possible meanings of “degree,” discusses the various systems proposed for calculating their combination, and assesses the bearing of the quantity of the ingredients on the eventual result. A series of dubitationes at the end of the work confirms that the problem had continued to be a magna controversia in hoc studio; Arnau’s writings had by no means settled the subject, and Jordan was openly scornful of the summary given in the Speculum medicine. He evidently had no difficulties with Arnau’s overall procedure for testing the quality and intensity of a medicine; it was one particular element in that protocol that he objected to, Arnau’s arbitrary assignment of prime doses to medicines of different degrees. Jordan agreed fully that all medicines, whatever their powers, could exercise them only in a specific quantity or dose (dosis), but having said this he began to attack the views of “a certain ‘great man’ in his Speculum”—one can almost hear the quotes around “great man,” as he refers sarcastically to Arnau whom, if I am right, he might have known personally twenty or thirty years before. He refuted a number of Arnau’s assertions, for example that all medicines of the fourth degree (pepper, for example) had a dosis of one drachm. What a stronger agent cannot do, a weaker one cannot do either, he argued, and he went on with a kind of thought experiment: “Imagine a hollow man constructed out of leather and heated to the heat of a temperate body; hang inside it a drachm of fire or charcoal with a good draft. It is obvious that even two [drachms] could not heat this man to a strong heat,” so certainly one drachm of pepper would not do so. “Granted that these examples do not fit the case exactly,” he continued, “they still in their way contradict the aforesaid position. . . . I am convinced that people have arrived at [dosages] only by approximation, discovery, or testing [extimationem, adinventionem, et determinationem].”

For this reason, Jordan went on, one common dose cannot be ascribed to all medicines of a given degree, and physicians have not been able to determine particular dosages in medicines, though
they have been able to fix their degrees precisely. They may have come upon doses by chance
discovery, but they have not been able support that discovery by a via rationis, in the way that degrees
can be rationally supported by logical considerations drawn from substantial nature or taste. To be
sure, our failure to establish particular dosages is not altogether calamitous, since we can give a tiny
quantity of a drug repeatedly to get the effect we want. Still, since we cannot use reason, if we have no
experience to call on, what can we do? There are two approaches we can take, he says:

One is that a physician should select from as temperate a locality in his region as he can find
the most temperate subject [famulum] that he can find in that area; then select a medicine hot in
the first degree, the best in that degree in all respects, and administer it to his subject at a
normal time of day, making sure that he is healthy, not stuffed or starving, not aching or hot or
cold. He should administer a first-degree medicine, for example in a quantity of half a drachm,
and note what effect it has [on the subject], considering urine, pulse, the color and temperature
of the body, and everything else that may be a sign of heat. He should determine whether [the
subject] feels any warmth or not; if he feels definite warmth, the quantity was too great, since
[a first-degree medicine] should have no effect when it is first given. If he does not, then,
maintaining the same conditions, he should administer it again in the same way and see what
happens. If he gives it four or five times and no change is apparent, he should wait several days
and then following the same procedure should give a greater quantity of it, and he should keep
doing this, adding or subtracting each time a greater or lesser quantity of the medicine, until he
should discover the first observation of the first degree. (I myself think it would be easier to
find this for the second degree.) Then note the quantity of this medicine under these
circumstances, and when you have determined that quantity, namely its weight, you should
determine its size with a vessel or a string [*vasculum vel filum*]. Thus you will have determined two things, its weight and size, and with these measures you will be able to compare other medicines of the same degree and by approximation [*existimationem*] find the dose that you think will be appropriate from this rule.\(^{40}\)

Jordan has here laid out a procedure that, perhaps consciously, adapts the Montpellier *via experimenti* for determining a medicine’s qualitative property to a new situation where the *prima quantitas* of a medicine of a given property needs to be determined—in this case, the primary quality of hotness, but of course the procedure can be generalized to other medicinal properties as well. In each case, a pure sample is being applied to a standard measuring device under constant conditions.

