

## Vital Matters

### Boerhaave's Chemico-Medical Legacy and Dutch Enlightenment Culture

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#### Summary of research proposal

Eighteenth-century Dutch chemistry and medicine have by and large been ignored. Many historians have argued that with Herman Boerhaave's death in 1738 the 'Golden Age of Dutch science' had come to an end. The next momentous phase allowed for in this narrative is the big chemico-medical Revolution inaugurated by the work of Lavoisier towards the end of the eighteenth century. This research project takes issue with this view and in so doing takes its cue from recent initiatives towards a re-appreciation of eighteenth century history of chemistry. The project offers a new and unique perspective by identifying the Boerhaavian vitalist tradition as central to Dutch Enlightenment science and culture. Instead of viewing Boerhaave as the 'end of an era', this project studies Boerhaave as the beginning of something excitingly new. And instead of fitting Boerhaave into the 'old' (Cartesian / Newtonian) mechanical tradition, the project aims at identifying Boerhaave as a 'father' of the new vitalist thinking in Enlightenment Europe.

What was so special about Boerhaave's legacy, *i.e.* how did it give direction to Enlightenment medicine and why does it merit extensive historical research? The project proposed here is built on the premise that Boerhaave's pupils continued Boerhaave's emphasis on chemically exploring the many 'latent peculiar powers of bodies'. In three sub-projects on (1) the physiology of the bodily fluids, (2) Boerhaavian alchemy and (3) Enlightenment neurology, the project analyses how Boerhaave's Dutch followers made the vital principles of matter central to their medicine.

Methodologically the present project leaves the well-trodden path of studying vitalism in the perspective of the history of ideas. It is innovative in bringing recent theories on the material aspects of scientific practices to the study of vitalism. In so doing the research offers a new perspective on Dutch Enlightenment science and culture.

#### Research aim

This project aims at analysing how Boerhaave's chemistry became pivotal in eighteenth-century Dutch medicine. The import of the project, however, goes much further than writing a reception history of Boerhaave's ideas. The different projects tie in with current historiographic concerns with the traditional divide between artisanal epistemology and practices on the one hand and academic (scientific) knowledge on the other as well as with ongoing discussions on materiality. A focus on the history of chemistry for medicine allows the researchers to develop new perspectives on the histories of eighteenth-century chemistry for medicine and Enlightenment thought, with three concrete goals: (1) to illuminate the importance of manual and sensual engagement with nature for our understanding of eighteenth-century academic medicine; (2) to explore the various uses and changing meanings of (al)chemical materials and procedures in medicine and (3) to emphasize the importance of vital principles for eighteenth-century Dutch medicine and culture. The project challenges the view that Boerhaavian medicine was rooted in a 'Scientific Revolution' mechanical understanding of the body-machine. With its emphasis

on the Boerhaavian vital principles of matter, the project offers a new perspective on the Enlightenment body.

## Introduction

Without doubt Herman Boerhaave (1668-1738) was the most famous and influential medical teacher in early eighteenth-century Europe. Historians of science and medicine have often attributed Boerhaave's import and popularity to (1) his excellent capacities as *clinical* teacher<sup>1</sup> and (2) his promotion of a mechanistic medicine.<sup>2</sup> However, the image of Boerhaave as clinical teacher has no grounding in the sources and the image of Boerhaave the mechanist is far too simple.<sup>3</sup> In the latter part of his academic career Boerhaave no longer believed the mechanical philosophy could fully explain the workings of the body. Instead Boerhaave stressed the importance and uses of chemistry for medicine – a fact which has been largely overlooked by Boerhaave scholars.<sup>4</sup> Although the difference between mechanics and chemistry was diffuse, Boerhaave argued that unlike the mechanicians who captured the working of nature into a few general laws of matter and motion, chemistry better explained the many non-mechanical latent powers of bodies, so Boerhaave emphasized the workings of seminal principles (which he called 'threads of the warp!'), various spirits, *vis vitalis* and the Ancient moving principles of *hormê* and *enormôn*.

Boerhaave's followers established chemistry for medicine in medical faculties across Europe. Unlike other historical studies which have mainly focused on Boerhaave's *British* pupils<sup>5</sup>, the research proposed here is about the *Dutch* Boerhaavians, most notably Hieronymus Gaub (1705-1780), Johannes de Gorter (1689-1762), Abraham Kaau (1715-1758) and Frederick Winter (1712-1760). The project takes as its starting point Boerhaave's last research and teaching projects: (1) on the purification of mercury and (2) on nervous diseases. Both topics became of pivotal importance in the Leiden school of medicine which shows that Boerhaave's interest in chemistry as an independent discipline auxiliary to medicine, his emphasis on the working of vital powers, his interest in alchemical materials and techniques, and his concern for the nervous system all gave direction to eighteenth-century medicine. Ultimately Boerhaave's teaching led to a devaluation of the mechanical philosophy in eighteenth-century physiology.<sup>6</sup>

The project builds on the premise that Boerhaave's chemico-medical legacy was intricately tied up with Enlightenment thought. It gives the Boerhaavians a central role in shifting the seventeenth-century understanding of the Cartesian body (essentially defined in opposition to *res cogitans*, the thinking mind) in the direction of redefining the Enlightenment body in vitalist terms. Rather than presenting a static image of the body, the project analyses the Enlightenment body as a series of problems and debates or a 'pocket' where projects of intellectual expansion and material knowledge circulated and continuously challenged the nature and understanding of the body.<sup>7</sup> It focuses on Enlightenment pre-occupations with the multitudinous aspects of the flesh and of bodily functions.<sup>8</sup> At the same time it puts the

<sup>1</sup> Most notably Lindeboom (1968) and Risse (1987).

