



## Brooke on the Merton Thesis: A Direct Replication of John Hedley Brooke's Chapter on Scientific and Religious Reform

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Awareness of the need for replication studies is growing in multiple disciplines. Replication in history and the humanities, however, is close to nonexistent. This article presents the results of a direct replication of John Hedley Brooke's study into the role of Puritanism in increasing the legitimacy of (practical or applied) science. The study serves as a pilot for the possibility and feasibility of replication in history. We give an overview of both what replication studies are and Brooke's original study. We subsequently revisit Brooke's study. For this purpose, we reconstruct Brooke's research protocol, revisit his sources, and include some new sources. We note minor points of divergence with the interpretation of sources on the dominance of Puritans in applied sciences. We conclude that the pilot study shows the importance of replication for history and that replication in history raises new challenges for replication studies.

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## Introduction

This article presents a replication study of John Hedley Brooke's discussion on the contribution of Puritan religious values to the development of modern science.<sup>1</sup> The study replicates Brooke's original study using the same research protocol and some new sources in addition to Brooke's original sources.<sup>2</sup> The study is also a case study for the possibility and feasibility of replication in history and what replication studies can contribute to the discipline.

Brooke's study features in a broader discussion on the importance of English Puritan ideas for science. Brooke argues that there is little convincing evidence that Puritan ideas or sentiments led to greater receptivity for new scientific ideas. Here, we assess whether Brooke's conclusions are confirmed by replicating his study. Chapter three of Brooke's *Science and Religion: Some Historical Perspectives* can be divided in two main parts. The first addresses the question whether the Protestant Reformation in general provided a more fertile soil for the acceptance of new scientific ideas (heliocentrism in particular). The second is similar but investigates whether theological changes in more radical, ascetic Protestant groups (especially Puritanism) led to greater receptivity to (practical) science. The direct replication in this thematic section zooms in on the second part, as it more easily lends itself to replication.

This article is structured as follows. We first discuss the methodology used in the original and replication studies. We then discuss the background to Brooke's discussion. After that, we present Brooke's original discussion and conclusions. Subsequently, we revisit Brooke's sources as a case study in replication, using the same research protocol (as far as possible) and looking at new sources. We end with some concluding remarks.

## Methodology

Not all studies in history include robust details regarding how the study was performed. While Brooke did include a bibliographical essay in which he laid out which sources he used and why (Brooke [1991] 2014, 490–97), he did not include a clear explanation on his research protocol. Nonetheless, by looking carefully at how Brooke discusses his use of the sources and how he draws conclusions about them, a research protocol can be reconstructed. Earlier drafts of this reconstruction were shown to the original author and adapted to incorporate his comments.

The present replication study mainly relies on textual analysis of secondary sources and an in-depth analysis of the original study by Brooke. Most of these secondary sources analyze multiple original sources from England or New England Puritans or argue for recurring values or motivations in several Puritan writings. Some concern quantitative data on membership of scientific societies.

The methods used in the replication study are similar to those used in Brooke's original study. Yet, the original author mentioned in an advisory board

meeting that his original study leaned on a decade-long immersion in sources on the relation between religious and scientific reform. A similar immersion was, of course, not feasible in the relatively short time frame of this replication study. While full immersion was not possible, we did rely on overviews and monographs on the topic to some extent.<sup>3</sup> Apart from the obvious impossibility of copying someone's life-long immersion in certain historical sources, in line with the requirements of a direct replication, we stayed as close as possible to the research protocol used in the original study. This holds for the analyses of both the sources used in the original study and the new sources. The selection of new sources departed slightly from the original research protocol by including sources on Puritanism in New England, while the original study exclusively relies on sources on Great Britain. Given the close links between Great Britain and the North American colonies around the time (seventeenth century), this does not signal a stark departure from the original protocol. New sources are limited to the same historical period as in the original study.

The inclusion of new sources may give rise to the worry that we are pursuing an unfair evaluation of Brooke's original study. Brooke did not have access to sources published after his original study. Including them in an evaluation of his original claim might therefore lead to an unfair verdict on his original work. The use of new sources is, however, not intended to assess the reliability of Brooke's original study but rather to evaluate the validity of his conclusions. A replication study may conclude that the original study was of good (or even excellent) quality, yet add that new evidence or sources tilt the balance in favor of a rival hypothesis. Assessment of reliability (whether the original study is of good quality) and validity (whether the conclusions continue to hold water) can thus be distinguished, and including new sources is only relevant for the latter.

In order to stay close to the original research protocol, the replication study did not look into claims similar to but different from the Merton thesis. Since the publication of Brooke's study, a rich body of literature has emerged discussing the impact of various theological changes (associated with the Protestant and Catholic reformations) on the development of early modern science.<sup>4</sup> Ideas defended or criticized there were not on the radar of Brooke's original study. They were therefore left out of the replication study as well.

### **The Merton Thesis**

A considerable part of John Hedley Brooke's third chapter of *Science and Religion: Some Historical Perspectives* addresses what is known as the Merton thesis,<sup>5</sup> which owes its name to Robert Merton, its foremost defender.<sup>6</sup> In this section, we give a brief overview of the thesis and its central claims. The Merton thesis can be stated as follows: theological changes associated with the rise of Puritanism in England (and to a lesser extent the New England colonies) led to a greater interest in and greater receptivity for new scientific ideas.

This thesis bears some similarities to Max Weber's well-known thesis connecting Calvinist religious ideas to the emergence of capitalist entrepreneurship (Weber 2013). Along similar lines, Merton (1938) argues that changes in theology or religious practice were not (only) instrumental for economic changes but for scientific changes as well.

