TRANSLATION, EXPERIMENTATION AND THE SPRING OF THE AIR: RICHARD WALLER’S ESSAYS OF NATURAL EXPERIMENTS

by

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In 1668, when the Royal Society of London received a copy of the book of experiments compiled by the Tuscan Accademia del Cimento, it was deemed by the Society to contain little that was new or innovative, and was seemingly soon forgotten. Yet 15 years later, Richard Waller’s English translation of this book was licensed and published by the Society. The only reason offered by historians for this turnaround in the English attitude towards the book has been the social and political circumstances facing the Society in the early 1680s. However, a closer look at the reception of the translation and the intellectual interests of some of the Society’s members at this time, especially the Society’s temporary curator, Denis Papin, reveals that the Tuscans’ work was re-evaluated for its significance to natural philosophical theories developed in the field of pneumatics.

Keywords: Accademia del Cimento; Essayes of Natural Experiments; Robert Boyle; Denis Papin; experiments; pneumatics

INTRODUCTION

In March 1668 the Royal Society of London received a copy of Saggi di naturali esperienze (Florence, 1667), the book of experiments published by the Accademia del Cimento under the patronage of Prince Leopoldo de’ Medici. An official record of the Cimento’s experiments had been much anticipated by some members of the Society.¹ Yet they did not scrutinize the text thoroughly until 1683, when Richard Waller FRS made an English translation, published by the Royal Society: Essayes of Natural Experiments Made in the Academie del Cimento, Under the Protection of the Most Serene Prince Leopold of Tuscany (London, 1684).

There are some well-documented reasons why the Society did not take an immediate interest in the Saggi in 1668. The book was not sold or widely distributed in London, and few of the Society’s Fellows could read Italian, further limiting the book’s potential audience.² However, the main reason for the book’s poor reception in London was its apparent redundancy from the point of view of the Society. There was a long delay in the

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Saggi’s arrival in England, resulting from the time taken by the Cimento’s secretary, Lorenzo Magalotti, to complete the text. By the time the Society received its copy, most of the experiments described in its pages had already been performed in England.

Consequently, the Society granted the book little attention. It was handed to Christopher Merret and William Balle to ‘peruse the book, and to give the society an account of the contents of it, and the manner of treating the several subjects in it.’ At some point that duty was seemingly transferred to Walter Pope and Robert Hooke, who reported that ‘many subjects and experiments treated of in it had also been considered and tried in England, and even improved beyond the contents of that book.’ Henry Oldenburg, presumably on the basis of this report, also wrote to Boyle ‘that there is nothing new in it.’

The failure of the Saggi to excite readers in England is well known. But this reception in 1668 raises a question that has rarely been asked: why was the Saggi then translated into English 15 years later? By 1683–84 the Cimento no longer existed, and relations between Tuscan and English natural philosophers were limited. What, then, had changed in that period to shift the English attitude towards the Tuscan book of experiments? Perhaps surprisingly, there has been only one attempt to answer these questions. W. E. K. Middleton reveals that on the basis of a conversation about this topic with Stillman Drake, he came to the following conclusion:

I think there is a simple and yet adequate reason for the appearance of the Waller translation in 1684. While it was of no use to the professionals, there was enormous interest in the new natural philosophy among educated laymen, and nowhere more so than in England. This ‘popular’ audience was more greedy than critical, and cheerfully purchased such trivia as the translated reports of the fantastic academy organized in Paris by Théophraste Renaudot. The interest of the Royal Society in the translation can be referred to the Society’s urgent need to keep its name before the public in the seventeenth century, especially after the long interruption of the Philosophical Transactions that followed the death of Henry Oldenburg.

In the early 1680s, the Royal Society’s future was uncertain: it was struggling financially, losing members, and failing to gain the interest and approval of the Crown. After Oldenburg’s death in 1677, and consequently the suspension of publication of Philosophical Transactions, the Society also lost its greatest link to its foreign correspondents and the broader public. During this period the Society’s Council took other measures to maintain its public profile, including the translation and publication of foreign books, among them the Saggi.

In addition, in her analysis of relations between Italian and British scientists in the seventeenth century, Marie Boas Hall argues that the decision to translate the Saggi might have been made as a sign of ‘respect for Italian achievement’, as Italian and English natural philosophers in the 1680s attempted to establish cordial and mutually beneficial relations.

The political, social and financial circumstances in the 1680s would therefore seemingly explain why the Society would seek to revive and translate the Saggi. The Society’s Fellows were attempting to revive their fortunes in England and maintain relations with their Italian counterparts. However, this argument, although plausible, contains some shortcomings. First, Middleton does not mention what specific sections, themes or experiments contained in the Saggi could have interested potential readers in the early 1680s. Second, publication of Philosophical Transactions was revived several months before Waller
published his translation. Was it then necessary to release an allegedly trivial and redundant book of Italian experiments if the Society was already re-engaging with a wide audience through more reliable and consistent means? Finally, there is no evidence to suggest that the translation was delivered or even advertised to Italian natural philosophers, casting some doubt on Hall’s suggestion.