<sup>2</sup> See among others Luyendijk-Elshout (1982), Cook (2000), Debus (2001).

<sup>3</sup> Beukers (1987) and Knoeff (2010).

<sup>4</sup> Knoeff (2002), see also Powers (forthcoming).

<sup>5</sup> See Lindboom (1974), Ashworth-Underwood (1977), Christie (1994).

<sup>6</sup> See Brown (1974), Guerrini (2000) and Knoeff (forthcoming 2011b).

<sup>7</sup> Shapin in Rousseau and Porter (1980) pp. 111-112, Outram (1995) p. 3. See also Reeves (2010).

<sup>8</sup> Porter (2003).

body's vital principles centre stage and thus seeks to understand how eighteenth-century Dutch medical teachers addressed the problem of mind (and soul)-body dualism.<sup>9</sup> In so doing the project follows the suggestion of Elizabeth Williams to analyse the body's 'vitalism' as a cultural movement, indicative of dynamic cultural activity, which was fully part of the Enlightenment.<sup>10</sup>

### **Theoretical Framework and historiography**

The work of a number of historians is particularly important to the project: (1) historians working on the shared worlds of material and knowledge production (2) historians working on the history of materials and materiality and (3) historians working on the emergence of vitalist ideas in eighteenth-century Enlightenment medicine.

#### *Material and knowledge production*

The project follows the lead of historians of science and medicine who have stressed the relevance of the down-to-earth experience of working with materials, objects, techniques and chemical substances for early modern natural philosophy.<sup>11</sup> In particular the Dutch were extremely skilled *handworkers*, since the rise of commerce in the early modern Republic instigated the advancement and social upgrading of artisanal skills and knowledge. In academia, the Dutch were among the first to employ instrument makers and to install laboratories. Boerhaave was an important proponent of this Dutch academic tradition in which artisanal and scholarly knowledge went hand in hand. Ursula Klein has recently presented Boerhaave as having abolished the "traditional dichotomy between the hand and the mind" and as having taught chemistry in carefully linked theoretical and practical terms.<sup>12</sup> Hence, Boerhaave never gave his students ready-made prescriptions, but he taught them methods in order to experiment themselves.<sup>13</sup> Boerhaave's pupils were likewise involved in incorporating hands-on chemical knowledge in academia. Thus the project follows the recent attention for what Lissa Roberts has called "the mindful hand", and analyses how Boerhaave's disciples fully integrated the handiwork of chemical practices as well as the things produced in the laboratory into medical theory and practice.

#### *Materials and materiality*

An important part of the project is centred on the chemistry of the fluids of the body as well as on the (al)chemical materials healing and representing the body. As such the project takes its inspiration from recent research on the history of materials. Most notably Ursula Klein and Wolfgang Lefèvre started questioning the provenance of the processed chemical substances that late seventeenth-century and eighteenth-century academic chemists studied in their laboratories (instead of only looking at how natural philosophers experimented with particular substances or looking at theories about salts, blood and other substances). The project follows their suggestion that "chemical substances were multidimensional objects of inquiry that could be investigated in practical and theoretical contexts and that amalgamated perceptible and imperceptible, useful and philosophical, technological and scientific, social and natural features".<sup>14</sup> In other words, materials moved

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<sup>9</sup> See also Rousseau (1990) and Wright & Potter (2000).

<sup>10</sup> Williams (2003) p. 11.

<sup>11</sup> Smith (2004), Klein et al (2007), Cook (1993, 2002 and 2007) and Roberts et al (2007).

<sup>12</sup> Klein (2003) p. 547.

<sup>13</sup> Knoeff (2010).

<sup>14</sup> Klein and Lefèvre (2007) p. 1. See also Klein and Spary (2010), Daston (2004).

in and between different knowledge domains, thereby continuously acquiring different values and meanings. Even so, the bodily and chemical substances which are the subject of the proposal were differently identified from chemical, medical, artisanal and patients' points of view for which they each constituted distinctly diverse objects of inquiry.<sup>15</sup> Thus, the project analyses the materials relevant to the body as locations of knowledge, where scientific and cultural concerns intersected.