As Steven Shapin (1988) notes, the thesis does not state that religious changes had a direct causal influence on the development of new methods in science or on the genesis of scientific ideas. It merely states that the dynamics and social standing of science as an enterprise received an impetus from religious changes. The explananda are therefore phenomena noticeable in England from the sixteenth century onwards such as increased attention to science, growth of interest in science and technology, increased tempo of scientific activity, enhanced cultivation of science, elevation of science to a place of high regard in the social system of values, and the fact that science became positively sanctioned (Shapin 1988). All these can be put under the header of increased legitimacy or valuing of science.

Merton argues that the increased legitimacy and valuing of science in sixteenth and seventeenth century England was partly due to the influence of Puritanism, a religious reform movement within the Church of England predominantly active at that time.<sup>7</sup> Adherents sought to purify the Church of England of remnants of Roman Catholicism, such as perceived Catholic elements in liturgy and worship. Puritans became known for a spirit of moral and religious earnestness. Through church reforms, they sought to make their religious lifestyle the pattern for the whole nation. Much of Puritan theology drew from Calvinist ideas like the doctrine of double predestination. More than contemporary Calvinists, Puritans stressed the need for a personal relation with God to redeem one's sinful condition. They also emphasized the inner working of the Holy Spirit in individuals (Encyclopaedia Britannica 2024).

Merton argues that Puritan religiosity gave rise to a religious sentiment that in turn fostered the legitimacy of science. The sentiment consists of two elements. First, according to Merton, increased stress on individual responsibility for salvation without a strong mediating role of the church motivated individuals to take action in the world. Acting and bringing about change in the world were increasingly regarded as ways to glorify God. Nature was seen as sinful and corrupt and bringing about control of that sinful world was a true sign of God's salvific work through individuals. Merton notes a link to scientific practice around the time. In the writings of members of the Royal Society, one can note a widely shared idea that science is to be fostered and nurtured as leading to the domination of nature. The study of nature was also seen by members as enabling a fuller appreciation of God's works as manifested in creation. The second key element in Puritan sentiment was an increased striving towards social welfare. Puritanism demanded constant, systematic labor and

constant diligence in each individual's calling. That calling included a strong concern for the welfare of others. Science could serve as a means to achieve this calling by developing new technologies (Merton 1936).

Some note that the Puritan ethos was given an extra impetus by a strong belief in the imminent return of Christ. Many people saw cataclysmic events at the time, like the Thirty Years' War and natural disasters, as signs that the world they knew was soon coming to an end. This created a sense of urgency in living a pious Christian life and bringing about changes in society that could prepare the way for the second coming of Christ (Webster 2002).

Merton is clear that Puritan sentiments and values were not the only factors driving the acceptance of science. He also does not claim that a (historically) particular sentiment like that of the Puritans is necessary for receptivity towards science. In a correspondence with Pitirim Sorokin, Merton writes: "I do not argue that these traits [sentiments] are peculiar only to Protestantism ... they were found to a certain degree in medieval and later Catholicism" (Merton 2018, 295). According to Merton, medieval and later Roman Catholic movements like the Dominican, Franciscan, and Jesuit orders may display a similar religious sentiment that paved the way for receptivity towards science. These (Catholic) movements share with Puritanism an emphasis on personal religiosity and the application of faith to worldly, ethical issues.

### **Brooke's Study**

One of Brooke's goals in the aforementioned chapter is evaluating the Merton thesis. Brooke's assessment is part of a broader chapter on the alleged impetus of Protestantism to modern science, which in turn features in a broader book on the history of the relations between science and religion. Brooke's chapter and overall book have been characterized as putting forward the complexity thesis.<sup>8</sup> The general idea of this thesis is that the relationship between science and religion is just too complex to be framed in terms of conflict or support. A close look at the history of the relation reveals too many intricacies and complicating factors to allow for strong conclusions about conflict or harmony.

Brooke's broader project has been criticized and qualified on numerous points (e.g., Numbers 2010). One of these criticisms, also raised during one of the advisory board meetings, is that merely pointing to increased complexity (over and against "simpler" narratives in terms of conflict, harmony, or separation) does not have much added explanatory value. Instead of merely pointing to complexity, Brooke could have highlighted broader patterns or advanced more nuanced claims.<sup>9</sup> An assessment of Brooke's broader project lies beyond the scope of this article. Instead, we zoom in on Brooke's specific claims regarding the Merton thesis, as previously laid out. As we discuss, these do not merely point to increased complexity but also aim at undermining claims in favor of the Merton thesis.



Most of Brooke's claims argue against the conflict thesis, which states that religion and science were in constant conflict, with religion being forced to yield. However, some of Brooke's claims go against theses that religion fostered science. His discussion of the Merton thesis is a clear example. His conclusion is overall negative, stating that the Merton thesis is rather difficult to test and some evidence rules against its viability. Below, we summarize Brooke's discussion and findings. In the next section, we revisit Brooke's sources and argumentation and reevaluate them. We also discuss some new sources not used by Brooke that bear on the Merton thesis.

Brooke's claims can be regarded as a slight restatement of Merton's original thesis. Brooke focuses on motivations to engage in (practical) science rather than on values at work in science.<sup>10</sup> While this may be regarded as a point of departure from Merton, it does not signal a stark difference. Values are generally conceived as motivating subjects towards achieving some goal or change (e.g., Parks and Guay 2009). If the same values that encouraged scientific inquiry can be found among Puritans, then Puritans can be said to be particularly motivated to engage in science. In this vein, Brooke's focus on motivations is not that different from the original focus on values but makes the influence of values more tangible.

