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## Newton and the Netherlands

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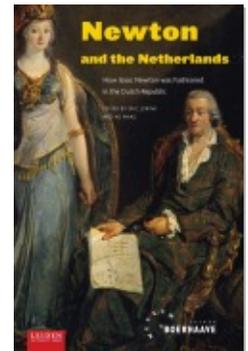
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# The Man Who Erased Himself

## *Willem Jacob 's Gravesande and the Enlightenment*

AD MAAS

It is a well-known fact that the Leiden professor Willem Jacob 's Gravesande was one of the most influential advocates of Isaac Newton. It is equally well-known that he was the author of the first 'Newtonian' physics handbook and attracted large numbers of students from all over Europe to Leiden University with his courses on experimental physics, in which he demonstrated the laws of nature with his self-designed instruments. Several of his students followed in his footsteps, spreading Newton's word at the universities of the Dutch Republic and abroad.<sup>1</sup> As recent research has revealed, 's Gravesande was also actively involved in the diffusion of the *Principia* in the Netherlands.<sup>2</sup> In addition, 's Gravesande's lesser known metaphysical and philosophical views have also been the subject of historical investigation: see in particular the clear expositions by Kees de Pater and Paul Schuurman.<sup>3</sup>

's Gravesande was indeed a leading figure, not only as a champion of Newton, but also in a broader sense as a pioneer of the so-called mainstream, or 'moderate' Enlightenment, which sought to harmonize reason, science and rationality with religion. Jonathan Israel describes him as 'the Leiden professor who did more than anyone else to engineer the triumph of English philosophy and science in the Dutch mainstream Enlightenment in the 1720s'.<sup>4</sup> However, his influence went far beyond the Dutch Republic. 's Gravesande was one of the main initiators of Anglomania – the absorbing hunger for English ideas and achievements in Europe in the 1730s and 1740s.<sup>5</sup>

In the literature, 's Gravesande's Newtonianism is mainly (and



Fig. 1:  
 Willem Jacob  
 's Gravesande.  
 (Etching by J.  
 Houbraken, after  
 a drawing by J.  
 Wandelaar, 1725–1750)

implicitly) described as the outcome of his personal considerations, namely as the fruits of his own convictions, consciousness, inner development and reasoning. In addition to this 'conceptual' approach, I would like to consider 's Gravesande in this article as a man of his time and culture. I will regard him and his ideas more particularly against the background of the political situation, rivalling scientific factions, religious sensitivities and the developments in the Republic of Letters in general and Leiden University in particular. This article will focus on 's Gravesande as a natural philosopher and will not address his less influential philosophical work.

To what extent, then, can we relate the development of 's Gravesande's convictions, preferences and way of reasoning to the cultural, political and academic circles in which he lived and functioned? In answering this question, I will look at his family background and youth, his experiences in the world of higher politics, his role in the

Republic of Letters and his performance as a professor at Leiden University. In my conclusion, I will further elaborate on what appears to be 's Gravesande's leitmotiv: the pursuit of 'unprejudiced', 'true' knowledge. But first I will briefly set out what 's Gravesande's Newtonianism actually involved: there do appear to be reasons to look beyond the workings of his inner self.

### **The invisible philosopher<sup>6</sup>**

In his works, 's Gravesande expressed the conviction that the natural philosopher's task was to investigate the natural laws with which God had created an orderly world for mankind to live in. Empirical studies and analogical and mathematical reasoning were the sources (and the *only* sources) to obtain 'true' knowledge of the natural world. All other means of arriving at higher truths are to be rejected, in particular deductive reasoning not sustained by observation as advocated by Descartes. Newton's physics proved to be useful for 's Gravesande in his attempt to harmonize modern natural philosophical ideas with his religious views.

's Gravesande elaborated his epistemology in his *Oratio de evidentia* (1724). In his view, God had given man the use of his five senses to observe the outside world and had granted him the capacity for reasoning by analogy to detect the regular patterns in these observations. In this way, we are able to derive useful information from the outside world. We can, for instance, watch the sun set and the sun rise and establish, by analogical reasoning, that each sunset is always followed by a sunrise. Thanks to a third tool, testimony by others, we are also able to obtain knowledge about events that happened in other places and in the past. We know, for instance from the reports of others, that Leiden University was founded in 1575.

It would be absurd to assume that an 'infinitely good' God created an entire world for humans to live in, without allowing them the skills to make optimal use of that world. Indeed, our senses, our ability to draw analogies and the testimonies of others enable us, when used with discrimination, to gather information from the outside world that is 'obviously' true. Knowledge thus obtained is 'morally evident'. 's Gravesande even regarded knowledge based on moral evidence no less irrefutable than the unshakable truths that can be obtained by 'mathematical evidence', which is the other source of 'certain' knowledge.

By giving a prominent role to moral evidence in his epistemology, 's Gravesande argued that the outside world, God's creation, was a main source of irrefutable knowledge. At the same time, he limited the role of the philosopher's own imagination, or hypotheses as he would call it. 's Gravesande pleaded for a type of modest philosopher, which is evident also from his interpretation of Newton's body of ideas.

As several contributions in this volume show, there is no such thing as a universal, monolithic Newtonianism. When we speak of 's Gravesande's Newtonianism, we speak of his personal interpretation of Newton's ideas. A brief glance at 's Gravesande's famous handbook *Physices elementa mathematica* (first edition 1720–1721), for instance, immediately makes clear that the book was not Newtonian in the sense that it simply explained Newton's theory: 's Gravesande's book was much wider in scope; it was really a handbook on mathematical physics, and it was 'Newtonian' because it pursued the Newtonian method of looking for mathematical regularities in nature on the one hand, and sought to establish the primacy of experiment and observation on the other. Accordingly, it contained systematic descriptions of experiments to support the theoretical expositions, and only brief treatments (or the omission) of topics that could not be treated mathematically (electricity, magnetism, meteorology).

Some aspects of 's Gravesande's interpretation of Newton are worth noting. Firstly, he consistently rejected 'feigning hypotheses' (i.e. not based on mathematical reasoning or empirical data)<sup>7</sup> even more than Newton himself – for example, he disregarded Newton's particle interpretation of light, which he must have considered too hypothetical.<sup>8</sup> Secondly, his preoccupation with finding true, unprejudiced knowledge excluded arguments simply based on the authority of a revered scholarly person, even if this was no less a figure than Isaac Newton. His point of view in the *vis viva* question, for instance, is striking. In the debate on whether the 'force' of an accelerated object increased proportionally with the velocity (*quantitas motus*) or with the square of the velocity (*vis viva*) 's Gravesande – convinced by his own experiments – publicly sided with Leibniz *cum suis*, thereby defying his idol and mentor Isaac Newton. Figure 2 shows the fall apparatus 's Gravesande used. It contained a layer of clay in a tray, in which 's Gravesande dropped brass balls of varying weights; he found that the same product of height and weight caused identical impressions in the clay.