In addition, not all natural philosophical texts were popular sellers in the English market in the 1670s and 1680s. Books with elaborate diagrams, such as Waller’s *Essayes*, were expensive to print. Furthermore, despite the narrative of experiments in the *Saggi*, its multiple tables and calculations regarding the properties of air place it firmly in the field of ‘physico-mathematics’, the expression used by seventeenth-century natural philosophers to refer to the application of the ‘mixed-mathematical’ sciences, such as hydrostatics and geometrical astronomy, towards gaining an understanding of the structure and properties of nature, as well as the causes of natural motion. According to Adrian Johns, such mathematical treatises were difficult to sell and were often published only through pre-existing contractual agreements between the Royal Society and its official printers and booksellers. So it is not likely that Waller’s translation could have had a wide appeal, and there is no evidence to suggest that the Royal Society thought it would. The Society did often try to reach a broad audience in England and overseas, but attempted to do so through works that were both profitable to printers and expected to acquire the interests of educated gentlemen. Such works included journals, encyclopaedias, maps and pamphlets, rather than long and little-known mathematical and natural philosophical works such as the *Essayes*.

We therefore need to look beyond the social, political and financial circumstances of the Royal Society in the early 1680s to supplement Middleton’s argument and provide a more convincing and comprehensive assessment of why the Society sought to publish Waller’s translation. More precisely, I ask whether there were any intellectual interests behind the publication of the *Essayes*. Do the Fellows’ natural philosophical concerns between 1668 and 1683 reveal anything about their interests in the Cimento’s work? Additionally, does the reception of the translation in England in 1684 hint at the topics that the Royal Society found relevant to its own intellectual pursuits? I intend to show that some of the Society’s Fellows, especially Robert Boyle (1627–91) and his assistant and curator of the Royal Society, Denis Papin (1647–1712), were seeking in the *Saggi*’s pages some support for their mechanistic natural philosophical assertions in the field of pneumatics. This was also a topic of concern for Robert Hooke (1635–1703), Richard Waller’s friend and collaborator. A mechanical natural philosophy required that the universe operate like a machine with mechanical parts and movements. Such a universe would consist of quantifiable effects of corpuscles, nature’s smallest particles, moving through space. Pneumatics, as a mixed mathematical discipline concerned with the mechanical effects of air and gases, was an ideal area in which mechanists in the seventeenth century could hypothesize about the mathematical and mechanical descriptions of natural motion.

This was also an area in which the Cimento specialized. Most of the *Saggi*’s pages were dedicated to the academicians’ experiments with the Torricellian barometer. In these experiments, the Tuscan academicians relied heavily on mechanistic and corpuscularian principles in which air, consisting of particles in motion, possessed weight and exerted pressure on all matter resting on the Earth’s surface. This led the Cimento to test the visible and measurable effects of air.

These experiments appealed to Hooke, Boyle and Papin in the early 1680s as they attempted to detect and measure the properties of air. Papin instigated most of this
research in support of Boyle’s earlier work on pneumatics and in relation to the work of his other mentor, Christiaan Huygens (1629–95). So rather than it being a trivial curiosity for a popular audience, the Saggi was reconsidered by some Fellows in 1684 for its natural philosophical value, especially for investigations into the properties of air. For this reason, to understand the status of pneumatic experiments in this period and the relevance of the Cimento’s work to this discipline, I shall begin by considering some of the details of Huygens’s, Boyle’s and Papin’s work on pneumatics in the 1660s and especially the early 1670s. Subsequently, a look at Hooke’s role and interests in pneumatics experiments at the beginning of the 1680s will add to the social and intellectual context of the translation. All this will help explain the relevance of, and the motivation for, the publication of the Essayes. It will also provide the context for the book’s reception, particularly the scrutiny it was given by Papin, who reviewed the book for the Society. In other words, we shall see that after several years of work on the properties of air, and in the light of developments within the Society in the early 1680s, Papin and his colleagues valued the Italian experiments highly for their natural philosophical significance. This describes the reason for the translation and its reception.

