Reading art, reading nature

How microscopic literature formed seventeenth-century readers

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> For what a better, fitter, guift Could bee
> In this world's Aged Luciosity.
> To helpe our Blindnesse so as to deuize
> A paire of new & Artificiall eyes.
>
> Henry Power: "In Comendation of ye Microscope" in *Microscopicall obseruations* (1661)

In the 1660s, two books treating microscopy were published by authors who were members of the English Royal Society.[1] In 1664, Henry Power (1623–1668) published *Experimental philosophy*, in which the first part dealt with microscopy. There, Power described his microscopic experiences using language replete with metaphors and imagery. The following year, the richly illustrated *Micrographia* was published by the experimentalist Robert Hooke (1635–1703). His *Micrographia* was a large and expensive book, dedicated to mediating microscopic experience.

A shared theme of the introductions to both *Experimental philosophy* and *Micrographia* was the praise of instruments in general and microscopic lenses in particular. For Power, glasses were "but a Modern Invention", something the ancients did not possess. Because of the lack of this "artifice", the ancients had erred not only in their views of the celestial bodies, but also in how they perceived the "smallest sort of creatures about us".[2] In *Micrographia*, Hooke explained that "it is the great prerogative of Mankind […] that we are not only able to behold the works of Nature […] but we have also the power of […] improving them to various uses".[3]

These experimental philosophers identified strongly with the microscope, seeing it as an extension of their own bodies and senses. The microscope and the act of seeing were tightly interwoven with the body and the identity of the experimenter. In this process, texts were mediators, artificial memories of experimental experiences which should be "delivering new and real Observations or Experiments".[4] For Hooke, books used in a "sensible way"[5] should narrate actual experience rather than mere products of fancy.

In the latter part of the seventeenth century, microscopy was in fashion among gentlemen experimentalists. Through their lenses, these observers saw a new world that was often compared to and considered as new and

exciting as the new lands discovered by explorers at sea. What was seen through the microscope was perceived as a discovery which changed the way one viewed the old world: microscopic experiences of everyday objects like food, fleas or printed text rendered these objects strangely different from everyday experience.

These books by Hooke and Power can be seen as part of the culmination of the interest in microscopy characteristic of the 1660s. They functioned as aids to microscopists who could compare what they had seen in their microscopes to descriptions of the microscopic world. But *Micrographia* and *Experimental philosophy* were not only read by microscopists. Through them, readers without access to microscopes could also experience the new microscopic world.

The last few decades have seen a substantial increase in interest in the experimental philosophy of the English Royal Society among historians of science. Many studies have discussed how experimental experiences could be transformed into credible collective knowledge and how this process was carried out by communicating experience in a social context. Among these, the thesis advanced by Steven Shapin and Simon Schaffer concerning the role of "literary technology" is central. According to their thesis, experimenters produced literary representations of experiments in order to show the experiments to "virtual witnesses" (i.e., readers). Through virtual witnessing, the experimenters could broaden the base of credible witnesses which constituted the foundation for making credible experimental knowledge.[6]

The two books on microscopy drawn on in this essay can be, and have been, studied as part of this process of knowledge production. But to see them only as parts of this process is, I believe, too narrow a way to view them. Their authors did not only seek to produce knowledge of the microscopic world. They also sought to mediate experience for other reasons than the creation of truth. Like travellers returning from foreign lands, they also narrated their experiences to an anticipating public to fulfil other needs than the demand for credible knowledge of their new world. Books on experimental philosophy were parts of an experimental philosophical culture, but also played a part in other contexts, such as in general philosophical discussion or in literary creations. What attitude did these readers, who responded from their respective positions, have to such narrated experiences?

Both contemporary readers, as well as later ones, read, commented on, discussed and satirized the contents of *Micrographia* and *Experimental philosophy*. In this essay I will focus on some of these texts in order to study how they used the concepts of art, nature and gentlemanliness and how these concepts were related to seventeenth-century microscopy. My choice of readers is not representative of readers in general, but comprises a range of attitudes of particular interest for showing how experimental

experience was mediated and related to by a wider social circle in seventeenth-century England. My essay focuses on the responses to these books by readers who were the authors' contemporaries. Even though at least *Micrographia* was read well into the 18th century, this essay will concentrate on cases from the 1660s and 1670s. The selection of sources has been made on the basis of the diversity of their stances towards *Micrographia* and *Experimental philosophy*, since it is my aim to show how readers *could* relate to these books rather than to give a representative description of how readers in general *did* respond to them. The responses are very different from one another, each belonging to a separate genre. This, I believe, will allow us to see how the literature on microscopy was appropriated and interpreted for very different purposes in a variety of contexts.

In the famous diary of Samuel Pepys (1633–1703), an example is offered of how a reader with a microscope of his own related to *Micrographia* and *Experimental philosophy* in his effort to become both an experimenter and a gentleman. In the second part, I turn to *Observations upon experimental philosophy* by Margaret Cavendish (1623 –1673), a philosopher who was both excluded from and included in the contemporary philosophical discussion. Her work contains an interesting philosophical critique of microscopy based on the concepts of art, nature and pictures. Finally, I turn to the satirist and playwright Thomas Shadwell (1642–1692) and his comedy *The virtuoso*. In *The virtuoso* a fictional example was provided of how men like Pepys could fail to become gentlemen through experimental philosophy, a failure which was related to the discussion of art and nature to be explored in the section on Margaret Cavendish.

Samuel Pepys. Approaching the art of microscopy

An important objective of both *Experimental philosophy* and *Micrographia* was to construct a moral and social framework which could be employed to mediate microscopic experience.

Steven Shapin has described the social framework of the experimentalists as a "social technology" based on the concept of the gentleman. Seventeenth-century experimenters lived during a period when English masculinity was in a state of flux. Men's use of violence declined and disputes which were formerly resolved physically were to a higher degree settled in court or by verbal insults. The social framework of experimental philosophy should be seen as a part of this shift. Among experimental philosophers, disputes were ideally confined to interpretations of matters of facts, thus reducing personal conflicts that could escalate into violence.[7]

Within this framework, microscopy and literature on experimental philosophy were linked to concepts of providence and utility. Further-

more, it was argued that conducting experiments was a way for a gentleman to better himself.[8] In the preface to *Micrographia* Hooke states that:

> The good success of all these great Men […] puts me in mind to recommend such studies […] to the Gentlemen of our Nation, whose leisure makes them fit to undertake, and the plenty of their fortunes to accomplish, extraordinary things in this way. And I do not only propose this kind of Experimental Philosophy as a matter of high rapture and delight of the mind, but even as a material and sensible Pleasure.[9]

Central to Hooke's claim, that experimental philosophy was suitable for a gentleman, was the argument that it could be seen as a "material sensible Pleasure" and not only as a "matter of high rapture". He argued that experimental philosophy was more suitable than rationalistic philosophy for a gentleman, because it was both a delight of the mind and something that let him use his senses to connect to the material world.

The famous diarist Samuel Pepys was one of these men, engaging in microscopy for the sake of "material sensible Pleasure". He had access both to a microscope and to books on microscopy and he used these objects together.[10] In Pepys' diary, we can clearly witness this interaction – a process that spans more than a year and involves Power's *Experimental philosophy* and Hooke's *Micrographia*.