Fig. 2:  
's Gravesande's fall  
apparatus. (Museum  
Boerhaave, V09630)

These two examples show us that in his search for truth, 's Gravesande tried as much as possible to limit human interference – he did not accept assumptions simply based on authority, or any *hypotheses* – as they only served to corrupt the study of nature. The only safe ways to arrive at higher truths were to observe nature and to employ both mathematical rigour and an innate, rather commonsensical use of analogical reasoning. The results of natural philosophy should not bear the marks of individual imagination, prejudice or personality. 's Gravesande's objective, therefore, was – in my words – to 'depersonalize' the study of nature. It even landed him in conflict with a few fanatical British Newtonians (like Samuel Clarke) and orthodox Calvinist ministers, who felt his epistemology could be interpreted as a limitation of the free will. Eventually, 's Gravesande was even accused of being a 'Spinozist'.<sup>9</sup>

There were limits to 's Gravesande's 'depersonalization'. His personal praise of Newton was both consistent and sincere. Yet above all he

remained an independent spirit who apparently managed to maintain a strict divide between epistemological views on the one hand and metaphysical and religious views on the other. If we wish to trace the roots of 's Gravesande's Newtonianism, we will not necessarily find them in his religious and metaphysical convictions. We will also have to look for them elsewhere.<sup>10</sup>

### Youth

Willem Jacob 's Gravesande was born in 's-Hertogenbosch (Bois-le-Duc), a town in the Catholic south of the Dutch Republic, in 1688. Yet the 's Gravesandes – or Storm van 's Gravesande as the full family name was – were not Catholics. The family belonged to the Protestant administrative upper echelon of 's-Hertogenbosch (the Catholic areas in the south, the so-called 'Generality Lands', were treated like occupied territories and were governed by the States-General). The roots of the Storm van 's Gravesande family can be traced to the province of Holland, more specifically to the city of Delft.<sup>11</sup> Willem Jacob's ancestors were already Calvinists when the Beeldenstorm (the Iconoclastic Fury) raged over the Low Countries in 1566. Some of them were convicted and banned from Delft because they had taken part in the uprising. Following the successful expulsion of the Catholics in 1572, however, members of the 's Gravesande family succeeded in obtaining vacant positions in Delft's city government. Half a century later, the 's Gravesandes in Delft apparently had lost some of their influence. It was Willem Jacob's grandfather Laurens who moved to 's-Hertogenbosch, as by this time he and his relatives were no longer able to secure places in Delft's city administration.<sup>12</sup>

The move took place after the conquest of 's-Hertogenbosch by stadtholder Frederik Hendrik in 1629. According to 's Gravesande's biographer (and successor) Jean Nicolas Sébastien Allamand (1713–1787), it was the stadtholder who offered Laurens 's Gravesande a number of posts in the administration.<sup>13</sup> In 's-Hertogenbosch, the pious Calvinist 's Gravesandes had to maintain themselves as part of a small Protestant minority and preserve their Protestant identity in a 'hostile', Catholic area. From his earliest youth, Willem Jacob must have been aware of religious dissent.

As a patrician's son, Willem Jacob was educated by a private teacher called Isaac Tourton. According to Allamand (whose biographical description does not appear reliable in every respect), Tourton's les-

sons encouraged 's Gravesande's talents and interest in mathematics. Together with two of his brothers, however, Willem Jacob was destined for the study of law at Leiden University. Perhaps his later, characteristic, preoccupation with obtaining 'unprejudiced' judgements was fostered by his legal education. He studied law from 1704 to 1707, during which period he is also said to have written his first mathematical treatise: *Essai de perspective*. This, however, was not published until 1711.

He did not receive a degree in the faculty of philosophy. There is also no evidence that he ever attended the courses and demonstrations of the philosophy professors Burchardus de Volder (1643–1709) and Wolferd Senguerd (1646–1724); in any case he never appears to have defended a philosophical or mathematical disputation under their direction.<sup>14</sup> 's Gravesande did not seem to be considering an academic career in this field by this time. After finishing his thesis on suicide – he maintained that it was a reprehensible deed<sup>15</sup> – he set up practice as a barrister in The Hague. His contacts with the Swiss mathematician Nicolaus (I) Bernoulli (1687–1759) and the physician and mathematician Bernard Nieuwentijt (1654–1718) show that he was still engaged in mathematics at the time.<sup>16</sup>

### Higher politics

The Dutch Republic was torn by an ongoing battle between the stadtholders and their followers, the Orangists, and the Republican States Party which – as the champions of '*Ware Vrijheid*' (True Freedom) – sought to limit the stadtholder's powers, or even eliminate the stadtholderate altogether. The latter faction dominated in the first stadtholderless period, which lasted from 1650 to 1672. After the '*Rampjaar*' (Disaster Year) of 1672, however, the Orangists gained the upper hand when the powerful William III (1650–1702) became stadtholder (assuming also the crowns of England, Scotland and Ireland after the Glorious Revolution of 1688–1689). William III died in 1702, two years before 's Gravesande enrolled in Leiden. The Orangists did not manage to have a new stadtholder elected and 's Gravesande would spend the rest of his life in a stadtholderless Dutch Republic (the Frisian stadtholder did not have much power).

Immediately after the death of William III, the Republic had to cope with the War of the Spanish Succession, which broke out in 1702 and ended with the Treaty of Utrecht in 1713. This war proved to be financially disastrous for the Dutch Republic; in fact, it was the last pan-

European conflict in which the Dutch Republic played an important, leading role and marked the end of the Republic as a major player on the European stage.<sup>17</sup>

In the aftermath of this conflict two camps were formed with opposing ideas on the Republic's foreign policy. The first sought to increase the military strength of the Republic, combined with a pro-British stance, in order to check French expansionism. The other camp was more concerned with Dutch trade opportunities than with French threats and tried not to involve the Republic in Britain's international intrigues against France and Bourbon Spain, in particular, which would only harm Dutch commercial interests. Some feared that England was heading for a new war with France. These two camps – the pro-British and the pro-trade parties – incidentally did not necessarily overlap with the traditional Orangist and Republican factions in Dutch society.<sup>18</sup>

Someone who definitely belonged to the pro-British party was Arent Wassenaer van Duyvenvoorde (1669–1721). This powerful Dutch nobleman, a great favourite of William III (he had been chosen to join William in his victorious voyage to Britain during the Glorious Revolution) was married to Anna Margaretha Bentinck (1683–1763), a daughter of William III's bosom friend Hans Willem Bentinck (c. 1649–1709), created 1st Earl of Portland in 1689. Wassenaer van Duyvenvoorde's brother-in-law was one of the powerful 'Whig lords' under George I (1660–1727). Van Duyvenvoorde regarded the alliance with England not only in political but also in religious terms; it was his strong conviction that the two Protestant states had to join forces to resist the Catholic threat from France.

