History-Writing as a Scientific Intervention:

Chemistry and Its Histories, 1750–1800

Thesis Submitted for the Degree of

Doctor of Philosophy in History

Faculty of History

University of Oxford

October 2024

Konradin Eigler

Wolfson College

Word Count: 78,828

DPhil Thesis in History
University of Oxford
Faculty of History

History-Writing as a Scientific Intervention:
Chemistry and Its Histories, 1750-1800

Short Abstract

The thesis analyses histories of chemistry as interventions in scientific praxis in France and Germany between 1750 and 1800. It explores how, through the form and content of works on the history of their field, chemists positioned themselves in methodological and epistemological controversies which arose both from chemical investigations and from the chemists' interactions with neighbouring fields. Additionally, historical narratives responded to controversies on the discipline's methodology voiced by other naturalists and served to consolidate its contested status within academic institutions. The chemist-historians flexibly adopted methods and concepts from other contemporary realms of historical inquiry. Thus, they created a diverse body of literarily complex and conceptually advanced historical works.

After an overview of chemistry as a field of study and its place in the Republic of Letters in chapter 1, the thesis shows how mid eighteenth-century histories of chemistry were designed to suggest that chemical methods conformed with the standards postulated by prominent philosophies of the natural sciences. By applying the techniques of conjectural history-writing, the evolution of chemistry's investigative practices was portrayed as a standard case of scientific progress in the natural sciences. Additionally, critical historical investigations featured in a debate on the status of alchemy and the uneasy heritage of hermetic philosophy. The second part of the thesis concentrates on the Chemical Revolution (chapter 2). In the 1780s, Antoine de Lavoisier surveyed the detrimental effect which theoretical preconceptions and nomenclature had had on chemistry's progress to defend his approach against British critics. Numerous German chemists critically revised Lavoisier's claims and drafted innovative histories of the field to mark their position in the debate (chapter 3 and 4). Concomitantly, the French chemist Antoine de Fourcroy defended Lavoisier's claims by historicising various aspects of the latter's theory and by reconstructing its emergence in the interdisciplinary setting of Parisian salon culture (chapter 5). Thus, by 1800, a wide array of methods and concepts had emerged to address the evolution of knowledge, in chemistry and beyond.

DPhil Thesis in History
University of Oxford
Faculty of History

History-Writing as a Scientific Intervention: Chemistry and Its Histories, 1750-1800

Long Abstract

The thesis analyses histories of chemistry as interventions in the scientific discourse in France and Germany between 1750 and 1800. It shows that chemists drafted historical narratives both to mark their stance in debates relating to the field's theoretical grounding and to foster its status as an independent discipline within the wider natural sciences. As a result, a diverse body of historical works emerged whose innovative character has been underestimated by scholarship thus far.

Although the public esteem for chemistry grew considerably in the second half of the eighteenth century, the discipline also witnessed numerous controversies on the systematic interpretation of experimental findings. For practising chemists, it was of outstanding importance to mark their position on these philosophically advanced topics, for similar issues were debated concomitantly by scholars working in the wider remit of natural history and thus in fields which were closely affiliated with chemistry. As a result, chemists developed a great interest in questions of epistemology and the philosophy of science, based on which they debated their methodological and theoretical choices during the final decades of the eighteenth century.

The thesis shows that writing the history of chemistry proved to be a particularly useful and flexible method to engage with such epistemological issues. Many chemists used a historical lens to substantiate the validity of their interpretative conclusions and to accuse their opponents of adhering to irrational traditions. Moreover, they made inquiries into the wider history of science to exhibit that modern chemistry had evolved in line with other branches of the natural sciences, a view which countered allegations of chemistry's roots in suspicious alchemical traditions. Such texts were written to vindicate the field's sometimes contested status as an academic discipline. This stress on the importance of historical inquiries as scientific interventions in the natural sciences contrasts with existing scholarship on the topic, for histories written by naturalists have often been discarded as mere illustrations of the Enlightenment's progressivist worldview.

In addition to exploring the argumentative thrust of history-writing, the thesis analyses the literary dimension of chemical histories. Indeed, they were carefully crafted literary items whose chronological framework, narrative composition, and visual presentation served the purpose of substantiating a particular scientific claim. To realise such ambitious projects, the chemists adopted concepts and methods which were popularised by Enlightenment historians of politics and culture, for example conjectural history. These intellectual transfers were often channelled through particular institutional or personal networks which are discussed in the thesis along with the close reading of historical works themselves. This analytical framework restores histories of chemistry to their place as innovative literary productions of the Enlightenment period.

Methodologically, the thesis is committed to the rigorous contextualisation of its source base in the tradition of contextualising intellectual history. Such an approach is of particular importance given the transnational perspective applied. Indeed, the environment in which German and French chemists worked differed considerably during the period at hand. Pharmacists, medics, and university professors formed the backbone of the decentralised community of

German chemists. They were scattered across the German-speaking world, often working in provincial towns and contributing to the scientific discourse via learned journals. While French apothecaries made important contributions to chemistry as well, aspiring scholars additionally found an unequalled number of opportunities to make a living as professional academic chemists in Paris. It was here that they encountered epistemological and methodological problems discussed in chemistry's neighbouring disciplines. Patronage relationships, institutional affiliations, and informal meetings in salons all contributed to the philosophical choices made by the chemists, which eventually informed their historical writing too. Assessing the institutional and intellectual affiliations of the chemist-historians is also important, as it highlights the channels through which they became familiar with particular approaches to historical writing.

So far, eighteenth-century histories of chemistry have not been analysed by scholarship regarding their scientific thrust and contextual embeddedness. The present thesis fills this gap in research, thus shedding new light on an otherwise well-explored period in the history of chemistry. In doing so, it also touches upon several issues which transcend the narrow remit of Enlightenment chemistry, and which may be of interest to historians of science and intellectual historians alike. By using histories of chemistry as a lens through which to examine scientific controversies, it offers a fresh look on the intricate dynamics of setting the methodological standards in the natural sciences before the advent of positivism. This perspective opens avenues for future exploration, for the approach could easily be applied to history-writing in disciplines such as physics, zoology, and botany, which also await an in-depth analysis. Moreover, the close reading of chemical histories as epistemological treatises unveils striking parallels with later writings. Many perspectives on the evolution of science and the nature of scientific knowledge that are usually associated with scholars such as Ludwik Fleck, Thomas Kuhn, or Bruno Latour can already be found in the writings of Enlightenment chemist-historians. Such insights can contribute to the ongoing endeavour of writing the history of the philosophy of science since the early modern period.

The introduction explores the topic and methodology of the thesis in relation to existing scholarship. It is also here that the notion of 'history' as an analytical terminus is discussed against the backdrop of early modern traditions. Chapter 1 explores the different facets of eighteenth-century chemistry, comparing Germany and France and attempts to give a preliminary definition of chemistry based on a semantic survey. To further specify the discipline's identity, the chapter analyses the institutional and financial resources available to professionally pursue chemistry in the eighteenth century as well as the mechanisms of social in- and exclusion which influenced the careers of chemists. Introducing the reader to the working environment of the chemist-historians is also important because the latter often drew on their everyday experiences in their historical writing.

Chapter 2 provides two case studies to showcase the argumentative use of history-writing by mid-eighteenth-century chemists. The first part of the chapter discusses the historical works written by three French scholars, Gabriel-François Venel, Marie-Geneviève Thiroux d'Arconville, and Pierre-Joseph Macquer. It argues that they aligned their historical narratives with the framework of contemporary *histoires de l'esprit* in order to present the preliminary and conjectural nature of its taxonomic practices in chemistry as conforming with the standards adopted in the wider natural sciences. Thus, progress in chemistry appeared to be the result of the interplay between scholarly reasoning and observation-based inquiries into nature and part of a greater trend which covered all branches of science. This perspective was also valuable for rebuffing accusations according to which chemistry was still burdened by the heritage of alchemy. The issue of alchemy is discussed in greater detail in the second part of the chapter. It centres on the hermetic revival in Germany in the late eighteenth century and the role played by historical arguments in debating the possibility of metallic transmutation. Of particular importance in this regard were the writings by Johann Christian Wiegleb, an apothecary based in

a small town in Thuringia. Drawing on a wide array of historical techniques, including conjectural history, Wiegleb defended the observation-based approach to chemistry towards scholars who believed in the superiority of a secret transmission of knowledge which could be accessed through secretly transmitted writings alone.
The subsequent three chapters assess the argumentative function of historical interventions in what is generally known to scholarship as the Chemical Revolution (1770–1800). During this period, contradictory interpretations of experimental findings on substances such as air, water, acids, and salts sparked a major European controversy on the appropriate approach to chemistry. Indeed, scholars clashed on a number of topics which belong to the realm of epistemology, such as the role of language and preconceived thinking in scientific reasoning, or the impact of social mechanisms on the establishment of scientific facts.

Chapter 3 discusses how chemists explored the history of chemistry to debate how to establish 'factual' knowledge from observations of nature and how to turn individual data into comprehensive taxonomic descriptions. Antoine de Lavoisier takes centre stage in this chapter, for he radically reinterpreted the impact of theoretical preconceptions on all aspects of scholarly reasoning in the 1780s, using a historical lens to bolster his arguments. While Lavoisier's British opponents such as Richard Kirwan and Joseph Priestley countered the Frenchman's claims from a general philosophical perspective, German chemists dismantled his historical arguments. Drawing on several traditions of history-writing in the German Enlightenment, Johann Christian Wiegleb and Johann Friedrich Gmelin designed large-scale histories of chemistry to intervene in this epistemological debate, both explicitly through their content and implicitly by way of their literary form.

In the fourth chapter, the thesis turns to the chemical nomenclature which scholars began to historicise from the 1780s onwards. In line with his wider reinterpretation of chemistry's history, Antoine de Lavoisier offered a fresh perspective on the potentially detrimental impact that the etymology of chemical signs could have on scholarly reasoning. Again, a group of German chemists noticed the Frenchman's strategy of bolstering his overall theory with a historical narrative. Taking different positions as to the desirability of a comprehensive reform of chemistry's terminology and overall theory, they also engaged with the history of nomenclature. As a result, divergent views on the evolution of signs and their impact on scientific progress emerged.

In its fifth chapter, the focus of the thesis returns to the Parisian scene. It centres on the intricate and methodologically complex history of chemistry which Antoine de Fourcroy wrote after Lavoisier's death to defend his teacher's scientific stances for both a European audience and the Parisian naturalist circles. While carefully reconstructing the genealogy of Lavoisian chemistry from different viewpoints, Fourcroy's account put particular emphasis on the positive impact which social interactions between elite scientists had had on the theory's emergence. In doing so, he appropriated a technique which had been developed by scientific outsiders, notably Jean-Paul Marat and Jacques-Pierre Brissot, to criticise the unconscious biases of the scientific establishment in the 1780s. In doing so, Fourcroy not only developed a complex perspective on scientific progress but also anticipated many aspects of the works written by twentieth-century philosophers of science such as Thomas Kuhn.

The thesis closes with a short conclusion, providing an outlook on how the present approach could be extended systematically to other disciplines of Enlightenment science and diachronically to scientific controversies in chemistry in the course of the nineteenth century.

Acknowledgments

Over the course of my university studies, I have received support from numerous people and institutions. I gladly take up this opportunity to acknowledge them.

First and foremost, I would like to thank my supervisor, Avi Lifschitz, for his constant encouragement. Always generous with his time, he guided me in my expeditions in the history of science, offering both intellectual stimuli and critical feedback. I will greatly miss our two-hour meetings which I always left feeling prepared to tackle the next stage of the project.

The History Faculty at Oxford has provided an inspiring environment to pursue my studies. I particularly benefited from the opportunity to present my work twice in the Long-Nineteenth-Century seminar. Thank you to its convenors, Will Clement and David Hopkin, for their encouragement, especially in the difficult early stages of a doctorate which started in the midst of the Covid pandemic. I am also indebted to Oliver Zimmer, who kindly welcomed me at Oxford and supervised the thesis during its initial months.

I am very grateful for the financial backing which I have received from the Arts and Humanities Research Council (OOC-DTP), the Clarendon Fund, and the Scatcherd European Scholarship. I have also greatly benefited from being a member of the *Schweizerische Studienstiftung*. In addition, the award of the *Johann-Lorenz-Bausch Stipendium* enabled me to spend four stimulating months at the *Nationale Akademie der Wissenschaften Leopoldina* in Halle. I would like to thank the *Leopoldina Akademie Freundeskreis* and its chair, Jutta Schnitzer-Ungefug, for their generosity, and my colleagues at the *Zentrum für Wissenschaftsforschung*, in particular Rainer Godel and Luise Beddies. During my stay in Halle, I have presented parts of the thesis in the *Zentrum*'s research seminar, the meeting of its *Arbeitsausschuss* and, upon the kind invitation of Theo Jung, in the *Kolloquium Neuere und Neueste Geschichte und Zeitgeschichte* at the University of Halle. I would like to thank all participants for their comments and suggestions. I am also indebted to Jana Hunter, Henner Petin, Allison Turner, and Dario Willi for proofreading parts of this thesis before submission.

Over the course of my studies, several scholars have shaped my thinking and encouraged me to pursue my intellectual interests. I am particularly grateful to Philippe Goridis, Jürg Glauser, Janina Gruhner, Benjamin Hartmann, Klaus Müller-Wille, Sebastian Scholz, and Roman Wild (Zurich), Lukas Rösli (Berlin), Joachim Grage and Jörn Leonhard (Freiburg), Roman Köster (Munich) Hanno Balz and David Reynolds (Cambridge), and Constanze Güthenke (Oxford).

I wish to thank Anhad Arora, Cornelia Bäurle, Leonie Boyle, Lukas Braun, Fanny Clemente, Greta Colombani, Caterina Domeneghini, Marc Eberhardt, Federica Eichelberg, Imad El Rayess, Luise Graichen, Philipp Heckmann-Umhau, Alexandra Hertlein, Thomas Hopkins, Jana Hunter, Frederic Jäncke, Ralf Kretzschmar, Oliver Leicht, Josef Lolacher, Jessica Rees, Loren Schaad, Ingrid Schreiber, Carl Seemann, Estela and Paulo de Souza, Marvin Strauß, Eyvind Venske, Simon Weißbeck and Dario Willi for remaining such loyal friends to me, even when I disappeared in the library for prolonged periods. For many years, conversations with Konrad Hauber have been a source of true inspiration and I am enormously grateful for our long-lasting friendship. To Jan Langemeyer and Henner Petin, I am indebted in many more ways than I can say. Although I will miss our time at Walton Well Road, I am confident that upcoming alpine hikes will make up for the loss of the odd nightcap.