### *Vitalism*

The project challenges the primarily Anglo-Saxon emphasis on Newton and Newtonian physiology as explanatory framework for the emergence of eighteenth-century vitalist theories (vitalism being the theory that the origin and phenomena of life are produced by a vital principle, as distinct from a mechanical force).<sup>16</sup> Instead, it analyses the introduction of vital principles or vital matter as a result of Boerhaave's teaching on the chemistry and physiology of 'latent peculiar powers'. Three authors are of principal importance: (1) Hubert Steinke has recently stressed the undervalued but important position of the eighteenth-century Netherlands as a centre of vitalism. He has, moreover, suggested that we should not study Dutch vitalism as a reaction against the prevailing Boerhaavian mechanism, but rather as "a development of Boerhaavian thought".<sup>17</sup> The research proposed here builds on this insight and investigates a direct link between Boerhaave's teaching and the work of his followers. (2) Peter Hanns Reill studied the intellectual move from mechanism to vitalism in the latter half of the eighteenth century.<sup>18</sup> Yet, unlike Reill's work which is mainly focused on a broad history of ideas, the research proposed here follows (3) Elizabeth Williams' suggestion that vitalism should not be treated as a set of abstract theories or disembodied ideas, but as a broad discourse of medicine that developed in the local practices of everyday life (*i.e.*, in the classroom, at the bedside, in publications etc.).<sup>19</sup> More precisely, Boerhaavian vitalism originated in the chemical laboratory, where *in vitro* experiments proved the existence and working of vital principles.

Although all three above-mentioned issues of "the mindful hand", "materiality" and "vitalism" resonate throughout the three subprojects, each project is primarily devoted to one aspect. Project (1) analyses the Boerhaavian focus on bodily fluids as a result of the hands-on use of chemistry for medicine. Project (2) addresses the issue of materiality while discussing the use and representation of (al)chemical substances in medicine. Synthesizing project (3) explicates the significance of medical vitalist thought as a novel way of understanding the Dutch Enlightenment.

### **Project 1: Blood, Sweat and Tears (aio, 1 fte, 4 years)**

*The central aim of project 1 is a description and analysis of the Boerhaavian physiology of the fluids which was rooted in his chemistry of living things. It moves beyond the popular image of the body machine. Instead, through following the eighteenth-century focus on chemical explanations of the states and movements of the humors, the project describes the body as an assemblage of individually localized chemical procedures, physiological concerns and Enlightenment debate. The project is centred on the hypotheses that the Boerhaavian ideas*

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<sup>15</sup> See also Orland (2010).

<sup>16</sup> See Guerrini (1985, 1986 and 1987), Brown (1974), Roe (1984 and 2003).

<sup>17</sup> Steinke (2005) pp. 201, 34-35.

<sup>18</sup> Reill (2005).

<sup>19</sup> Williams (2003).

differed from the mechanical physiology; that chemical practices affected the physiology of bodily fluids; and that the new physiology of fluids reflected Enlightenment concerns.

In his *Elementa chemiae* (1732) Boerhaave presented chemistry as the best method for investigating the individual natures of the bodily fluids and he described many *in vitro* chemical experiments on the nature of blood, lymph and other humors in order to explain the life and motion of the body. Boerhaave, however, did not present the body as a kind of chemical laboratory, but he presented chemical experiments and methods as important means to show the effects of chemical reactions inside as well as outside the body. Moreover, like many of his fellow chemists, Boerhaave as well as his pupils attempted to transform bodily humors into chemically defined and researchable objects.<sup>20</sup> In other words, the Enlightenment body, put forward by the Boerhaavians, must be understood in the context of laboratory work.

The Boerhaavian turn to the bodily fluids is reminiscent of the Ancient stress on the body's fluids.<sup>21</sup> However, whereas the Ancient interest in blood, bile and phlegm was mainly related to pathology (*i.e.*, indicative of disease) Boerhaavian physicians took the normal and healthy state of the fluids as their focal point of research. Moreover, while the Ancients explained illness in terms of humoral disbalances, the Boerhaavians were more likely referring to a change in the (chemical) make-up of the bodily fluids themselves. And it was precisely the Boerhaavian emphasis on chemico-medical practices – an emphasis which fitted Enlightenment concerns with the flesh and bodily functions ('equally seen as a source of pleasure and a nuisance, in need of care, attention and apology')<sup>22</sup> – which resulted in a focus on the bodily fluids.

The research will start with an analysis of laboratory practices based on (1) Boerhaave's experiments and (2) the experimental practices of his disciples beginning with those of Gaub. So far most research on Boerhaave's chemistry has focused on the theoretical part of his chemistry textbook.<sup>23</sup> Yet, the collection of 227 chemical "processes" offers important clues as to how Boerhaave identified the fluids of the body, as a result of the fusion of manual and mental labour. According to Klein "much of the fame of Boerhaave's *Elementa chemiae* relied on this second, practical part of the book".<sup>24</sup> Indeed, Boerhaave's insistence on the use of practical chemistry for medicine was exemplary in the work of his disciple Hieronymus Gaub. In 1731 Gaub argued in his inaugural lecture that chemical research on fluids such as saliva, lymph, blood and urine would lead to a better understanding of the body. Based on this premise and emphasizing the chemical aspect of illness, Gaub wrote his *Institutiones pathologiae medicinalis* (1758), which, until the early nineteenth century, was the internationally leading textbook on pathology.

### *Timetable*

Year 1: study of secondary sources on the history of medicine in the eighteenth century, Herman Boerhaave, and the history of Dutch eighteenth-century culture; Start with reading Boerhaave's chemical and medical textbooks; Refining of research hypothesis and questions.

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<sup>20</sup> See also Orland (2010).

<sup>21</sup> See among others French (2003) and Nutton (2004).

<sup>22</sup> Porter (2003), 25.

<sup>23</sup> Except Klein (2003).

<sup>24</sup> Klein (2007) p. 29.

Year 2: Analysis of Boerhaave's experiments; Start working on Gaub.