Everything in Wassenaer van Duyvenvoorde's personality negated the stereotypical image of the 'enlightened', well-balanced man of reason. The Scottish diplomat J. Drummond called this staunch Protestant nobleman an 'unmanageable, turbulent, interested spirit', who inspired fear in many. Shrewdly combining intrigue, corruption and power politics, he tried to consolidate his position in the world of Dutch higher politics. His opponents called him 'proud', 'hot-tempered', and 'money-mad'.<sup>19</sup>

In 1715 the States-General sent Wassenaer van Duyvenvoorde to England as a special envoy to congratulate George I on his accession to the throne. His second mission was to try and muster British support for the tough negotiations with Emperor Charles VI (1685–1740)

regarding the ‘Dutch barrier’ in the Southern Netherlands. This barrier involved a line of fortified towns in Belgium to protect the Republic against a possible French invasion. With George’s accession, the Whigs ousted the Tories in the British government, making Wassenaer van Duyvenvoorde with his Whig connections the obvious person to assume the ambassadorship (even though his enemies in the *ridder-schap* of Holland, one of the seven colleges of nobles in the Republic, strongly opposed his appointment).<sup>20</sup>

Wassenaer van Duyvenvoorde decided to take the young lawyer Willem Jacob ’s Gravesande with him as his ‘first secretary’. It is not clear why he asked ’s Gravesande. The two families were not related by marriage, nor have I found evidence of any other contacts existing between the two men. Even so, the journey would prove to be a turning point in the life of Willem Jacob.

Besides the administrative work involved in the job of secretary, ’s Gravesande in London took part in the ongoing round of visits, audiences, official dinners and other ceremonies regulated by complex protocols, which made up a great part of the delegation’s obligations.<sup>21</sup> In addition, he sometimes also acted as a private teacher to Duyvenvoorde’s son Brilanus. He taught the boy mathematics, a discipline beyond the competence of the ‘second secretary’ of van Duyvenvoorde’s delegation, Justus van Effen (1684–1735), who was the boy’s main tutor. Van Effen was no stranger to ’s Gravesande, because both men were on the editorial staff of the *Journal littéraire* (see next section). Duyvenvoorde apparently wanted only the best teachers for his son: a third tutor hired by him was no less a figure than John Theophilus Desaguliers (1683–1744), fellow of the Royal Society, and performer of spectacular demonstrations. Desaguliers became friends with ’s Gravesande and later translated his physics handbook into English.<sup>22</sup>

A few months after arriving in England, ’s Gravesande was elected as a member of the Royal Society. It was not – as one might expect – Desaguliers who introduced him, but an old university friend, William Burnet (1687–1729). ’s Gravesande met president Isaac Newton in person at the Royal Society. Unfortunately, no account exists of this meeting. In view of his attempts to ‘depersonalize’ the study of nature, ’s Gravesande will have regarded with special interest the way in which the Royal Society used the experimental method to avoid an ‘ad hominem’ type of debate and to reduce human interference in natural philosophy.<sup>23</sup>

William Burnet is an interesting member of 's Gravesande's network. He was the son of Bishop Gilbert Burnet (1643–1715), a Whig who had been among the first English subjects to transfer his allegiance to William and Mary. As one of the closest confidants and trusted counsellors of William, Gilbert Burnet became the head of his propaganda machine, which coordinated the efforts to win the hearts and minds of the British people for the new royal couple in the aftermath of the Glorious Revolution. It is almost certain that Gilbert must have known Huyvenoorde from these days. Gilbert Burnet, incidentally, was also acquainted with Newton, who likewise opposed the policy of James II (1633–1701), the king who was ousted during the Glorious Revolution. Newton's good standing with the new regime turned out well for his career and his public status.<sup>24</sup>

William Burnet was born in the Dutch Republic, where his father lived as an expatriate between 1686 and 1688.<sup>25</sup> He was named after William III, who was his godfather. In 1707 William studied at Leiden University, where he became acquainted with 's Gravesande.<sup>26</sup> As a member of the Royal Society, William Burnet was able to provide him with an introduction.

Allamand claimed that his personal encounter with Newton had far-reaching consequences for 's Gravesande's ideas about natural philosophy. However, he certainly knew of Newton's work before.<sup>27</sup> In May 1714 – a year before he went to England – he had already written to the English scholar. In this case, too, it was Burnet who paved the way. Burnet already acted as an intermediary between Newton and the latter's criticaster Johann Bernoulli (1667–1748) (at the time professor in Groningen). Bernoulli had published his criticism of the *Principia* in the *Acta eruditorum* in February and March 1713, but the work in question was not yet available in England. Burnet asked 's Gravesande to send a copy of the *Acta eruditorum* to Newton, which he did, together with a letter, in which he humbly offered his services '*dans toutes les occasions que je pourai vous estre de quelque utilité dans ce pais*'.<sup>28</sup> Apparently it was a ploy of Burnet and 's Gravesande, to give the latter an excuse to get in touch with Newton. 's Gravesande may have become interested in English philosophers through his contacts with the Burnets, or possibly through other British subjects connected to the court in The Hague (or perhaps – as will be mentioned later – by early Dutch 'Newtonians' like Bernard Nieuwentijt).

In spite of his not altogether polished diplomatic bearing, Wasse-

naer van Duyvenvoorde's mission was a success. The so-called Barrier Treaty was signed with the Austrian emperor with English support, while a new alliance was at the same time forged between England and the Dutch Republic. By May 1716 the mission had been successfully completed.

Had 's Gravesande not been a personal favourite of or political-ly useful to Wassenaer van Duyvenvoorde, it would have been highly improbable that the latter would have taken efforts to secure him a professorship in Leiden. After all, he was a man who thought in terms of clientelism, power and interests. According to Allamand, it had been Newton himself who had persuaded Duyvenvoorde to recommend the curators in Leiden to appoint 's Gravesande to a chair. Duyvenvoorde was on good terms with his (distant) relative Willem, Baron Wassenaer, Lord Starrenberg and Ruyven (1649–1723), who was chairman of the board of curators of Leiden University. In 1717 the latter seems to have secured the chair in 'astronomy and mathematics' for 's Gravesande, a chair that had been vacant for some years (in 1734 'philosophy' was added to his professorial duties).