Samuel Pepys' microscopic adventures began on the 13th of February 1664 in the "perspective glass maker" Mr Reeves' shop in London:

> I took coach and to [sic] Reeves's, the perspective-glass maker; and there did endeed see very excellent Microscopes, which did discover a louse or mite or sand most perfectly and largely. Being sated with that, we went away (yet with a good will, were it not for my obligations, to have bought one) and walked to the New Exchange[11]

Although, as he says, he was interested in attaining a microscope, Pepys seems to have been satisfied with this quite brief experience of microscopes for quite some time and he did not mention microscopes or microscopy again until some months later on the 25th of July:

> Thence to Mr. Reeves, it coming just now in my head to buy a Microscope – but he was not within. So I walked all round that end of the town, among the loathsome people and houses.[12]

Suddenly, Pepys became very insistent on getting a microscope and he returned to Mr Reeves the very next day to "chose one which [he] will have".[13] Why this sudden interest after waiting for over 5 months after his first visit to Mr Reeves? An explanation may be that microscopy see-

med to have become part of the conversation of the London elite. Some days after buying the microscope, Pepys wrote (the 7th of August):

> So I walked homeward and met with Mr. Spong; and he with me as far as the Old Exchange, talking of many ingenuous things, Musique, and at last of Glasses, and I find him still the same ingenuous man that ever he was; and doth among other fine things, tell me that by his Microscope of his own making he doth discover that the wings of a Moth is made just as the feathers of the wing of a bird, and that most plainly and certainly.[14]

Pepys' account of Spong's remarks shows that he saw the microscope as a status symbol. Not only did Spong describe his microscopic experiences in a way that made him seem "ingenuous" in Pepys' eyes, but the microscopic equipment itself and the ability to construct it also impressed the diarist. The microscope was not a homogeneous artefact in seventeenth-century England. There existed a variety of models of microscopes which all had different social functions. In the 1660s, observation through "flea glasses" was a fairly common pastime. Catherine Wilson has argued that these rather crude glasses filled a social role by letting people in the seventeenth century observe and discuss the unmentionable filth of their own bodies in a magnified and therefore socially acceptable way.[15] Though such basic magnifying lenses were fairly well spread, the art of microscopy referred to and practiced by the experimentalists was not. The microscopes that were central to the launching of the experimental philosophical community were very different from these "flea glasses".[16] While the flea glasses magnified its object of study roughly 10 times, which made it possible to see parts of insects, the microscopes utilised by the seventeenth-century experimentalists gave a magnification of 30 up to 275 times.[17] Still, experiences from these microscopes were discussed in gentlemanly conversation in certain circles of London, as seen in Pepys' conversation with Mr Spong.

On the 13th of August, six days after Pepys' conversation with Mr Spong, Mr Reeves delivered the microscope that Pepys had bought. It was not until then, after he had acquired a microscope, that he mentioned books on microscopy:

> There comes also Mr. Reeve with a microscope and scotoscope; for the first I did give him [£5] 10s, a great price; but a most curious bauble it is, and he says as good, nay, the best he knows in England, and he makes the best in the world. The other he gives me, and is of value; and a curious curiosity it is to [see] objects in a darke room with. […] Thence home and to my office; wrote by the post, and then to read a little in Dr. Powre's [sic] book of discovery by the Microscope to enable me a little how to use and what to expect from my glasse. So to supper and to bed.[18]

”Dr Powre’s book on discovery by the Microscope” mentioned here is without doubt Power’s *Experimental philosophy*. Pepys explicitly says that he read it to learn what to expect from his own microscopic observations. That is, Pepys used Power’s book as a manual for his own experiments.

Experimental philosophy is written in a very poetic mode. Power mixed descriptions of what he had seen with exclamations like ”How critical is Nature in all her works!”[19] and with recommendations such as ”It is worth an Hour-glass of Time to behold the Crystal Sands that measure it, for they all seem like Fragments of Crystal”.[20] Describing a nettle as seen through a microscope, he wrote that it ”looks like a Sword-cutler’s shop, full of glittering drawn swords, Tucks, and Daggers”.[21]

Christa Knellwolf has described the language in *Experimental philosophy* as a metaphorical mode of description. She contrasts it with the prosaic style typical of Hooke’s *Micrographia*, which uses a literary mode described by Michael Aaron Dennis’ as a ”disciplined seeing”. Dennis describes ”disciplined seeing” as reason disciplining the experience gained through the senses. In order to see the ”true shapes” of the microscopic world through the microscope, one had to learn to see in this disciplined way. The credibility of the pictures which were printed in *Micrographia*, of the images narrated through its text and of microscopy itself was based on the presupposition that reader and author shared this way of seeing.[22]

While I agree with Knellwolf that there is a distinct contrast in the descriptive modes of Power’s and Hooke’s books, her view of how these differences are related to the technique of ”disciplined seeing” is problematic in the light of Pepys’ diary.

Pepys used Power’s ”enthusiastically descriptive”[23] book as a practical tool for learning how to see in a disciplined way. By first reading *Experimental philosophy* and then doing microscopic observations of his own, Pepys learnt techniques of microscopy but also sought to gain hints on what he was supposed to see through the lens. On the evening after his purchase of the microscope, Pepys continued his microscopic observations:

> After dinner up to my chamber and made an end of Dr. Powre’s booke of the Microscope, very fine and to my content, and then my wife and I with great pleasure, but with great difficulty before we could come to find the manner of seeing anything by my microscope, at last did with good content, though not so much as I expect when I come to understand it better.[24]

For Pepys, reading *Experimental philosophy* was the starting-point of his experience with the microscope. When he had finished Power’s book and finally began his own microscopic observations (something he did together with his wife – a typical example of how women close to gentlemen phi-

losophers were included in the experimental philosophy in the private sphere while being excluded in the public area),[25] he noted the difficulty of seeing anything. Microscopy was not an easy enterprise in the seventeenth century, something which bears repeating. Pepys had problems seeing correctly through the lens, but was finally satisfied with what he saw, even though he thought he would be able to see more when he understood it better. He continued his observations two days later on the 16th of August, Power's book still playing an important role: "then to my office again a while, collecting observations out of Dr. Powre's booke of Microscopes".[26] He did not only learn how to see through the microscope by reading Power's book, but was also "collecting observations". That is, he also collected ideas of *what to observe* from *Experimental philosophy*.

By his reading of Power's book, Pepys got an idea of what he should see through the microscope. Here the book works in the same way as Pepys' earlier conversation on microscopy with Mr Spong, but does so in a more detailed way. Through narrations of earlier experiments, Pepys learned what to expect from the instrument and was able to separate "false" microscopic experiences from correct ones. Seeing correctly, or in a disciplined way, was a skill that Pepys acquired from interacting with his microscope and his book. The book's narrations formed an ideal that Pepys sought to attain through his own microscopic practice.

During the autumn of 1664, microscopy and Power's book were absent from Pepys' diary. It was not until the 2nd of January 1665 that the diary returned to the subject, and then only by briefly describing a new book:

> Thence to my bookseller's and at his binders saw Hookes book of the Microscope, which is so pretty that I presently bespoke it.[27]

Large and heavily illustrated books like *Micrographia* were not inexpensive and the fact that Pepys' ordered it as soon as he saw it is both a sign of his immediate liking of the book and of his wealth.[28] It was probably the illustrations that Pepys referred to when he described the book as "so pretty". The pictures were the most prominent feature of *Micrographia*, a fact which was also recognised by Henry Power at the end of his *Experimental philosophy* where he stated that:

> These are the few Experiments that my Time and Glass hath as yet afforded me an opportunity to make […]. But you may expect shortly from Doctor *Wren*, and Master *Hooke*, two Ingenious Members of the Royal Society at *Gresham*, the Cuts and Pictures drawn at large, and to the very life of these and other Microscopical Representations.[29]

Some weeks later, on the 20th of January, Pepys received the book he had ordered: "so to my booksellers and there took home Hookes book of Microscopy, a most excellent piece, and of which I am very proud".[30] He

started reading the book right away and, between diary entries, one can find him stating that: "Before I went to bed, I sat up till 2 a-clock in my chamber, reading of Mr Hookes Microscopicall Observacions [sic], the most ingenuous book that ever I read in my life".[31] After reading Power's *Experimental philosophy*, Pepys merely described it as being to his "content". In the quotes above we can discern a more emotional relation between Pepys and Hooke's *Micrographia* – one of fascination.