Year 3: Continuation of the analysis of the work of Gaub and others (as directed in the research of year 1 and 2) in relation to Enlightenment culture.

Year 4: writing of the thesis.

### **Project 2: Quicksilver Doctors (Marieke Hendriksen, 1 fte, 4 years)**

*The project is concerned with the materiality of the human body as well as with the materiality of substances (metals in particular) affecting the life and motion of the body. It is principally focused on the question of how the materiality of a substance was related to its supposed vital (and decidedly non-material) powers. Eighteenth-century alchemical materials – mainly metals – were considered particularly potent substances in medicine. Moreover, since alchemy has always involved both experimental practices and metaphorical meanings rooted in culture and society, the project seeks to analyse eighteenth-century alchemy as a (historically undervalued) part of broader Enlightenment thought. Central hypotheses are that the Boerhaavians integrated alchemical practices and materials into Dutch Enlightenment medicine; and that a better appreciation of alchemy in medicine helps in understanding the Dutch Enlightenment body.*

In the history of chemistry the status of alchemy has been a matter of dispute, some arguing that during the eighteenth century there was a transformation from alchemy to chemistry, others maintaining that we should discuss both alchemy and chemistry beneath an umbrella term such as 'chymistry' or 'technoscience'.<sup>25</sup> The project proposed here understands eighteenth-century "Boerhaavian" alchemy as (1) the part of chemistry concerned with the (purification and medical application of) metals, and (2) as an Enlightenment science with specific Enlightenment goals, work methods and ideals. It was distinct from alchemical currents aimed at the transmutation of base metals into gold and at the search for the philosopher's stone. Instead, it took the practical skills and unrelenting perseverance of alchemists as its method and example.

Even though alchemy itself became increasingly associated with deceit, alchemical materials remained of crucial importance in eighteenth-century medicine. Following the Ancients, the Boerhaavians defined alchemical materials as living substances which grow, feed themselves and reproduce. Metals – mercury in particular – were commonly used in the preparations of remedies and up until the nineteenth century mercury was also used in the making of anatomical preparations. On a metaphorical level metals symbolized the life and death of the body. Yet, the role of vitalism in early modern alchemy has been a matter of dispute, with historians claiming that vitalist ideas had little to do with alchemical matter theory, and others viewing alchemy as a study of life itself. The research follows the recent suggestion of Kevin Chang that "the significance of Renaissance vitalism in studies of nature invites reconsideration of its place in early modern alchemy. Such reconsiderations will shed light on the varied descriptions of life and matter, and indeed the diversity of science, in the early modern period".<sup>26</sup> Thus the project researches the Boerhaave school as a foundation for vitalist alchemy in eighteenth-century medicine. It centres on the import of alchemical materials and related questions on heat, combustion and respiration in order to clarify how alchemy remained at the root of much vitalist thought.

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<sup>25</sup> See for instance Principe (2011).

<sup>26</sup> Chang (2011).

The project consists of three parts: Part (1) is concerned with the definition, preparation and use of alchemical materials in medicine. (2) The research analyses the alchemy of Boerhaave and his Dutch disciples against the backdrop of eighteenth-century Enlightenment medicine. It is particularly concerned with alchemical experiments and intends to answer a recent call for more research on alchemical practices.<sup>27</sup> And (3) the research takes the incorporation of alchemical vitalism in the Boerhaavian physiology of the fluids (see project 1) as a means to understanding the Enlightenment body. Central to the research are the alchemical work of Boerhaave on the purification of mercury (published a few years before his death in the Transactions of the Royal Society in 1736; the views of Kaau (who simultaneously ridiculed many of the alchemists' claims, and busied himself with experiments on alchemical materials); and the practical application of (al)chemical views and therapies in the medicine of de Gorter.

#### *Timetable*

Year 1: Peer-reviewed article(s) on eighteenth-century Dutch alchemy.

Year 2: Peer-reviewed article(s) on the alchemy of Boerhaave and his disciples.

Year 3 and 4: Peer-reviewed article(s) on the import of vitalist alchemy and alchemical materials in the Boerhaavian physiology of the fluids.

#### **project 3: Chemistry and the Nerves (Rina Knoeff, 0,8 fte, 5 years)**

*Project 3 is a synthesizing project. It incorporates the results of projects 1 and 2 and is directed at studying the import of Boerhaave's insistence on chemical explorations of the nervous system. It analyses the rise of medical vitalism in the eighteenth-century Dutch Republic in relation to Enlightenment culture. Central hypotheses are: Boerhaave's insistence on a chemistry of subtle fluids and vital powers guided the eighteenth-century interest in the nervous system; ideas on the nervous system affected ideas on the human soul; the increasing interest in the nervous system reflected Enlightenment thought in the Dutch Republic.*

Illnesses of the brain and nerves (epilepsy in particular) have been discussed since Antiquity, but Boerhaave was among the first to systematically lecture on nervous diseases. He considered the nervous system crucially important for the healthy functioning of the human body (instead of the heart and circulation of the blood as was commonly emphasized). Boerhaave's increasing interest in the physiology of the nervous system largely resulted from his conviction that the body's life and motion originated in the actions of the most subtle fluids and vital powers contained in the smallest vessels of the body and that these actions could be explored chemically.<sup>28</sup> Boerhaave's pupils picked up his emphasis on the nervous system and they set up research and teaching following Boerhaave's ideas.