's Gravesande's appointment has been taken too much for granted in the research carried out on this topic so far. Whereas Leiden University had a reputation for appointing professors with considerable professional experience,<sup>29</sup> 's Gravesande had no appreciable scientific reputation at the time he was offered a chair. His only published feat was his *Essai de perspective*, which had met with the approval of the scholarly community. He did not have much experience as a teacher, nor did he have a degree in philosophy in his pocket (even though this was not an important requirement at the time).

's Gravesande's appointment, therefore, was a sample of unadulterated nepotism. The parallels with his predecessor Jacques Bernard (1658–1718) are worth mentioning. This French theologian certainly did not have a reputation as a natural philosopher before (or, for that matter, after) his appointment, even though in 1705 he succeeded no less a person than De Volder, who had put experimental physics firmly on the map at Leiden University (see below). It is very likely that De Volder's instruments for experimental demonstrations, which had cost the university curators a considerable sum of money, were completely ignored by Bernard. Interestingly, he seems to have been favoured by the curators because he championed British philosophers.<sup>30</sup>

I set out in the first section why, from the conceptual point of view,

Newton's ideas suited 's Gravesande very well. However, embracing the British philosopher may also have been instrumental in securing the patronage of powerful pro-British Dutchmen and English Whigs and a possible chair at one of the most prestigious universities of Europe. We will probably never know the true reason behind 's Gravesande's appointment. We may, however, conclude that the Anglo-Dutch connection, which offered 's Gravesande a stage to unfold his (Newtonian) ideas, indirectly contributed to the mainstream Enlightenment and the Anglomania that swept over Europe in the 1730s and 1740s.

### Republic of Letters

After having settled in The Hague as a lawyer – in the years before his trip to England – 's Gravesande moved in the literary and intellectual circles of booksellers, publishers and writers of this city. Quite a few of these men of letters were French (Huguenot) refugees, others were British, and occasionally linked to the court like the Burnets. 's Gravesande married the daughter of a French refugee family, Anne Sacrelaire. In 1713 he was involved in founding the *Journal littéraire de La Haye* and joined its editorial staff. At the time similar learned periodicals were published in the Republic, mostly run by French Huguenot refugees, aimed at informing the Republic of Letters, in French, about what was going on in the scholarly world. A large section of the *Journal littéraire* was devoted to book reviews. In addition, there were sections containing news about books and the Republic of Learning. Also, the journal offered room for discussion among readers.

An interesting feature of the *Journal littéraire* – and a novelty as well – was that the editors acted as a collective. They spoke with one voice, which meant that contributions were never signed with the name of an individual editor or the chief editor; all these remained anonymous. Book reviews written by one of the editors were commented on during the weekly meetings. In this way, the editorial staff hoped (besides benefiting from the specific expertise of the individual editors) to eliminate any personal preoccupations on the part of the reviewer and present an unbiased review. By not signing their contributions, the editors were able to avoid the risk of being considered as the spokesman of a certain group. It was imperative to shun every appearance of partisanship.

The journal started with a board of six editors. Four of them – Prosper Marchand (1678–1756), Henry Alexandre, Albert Henri de Sallen-

gre (1694–1723) and Thémiseul de Saint-Hyacinthe (1684–1746) – had French roots (although Sallengre was born in The Hague). A few of them had quite radical opinions. The other two were Dutch – ’s Gravesande and Justus van Effen. The publisher, Thomas Johnson (1677–1735), was Scottish.<sup>31</sup>

For the *Journal littéraire* ’s Gravesande wrote reviews on physical and mathematical works and probably on physico-theological publications, as well.<sup>32</sup> His (naturally anonymous) review of Nicolas Hartsoecker’s *Suite des conjectures physiques et des éclaircissements sur les conjectures physiques* (1712) led to a debate with the author about Newton’s theory of planetary motion. But ’s Gravesande also published articles relating to his own studies, as for instance his exposition on improvements of the air-pump and his contribution to the hotly debated *vis viva* question. Finally, he also published on ethical issues (such as liberty and falsehood) in the *Journal littéraire*.<sup>33</sup>

It looks as if his Leiden professorship in 1717 marked the end of ’s Gravesande’s editorship of the *Journal littéraire*. Nevertheless, he always remained loyal to the magazine’s principles. In 1729 ’s Gravesande, together with his friend Prosper Marchand, attempted to revive the *Journal littéraire*. Again they opted for a collective editorship – even though in the past this lofty formula for unprejudiced journalism had sometimes proved a little over-idealistic.

The *Journal littéraire* was founded at a time of growing unease in the Republic about French influence, or the ‘Frenchification’ of Dutch culture. Critics, for instance, discerned a culture of imitation in the field of literature, which was dominated by French classicism. Architecture, painting, fashion in clothes, even in wigs, gardening, interior decorating, and the style of conversation of the upper classes were also copied from the French. Many opponents to the trend of Frenchification, which was regarded as a threat to native Dutch culture, believed that French immigrants, in particular, were responsible for the dreaded invasion.

These adversaries tried to counter the taste for French customs by stressing the roots of national cultural identity, which they believed was especially to be found in Dutch literature adhering to classical principles.<sup>34</sup> In addition, English culture was enlisted to stop Frenchification. Van Effen for instance, who strongly denied the superiority of French culture, asserted in 1711 that the ‘new’ English philosophers who were emerging on the European scene, in particular Newton and

John Locke (1632–1704), might counterbalance French cultural domination.<sup>35</sup> 's Gravesande, closely associated with Van Effen as a fellow editor of the *Journal littéraire* and fellow secretary of Duyvenvoorde, never publicly expressed an opinion about Frenchification or the 'strategic' values of the English culture. However, by propagating the English philosopher Newton, he was in actual fact second to none in strengthening the desired English cultural 'counterbalance'.<sup>36</sup> As was the case in the world of higher politics, Dutch cultural and scholarly communities had their reasons to embrace English scholars and writers.

The position taken by Van Effen and 's Gravesande was of course an ambivalent one. As editors of the *Journal littéraire* they contributed to a 'French' periodical (one which was even produced on Dutch soil). The *Journal littéraire* was in fact the first French journal in the Republic to employ Dutch editors. Thus especially Van Effen, who made no secret about his low opinion of the state of Dutch literature, ironically became one of the chief targets for the adversaries of the Frenchification of Dutch culture.<sup>37</sup>

Van Effen and 's Gravesande apparently regarded the use of French with greater nuance than did the criticasters of the *Journal littéraire*. They realized that to write in French was not paramount to accepting the superiority of French culture in all respects. In fact, by writing in the very language that was fast growing into the *lingua franca* of the eighteenth century, their advocacy of English philosophers and writers actually reached the widest possible audience.

