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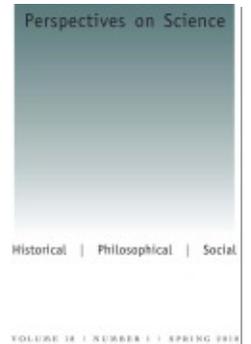
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Brian Vickers on
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A Response

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Vickers on the “Apologetic” Character of the “New Historiography” of Alchemy

From the publication of his 1984 *Occult and Scientific Mentalities in the Renaissance* if not before, Brian Vickers has vigorously maintained that “the occult sciences,” in which he includes alchemy, astrology, and natural magic along with several other fields, were distinct from and at best orthogonal to the advances in experiment and theory that characterized the birth of modern science in the seventeenth century.¹ At worst, in Vickers’ view, the occult sciences were outright hindrances to the Scientific Revolution. It is no surprise, therefore, that Vickers would take umbrage at the “New Historiography” of alchemy, which has shown in the last two decades that the aurific art was integral both to the Scientific Revolution and to the nascent science of modern chemistry. In his recent essay review, “The ‘New Historiography’ and the Limits of Alchemy” (2008), Vickers devotes well over half of his thirty-page review to a hostile critique of my 2004 book *Promethean Ambitions: Alchemy and the Quest to Perfect Nature*. His review of *Promethean Ambitions* is marked by an inordinate number of distortions and outright fallacies, and I will provide my response to these in the third part of this essay. One recurring theme in Vickers’ review needs to be met immediately, however, namely his claim that I, along with others in the “New Historiography,” have become apologists for alchemy.

The historical treatment of alchemy was long dominated by the Enlightenment rejection of chrysopoeia (transmutation of base metals into

1. Vickers expresses himself succinctly on this point in his introduction to the volume: “The error, as I see it, lies in arguing that the occult sciences in the Renaissance were productive of ideas, theories, and techniques in the new sciences” (see Vickers 1984a, p. 44).

gold). A contemptuous view of the subject as nothing but the province of charlatans and cheats, broadcast by the French academicians Bernard le Bovier de Fontenelle and Etienne-François Geoffroy among others in the early eighteenth century, became a foundational element of the historiography of science that was still widely parroted by historians of the Scientific Revolution up until the 1970's (Principe and Newman 2001). Hence we find A. Rupert Hall, a widely respected historian of seventeenth-century science, not only denying in 1962 that alchemy was a forerunner of chemistry, but even going so far as to describe it as "the greatest obstacle to the development of rational chemistry" (Hall 1962, p. 310). Similarly, E. J. Dijksterhuis would describe alchemy *tout court* in his 1961 *Mechanization of the World Picture* as an example of "the pathology of thought," and would go on to say that Robert Boyle's chrysopoetic endeavors were "a mysterious trifling with impure substances, guided by mystical conceptions and hazy analogies" (Dijksterhuis 1961, pp. 160, 440). These remarkably comprehensive denunciations ignore the fact that Enlightenment chemistry before Lavoisier still employed the apparatus, materials, theories, and practices provided to it by centuries of alchemists. Long before the "New Historiography" made its appearance, historians were pointing to the fact that Georg Ernst Stahl's influential phlogiston theory, for example, derived from Johann Joachim Becher's adaptation of the Paracelsian theory that metals and minerals were composed of mercury, sulfur, and salt (Metzger 1930, pp. 159–88). It is true that Stahl became an outspoken opponent of *Goldmacherei* during the last quarter of his life, but to deny the influence of alchemical theory and practice on him or other eighteenth-century chemists is to turn the historical evidence on its head.

To read Vickers' essay review is to find oneself suddenly back in the world of Rupert Hall and E. J. Dijksterhuis in the 1960's. Unlike Hall, who later modified his views, Vickers is still able to say of the colonial American alchemist George Starkey that "the early modern alchemist's life, like his day-to-day operations, are to be seen not as a forerunner of industrial or pharmaceutical chemistry (although Starkey did produce medicine and cosmetics) but as a narrative of quests for revelation" (Vickers 2008, p. 136). It is amusing to learn that spending one's life doing chemistry (or as I prefer, "chymistry") and even teaching Robert Boyle the foundations of the discipline as Starkey did, does not make one a chemist or even a forerunner of chemistry. Upon what evidence does Vickers base this claim? His proof lies in the fact that Starkey occasionally prayed to God for success and acknowledged the gifts that had been granted to him from on high. Did any seventeenth-century believer in the Providence of God do otherwise? Yet to Vickers, Starkey's prayers (interspersed with his own

candid descriptions of his erotic dreams and drunkenness) are evidence of the essential “spiritual dimension” of alchemy.

Given Vickers’ predilections, it is hardly surprising that he would see any book about alchemy that recognizes its contributions to the Scientific Revolution as providing an apology for the discipline. But the fact is that as a historical subject, alchemy, having been considered too despicable to be worthy of serious scholarly study by generations of historians, contains unexamined riches. In what other field could one have unearthed a figure like George Starkey, born in Bermuda in 1628 and educated in the provincial outpost of Harvard College, who would then go on to become Boyle’s scientific tutor and Isaac Newton’s favorite alchemical writer? If Starkey had been an astronomer or mathematician, his influence would have been exposed and announced to the scholarly community a century ago. As it happens, his story had to wait until 1994 to be revealed in its fullness, and even after that new details have continued to emerge. Or, to consider another example, how is it that historians until the 1990’s failed to notice the major debt that Robert Boyle, long reputed to be “the father of modern chemistry,” owed to techniques of analysis and synthesis pioneered by medieval alchemists and transmitted to him by the Wittenberg iatrochemist and apologist for chrysopoeia Daniel Sennert? Not only was this debt ignored, but the major historian of Boyle in the immediate postwar period, Marie Boas, announced that Sennert was “neither original, successful, nor, ultimately, influential” (Boas [Hall] 1962, p. 263n*). Never mind that Sennert employed analysis and synthesis to prove the existence of atoms, just as Boyle did when he made unacknowledged use of Sennert’s work (see Newman 2006).

The reality of the matter is that alchemy until recently lay in such disrepute among most historians—particularly among those who work in the seventeenth century like Vickers—that they did not bother to look for the obvious traces of its influence on more “mainstream” scientific endeavors. Rather, like Boas, they were all too willing to dismiss the discipline as a “mystic science,” and to rule out any possible influence on the Scientific Revolution *ab initio*.² Now that the tables are turned and a generation of historians has turned its sights on alchemy, is there any room for wonder that a field so long ignored by scholars will begin to reveal new and sometimes startling material? Perhaps not, but as Vickers shows, there is certainly room for denial, especially if one comes at the “New Historiography” with ideological blinders intact. The ideology to which I refer consists of an analytical framework that Vickers has developed for the study of the “occult sciences” or “the occult tradition” and upon which he

2. For the term “mystic science,” see Boas [Hall] 1962, p. 167.

has been publishing since at least the 1980's. At various points throughout his essay review Vickers supports himself with references to his previous writings on alchemy and "the occult" (Vickers 2008, pp. 132, 133n17, 146, and 154n50). At no point does Vickers reveal a need to modify his previously expressed views, despite the fact that they extend back at least twenty-five years, and therefore reflect a period when scholarship on "the occult tradition" in the Renaissance was still dominated by the work of Frances Yates and her critics.³ It is therefore fitting, and indeed long overdue, that the analytical framework undergirding Vickers' approach receive some of the scrutiny that it deserves. The result, I believe, will provide a much needed first step at a reassessment of the relationship obtaining among premodern alchemy, astrology, and natural magic.