The alternative method he proposes is one based on inference—not inference from personal observations, however, as in the *via rationis* (which in any case he has already said is inapplicable), but from authority:

Alternatively, you can pick a compound medicine from those listed by Avicenna in the *Canon*, books III and V, and see its dose, then consider its degree and its quality as best you can, and what it is meant to do, and the properties of all the ingredients in it and how far they vary from the mean; also the illness and the members that they address, when it, and they, are taken in a temperate body. Then I say that you can guide yourself by that compound in the dosage of a simple medicine in respect to the illness of members or some other aim. I say these things not as demonstratively true, but rather as inferences [*inductiones*] for sound practice.\(^{41}\)

For Jordan was far from believing that *all* medicines needed to have their doses determined anew by testing: simple medicines were the only real problem. “The dosages of purges, poisons, remedies for
poisons or for illnesses or for the different members,” he concluded, “have been set down by authors, established and discovered by long experience.”

In the Introductorium iuvenum of Gérard de Solo, writing only ten or fifteen years after Jordan, we seem to see a decline in Montpellier’s intellectual engagement with medicines and their qualitative properties. Gérard appears in the faculty rolls of 1335 along with Jean de Turre, Jordan’s son, and thus belongs to the intellectual generation after Jordan. He could quite well have studied with him in the 1320s, that is, while De adinventione was being composed; indeed, he was actually associated with Jordan in one recorded case. He clearly knew De adinventione and often drew on it in the discussion of medicinal degrees that he offered in the Introductorium, which however is of a much lower intellectual standard. He skimmed the discussion of philosophical issues present in Jordan’s work, and his discussion of the mathematics involved in medicinal compounding was uninspired and careless. The question that had been of such concern to Jordan, how to determine experimentally the prime quantitates of medicines, was similarly scanted by Gérard. He agreed that doses of simple alterative medicines were not specified in the medical literature, but this did not mean that they should undergo experimental determination, rather it meant that they were not actually particularly important: partly because the medicines were not really very dangerous, partly because they could always be given in tiny repeated doses until the physician saw the desired results, partly because their properties were learned from taste, as well as from the other senses “in quibus non est certitudo.”

Gérard gave accounts of the via experimenti and the via rationis as ways of determining medicinal properties, but they too are predictably somewhat simplistic. As to the former method, he boasted of having reduced Avicenna’s seven rules to five, yet in fact he has sneaked in Avicenna’s last rule (that one should test only on a human subject) without acknowledging it; and while he declared
that a medicine must be tested on a temperate subject, he went on immediately to say that if it were
tested on a distempered body, the medicine must be of the opposite quality but equal in intensity, thus
maintaining the Avicennan and Bernardian-Arnaldian criteria simultaneously without recognizing the
contradiction. The latter method he treated quite briefly: substance, taste, odor, and color are all
indicators of qualitative nature, he explained, and he expressed only mild reservations about the
predictive character of any of them. Gérard does not strike the reader as a model of intellectual
consistency or depth. Yet his discussion concludes with a new topic showing that he had given at least
some serious thought to controlling the test situation. It is a list of ten preconditions that must be
observed in order for a compound medicine’s degree to be established: for example, the simples going
into it must be the “best” of their kind, collected at full maturity from a temperate locale,
uncontaminated by anything else, prepared in a standard manner, and used in their correct quantities.
Evidently Montpellier’s earlier recognition of the “normal” as an explicitly necessary referent for
judgment had not been entirely lost on him.

V

This little series of texts shows us a self-contained, self-conscious intellectual tradition at Montpellier
over roughly fifty years, one in which the school’s masters (and evidently not just these four authors)
had continually debated the nature of medicinal activity with one another as well as with their
predecessors, back to Galen. In the course of that debate they realized that a precise understanding of
how drugs of different strengths acted on the human body, sick or well, required them to start by
determining those strengths and those actions with certainty, and they evolved a procedure, based on a
Galenic hint, that would do just that. They developed a clearheaded test protocol for the measurement
of medicinal strength against a null point, a temperate zero point, instead of against a variable and indeterminate disease intensity. And in the process they came to recognize the need to reduce the action of a medicine on a patient to its essentials, to strip it down to pure agent acting on pure object: their fully developed protocol for the via experimenti required a specified quantity of a pure drug unaffected by external conditions to be applied to what might be called a standard measuring instrument.