Brooke's interest does not lie in evaluating Merton's portrayal of the Puritan sentiment that allegedly fostered scientific legitimacy. Instead, his focus is on whether that sentiment led to greater acceptance of science. Brooke does add that science may have been valued by Puritans because it affords a useful diversion from sensuality—from bags, bottles, and mistresses, as Robert Boyle would put it (Brooke [1991] 2014, 148). Brooke ([1991] 2014, 149) does slightly rephrase Merton's original thesis to state that "Puritan values helped to create an audience receptive to programs for the improvement of man's estate." Brooke therefore stresses the increased legitimacy of practical or applied science rather than all of science—an element also at work in Merton's original defense.

Whether Brooke's alterations or different points of focus constitute a stark alteration of Merton's original thesis is less important for our purposes. Brooke's interpretation has been influential in the debate regarding the influence of Puritanism on the emergence of science. By replicating his original study, we are replicating his particular reading. We are not replicating Merton's original studies. Whether the replication has implications for Merton's original thesis depends on how large the differences are. An assessment thereof again lies outside the scope of this article.

### ***Brooke's Research Protocol***

Like the vast majority of studies in history, Brooke's chapter does not include a clear statement of his methodology or research protocol.<sup>11</sup> Nonetheless, a

research protocol can be reconstructed. This section summarizes Brooke's research protocol and how he applies it to his sources.

Brooke's methodology mainly consists of analyzing secondary sources. Brooke evaluates the Merton thesis in a way similar to his broader assessment of an alleged link between theological reforms and willingness to accept science. First, he looks at sources that allow for "counting heads", i.e., investigating whether a larger proportion of scientists or people interested in science were Puritan compared to mainline Anglican.<sup>12</sup> For this purpose, he mainly looks at memberships of the Royal Society. Second, Brooke looks at writings that shed light on the motivations of (Puritan) scientists to accept new ideas. Noting that a considerable number of scientists drew inspiration from Puritan ideals or sentiments could provide support to the Merton thesis. Noting motivations in non-Puritan, mainline Anglican values or ideas would provide evidence against the thesis.

Brooke notes problems with both approaches. Pointing to a larger number of Puritans accepting new ideas reveals nothing about their motivations for doing so. Puritans may have been more accepting of new ideas or more engaged with science for a host of reasons other than their religious sentiments. Looking at writings does shed more light on the motivations or values for engaging in science. In this way, the writings of Puritans serve as a proxy to understand their values and motivations. This approach, however, runs the risk of cherry-picking and leaves scientists who did not write on their motivations out of the picture. We discuss both methods in greater detail.

### **Counting Heads**

Brooke notes that Merton himself drew support from data akin to counting heads. Merton (1938) notes that of the foreign associates of the French Academy of Sciences, only eighteen had been Catholic, whereas eighty had been Protestant. Being Protestant is of course not identical to being Puritan or an ascetic Protestant. Given that the majority of Europe was Catholic around the time, the large number of Protestants is nonetheless noteworthy.

Brooke notes that a similar test can be done by identifying the religious allegiance of Europe's most prominent natural philosophers of the late sixteenth and seventeenth centuries and comparing the ratios of scholars accepting new ideas and scholars more reluctant (Brooke [1991] 2014, 151). Brooke notes that a similar comparison has been challenged by some who point to distinct Catholic motivations to accept new scientific ideas. For this purpose, Brooke refers to work by William Ashworth Jr., who argues that a number of Catholic scholars of the sixteenth and seventeenth centuries were motivated by religious sentiments as well. Therefore, counting heads does not readily support the Merton thesis. Some were motivated by the threat of occult or naturalistic

philosophies, others by providing support for divine design in nature, and still others by countering the threat of Cartesian philosophy. Members of the Society of Jesus were motivated to do scientific inquiry to recruit bright minds in the spread of Counter-Reformational ideas (Ashworth Jr. 1986). Brooke counters that other (non-Protestant) religious motivations are compatible with Merton's claim for distinctive ascetic Protestant motivations (Brooke [1991] 2014). To this we add that motivation from Catholic ascetism (e.g., from Dominican, Jesuit, or Franciscan orders) is compatible with Merton's original statement of his thesis (see the earlier section "The Merton Thesis").

Applying this method to Merton's thesis, Brooke notes that there was no strong Puritan presence among the early members of the Royal Society in England (founded in 1660).<sup>13</sup> Given that the Royal Society was the most notable institution for science around at the time, a large number of Puritans would signal a strong motivation for them to engage in science. From a sample of 162 eventual fellows of the Royal Society who had been old enough to be engaged in the English Civil Wars, thirty-eight fought for or supported parliament and were therefore likely Puritan. Of the sample, eighty-five were royalist and therefore likely not Puritan.<sup>14</sup> The high ratio of non-Puritans seems to rule against Merton's core idea. Brooke adds that as little as one in twenty of the sample can be properly described as scientists mostly engaged with applied science and of Puritan middle-class background. Quoting Lotte Mulligan (1973), Brooke ([1991] 2014, 154; emphasis added) writes: "The typical background of a science enthusiast in the 1660s was not middle class, mercantile, *Puritan*, politically radical, unacademic, or utilitarian. Rather, our typical Fellow was a royalist, *Anglican*, university-educated gentleman."