An Examination of Vickers' Work on the Essential Unity of the Occult Sciences

That the subject of the occult sciences needs reappraisal appears from the very ambiguity of the word "occult." To Vickers, the term is a convenient place-marker for a particular mindset representing a "closed system" of thought characteristic of traditional cultures. In other words, the mental world of the occult sciences was incapable of accepting novelty, like the so-called "primitive mentality" or "savage mind" proposed by anthropologists in their less politically sensitive days.⁴ I reject Vickers' use of "occult" for reasons that will shortly become clear. But the Latin *occultus* ("hidden" or "secret") did have currency in the Middle Ages and Renaissance when applied to certain types of knowledge, in at least two senses. First, the Latin *occultus* served as a term for powers or qualities that escaped sensory perception and were therefore mysterious, such as the imperceptible causes of magnetic phenomena and the remarkably powerful effects of certain allergens and fast-acting poisons. It was widely held that such marvelous phenomena could not be explained in terms of the manifest "primary" or "tactile" qualities of scholastic Aristotelianism, hot, cold, wet, and dry.⁵ Instead, they were attributed to the operation of "occult qualities" whose actions were often thought to flow directly from a given body's substantial form. This sense of "occult," while it may have applied to at least some of the phenomena of natural magic, is problematic when one

3. Vickers' own foray into the occult sciences seems in fact to have been stimulated by his visceral response to Yates. See his early essay review, "Frances Yates and the Writing of History" (1979). His "Introduction" is also largely framed as a response to Yates (see Vickers 1984a, pp. 4–7).

4. Vickers 1984a, pp. 39–44. See p. 33 for Vickers' on "the primitive mentality."

5. On occult qualities, see Brian Copenhaver 1984, 1988, 1998.

comes to astrology and alchemy, for these disciplines were often thought to work by means of the Aristotelian primary qualities.⁶

A second sense of *occultus* occurred in cases when medievals and early moderns applied the term to branches of knowledge that they viewed as needing to be kept hidden or secret. This meaning is already employed by the thirteenth-century scholastic Roger Bacon, who not only includes the usual suspects among the occult sciences but adds “occult” medicines and remedies which, because of their power to prolong human life, must be kept from the masses (Bridges 1897, vol. 2, pp. 207–10).⁷ “Secret knowledge” is the primary sense of Renaissance *occulta philosophia* as well. But arguments could be made, of course, for keeping virtually any sort of sensitive knowledge secret. Agrippa von Nettesheim, who did as much as anyone to popularize the term *occulta philosophia* in the Renaissance, even included knowledge of sophisticated engines for building and warfare within the latitudinarian category of his “occult philosophy” (Agrippa 1992, 250–51).⁸ On the other hand, it does not follow that the fields usually classified as “occult” by moderns (such as alchemy, astrology, and natural magic) were necessarily treated as secret knowledge in their own day. A good example is the astrology of Ptolemy’s second-century *Tetrabiblos*, which neither engages in pseudonymy nor employs cover names or other obfuscatory language. Hence if one can accept “the occult sciences” as a term meaning branches of knowledge that were viewed by their possessors (or would-be possessors) as requiring secrecy, certain qualifications must be added. First one must recognize that secrecy was imposed or discussed at the discretion of individual authors and not as a necessary consequence of the material itself. Second, and perhaps even more important, one must acknowledge that the secrecy at hand may either have been a genuine withholding of knowledge or a mere marketing technique aimed at titillating the interest of readers. In either case, the “occultness” of such literature has no more necessary connection with Vickers’ “occult mentality” than does the confidentiality employed for military secrets at Los Alamos National Laboratory, the trade secrecy applied to pharmaceutical research at the Eli Lilly Corporation, or the purely venal trumpeting of “secrets” for dieting and a healthy sex life that line the checkout counters of modern supermarkets. Although writers on the occult sciences could be as mud-

6. For a discussion of this issue in alchemy, see Newman 1996.

7. See also A. G. Little and E. Withington, eds. 1928, pp. 15–16.

8. Ironically, this reference to construction machines has recently been shown to have stemmed from Leon Battista Alberti’s *L’architettura*—surely not a work known primarily for its occult leanings. See Anthony Grafton 2007, pp. 185–210; and Pamela Long 2001.

dle-headed as anyone else, they were not required by their subject to be so.⁹

Vickers, to the contrary, sees an essential unity among the various disciplines that he views as making up the occult sciences or “the occult tradition.” As he says in one of his various publications on the subject:

There are sufficient internal resemblances among astrology, alchemy, numerology, iatromathematics [i.e. astrological medicine], and natural magic for one to be able to describe the occult sciences as forming a unified system. They all invoke a distinction between the visible and invisible worlds; they all depend on the designation of symbols relating to this dichotomy; they all make great use of analogies, correspondences, and relations between apparently discrete elements in man and the universe. As a system the occult sciences were imported into Greece from various oriental cultures, and were systematically codified in the Hellenistic period, following the death of Alexander in 323 B.C. Once codified they retained their essential assumptions and methodology through the Middle Ages, into the Renaissance, and beyond, indeed, one of the most remarkable features of the occult tradition is its static nature, its resistance to change. (Vickers 1988, p. 265)

This remarkable credo reflects Vickers’ transchronological view of the occult sciences as a sort of universal analytical category opposed, in quite dualistic fashion, to right reason.¹⁰ From this and many similar passages in Vickers’ work, we should first expect the occult sciences to share a focus over their entire history on a “distinction between the visible and invisible worlds,” which I take to mean the relation of the physical world to the spiritual or formal in a way best exemplified by the Neoplatonists.¹¹ Sec-

9. For the futility of trying to define “occult” or secret knowledge according to tightly delimited “mentalities” such as those identified by Vickers, see the marvelously detailed work of William Eamon, *Science and the Secrets of Nature*, 1994. Everything from eyewash to ore dressing was viewed as “secret” by those who wished to profit from it.

10. I am not the only scholar to have noticed the ahistorical and dualistic character of Vickers’ thought on the subject of the occult. See John M. Forrester and John Henry 2005, p. 64n191. See also the remark about Vickers on p. 33 of Henry’s recent and important article, “The Fragmentation of Renaissance Occultism and the Decline of Magic,” 2008.

11. One could obviously be uncharitable and interpret Vickers’ claim here to apply to the distinction between heaven and earth in the Abrahamic religions in general, which would thereby become “occult” *tout court*. I prefer to give him the benefit of the doubt, and to interpret his distinction between the “visible and invisible worlds” not just as a reference to heaven versus earth, but as containing a more specific allusion to the formal or

ond, we should anticipate a particular fixation upon and way of using symbol, analogy and correspondence, and third, we should find the occult sciences to display a static, unchanging nature. Moreover, Vickers claims that all three characteristics are present as essential features in *each* of the occult sciences, again taken over the entire span of their existence. There is a deeply ahistorical character to Vickers' way of thinking, and this alone would be enough to disqualify his methodology in the eyes of many historians. Instead of dismissing his approach out of hand, however, I will consider the details of his claim on their own terms and by comparing them to the beliefs of central figures in the history of astrology, magic, and alchemy. In this fashion it will be possible to demonstrate the failure of Vickers' approach as a tool of historical analysis rather than rejecting it merely as a matter of taste. First I will contest Vickers' general claim for an essential unity among the occult sciences and then address their three supposed characteristics in the order just described.