The project is divided in two parts. Part 1 focuses on (1) the uses, practices, materials and metaphors of chemistry for the vitalist neurology of the Leiden School and (2) on an analysis of post-Boerhaavian neurology as a product of Dutch Enlightenment thought and culture. The research investigates the chemistry for neurology of the so-called 'Leiden school', and analyses in particular the work of Gaub (see project 1), de Gorter (see project 2), and Winter.

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<sup>27</sup> Nummedal (2011).

<sup>28</sup> See Knoeff (2006 and forthcoming 2011a).

Gaub and Winter were each appointed to the combined chairs of medicine and chemistry at the universities of Leiden and Franeker respectively. With de Gorter occupying the chair of medicine in Harderwijk, Boerhaave's teaching was firmly established at Dutch universities. The teaching of all three professors centred on the Boerhaavian theory that the body consisted of fibres animated by a force acting in all parts of the body. Yet, rather than studying these vital forces as theoretical principles, the project will focus on the hands-on chemistry and medicine of the three professors as important sources for evaluating how vitalist neurology was created in the laboratory and in everyday medical practice.

The second part is directed at studying the work of the 'Leiden School' in relation to Dutch Enlightenment culture. So far, discussions of Boerhaave's lectures on nervous diseases have mainly been discussed in the wake of modern psychology, psychiatry and neurology. Yet, the Boerhaavian concern with nervous diseases was of central importance for Enlightenment thought. It not only referred to illnesses caused by an interruption of the healthy working of the powers of sense and motion – so apoplexy and indigestion as well as madness and melancholy were seen as diseases of the nerves – but ideas on the nervous system were also embedded in the philosophical, theological, social and political context of the Enlightenment.<sup>29</sup> O'Neill has argued that in particular 'sensationalist arguments from the very experience of the body (...) enabled all individuals to challenge the sometimes arbitrary authority of those in positions of power and led to the establishment of a new authority, the authority of experience'.<sup>30</sup> Eighteenth-century doctors and natural philosophers considered the faculties of the mind as transformed sensations; they debated the function and importance of the soul in relation to the mind and body, and moral behavior was viewed in the light of self-preservation. In this context, theories on the nervous system as well as chemical ideas on the working of the brain and nerves became important issues in Enlightenment intellectual debate.

#### *Timetable*

Year 1- 2: Peer-reviewed article(s) on the neurology of the Leiden School.

Year 3-5: The writing of a monograph on 'Chemistry, the Nerves and Dutch Enlightenment Culture'. The organisation of a conference on chemistry, medicine and Enlightenment culture.

#### **Innovative aspects**

Although the three individual projects could perfectly stand alone, they jointly create a substantial surplus value as a coherent *Vidi*-project. Together they make up a comprehensive history of post- Boerhaavian Dutch medicine. Moreover, the program as a whole crucially enhances our understanding of the nature of the 'Dutch Enlightenment body', which was, to speak with Roy Porter, 'hardly less puzzling than the soul and, if more concrete, far more objectionable'.<sup>31</sup>

The project is innovative on two counts: (1) the research moves away from the tendency to interpret Dutch Enlightenment medicine in the tradition of seventeenth-century Cartesian and Newtonian mechanical philosophy.<sup>32</sup> The research challenges the key themes of

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<sup>29</sup> Lawrence (1979), Vila (1998) and Riskin (2002).

<sup>30</sup> O'Neill (1996) pp. 1-2.

<sup>31</sup> Porter, 2003, p. 24

<sup>32</sup> Although some historians have already done a great deal to overcome the simplistic view of Newtonian mechanics (see for instance the work of A. Guerrini and J.B. Shank), this has hardly been the case for the history of Dutch Newtonianism.



universal (mathematical) laws of nature, the body machine, determinism, and Newtonianism. It emphasizes practices and materials, rather than intellectual natural philosophical debates and theories. Also, instead of interpreting Dutch medicine as a reflection of French Enlightenment thought, the research looks at local Dutch university practices which were much more receptive towards ideas (imported to the Provinces by students from the German speaking countries) on the working of animate principles governing the body's vital functions than has hitherto been assumed.

(2) Methodologically the project initiates a new approach in studying the history of Enlightenment vitalism. So far, most studies are rooted in the history of ideas. Yet, the project proposed here, takes the existing research further. It is built on the paradoxical premise that the history of (non-material) vital principles is rooted in the history of materiality and expertise. 'Vital matters', therefore, is more than a seemingly paradoxical title – it lies at the very heart of the project.

**The project is affiliated with:**

- 1) The Leiden University Institute for Cultural Disciplines (LUICD). The researchers will particularly profit from the research expertise on the history of collections, with its focus on the materiality of objects.
- 2) The Scaliger Institute (based at the Leiden University Library) facilitates access to primary sources.
- 3) The international research network 'Geographies, Practices and Exchanges in Eighteenth-Century Chemistry', coordinated by Prof. Dr. Lissa Roberts (University of Twente) with partnering institutions in the UK, France, Germany, Sweden, Spain, Belgium and the US.
- 4) A team of international advisors:

**Project 1:**

Prof. Dr. Harm Beukers (Leiden University), historian of medicine, special focus on Leiden.