Not surprisingly, their language suggests that they thought of the problem in terms of cause and effect: given the effect, can we establish the cause? Medieval physicians had long asked themselves, how can we be truly sure what drugs do? The Montpellier master Cardinalis had expressed his frustration over just this question in the mid-thirteenth century: “if a physician gives violet sugar to someone with a choler-based fever, he won’t know what cured him if he recovers, and he won’t know what killed him if he dies.”48 The procedures that were developing in the early fourteenth century were designed to go some way toward this: they made it possible for the physician, given a drug, to decide how much of it would be required to produce a specific measurable effect on his patient.

Where did these protocols come from? In part, from Galenic rules; in part, I suppose, from what might vaguely be called “common sense.” And in part, I would suggest, from a theme that another quite different constituent of the “new Galen,” De interioribus, had made prominent in Latin medicine in the years around 1300. There Galen had given examples of how contingent factors could intrude into the medical encounter and introduce an unexpected element that would have to be taken into account if the normal cause-effect connection were to be recognized. In one story he told how he asked a healthy man who had begun to vomit blood, what he had been eating and drinking; told that he had drunk water from an impure fountain when very thirsty, Galen gave him the medicine needed to
vomit up a leech that he had swallowed with the water. Arnau and Bernard both commented explicitly on the complexity of cause and effect in medicine and the difficulty that that led to in drawing conclusions. The Montpellier physicians’ increasing consciousness of the distorting effect of external contingent factors in medicine would have helped make them particularly aware of the need to strip away anything that might distort the ideal norm, the mean, the temperate state of things in their experimental design, as they pursued the via experimenti to determine what effect a drug caused on the human body.

Yet in the event, this new model test procedure led nowhere after Jordan extended it to the testing of dosages in the 1320s. It may be wrong to interpret Gérard de Solo as evidence of its decline, but he is the final author in the surviving tradition, and the test procedure clearly was of relatively little importance to him. What happened? Perhaps it was carried on by other figures, and Gérard was simply atypical. Perhaps Montpellier’s discussions were sidetracked by new problems of plague and war after 1350. But we must realize that testing medicines’ powers was never an end in itself for the faculty. These writers were imagining doing so primarily because that would allow them to establish the powers of a new medicine. Once that problem no longer seemed intellectually intriguing or practically valuable, it was dropped, and with it was lost their incentive to determine experimentally the powers of simple or compound medicines. And indeed this is what we see in Gérard’s Introductorium: a failure to engage with the issues of the tradition de gradibus associated with a failure to appreciate the role of testing to carry it out.

Were these tests ever actually put into practice? The men who developed them most thoughtfully, Arnau de Vilanova and Jordan de Turre, certainly wanted them to be practicable; they imagined themselves as actual experimentatores. The continuing elaboration of experimental
procedures to eliminate all conceivable contingent sources of error demonstrates that imagining a test was not simply a rhetorical device for them. The test procedure was not, like Jordan’s hollow man made of leather, a thought experiment thrown out to make a point that readers would recognize did not exactly fit the case; rather, exactness of fit to the real world mattered and was extended by these authors as far as possible. Looking at the care with which they developed their protocols, we can scarcely extend to them Owsei Temkin’s assessment that Galen was interested in “methodological speculation with little regard for the establishment of fact or for the possibilities of practical application.”51 In this respect they had gone well beyond their master.