### Academic world

Being a follower of Newton offered a very practical advantage for the way 's Gravesande managed to organize his classes: the characteristic emphasis on mathematics and empiricism in Newton's natural philosophy coincided perfectly with his own interests. 's Gravesande's fondness for designing and improving instruments supported the empirical part of his courses. 's Gravesande had been experimenting with air-pumps since he was a student. As a professor – together with instrument maker Jan van Musschenbroek (1687–1748) – he would devise many innovative machines.<sup>38</sup>

It must be emphasized that the use of demonstration instruments in Leiden University's physics classes was not introduced by 's Gravesande. It was one of his predecessors, the professor of philosophy and

(eclectic) Cartesian Burchard de Volder, who first made use of demonstration experiments in his (public) courses in 1675. He founded a *theatrum physicum* (physics theatre) with the financial support of the governors of the university. De Volder's colleague Wolferd Senguerd, appointed extraordinary professor in peripatetic philosophy in 1675, likewise conducted experiments in the presence of his students.<sup>39</sup>

's Gravesande, officially appointed professor of astronomy and mathematics in 1717, was only able to use the *theatrum physicum* for public lectures after the death of Senguerd in 1724, when he became its director. In his early days as a university professor, however, he demonstrated physics instruments at home during his lucrative private courses (to attend private courses, students had to pay their professors a fee). More than had been the case in De Volder's or Senguerd's courses, experiments were systematically interwoven with the subjects on the curriculum. 's Gravesande acquired great fame, in particular, with these courses.

According to Adriaan Cornelis de Hoog and Gerhardt Wiesenfeldt, De Volder introduced the experimental method to find a way out of the heated metaphysical arguments in which natural philosophy had become hopelessly entangled. From the 1640s onwards, the Dutch universities had been afflicted by religious and philosophical controversies, with orthodox Calvinists confronting their more liberal fellow believers. Roughly along the same divide, scholastics opposed Cartesians. The years 1672–1673 in particular had been troublesome for Leiden University.<sup>40</sup> De Volder, tired of the continuing metaphysical controversy and also increasingly critical of some of Descartes' views, decided to seek refuge in the new experimental natural philosophy coming from Britain. Following the example of the Royal Society, De Volder saw in the experimental method a way of detaching natural philosophy from philosophical and religious arguments. The experimental method yielded empirically obtained, irrefutable 'matters of fact' capable of superseding bitterly contested dogmatic arguments. Thus scientific instruments – the air-pump especially became the paragon of this experimental approach – were employed to get the university, and natural philosophy in particular, out of hot water.<sup>41</sup>

The empirical method, which relied on 'eyes and hands' rather than on 'minds and tongues', was regarded as the pre-eminent tool to reduce human agency in the practice of natural philosophy.<sup>42</sup> If this also applies to 's Gravesande, his use of instruments was in agreement

with the other activities discussed above: the collective performance of the editorial staff of the *Journal littéraire* and the ‘depersonalized’ appreciation of – even – Newton’s work. This was yet another example of separating – in modern words – the object from the subject. In his experimental courses it was the machines that produced knowledge, not the mind of the professor.

However, there were also more earthly reasons to found the physics theatre, which, it was hoped, would attract more students. De Volder himself asserted that he was convinced that the ‘usefulness and entertainment of the proposed pursuit of experiments’ would draw ‘many students from other universities and schools elsewhere’.<sup>43</sup> ’s Gravesande regarded demonstrations a means to make the physics courses more accessible and attractive to wider audiences. In a letter to Newton, he wrote: ‘as I talk to people who have made very little progress in mathematics I have been obliged to have several machines constructed to convey the force of propositions whose demonstrations they had not understood’.<sup>44</sup> ’s Gravesande even enchanted his students with a magic lantern, which projected slides showing images of satyrs, dwarfs and Arcadian landscapes, and an anamorphoscope (a distorted picture that takes on a normal appearance only when seen in an appropriately shaped, mostly cylindrical or pyramidal, mirror).<sup>45</sup> Such demonstrations could hardly have served other ends than to lend ’s Gravesande’s courses a touch of entertainment and spectacle. It will have brought him extra students and, perhaps not unimportantly, extra income.

The various types of instruments used by ’s Gravesande are all described in his textbook (down to the magic lantern, to be found in the chapter on telescopes and microscopes), with one notable exception, namely the ‘useful’ machine models which appeared in the *theatrum physicum* from the 1730s onwards. The windmills, a dredging machine, even a steam engine, and so on, were apparently meant to have an emblematic character and demonstrated ’s Gravesande’s deep-rooted conviction that God had created nature, and its laws, in the service of humankind. In other words, the models had to show how man might benefit from nature in the pursuit of his own well-being, a theme that cannot be considered typically ‘Newtonian’. The presentations in ’s Gravesande’s physics theatre, in short, offered the audience the cutting edge in physics, combined with entertaining and – religiously inspired – moralistic elements. The students were offered much more than sheer Newtonian physics and philosophy.

From a broader perspective, the ostentatious use of instruments was consistent with the policy of the university governors to enhance the reputation of Leiden University as a Dutch – even European – centre of science and to attract (affluent) students by building rich collections. Thus, the botanical garden was enlarged (1687–1688), important collections of books and manuscripts were purchased (especially the enormous collection of Isaac Vossius in 1690, which among a host of natural philosophical and mathematical works contained a copy of the *Principia*), the observatory was upgraded (1689), the anatomical theatre was fitted out with *curiosa* and a chemical laboratory was founded (1669). In the Baroque era, Leiden University thus tried to present itself as the most exquisite university of Europe.<sup>46</sup> The spectacular collection of physics demonstration instruments clearly suited this policy.

's Gravesande made it a point of honour to present difficult subjects in an accessible and clear manner. In the same way as he attracted students with 'very little progress in mathematics' by offering experimental courses, his *Physices elementa mathematica* was the first comprehensible handbook to disseminate Newtonian physics. The board of the *Journal littéraire*, too, took considerable efforts to present its contributions in a clear and accessible style; the journal had a reputation for its lucidity. 's Gravesande regarded it as a main task to communicate difficult topics to wider audiences.

's Gravesande's love of mathematics, as we have seen, dated from his youth. Mathematics had traditionally played an important role in Dutch culture, but at the time of 's Gravesande's appointment in 1717, the discipline had been discredited by philosophers like Descartes and especially Spinoza, who used the mathematical method to unfold his 'ungodly' views.<sup>47</sup> In his inaugural lecture, 's Gravesande felt a need to defend the use of mathematics by contending that mathematical reasoning, when soundly applied, instead provided only useful insights into the working of nature. He referred to Isaac Newton's natural philosophy as a prime example of the profitable use of mathematics.<sup>48</sup> Newton, he felt, could help rehabilitate mathematics.