The unwavering support of my family has enabled me to pursue my studies in the first place. My parents Andrea and Ulrich Eigler have been with me at every step of the journey, providing their advice and encouragement. It is only apt if I say that their generosity exceeds any human measure. I am also indebted to my brother, Christopher Eigler. It fills me with great joy to know that we finish our studies around the same time, opening new chapters in both of our lives. My uncle Christoph Haefele has always shown great interest in my work and I have greatly benefited from our conversations. I also wish to thank Ladina Florineth and Christian Klainguti for welcoming me into their family.

Last but not least, my heartfelt thanks go to my partner, Sophia Florineth, for always being at my side despite the geographical distance that often separated us. Without her support, love, and – it must be admitted – remarkable patience with my rambling about the philosophy of science, I would not have been able to finish this thesis.

While my time at Oxford has greatly enriched my life in many aspects, it also coincided with the loss of my beloved grandparents, Gunther Eigler, Ingeborg Eigler, and Rosemarie Haefele. This thesis is dedicated to their memory.

Table of Contents

Conventions

In order to enable the reader to fully grasp the rhetoric of Enlightenment history-writing in France and Germany, quotations are always given in the original language and the spelling is maintained.

Several sources analysed in this thesis have prefaces which are not paginated. For better orientation and to allow for a seamless identification of references, I have created a pagination in brackets. I have explained the rationale behind each such pagination in the footnote in which the respective work is referenced for the first time.

Introduction

Prologue: The Neglected Tradition

This thesis addresses the topic of history-writing in the natural sciences during the second half of the eighteenth century, using chemistry as its test case. Although it is generally appreciated that numerous eighteenth-century scholars wrote historical accounts of their fields, the argumentative function and literary form of such texts remains understudied by modern scholarship. The idea of a rich tradition of historical works, initiated by Enlightenment scholars who were mainly concerned with analysing the natural world, contrasts too starkly with the stories which historians have told themselves and the wider academic world for a long time about the origins of their discipline. As early as 1858, Wilhelm von Giesebrecht, an up-and-coming German professor of history, argued that the experience of the French Revolution and the search for the national spirit were the central reasons for the emergence of a distinctly modern and critical approach to history which overcame older speculative and compilatory traditions and firmly established the discipline within the ranks of academic institutions. Hence, Barthold Georg Niebuhr, the author of a widely acclaimed *Römische Geschichte*, was the hero of Giesebrecht's account. Linking the disciplinary identity of history to cultural and political factors, as well as to a particularly German tradition, left no room for considering the historical works written by scientists across the European continent during the same period.[1]

The origin narrative proposed by Giesebrecht has been remarkably successful. Its cornerstones have been reiterated by historians ever since, and handbooks and specialist studies

[1] Wilhelm von Giesebrecht, 'Die Entwicklung der modernen deutschen Geschichtswissenschaft', *Historische Zeitschrift* 1 (1859): 7–15.

continue to rely on them in one way or another even today.[2] Notably, present-day historians of science do not usually consider Enlightenment historians of distinct scientific areas to be their predecessors who had engaged in a similar endeavour. They customarily trace the emergence of the history of science to the early twentieth century, a time when specialist journals, professional associations, and university positions dedicated to the history of science were first established. Accordingly, Pierre Duhem and George Sarton serve as the intellectual father figures for historians of science.[3] Within this narrative framework, eighteenth-century histories of science have often been presented as nothing more than expressions of the Enlightenment's progressivist world view which do not deserve greater attention, if they are mentioned at all.[4]

Given these traditions, we lack a compelling explanation for why, metaphorically speaking, so many eighteenth-century naturalists left their various sites of observational investigation and instead flocked to writing an astonishingly diverse body of histories of science, testing literary techniques and methods of historical investigation alike. The thesis aims to provide an answer to this question by investigating the practice of writing histories among an important and diverse group of Enlightenment chemists. It is my aim to show that histories of chemistry (in the sense of assessing the subject's evolution over time and presenting it in a narrative account) were written to intervene in various scientific controversies in the field between 1750 and 1800.

---

[2] Heinrich von Sybel, 'Über den Stand der neueren deutschen Geschichtsschreibung [1859]', in *Kleine historische Schriften* (Munich: Literarisch-Artistische Anstalt der J.G. Cotta'schen Buchhandlung, 1863), 345–59; John Emerich Edward Dalberg-Acton, 'German Schools of History', *The English Historical Review* 1, no. 1 (1886): 7–11. Such nineteenth-century narratives to assess the history of historical writing and methodology are reiterated by some contemporary scholars, see for example Stefan Berger, 'The Invention of European National Traditions in European Romanticism', in *The Oxford History of Historical Writing. Volume 3, 1400-1800*, ed. José Rabasa et al. (Oxford: Oxford University Press, 2012), 19–22; Frederick C. Beiser, *The German Historicist Tradition* (Oxford: Oxford University Press, 2011), 21–23; John Toews, 'Historicism from Ranke to Nietzsche', in *The Cambridge History of Modern European Thought*, ed. Warren Breckman and Peter E. Gordon (Cambridge: Cambridge University Press, 2019), 301–2.

[3] See for example Helge Kragh, *An Introduction to the Historiography of Science* (Cambridge: Cambridge University Press, 1987), 5, 15–19; Donald R. Kelley, *The Descent of Ideas. The History of Intellectual History* (Aldershot: Ashgate, 2002), 209–12; Bart Karstens, 'The Peculiar Maturation of the History of Science', in *The Making of the Humanities. The Modern Humanities*, vol. 3 (Amsterdam: Amsterdam University Press, 2014), 183–88.

[4] Kragh, *Introduction*, 6.

In this introduction, I shall elucidate this perspective and discuss the approach and structure of the thesis. To give the reader an idea of why the chemists resorted to constructing historical narratives to intervene in scientific debates, the first section outlines the complex process of discipline formation in chemistry and its intellectual implications during the eighteenth century. The second section highlights the methodological implications of my approach and explains the reasons for choosing Germany and France as test cases. Against this backdrop, a review of existing scholarship on history-writing in chemistry will further clarify the contribution of this thesis to historiography. The final, fourth section surveys the function and content of each of the thesis' chapters.

History-Writing as an Intervention: The Epistemological Approach

Writing a history was a particularly versatile literary means to respond to the methodological and epistemological dimension of scientific debates which arose both from chemical investigations and from the chemists' interactions with neighbouring fields. In my understanding of the terms 'epistemology' and 'epistemological', I follow the definition set by Hans-Jörg Rheinberger and I shall use them to denote what in the anglophone world is often covered under the umbrella of the 'philosophy of science'. According to Rheinberger, debates pertain to epistemology if they concern 'what conditions had to be created for objects to be made into objects of empirical knowledge'.[5] Implicitly, this covers a wide range of prominent issues for any observation-based approach including, but not limited to, the role played by precision instruments in producing reliable observations and the impact of theoretical preconceptions, linguistic signs, or mathematical calculations to validate, interpret, and systematise data. Where many

[5] Hans-Jörg Rheinberger, *On Historicizing Epistemology. An Essay* (Stanford CA: Stanford University Press, 2010), 3.

postmodern approaches trace the historical construction of knowledge through language or instruments, the historical study of the philosophy of science puts greater emphasis on how historical actors themselves debated these very issues, often based on their everyday experiences as scientific practitioners.[6]

Throughout the eighteenth century, chemists frequently had to mark their position on matters of epistemology, for several reasons. One of them was the idiosyncratic process of discipline formation in chemistry. On the surface, chemistry's path was an undeniable success story during the eighteenth century. Utilitarian rulers promoted studies into chemical processes because they promised advances in a wide array of fields from mining and dyeing to military technology and public health. Educating both practitioners and civil servants in existing and newly founded academic institutions or through public courses thus channelled financial resources to the experts in the field. As a result, the number of teaching positions related to chemistry grew both in France and in Germany.[7] Spectacular public experiments, which chemists increasingly staged during the second half of the century, also contributed to bringing the discipline's progressive character to the consciousness of a wider audience.[8]

At the same time, chemistry's rank within the academic sphere remained precarious throughout the century. As a result, the chemists were forced to legitimise the rational character

[6] A good overview of constructivist approaches to the history of science is provided by Jan Golinski, *Making Natural Knowledge. Constructivism and the History of Science*, Cambridge History of Science (Cambridge: University Press, 1998). For constructivism in the historiography of chemistry since the 1960s see John G. McEvoy, *The Historiography of the Chemical Revolution. Patterns of Interpretation in the History of Science* (London: Routledge, 2016), 195–228.

[7] Christoph Meinel, '"Artibus Academicis Inserenda." Chemistry's Place in Eighteenth and Early Nineteenth Century Universities', *History of Universities* 7 (1988): 96–100; John C. Powers, 'Learning and Institutions. Didactic Chemistry and Practical Instruction', in *A Cultural History of Chemistry in the Eighteenth Century*, ed. Ursula Klein and Matthew Daniel Eddy, vol. 4, A Cultural History of Chemistry (London: Bloomsbury Academic, 2022), 163–70; John Perkins, 'Chemistry Courses, the Parisian Chemical World and the Chemical Revolution, 1770-1790', *Ambix* 57, no. 1 (2010): 28–29; Bernadette Bensaude-Vincent, 'Culture and Science. Chemistry in Its Golden Age', in *A Cultural History of Chemistry in the Eighteenth Century*, ed. Ursula Klein and Matthew Daniel Eddy, vol. 4, A Cultural History of Chemistry (London: Bloomsbury Academic, 2022), 100–105.

[8] Bernadette Bensaude-Vincent and Christine Lehman, 'Public Lectures on Chemistry in Mid-Eighteenth Century France', in *New Narratives in Eighteenth-Century Chemistry : Contributions from the First Francis Bacon Workshop, 21-23 April 2005, California Institute of Technology, Pasadena, California*, ed. Lawrence Principe (Dordrecht: Springer, 2007), 77–96, especially 87-90; Christine Lehman, 'Pierre-Joseph Macquer. Chemistry in the French Enlightenment', *Osiris* 29, no. 1 (2014): 254–60.

of their methods in front of their intellectual peers on a regular basis. One reason for this situation was that the burdensome heritage of alchemy – whose practices served as a prime example for irrationalism in many Enlightenment writings – continued to loom over the chemists.[9] Lawrence Principe and William Newman have showcased that the terms 'alchemy' and 'chemistry' were semantically dissociated only in the 1720s and thus in close temporal proximity to the period under investigation in this thesis.[10] In addition, the frequent appearances throughout the eighteenth century of gold-makers, who claimed to have superior knowledge concerning chemical reactions, sparked concerns among those who sought to establish chemistry as a legitimate branch of natural history.[11]

It is also noteworthy that many contributions to the academic chemistry discourse in the eighteenth century continued to be made by scholars who worked in applied domains such as pharmacy or mining. In addition, the field's relationship to medicine and to the equally emerging discipline of physics allowed for fruitful interdisciplinary exchanges.[12] Yet, chemistry's close alignment with other fields of inquiry made it difficult at times to delineate the field's identity. As Christoph Meinel has convincingly argued, this instance was reflected by the struggles to assign chemistry a place within the traditional structure of European universities.[13]

---

[9] Christoph Meinel, 'Theory or Practice? The Eighteenth-Century Debate on the Scientific Status of Chemistry', *Ambix* 30, no. 3 (1983): 123–24; Bensaude-Vincent, 'Culture', 98.

[10] William R. Newman and Lawrence M. Principe, 'Alchemy vs. Chemistry. The Etymological Origins of a Historiographic Mistake', *Early Science and Medicine* 3, no. 1 (1998): 32–65.

[11] Lawrence Principe, *The Secrets of Alchemy* (Chicago, Ill: The University of Chicago Press, 2013), 89–92.

[12] Ernst Homburg, 'Two Factions, One Profession. The Chemical Profession in German Society 1780– 1870', in *The Making of the Chemist. The Social History of Chemistry in Europe 1789– 1914*, ed. David Knight and Helge Kragh (Cambridge: Cambridge University Press, 1998), 45–48; Karl Hufbauer, *The Formation of the German Chemical Community (1720-1795)* (Berkeley CA: University of California Press, 1982), 50–57. In recent years, the history of chemistry has partly been rewritten through the lens of practical arts. Examples for this are Hjalmar Fors, *The Limits of Matter. Chemistry, Mining, and Enlightenment* (Chicago: The University of Chicago Press, 2015); Jonathan Simon, *Chemistry, Pharmacy and Revolution in France, 1777-1809*, Science, Technology, and Culture, 1700-1945 (Aldershot: Ashgate, 2005). On the relationship between chemistry and physics see Rudolf Stichweh, *Zur Entstehung des modernen Systems wissenschaftlicher Disziplinen. Physik in Deutschland 1740-1890* (Frankfurt/Main: Suhrkamp, 1984), 94–143.

[13] Meinel, 'Artibus Academicis Inserenda', 92–99; Powers, 'Learning', 163–64.