By reading books on microscopy, Pepys tried to mimic the experimentalist authors. He tried to become a disciplined seer, capable of revealing the secrets of the microscopic world. The metaphorical "descriptive mode" of Power's book does not seem to have been a problem for Pepys when he used it as a manual for his microscopial endeavours. Strangely, it was the poetic *Experimental philosophy* he described to have used together with his microscope. Pepys did not write more about his reading of *Micrographia* and, therefore, there are no more signs of how he used Hooke's book. What we can say is that *Micrographia* and *Experimental philosophy* play two very different roles in the diary. The lack of comments on *Micrographia* in Pepys' diary is striking, since it was the "most ingenious book" he ever read.

Reading *Micrographia* and *Experimental philosophy* can be seen as ways for Pepys to fashion himself both as a gentleman and as a disciplined seer. These books on microscopy became part of Pepys' process of learning the techniques of microscopy. They thus worked, in a manner of speaking, as teachers of microscopy, even though this function is not prescribed in the books themselves. By reading literature on microscopy, Pepys could access experiences of microscopic experiments. These experiences then formed an integral part of Pepys' acquisition of the technical know-how.

When studying *Experimental philosophy*, one cannot help wondering how Power's book could fill this practical role. It does not contain many hints on how to actually use a microscope, how to look through it or how to prepare the objects of study. It was probably together with verbal communication, hinted at in the conversation between Pepys and Spong at the beginning of this section, that books such as *Experimental philosophy* could function as a manual for a microscopist like Pepys.

For Pepys to use these books on microscopy as manuals and to understand the experience mediated through them, he needed to trust the authors, as well as the representational techniques used to mediate experience. Pepys certainly seems to have had this trust, and he seems to trust the experimenters and their representational techniques partly because he has faith in the microscope and the art of microscopy. He seems to have shared the experimentalists' view of the microscope as intimately linked to the identity and body of the experimenter and he does not seem to reflect on the role of art and nature in making his observations. One could say that it is because he shared the experimentalists' view of the relation bet-

ween art and nature that he could trust the narrations of their experiments. Furthermore, for Pepys to find new truths about nature was not the central objective, if an objective at all. Pepys wanted to learn the art of microscopy for his personal pleasure and in order to be a gentleman. But what role did experimental philosophy in general and microscopy in specific have in the shaping of the gentlemanly identity of men like Pepys? In the next two sections I will pursue this question by shifting focus from Pepys' diary to texts where the art–nature dichotomy is both more visible and more problematic.

Margaret Cavendish. To observe pictures of artificial experience

In her work *Observations upon Experimental philosophy* (published in 1666; a second edition was published 1668) the Duchess of Newcastle, Margaret Cavendish, discussed the work of some unnamed experimentalists. Among these, Robert Hooke and Henry Power are easily identified. In her book, Cavendish also put forth a strong critique of the experimentalists' programme.

As stated in the preceding section, pictures play a central role in *Micrographia* and it is also what differentiates it the most from Power's *Experimental philosophy.* Power and Hooke agreed that text as well as illustrations were needed to mediate experience of the microscopic world.[32] Cavendish's critique of the art of microscopy was directed at this visual characteristic of microscopy, her criticism being based on the concepts of pictures, art and nature.

While her critique was strong, Cavendish began *Observations upon Experimental philosophy* by politely pleading with her experimentalist readers to take her seriously. Cavendish's discussion of the experimentalists' observations was very much formed by how seventeenth-century noble Englishwomen were to act in relation to males (and in this case mainly to men of lower social standing).

Cavendish did not have many possibilities of interacting philosophically with members of the experimental community, as the philosophical interactions of the Royal Society were firmly based on the concept of gentlemanliness. Margaret Cavendish was controversial. As a female author and philosopher, she transcended the role of an ordinary seventeenth-century woman. Furthermore, women who wrote and published were generally unmarried. During this period only a few women, all of them aristocrats, wrote under wedlock.[33] Thus, Cavendish's role as a writer, not to mention her role as a philosopher, was problematic. This can be seen in both her own writing and in writing about her.

In 1667, Cavendish made a much debated visit to the Royal Society. The visit indicates that she had an interest in experimental philosophy,

but the experimentalists' reaction to it also shows the mechanisms which excluded her from the experimentalist community. Pepys wrote of the visit in his diary, where he described Cavendish as a "very ordinary woman".[34] By describing her as such, Pepys and the other members of the Royal Society could ignore Cavendish's claims to be a part of the group of experimental philosophers. This made it possible for them to resolve the challenge that Cavendish constituted to their homosocial group.

One year after her visit to the Royal Society, Pepys read the Duchess' biography of her husband and reacted very strongly against it:

> the ridiculous History of my Lord Newcastle, wrote by his wife, which shews her to be a mad, conceited, ridiculous woman, and he an asse to suffer her to write what she writes to him, and of him.[35]

It was possibly even harder for Cavendish to conform to the male norms of the experimentalists, than to the role of a published author. As Hilda L. Smith notes, Cavendish, in order to gain fame and recognition, wrote in a variety of genres; adopted various personae and tried to "determine what the public, and especially male intellectual critics, might praise – or accept from a female pen".[36]

In *Observations upon Experimental philosophy*, Cavendish did not describe experiments which she had conducted herself. Instead, she discussed experiments made by unnamed experimentalists. Cavendish's book could thus be seen as a book by a virtual witness of experiments. But Cavendish does not fit the role of a virtual witness very well, which has been pointed out by Elizabeth Spiller. In her view, Cavendish was the radical opposite of a virtual witness. Spiller argues that "the New Science had little place for the contributions of readers"[37] and that Cavendish's texts "imagine active readers who are not simply necessary to the creation of knowledge but powerful enough to threaten that knowledge".[38] In Spiller's view, Cavendish's conception of reading was the opposite of the experimentalists', which was founded on Hobbes' philosophical view of reading "as occurring through the physical impact of visual images, striking the mind with external ideas".[39]

I would like to pursue a different line of argument, diverging from these two positions. The dichotomy of passive versus active readers is not very enlightening when studying the difference between Cavendish's and the experimentalists' conceptions of reading. The experimentalists did not want the readers to relate in a passive way to their books. What they wanted them to do was to interact in a disciplined way, in compliance with the social norms of the experimental community and the techniques established for using the material instruments. It is in the light of these expectations, governing the "ideal" reading of experimentalist literature, that we should understand what differentiated Cavendish from her male experimentalist contemporaries. It would be wrong to see the "ideal read-

ers" of the experimentalists, like the above-mentioned Pepys, as powerless. But at the same time, it would be wrong to identify Cavendish as a virtual witness of the type described by Shapin and Schaffer.

In the preface to *Observations upon Experimental philosophy*, Margaret Cavendish points out that:

> I have had the courage to argue heretofore with some famous and eminent writers in speculative philosophy, so have I taken upon me in this present work, to make some reflexions also upon some of our modern experimental and dioptrical writers. They will perhaps think me an inconsiderable opposite, because I am not of their sex, and therefore strive to hit my opinions with a side-stroke, rather covertly, than openly and directly; but if this should chance, the impartial world, I hope, will grant me so much justice as to consider my honesty, and their fallacy.[40]

It was not only her sex but also her methods that made Cavendish an "inconsiderable opposite" to the experimentalists. In *Experimental philosophy* and *Micrographia*, notions of the artificial and the natural were central. The "journey" into the microscopic world was seen to be conducted with the aid of the microscope, an "artificial organ" that augmented the senses. When combining these artificial organs and our natural organs, a "new visible World [is] discovered to the understanding".[41] In the prefaces by Hooke and Power, one can discern a fluid border between the body of the experimenter and the microscope. Power talked of "artificial eyes", the "Modern Engine (the Microscope)" and "this particular Engine we call the Body" and Hooke described the same process as "the adding of artificial Organs to the natural". Through the ambiguous use of the word "organ", the artificial instrument is more or less placed on a par with the natural parts of the experimenter's body.[42]