In the introduction to *Secrets of Nature*, Anthony Grafton and I argue against the thesis that alchemy and astrology, two of Vickers' occult sciences, were unified in any fundamental sense over the *longue durée* (Newman and Grafton 2001, pp. 14–27). Vickers, to the contrary, sees the occult sciences as a permanently “closed system” characteristic of “traditional thought” and goes so far as to argue that “in the occult tradition, likewise, if a belief in numerology were abandoned, it would destroy the basis for alchemy and astrology; if a belief in astrology were abandoned, it would destroy alchemy, botanical medicine, and much else” (Vickers 1984a, p. 35). Given this categorical claim of essential unity, any rejection of one “occult” field by another provides powerful countervailing evidence against Vickers. Yet his notion that the occult sciences formed a diachronically unified system whose parts required interdependency for their very survival is immediately vitiated by looking at the case of medieval astrology and astral magic. Readers of encyclopedic or synthetic early modern writers such as Agrippa, Giambattista della Porta, and John Dee may find this disunity surprising, but the fact is that the occult sciences were not always integrated, and were frequently even at odds with one another (Newman and Grafton 2001, pp. 18–27). Consider the foundational ninth-century figure Yaʿqūb ibn Ishāq al-Kindī, whose *De radiis stellarum* served as a key text in the formulation and spread of talismanic magic, and

supercelestial versus the sublunary. Vickers' works are peppered with references to the different levels of reality described by Neoplatonic (not to mention Neopythagorean and Christian) authors. See for example, Vickers, “Analogy versus Identity: The rejection of Occult Symbolism, 1580–1680,” 1984b, especially pp. 117–21; and Vickers 1988, especially p. 268.

whose writings on the “great conjunctions” that occur among the outermost planets set the stage for astrological explanations of the birth and longevity of religions (al-Kindī 1974, pp. 139–269).¹² Al-Kindī in turn went on to inspire the hugely popular writer Abū Ma’shar, whose *Introductorium* was surely one of the most influential astrological books in the history of the discipline.¹³ Yet despite his adherence to the most extreme forms of astrology and astral magic, al-Kindī’s successors report that he was an unequivocal opponent of alchemy, adopting the principle that human beings cannot successfully carry out actions that belong to the province of nature. His views were sufficiently strong that other Islamic alchemists, such as the ninth–tenth-century Persian writer Abū Bakr Muhammad ibn Zakarīyā’ al-Rāzī, felt the need to refute them (Ullmann 1972, p. 250). In another vein, Avicenna, among the most famous of Islamic scientific writers and immensely influential in the medieval West as well, opposed both astrology and alchemy (Mehren 1904, pp. 238–239; see also Ullmann 1972, p. 252). At the same time, however, Avicenna upheld a widely discussed position that “matter obeys the soul,” and that magical action can therefore be willed directly by those whose souls are endowed with sufficient power. Avicenna developed his ideas on magic within the context of an elaborate faculty psychology whose inspiration lay largely in the dry and abstract ambience of Aristotle’s *De anima* and *Metaphysics* (Zambelli 1985).¹⁴ The interlocking network of the occult sciences described by Vickers, and his associated belief that the rejection of one would result automatically in the death of the others, is belied by the case of Avicenna, just as surely as it is vitiated by the example of al-Kindī.

Vickers’ unification thesis is also called into question by the fact (among others) that highly influential Latin alchemists such as the pseudonymous medieval author Geber explicitly declared their freedom from astrology. Geber, whose *Summa perfectionis* is sometimes called the “Bible” of the medieval alchemists, makes an important distinction between what we would call astrology and celestial causation.¹⁵ This point reveals a major weakness in the first of the three characteristics that Vickers postulates as essential to the occult sciences, namely his claim that linking the celestial world and its invisible, planetary spirits or intelligences to the

12. For al-Kindī’s ideas on magic, see Nicolas Weill-Parot, *Les “images astrologiques” au Moyen Âge et à la Renaissance*, 2002, pp. 155–174 and *passim*.

13. Manfred Ullmann, *Die Natur- und Geheimwissenschaften im Islam*, 1972, pp. 313–14, 316–24. On conjunctionism, see John North 1989a, especially p. 63.

14. For Avicenna’s famous claim that “matter obeys the soul,” see Simone van Riet 1968, parts 4–5, pp. 64–66. See also Béatrice Delaurenti 2007, pp. 134–40.

15. The foundational character of the *Summa perfectionis* was already recognized by George Sarton, in his *Introduction to the History of Science*, 1931, vol. 2, p. 1043.

sublunary, visible world made a particular discipline “occult.” Geber distances himself from astrology by noting that even though the stars and planets may act as causes, it is unnecessary to employ astrological prognostication or to plan one’s experiments around the special propitious times known as “elections” (Newman and Grafton 2001, pp. 21–22). After all, as Geber states, “there is no species of generables and corruptibles” that fails to undergo generation and corruption every day, for the influences of the heavenly bodies collect in the atmosphere and are absorbed by material things *ad libitum*. Hence the alchemist should only prepare his experiments in accordance with the requirements of his materials, and nature will take care of the rest without any need to observe special times. Geber sees no more connection between his alchemy and the discipline of astrology than al-Kindī did between his astrology and the alchemy that he rejected or Avicenna between his magic and either of the foregoing “occult sciences.”

Geber’s declaration of freedom from astrological elections in his alchemy depends on a fundamental distinction between celestial influence, which almost all premodern learned Europeans accepted, and the putative ability of the astrologer to predict the exact framework of that influence and to plan one’s actions accordingly. One did not have to subscribe to Plato’s *Timaeus* in order to accept that nature was under the rule of the heavens. The same idea is implied by Aristotle’s famous dictum at *Physics* II 2 194b13 that “the sun and man make a man,” and in his *De generatione animalium* at 736b39–737a1, the Stagirite famously describes the heat in animals as “analogous to the element of the stars” (Aristotle 1986). These and many other passages both in Aristotle and in pseudo-Aristotelian works of a Neoplatonic stamp such as the *Liber de causis* and *Secretum secretorum* led the medieval scholastics of the Islamic and Latin worlds to develop a comprehensive theory of celestial influence that did not in itself countenance astrological predictions or associated magical operations, despite its dependence on the heavens. According to a long series of scholastic thinkers extending from Albertus Magnus and Thomas Aquinas up to the early modern world of learning, terrestrial matter acquired its influences, motions, and sometimes substantial form itself from the heavens, as mediated by the planets, “planetary intelligences,” or angels.¹⁶ The formal realm was linked to the terrestrial by means of the planets. To many this

16. See for example Thomas Aquinas 1976, vol. 43, pp. 184–85, lines 156–181, 230–245. For a comprehensive treatment of this subject, see Edward Grant 1994, pp. 569–617. Grant (p. 571) refers to the medieval belief in “celestial dominance over terrestrial matter” as “ubiquitous and pervasive.”

provided a philosophical justification for belief in astrological prognostication, but it was by no means a sufficient condition for that in itself. Most medieval natural philosophers accepted the causal preeminence of the heavens, and yet some, like Geber, were indifferent to genethliology and catarchic astrology, while others, like Avicenna, were vehement opponents. Vickers' claim that emphasizing the actions of the invisible world upon the terrestrial world made an author's ideas belong to the supposedly "unified system" of the occult sciences is to say that Saint Bonaventure, Thomas Aquinas, Durandus de Saint-Pourçain, and most of the remaining scholastics up to the seventeenth century were followers of the occult. If that is so, his claim is trivial indeed, for the occult sciences become such a broad category as to include nearly everyone who could read or write Latin, including outright opponents of astrological prediction such as the fourteenth century theologian and natural philosopher Nicole Oresme.¹⁷