's Gravesande's concern for mathematics coincided with that of the 'Amsterdam mathematicians' who were among Newton's first supporters in the Dutch Republic – men like Bernard Nieuwentijt, already mentioned earlier, and Lambert ten Kate (1674–1731; see Dijksterhuis and Jorink and Zuidervaart in this volume) belonged to this

small, informal group. Not only did they think Spinoza had damaged the reputation of mathematics, they also worried in particular about the moral dangers inherent in his 'atheist' views. By using (part of) Newton's work, they hoped to offer mathematical arguments to confirm religious truth.<sup>49</sup>

Although 's Gravesande will have appreciated the attempts of the 'Amsterdam mathematicians' to counter Spinoza's blasphemous and geometrical method of reasoning, his own writings do not reveal a similar pious engagement with religious matters.<sup>50</sup> When 's Gravesande refers to Spinoza by name in his oration 'De vera et nunquam vituperate, philosophia' (1734), it is to condemn his 'abuse' of mathematics. In fact 's Gravesande, who as described observed a strict divide between epistemology and metaphysics, quietly (and undetected by historians so far) managed to dissociate Newton's natural philosophy from the metaphysical and theological concerns of Newton's Dutch followers. Bearing in mind the still fresh memories of the bitter metaphysical controversies in the Dutch philosophical faculties in the recent past, it may even have been an important instrument to help introduce Newton's natural philosophical system into the Dutch academic curriculum. Following this line of argument, we may perhaps conclude that 's Gravesande did for Newton's philosophy what De Volder had achieved for natural philosophy at large, by introducing the empirical method forty years before.<sup>51</sup>

### Conclusion

From his earliest days on, 's Gravesande lived in places where people of different religious, political and philosophical persuasions had to try and find a *modus vivendi*. In 's-Hertogenbosch he was part of a Protestant enclave in a largely Catholic environment, at Leiden University a delicate balance was kept between strictly orthodox and more religiously moderate scholars and in Leiden and The Hague he moved in circles of expatriate French Huguenots and British subjects closely associated with the court. Perhaps moulded by these experiences, his own attitude was that of an independent thinker. Though he entertained strong convictions, he avoided partisanship and clearly managed to cooperate with people of other religious persuasions. That 's Gravesande firmly embraced Newton's natural philosophy, consequently, did not make him a dogmatic Newtonian.

Adhering to Newton's natural philosophy had beneficial practical

effects for 's Gravesande. He obtained both powerful patrons and a professorship as well as a means to award his beloved instruments an essential role in his teaching. In addition, Newton's natural philosophy helped to restore the reputation of mathematics. Also, assuming that, like Van Effen, he wanted to check the Frenchification of Dutch (and European) culture, it was a good strategic choice to promote British philosophers.

There is definitely something unsatisfactory about this conclusion. The problem is that all arguments rest on circumstantial evidence. We have no clear proof whether political or personal interests, rather than 'inner convictions', did or did not motivate his interest in the English natural philosophy of Isaac Newton. We do not know for sure if he was actually an Orangist or if he worried about the contamination of Dutch culture by French customs and style. Furthermore, if he did not accept arguments merely on authority in matters of natural philosophy, would not this conviction also extend into the political and religious spheres? Did he indeed develop deist inclinations, as Israel has recently suggested?<sup>52</sup> Did he use his instruments for intrinsic, methodological reasons, or simply to attract more students and to make money? Did he purposely detach Dutch Newtonianism from religious matters?

No characterization exists which gives us a good impression about what kind of person 's Gravesande was. Who was this exceptional figure, both a prominent journalist and a renowned professor, who as the son of one of the governors of a provincial town frequented circles of French freethinkers and who as a man of reason nevertheless moved in the cynical world of higher, Machiavellian politics? He seems to have been endowed with good social skills. He was deeply struck by the death of his sons and he is said to have been a man with a great sense of duty, but also a man of principle who stood by his opinions. But for the rest? Even the expansive biographical sketch of Allamand, who was very close to 's Gravesande, does not really bring out his personal traits and motives. Nor is it possible to deduce them from other testimonies. Do we have to conclude that our attempts to consider 's Gravesande in the context of his time will not give us a deeper understanding of his personality and convictions?

However, at a closer look, is not precisely the relative 'invisibility' of his personality consistent with his persuasions? Let us briefly summarize the conclusions of the previous sections. In his natural

philosophy, 's Gravesande did everything to avoid the interference of the imagination; he 'depersonalized' natural philosophy. His contributions to the *Journal littéraire* remained concealed behind the collective. In his courses, the apparatuses almost physically detracted attention from himself. He kept his natural philosophy separate from his religious sentiments. Another notable thing is the only personal criticism of 's Gravesande I have come across, which was that in the first two editions of his *Physices elementa mathematica* he did not name his sources.<sup>53</sup> Did he, as this criticism seems to suggest, want to appropriate the work of others? Or was this again a perhaps naïve but consistent example of downplaying the personal element? He did not claim intellectual ownership of his instruments, but rather helped to disseminate the designs by describing and drawing them in detail in his handbook.<sup>54</sup> The only thing *De boekzaal van Europa* has to mention about him in the obituary notice is that he did not want a funeral oration (which, incidentally, was not unusual). No personal papers and hardly any correspondence have survived of 's Gravesande (although this might not have been his own, deliberate choice). We know 's Gravesande's work very well, but we do not know the person behind the work: did he – consciously or unconsciously – 'depersonalize' himself?

It is a matter of speculation, but 's Gravesande's experiences with people of different philosophical and religious backgrounds may have taught him not to hold prejudices against people because of their (divergent) ideas. A person and his opinions are two different things. What we see in fact occurring in the activities of 's Gravesande is a principal, idealistic and fundamental separation between the person and his ideas. Nowadays every journalist, scientist and politician is familiar with this separation (or at least should be). Anyone who engages in public debates ought to confront ideas and opinions, but not the person expressing them.

We see 's Gravesande and his contemporaries – like his fellow editors of the *Journal littéraire* – actually attempting in a very deliberate manner to construct a division line between a person and his ideas. Perhaps they were inspired by the British experimentalists around Robert Boyle (1627–1691) to end pedantry and the contentiousness among scholars by introducing 'gentlemanly conventions' in the scholarly community (see also the previous section). Rejection of authority and the seeking of truth by a 'selfless self', who is not chasing celebrity

or personal benefit, was part of the values propagated by them.<sup>55</sup> It is interesting to see that 's Gravesande observed the separation between person and ideas more strictly than we do – we tend to allow more of our own personality into our professional work and opinions than he did (twenty-first century journals in general do not have editors who are willing to act as an anonymous collective). It is also interesting to notice that the question has not lost anything of its topicality since the days of 's Gravesande.