These tests that embodied the via experimenti could have been used, then, they might have been used—but there is no evidence that they were used, at least in a systematic way. For when you get right down to practice, such tests are laborious, they are time-consuming, they are hard to do correctly: most experimental procedures are. Unless there had been an overwhelming need to determine a degree perfectly accurately, or a dosage, it would have been much easier and quicker to follow the traditional via rationis in treating your patients. For after all, medieval physicians had no other incentives to test their medicines in order to determine their effects and dosage with absolute precision—the role of research scientist did not yet exist. Test compound medicines, available in the current pharmacopoeia? Their properties had already been determined by Avicenna and others, who could be trusted to have recorded them correctly. Test simple medicines? Here again, authorities could be trusted, confirmation by taste was feasible, and if a physician had any lingering concern about overdosing, the medicines could be given repeatedly in tiny quantities in order to avoid any problems. So, while a procedure for testing medicines to determine accurately their quality and strength and dosage was developed seriously and intelligently by the Montpellier masters in the early fourteenth
century, it must have been applied sporadically at best, and only as long as speculation de gradibus persisted: it was an idealized program that began to be forgotten when masters decided that the information it would yield if implemented was not really worth their trouble even to dream about acquiring.

MICHAEL MCVAUGH is William Smith Wells Professor of History (Emeritus) at the University of North Carolina. His research interests center on the transmission of Greco-Arabic knowledge to medieval Europe and its role in the creation of a learned (especially university-based) European medical culture in the thirteenth and fourteenth centuries.
Luis García Ballester, “Arnau de Vilanova (c. 1240–1311) y la reforma de los estudios médicos en Montpellier (1309): El Hipócrates latino y la introducción del nuevo Galeno,” *Dynamis* 2 (1982): 97–158. Vivian Nutton has questioned the appropriateness of the category, pointing out that a large Latin corpus of “new” Galenic writings was already circulating in the middle of the previous century, but García Ballester’s term is useful as referring to a small subset of these works (“la decantación académica del ‘nuevo Galeno,’” p. 121) that became the focus of instruction in European medical faculties about 1300. See Michael McVaugh, “The Future of a Disease: The Impact of Galen’s *De Crisi* on Medieval Medical Thought,” in *Die mantischen Künste und die Epistemologie prognostischer Wissenschaften im Mittelalter*, ed. Alexander Fidora (Cologne: Böhlau, 2013), 131–50, at 132–33.

2 “Et prima quidem quam tibi narro de conditionibus illis est quod cum affers corpori aliquam medicinarum aut aliquem ciborum, oportet ut sit medicina illa aut cibus quem affers nudus ab omni caliditate et frigiditate acquisita vehementi. . . . Cumque experiri volueris medicine virtutem, non oportet ut eam corpori cuiuslibet dispositionis afferas, sed oportet ut eam afferas illi ipso existente cum dispositione que est singularis et simplex secundum quod ultime possibile est, et cum hoc sit in ultimo eius. . . . Et non oportet etiam ut ponas experientiam rei qua operatur medicina secundum accidens et non secundum se. . . . Et extimes ut modereris quantitatem virtutis medicine et secundum quantitatem alicuius dispositionum corporis impedientis, verbi gratia si dispositio corporis fuerit in ultimo calida, oportebit ut sit medicina in ultimo frigida”; Galen, *De complexionibus* III.5, in *Opera Galieni* (Venice, 1490), 2.20va–21ra. The somewhat different medieval Greek-Latin translation of the same passage can


5 “Sit virtus que est in medicina opposite et quod equatur ei de potentia egritudinis. Sunt enim medicine quedam quorum caliditas minoratur a frigiditate egritudinis alciuius, quare penitus in ea non agit, et quandoque cum administratur in infrigidiatione aliqua leviorem illa facit calefactionem. Oportet ergo ut experiat prius in debiliiori, et secundum gradus fiat processio paulatim donec sciat virtus medicine et non dubitet”; Avicenna, Liber canonis (n. 4) II.1.2, fol. 82rb. The translation slightly modifies that of Crombie, Styles (n. 4), 1:344, who assumes that “deiblior” modifies an understood “egritudine” rather than an entirely conceivable “medicina.” Gerard of Cremona’s translation of the Canon was faithful to the Arabic, which also reads merely al-adżaf “the weaker” (Arabic edition of Rome, 1593, p. 115). Under either interpretation, of course, Avicenna is imagining medicines and
illnesses as being compared directly with one another, rather than against an externally determined midpoint of temperancy.

