BENJAMIN FRANKLIN AND GEORGE ADAMS, JR.: ENLIGHTENED ENTREPENEURS

Connor Wilson
History 4973: Living the Enlightenment
December 8, 2013

On April 8, 1758, Benjamin Franklin was on his first official diplomatic mission to England. Franklin was already world-renowned as an inventor and a scholar, and had traveled in his youth, but this marked the first major event in his political career. Still, he found the time to peruse the instrument shops that lined the streets of London, eventually entering the Fleet Street shop of the Adams family, the home of a future fellow writer and educator, George Adams, Jr., where he "bought of George Adams sundry electric implements," as did some of his fellow electrical pioneers.[1] At the time of Franklin's visit, Adams and his family were solely interested in producing instruments for use by others. Ironically, it was the War of American Independence, in which Benjamin Franklin himself played a major role, that led the Adams family to its new and highly successful business of producing books to teach others how to experience and experiment in the Enlightenment tradition – especially the owner's son, George Adams, Jr., who spent the last decade of his life writing books that helped popularize science among the public.[2]

Both Franklin and Adams, Jr. provide a useful look into the development of the Enlightenment: Franklin, born as he was at the beginning of the eighteenth century, was able to experience (and aid in) its development; his books, especially his *Experiments and Observations on Electricity*, are a direct product of that early period of enlightenment.[3] Adams, on the other hand, wrote near the end of the century, and with the full scientific experience of the rapidly

---

[1] James Delbourgo, *A Most Amazing Scene of Wonders* (Cambridge: Harvard University Press, 2006), 296.

[2] John R. Millburn, *Adams of Fleet Street: Instrument Makers to King George III* (Burlington, VT: Ashgate, 2000), 198.

[3] Benjamin Franklin, *Experiments and Observations on Electricity, Made at Philadelphia in America, by Mr. Benjamin Franklin, and Communicated in Several Letters to Mr. P. Collinson, of London, F. R. S.,* (London, 1751), *Eighteenth Century Collections Online,* Gale, University of Oklahoma Libraries, accessed October 30, 2013, http://find.galegroup.com/ecco/infomark.do?&source=gale&prodId=ECCO&userGroupName=norm94900&tabID=T001&docId=CW3308328711&type=multipage&contentSet=ECCOArticles&version=1.0&docLevel=FASCIMILE .

changing Enlightenment period behind him. Indeed, his works, such as his 1784 *Essay on Electricity*, were made possible by and draw greatly from the work of those predecessors.[4]

However, Adams and Franklin represent two distinct reasons for entering into the Enlightenment publishing market: Franklin began experimenting, and documenting those experiments, once he felt financially secure enough to do so. Thanks to his wealth, he was able to pursue his own scientific interests without worrying about their marketability, as others in the era had to.[5] Though he was not averse to profiting from his work (and he certainly did), Franklin was primarily concerned with furthering his own goals, whether scientific or political in nature, through his writings.

Adams, Jr., on the other hand, began writing, whatever his ethics, out of a financial need to appeal commercially to the public; he saw it as a way to continue, and extend, his father's business from primarily supplying scientific instruments to describing their use for the public.[6] Years before, Adams Jr.'s father had briefly entered into the world of science publications, and for similar monetary and marketing reasons, and Adams, Jr. was in that sense continuing the family business.[7] The younger Adams was capitalizing on a growing market for experiments and educational writing that Franklin had contributed to, and even helped to create.[8]

---

[4] George Adams, Jr., *An Essay on Electricity; in which the Theory and Practice of that Useful Science, are Illustrated by a Variety of Experiments, Arranged in a Methodical Manner*, (London, 1784), *Eighteenth Century Collections Online,* Gale, University of Oklahoma Libraries, accessed October 6, 2013, http://find.galegroup.com/ecco/infomark.do?&source=gale&prodId=ECCO&userGroupName=norm94900&tabID=T001&docId=CW106985163&type=multipage&contentSet=ECCOArticles&version=1.0&docLevel=FASCIMILE

[5] Bernard Cohen, "Benjamin Franklin as Scientist and Citizen," *The American Scholar* 12, No. 4 (Autumn 1943), 474, http://www.jstor.org/stable/41204624.

[6] Millburn, *Adams of Fleet Street,* 198.

[7] Ibid., 32.

[8] Ibid., 198.

Although these two men's primary motivations for their scientific work differed, each represents the lasting legacy of Enlightenment science, one that continued to shape scientific practice long after that era had ended. Specifically, while the field became more open, and its practitioners worked to appeal to and reach a larger audience who might have been uninterested or ignored by scientists in previous times, science fell under the considerable influence of marketability and commercialism, creating an interesting interplay of the democratic and the commercial embodied in the writings of Benjamin Franklin and George Adams Jr.

The importance of commercialism in Enlightenment science has not always been fully appreciated by historians, although in recent years modern historians such as Barbara Stafford and Paola Bertucci have been more likely to acknowledge the significant impact in those formative years of scientific progress of scientists seeking economic gain for their work. 18th-century writers often portrayed Enlightenment efforts toward dissemination of information, and the idealization of natural philosophers, as means of encouraging improvement, whether for society itself or for the individual – essentially, promoting activities worth doing purely for their own intrinsic value. Over time, however, the degree to which historians accept this altruistic view of Enlightenment science has varied.

This shift in focus is especially obvious in the case of historians' explorations of Enlightenment experiments in electricity, which captured the public's imaginations because of its spectacular destructive power – a power that could, suddenly, be investigated, seen, and controlled. Typical of the traditional historian's view of the Enlightenment, in 1943 Bernard Cohen wrote an article on Franklin, who won fame for his investigations of electricity, significantly titled "Benjamin Franklin as Scientist and Citizen." As the title suggests, Cohen's article focused on Franklin as a primarily altruistic figure who worked selflessly for the

betterment of others, or for the intellectual enjoyment of scientific pursuits.[9] Cohen writes that "by fulfilling his social obligation as he saw it, [Franklin] thereby achieved his full stature as a human being".[10] In other words, Franklin's actions were shaped by a desire to better his society, to fulfill his obligations to society, whether through politics, science or another avenue. It is an attractive image: the great Enlightenment thinker who, after securing his fortune through other means, turns to intellectual pursuits and philosophy, whether natural or political in nature.[11] Elsewhere, in an earlier work, Cohen posits that all scientists strive for and are delighted when their discoveries lead to some practical use.[12] Indeed, he argues that science in the Enlightenment (though not, he insists, the science practiced by Franklin) was pragmatic and practical, focusing on useful discoveries that could improve society or help people in some way.[13] Thus, to Cohen, writing in the 30's and 40's, the Enlightenment view of science was, in many ways, a valid one; it was an endeavor that was useful, and constructive, and practical. Cohen does not seem to find the question of marketability significant. However, that issue, suggesting as it does that Enlightenment scientists pursued their science with something other than pure practicality in mind, is a topic that intrigues many modern historians.