Thus, 's Gravesande lives on as an elusive person, a *Mann Ohne Eigenschaften* (man without qualities), whom we mainly know through his work and his ideas. Let us simply respect this and let the person 's Gravesande rest in an undoubtedly peaceful obscurity.

## Notes

- 1 For instance: J.N.S. Allamand, 'Histoire de la vie et des ouvrages de Mr. 's Gravesande', in: J.N.S. Allamand (ed.), *Oeuvres philosophiques et mathématiques de Mr. G.J. 's Gravesande* (Amsterdam 1774), pp. x-lix; P.L. Rijke, 'Levensschets van Willem Jacob 's Gravesande', *Album der natuur: een werk ter verspreiding van natuurkennis onder beschaafde lezers van allerlei stand*, nieuwe reeks 27 (1879), pp. 65–88; C. de Pater, 'Willem J. 's Gravesande', in: A.J. Kox (ed.), *Van Stevin tot Lorentz: portretten van achttien Nederlandse natuurwetenschappers* (Amsterdam 1990), pp. 81–92; C. de Pater, 'Inleiding', in: C. de Pater (ed.), *Willem Jacob 's Gravesande, welzijn, wetenschap en wijsbegeerte* (Baarn 1998), pp. 23–58; P. de Clercq, 'The 's Gravesande collection in the Museum Boerhaave, Leiden', *Nuncius* 1 (1988), pp. 127–137; R. Vermij, *The Calvinist Copernicans: the reception of the new astronomy in the Dutch Republic, 1575–1750* (Amsterdam 2002), pp. 335–348.
- 2 Jorink and Zuidervaart in this volume.
- 3 De Pater, *Welzijn* (note 1); C. de Pater, 'Willem Jacob 's Gravesande, een newtoniaans filosoof', *Wijsgerig perspectief op maatschappij en wetenschap* 29 (1988–1989), pp. 7–12; C. de Pater, 'Willem Jacob 's Gravesande (1688–1742) and Newton's *Regulae Philosophandi*, 1742', *Lias: sources and documents relating to the early modern history of ideas* 21 (1994), pp. 257–294; P. Schuurman, *Ideas, mental faculties and method: the logic of Descartes and Locke and its reception in the Dutch Republic* (Leiden, Boston 2004), pp. 129–155.
- 4 J. Israel, *Radical Enlightenment: philosophy and the making of modernity, 1650–1750* (Oxford 2001), p. 524.
- 5 Ibidem, pp. 555–568.

- 6 This section is largely based on: De Pater, *Welzijn* (note 1).
- 7 On the other hand, in his epistemology 's Gravesande saw wider applications than Newton for using hypotheses to generate knowledge. These, however, ought to be deployed in a strict manner, according to a set of six rules formulated by 's Gravesande: Schuurman, *Ideas* (note 3), p. 153.
- 8 Fokko Jan Dijksterhuis recently focused on a case whereby 's Gravesande's treatment of optics was actually more 'hypothetical' than Newton's: F.J. Dijksterhuis, 'Reading up on the *Opticks*: Refashioning Newton's theories of light and colors in eighteenth-century textbooks', *Perspectives on science* 16 (2008), pp. 307–327, on 311. Even for inveterate opponents of 'using hypothesis', it sometimes proved difficult in practice not to lapse into speculative arguments: see, in particular, De Pater in this volume.
- 9 J. Israel, *Enlightenment contested: philosophy, modernity, and the emancipation of man, 1670–1752* (Oxford 2006), pp. 215–222.
- 10 See also Jorink and Zuidervaart in this volume.
- 11 The main source of 's Gravesande's biography is the account written by his successor Allamand: Allamand, 'Histoire' (note 1); see also J.N.S. Allamand, "'s Gravesande", in: P. Marchand, *Dictionnaire historique ou mémoires critiques et littéraires*, 2 vols. (The Hague 1759), vol. 2, pp. 224–227. However, as the genealogic research of Koenen has shown in particular, Allamand's description of 's Gravesande's origins is not always accurate: H.J. Koenen, 'Het geslacht van professor 's-Gravesande', *Algemeen Nederlandsch familieblad* 11 (1885), pp. 261–268. See also: A. van der Wijck, 'Bijdrage tot de genealogie der familie Storm van 's Gravesande', *Heraldieke bibliotheek* 2 (1873), pp. 121–144.
- 12 Koenen, 'Geslacht' (note 11), p. 266.
- 13 Allamand (ed.), *Oeuvres* (note 1), p. ix-x.
- 14 G. Wiesenfeldt, *Leerer Raum in Minervas Haus: experimentelle Naturlehre an der Universität Leiden, 1675–1715* (Amsterdam 2002), p. 248.
- 15 W.J. 's Gravesande, *Dissertatio juridica inauguralis de autocheiria* (Leiden 1707).
- 16 E. Shoesmith, 'The continental controversy over Arbuthnot's argument for divine providence', *Historia mathematica* 14 (1987), pp. 133–146; R. Vermij, *Secularisering en natuurwetenschap in de zeventiende en achttiende eeuw: Bernard Nieuwentijt* (Amsterdam 1991), pp. 118–120.
- 17 J. Israel, *The Dutch Republic: its rise, greatness, and fall* (Oxford 1995), pp. 968–975 and 985–986.
- 18 *Ibidem*, pp. 988–989.
- 19 J. Aalbers, 'Factieuze tegenstellingen binnen het college van de ridder-schap van Holland na de vrede van Utrecht', *Bijdragen en mededelingen betreffende de geschiedenis der Nederlanden* 93 (1978), pp. 412–445; P.J. Buijnsters, *Justus van Effen (1684–1735): leven en werk* (Utrecht 1992), pp. 48–56.