Vickers' second criterion, that the occult sciences all rely on analogy and correspondence between "apparently discrete elements in man and the universe," requires further elaboration. This is in fact the most highly developed of Vickers's theses, running through most of his writings on the occult in one form or another. At one point, Vickers says that alchemists confused the two categories of sign and substance, and thereby turned their discipline into what he elsewhere calls "a verbal art" (Vickers 1984b, pp. 123–26)¹⁸ At another point, he argues that alchemists were hopelessly confused by their own proliferation of allegories and synonyms, which could not be expected to conform exactly to the series of metamorphoses produced in a series of chemical reactions (see Vickers 1991, pp. 26–27). At still another point, Vickers argues that the occult sciences in general employed a threefold process of "attribution, distribution, and assimilation," whereby "the occult imposed traditional thought categories onto the world" and thereby confused symbol for reality (Vickers 1988, p. 266). The fifteenth-century Neoplatonist and astrologer Marsilio Ficino, for example, was employing a "paratactic method" of heaping up arbitrary associations when he claimed that the rooster and the lion each had an in-

17. As Edward Grant points out, even the famous opponent of astrology Nicole Oresme admitted the existence of angels or planetary intelligences that moved the heavens. See Grant 1994, pp. 477–78, 537–39. For Oresme's tempered acceptance of celestial influences, see John North 1989b, pp. 299–310; see especially pp. 307–09. For the general theme of celestial influence, see also North's "Celestial Influence: the Major Premiss of Astrology," 1989c, pp. 243–98.

18. For the term "verbal art" see Brian Vickers 1992a, pp. 17–34.

nate relationship with the sun, and that they therefore shared a magical sympathy.¹⁹

In all of these cases the common thread in Vickers' thought is the reification of preexistent mental categories. Here he appeals to the distinction between *signifiant* and *signifié* employed by the influential linguist Ferdinand de Saussure and the bifurcation in metaphorical language of "tenor" and "vehicle" used by I. A. Richards.²⁰ Despite his gesturing to the terminology of linguistics and rhetoric, however, it is not hard to see that Vickers' ideas have a much closer affinity to the work of that Victorian armchair anthropologist *par excellence*, Sir Edward Tylor. In his famous *Primitive Culture* of 1871, Tylor announced that he too had found the unifying Ariadne's thread behind the occult sciences—"The principal key to the understanding of Occult Science is to consider it as based on the Association of Ideas, a faculty which lies at the very foundation of human reason, but in no small degree of human unreason also" (1920, vol. 1, pp. 115–16). What did Tylor's "Association of Ideas" consist of? Precisely as in Vickers' analysis, the occult sciences relied on the reification of analogy. As Tylor puts it in the case of astrological reasoning, "it is on an error of the first order that astrology depends, the error of mistaking ideal analogy for real connexion" (1920, vol. 1, p. 128). As examples, Tylor mentions several of the very cases adduced by Vickers:

As might be well supposed, a great part of its [i.e. astrology's] precepts have lost their intelligible sense, or never had any, but the origin of many others is still evident. To a considerable extent they rest on direct symbolism. Such are the rules which connect the sun with gold, with the heliotrope and paeony, with the cock which heralds day, with magnanimous animals, such as the lion and bull; and the moon with silver, and the changing chameleon, and the palm-tree, which was considered to send out a monthly shoot. (1920, vol. 1, p. 129)

Hence Tylor, like Vickers, sees "symbolism," metaphor, and the reification of mental associations as lying at the foundation of astrology's errors, and by extension, at those of the occult sciences as a whole. The yellowness of the sun links it with gold, while its "nobility" or magnanimity (as well as yellowness again) connects it with lions. Moreover, Tylor insists like

19. Vickers 1988, p. 273 for the term "paratactic," and pp. 276–77 for the analysis of Ficino (based heavily on the work of D. P. Walker).

20. Vickers 1984b, p. 97 for Saussure and p. 116 for Richards. Saussure seems to be a particular hero of Vickers, as his distinction between *signifiant* and *signifié*, accompanied by the diagram of a tree, also appears on p. 277 of "On the Function of Analogy in the Occult," 1988 and on p. 23 of "*Res and Verba*," 1991.

Vickers that such reifications, once established, go on to live a life of their own. This is what Vickers refers to as the stage of “distribution,” when the seven planets or the twelve signs of the zodiac, once they have acquired their particular symbolic values, serve as the basis for further, purely verbal associations that then become causal. Remarkably, Tylor pre-empted Vickers on this point as well:

In such cases as these [i.e. the examples of “direct symbolism” listed above] the astrologer has at any rate a real analogy, deceptive though it be, to base his rule upon. But most of his pseudo-science seems to rest on even weaker and more arbitrary analogies, not of things, but of names. Names of stars and constellations, of signs denoting regions of the sky and periods of days and years, no matter how arbitrarily given, are materials which the astrologer can work upon, and bring into ideal connexion with mundane events. That astronomers should have divided the sun’s course into imaginary signs of the zodiac, was enough to originate astrological rules that these celestial signs have an actual effect on real earthly rams, bulls, crabs, lions, virgins. A child born under the sign of the Lion will be courageous; but one born under the Crab will not go forward well in life; one born under the Waterman is likely to be drowned, and so forth. . . . Again, simply because astronomers chose to distribute among the planets the names of certain deities, the planets thereby acquired the characters of their divine namesakes. Thus it was that the planet Mercury became connected with travel, trade, and theft, Venus with love and mirth, Mars with war, Jupiter with power and ‘joviality’. (1920, vol. 1, pp. 130–31)

Thus like Vickers, Tylor sees the mistaking of “ideal analogy for real connexion” as belonging to several levels of abstraction. First there is direct symbolic association, as when gold or a lion are linked to the sun on the basis of their independently known qualities. But in addition there is the possibility of playing an elaborate game of words based on mere names, such as the mythological associations between the seven planets and the gods for which they are named, or the putative relationships between those born under a certain sign and the attributes of the beings making up the zodiac. According to the Tylor-Vickers approach, astrology therefore provides an archetype for the mistaken “Association of Ideas” that lies at the root of the occult sciences as a unified whole.

The striking correspondence between Vickers’ method and that of an anthropologist whose ideas have long been superseded within the field of academic anthropology is not an encouraging sign. It is hard, in fact, to see how Vickers has advanced in any significant way beyond the ideas pro-

moted by Tylor in his *Primitive Culture* of 1871. But is such an advance possible *ab initio* as long as one builds on Tylor's fundamental notion, that an invalid "Association of Ideas" can be used to group the occult sciences and to distinguish them from other realms of thought (and practice)? There are excellent reasons to think that it is not possible. A principal objection lies in the ease with which one can find central texts within the so-called occult sciences that are not at all dominated by the principle of invalid analogy. Let us consider Vickers' attack on the "New Historiography" of alchemy in the context of the most popular alchemical genre of the Middle Ages. His insistence on invalid analogy and paratactic heaping up of similitudes has little if any bearing on the omnipresent literature of alchemical *practicae*, the recipe literature that made up the daily bread of alchemical practice in the High and Late Middle Ages. Consider, for example, the *De aluminibus et salibus* ascribed to al-Rāzī, a work translated from Arabic that exists in numerous manuscripts from the High Middle Ages onwards. The greater part of the text consists of recipes for preparing and purifying salts and minerals to be employed in the alchemists' chrysopeoetic quest. A typical example is found in a recipe for preparing atrament or vitriol (iron sulfate):