Given these numerous challenges, it was a matter of priority for aspiring chemists to showcase that their investigations conformed with what their peers in the wider academic world considered to be a sound epistemological basis. This meant that they actively received (and contributed to) the discourse on the philosophy of science which evolved among eighteenth-century naturalists.[14] Indeed, scholars working in fields such as natural history, medicine, chemistry, and physics all faced similar challenges in developing observation-based inquiries into genuine systems, using philosophical arguments to defend their positions in the resulting controversies. One only has to think of the influential and long-lasting debate on systematics and nomenclature in botany to understand just how vividly Enlightenment naturalists discussed matters relating to the philosophy of science as part of their work.[15] The chemists came into regular contact with such discussions both through institutional affiliations and in less formal settings such as Parisian salon culture.[16] When developing their own approaches, the chemists compared them with the normative claims made by scholars in the wider realm of natural history, medicine, and physics claims about the appropriate scientific methodology to investigate nature.[17]

Finally, chemists also engaged in epistemological discussions because of scientific developments within their own field. Questions of systematisation and taxonomy in particular resulted from the staggering increase in observations on substance classes such as salts, acids, and alkalis since the early eighteenth century.[18] The analytical clarity of innovative theoretical

---

[14] Bensaude-Vincent, 'Culture', 108–12.
[15] Phillip R. Sloan, 'The Buffon-Linnaeus Controversy', *Isis* 67, no. 3 (1976): 356–75; Staffan Müller-Wille, 'Names and Numbers. "Data" in Classical Natural History, 1758–1859', *Osiris* 32, no. 1 (2017): 109–28.
[16] Mi Gyung Kim, *Affinity, That Elusive Dream. A Genealogy of the Chemical Revolution*, Transformations: Studies in the History of Science and Technology (Cambridge MA: MIT Press, 2003), 48–49. On the salon-laboratory run by Antoine de Lavoisier and Marie-Anne Paulze-Lavoisier see Francesca Antonelli, 'Becoming Visible. Marie-Anne Paulze-Lavoisier and the Campaign for the "New Chemistry" (1770s-1790s)', *Ambix* 69, no. 3 (2022): 227–28.
[17] With respect to the intersection between chemical and botanical nomenclature, Maurice Crosland made this point in the 1960s, see Maurice Crosland, *Historical Studies in the Language of Chemistry*, 2nd ed. (New York: Dover Publications, 1978), 142–43.
[18] This process has been reconstructed and interpreted from numerous angles in scholarship. For a good short overview see Lissa Roberts, 'Setting the Table. The Disciplinary Development of Eighteenth-Century Chemistry

concepts such as the idea of varying degrees of chemical affinity between substances, which had been introduced by Étienne-François Geoffroy only in the 1720s, had already been heavily challenged by the 1780s. Such controversies intensified when the study of gases and air sparked further questions regarding the field's appropriate methodological and theoretical framework. For its vibrant scholarly exchanges, this period is commonly known as the 'Chemical Revolution'.[19]

It is the purpose of this thesis to show that, for Enlightenment chemists, assessing the historical development of chemistry against the backdrop of the evolution of all sciences proved to be an excellent argumentative instrument to address philosophical problems in a subtle yet convincing way. Not all eighteenth-century chemists were keen to deny chemistry's deeper historical roots outright, as recently suggested by Bernadette Bensaude-Vincent.[20] On the contrary, they created nuanced accounts with varying chronologies whose implications were closely aligned with the positions which they championed in the ongoing scientific discourse. Writing the history of a particular investigative problem enabled the chemists to construct traditions or stage ruptures with particular theories – whichever was most suitable in order to substantiate their own approach or to delegitimise that of their opponents. Concomitantly, the historical gaze was crucial to assessing scientific methodology and praxis. When, for example, the role of preconceived hypotheses or substance names for the generation of reliable facts was debated, these problems could be applied to the past, which provided plenty of examples to make a particular claim. Thus, the numerous formal and content-related aspects of historical investigations and writing, such as the selection of events, the construction of

---

as Read Through the Changing Structure of Its Tables', in *The Literary Structure of Scientific Argument*, ed. Peter Dear (Philadelphia PA: University of Pennsylvania Press, 2015), 99–132. For a very detailed reconstruction of this development which takes into account both the theoretical and experimental developments see Kim, *Affinity*.

[19] Kim, *Affinity*, 132–46, 258–77; Jan Golinski, 'The Chemical Revolution and the Politics of Language', *The Eighteenth Century* 33, no. 3 (1992): 238–51. The most comprehensive literature review of the topic has been composed by McEvoy, *Historiography*. See also chapter 3 of this thesis.

[20] Bensaude-Vincent, 'Culture', 98–99.

chronologies, and the creation of genealogies, as well as their visual presentation, were not accidental at all. They formed an integral part of the scholarly discourse on chemistry. Although they might have not been professionally trained historians in the modern sense of the word, the chemist-historians analysed in this thesis thought long and hard about the methodology of writing about the past. Indeed, many of their techniques will be surprisingly familiar to readers versed in the history of the philosophy of science since they seem to anticipate arguments which were later made by luminaries in the field such as Ludwik Fleck, Thomas Kuhn, and Bruno Latour.[21] It is a by-product of this thesis to highlight these curious parallels, and I shall mention them in passing throughout the text.

The fact that chemists flocked to history-writing to make an intervention in scientific praxis and theory ties in with a wider intellectual trend during the Enlightenment period. As early as the 1950s, J. G. A. Pocock showed the importance of history-writing for the legal and political discourses in early modern Europe.[22] Historians of science who are familiar with early modern traditions of naturalism should not be surprised by the chemists' choice, either. Ever since antiquity, the concept of *historia* and its vernacular equivalents denoted literary writings about temporal evolution as much as they referred to the practice of describing of what was known on a given topic. In the Baconian tradition of naturalism, which emphasised the importance of accumulating observations for the growth in knowledge over the longer term, writing the history of a particular field of study could conflate both meanings.[23] Chemistry was no outlier in this regard. Historical introductions in the temporal sense of the word had been an essential part of textbooks since at least the beginning of the eighteenth century, while

---

[21] For a good introduction into these twentieth-century works and their trajectories see Rheinberger, *On Historicizing Epistemology*.
[22] J. G. A. Pocock, *The Ancient Constitution and the Feudal Law. A Study of English Historical Thought in the Seventeenth Century* (Cambridge: Cambridge University Press, 1957).
[23] Kragh, *Introduction*, 3–5; Gianna Pomata and Nancy G. Siraisi, 'Introduction', in *Historia. Empiricism and Erudition in Early Modern Europe*, ed. Gianna Pomata and Nancy G. Siraisi, Transformations (Cambridge MA: MIT Press, 2005), 4–7 the latter with reference to the vast body of literature on the topic.

describing observational findings in the form of a *historia experimentalis* was a crucial aspect of teaching and publishing in early modern chemistry.[24]

Both the descriptive and the temporal meanings continued to be used by chemists during the period at hand. For instance, Johann Friedrich Gmelin, a Göttingen professor of chemistry and medicine who will feature prominently in chapter 3 of this thesis, made repeated use of the German 'Geschichte' to denote both the descriptive and the temporal facet of the concept without any contradiction. While his *Geschichte der Chemie* (1797–1799) followed a chronological structure and clearly aimed at portraying the intricacies of chemistry's past and its evolution, his *Allgemeine Geschichte der Pflanzengifte* (1803) and *Allgemeine Geschichte der thierischen und mineralischen Gifte* (1806, posthum.) compiled existing knowledge on the effects and composition of different types of poison.[25] The semantic narrowing of 'history' to its temporal dimension, which Reinhart Koselleck has famously postulated,[26] therefore did not occur in chemistry during the period at hand. Considering the aforementioned important epistemic function of history as a concept and forms of historical writing as a practice in the natural sciences of the early modern period, the absence of disputes on its meaning in chemistry around 1800 underlines a critical point of the present thesis: constructing narratives of the discipline's past to intervene in current debates was seen as a legitimate scholarly practice in chemistry around 1800. Notwithstanding this continuity, I argue that the type of historical writing that

---

[24] Bensaude-Vincent, 'Culture', 98; John R.R. Christie, 'Historiography of Chemistry in the Eighteenth Century. Hermann Boerhaave and William Cullen', *Ambix* 41, no. 1 (1994): 4; Ursula Klein and Wolfgang Lefèvre, *Materials in Eighteenth-Century Science. A Historical Ontology*, Transformations: Studies in the History of Science and Technology (Cambridge MA: MIT Press, 2007), 21–31.

[25] Johann Friedrich Gmelin, *Geschichte der Chemie seit dem Wiederaufleben der Wissenschaften bis an das Ende des achtzehnten Jahrhunderts*, 3 vols, Geschichte der Wissenschaften seit der Wiederherstellung derselben bis an das Ende des achtzehnten Jahrhunderts. Von einer Gesellschaft gelehrter Männer ausgearbeitet, 8/II (Göttingen: Georg Rosenbusch, 1797); Johann Friedrich Gmelin, *Allgemeine Geschichte der Pflanzengifte*, 2nd ed. (Nürnberg: Raspesche Buchhandlung, 1803); Johann Friedrich Gmelin, *Allgemeine Geschichte der thierischen und mineralischen Gifte. Mit einer Vorrede von Johann Friedrich Blumenbach* (Erfurt: Friedrich August Knick, 1806).

[26] Reinhart Koselleck, 'Vergangene Zukunft in der Frühen Neuzeit', in *Vergangene Zukunft. Zur Semantik geschichtlicher Zeiten*, 8th ed. (Frankfurt am Main: Suhrkamp, 2013), 17–37 and with respect to the natural sciences ; Reinhart Koselleck, 'VI. Geschichte als moderner Leitbegriff', in *Geschichtliche Grundbegriffe. Historisches Lexikon zur politisch-sozialen Sprache in Deutschland*, ed. Otto Brunner, Werner Conze, and Reinhart Koselleck, vol. 2 (Stuttgart: Klett-Cotta, 1975), 678–82.

scrutinised the temporal evolution of science in general and of chemistry in particular from various angles gained in popularity from the 1750s onwards. From the mid eighteenth century onwards, the chemists began to fully explore the argumentative and rhetorical potential of historical narratives in the temporal sense of the word within current scientific debates while the descriptive facet of the concept remained in use.

Against this backdrop, it is possible to clarify my understanding of 'history-writing' and 'historical writing' throughout the thesis. I use the terms to encompass all forms of scholarly writing in which chemists constructed scientific arguments using the evolution of knowledge as a lens. In this sense, 'history-writing' does not refer to an independent genre which can always be easily recognised by its title but to all those texts that made scientific arguments by way of scrutinising the past.[27] Applying such a wide definition brings a wide array of text forms into sight, including abbreviated introductory discourses in experimental reports, journal articles, theoretical works, textbooks, and encyclopaedias in addition to large-scale monographs with 'history' in their title. It is one of my main aims to show that, if a chemist wrote a history as part of such a scholarly publication, the historical narrative was closely related to the overall scientific trajectory of the work. Given how widespread this practice became in the second half of the eighteenth century, these texts were the place for the chemists to deploy and discuss different methods of historical inquiry too.

Beyond adding novel insights to the study of eighteenth-century chemistry, the present thesis seeks to address two wider issues of interest to historians of science and intellectual historians. First, analysing histories of chemistry allows for a fresh look at the intricate and interdisciplinary dynamics of setting the methodological standards for investigations in the natural sciences around 1800.[28] In the German language, this instance was reflected in the

---

[27] Since the term 'historiography' is also used to refer to the current state of scholarship, it is ambiguous and will therefore not feature in the analytical vocabulary used in this thesis.
[28] See the classic studies by Michel Foucault, *Les mots et les choses. Une archéologie des sciences humaines*, Editions des sciences humaines (Paris: Gallimard, 1969), 229–313; Wolf Lepenies, *Das Ende der*

semantic shift of the concept of *Wissenschaft*, which was no longer synonymous with knowledge *tout court*, but slowly began to refer to the practice of reflecting the conditions of knowledge production to achieve a higher degree of reliability.[29] The focus on histories of chemistry as rhetorically advanced argumentative tools in such debates offers new perspectives which, in the future, could be easily applied to other nascent branches of inquiry such as physics or biology too.[30]

Second, my thesis fills an important gap in the growing body of studies in the history of science which assess the function of historical arguments in naturalist discourses ever since the sixteenth century. Those scholars studying the early modern genres of *historia literaria* and *historia philosophiae* have so far largely avoided the intricate and epistemologically challenging discourses of the natural sciences in general and of chemistry in particular.[31] Studies indebted to the approach of 'historical epistemology' have compellingly showcased the use of historical arguments by late-nineteenth- and twentieth-century scientists. However, this thesis shows that they overstate the novelty of a historical epistemology by placing its emergence in

---

Naturgeschichte. Wandel kultureller Selbstverständlichkeiten in den Wissenschaften des 18. und 19. Jahrhunderts (Munich: Hanser, 1976), 9–105; Peter Hanns Reill, *Vitalizing Nature in the Enlightenment* (Berkeley CA: University of California Press, 2005).

29 Waldtraut Bumann, 'Der Begriff der Wissenschaft im deutschen Sprach- und Denkraum', in *Der Wissenschaftsbegriff. Historische und systematische Untersuchungen. Vorträge und Diskussionen im April 1968 in Düsseldorf und im Oktober 1968 in Fulda*, ed. Alwin Diemer (Meisenheim am Glan: A. Hain, 1970), 64–75, esp. 74-75; Stefan Meier-Oeser and Helmut Hühn, 'Wissenschaft. I. Der Klassische Wissenschaftsbegriff. Antike bis 19. Jahrhundert', in *Historisches Wörterbuch der Philosophie*, ed. Joachim Ritter, Karlfried Gründer, and Gottfried Gabriel, vol. 12 (Basel: Schwabe, 2004), 910–11, 915–21.

30 Indeed, the large body of sources in these fields awaits further exploration, for writing the history of different branches of traditional natural history was a common phenomenon across the continent. See for example: Richard Pulteney, *Historical and Biographical Sketches of the Progress of Botany in England from Its Origin to the Introduction of the 'Linnaean' System*, 2 vols (London: T. Cadell, 1790); Friedrich Casimir Medicus, *Geschichte der Botanik unserer Zeiten* (Mannheim: Schwan und Götz, 1793); Johannes Spix, *Geschichte und Beurtheilung aller Systeme in der Zoologie nach ihrer Entwiklungsfolge von Aristoteles bis auf die gegenwärtige Zeit* (Nürnberg: Schrage'sche Buchhandung, 1811). Moreover, there was a vivid discourse on the form and methodology of history-writing in these fields too. In the early 1800s, for example, the publisher of Eichhorn's multi-volume project on the *Geschichte der Wissenschaften* replaced Friedrich Murhard as a contributor after its initial two volumes had been received unfavourably, see J.G. Rosenbusch, 'Nachricht über die in meinem Verlage erscheinende Geschichte der Künste und Wissenschaften seit der Wiederherstellung derselben bis an das Ende des Achtzehnten Jahrhunderts', *Intelligenzblatt der Allgemeinen Litteratur-Zeitung* 187 (12 November 1800): 1563–64.

31 See for example the contributions in the standard edited volumes on the topic Gianna Pomata and Nancy G. Siraisi, eds., *Historia. Empiricism and Erudition in Early Modern Europe*, Transformations (Cambridge MA: MIT Press, 2005); Frank Grunert and Friedrich Vollhardt, eds., *Historia literaria. Neuordnungen des Wissens im 17. und 18. Jahrhundert* (Berlin: Akademie Verlag, 2014).

the period between 1860 and 1900.[32] I also deviate from the established approach in historical epistemology on a methodological level, as I shall discuss in the next section.