6 Galen, *De simplici medicina* V.8.2, in *Opera Galieni* (n. 2), 2.56rb.

7 “Gradus quidem primus est illud quod . . . efficit in corpore sua qualitative operationem non perceptam . . . nisi postquam reiteratum fuerit et multum factum fuerit”; Avicenna, *Liber canonis* (n. 4) I.2.2.1.15, fol. 34ra.


9 “Queritur quot conditiones exiguntur ad viam experimenti. Solutio dicendum quod sex. Primo est quod medicina sit tuta ab omni qualitate complexionali; secunda est ut accipiens illam habeat morbum ad quod specialiter habet aspectum; tertia est ut per se exhibeatur; quarta est ut in eodem gradu sit opposite morbo; quinta est ut non tantum semel eam experiamur sed multotiens; sexta est ut in corpore debito ut in corpore hominis et non asini ipsam experiamur”; Isaac Israeli, *Liber dietarum universalium cum commento Petri Hispani*, in *Opera Ysaac*, I (Lyon, 1515), fol. 20va.

10 “Ut cibus et medicina quae offeruntur sint munda ab omni qualitate extranea . . . ; ut illa offerantur corpori cujus complexio est singularis simplex . . . ; ut fiat differentia inter operationem per se et operationem per accidens . . . ; ut quantitas medicinae mensuretur secundum quantitatem dispositionis corporis . . . ; ut medicina sit simplex singularis . . . ; ut sit corpus existens purae qualitatis”; Georg
Matern, “Die drei Bücher des Galen über die Temperamente” (Inaug.-diss., Berlin, 1894), 23. It can be seen that Jean’s expression of the first four rules is expectably very similar in language to Galen’s as given above, note 2, while his fifth and sixth rules seem for some reason to repeat his second and first. In Jean’s Expositio in Antidotarium Nicolai (in Mesue cum expositione Mundini [Lyon, 1519], fols. 273v–274) he gives seven numbered rules governing experiments to identify the properties of simple medicines which prove to be, not Galenic, but close paraphrases of the rules in the Canon. On Saint-Amand, see Danielle Jacquir, “L’oeuvre de Jean de Saint-Amand et les méthodes d’enseignement à la faculté de médecine de Paris à la fin du XIIIe siècle,” in Manuels, programmes de cours et techniques d’enseignement dans les universités médiévales, Actes du Colloque international de Louvain-la-Neuve (9–11 septembre 1993), ed. J. Hamesse (Louvain-La-Neuve: Institut d’études médiévales, 1994), 257–75; and W. O. Schalick III, “Add One Part Pharmacy to One Part Surgery and One Part Medicine: Jean de Saint-Amand and the Development of Medical Pharmacology in Thirteenth-Century Paris” (Ph.D. diss., Johns Hopkins University, 1997).


12 “Alterare corpus sensibiliter sine lesione operationis post frequentem applicationem”; Arnau de Vilanova, Aphorismi de gradibus, ed. Michael R. McVaugh, Arnaldi de Villanova Opera Medica Omnia II (Granada/Barcelona: University of Barcelona, 1975; reprinting with indexes, Barcelona: Universitat de Barcelona, 1992), 162. This volume includes an introductory essay (3–136) that
examines the earlier Galenic and Arabic theories of the measurement of qualitative intensity in medicines, and shows the ways in which they were adapted by Arnau de Vilanova in his *Aphorismi*.


14 Ibid., 132.


16 “Quod si aliquam medicinam volumus experiri in corpore humano, quod prius experiamur in avibus et postea in brutis animalibus et postea in hospitalibus et postea in fratribus minoribus et postea in aliis per ordinem, quia si forte esset de genere venenorum interficeret”; Pagel, “Ueber die Grade” (n. 13), 143, and Demaitre, *Doctor Bernard de Gordon* (n. 15), 128.

17 The rules are given in Arnau de Vilanova, *Speculum medicine*, cap. 22: *De modo cognoscendi virtutes complexionatorum, primo per experimentum*, in *Opera Arnaldi* (Lyons, 1504), fols. 10ra–11ra.