DENIS PAPIN AND THE PROPERTIES OF AIR, 1660–82

During a trip to England in 1661, Christiaan Huygens observed a demonstration of Robert Boyle’s and Robert Hooke’s air-pump. Huygens then replicated and modified this instrument in Holland in 1662, and then again for the Montmor Academy in Paris in 1663, and finally for the Académie Royale in 1668. Among the many English experiments that Huygens repeated was the observation of the barometer inside the receiver of the air-pump. This was an experiment described by Boyle in his New Experiments Physico-Mechanical, Touching the Spring of the Air (London, 1660). In this experiment, the liquid in the barometer maintained its height until air was extracted from the receiver, at which time the liquid descended. The curiosity of such an observation was based on the hypothesis that air atoms possess weight and thus exert pressure on the atoms and objects below them. This means that the barometer, when placed inside a sealed container, theoretically no longer has the full weight of the atmospheric air pressing upon it. Nevertheless, Boyle showed that when the barometer was placed inside the air-pump before the extraction of air, the mercury inside the barometer remained at its usual height. Boyle argued that this was due to the elastic qualities of air. In other words, even when the air in the receiver is cut off from the weight of the atmospheric air above it, its elasticity continues to exert pressure on the mercury used for the barometer. Only when air, with its elasticity and weight, is evacuated from the receiver does the liquid in the barometer descend.

Huygens had a different approach, which he had developed since his first replication of the air-pump in 1662, in which the liquid in the barometer maintained its height even after air was extracted from the air-pump’s receiver. Huygens argued that when the receiver is vacated, ‘a substance more subtle than air’ somehow infiltrates the apparent empty space and exerts pressure on the liquid used for the barometer. According to Huygens, this substance possessing greater elasticity than common air could be detected only when using liquid that had previously been left for an extended period in the air-pump and was thus purged of air bubbles. With such a claim, Huygens attempted to
prove the superiority of his air-pump over Boyle’s, but he did not deny Boyle’s theory of the elasticity of air. Instead, Huygens simply claimed that the Boylean notion of the spring of air could not explain everything that occurred when one places a barometer inside the air-pump receiver. In other words, Huygens argued that the elasticity of common air was not as important or potent as the pressure of ‘subtle matter’.19

This debate subsided during the middle of the decade, but was revived with Huygens’s demonstration of the air-pump to the Académie Royale in 1668, the same year in which Boyle completed Continuation of New Experiments (London, 1669), his first sequel to his 1660 book on the spring of air. In 1670, Boyle also published two papers on pneumatics experiments in Philosophical Transactions,20 which was followed by Huygens’s only published description of his air-pump experiments, including his theory of ‘subtle matter’, in the Journal des Scavans.21 Huygens’s work was subsequently translated into English in Philosophical Transactions,22 eliciting criticism from some Fellows. Boyle’s supporters criticized Huygens’s abilities as an instrument maker. In an article in Philosophical Transactions, John Wallis commented that the Englishmen could not replicate Huygens’s experimental results, creating considerable doubt about the efficacy of Huygens’s air-pump. Furthermore, Wallis argued, Huygens’s account of the effect of ‘subtle matter’ and its supposed entrance into the receiver seemed inconsistent and implausible.23

We must be clear, therefore, that these experiments were intended to engage in a mechanical and corpuscularian view of the properties and effects of air.24 Similar natural philosophical principles were used by the Cimento’s academicians to explain their observations with the Torricellian tube between 1657 and 1662. First, the academicians tested the barometer inside a sealed vase, protecting the barometer from the weight of the external air. The height of the mercury remained the same, leading the academicians to discuss the elasticity and compressibility of air.25 Second, they placed a barometer inside the apparent vacuum of another barometer. This experiment was first performed in France by Roberval and was believed to confirm the role of the weight of air in the movement of the liquid inside the tube.26

Within this intellectual context, in 1673 Denis Papin acquired a job as Huygens’s assistant.27 Under Huygens’s supervision, Papin published a book, Nouvelles Expériences du Vuide (Paris, 1674), based on the experiments he had heard about during his apprenticeship. This included Huygens’s design of the air-pump as well as many of his experiments with the instrument that he had performed since 1668, including testing the reaction of animals and plants inside the pump and observing the barometer in the apparently vacuous receiver. Indeed, a section of Papin’s book closely follows a lecture that Huygens delivered to the Académie Royale in 1668.28 Dismissive of the debates in which Huygens had been involved, Papin preferred instead to improve the instrument and to narrate observations of natural phenomena occurring inside the rarefied space of the air-pump.

Also in 1674, Boyle, unaware of Papin’s book, published a collection of short papers that included works about the ‘hidden qualities of the air’, ‘Mr Hobbes’ Problemata de Vacuo’ and ‘New Experiments about the Preservation of Bodies in Vacuo Boyliano’.29 These tracts, with the exception of the last paper, feature very few references to experiments with the air-pump but were nevertheless concerned with the corpuscular quality and ‘springyness’ of air.30

Huygens received Boyle’s collection of papers in June 1675,31 and in the following month Papin travelled to England with his own air-pump to engage directly with Boyle.32 Papin carried with him a letter of introduction from Huygens to Oldenburg, in which Huygens noted Papin’s book and his wish ‘to see what is being done in your country, even with the plan of
establishing himself there if he can find the opportunity.’ Huygens also appealed to Oldenburg to ease Papin’s entry into the English scientific community and to introduce him to Boyle: ‘I beg you kindly to grant him your favour and protection, and that by your means he may be known by your illustrious friends, above all by Mr. Boyle and Lord Brouncker.’