Methodology: History-Writing between Text and Context

The thesis is committed to approaching epistemological debates by contextualising them within their respective intellectual and institutional environments. This seems most apt given that the theoretical and epistemological positions which chemists voiced in the transnational discourse were often informed by their local institutional and intellectual environment.[33] To put this general perspective to work, I follow the methodological example set by the works of Pietro Corsi. In focusing on the Parisian intellectual circles of the 1790s, Corsi showcased that, to understand the numerous methodological exchanges between different branches of inquiry in the natural sciences, historians need to carefully consider the channels which allowed for such intellectual exchanges in the first place. Institutional settings, personal relationships, and the attribution of scarce financial resources often impacted a scholar's scientific arguments and, therefore, need to be considered in the historical reconstruction, too.[34] The architecture of communicative channels which allowed for scientific debates over long distances also has to be taken into account since changes in the availability of information on, say, experimental results or novel

---

[32] Rheinberger, *On Historicizing Epistemology*, 2–3, 5–17; Stefano Bordoni, *When Historiography Met Epistemology. Sophisticated Histories and Philosophies of Science in French-Speaking Countries in the Second Half of the Nineteenth Century*, History of Modern Science 2 (Leiden: Brill, 2017), viii–ix, 273.

[33] Dorinda Outram, *Georges Cuvier. Vocation, Science, and Authority in Post-Revolutionary France* (Manchester: Manchester University Press, 1984), 2–3.

[34] Pietro Corsi, *The Age of Lamarck. Evolutionary Theories in France, 1790-1830*, trans. Jonathan Mandelbaum (Berkeley CA: University of California Press, 1988), 1–39; Pietro Corsi, 'Models and Analogies for the Reform of Natural History. Features of the French Debate, 1790-1800', in *Lazzaro Spallanzani e la bioologia del settecento. Teorie, esperimenti, istituzioni scientifiche. Atti del convegno di studi Reggio Emilia, Modena, Scandiano, Pavia 23-27 marzo 1981*, ed. Giuseppe Montalenti and Paolo Rossi (Florence: Leo S. Olschki, 1982), 381–96, esp. 383. Many works affiliated with historical epistemology have increasingly been criticised for not contextualising scientific works appropriately, see Katherina Kinzel, 'Geschichte ohne Kausalität. Abgrenzungsstrategien gegen die Wissenschaftssoziologie in zeitgenössischen Ansätzen historischer Epistemologie', *Berichte zur Wissenschaftsgeschichte* 35, no. 2 (2012): 147–62.

theoretical suggestions naturally impacted a scholar's views. While the growth in number of learned journals, including the foundation of those with a particular focus on chemistry, enhanced the availability of chemical investigations especially from the 1770s, the period of Terror during the French Revolution and the ensuing Revolutionary Wars made such exchanges more challenging at times.[35]

It seems most promising to put the contextualising approach to work by way of a comparative analysis which considers both local circumstances and transnational exchanges. I have chosen the academic French community of chemists, centred around Paris, and the geographically more dispersed German-speaking academic sphere as my case studies because of the different conditions under which their members worked.[36] For example, Johann Christian Wiegleb, a German pharmacist working in Langensalza, was one of the most important chemists of his generation. Given his artisanal background and provincial context, Wiegleb's biography contrasts with that of Antoine de Lavoisier, who, as the son of a tax farmer and a member of the *Académie des Sciences* in Paris, could rely on his wealth and personal connections to have new instruments designed exclusively for him or to stage spectacular public experiments.[37] Notwithstanding such differences in wealth and standing, they were both fully acknowledged members of the European chemical community whose contributions were taken

[35] Raffaella Seligardi, 'The Italian Network and the European Network. Scientific Journals and the Chemical Revolution', *Archives Internationales d'histoire Des Sciences* 63, no. 170–171 (2013): 427–54; Patrice Bret, 'The Letter, the Dictionary and the Laboratory: Translating Chemistry and Mineralogy in Eighteenth-Century France', *Annals of Science* 73, no. 2 (2016): 122–42; Maurice Crosland, *In the Shadow of Lavoisier. The 'Annales de Chimie' and the Establishment of a New Science*, BSHS Monographs 9 (Oxford: British Society for the History of Science, 1994), 81–86. See chapter 3 for further reference.
[36] Following the example by Karl Hufbauer, I use the concepts of Germany and the attribute German not to refer to a political entity. What Hufbauer called the 'German chemical community' refers to those scholars who contributed to the chemical discourse in the German language, mainly by publishing in journals such as the *Chemische Annalen* and regardless of their exact geographical position or national identity, see Hufbauer, *Formation*.
[37] For their biographies see Jean-Pierre Poirier, *Lavoisier. Chemist, Biologist, Economist*, trans. Rebecca Balinski, Chemical Sciences in Society Series (Philadelphia PA: University of Pennsylvania Press, 1996); Achim M. Klosa, *Johann Christian Wiegleb (1732-1800). Eine Ergobiographie der Aufklärung*, Quellen und Studien zur Geschichte der Pharmazie 88 (Stuttgart: Wissenschaftliche Verlagsgesellschaft, 2009).

equally seriously. This was also the case for their historical works, which will be discussed in chapters 2, 3, and 4.

In juxtaposing Parisian elite chemists with German practitioners and professors, the thesis restores the German chemists to their place as fully recognised members of the transnational chemical community. Abandoning the long-standing focus on Lavoisier and the Parisian community on the one hand, and their British opponents on the other, has frequently been marked as a desideratum in scholarship. Yet, few case studies have realised this imperative in practice.[38] The value of this perspective will become particularly evident in chapters 3, 4, and 5, where I elaborate on the position of German chemists in what is customarily known as the Chemical Revolution. In abandoning the still pertinent narrative of the one-way reception of Lavoisier's finished theory in Germany, I show instead how the German chemists critically compared the epistemological positions made by all participants in the debate and used historical narratives to stake their own claims.[39]

The imperative of contextualisation also applies to the writing of histories as a literary and intellectual practice. The thesis demonstrates just how many chemists actively employed methods and approaches to historical writing which were simultaneously developed and debated in political or cultural history. From an analytical point of view, it will be key to scrutinise how the chemists had encountered such approaches, why they chose them for their interventionist purposes, and which particular forms of history-writing can be identified as their own innovations. This requires a close reading of the historical sources, a methodological principle which also explains the relatively limited number of works discussed in this thesis. Just like

[38] A rare exception are the essays edited in Ferdinando Abbri and Bernadette Bensaude-Vincent, eds., *Lavoisier in European Context. Negotiating a New Language for Chemistry* (Canton MA: Science History Publications, 1995). See the introduction and concluding remarks in the same volume for further reference.
[39] The most recent example for an analysis which largely remains within the traditional framework of reception is Jan Frercks, 'Kommentar', in *Lavoisier. System der Antiphlogistischen Chemie. Mit einem Geleitwort von Friedrich Steinle*, ed. Jan Frercks and Jürgen Jost, 2nd ed. (Berlin: Springer Spektrum, 2023), 313–33. The issue is discussed at length in chapter 3 of this thesis.

writings in political theory or philosophy, which intellectual historians and literary critics alike unquestionably scrutinise for their internal structure, chemical histories, too, need to be read as literary items.[40]

Above all, this means that numerous aspects of any given history need to be taken into account in the analysis, for example the chronological framework, the selection of events, the author's – implicit or explicit – assumptions concerning the driving forces of scientific progress, and their judgements of particular events or agents which had played a role in chemistry's history. Moreover, the formal composition of chemical histories, such as the insertion of philosophical digressions or the visual arrangement of the narrative, must not be seen as accidental. These writing techniques too often had an argumentative thrust. One might object to this methodology by pointing to the danger of an over-interpretation; however, we shall witness how carefully eighteenth-century readers approached these histories, which suggests that they were attentive to the form of history-writing. Even the most bulky and inaccessible work discussed in this thesis, Johann Friedrich Gmelin's almost three-thousand-page-long *Geschichte der Chemie* (1797–1799), was scrupulously assessed by numerous reviewers regarding its arguments, methodology, and literary form. Some reviewers additionally exhibited their close reading by indicating the pages on which mistakes had been made while also discussing the work's overall structure.[41]

---

[40] For an introduction to the contextualising methodology intellectual history see Richard Whatmore, 'Quentin Skinner and the Relevance of Intellectual History', in *A Companion to Intellectual History*, ed. Richard Whatmore and Brian W. Young, Blackwell Companions to History (Chichester: John Wiley & Sons, 2016), 97–112; Kenneth Sheppard, 'J.G.A. Pocock as an Intellectual Historian', in *A Companion to Intellectual History*, ed. Richard Whatmore and Brian W. Young, Blackwell Companions to History (Chichester: John Wiley & Sons, 2016), 113–25. For existing scholarship on literary analysis in historical studies of the sciences see Christine Lehleiter, 'Introduction. Fact and Fiction. Literary and Scientific Cultures in Germany and Britain – Thoughts on a Contentious Relationship', in *Fact and Fiction. Literary and Scientific Cultures in Germany and Britain*, ed. Christine Lehleiter (Toronto: University of Toronto Press, 2018), 1–4.

[41] See for example [anon.], 'Geschichte der Chemie, seit dem Wiederaufleben der Wissenschaften bis an das Ende des achtzehnten Jahrhunderts, von Johann Freidrich Gmelin, Dritter Band (Review)', *Litteratur-Zeitung (Erlangen)*, no. 150 (1 August 1800): 1193–95; Johann Jacob Hartenkeil, 'Geschichte der Chemie seit dem Wiederaufleben der Wissenschaften bis an das Ende des achtzehnten Jahrhunderts, von Johann Friedr. Gmelin, Dritter Band (Review)', *Medicinisch-Chirurgische Zeitung,* 3, no. 66 (19 August 1799): 257–62.

Literature Review

Although scholars have frequently pointed out the potential value of a study which would scrutinise the large number of histories written on the sciences in general, and on chemistry in particular, during the eighteenth century, scholarly literature on the subject is scarce.[42] In fact, the last monographs on the topic date back to the 1970s. Dietrich von Engelhardt's study of histories of science written between circa 1700 and 1850 offers a useful overview of the vast body of sources. Due to its large thematic, geographical, and temporal scope, however, its analysis remains somewhat tangential.[43] In 1974, Jost Weyer and Wilhelm Strube each published a book on history-writing in chemistry between the late eighteenth and the twentieth century, providing a valuable map for accessing the relevant material. Yet their approaches suffer from methodological flaws which can no longer satisfy contemporary scholarship. Beyond some scattered remarks, they did not contextualise their sources within scholarly debates on chemistry nor within the wider intellectual context. The analytical clarity of Strube's account is blurred by his framing of the problem in the Marxist paradigm of historical materialism.[44] In Weyer's work, the normative understanding of what an appropriate, critical approach to history-writing should look alike prevails that is implicitly informed by the postulates of nineteenth-century historicism. By tracing the diachronic realisation of this ideal in the chemists' histories, the book assumes the form of a teleological narrative based on which Weyer

---

[42] A good guide to histories of science written between the early modern period and 1914 is Rachel Laudan, 'Histories of the Sciences and Their Uses. A Review to 1913', *History of Science* 31, no. 1 (1993): 1–34. Paul Ziche, 'Science and the History of the Sciences. Conceptual Innovations Through Historicizing Science in the Eighteenth Century', *Berichte zur Wissenschaftsgeschichte* 35, no. 2 (2012): 103–8 has created a typology of different histories of science written in the eighteenth century. Short summaries of various histories of chemistry feature in Wilhelm Strube, 'Der Beginn der Chemiegeschichtsschreibung im 18. Jahrhundert in Deutschland', in *Beiheft zur Schriftenreihe für Geschichte der Naturwissenschaften, Technik und Medizin. Zum 60. Geburtstag von G. Harig* (Leipzig: Teubner, 1964), 154–63; Wilhelm Strube, 'Zur Stellung und Bedeutung des chemiehistorischen Werkes von Johann Bartholomäus Trommsdorf', *Beiträge zur Geschichte der Universität Erfurt (1392-1816)* 16 (1971–1972): 149–64; Eduard Farber, 'Historiography of Chemistry', *Journal of Chemical Education* 42, no. 3 (1965): 121, all of whom focused on Germany.

[43] Dietrich von Engelhardt, *Historisches Bewusstsein in der Naturwissenschaft. Von der Aufklärung bis zum Positivismus*, Orbis academicus. Sonderband 4 (Freiburg/Breisgau: Karl Alber, 1979).