In recent years, it has become more common for historians to discuss public science in terms of the public and their desire for science as entertainment and product. Patricia Fara,

---

[9] Cohen, "Benjamin Franklin," 480.

[10] Ibid., 481.

[11] Ibid., 475.

[12] Bernard Cohen, "How Practical Was Benjamin Franklin's Science?," in *The Pennsylvania Magazine of History and Biography* 69, no. 4 (October 1945), 291.

[13] Ibid., 293.

writing in the early 90's, examined the role of marketing in the sale and study of magnets.[14] Magnets offer an interesting example of a product that had definite practical uses; Fara specifically emphasizes their benefits for sailors and the navy, who were in great need of high-quality, cheap magnets for compasses to improve navigation.[15] This need was undeniably answered during the Enlightenment by scientists, not just in the improved quality of magnets, but in accessibility: the newer models were not just better but cheaper as well.[16] And, as Fara points out, the men who made these discoveries and advances gained greatly in capital and fame. Of course, these products, while profitable, were a real benefit to those who needed them, bettering their lives – an outcome that seems at first to reflect the traditional idealistic view of Enlightenment science. However, Fara's interest is in exploring how that very practical product transitioned into a popular product altogether removed from its practical use. As happened with many scientific discoveries in the Enlightenment, the promoters of these magnets ran demonstrations to prove their efficacy, and Fara describes these events as "spectacular entertainment," essentially no different from any other form of entertainment, and with the goal not of edifying but of selling the product, even though the promoters might have described them differently.[17] In one striking example, she describes playing cards, printed with mathematic information about magnetism, yet priced far too high for anyone who would have had a practical need for such information.[18] Indeed, she points out that even those scientists who undertook

---

[14] Patricia Fara, "'A Treasure of Hidden Vertues': The Attraction of Magnetic Marketing," in The British Journal for the History of Science, 28, no. 1 (March 1995).

[15] Ibid., 23.

[16] Ibid., 17.

[17] Ibid., 21.

[18] Ibid., 5.

serious research in the academies, or who gave lectures to educate the public, were sometimes driven by the popularity of magnetism to include the subject, if in passing, to more readily attain grants or to increase the marketability of their work.[19] Fara's portrayal, then, paints many natural philosophers of the Enlightenment as essentially showmen who often focused more on selling an idea or product than on making new discoveries, rather than as altruistic scientists pursuing the good of society.[20] This is a somewhat extreme view, admittedly, but not entirely untrue. Fara deliberately attempts to break down the idealized view of the Enlightenment furthered by earlier writers like Cohen, and other historians have shared her desire for reexamining the aims of Enlightenment scientists.

Historian Barbara Stafford explains that "the Enlightenment idea of progress was pictorialized as tireless doing"; that the ideal of the era, as depicted in artistry, was of a people who shunned idolatry.[21] But that emphasis on action and constructive work meant that some sought a way to *combine* pleasure and edification all in one. Electricity, with its spectacular and, above all, visible effects, offered a grand way to do this. It was new; it was exciting; and it offered a palpable display of nature's, and thus God's, power. Another benefit was that the study of electricity was, above all, thoroughly modern. Lightning was previously known to the public, and magnetism was understood in a limited way by them as well,[22] but the ability to control and create lightning was not just intellectually exciting, but also visually so – the effects could be

[19] Ibid., 22.

[20] Ibid., 34.

[21] Stafford, Barbara, *Artful Science: Enlightenment Entertainment and the Eclipse of Visual Education* (Cambridge: The MIT Press, 1992), 163.

[22] Fara, "Hidden Vertues," 11.

spectacular, and this made both demonstrations and experimentation at home a potentially popular business.

Stafford addresses this public interest in science in her book, *Artful Science: Enlightenment Entertainment and the Eclipse of Visual Education*. "Aristocratic jeux d'esprit and occult problèmes divertissans," she argues, were adjusted to accommodate a new "science mania" – in other words, a new and popular desire for scientific knowledge and research.[23] She specifically mentions one practitioner, Charles Rabiqueau, who attained popularly with spectacular scientific demonstrations that were, in a way, more like shows than science lectures; his performances were described at the time as akin to a library, as they made the subject available to those who could not afford to purchase the books required for self-instruction.[24] To Stafford, the combination seen in public demonstrations was a hybrid between science, education, and entertainment – a way of passing time both enjoyably and constructively, in essence.[25] This is certainly true of the new electric science, which could be visually very exciting (Rabiqueau, for example, was known to deliberately hook himself to energized wires for the entertainment of his audience), but nevertheless attendance was believed by many at the time, according to Stafford, to be a constructive way to improve oneself and one's youth.[26] Learning, and learning to be rational, would thus allow one a deeper connection to one's religion, and therefore scientific demonstrations and entertainment were constructive rather than purely leisure (although of course, the educational value of many such pursuits might be somewhat questionable). This attitude is interesting, since it opens the door to religious scientists, who

[23] Stafford, *Artful Science*, 29.

[24] Ibid., 183.

[25] Ibid., 51.

[26] Ibid., 70.

sought to understand their respective beliefs through the context of discovery – or by taking God out of the equation, in a sense, through Deism. In any case, Stafford argues that one of the basic ideals of the Enlightenment was, if not always learning through doing, at least doing[27] – so being able to obtain enjoyment while still ostensibly improving one's knowledge was thus a great boon. This public interest in science, as complicated as it might be, created a market for science that could lead to real profit for those practicing it.

These modern historians, as well as others, find in the Enlightenment not the grand pursuit of discovery that earlier writers described, but a period in which the need for exposure and marketability regularly shaped scientists' pursuits. Trent Mitchell, who wrote at length about the economic and political ramifications of the invention of the lightning rod, rather than its utility, viewed science in the Enlightenment as a way of reaching and influencing a public that was already interested in the topic .[28] But what all these authors, even earlier historians like Cohen, seem to agree on is that one undeniable reality of the Enlightenment was a populace ravenous for new and exciting scientific discoveries.

Science and philosophy were not just important intellectual endeavors in the Enlightenment; they were its entertainment, its popular culture – they were, basically, a growing industry the product of which was valued not for its practical nature, but its connection with knowledge.[29] In some cases, this meant that men and women who would have been shut out from academia in centuries past became able to enter into the important intellectual discussions of the day – a kind of democratization of intellectualism. For example, some physicists, both lecturers

---

[27] Ibid., 163.