18 “. . . applicetur corpori in ea perfectione ac puritate que sue speciei debetur”; ibid., fol. 11a.

19 Ibid., cap. 32: *De cognitione virtutum complexionatorum ex operationibus*, fols. 18vb–19ra.
Note that the only effect Bernard de Gordon mentioned as possibly to be revealed by his version of the test procedure is the power to poison, which is of course a second- or even third-level quality; above, n. 16.

My own interest in this material was originally expressed in M. R. McVaugh, “Quantified Medical Theory and Practice at Fourteenth-Century Montpellier,” Bull. Hist. Med. 43 (1969): 387–413, whose language I now suspect implies a closer connection between the calculation of degrees and programs of medicinal testing than was actually the case.

“De cognitione virtutum complexionum medicinarum singularium per experimentum”; Avicenna, Liber canonis (n. 4) II.1.2, fol. 82r–v; “De cognitione virtutum medicinarum singularium per ratiocinationem”; ibid., II.1.3, fols. 82v–84v.

“Deridet eos qui investigant per viam rationis et pro tanto objicitur via illorum qui volunt venire in cognitionem simplicium per colorem, per odorem, per saporem, per rarum, per densum et sic de aliis, quare horum cognitio non est nisi solum per experimentum”; Pagel, “Ueber die Grade” (n. 13), 132.

Demaitre, Doctor Bernard de Gordon (n. 15), 129, misunderstands Bernard on this point.

“Nos pervenimus ad verificandum et certificandum illud . . . simul ex duobus modis, quorum unus est sensus et alter ratiocinatio. Sed via verificationis quidem ex sensu est confiteri res ex operibus, via vero verificationis per ratiocinationem est ex ipsa substantia harum medicinarum”; Galen, De simplici medicina (n. 6) IV.2.4 (“In quo inquiritur virtutem medicine per saporem stipticam et acetosam”), Opera Galeni, 2.44rb.
Galen’s understanding of the relationship between human perceptions of taste, color, etc. in medicines and the qualitative natures that they imply is examined in Georg Harig, Bestimmung der Intensität im medizinischen System Galens (Berlin: Akademie Verlag, 1974), 78–83. It needs to be borne in mind, however, that Harig’s analysis is based upon the Greek texts of Galen’s works, which after passing through Arabic into Latin (as in the case of De complexionibus and De simplici medicina) frequently had a slightly (occasionally even greatly) different meaning for their medieval readers.

“Hoc quidem in saporibus non secundum quod sit necessarium sed secundum quod est plurimum, et post saporest in odoribus, et post utroque est in coloribus—et in coloribus quidem est sicut sine fiducia cum eo”; Avicenna, Liber canonis (n. 4) II.1.3, fol. 83rb.

“Acutus sapor et amarus et salsus et dulcis et unctuosus a caliditate secundum plus et minus causantur, ponticus vero et stipticus et acutosus a frigiditate”; Arnau de Vilanova, Speculum medicine (n. 17), cap. 26, fol. 16va. Cf. Avicenna, Liber canonis (n. 4), fol. 83ra: “Ex aliis canonibus necesse est medicos rem unam scire, quoniam non est possibile ut sapore dulcis et amarus et acutus sit nisi in substantia calida, neque ponticus stipticus et acetosus nisi in substantia frigida.”