[44] Wilhelm Strube, *Die Chemie und ihre Geschichte* (Berlin: Akademie-Verlag, 1974), 5–21.

evaluated his sources.[45] The attitude of judging the quality of eighteenth-century histories of chemistry rather than analysing their function was common in scholarship well into the 1980s.[46]

A more productive approach emerged in the 1980s as part of the ongoing reception of two seminal publications in the history of science, Thomas Kuhn's *The Structure of Scientific Revolutions* and I. Bernhard Cohen's *Revolution in Science*. Since both Kuhn and Cohen wrote extensively on Antoine de Lavoisier as the scholar who prompted a scientific revolution in chemistry,[47] historians of chemistry developed an interest in the question of how eighteenth-century chemists conceived of the concept. Eighteenth-century histories of chemistry often formed the body of evidence for the ensuing lively debate.[48]

Since the 1990s, attention has shifted to assessing the links between the process of discipline formation and histories of chemistry, although no comprehensive study has been published on this topic either. Marco Beretta has explored this link in two articles and added that the emergence of chemical theories could be related to historical works, too. Yet, he failed to single out how such an interaction played out in specific scientific debates or institutional settings.[49] A different approach has been taken by Christoph Meinel. On several occasions, Meinel

---

[45] Jost Weyer, *Chemiegeschichtsschreibung von Wiegleb (1790) bis Partington (1970). Eine Untersuchung über ihre Methoden, Prinzipien und Ziele* (Hildesheim: Verlag Dr. H. A. Gerstenberg, 1974), 16–44.
[46] Colin A. Russell, 'Presidential Address. "Rude and Disgraceful Beginnings". A View of History of Chemistry from the Nineteenth Century', *The British Journal for the History of Science* 21, no. 3 (1988): 280–81; Alan J. Rocke, 'History and Science, History of Science. Adolphe Wurtz and the Renovation of the Academic Profession in France', *Ambix* 41, no. 1 (1994): 24.
[47] Thomas Kuhn, *The Structure of Scientific Revolutions*, International Encyclopaedia of Unified Science 2/2 (Chicago: The University of Chicago Press, 1962), 52–57, 69–72; I. Bernard Cohen, *Revolution in Science* (Cambridge MA: Belknap Press of Harvard University Press, 1985), 213–36.
[48] A. Levin, 'Venel, Lavoisier, Fourcroy, Cabanis and the Idea of Scientific Revolution. The French Political Context and the General Patterns of Conceptualization of Scientific Change', *History of Science* 22, no. 3 (1984): 303–20; Carleton E. Perrin, 'Revolution or Reform. The Chemical Revolution and Eighteenth Century Concepts of Scientific Change', *History of Science* 25, no. 4 (1987): 395–423; Janis Langins, 'Fourcroy, Historien de la révolution chimique', in *Lavoisier et la révolution chimique. Actes du colloque tenu à l'occasion du bicentennaire de la publication du Traité élémentaire de Chimie 1789*, ed. Michelle Goupil, Patrice Bret, and Francine Masson (Paris: SABIX-Ecole Polytechnique, 1992), 13–33. The history of the concept also structures Bernadette Bensaude-Vincent's seminal work on Lavoisier: Bernadette Bensaude-Vincent, *Lavoisier. Mémoires d'une reévolution* (Paris: Flammarion, 1993), 25–27, 33–44, 61–72, 80–82, 127–38, 191–93.
[49] Marco Beretta, 'The Historiography of Chemistry in the Eighteenth Century. A Preliminary Survey and Bibliography', *Ambix* 39, no. 1 (1992): 1–10; Marco Beretta, 'The Changing Role of the Historiography of Chemistry in Continental Europe Since 1800', *Ambix* 58, no. 3 (2011): 257–58.

has convincingly argued that histories of chemistry were written to facilitate the subject's integration into existing academic institutions from the eighteenth century onwards. In the decades around 1800, the historical narratives served to delineate chemistry's boundaries both within the university and towards a wider audience.[50] In addition, a short case study by John R.R. Christie on two histories of chemistry, written by the Scot William Cullen and the Dutch Herman Boerhaave between the early and the mid eighteenth century, deserves to be mentioned. Christie succeeded in showing that, while such histories were written for members of local universities, they also mirrored the scientific attitudes of the scholars involved, with Cullen's historical essay being a direct critique of Boerhaave's earlier publication.[51] Christie's essay thus highlights that histories of chemistry could serve as argumentative resources both in particular local contexts and within the wider European discourse on chemistry, an observation which I shall elaborate upon below.

The Structure of the Thesis: Temporal Scope and Chapter Outline

By focusing on the second half of the eighteenth century, the thesis discusses the argumentative scientific function of historical works in two consecutive phases which were characterised by different epistemological challenges. Between circa 1750 and 1780, chemists emphasised the philosophical implications of the observation-based approach for both their academic critics

---

[50] Christoph Meinel, 'Die Rolle der Chemiegeschichte in der Wissenschaftskommunikation', in *Zwischen Faszination und Verteufelung. Chemie in der Gesellschaft*, ed. Marc-Denis Weitze, Joachim Schummer, and Thomas Geelhaar (Berlin: Springer Spektrum, 2017), 85–90; Christoph Meinel, 'Demarcation Debates. Lavoisier in Germany', in *Lavoisier in Perspective*, ed. Marco Beretta (Munich: Deutsches Museum, 2005), 147–60, especially 148-151. Additionally, it is worth pointing out that Meinel, in the aforementioned article entitled 'Demarcation Debates', and Bernadette Bensaude-Vincent have analysed the changing image of Lavoisier in nineteenth-century histories of chemistry within the context of chemistry's discipline formation process, see Ibid., 151–60; Bensaude-Vincent, *Lavoisier Mémoires*, 363–417; Bernadette Bensaude-Vincent, 'A Founder Myth in the History of Sciences? The Lavoisier Case', in *Functions and Uses of Disciplinary Histories*, ed. Loren R. Graham, Wolf Lepenies, and Peter Weingart, Sociology of the Sciences 7 (Dordrecht: D. Reidel, 1983), 53–78.

[51] Christie, 'Historiography of Chemistry', 4–19.

and the adherents of traditional hermeticism. From around 1780, a new generation of scholars shifted its focus to the role of language, theoretical presumptions, and contextual factors in gaining secure knowledge. After circa 1800, chemists moved on to new pastures, debating epistemological problems in relation to stoichiometry as a method and Dalton's theory of atomism.[52] Discussing the latter phase would go beyond the limitations of this thesis (see the conclusion for some preliminary reflections). This analytical and temporal framework explains the absence of some histories of chemistry which some readers might expect to be treated, notably Johann Bartholomäus Trommsdorff's *Versuch einer allgemeinen Geschichte der Chemie*, which was published in 1806.[53]

Chapter 1 offers an overview of chemistry as a scientific discipline in the eighteenth century based on the current state of research. In addition to covering the emergence of the conceptual distinction between 'alchemy' and 'chemistry' early in the century, it compares the different institutional settings in which the careers of the French and German chemists developed. Moreover, I shall highlight mechanisms of in- and exclusions and give a brief overview of laboratories as places of knowledge production. For the thesis as a whole, the chapter thus serves a twofold purpose. On the one hand, it situates the protagonists of the thesis within their respective intellectual and institutional environments by providing a contextual comparison of the French and German chemical communities. On the other hand, the chapter introduces the social, cultural, and institutional factors that are crucial to understanding the form and function of histories of chemistry. Indeed, the culture of chemistry formed a conceptual reservoir for history-writing which the chemist-historians selectively and consciously resorted to, or, in other cases, deliberately ignored. Their respective choices were guided by their scientific

[52] For an overview of these debates see W. H. Brock, *The Norton History of Chemistry*, 1st American edition, Norton History of Science (New York NY: W.W. Norton, 1993), 128–72.
[53] Johann Bartholomäus Trommsdorff, *Versuch einer allgemeinen Geschichte der Chemie. In drei Abtheilungen* (Erfurt: Hennings'sche Buchhandlung, 1806).

positions, which in themselves were also influenced by their intellectual and institutional environments.

Chapter 2 provides the first test case for this analytical framework. It explores two instances in which chemists resorted to crafting historical works in order to defend the conformity of their practices with the standards postulated by prominent philosophies of the natural sciences around the middle of the eighteenth century. In the chapter's first part, I analyse how the Parisian chemists Gabriel-François Venel, Pierre-Joseph Macquer, and Marie-Geneviève Charlotte Thiroux d'Arconville adopted the chronological and conceptual framework provided by contemporary *histories de l'esprit*. Such histories prioritised the interplay between observational findings and creative hypotheses as the key drivers of scientific progress, which enabled the chemists to vindicate the contested taxonomic practices in their field using conjectural techniques. Thus, the chemist-historians could downplay the field's alchemist heritage and integrate chemistry within a general narrative which focused on the joint evolution of all the natural sciences. The drawback of focusing on observations and systems as motors of the smooth progress of science was the exclusion of contextual factors.

Conjectures and hypotheses as scientific practices are also very much present in the second part of the chapter, focused on the argumentative function of historical works in debating the rationality of hermetic philosophy in general and the feasibility of metallic transmutation in particular. The issue arose when, in 1775, the Marburg professor Friedrich Wilhelm Josef Schröder assembled textual evidence to call for the abolition of observation-based inquiries in favour of the revived tradition of hermeticism. In this older framework, knowledge of nature could be gained only by way of uncovering the divine messages hidden in ancient texts. Johann Christian Wiegleb reacted to Schröder's claims, seeking to delegitimise the hermetic approach and to defend the primacy of controlled experience. To do so, he directly engaged with Schröder's textual readings and historical claims and deployed numerous methods prominent in Enlightenment history-writing – most notably philological and conjectural tools – to counter them.

Chapters 3, 4, and 5 concentrate on the function of historical narratives in what is known as the period of the Chemical Revolution (1770–1800). Each of the chapters assesses a different epistemological facet of the debate and explains their respective emergence from transnational or local intellectual developments. A recurring theme uniting all the histories discussed in these chapters is that, notwithstanding the different scientific positions which they championed, they all departed from the older approaches to writing the history of chemistry discussed in chapter 2. Indeed, late-eighteenth-century chemist-historians creatively borrowed from their colleagues in other fields or developed innovative approaches in order to make powerful scientific interventions. Thus, a rich body of historical writing on chemistry emerged which, in both its formal diversity and its methodological sophistication has been all but forgotten by modern scholarship.

Chapter 3 assesses the function of histories in the debate on scientific facticity in chemistry, that is, the appropriate methods to gain reliable knowledge in observation-based scientific settings. I shall reconstruct how this issue arose from observational disagreements in the realm of pneumatic chemistry, closely intertwined with the evolution of Antoine de Lavoisier's oxygen theory whose philosophical fundaments ran counter to several established notions. To defend his positions, Lavoisier developed a novel way of analysing chemistry's history in his *Réflexions sur le Phlogistique* (1783/1786) and *Traité élémentaire de chimie* (1789) which, in many respects, abandoned the narrative and conceptual framework of previous histories of chemistry. Conversely, the German chemists Johann Christian Wiegleb and Johann Friedrich Gmelin resorted to contemporary German models of historical writing and methodology to endorse the philosophical positions on facticity championed by Lavoisier's British opponents, such as Richard Kirwan and Joseph Priestley, in the debate on the nature of airs, acids, heat, and water. Indeed, I argue that the German chemists' histories can be read as sophisticated epistemological interventions which made use of a variety of literary and historical techniques, including the strategic selection of events in chemical history and their visual representation.

Chapter 4 sheds light on another aspect of the controversy, namely the history of chemical terminology. After reassessing why chemical nomenclature became a bone of contention towards the end of the eighteenth century, I show how contrasting accounts of the history of chemical signs entered the chemical discourse in the 1780s. In 1787, it was again Antoine de Lavoisier who proposed a radical reinterpretation of chemistry's history through the lens of language. In doing so, he substantiated the reform of the field's terminology which he simultaneously proposed with five other Parisian chemists, while at the same time supplementing his earlier claims on chemistry's history to defend his overall approach. Three German chemists, Lorenz Florenz von Crell, Johann Andreas Baptist Scherer, and Johann Friedrich Westrumb, scrutinised these claims from various perspectives. Thus, by the early 1790s, a vivid debate on the history of chemical terminology emerged.

The final, fifth, chapter centres on a particularly complex account of chemistry's evolution written by Antoine de Fourcroy, Lavoisier's close collaborator and his intellectual and institutional successor after the latter's premature death in 1794. In 1796, Fourcroy crafted a history of chemistry in the *Encyclopédie Méthodique* which defended Lavoisier's epistemology and its implications. Crucially, the text was aimed at the critics of Lavoisier's theory both across the continent and within the Parisian naturalist community. To realise this goal, Fourcroy crafted a long historical account which historicised many aspects of Lavoisier's philosophy of science, such as language of precision instruments, to assess how their evolution had impacted chemistry during the eighteenth century. He also traced its interdisciplinary roots in the personal interactions between numerous Parisian scholars on the eve of the Revolution. Writing the genealogy of Lavoisier's approach through the lens of the social context in which it had emerged vindicated its intellectual superiority. Curiously, in doing so, Fourcroy adopted a perspective on history which had been developed by a group of scientific outsiders, notably Jean-Paul Marat and Jacques-Pierre Brissot, to criticise elite scientists such as Lavoisier. Fourcroy's appropriation of these views resulted in a labyrinthine historical account which championed a complex notion of scientific progress.

Chapter 1: Meet the Chemists

Introduction

If one wanted to embark on the admittedly odd endeavour of assigning a colour to eighteenth-century chemistry, one would have to choose Prussian Blue. Developed in the first decade of the eighteenth century in Berlin jointly by the chemical practitioner Johann Konrad Dippel and the laboratory worker Johann Jacob Diesbach, Prussian Blue was successfully marketed by Johann Leonard Frisch, a teacher in Berlin. Frisch used the considerable income made through selling the colour to buy land for investigations into the productivity of mulberry trees. The group succeeded in keeping the recipe a secret until the 1720s when the British scholar John Woodward was informed via unknown channels about the necessary laboratory processes to produce it. Consequently, Woodward, together with John Brown, both members of the Royal Society, published the news, including a number of supplementary experiments on the chemical processes involved, in the *Philosophical Transactions* in 1724. These experiments were picked up on by the Parisian chemist Étienne-François Geoffroy, best known for developing the first table of chemical affinities and a widely known member of the *Académie Royale des Sciences*. He and his successors – most notably Pierre-Joseph Macquer, Carl Wilhelm Scheele, and Jean Hellot – continued to investigate the nature of the colour in experiments, fitting them into their wider attempts of systematising chemical substances.[54]

As recent scholarship has remarked, the history of the world's first synthetically produced colour encapsulates a number of characteristics defining the field of chemistry in the Enlightenment period. It highlights the close connection between industrial production and

[54] I follow the reconstruction of the story by Alexander Kraft, 'On the Discovery and History of Prussian Blue', *Bulletin for the History of Chemistry* 33, no. 2 (2008): 61–65.

scientific investigations in the Enlightenment and thus demonstrates that artisanal workshops and academic institutions played different yet equally important roles in developing chemistry and defining it as an independent realm of study. In addition, the genealogy of Prussian Blue illustrates the fact that chemical knowledge was produced, debated, and refined on both a local and a transnational level across political boundaries.[55]

Taking its cue from these observations, the present chapter maps chemistry as a science in Enlightenment France and Germany. Within the larger remit of the thesis, it is important for two reasons. First, it introduces the chemist-historians whose works will stand at the centre of all later chapters, by situating them within the wider culture of eighteenth-century chemistry. Second, beyond providing useful and necessary background knowledge, the reconstruction serves a crucial argumentative purpose. As we shall see throughout the thesis, the practical and institutional working environment of the chemists impacted their scientific positions and aligned adventures in history-writing in manifold ways. For example, the chemist-historians of chapter 2 depicted their methods of investigating substances as conforming to a particular philosophy of science which emphasised the global advancement of the human spirit over long periods of time. Accordingly, their histories portrayed the field's genesis in the modern period as being determined by the joint evolution of facts and theories, leaving aside most contextual factors such as institutional settings or personal bonds between scholars. This, however, drastically changed between circa 1770 and 1800, once their successors began to scrutinise the impact of various intellectual and social factors on production of knowledge in chemistry. When creating novel ways of assessing the discipline's history which evolved as part of such scientific controversies, the chemist-historians often drew on their everyday experiences as practising scholars and their wider understanding of what chemistry was and should be (see

[55] Charlotte Guichard, Anne-Solenn Le Hô, and Hannah Williams, 'Prussian Blue. Chemistry, Commerce, and Colour in Eighteenth-Century Paris', *Art History* 46, no. 1 (2023): 158–64; Ursula Klein, 'The Chemical Workshop Tradition and the Experimental Practice. Discontinuities within Continuities', *Science in Context* 9, no. 3 (1996): 251–87.

chapters 3–5). Hence, a brief reconstruction of what their world looked alike is most informative. This brief outlook clarifies the scope of the present chapter. It is neither an exhaustive institutional or cultural history of chemistry during the period at hand nor does it claim to make any novel contribution to historical scholarship on these fields. Also, it should be noted that the purely scientific controversies in chemistry as part of which chemists wrote historical works will be introduced in the relevant chapters.