[28] Trent Mitchell, "The Politics of Experiment in the Eighteenth Century: The Pursuit of Audience and the Manipulation of Consensus in the Debate over Lightning Rods," in *Eighteenth-Century Studies*, 31, no. 3, (Spring, 1998), 308.

[29] Fara, "Hidden Vertues," 32.

and academicians, found themselves faced with the question of how to deal with earnest pupils who lacked the fundamental knowledge of mathematics required to learn the subject, but nevertheless were willing to make the effort to learn.[30] In other cases, the intention to disseminate science was not wholly altruistic – public science was big business, and not everyone going into the business was careful or scrupulous enough to present the truth – and yet, often enough, even these practitioners would attract crowds.[31] Bacon has often been given credit for the modern scientific method and its emphasis on empiricism, even by 18th-century writers; George Adams, Jr., himself wrote about this in the introduction to his *Lectures*, and gave Bacon credit for helping to find a way to disprove false claims about natural (and religious) philosophy.[32] But part of the reason these pursuits held such sway over the public was the connection they made between the physical and the religious, rather than asserting a simply physical nature. Some found in scientific discoveries a new justification for ethics; others found religion, or a way to understand God – this was especially true for the field of electricity.

It is easy to view this movement as solely the realm of the financially elite, and certainly some marketed products directly to the richer parts of society.[33] But, as Alexi Baker recently noted in her lecture on "Polite Society and the Public Theatre," the Enlightenment era British

---

[30] Paula Findlen, "A Forgotten Newtonian," in *The Sciences in Enlightened Europe,* ed. William Clark et al. (Chicago: University of Chicago Press 1999), 343. Findlen focuses on Cristina Roccati, an 18th century lecturer who focused on physics.

[31] Robert Darnton, *Mesmerism and the End of the Enlightenment in France* (Cambridge: Harvard University Press, 1968), 10-11.

[32] George Adams, Jr., *Lectures on Natural and Experimental Philosophy, Considered in It's Present State of* Improvement, (London, 1794) *Eighteenth Century Collections Online*, Gale, University of Oklahoma Libraries, Accessed October 8, 2013, http://find.galegroup.com/ecco/infomark.do?&source=gale&prodId=ECCO&userGroupName=norm94900&tabID=T001&docId=CW106774705&type=multipage&contentSet=ECCOArticles&version=1.0&docLevel=FASCIMILE, 3:32.

[33] Fara, "Hidden Vertues," 5.

public – both the wealthy and the working class – held a fascination for natural philosophy. This fascination led to a robust market in scientific instruments, lectures and publications that encouraged people to explore science for themselves. For the elites, this was fueled at times by a genuine interest in science, and sometimes by a desire to appear fashionable.[34] Baker notes that decorating one's home with scientific instruments, as well as purchasing, reading and discussing books on science, became signs of one's refinement and taste. But the creators of such items also encouraged the general public to take an interest in natural philosophy, redesigning their demonstrations and publications to highlight the more entertaining aspects of science and scientific study. Some speakers in this era were liked for their ability to reach those with less education,[35] or for being an affordable alternative to more expensive methods of education.[36] Many elements of society could enter into this world, rather than just the wealthy. As the audience was broad and numerous, lectures and publications ranged from the relatively serious to the rather lightweight. But, Baker argues, Enlightenment era society saw the growth of a thriving, highly profitable market for the study of natural philosophy at a time when commercialism was a central concern, especially in urban areas.[37]

Science was big business. For example, Franz Mesmer made his living performing public demonstrations of his "animal magnetism" and explaining his theories to an enthusiastic audience – an audience made of admirers from all levels of society, from merchant to aristocrat to, on occasion, the religious elite. And while today we know that his Mesmerism was complete

---

[34] Anita Baker, *Polite Society and the Public Theatre,* podcast audio, Newtonian Audiences, MP3, accessed December 4, 2013, http://www.enlighteningscience.sussex.ac.uk/resources_for_teachers/newtonian_audiences/.

[35] Findlen, "A Forgotten Newtonian," 344.

[36] Stafford, *Artful Science,* 159.

[37] Baker, *Polite Society.*

falsehood, it is not clear that he himself knew this, and is certainly clear that his fans did not. Indeed, they defended it fervently against its detractors, among whom can be counted the illustrious Benjamin Franklin himself, who was part of a Royal Society commission to investigate Mesmer's claims, and found the concept to be fundamentally unsound.[38] Unlike Franklin, Mesmer's fans found the subject edifying, entertaining, but also inherently practical – healings done through mesmerism were a common and popular pursuit.[39] And while Robert Darnton has argued that Mesmerism, with its arcane rules and its contradiction of other modern natural philosophies, was in the end anathema to the kind of scientific growth with which many credit the Enlightenment[40] – and perhaps rightly so – it still offered qualities that fit into that populist mold; it was practical, it was comprehensible (if not always admitting of full explanation), and it was exciting. Entertainment could be educational, constructive, profitable – all these things and more.[41]

It is important for the reader to understand that electricity, however, had a somewhat special place in the Enlightenment. Mesmerism had been popular both as a science and, as its popularity grew, as a justification for politics (not unlike Franklin's own use of his scientific fame and exploits for political gain),[42] but the electric forces had the potential to be far more valuable. After all, they could be tested and replicated successfully, and unlike Mesmerism they had the benefit of having a basis in the known world – no one would deny the existence, for

---

[38] J. L. Heilbron, "Benjamin Franklin in Europe: Electrician, Academician, Politician," in *Notes and Records of the Royal Society of London* 61, no. 3 (Sep. 22, 2007), 363.

[39] Darnton, *Mesmerism,* 59.

[40] Ibid., 159.

[41] Stafford, *Artful Science,* 29.

[42] Darnton, *Mesmerism,* 3.

example, of lightning. Of course, one might argue over its source and cause, but the effects were obvious. Sparks and magnetism were thus a far cry from the invisible power of Mesmer, which healed or influenced invisibly[43] – and electricity became a popular phenomenon. Thinkers of the day wrote many works on the subject, sometimes in an attempt to create discourse on the subject, though others simply restated accepted knowledge to make a quick profit – sometimes with outlandish packaging, like the infamous Gustavus Katterfelto, who was known to raise his daughter up with the aid of a steel helmet and strong magnets[44]. Many of these works were hugely successful publishing projects, like Benjamin Franklin's *Experiments and Observations on Electricity.*[45]

Obviously, then, the new technologies of the Enlightenment had considerable popular appeal, and there was a desire among the public to have access to these new ideas – as well as the old. Those responsible could become wealthy and famous; for example, Benjamin Franklin remains a popular and often-discussed figure of American history, and not just because of his involvement in the Revolution, but for his inventions and discoveries as well. He was, of course, a central figure in the founding of the nation and the creation of its legal underpinnings, and continued to work diplomatically for the new American republic for many years after the revolution. Bernard Cohen argues that this idea of Franklin as a political figure first of all is unfair to the man, because his other accomplishments (in science, and in publishing) were

---

[43] Darnton, *Mesmerism,* 16.