Aristotle's definitions of art and nature were still actively in use in seventeenth-century natural philosophy. Still, the emergence of mechanical philosophy resulted in a radical conflation of the two concepts. Peter Dear identifies this conflation in the philosophy of Francis Bacon, who argued that art was a matter of setting up situations in which nature produces a certain result. Thus, art was not distinct from nature, but only an alteration of it.[43] Bacon's view of art and nature was a theoretical fundament for the experimental philosophical method, according to which an "artificial" experimental experience could produce natural knowledge. Even though Hooke and Power adopted Bacon's position up to a certain point (they both, for example, saw experimental observation as the foundation of their philosophy), they simultaneously used "artificial" and "natural" as oppositional concepts. *Experimental philosophy*, as well as *Micrographia*, contains comparisons of the perfection of nature and the imperfection of objects made through human art. The experimenters focused their

lenses on everyday objects, seeking to reveal man-made beauty as an illusion and to discover the true beauty in the objects of nature. The microscope rendered everyday objects different, and therefore made everyday experiences of these objects false in the eyes of the experimentalists. Hooke expressed it as:

> All the rest that roughen the surface, were onely so many marks of the rudeness and bungling of Art. The more we see of their shape, the less appearance will there be of their beauty: whereas in the works of Nature, the deepest Discoveries shew us the greatest Excellencies.[44]

From having enthusiastically embraced the potential of the microscope in her earlier work, Cavendish later grew more critical. Her critique of microscopy drew much of its power from the problematic use of the nature–art dichotomy, which she found in Hooke's and Power's books on microscopy.

Compared to Hooke and Power, Cavendish did not have much to say about artificial organs created through human art. Instead, she favoured "regular sense and reason".[45] Cavendish's use of the term "regular" is somewhat ambiguous. On the one hand, she used the term in conjunction with the term "rational", signifying a regular system of thoughts or perceptions opposed to an irregular one. On the other hand, she also used it to underline that, in her opinion, true knowledge was not gained through experimental experience and experimental instruments. Rather, knowledge was gained through everyday observations unaided by mechanical instruments, everyday observations that did not conform to the norms of the experimentalists' "disciplined seeing". In this sense, "regular sense" seems to resemble the common experience that was the basis of Aristotelian science. That is, experience that was publically shared and not related to a specific, artificial experimental situation.[46] Of microscopy, Cavendish says she is:

> confident, that this same Art, with all its instruments, is not able to discover the interior natural motions of any part or creature of nature; nay, the question is, whether it can represent yet the exterior shaped and motions so exactly, as naturally they are.[47]

As Cavendish saw it, artificial experimental experience (in this case microscopic experience) could not provide true knowledge of nature. She asked: "how can a Fool order his understanding by Art, if Nature has made it defective"?[48] In her view, artificial organs were imperfect because they *were art* and, therefore, they could neither perfect the senses nor show true pictures of nature. When seeing nature through a lens, one only saw images that were "hermaphroditical, that is, mixt Figures, partly Artificial, and partly Natural".[49] Even if the lens was to present a true natural shape,

”yet that natural figure may be presented in as monstrous a shape, as it may appear mis-shapen rather then natural”.[50]

Cavendish saw many faults in the lenses of microscopes:

> a glass that is flaw’d, crack’d, or broke, or cut into the figure of Lozenges, Triangles, Squares, or the like, will present numerous pictures of one Object. Besides, there are so many alterations made by several lights, their shadows, refractions, reflextions, as also several lines points, mediums, interposing and intermixing parts, forms and positions, as the truth of an Object will hardly be known.[51]

But the problem was not that microscopic experience was uncertain and that the images gained through the lens were blurred and distorted. Cavendish had a more fundamental critique of microscopic experience that was based on the concepts of ”art” and ”nature”. To her, the microscope presented only pictures:

> I say, the Picture, it is not the real Body of the Object which the Glass presents, but the Glass only Figures or Patterns out the Picture presented in and by the Glass, and there mistakes may easily be committed in taking Copies from Copies. [52]

Cavendish considered the images gained through lenses to be artificial pictures, rather than representations of real natural objects. These representations were imperfect and could not show the true shape of the microscopic world. She argued that:

> Artists do confess themselves, that Flies, and the like, will appear of several Figures or shapes, according to the several reflections, Refractions, Mediums, and Positions of several Lights; which is so, how can they tell or judg [sic] which is the truest Light, Position, or Medium, that doth present the Object naturally as it is?[53]

Her argument can be read in view of a reflection that Hooke made in his preface on how different positions and lighting conditions can make an object appear in different ways in the microscope:

> in making [a picture] I indeavoured (as far as I was able) first to discover the true appearance, and next to make a plain representation of it. This I mention the rather, because of these kind of Objects there is much more difficulty to discover the true shape, then of those visible to the naked eye, the same object seeming quite differing, in one position to the Light, from what it really is, and may be discover’d in another.[54]

Even though he admitted that it was complicated, Hooke believed that he had the ability to separate the true shapes of the objects from the false illusions created by wrong lighting conditions. But to separate true shapes

from false images, he thought one had to observe in the right way. Hooke showed how one might fail in doing this by criticising Power's *Experimental philosophy*:

> The Eyes of a Fly in one kind of light appear almost like a Lattice, drill'd through with abundance of small holes; which probably may be the Reason, why the Ingenious Dr. Power seems to suppose them such.[55]

Hooke's solution to the distortive lenses of his microscope was the illustrations in his *Micrographia*. In recent research, there are some diverging opinions on how early modern illustrations functioned. Brian W. Ogilvie, for instance, has shown how the illustrations of the naturalists were constructed according to specific norms. The naturalists' illustrations depicted natural objects in a way in which they would never be seen in nature. For example, whereas the artist painted a plant as seen at a given moment of its existence, the naturalist created an ideal picture which combined attributes of the plant which in nature were manifested at various stages of its development.[56]

On the other hand, the art historian Svetlana Alpers has argued that the pictures of the experimentalists were part of a contemporary visual culture where "seeing [was] believing".[57] Alpers relates this visual culture to Johannes Kepler's (1571–1630) theories of optics and his investigations into the optics of the eye. According to Alpers, Kepler viewed the eye as a creator of representations: "The function of the act of seeing is defined as making a representation: representation in the dual sense that it is an artifice […] and that it resolves the rays of light into a picture".[58] According to this view, English seventeenth-century experimentalists used images as a mimetic device that was "not a schematized line drawing but an attempt at detailed naturalistic representation".[59]

Their views might seem irreconcilable, but in my view, to understand the illustrations in *Micrographia*, one must see how Hooke wanted simultaneously to convey ideal pictures of truth and naturalistic representations of experience. His use of illustrations can be seen as a rhetorical strategy to solve this double-bind. Through his technique of drawing he mediated idealised truth in a representational form which at the same time could be accepted by his audience as naturalistic images of individual experiences. That is, he made idealised illustrations of what a naturalistic representation of microscopic experience would look like, should the faults of the microscope be overcome.

Thus, like Cavendish, Hooke recognised that microscopic images were often blurred and faulty. But in contrast to her, he believed in the possibility of separating true figures from illusory ones by learning to see in the right way. In her more fundamental critique of microscopic images, Cavendish questioned the possibility of overcoming the problem of faulty lenses.

By questioning this, she also undermined the superiority of Hooke's observations and his way of mediating these, for example, over Power's way of mediating his. Stating that microscopic observations were only pictures and not true shapes of microscopic objects, she also implied that *Micrographia*'s drawings were only copies of illusory pictures, or "copies of copies".

Where Hooke saw his pictures as pictorial representations of the microscopic world, Cavendish instead regarded experimental works such as *Micrographia* as one possible set of pictures among many. Through Cavendish's criticism, Hooke's pictures were reduced to something more similar to Power's poetic metaphorical descriptions. Cavendish stated that "though there be numerous books written of the wonders of these glasses […] they are but superficial wonders, as I may call them".[60] Superficial, because of their unfounded claims to truth, as they can show neither inner truth nor exterior appearance correctly.