The chapter is structured as follows. Having briefly introduced the identity and changing status of chemistry as a practical and academic discipline in the eighteenth century, I shall outline its institutional development as well as the careers pursued by those who contributed to this realm of knowledge. This will be followed by a discussion of the various ways in which institutional settings and social patterns – especially the practice of patronage – impacted the production of chemical knowledge. Finally, I shall focus on the collaborative aspect of investigating chemistry with a special look at laboratories as sites of scientific investigation. Only briefly will I touch upon the topic of communication networks; these will be discussed in greater detail in chapter 3, because the changes in the practice of translating and publishing investigative reports and entire monographs which occurred in the 1770s were closely entwined with the scientific controversy on pneumatic chemistry.

Approaching Enlightenment Chemistry

A key aspect of chemistry's development in the eighteenth century was the change in its public perception. Given the heritage of alchemy, the field occasionally continued to be associated with charlatanerie and deceit still in the first decades of the 1700s. Hence, chemists continued to feel the need to defend their practical laboratory work.[56] Concomitantly, however, there was a noticeable and strong trend of chemistry becoming fashionable both for practising scholars and among a wider learned audience interested in the natural sciences.[57] The growth in its popularity was mirrored by an increase both in the institutional positions dedicated to its study, and in the number of participants in public or private lectures.[58] John Perkins has calculated that already by 1761, 1,100 auditors regularly attended lectures focusing on chemistry in Paris alone, a number which increased to 3,140 by 1786.[59] This phenomenon was not restricted to the capital, for by the late 1780s no fewer than twenty-four French cities and towns could boast one or several regular public chemistry courses.[60]

The main reason for this notable shift in chemistry's public image lay in the acknowledgment of how useful chemical knowledge was for a variety of purposes. State officials discovered that its insights could help improve profits in a wide array of economic fields from agriculture and mining to industrial production. They therefore needed experts with knowledge of chemistry to guide these processes. Consequently, public and private funding for institutional positions and investigative endeavours relating to chemistry in general greatly increased over the century.[61] The readiness of aristocrats to support such endeavours was enhanced by the fact that witnessing and, at times, performing chemical experiments became somewhat of a fashion within the higher echelons of society, an observation which is further evidenced by

---

[56] Meinel, 'Theory', 123–26; Meinel, 'Artibus Academicis Inserenda', 90; Lawrence Principe, 'A Revolution Nobody Noticed? Changes in Early Eighteenth-Century Chymistry', in *New Narratives in Eighteenth-Century Chemistry. Contributions from the First Francis Bacon Workshop, 21-23 April 2005, California Institute of Technology, Pasadena, California*, ed. Lawrence Principe, vol. 18, Archimedes (Dordrecht: Springer, 2007), 11–13.
[57] Ursula Klein and Matthew Daniel Eddy, 'Introduction. The Core Concepts and Cultural Context of Eighteenth-Century Chemistry', in *A Cultural History of Chemistry in the Eighteenth Century*, ed. Ursula Klein and Matthew Daniel Eddy, vol. 4, A Cultural History of Chemistry (London: Bloomsbury Academic, 2022), 17–18; Hufbauer, *Formation*, 28–29.
[58] Bensaude-Vincent, 'Culture', 94–96; Powers, 'Learning', 163, 167–68.
[59] Perkins, 'Chemistry Courses', 34–36. The exact number is found in the table on page 36.
[60] John Perkins, 'Creating Chemistry in Provincial France before the Revolution. The Examples of Nancy and Metz. Part 1. Nancy', *Ambix* 50, no. 2 (2003): 145.
[61] Bensaude-Vincent, 'Culture', 100–101; Perkins, 'Creating Chemistry Pt 1 Nancy', 145–46; Powers, 'Learning', 166; Meinel, 'Artibus Academicis Inserenda', 97–98.

the fact that these groups were regular participants in the aforementioned chemistry courses.[62] Another impulse to foster chemical inquiries came from the medical field. With public health becoming a major concern, medical education and practice developed an even deeper interest in pharmacological processes to treat diseases more efficiently. To do so, they often built upon the tradition of iatrochemistry.[63]

Yet what exactly was chemistry? Rather than postulating a normative definition, it is useful to consider the term's conceptual history, which has been reconstructed by Lawrence Principe and William Newman. Up until the final quarter of the seventeenth century, there was no difference in meaning between the concepts of *alchemia* and *chymia*: it was equally common to refer to the transmutation of metals by calling it chemistry as it was to designate investigations into the composition of substances and materials as alchemy, and vice versa. Scholars began to distinguish between the two concepts as late as the 1670s. Adepts of the controversial practice of metallic transmutation began to associate alchemy with a supreme form of investigations, mostly dealing with the production of gold, which contrasted with the more pedestrian chemical way of investigating substances. Those denying the possibility of transmutation, for instance the pharmacist Nicolas Leméry, gladly took up the opportunity to entrench a clear semantic distinction between alchemy as irrational and chemistry as rational.[64]

On such grounds, Newman and Principe have shown that associating the concept of alchemy with occultism featured in the attempt of French chemists to professionalise their

[62] Christine Lehman and Bernadette Bensaude-Vincent, 'Public Demonstrations of Chemistry in Eighteenth Century France', *Science & Education* 16, no. 6 (2007): 575–76; Bensaude-Vincent and Lehman, 'Public Lectures', 77; Perkins, 'Chemistry Courses', 29, 37–38. For the general phenomenon of aristocratic support to popularise science see Michael R. Lynn, *Popular Science and Public Opinion in Eighteenth-Century France*, Studies in Early Modern European History (Manchester: Manchester University Press, 2006), 20–22.
[63] Hufbauer, *Formation*, 34–36; Meinel, 'Artibus Academicis Inserenda', 93–94. For attempts to reconcile iatrochemical principles and chemical theory in the early eighteenth century see Kim, *Affinity*, 22–23, 31–33.
[64] Newman and Principe, 'Alchemy vs. Chemistry'; Lawrence Principe, 'Transmuting Chymistry into Chemistry. Eighteenth-Century Chrysopoeia and Its Repudiation', in *Neighbours and Territories. The Evolving Identity of Chemistry. The 6th International Conference on the History of Chemistry. Proceedings*, ed. José Ramon Bertomeu-Sanchez, Duncan Thorburn Burns, and Brigitte van Tiggelen (Louvain-la-neuve: Mémosciences asbl, 2008), 21–23.

discipline. Within the Parisian *Académie des Sciences*, chemists were under pressure to avoid any association with charlatanry following the *affaire des poisons*. By the end of the seventeenth century, the practice of working with substances in a laboratory, the chemists' natural home, was so suspicious that even the private ownership of furnaces was strictly regulated. Accordingly, Colbert tied the inclusion of chemists in the *Académie* to an official ban on searching for the philosopher's stone in the 1690s. Principe in particular has thus underlined that finding a clear semantic distinction to brand one's laboratory practices rational and to clearly delineate them from anything considered superstitious or fraudulent was thus part of the institutional politics at the recently reformed institution. Its permanent secretary, Bernard Le Bovier de Fontenelle, helped to craft an image of chemistry as a legitimate discipline, notwithstanding his ambivalent stance towards its current status as a science. The strategy proved overwhelmingly successful. By the 1720s, alchemy had become not only equivalent on a semantic level with the search for the philosopher's stone and the idea of artificially making gold but was furthermore associated with occultism and irrationality in general. Chemistry, by contrast, came to be seen as the academic discipline dedicated to synthesising and analysing substances whose contributions could benefit the kingdom.[65]

This distinction between 'irrational' alchemy and 'rational' chemistry entered the historical discourse on chemistry in the 1720s.[66] The historical introduction to Jean-Baptiste de Sénac's *Nouveau Cours de Chymie* (1723) is a striking example of this development. A medical doctor by training, Sénac joined the Parisian *Académie* in the year of the *Cours*'s publication and thus precisely at the time when its members were intensifying their efforts to alter

---

[65] Newman and Principe, 'Alchemy vs. Chemistry', 38–39, 63; Lawrence M. Principe, 'The End of Alchemy?', *Osiris* 29, no. 1 (2014): 100–106; Principe, 'Revolution', 10–13; Christine Lehman, 'Alchemy Revisited by the Mid-Eighteenth Century Chemists in France. An Unpublished Manuscript by Pierre-Joseph Macquer', *Nuncius* 28, no. 1 (2013): 166–67.

[66] Beretta, 'Historiography of Chemistry', 2; from a more general perspective Wouter J. Hanegraaff, *Esotericism and the Academy. Rejected Knowledge in Western Culture* (Cambridge: Cambridge University Press, 2012), 202–5.

chemistry's status and juxtapose it to alchemy.[67] Sénac adopted their relatively novel distinction between chemistry as an allegedly rational science, rooted in the practice of observation, and alchemy as an irrational endeavour whose followers sought to evidence the possibility of transmuting metals by assessing ancient books, and translated it into a historical argument: even if alchemical practices such as the transmutation of metals seemed to be confirmed by writings from antiquity, the reports could not be true because they had never been proven in an observation-based setting.[68]

The sharp distinction between alchemy and chemistry altered the chronology and temporal evolution in Sénac's historical account, a fact which made Sénac lash out at his predecessors right at the outset of the text. He presented a narrative in which chemistry's true history only began in the ninth century CE with the Arab philosopher Geber (Jabir ibn Hayyan) and, after a scholastic intermezzo, progressed continuously from the thirteenth century onwards until it reached a peak in recent years with Geoffroy's affinity tables. Hence, chemistry did not need any reference to ancient origins as it was vindicated by its evident usefulness to present endeavours. Nonetheless, a second, irrational attitude to the problems of chemistry – embodied by charlatans such as Paracelsus –continued to exist separately.[69]

Yet, notwithstanding this semantic narrowing of chemistry to a 'science of materials',[70] chemistry's identity and exact purpose remained in flux throughout the eighteenth century. This non-teleological process of discipline formation encapsulated two antagonistic aspects. On the one hand, chemical knowledge was greatly enriched by investigations conducted in related fields such as physics, pharmacy, natural history, and medicine, as well as by the

---

[67] William Arthur Smeaton, 'Jean-Baptiste Sénac', in *Complete Dictionary of Scientific Biography*, vol. 12 (Detroit MI: Charles Scribner's Sons, 2008), 302–3.
[68] [Sénac, Jean Baptiste de]. *Nouveau Cours de Chymie, suivant les principes de Newton & de Sthall. Avec und Discours Historique sur l'Origine & les progrez de la Chymie* (Paris: Jacques Vincent, 1723), xxix-xxxviii and liii, esp. xxxvi-xxxviii.
[69] Ibid., iii-iv, liv-lxvii.
[70] Klein and Lefèvre, *Materials*, 1.

professional insights gained by artisans. On the other hand, scholars were keen to point out what was idiosyncratic about chemistry as a science in contrast to mere crafts or other fields of inquiry, which could result in competing definitions, too.[71] Over the course of the century, however, the idea of viewing chemistry as an independent discipline was reinforced by the growing body of textbooks which recorded explicitly 'chemical' knowledge. Additionally, internal distinctions between 'pure' and 'applied' chemistry, as well as the idea of a philosophical chemistry which focused on systematising facts, gained traction.[72] Yet, there was not yet a standardised way to become a chemist and the efforts to narrowly define chemistry contrasted with the diverse career paths of individual scholars. Assessing their backgrounds, careers, and institutional affiliations will be the topic of the next section.

Careers in Eighteenth-Century Chemistry

Due to its close links with different branches of inquiry, chemistry as an evolving discipline has to be situated within the architecture of the Republic of Letters in the eighteenth century. The Republic of Letters – here broadly understood as the community of those interested in producing and discussing knowledge – had a peculiar shape in the eighteenth century. It is with good reason that Daniel Roche once called it a 'pays problématique, paradoxal' given that, as a social system, it was marked by its great diversity.[73] One of its key features was its

---

[71] Jonathan Simon, 'Pharmacy and Chemistry in the Eighteenth Century. What Lessons for the History of Science?', *Osiris* 29, no. 1 (2014): 285–86; Meinel, 'Theory', 122–23; Hufbauer, *Formation*, 20–22; Jan Golinski, 'Chemistry', in *The Cambridge History of Science*, ed. Roy Porter, vol. 4 (Cambridge: Cambridge University Press, 2003), 379–80. For an overview over the various chemical industries see Leslie Tomory, 'Trade and Industry. An Era of New Chemical Industries and Technologies', in *A Cultural History of Chemistry in the Eighteenth Century*, ed. Ursula Klein and Matthew Daniel Eddy, vol. 4, A Cultural History of Chemistry (London: Bloomsbury Academic, 2022), 137–56. For a theoretically advanced analysis of the co-evolution of chemistry and physics in eighteenth-century Germany see Stichweh, *Zur Entstehung*, 94–143.

[72] Powers, 'Learning', 158; Meinel, 'Theory', 125–29. For a detailed analysis of the history of theoretical chemistry see Kim, *Affinity*.