A problem for the counting heads test was that not all members of the early Royal Society were active members. Restricting the sample to active core members shows that of the ten most active members, five supported the Parliamentary, Puritan regime. Mulligan (1973) also notes that applied scientists, like physicians, instrument makers, naval experts, agricultural reformers, and general applied scientists are more often found among supporters of parliament (and therefore among people with potential Puritan leanings) in the sample.

Counting heads therefore provides, at best, ambiguous evidence. Brooke reads the ratios of members of the Royal Society as supportive of an alternative thesis, i.e., that moderate Anglicanism was equally (or even more) conducive to the acceptance of science. Brooke does not outright deny that Puritan sentiments may have led some to be more accepting towards science. He does note that an excessive religious zeal or enthusiasm among many Puritans may have been an impediment to accepting science. He also argues that other religious sentiments, like Latitudinarian tolerance, also may have paved the way for accepting science, writing: "[I]t may imply that the kind of Protestant spirituality, for which the



term *Puritan* is commonly used, was not the only catalyst for the expansion of science. Perhaps a certain *detachment from* Puritan enthusiasm, an insistence on moderation and toleration on religious issues, defined the mentality that most often coincided with an interest in science in seventeenth-century England” (Brooke [1991] 2014, 155; second emphasis added).

Brooke’s conclusions can be read in multiple ways. On the one hand, he does not deny Merton’s core claim that Puritan (or broader ascetic Christian) sentiments led to greater acceptance towards (applied) science. On the other hand, most of his argument and sources cited in the chapter are aimed at providing arguments against a specific contribution of Puritan sentiments.

### **Probing Puritan Motivations**

A second kind of source used by Brooke is information concerning the ideas and motivations of various Puritan thinkers, some of whom were scientists or science enthusiasts. By investigating whether they voiced ideas about science or related ideas like empiricism and how these were connected to their religious ideas, we can get a sense of how a Puritan sentiment might have fostered science. Brooke relies on secondary sources for this purpose. The number of sources in which Puritans discuss their motivations to engage in science turns out to be severely limited. However, given that some of the authors were highly influential within their communities, these sources do provide some evidence for sentiments or values shared more broadly.

Brooke acknowledges that some Protestant writers indeed saw experimental science as a way of mitigating the effects of original sin and making the world better in a way more befitting Christ’s Earthly rule. John Beale wrote in a letter: “Here you must add the discovery of, or dominion over all the works of God; the conversion of stones into metals and back again; of poisons into powerful medicines, of bushes, thorns and thickets into wine and oil, and of all the elements to take such guise as man by divine wisdom commands” (Brooke [1991] 2014, 149). It is not clear whether Brooke ranks Beale among the Puritans, particularly because such identifications from that era are often difficult. He does seem to regard Beal as a prime example of the millenarian sentiment that may have fostered the acceptance of science.

Another example in support of Puritan zeal for scientific acceptance is Thomas Culpeper’s remark that just like reformed theology rejected a pope in religion, a reformed science rejected a pope in philosophy (Brooke [1991] 2014, 150). Culpeper’s reference to a “pope in philosophy” probably referred to the post-Copernican upheaval of the hierarchy of the sciences. A strong current of objections against Copernicus’s heliocentrism was that his theory assigned primacy to mathematics over philosophy. Making claims about the position and movements of the Earth and sun was commonly regarded as the proper domain

of (natural) philosophy, which was of a higher status than most other sciences (all apart from theology). Copernicus instead drew conclusions about the Earth's place and movement on mathematical grounds. Most scholars in the sixteenth century regarded this as unacceptable. Culpeper suggests that reformation in theology (of which Puritanism was the successor and, in some sense, radicalizer) provided fertile ground for rejection of the traditional hierarchy of the sciences and, by implication, the acceptance of new scientific ideas.

Parliamentarian soldier Walter Blith writes in a letter that "the English nation might be made the paradise of the World, if we can but bring ingenuity into fashion" (Brooke [1991] 2014, 150). Blith expresses support for Merton's claim that Puritans sought to glorify God in creation by scientific innovation. An explosion of scientific publications between 1645–60 suggests that such ingenuity indeed took hold in England.

Brooke notes, however, that not all Puritan writings are in line with Merton's portrayal of the importance of the Puritan sentiment. To Puritan writers like William Perkins and William Pebble, it was not at all clear that the works of science were also good works. Scientific inquiry did not point toward the God who had entered into covenant with sinful humanity. Natural knowledge could not "set straight the wryed and distorted image of God in us," according to Pebble (Brooke [1991] 2014, 153). William Perkins (2014, 73) did stress the need to act in the world and "bring forth fruits worthy of life." It is, however, not at all clear that scientific endeavors were seen as included in such fruits. Perkins likely mainly referred to charitable works or spiritual fruits rather than empirical or scientific ones.

As a last example, Brooke notes the case of John Wilkins. Although Wilkins sided with the Puritan Parliamentarians during the English Civil Wars, he objected to much of their excessive enthusiasm (most notably, the beheading of King Charles I) and would not go along with more zealous reformers afterwards. He also stood up for universities when they were threatened by the Parliamentarian army chaplain John Webster. Brooke sees Wilkins as a clear example of the "Latitudinarian mentality,"<sup>15</sup> which involves shying away from obstructing religious controversies, a suspicion of (religious) dogma, and an advocacy of tolerance. Brooke suggests that the Latitudinarian mentality may have been as conducive towards the acceptance of new ideas than a Puritan sentiment ever was (Brooke [1991] 2014). Brooke thereby suggests that an enthusiastic zeal is typical of and perhaps defining for a Puritan religious sentiment. Such enthusiasm would often oppose science rather than foster it.