- 20 Ibidem; Th. Bussemaker, 'De Republiek der Vereenigde Nederlanden en de keurvorst-koning George I', *Bijdragen voor vaderlandse geschiedenis en oudheidkunde*, 4th series, 1 (1900), pp. 263–344; R. Geikie and I.A. Montgomery, *The Dutch barrier, 1705–1719* (Cambridge 1930).
- 21 On the tasks of a secretary: J. Aalbers, *De Republiek en de vrede van Europa* (Groningen 1980), pp. 283–286.
- 22 Buijnsters, *Justus van Effen* (note 19), pp. 99–114. Desaguliers' translation: *Mathematical elements of natural philosophy confirmed by experiments: or an introduction to Sir Isaac Newton's philosophy* (London 1720); on Desaguliers, see also Jorink and Zuidervaart in this volume.
- 23 S. Shapin and S. Schaffer, *Leviathan and the air-pump: Hobbes, Boyle, and the experimental life* (Princeton 1985).
- 24 L. Jardine, *Going Dutch: how England plundered Holland's glory* (London 2008), pp. 310–314.
- 25 Ibidem, pp. 27–52.
- 26 L. Maass, *Het Journal littéraire de La Haye (1713–1723): de uitwendige geschiedenis van een geleerd tijdschrift* (PhD thesis, Katholieke Universiteit Nijmegen, 2001), p. 158n.
- 27 See also Jorink and Zuidervaart in this volume.
- 28 W.J. 's Gravesande to I. Newton, 28 May 1714, in: H.W. Turnbull, A.R. Hall and L. Tilling (eds), *The correspondence of Isaac Newton*, 7 vols. (Cambridge 1976), vol. 6, pp. 144–145; W. Burnet to J. Bernoulli, 8 April 1714, in: ibidem, pp. 96–97. See also: R.S. Westfall, *Never at rest: a biography of Isaac Newton* (Cambridge 1980), pp. 741–744.
- 29 W. Otterspeer, *De vesting van de macht: de Leidse universiteit, 1673–1775. Groepsportret met dame* (Amsterdam 2005), p. 77.
- 30 Israel, *Contested* (note 9), p. 70.
- 31 Maass, *Het Journal littéraire de La Haye* (note 26); Buijnsters, *Justus van Effen* (note 19), pp. 75–98.
- 32 About physico-theology in the *Journal littéraire*: H. Bots and J.J.V.M. de Vet, 'De fysico-theologie in het *Journal littéraire*: Haagse journalisten ten strijde tegen het ongelof', *Documentatieblad werkgroep achttiende eeuw* 18 (1986), pp. 213–226.
- 33 Allamand, 'Histoire' (note 1), pp. xii–xxi; De Pater, *Welzijn* (note 1), p. 154; C. Berkvens-Stevelinck, 'Nicolas Hartsoeker contre Isaac Newton ou pourquoi les planetes se meuvent-elles?', *Lias: sources and documents relating to the early modern history of ideas* 2 (1975), pp. 313–322.
- 34 W.W. Mijnhardt, 'Dutch culture in the age of William and Mary: cosmopolitan or provincial?', in: D.E. Hoak and M. Feingold (eds), *The world of William and Mary: Anglo-Dutch perspectives on the revolution of 1688–89* (Stanford 1996), pp. 219–233.
- 35 Buijnsters, *Justus van Effen* (note 19), p. 71.
- 36 Israel, *Radical Enlightenment* (note 4), pp. 515–527.

- 37 Mijnhardt, 'Dutch culture' (note 34), pp. 229–230.
- 38 P. de Clercq, *At the sign of the Oriental Lamp: the Musschenbroek workshop in Leiden, 1660–1750* (Rotterdam 1997), pp. 73–102; P. de Clercq, *The Leiden Cabinet of Physics: a descriptive catalogue*, Museum Boerhaave Communications 271 (Leiden 1997).
- 39 E.G. Ruestow, *Physics at 17th- and 18th-century Leiden* (The Hague 1973); Wiesenfeldt, *Leerer Raum* (note 14); A.C. de Hoog, *Some currents of thought in Dutch natural philosophy, 1675–1720* (PhD thesis, Oxford University, 1974), pp. 122–256.
- 40 For this controversy, see also: W. van Bunge, *From Stevin to Spinoza: an essay on philosophy in the seventeenth-century Dutch Republic* (Leiden, Boston, Köln 2001); Th. Verbeek, *Descartes and the Dutch: early reactions to Cartesian philosophy, 1637–1650* (Carbondale, Edwardsville 1992); J.A. van Ruler, *The crisis of causality: Voetius and Descartes on God, nature and change* (Leiden, New York, Köln 1995).
- 41 De Hoog, *Some currents* (note 39), p. 143; Wiesenfeldt, *Leerer Raum* (note 14), pp. 7 and 111–112; Otterspeer, *Vesting* (note 29), pp. 54 and 108.
- 42 Shapin and Schaffer, *Leviathan* (note 23).
- 43 Wiesenfeldt, *Leerer Raum* (note 14), p. 62.
- 44 's Gravesande to Newton, 13/24 June 1718, in: A. Rupert Hall, 'Further Newton Correspondence', *Notes and records of the Royal Society of London* 37 (1982–1983), pp. 7–34 [original in French].
- 45 De Clercq, *Leiden Cabinet of Physics* (note 38), pp. 108–124.
- 46 Otterspeer, *Vesting* (note 29), pp. 95–145.
- 47 Van Bunge, *Stevin to Spinoza* (note 40); R. Vermij, 'The formation of the Newtonian philosophy: the case of the Amsterdam mathematical amateurs', *British journal for the history of science* 36 (2003), pp. 183–200.
- 48 'Oratio inauguralis de Matheseos omnibus scientiis, praecipue in Physicis, Usu, nec non de Astronomiae perfectione ex Physica haurienda'; Dutch adaptation in: De Pater, *Welzijn* (note 1), pp. 72–86.
- 49 Vermij, 'Formation' (note 47).
- 50 By the time 's Gravesande had been appointed, 'Amsterdam mathematicians' like Nieuwentijt and Ten Kate had come to realize the fruitlessness of their attempts to support religion by mathematical argument. They now directed their attention to physico-theological reasoning, which aimed at providing a more 'empirical' evidence for God's providence. See: Vermij, 'Formation' (note 47), pp. 194–196. For Ten Kate see Dijksterhuis in this volume.
- 51 On the other hand, before 's Gravesande entered the stage, the religious and metaphysical aspects inherent in Dutch Newtonianism may also help to explain the 'remarkable consensus' among professors like Senguerd, De Volder and Jacob le Mort (1650–1718) that 'Newtonian philosophy [...] was not considered an appropriate alternative for the purposes of

- Leiden University', in: Wiesenfeldt, *Leerer Raum* (note 14), p. 10.
- 52 Israel, *Contested* (note 9), pp. 215–222 and 395.
- 53 G.A. Lindeboom, *Herman Boerhaave: the man and his work*, 2nd ed. (Rotterdam 2007), p. 216.
- 54 De Clercq, 'Collection' (note 1), p. 129.
- 55 S. Shapin, *A social history of truth: civility and science in seventeenth-century England* (Chicago, London 1994), esp. pp. 123–124.