[73] Daniel Roche, *Le siècle des lumières en province. Académies et académiciens provinciaux, 1680–1789*, vol. 1 (Paris: Mouton, 1978), 15. Irène Passeron, René Sigrist, and Siegfried Bodenmann, 'La république des sciences.

decentralised, transregional, and accessible character. As Lawrence Brockliss has shown in his case study on the Provençal naturalist and antiquarian Esprit-Claude-François Calvet, the learned world was a decentralised web, composed both of scholars and institutions, which formed numerous partly intersecting networks. The overwhelming majority of the estimated 30,000 scholars who had become its citizens by the end of the eighteenth century were not professionals in the modern sense. Rather, they collected and discussed information on all kinds of subjects for their personal pleasure. Their many individual networks of spoken and written communication extended from the local to the intercontinental level and often encapsulated personal relationships both with amateurs and with scholars of renown. Amateurs who lived in the provinces were thus directly or indirectly connected with the learned institutions and salons in cities.[74]

Provincial scholars with an interest in chemistry were integrated into such networks and, therefore, were of great importance to the development of chemistry in the eighteenth century. This is exemplified by the case of Bernard Louis Guyton de Morveau. Having joined the *Académie des Sciences* of Dijon in 1764, he went on to publish numerous treatises on combustion, salts, and metallurgy with a strong bend towards chemical theory. As early as 1782, he called for a comprehensive revamp of the chemical nomenclature, which he realised together with the Parisian chemists Antoine de Lavoisier, Antoine de Fourcroy, Claude Louis Berthollet, Jean-Henri Hassenfratz, and Pierre Adet in 1787 (see chapter 4). Although their careers were exceptionally successful, Guyton, as well as his colleague Jean-Antoine Chaptal, exhibits

---

Réseaux des correspondances, des académies et des livres scientifiques', *Dix-huitième siècle* 40, no. 1 (2008): 5–27 debate the usefulness of distinguishing between the Republic of Letters and its equivalent in the sciences.

[74] Laurence W. B. Brockliss, *Calvet's Web. Enlightenment and the Republic of Letters in Eighteenth-Century France* (Oxford: Oxford University Press, 2002), 8–16, 390, 395–99; Laurence W.B. Brockliss, 'Starting-Out, Getting-On and Becoming Famous in the Eighteenth-Century Republic of Letters', in *Scholars in Action: The Practice of Knowledge and the Figure of the Savant in the 18th Century*, ed. André Holenstein, Hubert Steinke, and Martin Stuber, vol. 1, History of Science and Medicine Library 34/1 (Leiden: Brill, 2013), 76–83; Charles W. J. Withers, *Placing the Enlightenment. Thinking Geographically about the Age of Reason* (Chicago Ill: University of Chicago Press, 2007), 42–61, 76–82; Lynn, *Popular Science*, 2–3, 44–46; Mary Terrall, *The Man Who Flattened the Earth. Maupertuis and the Sciences in the Enlightenment* (Chicago Ill: The University of Chicago Press, 2002), 5–6.

the profound impact which the diverse communities of provincial savants had on chemistry.[75] What is most unusual about Guyton's career, however, is his educational background. Having been trained as a lawyer, he never received any scientific education and acquired his chemical knowledge through self-study.[76] Many of those contributing to chemistry, by contrast, were educated in the fields of medicine or pharmacy. Indeed, apothecaries and pharmacists became a pillar of investigating and teaching chemistry in provincial settings in the eighteenth century, while medics remained an important group too. In contrast to their colleagues in medicine, most future pharmacists usually received their training in apprenticeships.[77]

In France, local guilds defined an apprentice's entry conditions such as the necessary qualifications and the fees to be paid to the master in return for teaching. The apprenticeship usually lasted four years and was followed by a period in which the aspiring apothecary travelled as a journeyman across the kingdom for three years. Afterwards, he was allowed to open a business and could eventually apply to become a master himself. Several groups – the sons of apothecaries or the *Apothicaires privilégiés* for example – did not have to sit such exams, a factor contributing to unequal standards in pharmacy across France.[78] Apprenticeships for apothecaries were even less streamlined in the German states because of political fragmentation. It could take up to fourteen years for a young man to complete his education as an apothecary, first as an apprentice in the master's shop and then as a travelling *Geselle*, before he was examined by the local authorities.[79]

---

[75] Homer E. LeGrand, 'Chemistry in a Provincial Context. The Montpellier Société Royale Des Sciences in the Eighteenth Century', *Ambix* 29, no. 2 (1982): 88–100; William Arthur Smeaton, 'L.B. Guyton de Morveau (1737-1816). A Bibliographical Study', *Ambix* 6, no. 1 (1957): 18–34; Perkins, 'Creating Chemistry Pt 1 Nancy', 147; John Perkins, 'Creating Chemistry in Provincial France before the Revolution. The Examples of Nancy and Metz. Part 2 Metz', *Ambix* 51, no. 1 (2004): 44–46; Bensaude-Vincent and Lehman, 'Public Lectures', 82–84.
[76] Kim, *Affinity*, 229–33.
[77] Bensaude-Vincent and Lehman, 'Public Lectures', 85; Powers, 'Learning', 158–60. With respect to Germany, Karl Hufbauer has claimed that pharmacists took over the lead as the most important group of chemists in the course of the eighteenth century, see Hufbauer, *Formation*, 57–58.
[78] Simon, *Chemistry*, 24–25.
[79] Ursula Klein, 'Apothecary-Chemists in Eighteenth-Century Germany', in *New Narratives in Eighteenth-Century Chemistry. Contributions from the First Francis Bacon Workshop, 21-23 April 2005, California Institute of*

Attempts to reform pharmaceutical education were made throughout the eighteenth century both in France and in some German states such as Prussia. In general, such efforts aimed at standardising curricula to elevate practical standards across the band, but this overall goal was not universally reached. The foundation of the Parisian *Collège de Pharmacie* in 1777 was mirrored in Germany both by efforts to offer additional training for pharmacists at universities and academies and by private initiatives. For example, the Thuringian pharmacist Johann Christian Wiegleb, who will feature prominently in chapters 2 and 3 of this thesis, opened a pharmaceutical school in 1779. Tuition and practical training went hand in hand, for the school was attached to Wiegleb's pharmacy in the town of Langensalza. Some of his pupils yearned to continue their teachers' efforts. Among them were Sigismund Friedrich Hermbstädt and Johann Bartholomäus Trommsdorff, who founded their own schools in 1789 and 1794, respectively.[80] Yet, for most pharmacists in the eighteenth century, their master's shop and in some cases its adjunct laboratory and library were their first point of contact with the science of chemistry.[81]

However, insisting on the relevance of private initiatives and pharmacies in provincial towns, should not lead us to underestimate the vital role which learned institutions played in the development of chemistry as a science in the eighteenth century. Although chemistry was not always seen as an independent discipline, it is undeniable that the number of lectures delivered on topics related to chemistry greatly increased over the century. This is true above all for universities on both sides of the Rhine.[82] In France, the content of chemistry courses was reformed at universities with a long tradition in medicine, such as Montpellier, Strasbourg, and Toulouse, while chairs specifically dedicated to chemistry were set up in a number of medical

Technology, Pasadena, California, ed. Lawrence Principe, vol. 18, Archimedes (Dordrecht: Springer, 2007), 99–100.

[80] Simon, *Chemistry*, 25–27; Klein, 'Apothecary-Chemists', 101–3; Meinel, 'Artibus Academicis Inserenda', 105–6; Powers, 'Learning', 160–63.

[81] Klein, 'Apothecary-Chemists', 102, 113–14.

[82] Powers, 'Learning', 163–66.

faculties, including Caen, Nancy, and Nantes.[83] In the German lands, university positions dedicated to teaching chemistry to students of medicine had been increasing since the second half of the seventeenth century; there were almost fifty such positions by the 1790s. That most of these professorships were no longer confined to propaedeutics underlined chemistry's enhanced status as an academic field. In addition, there were tentative attempts from the 1770s onwards to create chairs in chemistry at the philosophical faculties to allow for an even greater autonomy of the evolving discipline.[84]

Chemistry found another home in establishments that emerged in response to the practical needs of governments. Across the German-speaking states, such institutions were closely related to the cameralist movement. Building upon the model of Swedish universities in Uppsala and Lund, *Bergbauakademien* flourished from the 1760s onwards in places such as Freiberg, Schemnitz, and Berlin to enhance the productivity of the mining industry.[85] In 1783, the Parisian *École des Mines* was established after such models at the initiative of the geologist and chemist Balthazar-Georges Sage, who would later become one of Lavoisier's most ardent critics. Similarly, French botanical gardens and those institutions which were aligned with the military dedicated resources to studying and teaching chemistry.[86] Notwithstanding these similarities, scholarship has unveiled considerable differences between the institutional landscapes of chemistry in France and in Germany. They varied particularly in the degree of centralisation, which had considerable effects upon the concentration of resources and institutional power and, as a result, on the career paths of scholars in chemistry.

---

[83] Perkins, 'Creating Chemistry Pt 1 Nancy', 147–49.

[84] Meinel, 'Artibus Academicis Inserenda', 98–100, in particular the graph on 100; Stichweh, *Zur Entstehung*, 102–5.

[85] Meinel, 'Artibus Academicis Inserenda', 97–98; Meinel, 'Theory', 127–28; Hufbauer, *Formation*, 24; Homburg, 'Two Factions', 46.

[86] Roger Hahn, 'Scientific Careers in Eighteenth-Century France', in *The Emergence of Science in Western Europe*, ed. Maurice Crosland (London: Macmillan, 1975), 132–34; Charles Coulston Gillispie, *Science and Polity in France. The End of the Old Regime* (Princeton NJ: Princeton University Press, 2004), 499–504; Perkins, 'Creating Chemistry Pt 1 Nancy', 149–51.

Institutions of Chemistry in Eighteenth-Century France

Just like with any other discipline in the natural sciences, French scientific academies were crucial for the development of chemistry in the eighteenth century. They were important promoters of the sciences, providing resources to pursue scientific trajectories and affording its members reputational benefits in a hierarchical society. Winning one of their numerous prize contests provided up-and-coming scholars with the opportunity to make themselves known across Europe and to disseminate their ideas at an academy's or a sponsor's expense. The periodicals which many learned institutions published also ensured the circulation of insights across political and geographical spaces.[87]

Despite providing such opportunities, academies were elitist bodies and deeply entangled with the political culture of the *Ancien Régime*. In France, this was particularly true for the *Académie Royale des Sciences* in Paris. Founded by Jean-Baptiste Colbert in 1666 to provide the monarchy with useful information in realms such as weaponry and infrastructure, it quickly became a place for scholars to conduct their investigations relatively freely under the protection of the crown.[88] Since the *Académie*'s earliest days, chemistry had been a matter of both interest and controversy among its members with different visions of the nascent discipline competing among them in the late seventeenth century. After the reform of 1699, chemistry – together with astronomy, geometry, mechanics, anatomy, and botany – was one of the establishment's six thematic classes. The *Académie* offered membership to eight chemists a

[87] Jeremy L. Caradonna, *The Enlightenment in Practice: Academic Prize Contests and Intellectual Culture in France, 1670-1794* (Ithaca N.Y: Cornell University Press, 2012), 4; Jeanne Peiffer and Jean-Pierre Vittu, 'Les journaux savants, formes de la communication et agents de la construction des savoirs (17e-18e siècles)', *Dix-huitième siècle* 40, no. 1 (2008): 281–300; Brockliss, *Calvet's Web*, 10; Brockliss, 'Starting-Out', 83,92. For a detailed account of academies in the eighteenth century see James E. McClellan III, *Science Reorganized. Scientific Societies in the Eighteenth Century* (New York NY: Columbia University Press, 1985), 41–151.
[88] For the vexed history of this development see Robin Briggs, 'The Académie Royale Des Sciences and the Pursuit of Utility', *Past & Present*, no. 131 (1991): 38–88.

time throughout the eighteenth century, which made it an outstanding, if not the most important, scientific institution for chemical investigations across Europe.[89]

It is crucial to note, however, that the *Académie*'s composition was not egalitarian. Even the reform of 1785, which was enforced by the chemist Antoine de Lavoisier, did not change the fact that different ranks within the institution went along with certain privileges. The previously lowest position (*adjoint*) was abolished but the distinction between *pensionnaires* with voting rights and financial compensation and *associés* without such rights and privileges was left intact. Until its abolition in 1793, the *Académie* had a perpetual secretary, twelve honorary members (*honoraires*) who were often scientific amateurs, and numerous corresponding members. When vacancies arose due to the resignation or death of a previous member, *honoraires* and *pensionnaires* voted upon a shortlist drafted by *pensionnaires* of the class concerned. The ultimate decision, however, was subject to approval by the crown which, on certain occasions during the eighteenth century, intervened in election matters.[90]

The Parisian Academy wielded a particular type of power over the scientific community. Taking advantage of the printing privilege granted to the Academy in 1699, academicians had been published their own findings in the *Histoires* et *Mémoires* of the Academy. Owing to the growing number of investigations into the sciences which were conducted outside the Parisian institution, the Academy began to publish works submitted by non-members, if indeed the academicians considered them worthy of endorsement.[91] Individually assembled commissions, often consisting of five academicians, gathered behind locked doors to assess whether

[89] Frederic Lawrence Holmes, *Eighteenth-Century Chemistry as an Investigative Enterprise. Five Lectures Delivered at the International Summer School in History of Science, Bologna, August 1988*, Berkeley Papers in History of Science 12 (Berkeley: Office for History of Science and Technology, University of California at Berkeley, 1989), 11–12, 33–35; Principe, 'Revolution', 8; Roger Hahn, *The Anatomy of a Scientific Institution. The Paris Academy of Sciences, 1666-1803* (Berkeley CA: University of California Press, 1971), 98–99. The role of chemistry in the early *Académie* has recently been investigated by Lawrence Principe using the chemist Wilhelm Homberg as a lens, see Lawrence Principe, *The Transmutations of Chymistry. Wilhelm Homberg and the Académie Royale Des Sciences*, Synthesis (Chicago: The University of Chicago Press, 2020), in particular 67-130.
[90] McClellan III, *Science Reorganized*, 17–20; Terrall, *Man*, 29–30; Hahn, *Anatomy*, 76–80, 99–100, 133.
[91] Hahn, *Anatomy*, 61–63; Gillispie, *Science Old Regime*, 98.

submissions were worthy to be endorsed and published in the *Histoire*. Given the outreach of the Academy's periodicals across Europe, it had considerable impact on both the scientific standards and the careers of individual scholars.[92] The same can be said about the realm of inventions. Due to the lack of a coherent patent law in pre-revolutionary France and following from the Academy's utilitarian origins, its commissions also judged whether an invention was innovative or not, thus extending the institution's reach into the realm of crafts.[93] Finally, the Parisian Academy sponsored one of the most prestigious annual prize contests in the Republic of Letters from 1714 onwards.[94]