Oldenburg found some temporary employment for Papin as a tutor, and in the meantime the Frenchman liaised with Boyle. However, during Papin’s first few months in England he spent much of his time improving his English rather than engaging in experiments or natural philosophical discussion. Indeed, as is revealed in his correspondence to Huygens, Papin’s thoughts at this early stage of his career in England were to find his feet. This was also during a particularly difficult financial period in the Society’s history, restricting the frequency and activities of its meetings. This lack of activity at Gresham College, from which Boyle kept his distance during this period, might have also impacted on Papin’s early opportunity to interest Boyle in pneumatic experiments.

Nevertheless, by the autumn of 1675, when Papin was well and truly settled into English life, he began to use his previous work with the air-pump to gain Boyle’s attention. In fact, at the end of 1675 and beginning of 1676, Papin and Huygens published a series of papers in Philosophical Transactions. These papers narrate some of the experiments contained in Papin’s Expériences and were aimed at engaging directly with the Royal Society, and especially Boyle, on pneumatics. Indeed, in February 1676, as the last of these papers went to print, Oldenburg read an account of Huygens’s and Papin’s experiments to a meeting of the Royal Society, where some of the experiments were replicated. Additionally, Papin and Huygens stated their intention on one occasion, to ‘compare Mr. Boyles New Experiments about the Preservation of Bodies in Vacuo Boyliano.’ At another point, in relation to their experiments on animals inside the vacuum, they invited readers to: ‘Compare Numb. 62 and 63 of these Tracts, where many Experiments of this kind, made by Mr. Boyle, are recorded.’

These statements refer to Boyle’s publications about the properties and movement of air, including New Experiments Physico-Mechanical in 1660, A Continuation of New Experiments in 1669, two papers on respiration in Philosophical Transactions in 1670, and the 1674 collection of short papers. If the intention was to draw Boyle’s attention to the subject of pneumatics once again, then Papin and Huygens succeeded: Boyle soon offered Papin a position as his assistant. Later, Boyle would recall meeting Papin ‘seven or eight years’ after the 1669 publication of Continuation of New Experiments, just as he was performing once again some experiments with the air-pump:

At which time it happened very opportunely, That a certain Tract written in French, small in bulk, but very ingenious, containing sundry Experiments concerning the Preservation of Fruits, and some other Tracts of a different nature, was brought unto me by Monsieur Papin, who had joined his Pains with the eminent Monsieur Christian Hugenius, in making the said Experiments.

Together, Papin and Boyle conducted further experiments with the air-pump between 1675 and 1680 and published Experimentorum novorum physico-mechanicorum continuatio secunda (London, 1680), a second sequel to Boyle’s original treatise on the spring of the air. This was translated into English two years later. In the preface to this book Boyle tells his readers about his acquaintanceship with Papin, cited above, and the Frenchman’s invaluable assistance to his work. Indeed, while Boyle was for a time forced to rest because of illness, Papin was entrusted by Boyle to perform and write about most of the
experiments described in the book, ‘as if they had been made and observed by his own Skill; and moreover, the Calculation of the Degrees of the Rarefaction and Condensation of the Air, included in our Mercurial Gage, was intrusted to his Care.’ For this reason, some of the book was ‘first set down, for haste, by Monsieur Papin in his own native Tongue, the French, and afterwards turned into Latine.’

Boyle confessed in the preface that although the book takes the form of a diary with very bare narrations of experiments, his interests were in testing the effects of compressed air. He was also guided by Papin’s own insistence on performing experiments on the preservation of bodies in the rarefied space of the air-pump. So the book contains, once again, observations of various foods, plants and animals in the apparent vacuum. In particular, Papin used his own double-barrelled air-pump, described in the opening pages of the book, to observe how bread and fruits could be preserved for longer periods when air has been extracted from them. However, the central feature of Papin’s and Boyle’s work presented in this text is their attempts to measure the compression of air. In describing the gauge used for this purpose, featuring in many of the experiments narrated in the book, Papin referred to one diagram that best illustrates his and Boyle’s intention to provide a mathematical demonstration of the air’s elasticity (figure 1): ‘the space possessed by the Air, is diminished in the same proportion, as the compressing force is increased, and vice versa.’

This argument of proportionality was the basis also for Edmé Marriotte’s work on the same topic published in 1678 and 1679. It would seem that Boyle and Papin were measuring the reciprocal relationship between the volume and pressure of air at the same time as Marriotte in the Académie Royale in Paris. The argument is thus known as the Boyle–Marriotte law, and it adds further relevance to pneumatics experiments in the late 1670s and early 1680s, just before the publication of Waller’s Essays.