Though Cavendish questioned the utility of experimental knowledge, she centred her criticism on the techniques used to gain and mediate knowledge. This criticism was directed both at the lenses themselves and at the techniques used to represent microscopic experience in *Micrographia* and *Experimental philosophy*, in other words at the acts of disciplined seeing and virtual witnessing. In a way, the genre of philosophical critique that Cavendish engaged in, presupposed a certain respect for the issues criticised. That Cavendish wished to engage in philosophical discussion with the experimentalists also meant that she had to accept some of their social norms. As in the controversies within the experimentalist community, Cavendish chose to focus on the faults of the instruments and the techniques used rather than to attack the experimentalists themselves. In the next section, I will discuss an early modern setting in which even these norms could be problematised. We will also see how Cavendish's criticism of the microscope's images had a bearing on the way microscopy was used to form a gentlemanly identity. If microscopy provided illusory images, was its practice really suitable for a man of leisure?

Thomas Shadwell. The experimentalist as coxcomb

The early Royal Society had a tense relation to contemporary theatre. The theatre was sometimes used as a metaphor for the shallowness of mere fancy. In Power's preface to *Experimental philosophy*, he described stage-scenes as pretending to show "things inwards, when they are but superficial paintings"[61] (a description very much like Cavendish's description of the art of microscopy). Thomas Sprat's *History of the Royal Society* (1667) contains some thoughts on the relationship between experimental philosophy and contemporary theatre as well as literature. Sprat argued that experiments could be beneficial to "wits and writers",[62] there being "in

the *Works of Nature* an inexhaustible Treasure of *Fancy* and *Invention*".[63] Therefore, Sprat hoped that he would be able to

> Prevail something with the *Wits* and *Railleurs* of this *Age*, to reconcile their Opinions and Discourses to these *Studies*. For now they may behold that their Interest is united with that of the *Royal Society*; and that if they shall decry the promoting of *Experiments*, they will deprive themselves of the most fertile Subject of *Fancy*.[64]

An early modern wit who used "these studies" of the Royal Society in his dramatic production was Thomas Shadwell. His comedy *The virtuoso*, which was performed at Dorset Garden in May 1676, is one of the most striking examples of satire of experimental philosophy, and it received a considerable amount of attention from contemporary audiences.[65]

Albert Borgman has pointed to two textual sources for Shadwell's comedy: the Royal Society's *Philosophical transactions* and Robert Hooke's *Micrographia*, but the subjects satirised can also be found in Henry Power's *Experimental philosophy*. The play explicitly refers to experiments described in *Micrographia*, such as Hooke's descriptions of mites in cheese, of eels in vinegar and of the geography of the moon.[66] There is a textual similarity between these works, and it cannot be denied that *The virtuoso* contains an explicit satire of *Micrographia*. But Borgman misses a central prerequisite for Shadwell's satire: the interaction between the actors on stage and the audience that was a central component of English Restoration theatre.[67]

After having seen Shadwell's play on the 2nd of June 1676, Robert Hooke noted his reaction in his diary: "With Godfrey and Tompion at Play. Met Oliver there. Damned Doggs. *Vindica me Deus*. People almost pointed".[68] Hooke is known to have been rather sensitive in regard to public opinion,[69] and the note shows that he was concerned both with what happened in the audience during the performance of *The virtuoso* and with what happened on the stage.

The ways in which Restoration theatrical satire worked and how the audience reacted to being satirised by actors on stage have been discussed by theatre historians. As the audience of the theatre was constituted by a relatively heterogeneous assortment of people, one cannot consider the audience as a single body which reacted uniformly to what happened on stage. Rather, the interactions among the audience produced by the action on stage were a central and deliberate part of Restoration comedy. Subjecting different subgroups in the audience to satirical treatment by turns, the playwright could create reactions of hissings and applause among various groups of spectators.[70]

In playhouses, one could not take for granted that everyone shared the social norms of the experimental community. Both the expected conflict of norms in the audience and the literary clash between experimental prose

and Shadwell's satiric drama were the basis for *The virtuoso*. Through these collisions, Shadwell's comedy played with the authorial voice of the experimentalists. Hooke's experience of an audience that "almost pointed" at him might not be so noteworthy after all, as pointing and laughing among the spectators was commonplace in Restoration comedy.

In the prologue, read as a monologue to the audience, Shadwell explained that:

> Yet no one Coxcomb in this Play is shown
> No one Man's Humour makes a part alone
> But scatter'd follies gather'd into one.[71]

So which were these gathered follies? What was presented to the audience watching *The virtuoso* was a group of humorous characters that Shadwell himself, in a manner typical for his time, described as entirely new.[72] Sir Formal Trifle[73] was a "great master of Tropes and Figures: The most *Ciceronian* Coxcomb",[74] a coxcomb of no substance: he was nothing but the words with which he sought to please and flatter. His opposite was his good friend Sir Nickolas Gimcrack,[75] the virtuoso, who "ha[d] broken his brains about the nature of Maggots" but who "never care[d] for understanding Mankind".[76]

It has been argued whether Sir Nicholas was a straightforward parody of Robert Hooke himself or if *The virtuoso* rather should be seen as a parody of experimental philosophers in general. Shapin, for example, identifies Gimcrack as Robert Boyle, while acknowledging that Hooke believed that "*he* was Gimcrack".[77] To simply equate Sir Nicholas with Robert Boyle (or Robert Hooke for that matter) is too simple an analysis of Shadwell's satire as well as of the experimenters' responses to it. Gimcrack contained ingredients from a variety of contemporary experimentalists. This was probably what made the experimenters interested in the satire, as seen in Hooke's diary.

Among other "humorous" characters was the fool Sir Samuel Hearty,[78] "an original of another kind; one that thinks that all Mirth consists in noise, tumult, and violent laughter : At once the merriest and dullest Rogue alive".[79] Through Sir Hearty, Shadwell could satirise comedy, or wit, he considered inferior to his own. The opposite to Sir Hearty was Snarle,[80] "a great Declaimer against the Vices of the Age, a clownish blunt Satyrical Fellow; a hater of all young People, and new Fashions".[81] Snarle fills the function of a character who "spares nobody",[82] declaiming all around him in a way that reflects as much on himself as on his surroundings.

Common to all these characters is, as Shadwell stated in his preface to the play, that they are "not Coxcombs by nature, but with great Art and Industry make themselves so".[83] Though the ways in which they become coxcombs differ, what they have in common is that they all have affections that Shadwell considered "misguide[d] men in Knowledge, Art, or Science,

or that cause[d] defection in Manners, and Morality, or pervert[ed] their minds in the main actions of their lives".[84] Using these characters, Shadwell exhibited negative examples of what could happen if men engaged in any of these activities too fanatically or in the wrong way.

The plot of Shadwell's comedy centred around a love story. The "gentlemen of wit and sense",[85] Longvil and Bruce, fall in love with the nieces of the virtuoso, Clarinda and Miranda. Longvil and Bruce are the play's positive examples. When Longvil is angered by Sir Samuel Hearty, Bruce stops him, saying: "do not kill him; 'twill be something uncivil",[86] indicating that they are civil men who keep each other in check. Furthermore, their love for the virtuoso's nieces is portrayed as an interest diametrically opposed to the misguided affections of the play's four coxcombs. Comedy is created when these young lovers interact with the humorous and flawed characters described above.

The comic mechanism in *The virtuoso* is very similar to that in plays treating the concept of "foppery" in late seventeenth-century and eighteenth-century theatre. A fop during this time was a character who because of his vanity and affection failed in being a gentleman. He indulged in fashion and in his appearance, which every civil gentleman was supposed to do, but did so to an inappropriate degree. The fops' comic potential lay in the "juxtaposition between fops' pretensions to an enviable manly refinement and the conduct of ideal gentlemen, however defined".[87] The fop failed to be manly because he was too refined, thus rendering him effeminate. The comic characters in *The virtuoso* seek refinement in other ways than through their appearance, but it is still obvious that the comedy in *The virtuoso* is based on the same kind of juxtaposition between the ideal gentleman, in the form of Bruce and Longvil, and the four men who fail in their ambitions to be manly.