[44] Fara, "Hidden Vertues," 24.

[45] "Franklin, Benjamin," in *Complete Dictionary of Scientific Biography,* Vol. 5 (Detroit: Charles Scribner's Sons, 2008), accessed November 1, 2013, http://go.galegroup.com/ps/i.do?id=GALE|CX2830901508&v=2.1&u=norm94900&it=r&p=GVRL&sw=w&asid=5c09ea78df8ce8010252cf025780b503#contentcontainer, 138.

impressive.[46] But in truth it is clear from Franklin's actions that he considered politics to be incredibly important, and they remained a priority before and after his famous scientific career – which, though clearly a passion for him, he was not above using to further those political goals. Of course Franklin was much more than just a diplomat – he was a child of the Enlightenment, born in 1706. As such, he was in a perfect position to experience much of the intellectual and scientific growth that the time had to offer, and it is fair to say that he certainly tried a great many things, often with great success. And yet, he cared very little for traditional methods of teaching; he felt the Classical education was insufficient, or unimportant, in the modern era. Instead, Franklin felt educators should emphasize practical pursuits and knowledge, like modern languages or sciences.[47]

When he was young, Franklin served apprenticeship to a printer, and as a result came into contact with new ideas from all levels and spheres of literate society.[48] But he also learned something else: having control of information, and being known for its dissemination, also gave one influence over his fellows; inspired by the evangelism of one of the great preachers of the age, George Wakefield,[49] Franklin published pamphlets, and used his popular *Poor Richard's Almanac* (one of the publications that helped make his fortune), for the purposes of propagandizing to the public.[50] *Poor Richard's Almanac* offered advice and trivia on all manner of scientific pursuits – some practical, such as meteorology, but many topics were included

[46] Cohen, "Benjamin Franklin," 474.

[47] George N. Heller, "'To Sweeten Their Senses': Music, Education, and Benjamin Franklin," *Music Educators Journal* 73, no. 5, (2007): 24.

[48] Philip Dray, *Stealing God's Thunder* (New York: Random House, 2005),, 26.

[49] Ibid., 75.

[50] Ibid., 77.

simply to educate and amuse the reader (or, perhaps, Franklin himself).[51] Even at this early date, Franklin was combining two interests, politics and science, though he was as yet an amateur in both. Most of these endeavors, whether on his own behalf or simply as a means of employment, emphasize his constant striving not just to understand, but to spread information to others. But it should be emphasized that Franklin was not just writing for the educated elite. His works, especially his later scientific tracts, would reach a great number of people, enlightened and unenlightened alike.

Though he had dabbled in the sciences before, Franklin's most active research was done after 1746, when he found himself, thanks to his printing job and book sales, wealthy enough to retire and engage in natural philosophy and other pursuits that, while interesting, were less likely to be profitable.[52] Specifically, Franklin had become fascinated with electricity, wanted to explore the discipline to the best of his ability, and endeavored to document his experiments carefully so that others could do the same and personally see the same results.[53] His experiments helped him to improve his own understanding of electricity, but they also made him famous, and increased his not inconsiderable wealth.[54]

In the preface to the 1751 edition of his *Experiments and observations on electricity,* the editor of the work writes that "some persons to whom [these experiments] were read, and who had themselves been conversant in electrical disquisitions, were of opinion […] that it would be doing a kind of injustice to the publick, to confine them solely to the limits of a private

[51] Ibid., 27.

[52] Cohen, "Benjamin Franklin, 475.

[53] "Franklin, Benjamin," 133.

[54] Ibid., 135.

acquaintance."[55] The work, made up of a series of letters Franklin had written to fellow enthusiasts and experimenters, is intriguing. Rather than merely a discourse on discoveries and laws, the letters set down, step by step, unusual phenomenon and interesting effects that Franklin had discovered electricity offered:

> A man standing on wax may be electrified a number of times, by repeatedly touching the wire of an electrified bottle (held in the hand of one standing on the floor) he receiving the fire from the wire each time: yet holding it in his own hand, and touching the wire, tho' he draws a strong spark, and is violently shock'd, no Electricity remains in him; the fire only passing thro' him from the upper to the lower part of the bottle.[56]

For some of these effects he provides an explanation, but the letters are interesting for another reason: in each case, he describes several experiments that the readers can do for themselves, many of which are quite simple and modest in scope – but with such a fascinating and untapped source of discovery as electricity (and its related field, magnetism), such effects were an end in and of themselves. For example, many of the experiments in the first letter involve magnetizing and moving about small objects in order for the experimenter to see the interplay of the positive and negative forces of magnetism:

> Lay two books on two glasses, back towards back, two or three Inches distant. Set the electrified phial on one, and then touch the wire; that book will be electrified *minus;* the electrical fire being drawn out of it by the bottom of the bottle. Take off the bottle, and holding it in your hand, touch the other with the wire; that book will be electrified *plus;* the fire passing into it from the wire, and the bottle at the same time supply'd from your hand. A suspended small cork-ball will play between these books 'till the equilibrium is restored.[57]

Another letter involves Franklin describing experiments to determine how, and where, the electrical charge is transmitted,[58] something that he wanted to understand in order to determine

---

[55] Franklin, *Experiments and Observations on Electricity,* 2.

[56] Ibid, 8.

[57] Ibid, 7.

[58] Ibid., 20.

what, in fact, electricity might *be*. It may be somewhat hard for us to remember today that simply understanding what an electrical circuit *is,* much less how it works, was considered by the public and scientists alike at this time ground-breaking research. While these may be basic tenets of science in the modern era, for Benjamin Franklin and the Enlightenment public at large electricity was a field still being defined – it is significant that the terms used in the modern day to describe electrical current – "'plus,' 'minus,' 'positive,' 'negative,' 'battery,' and many other words […] – are still basic in electrical discussion."[59]

In truth, however, few of the experiments in Franklin's manuscript are strictly practical, in the sense that they offer a useful effect, but they also offer an opportunity for the reader to become involved in the scientific process. Many are relatively simple to do, and create effects that are tangible for the experimenter, even if at times Franklin's examples may seem to illuminate little of the underlying nature of the phenomenon. But it is significant that, when Franklin states something categorically – for example, that "the direction of the electrical fire being different in the charging, will also be different in the explosion" – there often follows an exhortation to the readers to try something, or do something, in order to prove to themselves that the effect exists:

> To prove this; take two bottles that were equally charged thro' the hooks, one in each hand; bring their hooks near each other, and no spark or shock will follow; because each hook is disposed to give fire, and neither to receive it. Set one of the bottles down on glass, take it up by the hook, and apply its coating to the hook of the other; then there will be an explosion and shock, and both bottles will be discharged[60]

This seems to fit with Stafford's idea of the Enlightenment individual's learning by doing. It would have been simple for Franklin merely to write down in his letters the theories that he had

---

[59] Cohen, "Benjamin Franklin," 475.