### **Replicating Brooke's Study**

As noted, Brooke draws support for his arguments against the Merton thesis from analysis of texts by scientists and by looking at membership of scientific

societies. In this section, we move on to replicating Brooke's study. The replication is done in two ways. First, we revisit Brooke's sources and assess Brooke's conclusions drawn from them. Second, we look at some new sources not used by Brooke that bear on the investigated thesis.

Brooke's claim that analysis of the religious affiliation of members of the Royal Society shortly after the English Civil Wars does not support the Merton thesis mainly draws on a study conducted by Lotte Mulligan.<sup>16</sup> Mulligan's study set out to test the Merton thesis by investigating the proportions of Puritan and non-Puritan members of the Royal Society. It also compares whether Puritan members were more drawn towards applied science than non-Puritan members. As a proxy for religious affiliation, Mulligan counts how many members (or how many members associated with applied science) sided with the Parliamentarians or with the royalists during the English Civil Wars. She notes that religious affiliation followed political leaning rather closely during the war.

Mulligan notes different views regarding the Merton thesis, one being Brooke's favored alternative account: that Latitudinarian Anglicanism provided an equally or more fertile soil for the new sciences than the more radical Puritanism.<sup>17</sup> Mulligan's own favored account is different, i.e., that acceptance of new scientific ideas in the Royal Society was the result of waning interest in religious disputes and waning influence of religious ideas (Mulligan 1973). She supports her view mostly by pointing to the low level of differences between Puritans and non-Puritans. Her conclusion, however, can be read as providing some support for the Merton thesis.

As Brooke notes, Mulligan observes that out of the 162 members old enough to have sided in the civil war, thirty-eight were Parliamentarian and eighty-five were royalists in 1642. Others were not active members or were foreign associates. These numbers indeed do not fit well with the Merton thesis. However, as Brooke briefly notes, distinguishing between theoretical and pure scientists on the one hand and more practically orientated scientists on the other (e.g., physicians, nautical scientists, etc.) shows a higher proportion of Parliamentarians in the latter group. Mulligan adds that the small number of applied scientists and relatively small differences between both groups do not allow for strong conclusions in support of the Merton thesis. She also notes that hardline Puritans who objected to the restoration of Charles II were less well represented in the Royal Society (Mulligan 2012).<sup>18</sup> According to Mulligan, the last point suggests that a high level of adherence to Puritan ideas and sentiments was detrimental rather than conducive to the acceptance of new scientific ideas. Mulligan therefore suggests that differences in religious sentiment between Puritans and non-Puritans do not predict the acceptance of science. Instead, she claims that a diminished interest in religious questions overall was the key factor (Mulligan 2012).

Mulligan's own assessment of the number of Puritans and non-Puritans in the Royal Society is thus rather different from Brooke's. Brooke focuses on a number of claims made by Mulligan that highlight the greater contribution of non-Puritan, Latitudinarian members. This is most evident in how Brooke quotes Mulligan's claim that the typical science enthusiast did not display a Puritan sentiment but was rather a royalist, university-trained member of the upper class (see previous sections; Brooke [1991] 2014, 154). Mulligan, however, insists that this is unsurprising, since non-Puritan royalists outnumbered Puritans by two to one in the Royal Society (Mulligan 2012, 108). The results of counting heads in the Royal Society are therefore not as indicative against the Merton thesis as Brooke claims. Mulligan herself instead claims the evidence is unconvincing for a very different reason, i.e., a too limited sample. Her conclusions also allow for a different reading where three groups are to be distinguished: Latitudinarians, moderate Puritans, and radical Puritans. Of the three, moderate Puritans appear to have held applied science in highest esteem.

We noted earlier how Brooke raises worries about drawing conclusions from counting heads. Other scholars not discussed in Brooke's study note other reasons to be reluctant to see links between religious affiliation and a sentiment towards accepting science. Theodore Hoppen (1976) notes that a number of members were engaged in hermetic and alchemical practices. The alchemist practice of experimentation and empirical observation would have motivated at least some to be interested in science. Since members probably had reasons not to display their alchemical urges to a broad public, little can be said about the contribution of these or similar philosophical outlooks to the acceptance of science. Distinguishing members among Puritan and non-Puritan lines might conceal other such religious or philosophical motivations (Hoppen 1976).

Replication thus far highlights a new problem. We noted how the sources cited by Brooke allow for multiple interpretations. Some are in support of the Merton thesis while others run against it. All readings appear to have some degree of warrant. Brooke appears to put considerably more evidential weight on looking for traces of the Puritan sentiment, that allegedly provided a fertile soil for science, in writings of science enthusiasts. In the remainder of this section, we revisit the figures discussed in Brooke's original research and add some new ones. Some new sources concern New England Puritans and other English Puritans. Brooke mentions four Puritan figures in his original study. Of these, we omitted Thomas Culpeper due to a lack of sources.