What Shadwell did through satire is similar to what Hooke did in *Micrographia*: he showed the imperfections of human art. But Shadwell also showed the hopelessness he saw underlying all human strife to perfection through imperfect art. In one way this makes Shadwell's criticism similar to Cavendish's. But where Cavendish mostly criticised the possibility of gaining knowledge through microscopes and other instruments, Shadwell pointed to what the hunt for experimental knowledge could do to the experimenter himself. Magnifying the moral framework of the experimenters by exaggerating it on stage, Shadwell revealed some of its components, which were not necessarily well-natured or gentlemanly.

A potential danger in experimental philosophy was that the experimenter could lose grasp of what was important and what was not. Shadwell implies that by growing dependant on artificial organs, the experimentalist lost his focus on what was important: the everyday experience of human life. This danger was inherent in the experimentalist method, which was based on an artificial experimental experience rather than on common

experience as used by Aristotelian science. The experimentalist lost in the artificial micro-world could neither maintain his gentlemanliness nor claim the utility of his observations. When the virtuoso is described by Sir Formal in the first act of the play, he is described as:

> the finest speculative Gentleman in the whole World, […] Not a Creature so little, but affords him great Curiosities […] Not a Creature so inanimate, to which he does not give a Tongue ; he makes the whole World Vocal ; he makes Flowers, nay, Weeds, speak eloquently, and by a noble kind of *Prosopopeia*, instructs Mankind.[88]

This is probably a description of the experimenter that both Power and Hooke might have identified and agreed with. But as the satire progresses, the description of Sir Gimcrack changes. He is described as:

> Clarin. A Sot, that has spent [£2000] in Microscopes, to find out the Nature of Eels in Vinegar, Mites in Cheese, and the Blue of Plums, which he has subtilly found out to be living Creatures.
> Miran. One who has broken his brains about the nature of Maggots ; who has studi'd these twenty years to find out the several sorts of Spiders, and never cares for understanding Mankind.[89]

This dialogue on mites in cheese, eels in vinegar et cetera refers explicitly to *Micrographia*. On mites, Hooke wrote: "a good *Microscope* discovers those small movable specks to be very prettily shap'd Insects, each of them furnish'd with eight well shap'd and proportion'd legs".[90] On Eels in vinegar he wrote only a short text, because:

> I shall add no other observations made on this minute Animal, being prevented herein by many excellent ones already publish'd by the ingenious, Doctor *Power*, among his *Microscopical* Observations.[91]

Over the course of the play Sir Gimcrack thus deteriorates. What Shadwell demonstrated through this character was what would happen if the experimenter crossed the narrow line of taking the microscopic objects of study too seriously. Sir Gimcrack is an experimenter who totally ignores the world around him and who only focuses on artificial experimental experience of the microscopic world. This makes him fail in his manliness and made him ridiculous in the eyes of the contemporary audience. When Shadwell let the virtuoso himself legitimise his choice of objects to study by saying that it is "below a *Virtuoso*, to trouble himself with Men and Manners. I study Insects",[92] the narrow line between the gentlemanly experimenter and the coxcomb had been crossed by far. In an illustrative scene, the virtuoso is learning how to swim on a table. His friend Sir Formal exclaims that frogs are "the most curious of all amphibious Animals (in the Art, shall I say, or rather Nature of Swimming)".[93] The scene

pinpoints Shadwell's criticism perfectly: the virtuoso seeks to learn how to swim not by the means of gaining common experience of it but by practicing in an artificial environment. The procedure is legitimised by the experimental study of a frog, through which Sir Formal can consider the virtuoso's strange way of swimming the "nature of swimming".[94] To further accentuate the irony of the virtuoso's experimental project, Sir Formal tells the virtuoso that he does not "doubt but your Genius will make Art equal, if not exceed Nature".[95]

But Shadwell did not just stop at showing Sir Gimcrack's experiments to be silly and artificial. As the play continues, the comic characters' failings in their arts backfire on their private lives and take on a sexual dimension.[96] Sir Samuel Hearty, a lover of comic disguises and trickery, dresses in drag but is discovered by Bruce and Longvil. They lock him up in a vault together with Sir Formal, who mistakes him for a lady and tries to take advantage of him: "Sweet Lady, let's make our condition as happy as in us lies".[97] But Hearty manages to intimidate him, making Sir Formal exclaim: "Upon my verity I think this be an Amazon".[98] Through their encounter, they are both rendered unmanly: Hearty because he is mistaken for a woman and Sir Formal because he mistakes Hearty's female appearance for his true nature (just as Sir Gimcrack mistakes the artificial for nature).

But the principal failure is the virtuoso himself. Lost in the world of insects and mites, Sir Gimcrack falls short in his role as a husband. Throughout the play he is constantly cuckolded by his wife, Lady Gimcrack. But by the end, she turns the tables on him, accusing *him* of being the unfaithful one: "I have broken open your Closet, and here are all your Letters from your several Whores".[99] Lady Gimcrack then threatens to "publish [them] into a bargain, and send 'em to *Gresham Colledge*",[100] making him "more despis'd than now [he is] there".[101] The shortcomings in his private life accentuate his failure as an experimentalist and vice versa, finally resulting in the immediate collapse of his role as husband as well as experimentalist.

Taken together, Sir Gimcrack should be seen as the archetype of the failed experimentalist. In this sense, the title of the play must be seen as ironic: the virtuoso Sir Gimcrack was the antithesis of what Pepys wanted to become through learning the microscopic art. By failing in the art of experimental science he mistakes the natural for the artificial as well as fails in becoming a gentleman.

Conclusion. Art, nature and microscopy

In this essay, I have sought to show how Hooke's and Power's words and pictures of the microscopic world existed in a social space, where what was at issue was not primarily the knowledge of the microscopic world

presented in their works. I have shown three very dissimilar receptions of Power's *Experimental philosophy* and Hooke's *Micrographia*. Not only do the three readers respond to the books in diverse ways, they use them for very different purposes.

Samuel Pepys read the books as a way of learning the art of microscopy, by which he sought to fashion himself as a gentleman. For Margaret Cavendish, it was not possible to relate to microscopy in the same way as Pepys (even though she did try to be accepted in the experimentalist community). Instead, she used *Micrographia* and *Experimental philosophy* as the basis for a philosophical critique of the experimentalist programme. This critique, based on the dichotomy of art and nature, was made possible by an ambiguity in the relation between art and nature in the works of the experimentalists. In *The virtuoso*, Thomas Shadwell depicted four men who became "coxcombs" by failing in their respective arts. The central character was the experimentalist Sir Gimcrack. Like Pepys, Sir Gimcrack sought to attain the gentlemanly role of the experimentalist. But where Pepys succeeded in balancing experimental practice with everyday responsibilities, Gimcrack was alienated from everyday life because he focused on the artificial world of lice, mites and weeds.

For Pepys to improve his status as a gentleman by the means of microscopic observations, he had to share the experimenters' trust in the art of microscopy. This involved sharing the view of the relationship between art and nature that made artificial experimental experience an unproblematic image of nature. Being a disinterested gentleman, Pepys seems to have accepted Hooke's proposal that gentlemen should see experimental philosophy "as a material and sensible Pleasure".[102] For Pepys, microscopic observation was an art which facilitated pleasurable conversations and gave him access to new social spaces. The difference from the single-minded Sir Gimcrack could not be clearer.

In these three responses to Hooke's and Power's works, we witness ambivalent attitudes towards experimentalists who based their knowledge on "artificial experience". On one hand, learning how to attain this kind of experience could, as for Pepys, be a way of gaining the social status of a gentleman. On the other hand, this was a dangerous approach, as one risked the criticism of being artificial, a criticism we observe in Cavendish's work and which is also embodied in the character of Sir Gimcrack.