[60] Franklin, *Experiments and Observations on Electricity,* 20.

developed; they certainly form an important part of the work. But instead the document is a combination of theory and practical, hands-on experimentation. It is possible that he was inspired by his earlier experiences as a writer and his tendency towards the practical to do this, but the reason is less important than the result: simply reading about theory in a book did not fit the needs of the people for whom such a book was written, but Franklin's book offered ways in which any individuals who could read and obtain a copy could test these experiments for herself – or, for entertainment purposes, she could of course share the experience with others. Perhaps this is part of why his work took off commercially the way that it did, and why he became such a celebrity in his own era.

This kind of hands-on experience was a new way for Enlightenment thinkers to bridge the gap between their ideas and a willing, eager public – and Franklin did so with great success. Naturally, of course, Franklin's *Experiments* offered his conclusions in the book, and while future experimenters have improved upon his work, his conception of the positive and negative forces of electricity has remained the dominant terminology to this day. As such, Franklin's book is a successful work of scientific inquiry. But commercially, too, it was an instant hit; it enjoyed several reprints and revised editions, and continued to sell in later years, even being translated into foreign languages and published in countries far removed from his homeland.[61] It was first published not in his native colonies but in London, from which many new and exciting ideas and gadgets were being shipped far and wide – including Franklin's new book.[62] This success led not just to further editions of the *Experiments and observations on electricity*, but to a great many other works by Franklin on a variety of topics. Clearly, while he continued to look into subjects

[61] "Franklin, Benjamin," 135.

[62] Dray, *Stealing God's Thunder*, 77.

that interested him (something not all thinkers in this era were free to do, thanks to their need to sell copies and seats for their shows), he was not averse to making money on the side, or republishing his work to continue profiting from its popularity.

Some writers have remarked on the relative lack of any practical application in many of Franklin's electrical studies. However, as Joyce Chaplin has pointed out, he was hardly alone in this: Enlightenment thinkers "instead asked more abstract questions about electricity, particularly about its ability to give clues as to the nature of matter."[63] Lightning was, in essence, a force of nature, and studying it might give to the public an understanding of how the world worked on a fundamental level – or, perhaps, how God worked through those laws of nature. Indeed, science and religion are hard to separate, especially in Franklin's case, as he was essentially a Deist. But, despite his own shaky relationship with organized religion, Benjamin Franklin found his work connected with a higher power. Immanuel Kant himself, that great Enlightenment philosopher, was impressed by the man's inventiveness; he went so far as to claim that Franklin's invention of the lightning rod marked him as a "modern Prometheus."[64] Others, perhaps trying to promote him in a more distinctly nationalist context, dubbed him the American Jupiter.[65] Both of these names, derived from mythology, demonstrate the powerful implications of what he had accomplished. Prometheus is especially significant; he was the mythic figure who stole the power of fire from the gods and gave it to man. Electrical scientists had, in their own way, seemingly captured a natural power – and it could be controlled.

---

[63] Joyce E. Chaplin, "Benjamin Franklin and Science, Continuing Opportunities for Study," *Perspectives on Science* 14, no. 2 (2006): 143.

[64] Delbourgo, *A Most Amazing Scene of Wonders,* 3.

[65] Ibid., 279.

Still, his work with electrical power, embodied in that work and his later inventions based on the technology, remained his greatest scientific legacy. By the time he was sent to Paris in 1776, he was world famous for his explorations of electricity and an honorary member of the Royal Academy of Sciences – and despite his success in the field, many asked him to give up diplomacy and return to scientific study.[66] But, to their disappointment, he did not – he seems to have felt that, despite his liking for experimentation, his role as a politician and diplomat and his desire to work for the advantage of the North American colonies were more important.

Franklin's ability to combine his scientific ideas and his political ideals is clearly illustrated in the conflict between himself and another 18th century inventor, Benjamin Wilson. Both were inextricably linked to the study of lightning, and both had their own design for a lightning rod to prevent the damaging effects of that phenomenon (Franklin favored his pointed lightning rod, while Wilson's was blunt).[67] In theory, this was a simple, practical issue, but it became an inherently political one as well, thanks to simple fact that Wilson was a loyal British citizen and Franklin, for his part, represented a colonial America already on its way to revolution. For, while Wilson first publicly criticized Franklin's design in 1764, it was in 1772 that the British government asked both men, among others, to work together in a committee to determine which design was best – and both men used the situation to benefit not just their design of choice but their political allegiance as well.[68] The rhetoric used seems to have been

[66] "Franklin, Benjamin", 130.

[67] Trent A. Mitchell, "The Politics of Experiment in the Eighteenth Century: The Pursuit of Audience and the Manipulation of Consensus in the Debate over Lightning Rods," in *Eighteenth-Century Studies* 31, no. 3 (Spring 1998), 308.

[68] Ibid., 314.

shaped by their politics as well as their science, all in a debate that in theory could have been boiled down to an empirical resolution.[69]

Franklin was an accepted luminary, and communicated regularly with the Royal Society and learned scholars in Europe.[70] He certainly had supporters, but Wilson had his as well, and they tended to be on opposing sides of the debate slowly brewing over the issue of the colonies.[71] Franklin seems to have appealed to the popular European vision of the colonies,[72] and his advocacy of their cause linked him in the eyes of the public to the burgeoning soon-to-be republic. He has been seen by some as a kind of altruistic figure, working for the good of society and the betterment of science – Cohen certainly argued for that interpretation – but Franklin seems to have had no qualms about pursuing his own interests or goals. He certainly managed to remain above some of the more ridiculous extravagances of the period (Benjamin Wilson, for example, actually built a giant lightning generator to represent the rainclouds for his lightning rod demonstrations, eschewing practicality in favor of being impressive and convincing during his conflict with Franklin[73]). Thanks to his relative financial independence, he was less limited by the vagaries of the public science marketplace than some of his contemporaries, but in politics he used the outcome of that market, his supporters and popularity, to his own advantage. But his works carried with them genuine scientific research, and he invented some practical and popular items still used today. That in itself sets him apart from another participant in the same field of writing, George Adams, Jr., whose collections of experiments, marketed to the public as

---

[69] Ibid., 316.