So Boyle and Papin’s publication, particularly its English translation in 1682, printed in the same year as the release of the third edition of Boyle’s classic first book of pneumatic experiments, brings us closer to Waller’s translation of the Saggi. During the period between 1668 and 1683 in which Huygens, Boyle, Papin and others worked on the air-pump experiments and the properties of air, the Cimento’s book of experiments sat untouched in the Royal Society’s library. Yet its contents, although quickly dismissed in 1668 by its English reviewers, were relevant to the subsequent developments in the field of pneumatics. As has been mentioned, the Cimento’s interests in the atomistic and mechanical properties and effects of air, particularly the elasticity and compressibility of air, resonated with Boyle’s work on the same topic. This provides some essential intellectual context to the revival of the Saggi in England in the early 1680s, and an
understanding of the reasons behind the translation and its reception. As we shall now see, also providing crucial background to this case were the continued interests in pneumatics pursued by Robert Hooke, who extended his influence over Papin and Richard Waller, thus facilitating the publication of the book.

THE CONTEXT OF WALLER’S TRANSLATION

In the late 1670s Robert Hooke, who had worked with Boyle on the construction of the first air-pump in England, also renewed his interests in pneumatics by replicating some of Boyle’s air-pump experiments. Interestingly, in 1679 Hooke worked closely with Papin on this topic. In May that year Hooke gained permission for Papin, not yet a Fellow, to perform an experiment at a meeting of the Society, with his newly invented food digester. During the following months, Papin and Hooke spent a great deal of time together testing the Boyle–Marriotte law.50 A relationship therefore emerged between Papin and Hooke on the basis of their shared interests in pneumatics.

Papin’s work with Boyle and Hooke earned him his Fellowship of the Royal Society, and in 1681 he departed from England to assist in the formation of a scientific academy in Venice.51 In the meantime, possibly inspired by the Latin and English editions of Boyle’s and Papin’s recently published work, in February 1683 Hooke performed more barometric experiments for the Society, which he was then asked to put in writing.52 In May the following year he read a paper to the Society in which he discussed the ‘vacuo Boyliano’ and, in reference to Huygens’s work, the likely existence of a ‘subtle fluid’ penetrating the air-pump’s receiver.53

Meanwhile, at the end of 1683 Robert Plot took over from Hooke as secretary to the Society and demonstrated an interest in barometric experiments. He and Martin Lister conducted several observations of the barometer in 1683 and 1684 in diverse weather conditions. Their intention, as Plot admitted, was to use the barometer to accumulate meteorological information that could contribute to an understanding of weather patterns.54 John Locke had been conducting similar observations between 1666 and 1683, sometimes in consultation with Boyle.

Barometric and air-pump experiments were therefore a significant part of the Society’s activities at the beginning of the 1680s, occupying the time of some of the Society’s most prominent and active members, adding further relevance to the barometric observations contained in the Saggi. Indeed, in November 1683, in the midst of this activity concerning pneumatics, the Society’s president, Sir John Hoskyns, recommended the publication of Richard Waller’s translation of the Tuscan book of experiments.55 There is no known record of Waller’s discussing the Saggi or engaging in its translation before this date.56 Nevertheless, given the prevalence of pneumatic experiments and their philosophical significance, we must assume that the relevance of the Cimento’s experiments was not lost on some of the Fellows who had been involved in such work and who were acquainted with Waller.

Richard Waller was a well-educated classicist who during the 1670s gained a reputation as a translator of classical and foreign works. He eased himself into the Royal Society through the company of some prominent Fellows. In particular, Waller and Hooke seem to have become acquainted in 1678, not long before Papin and Hooke collaborated on their air-pump experiments for the Society. This acquaintanceship resulted in Papin’s
election as a Fellow in 1681, at about the same time as Papin. There was thus a network centred on Hooke in the early 1680s, consisting of Waller (the Saggi’s translator) and Papin, the expert in pneumatics and future reviewer of the translated text. Apart from Hooke’s assessment of the Saggi for the Society in 1668, neither of these figures seemingly left any record of having discussed the Cimento’s book before 1683. However, the connection between them, as well as Hooke’s previous experience with the Saggi, and the prevalence of pneumatics in the Society’s activities, which matched the published interests of the Cimento, reveal a probable motivation behind the translation of the book.

In fact, in May 1684, when Papin returned to London to take up the position, temporarily, of curator of experiments for the Royal Society, he immediately returned to his pneumatics experiments. He performed several experiments on the reactions of various animals, fruits and liquids in the vacuum, reminiscent of his earlier experiments with Huygens and Boyle. On 5 November 1684 Papin also repeated Huygens’s trial of the barometer inside the air-pump’s receiver, using liquid supposedly purged of air. Papin informed the Society that he had performed this experiment in Venice with varying results, ‘the cause of which’, he admitted, ‘is not yet known enough.’ This is revealing of Papin’s continued interest in the effects of the spring of ‘common air’ and Huygens’s ‘subtle matter’.