“Sit medico necessarium uti predictis duobis modis ad investigandum notitiam primarum et secundarum virtutum in medicinis. . . . differunt in duobus, quorum primum est instrumentum quo exercetur. Nam modum investigandi notitiam predictam per gustum potest exercere medicus proprio corpore, quia proprio gustu. Sed alium exercet in alieno, quia licet medicus in seipso corpus temperatum haberet, non tamen ignotis et dubiis alterationibus debet suum exponere ne labatur, quoniam publice utilitatis est instrumentum; plus enim communitati obsequitur sapiens medicus quam
mediocres et minores in populo. Secundum vero in quo differunt est qualitas notitie quam exhibet de predictis, etenim notitia perfecta per gustum est quasi probabilis, quia facit opinionem quandam in qua plene non quiescit animus cum formidet contrarium, sed notitia facta per alium modum est quasi demonstrativa propter certitudinem possibilem quam habet in tali materia. Cum igitur sit medico necessarium quandoque prompte cognoscere—saltem in generali et probabiliter—naturam complexionat propositi, ut cum habitatoribus regionis quam ingreditur est in usu communi. Interrogatus enim convenit ut dubitationibus lapsorum circa usum ipsius aliquam prebeat directionem, quod nequit prompte facere nisi recurrendo ad gustum, supposito quod ignotum fuerit ei complexionatum quod presentatur, neque debeat esse contentus gustu aliorum postquam res est in usu communis. Quandoque vero necessarium est medico certificari de re proposita, ut quando non est communiter usitata vel via cibi vel via saporis aut condimenti, nec urget necessitas applicandi eam, et ideo convenit ut eius effectus experiantur in sanabili corpore secundum regulas et cautelas expressas in expositione primi amphorismorum Ypocratis doctissimi: ibi enim data est doctrina prudenter experiendi medicinas ignotas in humanis corporibus”; Arnau de Vilanova, Speculum medicine (n. 17), cap. 77, fol. 27vb. A slightly different translation is given in Arnau de Vilanova, Aphorismi de gradibus (n. 12), 120.

29 The Speculum reveals that, like other learned physicians, Arnau accepted that some medicines’ effects arise ex tota substantia and are not rationally predictable but can be discovered only empirically. Presumably their qualities could be explored only by the via experimenti, not the via rationis, but Arnau does not address this issue.
Quoted above, n. 16; Pagel, “Ueber die Grade” (n. 13), 143.

“Hic apud nos experimur quod caulis crescens in locis frigidis et siccis . . . est valde terrestris et stipticus, in calidis autem et humidis . . . multum est humidus”; “sepius experimur quod in aliquibus membra confricata cum cepa tantum rubificantur, in aliis autem pruritum incurrunt”; Arnau de Vilanova, *Speculum medicine* (above, n. 17), capp. 23, 43, fols. 13a, 21ra.


See Arnau de Vilanova, *Aphorismi de gradibus* (n. 12), 97–100.

“Quaelibet enim virtus naturalis exigit quantitatem medicinae sufficientem ad sui actionem”; Pagel, “Ueber die Grade” (n. 13), 222–23.

Arnau de Vilanova, *Speculum medicine* (n. 17), cap. 22, fol. 10vb.

37 “Quidam magnus in speculo suo”; Jordanus de Turre, *De adinventione graduum*, MS. Vatican City, Lat. 2225, fol. 60ra.

38 “Supponamus hominem factum de corio concavum, et calefiat calefactionem corporis temperate et suspendatur in medio ʒ ignis vel carbonum cum bona flabellacione; certum est etiam si essent due quod non calefacerent hunc hominem ad fortem caliditatem tangentem, quare hic non videtur habere veritatem. Et licet hec plenarie similitudinem non habeant, tamen suo modo contrarium ostendunt predicte positionis perspicaciter et sensibiliter intuenti. . . . Sed credo quod nunquam fuerit per aliquem compertum nisi per eius extimationem adinventionem et determinationem”; Jordanus de Turre, *De adinventione* (n. 37), fol. 60rb. See also McVaugh, “Two Faces” (n. 36), 315.

39 His reasoning is presumably based on the Avicennan definition that the second degree manifests itself to the senses immediately, while the first degree does so only after a lapse of time.