Prof. Dr. Harold Cook (Brown University), historian of early modern medicine, with special reference to the Dutch Republic.

Prof. Dr. Anita Guerrini (Oregon State University), historian of the life sciences.

**Project 2:**

Dr. Andrew Cunningham (Cambridge University) historian of early modern medicine.

Prof. Dr. Ursula Klein (Max Plank Institute for the History of Science, Berlin), historian of chemistry and materials.

Prof. Dr. Lawrence Principe (Johns Hopkins University), historian of early modern chemistry and alchemy.

**Project 3:**

Prof. Dr. Lissa Roberts (University of Twente), historian of science, chemistry and technology.

Prof. Dr. Elizabeth Williams (Oklahoma State University), historian of medicine and Enlightenment vitalism.

Prof. Dr. Robert Zwijnenberg (Leiden University), specialized in art history in relation to the development of science and technology.

## Literature references

- Ashworth Underwood, E. (1977). *Boerhaave's Men at Leyden and After* (Edinburgh).
- Beukers, H. (1980). 'Het Laboratorium van Sylvius', *Tijdschrift voor de Geschiedenis der Geneeskunde, Natuurwetenschappen, Wiskunde en Techniek* **3**, 28-36.
- Beukers, H. (1982). 'Mechanistische principes bij Franciscus Dele Boë, Sylvius', *Tijdschrift voor de Geschiedenis der Geneeskunde, Natuurwetenschappen, Wiskunde en Techniek* **5**, 6-15.
- Beukers, H. (1987). 'Clinical Teaching in Leiden from Its Beginning until the End of the Eighteenth Century', *Clinical Teaching Past and Present. Clio Medica* **21**, 139-152.
- Brown, T.M. (1974). 'From Mechanism to Vitalism in Eighteenth-Century English Physiology', *Journal of the History of Biology* **7**, 179-216.
- Boerhaave, H. (1708). *Institutiones medicae* (Leiden).
- Boerhaave, H. (1732). *Elementa chemiae* (Leiden).
- Boerhaave, H. (1733-1736). 'De mercurio experimenta', *Philosophical Transactions of the Royal Society, 1733-1734*, xxxviii; 1735-1736, xxxix, 343-359, 368-376.
- Boudry, J.C. (2002). *What Was Mechanical about Mechanics. The Concept of Force between Metaphysics and Mechanics from Newton to Lagrange* (Dordrecht).
- Chang, Ku-Ming (2011). 'Alchemy as Studies of Life and Matter. Reconsidering the Place of Vitalism in Early Modern Chymistry', *Isis* **102**: 322-329.
- Christie, J. (1994). 'Historiography of Medicine in the Eighteenth Century: Herman Boerhaave and William Cullen', *Ambix*, **41**, 4-19.
- Cook, H.J. (1993). 'The Cutting Edge of a Revolution? Medicine and Natural History near the Shores of the North Sea' in J.V. Field and Frank, A.J.L. James (eds.) *Renaissance and Revolution: Humanists, Scholars, Craftsmen, and Natural Philosophers in Early Modern Europe* (Cambridge) 45-61.
- Cook, H.J. (2000). 'Boerhaave and the Flight of Reason in Medicine', *Bulletin of the History of Medicine* **74**, 221-240.
- Cook, H.J. (2002). 'Time's Bodies. Crafting the Preparation and Preservation of Naturalia' in Pamela Smith and Paula Findlen, *Merchants and Marvels. Commerce, Science and Art in Early Modern Europe* (New York / London) 223-247.
- Cook, H. J. (2007). *Matters of Exchange. Commerce, Medicine, and Science in the Dutch Golden Age* (New Haven / London).
- Cunningham, A., French, R. (1990). *The Medical Enlightenment of the Eighteenth Century* (Cambridge).
- Cunningham, A. (1990). 'Medicine to Calm the Mind. Boerhaave's Medical System and Why It Was Adopted in Edinburgh', in A. Cunningham, French, R. *The Medical Enlightenment of the Eighteenth Century* (Cambridge).
- Daston, L., Galison, P. (2007). *Objectivity* (New York).
- Daston, L. (ed.) (2004). *Things that Talk. Object Lessons from Art and Science* (New York).
- Debus, A. G. (2001). *Chemistry and Medical Debate. Van Helmont to Boerhaave* (Canton).
- Dewhurst, K. (1957). *The Quicksilver Doctor. The Life and Times of Thomas Dover, Physician* (Bristol).
- French, R. (2004). *Medicine before Science. The Business of Medicine from the Middle Ages to the Enlightenment* (Cambridge).
- Gaubius, H.D. (1707 (1731)). *Inaugurele rede van Hieronymus David Gaubius, waarin wordt aangetoond, dat de scheikunde met recht een plaats verdient onder de akademische wetenschappen, gehouden op den 21sten mei 1731* (Amsterdam).
- Gaubius, H.D. (1758) *Institutiones pathologiae medicinalis* (Leiden).
- Grell, O.P., Cunningham, A., Arrizabalaga, J. (eds.) (2010). *Centres of Medical Excellence? Medical Travel and Education in Europe, 1500-1789* (Farnham).
- Guerrini, A. (1985). 'James Keill, George Cheyne, and Newtonian Physiology, 1690-1740', *Journal of the History of Biology* **18**, 247-266.
- Guerrini, A. (1986). 'The Tory Newtonians: Gregory, Pitcairne, and their Circle', *Journal of British Studies* **25**, 288-311.
- Guerrini, A. (1987). 'Archibald Pitcairne and Newtonian Medicine', *Medical History* **31**, 70-83.
- Guerrini, A. (2000). *Obesity and Depression in the Enlightenment: The Life and Times of George Cheyne*. (Oklahoma Project for Discourse and Theory. Series for Science and Culture, number 3.) (Norman).
- Goldwater, L.J. (1972). *Mercury. A History of Quicksilver* (Baltimore, Maryland).
- Gorter, J. (1739-1742). *Medicina Hippocratica exponens aphorismos Hippocratis* (Amsterdam)
- Hall, T.S. (1969). *History of General Physiology, 600B.C. to A.D. 1900*, vol. 2, *From the Enlightenment to the End of the Nineteenth Century* (Chicago).
- Homburg, E. (2008). "Chemistry in the Low Countries: A Comparison between North and South, 1600-1900", *Proceedings of the Sixth International Conference on the History of Chemistry* (Memosciences) 65-88.
- Huisman, T. (2009). *The Finger of God. Anatomical Practice in 17<sup>th</sup> Century Leiden* (Leiden).
- Jacob, M.C. (1981). *The Radical Enlightenment: Pantheists, Freemasons and Republicans* (London).
- Jacob, M.C. (1992). *The Dutch Republic in the Eighteenth Century: Decline, Enlightenment and Revolution* (Ithaca/London).
- Jacob, M.C. (1994). 'Contemporary Enlightenment Historiography', in *Geschiedenis van de Wijsbegeerte in Nederland* **5**, 7-14.
- Jorink, E. (2006). *Het Boeck der Natuere. Nederlandse Geleerden en de Wonderen van Gods Schepping 1575-1715* (Leiden).
- Kaau-Boerhaave, A. (1738). *Declaratio academica de gaudiis alchemistarum in Perspiratio dicta Hippocrati* (Leiden).
- Kegel, Brinkgreve, E., Luyendijk-Elshout, A.M. (1983). *Boerhaave's Orations* (Leiden).
- King, L. (1970). *The Road to Medical Enlightenment, 1650-1695*. London: McDonald, 93-112.