[70] "Franklin, Benjamin," 130.

[71] Mitchell, "The Politics of Experiment," 318.

[72] Delbourgo, *A Most Amazing Scene of Wonders,* 144.

[73] Mitchell, "The Politics of Experiment," 320.

educational works, were mostly based upon the work of others; and whose initial goal with his books was not discovery, but profit.

The Adams family instrument business began some time in 1734, under the auspices of George Adams, Sr., in London's Fleet Street.[74] The company initially earned its profits producing devices for the East India Company, especially sextants, and later would do the same for the British navy.[75] This would comprise the bulk of their business even into son George Adams Jr.'s ownership of the company. However, George Adams, Sr. was inspired by popular science publications of the time, several of which had helped fuel an interest in microscopes – something of relevance to an instrument maker.[76] To benefit from that public interest, he produced two publications during his lifetime, and his attempt to explain and justify the use of microscopes was sufficiently popular to justify a new edition later on in his life.[77] They would also serve as a catalyst for his far more prolific son's writing career. His son, then, would have been exposed to not just the technical questions of the Enlightenment-era instrument market, which included, as a necessity, knowledge of scientific developments in order to remain competitive, but also to the educational and, importantly, *commercial* potential of writing scientifically for public consumption. As Adams, Sr. himself pointed out, the writer or demonstrator has the ability to show his audience the facts, and thereby lead the public to an understanding of the subject at hand.[78] This sentiment would not have seemed unusual to Benjamin Franklin, or to the many other men and women of the period interested in the sciences

---

[74] Millburn, *Adams of Fleet Street,* 14.

[75] Ibid., 20.

[76] Ibid., 32.

[77] Ibid., 37.

[78] Peter Heering, "An Experimenter's Gotta Do What an Experimenter's Gotta Do—But How?" *Isis* 101, no. 4 (December 2010): 804.

– and, as shall be seen, was an idea that his son was to seize upon in his own intellectual investigations of electricity.

George Adams, Jr., strove at first to follow in his father's footsteps, selling instruments to the navy and deriving the majority of his profits from the family business. Thanks to continued warfare, especially the eventual onset of the American War of Independence, profits were initially high, but when the war ended, the naval source of revenue dropped quickly.[79] It is possible that this is what caused his return to the writing that had briefly occupied his father, though he also was likely inspired by the popular culture of the era. However, it is certain that he began by retracing his father's footsteps, revising the elder Adams' still-popular work on microscopes, which publishers wanted to reissue.[80] But Adams felt a need for a new commercial niche in order to sustain the business, and he found it in the growing public market that books like Franklin's had helped develop for electrical experimentation. It should be noted that Adams, Sr., had likely created some of the instruments Franklin himself used to experiment, and Adams, Jr., continued this trade,[81] but he also saw potential in the manuscript market that his father had contributed to, and the last decade of his life would be spent in the creation of a large variety of works on multiple subjects.[82]

Considering his trade, it should not be surprising that the first work Adams, Jr., wrote on his own was his 1784 *Essay on Electricity*, a substantial work that was to include not just an explanation of the theory of the science, but experiments in order to demonstrate those ideas.[83] In

---

[79] Millburn, *Adams of Fleet Street*, 198.

[80] Ibid., 198.

[81] Paola Bertucci, "John Wesley and the Religious Utility of Electrical Healing," *The British Journal for the History of Science* 89, no. 3 (September 2006): 353.

[82] Millburn, *Adams of Fleet Street,* 245.

[83] Ibid., 198.

substance, then, it was akin to Franklin's own experiments and writing, although thanks to the later publishing date it was perhaps more theoretically advanced in its understanding of the science. But while Franklin seems to have viewed his work as almost altruistic, and was only able to turn to scientific experimentation and discourse once he had already made his profits through other work, for Adams this publication seems to have been at least in part spurred by a need to simply draw a profit from a popular type of publication – the fact that such a work could be popular and profitable is itself indicative of the social climate of his era and the ideas that culture valued. And while his work may have been somewhat mercurial in nature, he seems to have embraced the idea that knowledge and the publication of that knowledge was capable of improving the individuals who partook of it.

The preface to Adams's work on electricity is worthy of note. "The science of electricity," he writes, "is now generally acknowledged to be useful and important; […] at a future period it will [likely] be looked up to as the source from whence the principles and properties of natural philosophy must be derived."[84] In other words, the study of what people had once thought something of a novelty by Adams' time they accepted as a useful and, perhaps, even revelatory pursuit. But, he argues, nature is too complex to be explained simply; certainly this work, at least, does not explain the deeper theories of electricity. The book, he says, is meant to make the essential parts of the science "easy, pleasant, and obvious to the young practitioner"[85] so that such readers, or anyone uninformed in such matters, can learn for themselves the proof for the new laws of this science. The work is meant to be very definitely, then, a *practical* instructive tool that can appeal to broad audiences rather than the professional –

[84] Adams, Jr., *An Essay on Electricity,* iii.

[85] Ibid., iv.

to the general public, rather than those who already have attained some mastery of the subject. In a sense, this differentiates his work from Franklin's early electrical publications: while Franklin's book was made up of practical demonstrations, they were originally addressed to fellow aristocrats – learned friends, essentially – and later revised and compiled by the author and his publisher for public consumption. Adams is writing here specifically, and directly, for as broad an audience as possible.

Adams writes that he wishes to show the connection between experiment and theory,[86] and the work itself is indeed very didactic in tone and writing style:

> In chapter 6 we observed, that the different appearances of light on electrified points was deemed a criterion of the direction of the electric fluid. That the luminous star, or globule, shews the point is receiving the electric matter, whilst the luminous brush, or cone, indicates that it is proceeding from the point. We shall now examine the states of the different sides of the Leyden bottle by these appearances.[87]

This is not the work of someone trying to prove his theories, but someone explaining already known concepts. Indeed, he often cites the work of other people (and he would have been versed in new developments in order to keep his shop up-to-date). In any case, the experiments build upon each other in order to demonstrate the basic principles of the science – including principles, of course, that Benjamin Franklin had set down, such as the presence of positive and negative charge in electrically charged substances.[88] Its usefulness as an educational text is somewhat suspect: the explanation of what exactly is being demonstrated by the text, and how, is sometimes explained too briefly, especially when compared to the detailed nature of the rest of the work. At other times the work continues at length, giving exhaustive lists of what effect various substances will have upon others without really explaining why, as when Adams

[86] Ibid., 2.

[87] Ibid., 103.

