MIT Student
STS.003
Paper 1

Alchemistry

Despite the many aspects of each field which distinguish alchemy and chemistry, when viewed in sequential order as part of the larger historical context, the two seem natural neighbors in the transition from religious mysticism to scientific inquiry. Their consanguinity is evidenced here by our examination of two sources, Starkey's *Alchemical Laboratory Notebooks and Correspondence* and Boyle's *New Experiments Physico-Mechanicall,* and the motivations behind these pieces, one of which is the search by people throughout the ages to understand the universe. Claiming that this search is a valid motivation for thousands of developments doesn't explain how these developments were able to occur, but it does immediately unite chemistry and alchemy as tools through which people attempted to understand the universe out of a deep-seated need**. In any case, chemistry and alchemy at their best seem to have this as a common starting point.

Alchemy predates chemistry; Boyle, in fact, the “Father of Modern Chemistry,” was the student of alchemists – in particular, the student of Starkey himself. That alchemy is the older field can be viewed as an explanation of its more religious nature; the secret signs, the semi-magical transmutations are the relics of the pre-scientific world left extant as it transitions. Traces of this mysticism are found in Starkey's lab notes, as in his use of a symbol of his own invention for regulus of antimony[1]. Starkey is not writing in such a way that his notebooks seem intended to help others understand and build upon what he has himself discovered – evidence of this is he does not describe, in the final entry, the mysteries of alkehest which he feels have been revealed to him[2]. Here he differs starkly from Boyle, but part of that may be due to the circumstances under which each piece was written; Boyle's was, after all, intended for publication. However, that Boyle intended his work for publication and that Starkey.

[1]Starkey, George. 2004 [1656]. Alchemical Laboratory Notebooks and Correspondence, ed. William R. Newman and

did not may be important distinctions between chemistry and alchemy. Alchemy may seem less suited[1] to the search for understanding, and therefore less likely to be a valuable step in the road from mysticism to science, because of its secrecy, but that may be unfair; the Pythagoreans, after all, were extremely secretive, lay on the border between mysticism and science, and would, nevertheless, certainly be considered a step taken towards science and understanding. Alchemy was secret in part because he who discovered the mystery of transmutation could make himself – and his funders – rich, and because, since it sought answers to two main questions (is matter transmutable and can we make a philosopher's stone), the man to solve either of these puzzles would win immortal glory. However, alchemy was also secretive because its results were considered too dangerous to be played with by the uninitiated and because, in later times, to be an alchemist was considered a sign of foolishness. The huge pay offs to any man who unlocked the secrets of alchemy, evidenced by Starkey's agreement to work for Captain Watson for half a year on the derivation of noble metals from the baser ones in return for monetary remuneration[3], and the belief that the alchemist could uncover dangerous information, might therefore be looked at as explanations of its secrecy that still allow it to retain its status as one of the ways through which human beings sought to uncover the mysteries of the universe.

Alchemy, at least as taken from Starkey, might also seem less exact, and thus less scientific, than chemistry (as taken from Boyle). Starkey's results are certainly related in qualitative and sometimes anthropomorphic (as in the “vinous spirit” which is “friendly to that of urine” [4]) terms. Take, for example, his statement that the vinegar (when added to his urine/brandywine mixture) “mortifies in a moment and advances into a deep color, and that the spirits attack one another with a certain fuming and a sensible heat.”[5] However, he still tells us that the reaction is chemical, resulting in a color change and release of heat, and that gases are produced as a byproduct. He also, in general,

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Lawrence M. Principe, 127 – 129, 170 – 175. Chicago: The University of Chicago Press. (127)

[2] Starkey, 175.

1 [3] Starkey, 175.

[4] Starkey, 174.

[5] Starkey, 172.

relates the quantities of each amount of mixture he is adding. His experiments might be reproducible and his results verifiable, then, except that he does not always give a clear treatment of his methods (as when he refers to the "perhaps six pints of phlegm" he has removed[6] – what exactly the "phlegm" is and how one ought to go about its removal goes unspecified). However, it is possible that Starkey included fewer exact specifications because his were private records and he considered himself able to remember any other relevant details. And, if he perhaps considered what the heirs to his notes would gain from them, he almost certainly assumed anyone reading his notes would also be an alchemist – perhaps the details he did not include he assumed any alchemist would be able to infer. Or, perhaps he did not want any rivals to be able to use his results to beat him to finding a means of transmuting the base to noble metals, although this seems unlikely – first, because his notebooks were private records, and second, because if he was so concerned, it seems he might have obfuscated more than just a few details here and there, especially details he seems to consider peripheral (as with the "phlegm" - he seems to consider it and its removal an unimportant sideline). His notes seem more like those of a man to himself, recording his experiments so that he could rely upon them in the future (as with his detailed description of the flammable properties of his urine mixture[7]). Looking only at Starkey's lab notebooks, it seems that Starkey may have undertaken his research with the intent to discover a solvent that could further some larger project, perhaps the transmutation of base metals to noble, in other words, spurred by material interests more than Boyle, but it is certainly true that he was excited and awed to discover the secrets of (what he termed) alkehest, attributing his discoveries to the glory of God.