The first figure is John Beale. His letter to Samuel Hartlib appears to display a drive to take active dominion over God's creation and lift it to a higher, more perfected level. Brooke does not dwell on what Beale's words imply or how they might reveal a pro-science Puritan sentiment. As Mayling Stubbs (1982) notes, Beale can be characterized as a Latitudinarian and monarchist and enjoyed a

Presbyterian upbringing. He nonetheless displayed some affinities with Puritan thought. After the restoration of Charles II, Beale fiercely opposed “popery.” He also opposed the king’s and other nobles’ infatuation with wealth and luxury and made attempts to curb the influence of new Hobbesian, or atheist, ideas (Stubbs 1982). His stance towards science fits very well with Merton’s thesis. Beale was an ardent Baconian, making considerable efforts to proliferate ideas concerning the new scientific methods in the Royal Society. Beale explicitly saw scientific endeavors as accompaniments to the Protestant Reformation, writing: “Our Savior hath built a fayrer Temple than yt of Solomon ... Hee hath sent out the wise and learned, and his ship is landed in ye other world. And this is ye First, or most public attempt that hath beene of advancing the Light of nature into ye Light of grace, yt all usefull arts may be compleated in ye great prophesy” (Stubbs 1982, 327).

This quote clearly shows a sentiment to better the world and pave the way for God’s glory. Furthermore, Beale saw the Royal Society and its advancement of science as an agent for the public good. According to Beale, the society should foremost advance utilitarian, applied science, for example by promoting agricultural reforms. Beale’s efforts for reform stretched beyond science to advocating the need for economic reforms in response to poverty and unemployment (Stubbs 1982).

Beale seems to fit well into Merton’s view. He was a science enthusiast and saw a clear connection to the Christian ideas mentioned by Merton. The problem is that Beale was not unambiguously Puritan. His ideas bear some resemblance to Puritan ideas, but he diverges in his Latitudinarianism and support for the monarchy. One may wonder if Beale can be regarded as a moderate Puritan. Given that Puritans were not a uniform group and Puritanism’s initial focus was religious rather than political, a Puritan incorporation of Beale may be warranted.

The second figure in Brooke’s overview is Thomas Sprat. Sprat indeed drew a clear parallel between the Protestant Reformation and the scientific revolution in their rejection of old authorities. The text wherein Sprat made the remarks, *The History of the Royal Society*, saw to defend the Royal Society that feared for its continued existence. John Morgan (2009) claims that the text was always read as a “forceful, though inaccurate propagandistic tract on behalf of the allegedly ‘Baconian’ methods, achievements, and values of the Royal Society.” One way of defending the society was to show that it had public value. Sprat himself was an ardent royalist and insisted that the restored Church of England should not compromise towards political (Parliamentarian) or religious (Puritan) views (Morgan 2009). The context in which Sprat wrote on the links between religious reformation and scientific reformation renders it highly unlikely that Sprat’s remarks can be regarded as support for the Merton thesis. Sprat appears to have had little affinities with Puritan sentiments, and his claim was foremost made for propagandistic uses.



The third figure is Parliamentary soldier Walter Blyth. Little is known about Blyth's motivations or religious beliefs apart from his military allegiance to the Puritan Parliamentarians. David Noble sees Blyth's remark as exemplary of the millenarian spirit that gained momentum at the time. A considerable number of people saw the great turmoil and upheavals of the time (like the English Civil Wars) as evidence of the coming end of times. Ingenuity and constant labor would be required to be ready for the final days (Noble 1998). Noble notes that millenarism and associated zeal were not the exclusive domain of Puritans at the time.<sup>19</sup> This is, however, compatible with Merton's portrayal of his thesis.

Brooke suggests that these first three figures fit well with Merton's main claim. Our review casts some doubt on whether this is true for the first two. Brooke notes severe problems for Merton's thesis in other figures. He notes that prominent Puritan writers and preachers such as William Perkins and William Pemble claim that science can do little to set the distorted image of God in man right. Doing so is the sole prerogative of scripture. Perkins indeed accepts no equivalent of scripture in delivering truths about God. Scripture is also the sole means by which man can be informed of Christ's salvific works. However, some ideas in Perkins's writings chime better with Merton's thesis. Perkins stresses the need for continued repentance. He defines repentance as "a work of grace arising of a godly sorrow whereby a man turns from all his sins unto God and brings forth fruits worthy [of] amendment of life" (Perkins 2014, 73). Bearing fruits can therefore be seen as having some degree of evidence for being freed from sin by God. Merely professing faith is insufficient. Man also needs obeisance and to continuously search for the least of evidence of salvation (Perkins 2014). Echoing Max Weber, Merton sees the religious zeal stemming from the need to bear fruits as conducive for science. Although bearing fruits is often reduced to bearing moral fruits, there is reason to believe that it also includes material fruits. Brooke's emphasis on undoing sin or setting the image of God right by science is thus somewhat strange. Puritans and most Christian churches alike agree that doing so is impossible.<sup>20</sup> According to Merton, this is not really what would make Puritans accepting of science. The need to achieve practical success as a means of gaining evidence for salvation, however, might be.

In his discussion of the Merton thesis, John Morgan (1979) complains that defenders tend to cherry-pick Puritan examples with a pro-science attitude. Like Brooke, others skeptical of Merton's thesis point to prominent Puritan scholars who express ideas detrimental to science. As one example, Barbara Shapiro points to ideas voiced by Puritans William Dell and John Webster. Although their ideas seem to fit well with Merton's claim at first glance, a closer look reveals deep tensions. William Dell argues that neither learning nor reason have any role in achieving spiritual illumination. Therefore, universities should stop training ministers and philosophers and focus on applied, secular sciences

instead. The parts of mathematics, geography, and geometry that “carry no wickedness in them” (Shapiro 1971, 64) should be especially esteemed. John Webster advocates Baconian ideas and proposes educational reforms along those lines. Some doubts can be raised concerning Webster’s pro-scientific sentiments, however, because he also advocates the study of magic and astrology. William Dell’s claims are interesting because they triggered pamphlets in defense of universities’ role in educating ministers. Shapiro (1968) notes that there is no discernable difference between Puritan and non-Puritan pamphlets. She thereby suggest that Dell’s ideas were exceptional rather than indicative of a shared sentiment among Puritans at the time.