The description of its quality of operation is that you take as much of it as you want and put it in a vessel; then leave it for one night in a hot furnace. Then the atrament will become red, indeed of an intense redness. Then cover it with four times as much clear, fresh water and leave it until it has dissolved, and it will be deprived of its sediment. Then filter it and put it in a pot until you have need of it. (Ruska 1935, p. 79)

The atrament is first heated overnight at a high temperature, whereupon it oxidizes, to use modern terminology, and turns red. It is then dissolved and filtered in order to separate out the gross impurities. The *De aluminibus et salibus* contains scores of such semi-artisanal recipes, and very often they can be decoded into the language of modern chemistry. There is little if any discernable connection between these dry manual operations and Vickers' elaborate system of analogical typology. In fact, his analysis bears little if any relation to the hundreds of other medieval and early modern *practicae* that are filled with sober and factual descriptions of alchemical apparatus, mineral materials, and techniques.²¹ Nor does Vickers' emphasis on correspondences and analogies fail to do justice to the *practicae* alone: it is quite inadequate as a tool for explaining the

21. For a good sense of the content of these works, which often find their inspiration in the *oeuvre* of Rāzī, see Julius Ruska 1937, pp. 35–82.

theoricae of medieval alchemy as well. Consider the *Summa perfectionis* of Geber, for example, the “Bible” of the medieval Latin alchemists. The *Summa* contains a comprehensive discussion of purification and transmutation of metals based on a corpuscular theory of matter largely derived from the fourth book of Aristotle’s *Meteorology* (See Newman 1991). Aside from its purely conventional use of the planetary names as designations for the metals (a practice to which we moderns still subscribe in the case of “mercury”), one would not recognize the *Summa* as a work of alchemy at all by applying Vickers’ criteria. And yet the *Summa perfectionis* was not just any work of alchemy: its popularity was so great that even in the late sixteenth century, the critic of alchemy Thomas Erastus could refer to Geber as the “God” and “master of masters” of those who followed the aurific art (Newman 2006, p. 48). The reality of the matter is that Vickers’ principle of invalid association, with all its additional linguistic and rhetorical apparatus, is no better at categorizing a discipline as “occult” than is his first criterion, the visible-invisible bifurcation.

Finally, we arrive at the supposed “static” nature of Vickers’ occult sciences, the third of his criteria. Vickers’ evidence for the fact that the occult sciences “never threw away anything,” and thereby underwent no substantial historical change over the centuries finds most of its justification in astrology.²² Without entering unduly into this discipline, which is not the major focus of my response, let me merely point out that it is a form of question begging when a scholar consciously excludes all technical and mathematical developments from the realm of astrology and then labels them “astronomy.” When the purpose of planetary tables, astrolabes, and equatories—which all underwent continuous development in the Middle Ages and Renaissance—was largely that of making astrological prognostications and determining propitious times, how can one say that astrology was “static”?²³ Medieval and early modern scholars also had the model of Ptolemy to consider, whose *Tetrabiblos* begins with the claim that there are two “means of prediction through astronomy” that are “the most important and valid.” The first lies in the prediction of planetary positions, which we would call “astronomy,” while the second consists of predicting the sublunary effects of the planets as they change their locations, which

22. For the expression “never threw away anything,” see Vickers 1984a, p. 37. For his focus on astrology, see Vickers 1992b, pp. 43–92.

23. Consider the following passage from James Evans’ excellent *The History and Practice of Ancient Astronomy*: “Although there were always scholars who were interested in understanding the motions of the planets either for their own sake or for insights into God’s creation, astrology was widely perceived as the most important practical application of astronomy. And astrology was undoubtedly the greatest stimulus for the copying and refinement of planetary tables” (1998, p. 400).

we would call “astrology” (Ptolemy 1980, p. 3). To Ptolemy, however, both forms of prediction (*prognōstikon*) are branches of an overarching science called “astronomy” (*astronomia*), not independent disciplines.

Vickers’ technique for attributing stasis to astrology is much like that of progressivist historians of science who used to extract the “positive contributions” from alchemical texts and refer to them as “chemistry,” while ignoring the philosophical and practical goals of the works under consideration. In reality, pulling the more familiar elements out of any premodern discipline while leaving the unwanted detritus behind and giving it another name is mere cherry-picking. If we consider alchemy over the *longue durée*, it is quite clear that numerous important discoveries were linked to goals that Vickers would consider “occult.” These include the development of fully functional distillation apparatus in late antiquity, which was closely related to views about the desirability of separating *pneuma* from inert matter, and the associated but much later developments of alcohol isolation and the production of the mineral acids, both of which in turn required distillation.²⁴ Similarly, the most exact and comprehensive descriptions of metallurgical assaying in the Latin Middle Ages are found in the alchemical *Summa* of Geber, a text professedly directed to the aim of transmuting metals. And when we pass to the early modern period we find Andreas Libavius, a vigorous and famous champion of chrysopoeia, writing the first explicit textbook of chemistry, which he aptly enough entitled *Alchemia* (1597). From Libavius’s *Alchemia*, in turn, an important pedagogical tradition of *Cours de chimie* would emerge in France.²⁵ In short, Vickers’ criterion of stasis holds up no better than his other two differentiae when subjected to scrutiny.

We have now seen that Vickers’ claims for the unity of the occult sciences are either so generally applicable as to be empty of meaning (as in the case of the visible-invisible distinction), not characteristic of central texts and traditions within the fields that he takes to be occult (as in the case of invalid analogy), or based on exclusionary question begging (as in the criterion of stasis). Since each of Vickers’ criteria has been shown to fail independently and on its own terms, it is obvious that they cannot be used to support his assertion that the occult sciences form a “system” in which all three characteristics are displayed. As I stated earlier in this essay, there may be other ways in which the term “occult sciences” makes sense, but these have nothing to do with distinctions involving spirit and matter, in-

24. For the theme of distillation and *pneuma* in late antique alchemy, see Michèle Mertens, 1995, vol. 4. For the mineral acids and alcohol, see Robert Multhauf, 1966, pp. 140–41, 204–8, and *passim*.

25. See Hélène Metzger, 1923; also Owen Hannaway, 1975.

valid analogy, or historical stasis. It is time to recognize that Vickers' approach is little more than a reintroduction of long-ago rejected ideas about "the primitive mind" and the permanently "closed" character of traditional culture that provide him with a broad brush for disparaging current research in areas that show an influence of the so-called occult sciences upon the Scientific Revolution. It is this ideology of rejection that underlies Vickers' dismissal of the "New Historiography" of alchemy. I will now proceed to individual cases where Vickers' presuppositions have led him to distort or misunderstand the meaning of *Promethean Ambitions*.

Vickers' Critique of Promethean Ambitions

Much of Vickers' critique of *Promethean Ambitions* consists of pronouncements stemming from a reflexive "gut reaction" without his addition of any countervailing historical evidence, as in his response to my treatment of the sixteenth-century potter Bernard Palissy or the anti-alchemical writers Nicholas Eymereich and Thomas Erastus (Vickers 2008, pp. 143–44). It would be pointless for me to respond to him on this level, since I would simply be restating my arguments in other terms. Let the reader turn to *Promethean Ambitions* itself (Newman 2004) to see whether Vickers gives the better interpretation in these instances or not. Rather than replying to Vickers' arbitrary and unsupported claim that I have tried to "demonize" these and other authors or to give them "ulterior motives," I will avoid engaging him in matters of purely normative interpretation and focus rather on points where he has demonstrably distorted my purpose or twisted the meaning of my text. Multiple examples of egregious misrepresentation and error on Vickers' part will immediately come to the fore.