- Klein, U. (2003). 'Experimental History and Herman Boerhaave's Chemistry of Plants', *Studies in History and Philosophy of Biological and Biomedical Science* **34**, 533-567.
- Klein, U., Lefèvre W. (2007). *Materials in Eighteenth-Century Science: A Historical Ontology* (Cambridge, MA).
- Klein, U., Spary, E. (eds.) (2010). *Materials and Expertise in Early Modern Europe. Between Market and Laboratory* (Chicago).
- Knoeff, R. (2002). *Herman Boerhaave (1663-1738). Calvinist Chemist and Physician* (Amsterdam).
- Knoeff, R. (2006). 'Chemistry, Mechanics and the Making of Anatomical Knowledge. Boerhaave vs. Ruysch on the Nature of the Glands', *Ambix* **53**, 201-219
- Knoeff, R. (2010). 'Herman Boerhaave at Leiden: *Communis Europae Praeceptor*', in A. Cunningham, O.P. Grell, J. Arrizabalaga (eds.), *Centres of Medical Excellence? Medical Travel and Education in Europe, 1500-1789* (Farnham) 269-286.
- Knoeff, R. (forthcoming, 2011a). 'Herman Boerhaave's Neurology and the Unchanging Nature of Physiology', in M. Horstmannshoff, H. King, C. Zittel (eds.), *Blood Sweat and Tears. The Changing Concepts of Physiology from Antiquity into Early Modern Europe* (Amsterdam).
- Knoeff, R. (forthcoming 2011b), 'How Newtonian Was Herman Boerhaave?' in A. Maas, E. Jorink (eds.) *Newton in the Netherlands* (Leiden).
- Lindeboom, G.A. (1968). *Herman Boerhaave. The Man and His Work* (London).
- Lindeboom, G.A. (1974). *Boerhaave and Great Britain. Three Lectures on Boerhaave with Particular Reference to his Relations with Great Britain* (Leiden).
- Luyendijk-Elshout, A.M. (1982), 'Mechanicisme contra vitalisme. De school van Herman Boerhaave en de beginselen van het leven', *Tijdschrift voor de Geschiedenis der Geneeskunde, Natuurwetenschappen, Wiskunde en Techniek* **5**, 16-26.
- Metzger, H. (1930). *Newton, Stahl, Boerhaave et la doctrine chimique* (Paris).
- Nutton, V. (2004). *Ancient Medicine* (London).
- Nummedal, T. E. (2011). 'Words and Works in the History of Alchemy', *Isis* **102**, 330-337.
- Mijnhardt, W. (1995). 'Dutch Culture in the Age of William and Mary, Cosmopolitan or Provincial?', in D. Hoak and M. Feingold (eds.), *The Glorious Revolution* (Stanford).
- Mijnhardt, W. (2009, augustus 26) *Sociability, the Decline of the Republic and the Discovery of the People: The Foundation of the Dutch Society for the Common Good*. Utrecht University, Plenary Lecture, International Standing Conference "Educating the people. The history of popular education".
- Newman, W.R. (1998). 'Alchemy vs. Chemistry: The Etymological Origins of a Historiographic Mistake', *Early Science and Medicine* **3**, 32-65.
- Orland, B. (2010). 'Enlightened Milk: Reshaping Bodily Substance into a Chemical Object', in U. Klein, E. Spary (eds.), *Materials and Expertise in Early Modern Europe. Between Market and Laboratory* (Chicago).
- Outram, D. (1995). *The Enlightenment* (Cambridge).
- Porter, R. (2003). *Flesh in the Age of Reason. How the Enlightenment Transformed the Way We See Our Bodies and Souls* (London).
- Power, J.C. (2001). *Herman Boerhaave and the Pedagogical Reform of Eighteenth-Century Chemistry* (Ph.D. thesis, Indiana University).
- Principe, L. M. (2007). *New Narratives in Eighteenth-Century Chemistry* (Dordrecht).
- Principe, L. M. (2011). 'Alchemy Restored', *Isis* **102**, 305-313.
- Rather, L. J. (1965). *Mind and Body in Eighteenth-Century Medicine. A Study Based on Jerome Gaub's De regimine mentis* (California).
- Reeves, C. (2010). *A Cultural History of the Human Body in the Enlightenment* (Oxford/New York).
- Roe, S.A. (1984). 'Anatomia Animata: The Newtonian Physiology of Albrecht von Haller', in E. Mendelsohn (ed.), *Transformation and Tradition in the Sciences* (Cambridge), 273-300.
- Roe, S.A. (2003). 'The Life Sciences', *The Cambridge History of Science. Vol. 4. Eighteenth-Century Science* (Cambridge) 397-416.
- Riskin, J. (2002). *Science in the Age of Sensibility. The Sentimental Empiricists of the French Enlightenment* (Chicago).
- Risse, G.B. (1987). 'Clinical Instruction in Hospitals: The Boerhaavian Tradition in Leyden, Edinburgh, Vienna and Pavia', *Clinical Teaching Past and Present. Clio Medica* **21**, 1-19.
- Roberts, L., Schaffer, S., Dear, P. (eds.) (2007). *The Mindful Hand. Inquiry and Invention from the Late Renaissance to Early Industrialisation* (Amsterdam).
- Roberts, L. (n.d.). *Chemistry in Everyday Life: A Research Programme in the History of Chemistry in the Netherlands during the Second Half of the Eighteenth Century* (NWO program, awarded in 2010).
- Rousseau, G.S. (ed.) (1991). *The Languages of Psyche. Mind and Body in Enlightenment Thought* (Berkeley, Los Angeles, Oxford).
- Rousseau, G., Porter, R. (eds.) (1980). *The Ferment of Knowledge: Studies in the Historiography of Eighteenth-Century Science* (Cambridge).
- Shank, J.B. (2004). 'There Was No Such Thing as the 'Newtonian Revolution,' and the French Initiated It. Eighteenth-century Mechanics in France before Maupertuis', *Early Science and Medicine* **3**, 257-292.
- Shank, J.B. (2008). *The Newton Wars and the Beginning of the French Enlightenment* (Chicago).
- Schulte, B.P.M. (1959). *Hermanni Boerhaave praelectiones de morbis nervorum, 1730-1735. Een medisch-historische studie van Boerhaave's manuscripten over zenuwziekten* (Leiden).