Another complaint against drawing attention to points of convergence in Puritan writings to a scientific, empirical outlook states that the similarities are merely shallow. Puritans may have been more inclined towards this-worldliness and betterment of the earthly situation. This could, however, delude the fact that Puritans imposed stark limits on the study of nature and saw betterment as a primarily spiritual, religious task. As a result, Puritan acceptance of science was severely limited and could work diametrically against receptivity towards science. Authors who voiced similar criticisms are Barbara Shapiro (1968) and Robert Middlekauff (1999). Maxine Van de Wetering notes how some remarks by Puritans can indeed be read in this way. Puritan Cotton Mather warns that notions of an “all-conquering science” could lead to a “theory of blind mechanism” without a role for an actively intervening God (Van de Wetering 1982). Middlekauff (1999) notes that Mather always insists on the central importance of the indwelling presence of God in order to “undermine the authority of scientific explanation of natural phenomena and to substitute the ancient sense of divine mystery.”

Van de Wetering, however, adds some nuance to this picture. Mather, like other New England Puritans of his time, saw some limits to scientific inquiry but tended to incorporate scientific ideas in his sermons and allow for a significant explanatory scope for science. This is especially noticeable in his sermons on earthquakes. Earthquakes have always been closely connected to direct supernatural activity in the history of Christianity. The idea that earthquakes are interventions from God (to punish for sin) traces back to Biblical sources.<sup>21</sup> Puritan ministers, like Mather, accepted this view but clearly stated that earthquakes can be explained by natural laws that can be studied by science. Preachers tended to add moral causes on top of the material causes studied by scientists. Van de Wetering notes no urge in Puritan sermons to uphold the old idea of earthquakes as deeply mysterious and unexplainable by material causes, although doing so would have been acceptable at the time. Puritan minister Thomas Doolittle discussed the natural laws that gave rise to earthquakes in his sermons as well. He added that God can make use of natural, material forces as secondary causes to punish humans for moral transgressions. Therefore,

earthquakes are open to empirical investigation and have a supernatural element in them at the same time. Similar ideas can be noted in other New England Puritan sermons delivered around the same time (Van de Wetering 1982).

Mather was a man of some influence and urged young candidates for the ministry as follows: “As thorough an Insight as you can get into the Principle of our Perpetual Dictator, the Incomparable Sr. Isaac Newton, is what I mightily commend to you—Be sure, the Experimental Philosophy is that, in which alone your Mind can be at all established” (Lord 2000, 125). Middlekauf (1999) argues that some of the threats of a purely mechanical view of nature were stilled in Mather’s mind because of Newton’s insistence on God as divine lawmaker. Michael Winship argues that Mather had some worries about the implications of the science of his time but did not dare object to it for fear of ostracism by the intellectual class. Winship also notes how the study of prodigies may have led Mather to an empirical outlook. Prodigies needed to be subjected to exact observation and discrimination and were therefore a scientific issue. To give his view on prodigies a certain sense of intellectual respectability, Mather would have been motivated to wed them to material secondary causes (Winship 1994).

As noted, Brooke sees John Wilkins as a prime example of how a Latitudinarian (more than Puritan) sentiment fits well with the acceptance of science. Shapiro (1968) also notes how Wilkins was unsympathetic to religious quibbling among theologians. Wilkins advocated a moderate policy towards Puritans after the Restoration and claimed that (religious) controversies hinder the progress of science. Wilkins changed religious allegiance as regimes changed. His own religious stance was so moderate that his loyalties were questioned by Puritans and Anglicans alike. He made considerable efforts to advance a natural theology that would eliminate the issues that divided Puritans and Anglicans.

Shapiro also provides other examples of pro-science Latitudinarians. Walter Raleigh displayed no strong feelings towards religious dogma and opposed condemning people for (religious) opinions. Raleigh also displayed a broad tolerance towards religious views, including deism. Robert Boyle voiced sympathetic views towards many religious views, including those of the Cambridge Platonists, who rejected the Calvinist doctrine of predestination. He was a member of a group of scientists that he described as “persons that endeavor to put narrow-mindedness out of countenance, by the practice of so extensive a charity that it reaches unto everything called man” (Shapiro 1968).

The new investigation of Puritan writers discussed by Brooke and other writers attests to Brooke’s overall conclusion. Some Puritans voiced ideas in line with scientific practice, while others did not. There is also ample evidence for pro-science sentiments among non-Puritans. The investigation therefore does not allow strong claims in support of an exclusive connection between a Puritan sentiment and a pro-science attitude. However, some sources can be

read as more in line with Merton's thesis than Brooke acknowledged. Puritans did stress that the emphasis should always be primarily on spiritual fruits and salvation from sin through God's work rather than by engaging in science. Some of the discussion here, however, strongly suggests that Puritans saw this as compatible with scientific practice and therefore did not see their theological conceptions as impeding scientific practice. This point is underappreciated by Brooke (and Shapiro).