The main differences between the general form of Starkey's notes and the sort of notes we might today identify with scientific research are his assumptions and his reference to God (God's revelation of the secret of Alkehest[8]. This admixture of religion and science seems to make sense if we cast alchemy as part of a transition from mysticism to science. However, Boyle was also a religious man and

mentions God at least in his Preface[9]; even today, religious beliefs are not a barrier to a profession in the sciences – we have, though, imposed a barrier between our religious and scientific publications. The assumptions underlying Starkey's research, that metals could probably be transmuted, may seem akin to arbitrary beliefs by today's standards, but they were probably based on the belief that this knowledge had been possessed by the ancient Greeks and somehow lost, or at least that, by the nature of the observable world around him, it would be reasonable to predict transmutation. This isn't entirely different than many of the intuitions that guide science today, although we have had hundreds of years to refine our concept of proper scientific method and to delineate patterns upon which to base our intuitions; the assumptions which underlie research, which form our questions, are controlled perhaps more than any other factor, by the state of knowledge available to us at the time. Wider proof of this, not just derived from two sources, is easily found in the history of math, for example in Russell's criticisms* of the false assumptions in Euclid's *Elements.*

Chemistry, as taken from Boyle, seems closer to what today we call science than does alchemy, although it shares some of the same scientific “shortcomings” as Starkey's alchemy. For example, although the apparatus (the “Engine”) being used to carry out the experiments is described in some detail[10], we are not given a diagram of the equipment or detailed instructions as to how to build it and then carry out the experiments ourselves, although all of these may be included later in the work. Part of this, as Boyle himself says, is due to the expense of such undertakings, and to the inadequacy of one published letter to allow someone to accurately reproduce his experiments in an era without standardized equipment or supplies[11]. Perhaps Boyle is concerned that if he tries to detail exactly his experimental set-up, because of the inadequacy aforementioned anyone who tried to recreate the

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[6] Starkey, 172.
[7] Starkey, 171.
[8] Starkey, 175.
[9] Boyle, Robert. 1660. *New Experiments Physico-Mechanicall, Touching the Spring of the Air, and its Effects, (Made, for the Most Part, in a New Pneumatical Engine).* A3 – A8, 20 – 37. Oxford: H. Hall, Printer to the University. (A7)
[10] Boyle, 20.
[11] Boyle, Preface.

experiment would fail to reproduce his results; perhaps his own results would be discredited as a result. Maybe, then, he considered it in everyone's best interest to run his own experiment in such a way that he and his observers were satisfied with its validity, and then to publish his results as an addition to the canon of accepted knowledge[12]. Here, even though Boyle has brought up the importance of validating one's results, in this case by saying that many ingenious men observed his experiment and found it convincing[12], and even though he intends to release his discoveries for others to build upon[13], he has not provided what today we would consider “proof” that the results of his experiments are valid. Although we've already noted that Boyle's and Starkey's works must be taken in context as, respectively, intended for publication and intended for personal record-keeping, Boyle includes in his text a key element of the modern scientific process entirely lacking in Starkey's: the intent to teach, to proffer his own work as a foundation upon which other mean might build[14]. Proof of his genuine intent to broaden the knowledge of his readers is in his use of metaphor. As we use our conception of modern science today to improve our understanding of the human mind, the importance of the metaphor in learning and even conceiving of new ideas has become more and more apparent[15]. The metaphor seems to be a tool which we use for much of our communication and especially our communication of new or abstract ideas. Therefore, when Boyle introduces the metaphor of sheep's wool for the air corpuscles[16], and he uses it to explain the behaviour of air and the relation between air and its environment, he is clearly writing with the intent of bringing to his audience the understanding of something new.

By examining Starkey's *Alchemical Laboratory Notebooks and Correspondence* and Boyle's *New Experiments Physico-Mechanicall*, we see that although alchemy and chemistry differ in some respects, it is not the case that a clear fault-line runs between the two, separating chemistry from alchemy and science from religion, where we take “science” and “religion” to be defined not so much by what we take to be scientific or religious content, but by the methodologies of thinking they embody. Instead, it seems that both lie along the path from science to religion, that both sought to aid the search for understanding.

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. [12] Boyle, A4.
[13] Boyle, A8.
[14] Boyle, Preface.
[15] Pinker, Steven. 2007. *The Stuff of Thought: Language as a Window into Human Nature.* New York: Viking.
[16] Boyle, 23.

Bibliography

Boyle, Robert. 1660. *New Experiments Physico-Mechanicall, Touching the Spring of the Air, and its Effects, (Made, for the Most Part, in a New Pneumatical Engine).* A3 – A8, 20 – 37. Oxford: H. Hall, Printer to the University.

Starkey, George. 2004 [1656]. *Alchemical Laboratory Notebooks and Correspondence,* ed. William R. Newman and Lawrence M. Principe, 127 – 129, 170 – 175. Chicago: The University of Chicago Press.

Note: Starkey's notebooks referenced here were in use by Starkey from 1653 – 1656.
All page numbers denoted in the text refer to either Boyle's or Starkey's texts given here.

Pinker, Steven. 2007. *The Stuff of Thought: Language as a Window into Human Nature.* New York: Viking.

Note: I wasn't sure whether or not to cite Pinker as I have his book as an audiobook and have listened to it several times for fun – I know it was the source for my statement about the importance of the metaphor, but I did not read it particularly recently or with the intent to use it in this paper, and I do not know the page numbers from whence this idea came. I felt I ought to somehow denote that the idea was not my own, though. If the format I have chosen is incorrect I apologize and will gladly correct it.

*As was pointed out to me by another student, I might need to cite this as well. I don't know where I first learned that Russell had criticized Euclid for his false assumptions in *The Elements*, possibly in Abraham Fraenkel's *Integers and Theory of Numbers* or in *The Nothing that Is: A Natural History of Zero*, by Robert Kaplan, or in *The Semiotics of Zero*, or in *Ad Infinitum... The Ghost In Turing's Machine: Taking the God out of Mathematics and Putting the Body Back In*, both by Brian Rotman. However, it could have conceivably been in a different source and I think I have heard about Russell's criticisms multiple times.

**[2] I have a tangential comment that I felt was too informal and speculative to include in the body of the text but which I thought was an interesting idea: (Perhaps this is even a consequence of human sentience, similar to the creation of language under UG theory.)

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STS.003 The Rise of Modern Science

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