Consider, for example, Vickers' claim on his page 140 (2008) that I ignore alternative meanings of "nature" in Aristotle. This cavil is severely undercut by the fact that *Promethean Ambitions* is manifestly not intended to be a comprehensive analysis of the concept of nature in Aristotle, but rather a study of alchemy's role in determining the limitations of human art (the subtitle of the book, after all, is *Alchemy and the Quest to Perfect Nature*). Of course I am aware of the many senses in which Aristotle used *physis*, but few of these are germane to the argument in *Promethean Ambitions*. The goal of *Promethean Ambitions* was to provide "an examination of alchemy's contribution to the art-nature debate" (Newman 2004, p. 63), as I make quite clear in multiple places throughout the text. The crux of the art-nature debate in its alchemical incarnation lay in the alchemists' claim that humans could manufacture an artificial gold that was identical to its natural exemplar in every way. In defending this position, alchemical texts typically refer to Aristotle's assertion at *Physics* II 1 192b9–19

that natural things have an innate principle of movement (or change) that artificial products lack. The alchemists saw their brief, typically, as one of showing that alchemical products—not just gold and other metals, but also salts, vitriols, and pigments such as vermilion and orpiment—fulfilled Aristotle’s criterion of naturalness as opposed to being artificial. Hence there is an overwhelming tendency in alchemical literature to view nature in the terms laid out at *Physics* II 1 192b9–19, not in terms of the other passages enumerated by Vickers.

Moreover, Vickers fails to note that I have identified an element of “perfective art” based on Aristotle’s treatment of the subject at *Physics* II 8 199a15–17, where the Stagirite points out that arts can either mimic nature or carry things further than nature can. This passage, as I show at length, formed one support to a highly significant alchemical tradition of asserting the permeability of nature and art, which was later adopted by seminal figures in the development of experimental science during the Scientific Revolution. The appeal to “perfective art” among scholastic alchemists and their heirs also allows me to debunk the “noninterventionist fallacy” accepted by many modern scholars, according to which Aristotelianism necessarily classified intervention in nature, and hence experiment, as leading to “artifactual” results. Instead of addressing or even disputing these novel and important points, Vickers (2008, p. 141) accuses me incorrectly of engaging in a “category-error” by supposedly transporting the sense of nature in the first chapter of book two of the *Physics* (II 1 192b9–23), where Aristotle claims that a bed is not a natural thing because it lacks an internal principle of motion (*archē kinēseōs*), to a later part of the same chapter (*Physics* II 1 193b7–10), where the Stagirite uses the bed example again, in discussing the distinction between form and matter. According to Vickers, Aristotle’s meaning at *Physics* II 1 193b7–10 has only to do with form and matter, and the internal principle of motion is no longer on his mind at this point in the text. In reality, however, only four lines before the passage alluded to by Vickers, at II 1 193b3–5, Aristotle makes it very clear that he still has nature as *archē kinēseōs* in mind, although he is trying to clarify the concept further. As he puts it at II 1 193b3–5 (in the translation of Wicksteed and Cornford, Aristotle 1986), “Nature is the distinctive form or quality of such things as have within themselves a principle of motion (*kinēseōs archēn*), such form or characteristic property not being separable from the things themselves, save conceptually.” Having reintroduced the *archē kinēseōs* at II 1 193b3–5, Aristotle then proceeds at II 1 193b8–12 to repeat his example of a bed planted in the ground that cannot grow further beds, unlike the wood out of which it is made, which can under the right circumstances grow trees. In short, Vickers nowhere shows that I have engaged in the “category er-

ror” of reading the *archē kinēseōs* into the latter part of *Physics* II 1. It is plainly there in Aristotle’s text. Vickers’ criticism here is a red herring distracting readers away from the real issue, namely the important and influential way in which alchemists employed Aristotle’s concept of perfective art at *Physics* II 8 199a15–17.

An example of a different sort may be found on his page 144 (2008), where Vickers claims that I cite no evidence that critics of alchemy were forced to reconsider the belief that nature was stronger than art. The evidence is present in *Promethean Ambitions*, however. The section on Jesuit responses to the art-nature debate (Newman 2004, pp. 99–101), for example, shows that various prominent Jesuits, including Benedict Pereira and the Coimbrans, backed away from the widespread aprioristic view that chrysopoieia must fail because art is weaker than nature. Although these authors still were pessimistic about the success of chrysopoieia, they no longer used alchemy as an exemplar of the supposed weakness of art in the face of nature, as many others—both in their own time and before them—had done. Even more significantly, in Chapter Five I demonstrate at length that Daniel Sennert, Francis Bacon, and Robert Boyle all appropriated traditional alchemical arguments maintaining that art can equal or outdo the products of nature, and used these arguments to debunk the hard-line scholastic position of an a priori inadequacy of art. Vickers, drawing on an article by Sophie Weeks (2007), claims that “Newman also erred in aligning Bacon’s natural philosophy with the alchemists’ *imitationes naturae*, such as artificial rainbows and artificial gold” (2008, p. 155). If this is an error, it is one that Bacon made himself, for in his *De scriptio globi intellectualis*, Bacon explicitly uses the paired production or extraction of gold and the making of artificial rainbows to argue that “man and art can do everything” where nature cooperates (Bacon 1857–1874, vol. 5, pp. 506–7). The making of gold and the production of an artificial rainbow had already been linked as early as the fourteenth century in an alchemical context by scholastics belonging to the Paris terminist school, as I point out in *Promethean Ambitions* (2004, pp. 242–50). One of these scholastics, Themo Judaei, used these examples to argue for the significance of “makers’ knowledge,” just as Bacon would do some two and a half centuries later. Although it may be possible for Vickers and Weeks to argue that Bacon held even more radical ideas about the transformative powers of art than some alchemists did, the evidence that he drew arguments from the alchemical art-nature discussion is clear and incontestable. Rather than recapitulating more of this evidence here, I invite the reader to consult *Promethean Ambitions*.

This sort of failure to appreciate textual evidence is mirrored by Vickers’ surprisingly confused response to my treatment of Albertus

Magnus on pages 148 and 149 of his essay review (2008). Albert's role is particularly important to sort out, since he was at the head of a long tradition of incorporating alchemy into the discussion of demonic power, a fact that I believe I am the first to have pointed out. Vickers accuses me of making Albert look like an advocate of alchemy because I supposedly fail to note that Albert's support for the possibility of species transmutation by means of art is intended as a counterfactual. To Vickers, this is further proof that I have distorted the evidence and made Albert into a supporter of alchemy. How can I reasonably be accused of this? Two pages after the passage that Vickers quotes (Newman 2004, p. 49), I say "In his *Sentence* commentary, Albert evidently accepts the Avicennian position that alchemists cannot work real transmutation, but can only strip off transitive accidents and replace them with equally superficial ones." My explicit point here was not that Albert was a believer in chrysopoeia, but rather that he used the success or failure of chrysopoeia as a means of determining what demons could do in the world. Since alchemy—unlike other arts—made the transmutation of species its central goal—it was used by Albert and others as a test-case for the transmutation of species in general. If alchemists failed at this, then demons would likely fail as well, since the fault was seen as one of art *simpliciter*, not just of human art. If, on the other hand, alchemists could really transmute species, then so could demons, on the same principle. In either case, alchemy became a test-case for determining the limits of demonic power in the world, and as such it was taken up by theologians and ultimately by witch hunters like the authors of the famous *Malleus maleficarum*.