- Siegfried, R. (2002). *From Elements to Atoms: A History of Chemical Composition*, *Transactions of the American Philosophical Society* **92**, part 4, 56-73 (Stagnation of Chemical Theory: 1675-1750).
- Smith, P. H. (1999). 'Science and Taste: Painting, Passions, and the New Philosophy in Seventeenth-Century Leiden', *Isis* **90**, 421-461.
- Smith, P. H. (2004). *The Body of the Artisan. Art and Experience in the Scientific Revolution* (Chicago/London).
- Steinke, H. (2005). *Irritating Experiments. Haller's Concept and the European Controversy on Irritability and Sensibility 1750-90* (Amsterdam).
- Sturkenboom, D. (1998). *Spektators van de hartstocht. Sekse en emotionele cultuur in de achttiende eeuw* (Hilversum).
- Sturkenboom, D. (2004). *De elektrische kus. Over vrouwen, fysica en vriendschap in de achttiende en negentiende eeuw* (Amsterdam).
- Swiderski, R.M. (2008). *Quicksilver. A History of the Use, Lore and Effects of Mercury* (Jefferson, North Carolina / London).
- Williams, E. (2003). *A Cultural History of Vitalism in Enlightenment Montpellier* (Aldershot).
- Winter, F. (1736). *Dissertation medica inauguralis, de motu musculorum* (Leiden).
- Winter, F. (1747). *Oratio inauguralis de certitudine in medicina practica* (Franeker).
- Wright, J.P. (1990). 'Boerhaave on Minds, Human Beings, and Mental Diseases', *Studies in Eighteenth-Century Culture* **20**, 289-302.
- Wright, J.P., Potter, P. (2000). *Psyche and Soma. Physicians and Metaphysicians on the Mind-Body Problem from Antiquity to Enlightenment* (Oxford).