Additionally, in January 1683, Philosophical Transactions was resumed under the editorship of Plot. The preface to the new edition of the journal explains the editor’s desire to publish ‘a great variety of useful matter’. Plot would have clearly been thinking of his own meteorological interests and experiments with the barometer, and we may assume that his thoughts would not have been far from the innovative air-pump experiments undertaken by Hooke, Boyle and Papin. We cannot know whether this might have had a bearing on the decision soon afterwards to translate the Saggi, but we may speculate that the Cimento’s book, with its large number of barometric experiments, might have been seen to provide possible material for publication in the revived journal, alongside the Society’s recent work on pneumatics.

One year after Hoskyns recommended sending the translation to print, on 5 November 1684, the same day on which Papin repeated some air-pump experiments, the book was formally presented to the Society. Details of this published translation hint at the Society’s perceived importance of the experimental philosophy reportedly followed by the Cimento. For example, the frontispiece depicts allegories of the Cimento and the Royal Society in the company of Mother Nature who, uncovered, signals her approval of the Cimento’s book to Aristotle (figure 2). Waller’s dedication to Hoskyns also alludes to the way in which the Essays contributes to the Society’s aim ‘of promoting real Knowledge’, referring to experimentally produced knowledge, rather than speculative metaphysics. More importantly for our attempt to find the reason for this translation, Waller mentioned the experiments narrated in the text that had already been performed in England. These experiments should, Waller suggested, still be of interest to the Society:

Many indeed of these experiments have been made, and shewn in several Meetings of the Royal Society (before, and since the Publication of this in the Italian, in the Year 1667) by the Honourable Robert Boyle, Esq; and other worthy Members thereof; but for all this, I hope it may not prove unacceptable to find the Ingenious in other Parts of the World, have not thought their time misspent in these Endeavours, what contrary Sentiments soever some may have; nor will the agreement between the success of Experiments made there, and what has been attempted here (often with a differing Apparatus) be less pleasing.
Figure 2. The frontispiece to *Essayes of Natural Experiments* (London, 1684). (Reproduced courtesy of the University of Sydney Library.)
Waller was clearly alluding to the relevance of the experiments found in the book to the work of several Fellows of the Royal Society in the early 1680s. Given the importance of experiments on air pressure to the work of both organizations, and the dominance of such experiments in the pages of the Saggi, Waller would have had in mind the interests in pneumatics demonstrated by Hooke, Boyle and Papin. Indeed, his reference to ‘a differing Apparatus’ could only have been aimed at the use of the air-pump in England that had been unavailable to the Tuscans.

Another interesting passage from the dedication hints at what Waller describes as ‘no small Motive to this Undertaking’: to facilitate the availability of the Cimento’s work for English readers ‘at a cheaper rate’ than the Cimento’s original publication. We may take this to mean that there was some level of demand for the Cimento’s published experiments. Rather than that demand’s being based on a popular appetite for scientific trivia, as Middleton suggests, we may now argue that any interest in the book’s translation must have been based on the Society’s pneumatics experiments. As we shall now see, this is further reflected in the reception of the translation.

PAPIN’S ASSESSMENT OF THE CIMENTO’S EXPERIMENTS

As the Society’s curator of experiments, Papin was handed the book and asked to assess its contents. On 12 November he delivered his first report to the Society, revealing his central interest in the text:

[I]n obedience to the order of the Society, I shall only observe some particulars, that might be carried farther, by help of better instruments, which could not be got by the learned members of that academy. The first of these particulars begins page 22, where is described a very good and ingenious way to discover, how far the air may be expanded, before it will cease to make a sensible effect by its elasticity: and by three several trials they find, that when the air is expanded to a space about 200 times greater than its ordinary dilation, it will no more be sensibly elastic.

Papin here was discussing the experiment described in Waller’s translation as revealing, first, ‘if the Air near the Superficies of the Earth, is pressed by the weight of the Air above.’ This aim echoed Boyle’s hypothesis regarding the weight of the whole of the atmospheric air pressing on the air particles near the Earth’s surface. Second, the academicians wished to find ‘if it be put in a void space at its Liberty; whether it will expand itself to a greater space.’ Once again this followed Boyle’s thoughts on the compression and elasticity of the air and was also relevant to Boyle’s and Papin’s attempts between 1675 and 1680 to measure the air’s ‘springyness’ according to a law of proportion between the volume and pressure of air.