Replicating Brooke's discussion on traces of Puritan motivations in writings of science enthusiasts also highlights how interpretations can diverge. Some of the sources can be read as supporting the Merton thesis, and others may count as evidence against it to some extent. How sources are interpreted seems to depend partly on background information and partly on how the sources are used in the overall argument.

## Conclusion

We have presented the results of a direct replication of Brooke's discussion of the Merton thesis. Our conclusions depart somewhat from Brooke's original conclusions and therefore cast some minor doubt on the validity (but not the quality) of Brooke's study. We note that Brooke's version of the Merton thesis deviates slightly from Merton's original thesis. This may raise some worries about Brooke's original study, but we argue that these are fairly minor. In some interpretations of sources used by Brooke, we found reason to draw different conclusions. While this may cast some doubt on the reliability of Brooke's original study, it did not raise significant worries. Only in the study of the ratios of membership in the Royal Society did our interpretation of the sources used differ considerably from Brooke's. Differences in interpretation may also stem from focusing on different theses. While Brooke seems to mainly assess the claim that Puritans were more engaged in science simpliciter, conclusions differ with regard to whether Puritans were more engaged in applied science.

The differences in the general conclusion also follow from the analysis of new sources. Analysis of these mitigates Brooke's (and others') claims that Puritanism provided theological stumbling blocks for the acceptance of or engagement in (applied) science.

The present direct replication study highlights the need for replication in the humanities more generally. Replication can point to different possible ways of interpreting secondary sources. Incorporating new sources while employing a similar research protocol can also lead to different conclusions. The case study also lays bare some difficulties in replicating historical studies. Much of the key information required for any replication, like hypothesis, methods, and research protocol used, are not clearly stated and sometimes tacit in historiographical studies. Replication therefore requires a detailed attempt to reconstruct the steps

performed in the original study. A second issue concerns the interpretation of sources. Unlike data in other disciplines, historical sources are often not univocal (though certainly not always) and allow for multiple interpretations. While Puritan writings may be interpreted as supporting the Merton thesis, a different reading can provide support against it. Careful deliberation on what interpretations are warranted is therefore needed in replicating historiographical studies.

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## Notes

- <sup>1</sup> Brooke's discussion is found in the third chapter of *Science and Religion: Some Historical Perspectives* (Brooke [1991] 2014: 110–58).
- <sup>2</sup> The current replication study was preregistered here: <https://osf.io/xndwt>. A related but conceptual replication (see the third article in this thematic section) was conducted in tandem by Rachel Pear, Gijsbert van den Brink, and Rik Peels, see: <https://osf.io/j8n59> and the conceptual replication article in this thematic section.
- <sup>3</sup> Such as, e.g., Charles Webster (2002).
- <sup>4</sup> See, for example, Peter Harrison 2007.
- <sup>5</sup> Brooke's discussion is found in the section "Protestantism and Practical Science" in chapter three (Brooke [1991] 2014, 147–57).
- <sup>6</sup> Merton put his thesis forward in a number of publications. In this section, we focus on his later defense (Merton 1938) and a summary provided by Stevin Shapin (1988).
- <sup>7</sup> While the movement was most dominant during that time, it has exerted an enduring influence on English and American religious life.
- <sup>8</sup> It should be noted that Brooke was by no means the first scholar to argue that the relationship between science and religion was much more complex than often assumed (see, for example, Hooykaas 1987). See also the article on conceptual replication in this thematic section.
- <sup>9</sup> The last criticism is also put forward by Ronald L. Numbers (2010).
- <sup>10</sup> This point was suggested by an anonymous reviewer. The reviewer argues that the changed research question severely compromises Brooke's study and renders his arguments (largely) immaterial for the status of Merton's original thesis. We disagree, since values only have effects (on scientific activity) if they motivate actions.
- <sup>11</sup> As mentioned, however, Brooke did add a bibliographical essay to the book where he lays out the sources he used (Brooke [1991] 2014: 475–42).
- <sup>12</sup> Use of the phrase "mainline Anglican" is a bit anachronistic. The distinction between Puritans and Anglicans may be confusing, as people did not strongly identify as being part of a different group or denomination at the time. Nonetheless, both groups can be distinguished by the actions and points of view of their members.
- <sup>13</sup> An obvious response could be that Puritans (especially hardline Puritans) frowned upon joining a royal society because it was supported by an institution they had spent years combating. Nonetheless, the presence of a considerable number of Puritans indicates the worth of checking the membership ratios.
- <sup>14</sup> The remainder of the 165 were foreigners not in England during the English Civil Wars or individuals without sufficient documentation regarding their religious affiliation.

- <sup>15</sup> The positive link between religious Latitudinarianism and science, rather than Puritanism and science, was first discussed by Barbara Shapiro (1968).
- <sup>16</sup> Mulligan also presents an analysis of other, smaller scientific societies. She notes that these do not allow support for or against the Merton thesis because the proportion of religious affiliations was skewed due to the political context.
- <sup>17</sup> Mulligan associates this view with Barbara Shapiro (1968).
- <sup>18</sup> The reluctance of hardline Puritans to join a royally decreed institution after the Restoration may also have more obvious political explanations rather than them having ideas detrimental to science. However, barring themselves off from institutions like the Royal Society because of religious objections may also have formed a barrier against accepting science.
- <sup>19</sup> A well-known example is the Anabaptist Munster rebellion of 1534–35.
- <sup>20</sup> The motive of setting the image right was at work in some thinkers, like Robert Boyle (see Harrison 2007). It, however, remains the prerogative of God for most Christian churches.
- <sup>21</sup> See, for example, 1 Samuel 14:15.

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