40 “Una est quod medicus in regione sua et in loco temperato magis quam ibidem reperire poterit, debet eligere sibi famulum temperatum ut melius poterit in regione illa, deinde eligere medicinam calidam in primo gradu meliorem in omnibus suis dispositionibus in illo gradu, et exhibere ei, eo sano existente, non repleto vel famelico, non subdolente vel infrigidato vel calido existente, tempore die hora temperato; et ei administrare aliquam medicinam in primo gradu, ut puta aliquam quantitatem medie ʒ gratia exempli, et notetur quid fecerit impressionis, et consideretur urina pulsus corporis color et calor corporis et alia pertinentia signa caliditatis. Investigentur an senserit caliditatem vel ne; si notabilem senserit, iam quantitas excessiva fuit, cum prima obviacione hoc facere non debuerit. Si vero non, iterum, condicionibus servatis, exhibeatur itidem et perciapiatur quid operatum fuerit. Si quatuor vel .v.
vicibus fuerit exhibita et nihil perceptum fuerit mutationis in sensu, sibi ipsi relinquatur per multos dies, et servato quod prius redeatur ad quantitatem eius maiorem, et hoc operaberis addendo vel subtrahendo in eadem vel maiorem vel minorem quantitatem usquequo perveneris ad inventionem operationem prime experiencie primi gradus. (Sed ego estimo quod facilius et melius reperietur hoc in secundo gradu et in aliis quam in primo.) Et nota hanc quantitatem huius medicine in natura sua in conditionibus suis; causa tamen in primo vel in secundo accipiatur ex ipsa quantitate nota, id est pondere ipsius, eius dimensio per vasolum vel per filum postea ponderetur. Notentur ergo duo, pondus eius et dimensio per vasolum vel filum; et cum ista mensura dimensionum et ponderum medicine exparte, poteris eius aliquis comparare eiusdem gradus, addendo vel subtrahendo habitudine ad illam, et existimatione accipere dosim quam credes cum hac regula esse decentem”; Jordanus de Turre, De adinventione (n. 37), fols. 61rb–61va. The translation slightly modifies that given in McVaugh, “Two Faces” (n. 36), 312–13.

41 “Vel alter accipe unam medicinam compositam earum que ponuntur ab Avicenna in tertio vel in quinto, et vide dosim eius, et considera cuius gradus sit et cuius qualitatis ut melius poteris, et ad quam ponitur intentionem in composita medicina, et considera etiam qualitates omnium medicinarum et quantum recedunt a medio vel ab intentione alio; et iterum considera morbum ad quem ordinatur et membra, cum quotlibet accipiatur in corpore temperato et respectu istorum positorum in corpore temperato. Tunc dico quod respectu passionis membrorum vel intentionum aliarum per illam compositam in simplici medicina te poteris in dosibus regulare. Istas non assero demonstrationes, sed
potius inductiones ad bene operandum”; Jordanus de Turre, *De adinventione* (n. 37), fol. 61va–b. The translation modifies that given in McVaugh, “Two Faces” (n. 36), 313.

42 “Doses autem laxativarum medicinarum, venenosarum, tiriacalium, passionibus valentium et membris, note sunt ab auctoribus et determinate, per longevam experientiam invente”; Jordanus de Turre, *De adinventione* (n. 37), fol. 62va.

43 *Cartulaire de l’Université de Montpellier*, vol. 1 (Montpellier, 1890), no. 61, 292–93; Danielle Jacquart, *Ernest Wickersheimer: Dictionnaire biographique des médecins en France au moyen âge, Supplément* (Geneva: Droz, 1979), 188.


45 The evidence for this was presented in Michael McVaugh, “The Medieval Theory of Compound Medicines” (Ph.D. diss., Princeton University, 1965), 189–91.

46 I am basing this account of Gérard’s discussion of medicinal degree on the material in Gérard de Solo, *Introductorium iuvenum*, cap. 5 (Venice, 1505), fols. 4v–8r.

47 Ibid, fol. 7va.

49 Galen, De interioribus IV.5, in Opera Galeni, 2.129rb; = De locis affectis IV.8 (K 8.265–66).

50 Arnau paid particular attention to this idea of medical contingency in his commentary on Hippocrates’ aphorism I.1, which he completed in 1301. See Arnau de Vilanova, Repetitio super Aphorismo Hippocratis “Vita brevis,” ed. Michael McVaugh and Fernando Salmón, Arnaldi de Villanova Opera Medica Omnia XIV (Barcelona: Universitat de Barcelona, 2014), 324–28.