[88] Ibid., 6.

explains what charge rubbing different objects on each other will generate: this takes the form of a chart of objects and what objects will create a positive or negative static charge when rubbed on them – including, bizarrely, a "list of electric substances, and of the different electricities produced by them," which includes the explanation that rubbing any "`substance with which it has been hitherto tried" on a cat will create a positive charge.[89] Other substances range from glass to hare's skin. Some of these may be ideas that he found in other books, and many seem strange or incorrect in the light of a modern understanding of electricity or of magnetism, but Adams can hardly be held to such standards. His goal was to provide some theories, and to give his readers ways to achieve a *tangible* effect demonstrating those theories. If the theory proved to be incorrect or flawed, experimenters could discover that for themselves, through practical application.

Still, Adams often does not explain exactly what the examples and rules in the manual mean. Unlike Franklin, whose works strove to explain the reason for or makeup of electricity, proven through the experiments described, Adams is seemingly more concerned with creating a practical manual for performing experiments, even if the result is not always as instructive as one might hope. It is a practical work, providing experiments that can be performed by the layman, whether through objects available at home or via specialized machines, which would, of course, be available for purchase in Adams's shop:

> Since the publication of Dr. Priestley's History, the electrical apparatus has been considerably augmented, and many new experiments have been made. To describe the one, and to arrange the other, under such heads as will point out the connexion between the experiments and the received theory of electricity, was one of the principal views I had in composing this essay. I also wished to put into the hands of my customer a tract, which might enable them to use, with ease and satisfaction, the electrical machines and apparatus which I recommend.[90]

[89] Ibid., 13.

[90] Ibid., 2-3.

It was not intended by Adams to be a scholarly treatise on the subject.[91] Instead, readers find detailed and step-by-step instructions not just for the experiments but the procedure of setting up instruments and machinery to perform them:

> These experiments may all be made with a small and portable apparatus; consisting generally of two brass tubes, as A and B, fig. 22, each of these is supported on a glass pillar G, which screws into a wooden foot H, a pair of small bith balls suspended on linen threads, as I, K, fit upon each tube by means of a small brass ring; these tubes, with a piece of sealing wax or a glass tube, are sufficient to illustrate the greater part of the experiments in this chapter.[92]

He also, at times, provides an explanation of the terminology of a field and some theorists whose works may apply.[93]

The *Essay on Electricity* is, then, not a text demonstrating Adams's innovations in the field, but simply his attempt to cater to the public desire for that combination of information and entertainment that so defined the Enlightenment – a way for Adams to accomplish the important task of spreading information while also, by giving the public what they wanted, making a good profit. In a way, the book is analogous to a modern-day textbook, in that the discoveries within are not usually Adams's own, and perhaps not even all of the experiments – instead, the value comes from how comprehensibly it is explained and how comprehensively the material is covered.

If Adams hoped to gain some new business through his publication, that desire was unequivocally fulfilled. Even after his death, publishers continued to revise and reissue the *Essay*, to add new discoveries and experiments, and to keep his texts current with the popular interests of the time. For example, publishers added a section on animal electricity to the 1799

---

[91] Millburn, *Adams of Fleet Street,* 200.

[92] Adams, Jr., *An Essay on Electricity*, 51.

[93] Ibid., 331.

edition; they apparently felt the work was somewhat lacking, but that its popularity and value came in the detail and breadth of its experiments.[94] Clearly, his method continued to resonate with the public. But while Adams's writing career may have begun as a means of making money, he did not lose track of that idea of his father's – that information, properly explained, could improve those receiving it. This idea, not far removed from the way many others viewed the Enlightenment, would be a recurring theme throughout the rest of his writing career. The last years of his life were a decade of frequent publishing, in which he continued to grow in popularity and subscribers to his published works. The most obvious embodiment of this philosophy must be his final work, the *Lectures on natural and experimental philosophy*, a massive five-volume work that sought to demonstrate conclusively the basis of scientific principles, of scientific experimentation (as embodied, of course, in the iconic Roger Bacon, the "friend and father of modern philosophy"[95]) that would promote a comprehension of, and blossoming thereby in the reader of, a religious natural philosophy – a way to show up the "pretenders to philosophy" who undermined religion through their scientific discoveries.[96] A thorough examination of his final, multi-volume work is beyond the scale of this paper, but its preface is telling in its insistence that through scientific discovery, through an understanding of nature and physics, can come an understanding of God and of religion[97] – and, because they base their criticisms in a falsification of reason, the false philosophers who deny religion or corrupt it will, at least according to Adams, inherently be shown as liars if those who listen to them can test their claims. This transformation from the somewhat secular philosophy espoused in the *Essay*

---

[94] Millburn, *Adams of Fleet Street*, 207.

[95] Adams, Jr., *Lectures on Natural and Experimental Philosophy,* 40.

[96] Ibid., vii.

[97] Ibid., viii.

on Electricity at first may seem surprising, but in both cases the goal is to educate a willing public in order to equip them to learn and judge for themselves, so that when confronted with other thinkers' theories, they will be able to judge or accept those ideas for themselves. And certainly Adams's methods must have found a willing audience: at least a thousand copies of his *Lectures* were ordered by subscribers *ahead* of publication,[98] and the volumes continued to be published and reprinted after his death.

George Adams, Jr., represents an interesting Enlightenment figure: he was clearly concerned with his business and with profits, but at the same time seems to have sought to defend and promote the public's relationship with science and religion through his works. But, as was demonstrated by the public relationship to science during this time, those two categories were not always so distinct. Natural philosophy might give insight into religion, it might even shape or replace it – but in all cases, the pursuit of enlightenment was important. Franklin, and Adams offer us intriguing ways of approaching the issue: Franklin seems to have been interested most of all in discovery, and in discourse – and, through expanding the discussion to a greater number, could promote those causes. Adams is perhaps more complex. Was he a mercurial man who became a scientific missionary, or was he striving, with his appeals to religion, to defend and justify the pursuits and interests he had followed throughout his career? In any case, his approach to education, which relied heavily on explaining the work of others in a more accessible (and entertaining) way, demonstrates that his intended audience, at least, was a populist one. Franklin and Adams thus appear to be diametrically opposed – one worked for profit, the other for the betterment of science and education after having already made his profits – but the success, and the popularity, of both demonstrates clearly that, whatever the justification

[98] Millburn, *Adams of Fleet Street,* 245.

for their efforts, science as an experience was something that truly resonated with society on a fairly large scale in the Enlightenment.