I would argue that this ambivalence can be seen as an effect of the simultaneous use of two sets of definitions of the concepts of "art" and "nature" in the England of the 1660s. In the Baconian sense of art as manipulated nature, artificial experience was a way of taking control. According to this view, microscopists like Hooke, Power and Pepys could achieve dominion over nature through their experimental art. On the other hand, according to an Aristotelian view of art and nature, the arti-

ficial experimental experience was not a sufficient base for natural knowledge. Rather, microscopic experiences were deceptions that could fool the experimenter and in the end render him a Coxcomb. As Cavendish says: "How can a Fool order his understanding by Art, if Nature has made it defective"? Furthermore, through art even those who were not fools by nature, could still, in Shadwell's words, "with great Art and Industry make themselves so".

When trying to acquire a gentlemanly identity by conducting experiments, Pepys and the fictional character Sir Gimcrack had to relate to these two contradictory conceptual pairs simultaneously. On one hand, experimental philosophy could be seen as a way of gaining control over nature, which also implied gentlemanly self-control. On the other hand, experimental observations could be considered artificial, giving distorted images of nature that fool the observer. In this case, experimental experience was not a means to gentlemanly self-control, but to delusion. Cavendish instead established an external position from which she could criticise the experiments philosophically. From there, she could point out the inherent conflicts within the experimentalists' programme.

Pepys managed to balance these conflicting views. He was exited by what he saw through his microscopic lens and he seems to have shared the experimenters' Baconian view of art and nature. But he never lost himself in the microscopic world. After his short encounter with the microscope, his diary continues by covering other, vastly diverse, subjects. Where Sir Gimcrack is described as using the microscope to ignore the world around him, Pepys used it to interact with his peers. How these gentlemen situated their microscopic practice within their social context thus rendered their activities, and their own identities, radically different.

Summary

Reading art, reading nature. Forming the seventeenth-century gentleman through art and nature in readings of microscopic literature. By Jacob Orrje. This article discusses how two books on microscopical observations, *Experimental Philosophy* (1664) by Henry Power (1623–1668) and *Micrographia* (1665) by Robert Hooke (1635–1703) were related to by contemporaries. These books were read by diverse readers who used microscopic observations in forming their own identities. Samuel Pepys (1633–1703), Margaret Cavendish (1623–1673) and Thomas Shadwell (1642 –1692) all read Hooke's and Power's books and in their responses one can discern some of the roles microscopy had in early modern English society. What attitude did these readers, who responded from their respective positions, have to the experiences in *Micrographia* and *Experimental Philosophy*?

Samuel Pepys read the books as a way of learning the art of microscopy. He sought to fashion himself as a gentleman through microscopic

observations of nature. Margaret Cavendish did not relate to microscopy in the same way as Pepys. She used the books on microscopy in her philosophical critique of the experimentalist programme, a critique based on her seeing the microscopic picture as artificial. Thomas Shadwell's play *The virtuoso* depicted the fictional experimentalist Sir Gimcrack. Where Pepys succeeded in balancing experimental practice with everyday responsibilities, Gimcrack was alienated from everyday life because he focused on the artificial world of lice, mites and weeds.

The article shows how the way these three readers related to the books on microscopy was influenced by their opinions on the microscopic experience as either natural or artificial. Furthermore, it argues that one can discern an interaction between the readers' gender identities and their microscopic observations. In Pepys and Shadwell/Gimcrack's case how their gentlemanliness was formed in relation to their microscopic observations, in Cavendish's case how her critique of these observations gave her a position as a woman who published in natural philosophy.

Notes

1. This essay is a development of parts of my MA thesis, Jacob Orrje: "Narrating a new world. How microscopic experience was communicated through the words and images of Robert Hooke's *Micrographia*" (unpublished master thesis, Uppsala University 2008). I would like to thank Otto Sibum for his helpful comments on an early version of the essay and two anonymous reviewers for their valuable feedback. Bosse Holmqvist and Robert Österbergh have been kind enough to read and comment on the English in a final draft of this essay.

2. Henry Power: *Experimental philosophy, containing new experiments, microscopical, mercurial, magnetical,* (London, 1664), i–iii. All of the seventeenth-century books dealt with in this article have unnumbered prefaces. To facilitate my citations, I will refer to these prefaces with lower-case Roman numerals starting at the first page of the preface, as in this endnote.

3. Robert Hooke: *Micrographia or some physiological descriptions of minute bodies made by magnifying glasses with observations and inquiries thereupon* (London, 1665), i.

4. Power: *Experimental philosophy*, xix.

5. Ibid., xiii.

6. See for example, Steven Shapin & Simon Schaffer: *Leviathan and the air-pump. Hobbes, Boyle, and the experimental life* (Princeton, 1985); Steven Shapin: *A social history of truth. Civility and science in seventeenth-century England* (Chicago, 1994); Steven Shapin: "Pump and circumstance. Robert Boyle's literary technology" in *Social studies of science* 14:4 (1984); Donna Haraway: "Modest witness. Feminist diffractions in science studies" in Peter Galison & David Stump (eds.): *The disunity of sciences. Boundaries, contents, and power* (Stanford, 1996), 428–441; Adrian Johns: *The nature of the book. Print and knowledge in the making* (Chicago, 1998).

7. Steven Shapin: *A social history of truth. Civility and science in seventeenth-century England* (Chicago, 1994); Robert B. Shoemaker: "Reforming male manners. Public insult and the decline of violence in London, 1660–1740" in Tim Hitchcock (ed.): *English masculinities, 1660–1800* (London, 1999), 133–150; Philip Carter: *Men and the emergence of polite society. Britain 1660–1800* (Harlow, 2001). On the concept of "fact", see Barbara Shapiro: "The concept 'fact'. Legal origins and cultural diffusion" in *Albion*, 26:1 (1994), 1–26.

8. Jutta Schickore: *The microscope and the eye. A history of reflections, 1740–1870* (Chicago, 2007), 14–38; Larry R. Stewart: *The rise of public science* (Cambridge, 1992), 31, 361.

9. Hooke: *Micrographia*, xv.

10. For further examples of how books and lenses were used together, see Elizabeth Spiller: *Science, reading, and renaissance literature. The art of making knowledge, 1580–1670* (New York, 2004), 101–136.

11. Samuel Pepys: *The diary of Samuel Pepys. A new and complete transcription* 5 (1664; London, 1971), 48.

12. Ibid., 221.

13. Ibid., 223.

14. Ibid., 235.

15. Catherine Wilson: *The invisible world* (Princeton, 1995), 78.

16. Brian J. Ford: "The Royal Society and the microscope" in *Notes and records of the Royal Society of London* 55:1 (2001). For more information on the material history of the microscope, see Gerard L'Estrange Turner: *Essays on the history of the microscope* (Oxford, 1980).

17. Wilson: *The invisible world*, 80.

18. Pepys [1664]: *The diary of Samuel Pepys*, 241.

19. Power: *Experimental philosophy*, 1.

20. Ibid., 42.

21. Ibid., 51.

22. Christa Knellwolf: "Robert Hooke's *Micrographia* and the aesthetics of empiricism" in *The seventeenth century* 16:1 (2001), 182; Michael Aaron Dennis: "Graphic understanding. Instruments and interpretation in Robert Hooke's *Micrographia*" in *Science in context* 3:2 (1989), 309–364.

23. Knellwolf: "Robert Hooke's *Micrographia* and the aesthetics of empiricism", 182.

24. Pepys [1664]: *The diary of Samuel Pepys*, 241.

25. For more on the networks by which women excluded from the experimental community maintained a link to it, see Frances Harris: "Living in the neighbourhood of science. Mary Evelyn, Margaret Cavendish and the Greshamites" in *Women, science and medicine 1500–1700. Mothers and sisters of the Royal Society 1500–1700* (Stroud, 1997), 198–127.