Vickers' insouciance in matters of accuracy and his failure to follow my argument are particularly well demonstrated by his critique of my discussion of Paracelsus and the homunculus (2008, pp. 149–54). Here Vickers passes from mere distortion and elision to outright suppression of evidence. In *Promethean Ambitions*, I discuss three cases where Paracelsus is supposed to have considered the homunculus, an artificial man produced out of human semen by alchemical means. The first instance occurs in the *De natura rerum*, a probably-spurious work attributed to Paracelsus, the second in Paracelsus's genuine *De vita longa*, and the third in his equally genuine *De homunculis*. As I clearly point out, the pseudonymous *De natura rerum* contains a recipe for making homunculi and treats the artificial creation of humans as a worthy goal, whereas the *De homunculis* considers them in medical terms. Indeed, the *De homunculis* views retention of semen as leading to the involuntary creation of homunculi within the human body, which supposedly causes a host of medical problems. The solution that Paracelsus suggests—either get married and use up your semen properly in procreation or else castrate yourself—reveals a striking agree-

ment with his general attitude towards non-procreative sex as displayed throughout his corpus. As I also point out in *Promethean Ambitions*, Paracelsus' tortured views of sexuality may have been related to a physiological abnormality—a team of forensic researchers discovered in the 1990's that his skeleton betrayed signs of ambiguous gender. From all of this material, Vickers comes to the remarkable conclusion that I am “devaluing” a “critic of alchemy” (i.e. Paracelsus, though he was by no means an unambiguous critic of alchemy) by calling him a hermaphrodite. In other words, I am supposedly dismissing the negative view of the homunculus given in the genuine *De homunculis* by casting aspersions on Paracelsus' sexuality (2008, pp. 154–55). According to Vickers, the goal of this dismissal is to elevate the importance of the spurious *De natura rerum*'s account. In reality, of course, I had no such aspiration. The aim of treating Paracelsus—both genuine and spurious—in *Promethean Ambitions* was merely to show the complicated relationship of the homunculus legend to alchemy and the art-nature debate. For the moment, let us ignore Vickers' apparent belief that I am engaged in a covert conspiracy against the opponents of alchemy. Instead, consider the following passage from his review, which is erroneous by any standard:

But the most glaring hole in this argument is that, in the texts so diligently cited by Newman, *Paracelsus never referred to the alchemical homunculus* [Vickers' italics]. The *De natura rerum*, 'whether genuine or not,' as Newman finally describes it, did so, but Paracelsus did not (222). When the reader realizes that this is the case, they may well feel that Professor Newman has been wasting their time. It may have been legitimate to discuss pseudo-Paracelsus, but the man himself should have been left in peace, bones and all. (2008, p. 153)

Despite this supposed “glaring hole” in my argument, however, Paracelsus actually *did* refer to the alchemical homunculus. Moreover, the very passage from his genuine *De vita longa* where Paracelsus admits its possibility is given in the form of block-quotation on pages 210 and 215 of *Promethean Ambitions* (Newman 2004). Here Paracelsus interprets the legend that mandrakes grew out of the fluids dripping down from the bodies of hanged prisoners as a garbled recipe for the homunculus. He even uses the alchemical term of art *venter equinus* (i.e. horse's dung used for heating an alchemical flask) to describe the source of the gentle warmth needed for the homunculus's generation. Had Vickers read *Promethean Ambitions* a bit more carefully, he would not perhaps have resorted to the tactic of wishing away evidence that I presented in the text. But this would not have prevented him from constructing his peculiar interpretation of my motives as

a putative defender of alchemy. Here Vickers is driven by his own ideology rather than by any evidence from *Promethean Ambitions*.

Although I could continue to rebut Vickers point-by-point, there is little more that the reader would gain from extending the discussion of his critique of *Promethean Ambitions*, his rejection of the “New Historiography” of alchemy, or his approach to the occult sciences. An ideology extending back to the arguments of a previous generation and partially framed as a reaction to the claims of Frances Yates has found new expression in his essay review. Indeed, to read Vickers on the occult sciences is, oddly, to find oneself seeing the world as Yates saw it, but accompanied by an inverted set of values. Like Yates in her most categorical (and least satisfactory) writings, Vickers makes the assumption that alchemy, astrology, and magic were somehow intertwined in a deep and fundamental fashion throughout their long and complicated history, along with numerology, iatromathematics, and a host of other “occult practices.”²⁶ And Vickers would surely agree with the closing pages of Yates’ famous *Giordano Bruno and the Hermetic Tradition*, which admitted that the “procedures with which the Magus attempted to operate have nothing to do with genuine science” (Yates 1964, p. 449). Perhaps it is understandable that Vickers would unconsciously accept Yates’ claims for the unified character of the occult in an attempt to keep a convenient target in his sights. But in doing so, ironically, he has elevated the “occult tradition” of Frances Yates to a level of generality and historical rigidity that matches or exceeds even what she envisioned in her most doctrinaire moments. And in the process he has imposed a fixed and pre-existent mental grid on his material as surely as any “occult mentality” ever did. In Vickers’ work on the occult we have a striking example of the very reification of mental concepts that forms the central subject of his own complaint. It is time, in short, for scholarship to move on.

References

- Aquinas, Thomas. 1976. *De operationibus occultis naturae*, in *Sancti Thomae de Aquino opera omnia iussu Leonis XII. edita*. Rome: Editori di San Tommaso.
- Agrippa, Cornelius. 1992. *De occulta philosophia libri tres*. Edited by V. Perrone Compagni. Leiden: Brill.
- Aristotle. 1986. *The Physics: Books I–IV*. Translated by Francis MacDonalld Cornford and Philip H. Wicksteed. Cambridge, MA: Harvard University Press.

26. For a critique of Yates’ and Vickers’ approach, see Newman and Grafton 2001, pp. 17–27.

- Bacon, Francis. 1857–1874. *Descriptio globi intellectualis*. In *The Works of Francis Bacon*. Edited by James Spedding, Robert Leslie Ellis, and Douglas Denon Heath, London: Longman.
- Boas, Marie [Hall]. 1962. *The Scientific Renaissance, 1450–1630*. New York: Harper Torchbooks.
- Bridges, John Henry (ed.). 1897. *The “Opus maius” of Roger Bacon*. Oxford: Clarendon Press.
- Copenhaver, Brian. 1984. “Scholastic Philosophy and Renaissance Magic in the *De Vita* of Marsilio Ficino.” *Renaissance Quarterly* 37: 523–54.
- Copenhaver, Brian. 1988. “Astrology and Magic.” Pp. 264–300 in *The Cambridge History of Renaissance Philosophy*. Edited by Charles B. Schmitt and Quentin Skinner. Cambridge: Cambridge University Press.
- Copenhaver, Brian. 1998. “The Occultist Tradition and its Critics.” Pp. 454–512 in *The Cambridge History of Seventeenth-Century Philosophy*. Edited by Daniel Garber and Michael Ayers. Cambridge: Cambridge University Press.
- Delaurenti, Béatrice. 2007. *La puissance des mots: “Virtus verborum.”* Paris: CERF.
- Dijksterhuis, E. J. 1961. *The Mechanization of the World Picture*. Oxford: Oxford University Press.
- Eamon, William. 1994. *Science and the Secrets of Nature*. Princeton: Princeton University Press.
- Evans, James. 1998. *The History and Practice of Ancient Astronomy*. Oxford: Oxford University Press.
- Forrester, John M. and John Henry (eds.). 2005. *Jean Fernel’s On the Hidden Causes of Things: Forms, Souls, and Occult Diseases in Renaissance Medicine*. Leiden: E. J. Brill.
- Grafton, Anthony. 2007. “Renaissance Histories of Art and Nature.” Pp. 185–210 in *The Artificial and the Natural: An Evolving Polarity*. Edited by Bernadette Bensaude-Vincent and William R. Newman. Cambridge, MA: MIT Press.
- Grant, Edward 1994. *Planets, Stars, and Orbs: The Medieval Cosmos 1200–1687*. Cambridge: Cambridge University Press.
- Hall, A. Rupert. 1962. *The Scientific Revolution, 1500–1800: the Formation of a Modern Scientific Attitude*. Boston: Beacon Press.
- Hannaway, Owen. 1975. *The Chemists and the Word: The Didactic Origins of Chemistry*. Baltimore: Johns Hopkins University.
- Henry, John. 2008. “The Fragmentation of Renaissance Occultism and the Decline of Magic.” *History of Science* 46: 1–48.
- al-Kindī, Ya‘qūb ibn Ishāq. 1974. *De radiis*, M.-T. d’Alverny and