Both these men were indicative of and contributed to the Enlightenment trend towards public, hands-on science, both as profitable entertainment *and* as a means of education. Given the chance to learn new theories, the greater populace took advantage of it, whether by reading or by attending public lectures and demonstrations – but for the people to really engage with the subjects, that education had to have some value as a practical entertainment. Philosophically, as much as politically and scientifically, the Enlightenment was a complicated and paradoxical period. Some argued for more openness and debate; others publicly condemned those goals while implementing new ideas in scientific experimentation and theology *in private.* As we have seen, Enlightenment scientific documents often sought to popularize new inventions and discoveries, and to offer simplified methods for investigating science. But this ideology on the part of those already knowledgeable and involved in academia would have been worthless without a corresponding desire by outsiders to enter into that world. One of the characteristics of the Enlightenment, as many have noted, is that, coinciding with a greater dissemination of knowledge from the top down, there existed a desire on the part of the lower classes for that same knowledge. Attempts by scientists to fulfill that desire took many forms.[99] Some efforts took the form of published books – guides, in essence, to the hitherto closed world of science. Others involved speeches, sometimes even for free, expounding upon some new discovery or argument; Benjamin Franklin was actually inspired by just such a movement, the Great Awakening, although that affected the realm of religion.[100] And, of course, there was the ever-

[99] Stafford, *Artful Science*, xxi.

[100] Delbourgo, *A Most Amazing Scene of Wonders,* 96.

popular demonstration: an exciting yet (in theory) educational event in which the presenter would perform some experiment, or dissection, or other practical proof of his or her ideas – even if, as was sometimes the case, those ideas were completely wrong. In any case, those responsible for producing popular science works were often trying to reach whoever they could – even if that audience was relatively lacking in knowledge of the subject. This trend of combining both commercialism and scientific inquiry, a trend documented in the works of Benjamin Franklin and George Adams, Jr., is an approach that continues long after the Age of Enlightenment, thus becoming a lasting hallmark of the Enlightenment era.

Bibliography

Adams, George, Jr. *An Essay on Electricity; in which the Theory and Practice of that Useful Science, are Illustrated by a Variety of Experiments, Arranged in a Methodical Manner*. London, 1784. *Eighteenth Century Collections Online*. Gale. University of Oklahoma Libraries. Accessed October 6, 2013. http://find.galegroup.com/ecco/infomark.do?&source=gale&prodId=ECCO&userGroupName=norm94900&tabID=T001&docId=CW106985163&type=multipage&contentSet=ECCOArticles&version=1.0&docLevel=FASCIMILE.

Adams, George, Jr. *Lectures on Natural and Experimental Philosophy, Considered in it's Present State of Improvement.* Vol. 1, *Medicine, Science and Technology*. London, 1794. *Eighteenth Century Collections Online*. Gale. University of Oklahoma Libraries. Accessed October 8, 2013. http://find.galegroup.com/ecco/infomark.do?&source=gale&prodId=ECCO&userGroupName=norm94900&tabID=T001&docId=CW106774705&type=multipage&contentSet=ECCOArticles&version=1.0&docLevel=FASCIMILE.

Baker, Anita. *Polite Society and the Public Theatre*. Podcast audio. Newtonian Audiences. MP3. Accessed December 4, 2013. http://www.enlighteningscience.sussex.ac.uk/resources_for_teachers/newtonian_audiences.

Bertucci, Paolo. "John Wesley and the Religious Utility of Electrical Healing." *The British Journal for the History of Science* 89, no. 3 (September 2006): 341-362.

Brigden, Susan. *New Worlds, Lost Worlds: the Rule of the Tudors*. New York: Penguin Group, 2002.

Chaplin, Joyce E. "Benjamin Franklin and Science, Continuing Opportunities for Study." *Perspectives on Science* 14, no. 2 (2006): 232-51.

Cohen, Bernard. "How Practical Was Benjamin Franklin's Science?." In *The Pennsylvania Magazine of History and Biography* 69, no. 4 (October 1945): 284-293.

Cohen, Bernard. "Benjamin Franklin as Scientist and Citizen." *The American Scholar* 12, No. 4 (Autumn 1943): 474-481. http://www.jstor.org/stable/41204624.

Darnton, Robert. *Mesmerism and the End of the Enlightenment in France.* Cambridge: Harvard University Press, 1968.

Delbourgo, James. *A Most Amazing Scene of Wonders.* Cambridge: Harvard University Press, 2006.

Dray, Philip. *Stealing God's Thunder.* New York: Random House , 2005.

Fara, Patricia. "'A Treasure of Hidden Vertues': The Attraction of Magnetic Marketing." In The British Journal for the History of Science, 28, no. 1 (March 1995): 5-35.

Findlen, Paula. "A Forgotten Newtonian." In *The Sciences in Enlightened Europe,* ed. William Clark et al. (Chicago: University of Chicago Press 1999): 313-349.

Franklin, Benjamin. *Experiments and Observations on Electricity, Made at Philadelphia in America, by Mr. Benjamin Franklin, and Communicated in Several Letters to Mr. P. Collinson, of London, F. R. S.* London, 1751. *Eighteenth Century Collections Online.* Gale. University of Oklahoma Libraries. Accessed October 30, 2013. http://find.galegroup.com/ecco/infomark.do?&source=gale&prodId=ECCO&userGroupName=norm94900&tabID=T001&docId=CW3308328711&type=multipage&contentSet=ECCOArticles&version=1.0&docLevel=FASCIMILE.

"Franklin, Benjamin." In *Complete Dictionary of Scientific Biography.* Vol. 5. Detroit: Charles Scribner's Sons, 2008. Accessed November 1, 2013. http://go.galegroup.com/ps/i.do?id=GALE|CX2830901508&v=2.1&u=norm94900&it=r&p=GVRL&sw=w&asid=5c09ea78df8ce8010252cf025780b503#contentcontainer.

Heering, Peter. "An Experimenter's Gotta Do What an Experimenter's Gotta Do—But How?" *Isis* 101, no. 4 (December 2010): 794-805.

Heller, George N. "'To Sweeten Their Senses': Music, Education, and Benjamin Franklin." *Music Educators Journal* 73, no. 5 (1987): 22-26.

Kant, Immanuel. "What Is Enlightenment?" *Columbia University.* Translated by Mary C. Smith. Accessed October 7, 2013. http://www.columbia.edu/acis/ets/CCREAD/etscc/kant.html.

Millburn, John R. *Adams of Fleet Street: Instrument Makers to King George III*. Burlington, VT: Ashgate, 2000.

Mitchell, Trent A. "The Politics of Experiment in the Eighteenth Century: The Pursuit of Audience and the Manipulation of Consensus in the Debate over Lightning Rods." In *Eighteenth-Century Studies* 31, no. 3 (Spring 1998): 307-331.

Stafford, Barbara. *Artful Science: Enlightenment Entertainment and the Eclipse of Visual Education*. Cambridge: The MIT Press, 1992.

Wood, Allen W. *Kant.* Malden, MA: Blackwell Publishing, 2005.