After identifying the philosophical relevance of the text, Papin mentioned the shortcomings in the Cimento’s work. He argued that the Cimento’s barometric experiments, although constructed according to sound philosophical principles, did not yield accurate results because of the inadvertent intrusion of air in the apparently empty space of the Torricellian tube—Papin described this as ‘a defect of ordinary baroscopes.’ To resolve the issue, Papin suggested creating a barometer in which the top of the tube can be evacuated of air by using the air-pump. According to Papin, with this procedure the academicians would have found that the elasticity of air was far greater than they had supposed.
This reveals the weight that Papin, as curator of experiments at the Royal Society, placed on the philosophical presuppositions embedded in the Cimento’s barometric experiments. In other words, Papin recognized that the experiments performed in the Tuscan Court were flawed, yet he was prepared to look beyond that to identify their defining feature: the Cimento’s mechanistic natural philosophical aims and interests behind the experimental process.

On 17 November Papin again mentioned to the Society his method of ‘filling a barometer so as to be sure there will be no air left on the top of it’, indicating his continued interest in the Cimento’s pneumatic experiments and their value for measuring the elasticity of air. Finally, on 26 November, Papin gave a broader review of the text by listing what he believed to be its highlights. Apart from mentioning two observations of the effects of heat and cold, he once again focused on the Cimento’s barometric experiments. He then concluded, ‘This is all I have been able to observe, that might be carried farther. And I am ready to set upon any of these particulars, that the Royal Society will command me.’ Despite his evident enthusiasm, he was not asked to pursue any of the topics raised.

A review of the translation, probably written by Papin and consistent with his report to the Society, was later published in *Philosophical Transactions*. Once again, the Cimento’s academicians were praised for their intention to advance ‘real knowledge’. Moreover, the review also highlights the book’s experiments on air pressure, while mentioning that most such experiments were already known. Clearly, then, the driving force behind the reception of the *Essays* was its content of natural philosophy. This interest in the Cimento’s pneumatic experiments was consistent with the abundance of barometric and air-pump experiments pursued during the 1670s and early 1680s in relation to a mechanistic and corpuscularian world view. The *Saggi* was translated with these issues in mind.

Figure 3. Papin’s suggested experiment intends to improve on the barometric experiments of the Accademia. ‘EE’ is connected to an air-pump, allowing the experimenter to evacuate the top of the Torricellian tube on the left side of the diagram. From Thomas Birch, *The history of the Royal Society of London . . .*, vol. 4, p. 331. (Reproduced courtesy of the University of Sydney Library.)
CONCLUSION

Only 24 years after it was first published and less than 10 years after Waller’s translation, the Saggi’s relevance began to be re-evaluated. It was published again in Italian in 1691, followed by six new editions in the 1700s. It was also translated into Latin and twice into French during the eighteenth century. In the nineteenth and twentieth centuries it received similar attention, and historians today continue to demonstrate their interest in the text. This persistent interest in the Saggi is due to the widely held perception that it represents the emergence of experimental philosophy and the first scientific institutions in Europe. 74

Nevertheless, the first translation of the book was not undertaken as a commemoration of the Cimento’s experimentalism or to appreciate the Cimento’s reputed place in history as the first scientific institution. Instead, the English natural philosophers interested in pneumatics in the early 1680s were seeking confirmation of their mechanistic concerns in the experiments reported in the Saggi. Barometric experiments performed by Huygens and Marriotte in Paris during the 1670s, combined with Boylean work on pneumatics in England since the 1660s, yielded some contention regarding the elastic measurable properties of air, discussed by the academicians in the Saggi. The book was found to have little information that could be considered new to the likes of Papin and Boyle, but it is important that we understand the natural philosophical interests of some Fellows of the Royal Society in acquiring a translation of this book. Indeed, Papin’s scrutiny of the barometric experiments in the book, concerned with the air’s compressibility and elasticity, confirm the interest that he and his English colleagues held in the philosophical content of the Cimento’s published work.

So the proximity of the Cimento’s work to that of Hooke’s, Boyle’s and Papin’s in England in the late 1670s and early 1680s reflects the intellectual relevance of the Saggi and provides us with a clear reason for the book’s translation in 1683–84. This goes well beyond the broad social circumstances on which Middleton speculates, and informs us about the intellectual objectives of the Society’s Fellows when translating foreign texts. Indeed, Boyle and Papin were interested in the mechanical and corpuscular properties and effects of air and therefore could easily identify the compatibility of the Cimento’s work with their own. Its appeal was therefore not as a popular work, as Middleton suggests, but as a physico-mathematical and mechanical expression of the properties of air.

ACKNOWLEDGEMENTS

I thank Peter Anstey for his comments on a draft of this paper, and the anonymous referees for their suggestions.