26. Pepys [1664]: *The diary of Samuel Pepys*, 244.

27. Pepys: *The diary of Samuel Pepys. A new and complete transcription* 6 (1665; London, 1972), 2.

28. Hooke's *Micrograpia* initially sold for 30 shillings per copy. As a comparison, Pepys got his microscope for the price of £5-10-00, i.e. 110 shillings. See Allan Chapman: *England's Leonardo* (Bristol, 2005), 56.

29. Power: *Experimental philosophy*, 83.

30. Pepys [1665]: *The diary of Samuel Pepys*, 17.

31. Ibid., 18.

32. For a study of the use of images in *Micrographia* and *Experimental philosophy* and how the illustrations were related to the use of textual narrative, see Jacob Orrje: "Narrating a new world", 27–30. The pictures in *Micrographia* have been studied in Dennis: "Graphic understanding". See also John T. Harwood: "Rhetoric and graphics in *Micrographia*" in Michael Hunter & Simon Schaffer (eds.): *Robert Hooke. New studies* (Woodbridge, 1989), 119–147.

33. Actually, during this period, only Margaret Cavendish and Anne Conway, the Countess of Winchelsea, were simultaneously wives and authors. See David Roberts: *The Ladies. Female patronage of restoration drama 1660–1700* (Oxford, 1989), 7. On the other hand, the genres women participated in during this period have often been ignored in the history of science, see Elizabeth Tebeaux: "Women and technical writing, 1475–1700. Technology, literacy and development of genre" in Lynette Hunder & Sarah Hutton (eds.): *Women, science and medicine 1500–1700. Mothers and sisters of the Royal Society* (Stroud, 1997).

34. Pepys: *The diary of Samuel Pepys. A new and complete transcription* 8 (1667; London, 1974), 243.

35. Pepys: *The diary of Samuel Pepys. A new and complete transcription* 9 (1668–1669; London, 1976), 123f.

36. Hilda L. Smith: "Margaret Cavendish and the microscope as play" in Judish P. Zinsser (ed.): *Men, women, and the birthing of modern science* (DeKalb, 2005).

37. Elizabeth Spiller: *Science, reading, and renaissance literature* (New York, 2004), 141.

38. Ibid., 177.

39. Ibid., 176.

40. Cavendish: "Preface to the ensuing treatise" in *Observations upon experimental philosophy to which is added, the description of a new blazing world* (London 1668), vi.

41. Ibid., iv.

42. Ibid., iii; Power: *Experimental philosophy*, iii. In the 1660s the word "organ" was synonymous with "instrument" but could

also be used to describe discrete functions in a biological body or in a soul. See "organ" in *Oxford English dictionary*, 2 ed., 1989.

43. Peter Dear: *Discipline & experience. The mathematical way in the scientific revolution* (Chicago, 1995), 151–180. William R. Newman has a rather different take on the development as he sees seventeenth-century experimental philosophy as part of a longer tradition of working with a *natura vexata*, an art that perfects nature. William R. Newman: *Promethean ambitions* (Chicago 2004), 238–289. Furthermore, Lorraine Daston points out that this period did not embody a simple division between natural and nonnatural objects, but deployed a multifaceted set of concepts very much related to religion: natural, supernatural, preternatural and unnatural. Lorraine Daston: "The nature of nature in early modern Europe" in *Configurations* 6:2 (1998), 149–172.

44. *Hooke: Micrographia,* 2.

45. Cavendish: "To the reader" in *Observations upon experimental philosophy*, vii.

46. Peter Dear: *Discipline and experience*, 44.

47. Cavendish: *Observations upon experimental philosophy*, 7.

48. Ibid., 6–7.

49. Ibid., 8.

50. Ibid.

51. Ibid.

52. Ibid., 9.

53. Ibid.

54. Hooke: *Micrographia*, xxiv.

55. Ibid., xxiv.

56. Brian W. Ogilvie: "Image and text in natural history 1500–1700" in Wolfgang Lefèvre, Jürgen Renn & Urs Schoepflin (eds.): *The power of images in early modern science*, (Basel, 2003), 145.

57. Svetlana Alpers: *The art of describing. Dutch art in the seventeenth century* (London, 1983), 36.

58. Ibid.

59. Shapin & Schaffer: *Leviathan and the air-pump*, 62.

60. Cavendish: *Observations upon experimental philosophy*, 10.

61. Power: *Experimental philosophy*, xiix.

62. Sprat: *The history of the Royal Society*, 413.

63. Ibid., 413.

64. Ibid., 417.

65. Albert S. Borgman: *Thomas Shadwell. His life and comedies* (1928; New York, 1969), 160.

66. Ibid., 171f. See also Hooke: *Micrographia*, 213f, 242f.

67. Edward A. Langhans: "The theatre" in Deborah Payne Fisk (ed.): *The Cambridge companion to English restoration theatre* (Cambridge, 2000), 12, 18.

68. Robert Hooke: *The diary of Robert Hooke 1672–1680* (1672–1680; London, 1935), 235.

69. One should note that Hooke in 1676 was not the same man as the one who had published *Micrographia* in 1665. Through various setbacks and an intensive self-medication, Hooke's mental and physical health as well as his trust in others started to decline in the mid 70s. See Lisa Jardine: *The curious life of Robert Hooke. The man who measured London* (London, 2004), 214–216.

70. Harold Love: "Who were the restoration audience?" in *The yearbook of English studies* 10 (1980), 26.

71. Thomas Shadwell: "Prologue" in *The virtuoso* (London 1676).

72. Ibid., "preface".

73. The name indicates Sir Formal Trifle's role: a teller of lies wrapped in formal oratory or a teller of nonsensical sayings (see "trifle" in *Oxford English dictionary*, 2 ed., 1989)

74. Shadwell: *The virtuoso*, 4.

75. Even Sir Nickolas Gimcrack's name is revealing. Gimcrack in seventeenth-century language meant both a fanciful notion or a scientific/mechanical contrivance and an affected and showy person, synonymous with "a fop" (see "gimcrack" in *Oxford English dictionary*, 2 ed., 1989).

76. Shadwell: *The virtuoso*, 12.

77. Everett L. Jones: "Robert Hooke and the Virtuoso" in *Modern language notes*, 66:3 (1951); Shapin & Schaffer: *Leviathan and the air-pump* 70. A more recent study by Tita Chico also argues that Gimcrack alludes to Robert Hooke. See, Tita Chico: "Gimcracks's legacy. Sex, wealth, and the theatre of experimental philosophy" in *Comparative drama* 42:1 (2008), 31.

78. The satire hidden in this name is more obscure, but could refer to the use of the word 'hearty' to denote a person giving unrestrained expression to the feelings (see "hearty" in *Oxford English dictionary*, 2 ed., 1989).

79. Shadwell: *The virtuoso*, 5.
80. Not supprisingly, 'snarl' in seventeenth-century England could mean to quarrel, or to be to be against a person or thing (see "snarl" in *Oxford English dictionary*, 2 ed., 1989).
81. Shadwell: *The virtuoso*, 12.
82. Ibid., 36.
83. Ibid., iii.
84. Ibid.
85. Ibid., "Drammatis personae".
86. Ibid., 24.
87. Philip Carter: *Men and the emergence of polite society*, 128.
88. Shadwell: *The virtuoso*, 9.
89. Ibid., 12.
90. Hooke: *Micrographia*, 213f.
91. Ibid., 217.
92. Shadwell: *The virtuoso*, 49.
93. Ibid., 28.
94. Ibid.
95. Ibid.
96. For a further discussion on the use of sexuality in *The virtuoso*, see Tito Chico: "Gimcrack's legacy".
97. Shadwell: *The virtuoso*, 57.
98. Ibid.
99. Ibid., 95.
100. Ibid.
101. Ibid.
102. Hooke: *Micrographia*, xv.