- F. Hudry, eds. *Archives d'histoire doctrinale et littéraire du moyen âge* 41: 139–269.
- Little, A. G. and E. Withington (eds.). 1928. *Fratri Rogeri Bacon De retardatione accidentium senectutis cum aliis opusculis de rebus medicinalibus*. Oxford: Clarendon Press.
- Long, Pamela. 2001. *Openness, Secrecy, Authorship: Technical Arts and the Culture of Knowledge from Antiquity to the Renaissance*. Baltimore: Johns Hopkins Press.
- Mehren, A. F. 1904. "Vues d'Avicenne sur l'astrologie et sur le rapport de la responsabilité humaine avec le destin." Pp. 235–50 in *Homenaje á D. Francisco Codera*. Edited by D. Eduardo Saavedra. Zaragoza: Mariano Escar.
- Mertens, Michèle. 1995. *Les alchimistes grecs: Zosime de Panopolis*. Paris: Belles lettres.
- Metzger, Hélène. 1923. *Les doctrines chimiques en France du début du xvii^e à la fin du xviii^e siècle*. Paris: Presses Universitaires de France.
- Metzger, Hélène. 1930. *Newton, Stahl, Boerhaave et la doctrine chimique*. Paris: Librairie Félix Alcan.
- Multhauf, Robert. 1966. *The Origins of Chemistry*. London: Oldbourne.
- Newman, William R. and Anthony Grafton. 2001. "Introduction: The Problematic Status of Astrology and Alchemy in Premodern Europe." Pp. 1–37 in *Secrets of Nature: Astrology and Alchemy in Early Modern Europe*. Cambridge, MA: MIT Press.
- Newman, William R. (ed.). 1991. *The Summa perfectionis of pseudo-Geber*. Leiden: Brill.
- Newman, William R. 1996. "The Occult and the Manifest Among the Alchemists." Pp. 173–98 in *Tradition, Transmission, Transformation*. Edited by F. Jamil Ragep and Sally P. Ragep. Leiden: Brill.
- Newman, William R. 2004. *Promethean Ambitions: Alchemy and the Quest to Perfect Nature*. Chicago: The University of Chicago Press.
- Newman, William R. 2006. *Atoms and Alchemy: Chymistry and the Experimental Origins of the Scientific Revolution*. Chicago: University of Chicago Press.
- North, John. 1989a. "Astrology and the Fortunes of Churches." Pp. 59–90 in *Stars, Minds, and Fate: Essays in Ancient and Medieval Cosmology*. London: Hambledon Press.
- North, John 1989b. "Intimations of Cosmic Unity? Fourteenth-Century Views on Celestial and Sub-Lunar Motion." Pp. 299–310 in *Stars, Minds, and Fate: Essays in Ancient and Medieval Cosmology*. London: Hambledon Press.
- North, John. 1989c. "Celestial Influence: the Major Premiss of Astrology."

- Pp. 243–98 in *Stars, Minds, and Fate: Essays in Ancient and Medieval Cosmology*. London: Hambledon Press.
- Principe, Lawrence M. and William R. Newman 2001. “Some Problems with the Historiography of Alchemy.” Pp. 385–431 in *Secrets of Nature: Astrology and Alchemy in Early Modern Europe*. Edited by William R. Newman and Anthony Grafton. Cambridge, MA: MIT Press, 2001.
- Ptolemy, Claudius. 1980. *Tetrabiblos*. Translated by F. E. Robbins. Cambridge, MA: Harvard University Press.
- Riet, Simone van. 1968. *Avicenna Latinus: Liber de anima seu sextus de naturalibus*. Louvain: Peeters.
- Ruska, Julius (ed.). 1935. *Das Buch der Alaune und Salze*. Berlin: Verlag Chemie.
- Ruska, Julius. 1937. *Al-Rāzī's Buch Geheimnis der Geheimnisse*. Berlin: Julius Springer.
- Sarton, George. 1931. *Introduction to the History of Science*. Baltimore: Williams and Wilkins.
- Tylor, Edward B. 1920. *Primitive Culture*. London: John Murray.
- Ullmann, Manfred. 1972. *Die Natur- und Geheimwissenschaften im Islam*. Leiden: Brill.
- Vickers, Brian. 1979. “Frances Yates and the Writing of History.” *Journal of Modern History*, 51: 287–316.
- Vickers, Brian. 1984a. “Introduction.” Pp. 1–55 in *Occult and Scientific Mentalities in the Renaissance*. Edited by Brian Vickers. Cambridge: Cambridge University Press.
- Vickers, Brian. 1984b. “Analogy versus Identity: The rejection of Occult Symbolism, 1580–1680.” Pp. 95–163 in *Occult and Scientific Mentalities*. Edited by Brian Vickers. Cambridge: Cambridge University Press.
- Vickers, Brian. 1988. “On the Function of Analogy in the Occult.” Pp. 265–92 in *Hermeticism in the Renaissance*. Edited by Allen Debus and Ingrid Merkel. Washington: Folger Books.
- Vickers, Brian. 1991. “The Discrepancy Between *Res* and *Verba* in Greek Alchemy.” Pp. 21–33 in *Alchemy Revisited*. Edited by Z. R. W. M. von Martels. Leiden: Brill.
- Vickers, Brian. 1992a. “Alchemie als verbale Kunst: die Anfänge.” Pp. 17–34 in *Chemie und Geisteswissenschaften*. Edited by Jürgen Mittelstraß and Günther Stock. Berlin: Akademie Verlag.
- Vickers, Brian (1992b) “Critical Reactions to the Occult Sciences in the Renaissance.” Pp. 43–92 in *The Scientific Enterprise*. Edited by Edna Ullmann-Margalit. Dordrecht: Kluwer.
- Vickers, Brian. 2008. “The ‘New Historiography’ and the Limits of Alchemy.” *Annals of Science* 65: 127–156.

- Weeks, Sophie. 2007. "Francis Bacon and the Art–Nature Distinction." *Ambix* 54: pp. 117–45.
- Weill-Parot, Nicolas. 2002. *Les "images astrologiques" au Moyen Âge et à la Renaissance*. Paris: Honoré champion.
- Yates, Frances A. 1964. *Giordano Bruno and the Hermetic Tradition*. London: Routledge and Kegan Paul.
- Zambelli, Paola. 1985. "L'Immaginazione e il suo potere da al-Kindī, al-Fārābī e Avicenna al Medioevo latina e al Rinascimento." Pp. 188–206 in *Miscellanea medievalia 17: Orientalische Kultur und europäisches Mittelalter*. Edited by Albert Zimmermann and Ingrid Craemer-Ruegenberg. Berlin: Walter de Gruyter.