NOTES

10 The Society would have been wary of the expense of richly illustrated works after publishing Francis Willughby’s *Historia Piscium* in 1678, which nearly drove the Society into bankruptcy. Adrian Johns, *The nature of the book: print and knowledge in the making* (University of Chicago Press, 1998), pp. 447–449 and 489–490.
13 Johns, *op. cit.* (note 10), pp. 451–454. It is revealing that one of the only points of interest in the *Saggi* in England in 1668, was the Cimento’s small foray into cartography and the suggestion of, as Oldenburg put it, ‘a way of making a Mapp of a Contry by Sounds’. However, this, as Oldenburg also reveals, had already been considered by Boyle. Oldenburg to Boyle, 17 March 1668, *The correspondence of Robert Boyle, op. cit.* (note 5), vol. 4, p. 46.
18 Huygens’s Cartesian theory of ‘subtle matter’ equalled a denial of the vacuity of the air-pump. This was not, however, the point of these experiments. Rather than engage in a controversial debate about the possibility of creating a vacuum, Huygens, like Boyle, preferred to concentrate on describing the mechanical properties of air. Stroup, *op. cit.* (note 17), p. 137.
22 ‘An Extract of a Letter of M. Hugens to the Author of the Journal des Scavans of July 25. 1672. Attempting to Render the Cause of That Odd Phaenomenon of the QuickSilvers Remaining
Suspended Far above the Usual Height in the Torricellian Experiments’, *Phil. Trans. R. Soc.* 7, 5027–5030 (1672).

23 Ibid., pp. 269–273; Middleton, *op. cit.* (note 17), pp. 78–79.

24 Although the varying views about the air-pump’s efficacy provided some ammunition for scholastic critics of the instrument and other plenists, Huygens and Boyle managed to separate the question of the receiver’s vacuity from the debate regarding ‘subtle matter’ and the spring of the air. Stroup, *op. cit.* (note 17), p. 137.


30 Ibid., p. 129. Boyle argued that the spring of the air described in these tracts is necessary for the preservation of ‘animal substances’ and fruits.


34 Ibid., pp. 437–439.


36 Papin wrote to Huygens: ‘I do not think that the Royal Society is doing much and Mr Boyle told me that it is a full nine months since he was there, and when I arrived here it was already time for vacation to begin and it will not end for a long time’. *The Correspondence of Henry Oldenburg, op. cit.* (note 33), vol. 11, pp. 437–439.


38 Hall, *op. cit.* (note 8), pp. 68–69.


Boyle, op. cit. (note 42), pp. 125–126.

Ibid., pp. 124–125. During this time, Papin also worked on a food digester, used for softening and cooking food with the force of steam. This work resulted in a book published by the Royal Society in 1681: A New Digester or Engine for Softening Bones (London, 1681).

Papin described his air-pump as functioning with ‘greater ease and also with more speed, than on Pump in single Engines’. Boyle, op. cit. (note 42), p. 136. Boyle was reluctant to use it, but Papin’s variation to the air-pump made it easier to replicate and a commercially viable instrument. Shapin and Schaffer, op. cit. (note 16), pp. 275–276.

Boyle, op. cit. (note 42), p. 139.

Edmé Mariotte, Essai de logique (Paris, 1678); idem, Essays de physique (Paris, 1679).


Some of their experiments were performed before the Society. Hall, op. cit. (note 8), p. 79.

MacLachlan, op. cit. (note 27), pp. 292–293.


See Martin Lister, ‘A Discourse concerning the Rising and Falling of the Quicksilver in the Barometer; and What May be Gathered from Its Great Rise in Frosty Weather’, Phil. Trans. R. Soc. 14, 790–794 (1684); Robert Plot, ‘Observations of the Wind, Weather, and Height of the Mercury in the Barometer, through out the year 1684’, Phil. Trans. R. Soc. 15, 930–943 (1685).

Rupert Hall’s introduction to the 1964 reprint of the translation suggests that Hoskyns ordered the translation in 1682. However, I have not found any evidence proving that Waller worked on this project before November 1683, the date also provided in the book’s imprimatur from Hoskyns. Essays of Natural Experiments (London, 1684; reprinted by Johnson Reprint Corporation, New York, 1964).


These experiments were all reported to the Royal Society when it returned from the summer recess. Birch, op. cit. (note 3), vol. 4, p. 319.

Birch, op. cit. (note 3), vol. 4, p. 326.


Birch, op. cit. (note 3), vol. 4, p. 325.

According to D. B. Meli, this imagery was designed to persuade readers of the Saggi of the academy’s dedication to the reliable acquisition of natural knowledge. ‘Authorship and teamwork around the Cimento Academy: mathematics, anatomy, experimental philosophy’, Early Sci. Med. 6, 65–95 (2001), at p. 90.


Ibid.
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65 Ibid.
66 Birch, op. cit. (note 3), vol. 4, p. 325.
67 Ibid., p. 330.
68 Essays of Natural Experiments, op. cit. (note 56), p. 22.
69 Ibid.
70 Birch, op. cit. (note 3), vol. 4, p. 331.
71 Ibid., p. 332.
72 Ibid., pp. 335–336.