A good relationship with or, ideally, a position within the Academy was crucial not only to gain scientific merit but for economic reasons. To be sure, membership in the Academy alone only alleviated the existential pressures and did not allow for an extravagant life, since the lower positions were not paid at all and even the yearly income of *pensionnaires* averaged only 2,000 livres.[95] Yet the Academy was part of a wider range of opportunities to make a living for young scientists in general and chemists in particular. In response to the increasing interest in chemical education among different groups which has been discussed above, several institutions such, as the *Jardin du Roi*, the *Collège de France*, the *Jardin des Apothicaires* (which became the *Collège de Pharmacie* in 1777) the Faculty of Medicine, the *Collège de Chirurgie* and, after its inception in 1783, the *École des Mines*, all offered paid teaching positions for chemists in the final decades of the century.[96] Many chemists earned an extra income

[92] Stéphane van Damme, 'The Academization of Parisian Science (1660–1789). Review Essay on a Spatial Turn', in *The Institutionalization of Science in Early Modern Europe*, ed. Mordechai Feingold and Giulia Giannini, Scientific and Learned Cultures and Their Institutions 27 (Leiden: Brill, 2020), 33; Pascale Mafarette-Dayries, 'L'Académie royale des sciences et les grandes commissions d'enquête et d'expertise à la fin de l'Ancien Régime', *Annales historiques de la Révolution française* 320, no. 1 (2000): 121–35; Hahn, *Anatomy*, 63.
[93] Gillispie, *Science Old Regime*, 98–99.
[94] Hahn, *Anatomy*, 62; Gillispie, *Science Old Regime*, 96–97.
[95] Hahn, *Anatomy*, 79; Gillispie, *Science Old Regime*, 85.
[96] Bruno Belhoste, *Paris Savant: Capital of Science in the Age of Enlightenment*, trans. Susan Emanuel (New York, NY: Oxford University Press, 2011), 39; Powers, 'Learning', 169; Simon, *Chemistry*, 26; William Arthur Smeaton, *Fourcroy. Chemist and Revolutionary, 1755-1809* (Cambridge: Heffer's, 1962), 6–7; Hahn, 'Scientific Careers', 132–33.

by selling related textbooks as well as by providing private chemistry courses both to individuals and to larger audiences. These courses varied in length, duration, and format, and were often held jointly by several individuals with different academic backgrounds, thus fostering chemistry's interdisciplinary alignments. While such courses were rich in experimental demonstrations and therefore attracted an aristocratic audience which was keen to be entertained, they also served to instruct students in the practical dimension of chemical investigations and provided visual evidence for new findings in scientific controversies.[97] Chemists could also alleviate financial pressures by working as experts for the state or for rich aristocrats, whose aim of advancing the national industry they were able to support.[98]

For successful French chemists, accumulating positions at different institutions while teaching privately and working in the industry as state commissioners was the rule rather than the exception. Pierre-Joseph Macquer, whose role as a historian of chemistry will be discussed in chapter 2 of this thesis, is a perfect example for this observation. A medic by training, he quickly turned to chemistry under the influence of Guillaume-François Rouelle's lectures at the *Jardin du Roi*. After his election into the Academy in 1745, he co-edited the *Journal des sçavans* and gave private courses with the apothecary Antoine Baumé as his *démonstrateur* for more than ten years, before starting to lecture at the *Jardin* himself from 1770 onwards. While his *Dictionnaire de Chimie* (1766) sold well, he was additionally remunerated as a government official. Having invented a way to dye Prussian Blue, he became a commissioner at the *Bureau du Commerce* and got involved with the dyeing industry as well as the porcelain manufacturers at Sèvres. Being a member of so many state-funded institutions afforded Macquer the

[97] Christine Lehman, 'Innovation in Chemistry Courses in France in the Mid-Eighteenth Century. Experiments and Affinities', *Ambix* 57, no. 1 (2010): 3–16; Perkins, 'Chemistry Courses', 27–34; Lehman and Bensaude-Vincent, 'Public Demonstrations', 573–82; Bensaude-Vincent and Lehman, 'Public Lectures', 86–91; Powers, 'Learning', 167–68.

[98] Marco Beretta and Paolo Brenni, *The Arsenal of Eighteenth-Century Chemistry: The Laboratories of Antoine Laurent Lavoisier (1743-1794)*, Nuncius Series : Studies and Sources in the Material and Visual History of Science 10 (Leiden: Brill, 2022), 6, 14–15; Lehman, 'Pierre-Joseph Macquer: Chemistry', 246, 250; Hahn, 'Scientific Careers', 133–34.

additional benefit of having easier access to several laboratories, the importance of which will be discussed below.[99]

The example of Macquer exhibits that institutional and financial resources for investigating chemistry in France were concentrated in Paris. As was the case for most other segments of the learned world, the capital was the destination for many young French chemists.[100] Consequently, talented scholars such as Jean Antoine Chaptal who had started their careers in the provinces, quickly moved to Paris; those who had established themselves there, in turn, tended to stay.[101] A notable exception to this rule is Gabriel-François Venel, a medical doctor educated in Montpellier, who returned by the late 1750s to teach at his *alma mater* after a several-year-long stay in the capital. During his time in Paris, he came into contact with Diderot's circles and wrote several pieces for the *Encyclopédie*, among them the article 'Chimie' which was essentially a historical narrative of the field (see chapter 2).[102] The degree of centralisation became even higher towards the end of the eighteenth century due to the fact that the first two French periodicals specifically dedicated to the study of chemistry and its neighbouring disciplines – the *Journal de Physique* and the rivalling *Annales de Chimie* – were coordinated from Paris by Jean-Claude Delamétherie and Lavoisier, respectively.[103]

---

[99] William Arthur Smeaton, 'Pierre-Joseph Macquer', in *Complete Dictionary of Scientific Biography*, vol. 8 (Detroit MI: Charles Scribner's Sons, 2008), 618–24; Christine Lehman, 'Pierre-Joseph Macquer. An Eighteenth-Century Artisanal-Scientific Expert', *Annals of Science* 69, no. 3 (2012): 307–33; Lehman, 'Pierre-Joseph Macquer: Chemistry'; Beretta and Brenni, *Arsenal*; Bensaude-Vincent, 'Culture', 97.
[100] On the general trend see Robert Darnton, *The Literary Underground of the Old Regime* (Cambridge MA: Harvard University Press, 1982), 16–19.
[101] See Maurice Crosland, 'Jean Antoine Chaptal', in *Complete Dictionary of Scientific Biography*, vol. 12 (Detroit MI: Charles Scribner's Sons, 2008), 198–203.
[102] William Arthur Smeaton, 'Gabriel-François Venel', in *Complete Dictionary of Scientific Biography*, vol. 13 (Detroit MI: Charles Scribner's Sons, 2008), 602–4.
[103] Crosland, *Shadow*, 2–3, 67.

Chemists and Chemistry in the German Lands

While the French chemical community, though geographically diverse, had a firm centre of gravity in Parisian institutions, there was no comparable hub for chemical studies in Germany. Before 1780, the only academy of science with a position dedicated to the field of chemistry was located in Berlin: the *Kurfürstlich Brandenburgische Societät der Wissenschaften* employed two chemists ever since the 1720s. Under the reign of Frederick II, chemistry received increasing financial and material support, which also resulted in the refurbishment of its laboratory. However, in this the *Societät* remained an outlier.[104]

In comparison to France, there were even fewer academic positions available to German chemists which could provide them with sufficient resources to focus solely on the study of chemistry. The numerous contributions of German scholars to eighteenth-century chemistry therefore naturally raise the question of their professional and occupational background. Historians of science have convincingly shown that well into the nineteenth century, German chemists combined a number of positions in the emerging industries with publishing and teaching. Practitioners, rather than pure academics, were therefore at the heart of what has been called the German chemical community.[105] Just like in France, the emerging porcelain and metallurgical industries as well as agronomy offered an increasing number of positions in the German lands. In many regions rich in metals, the mining industry was particularly attractive to aspiring chemists.[106]

However, ever since the publication of Karl Hufbauer's seminal book on German chemistry during the eighteenth century in 1982, we have been aware that pharmacists formed the

[104] Hufbauer, *Formation*, 46–48.
[105] Homburg, 'Two Factions', 48–49.
[106] Ibid., 45–48; Klein, 'Apothecary-Chemists', 97–98. On the intersection between mining and chemistry see the Swedish case study by Fors, *Limits of Matter*.

backbone of the community. Hufbauer, and Ursula Klein after him, came to this conclusion by assessing contributors and readers of chemical periodicals, above all of the *Annalen der Chemie*. The subscription lists reveal that many readers of and contributors to that journal, as well as of the *Almanach für Scheidekünstler und Apotheker*, were located in provincial settings across the German-speaking lands. Notwithstanding their geographically peripheral position, many of them intervened in all sorts of advanced chemical debates, often in reaction to English and French chemical publications. Indeed, as we shall see throughout this thesis, such interventions could also include historical essays which were published next to, say, a piece on putrefaction or fertiliser. Of the eight most active contributors to the *Annalen*, only three lived off their appointments as professors at academies and universities. The other five remained practicing pharmacists throughout their entire careers. They were geographically dispersed, some living in Berlin but others in cities boasting a university such as Göttingen or Halle, or in even smaller towns such as Hameln or Langensalza.[107] Subscription rates were high among this group, too, typically making up around half of the journal's overall readership. In Prussia, most readers of the *Annalen* were apothecaries based in Berlin, but no similar geographical concentrations are observable in other principalities.[108]

The fact that pharmacists, and not medics, became major contributors to the *Annalen* in the final decades of the eighteenth century marks a considerable shift from the early decades of the century when the latter group had dominated the emerging chemical community.[109] This, however, is not to say that medical doctors lost interest in matters of chemistry. Towards the end of the century, a growing number of doctors became interested in pneumatic chemistry when studying the impact of gaseous substances on human health.[110] Indeed, one of the

---

[107] Hufbauer, *Formation*, 88–91; Crosland, *Shadow*, 2.
[108] Hufbauer, *Formation*, 96–87; Klein, 'Apothecary-Chemists', 118–19.
[109] Hufbauer, *Formation*, 54.
[110] For an intellectual history of eudiometry see Victor D. Boantza, 'The Rise and Fall of Nitrous Air Eudiometry: Enlightenment Ideals, Embodied Skills, and the Conflicts of Experimental Philosophy', *History of Science* 51, no. 4 (2013): 377–412.

chemist-historians discussed in this thesis, the Austrian Johann Andreas Scherer, wrote his doctorate in medicine at the University of Vienna on this very topic. Ten years later, he made an innovative contribution to the epistemological discourse on chemistry by publishing a history of chemical nomenclature (see chapter 4). The fact that his works were immediately reviewed in the *Annalen* testifies to the wide geographical scope covered by the journal.[111] Two more medical doctors with a strong bent towards chemistry and history-writing, Johann Friedrich Gmelin and Friedrich Josef Wilhelm Schröder, are discussed in this thesis. However, beyond such general similarities as well as their status as university professors, not much united them. Gmelin, a professor at Göttingen, defended the principles of a Baconian approach to the natural sciences throughout his career, including by constructing historical narratives. His generously endowed professorship came with a well-equipped laboratory and allowed him to focus on academic work alone. Due to his institutional position, Gmelin also came into close contact with the stimulating academic culture of late-eighteenth century Göttingen: here, scholars such as Johann Christoph Gatterer and Johann Friedrich Eichhorn developed novel avenues and methods to explore cultural and political history. As I shall show in chapter 3 of this thesis, Gmelin's historical method was directly influenced by them.[112] Schröder, by contrast, was affiliated with the university of Marburg where he championed a revival of hermeticism in the late 1770s. Having written a history to substantiate his claims, he was heavily criticised for his historical methodology and overall philosophical stances by the aforementioned Johann Christian Wiegleb (see chapter 2).[113]

[111] Lorenz von Crell, 'Anzeige chemischer Schriften', *Chemische Annalen für die Freunde der Naturlehre, Arzneygelahrtheit, Haushaltungskunst, und Manufakturen* 1, no. 6 (1793): 561–68; M Svojtka, 'Scherer, Johann Baptist Andreas Ritter von', in *Österreichisches Biographisches Lexikon, Online Edition*, 2nd ed., accessed 22 August 2024, https://www.biographien.ac.at/oebl/oebl_S/Scherer_Johann-Baptist-Andreas_1755_1844.xml.
[112] John Lewis Heilbron, 'Physics and Its History at Göttingen around 1800', in *Göttingen and the Development of the Natural Sciences*, ed. Rupke Nicolaas (Göttingen: Wallstein, 2022), 52–56; Hufbauer, *Formation*, 202.
[113] For Schröder's biography see Stefan Redies, *Friedrich Joseph Wilhelm Schröder. Ein Rosenkreuzer an der Universität Marburg*, Wissenschaft in Dissertationen 266 (Marburg: Görich & Weiershäuser, 1997), 25–49.

The decentralised character of the chemical community in Germany is further illustrated by the editorship of scientific periodicals. All of them were published by scholars who lived in smaller towns. The editor of the *Almanach*, Johann Friedrich August Göttling, was an apothecary in Weimar when he started the journal in 1780 before he moved on to study chemistry with Georg Friedrich Lichtenberg and Johann Friedrich Gmelin in Göttingen. One of Göttling's apprentices, Johann Bartholomäus Trommsdorff, later founded the *Journal der Pharmacie* (1794) while working as an apothecary in Erfurt where he eventually became a professor at the local university.[114] Lorenz von Crell, the founder of the *Annalen*, was also a professor at the University of Helmstedt. He is of particular interest to the present thesis because his oeuvre includes a critical survey of Lavoisier's claims on the history of chemical nomenclature.[115]

The educational background of the apothecary-chemists as analysed by Klein and by Hufbauer deserves a closer look because two of the German chemists whose contributions to chemical history-writing will be assessed in this thesis, were apothecaries by training: Johann Christian Wiegleb, who engaged with the history of both alchemy and modern chemistry (see chapters 2 and 3), ran a pharmacy in the Thuringian town of Langensalza for almost forty years until 1796. Johann Friedrich Westrumb, who published a critical revision of Lavoisier's claims on the history of chemistry's nomenclature in 1793 (treated in chapter 4), was also an apothecary by training; after years as a journeyman, he settled down in the provincial town of Hameln.[116] Indeed, the tradition of pharmacist-historians continued beyond the chronological boundaries of this thesis. A case in point is Johann Bartholomäus Trommsdorff, who, in 1806, published his *Versuch einer allgemeinen Geschichte der Chemie*, after he had written on the history of Galvanism a few years earlier.[117]

---

[114] Klein, 'Apothecary-Chemists', 115–16, 122; Hufbauer, *Formation*, 207–8, 218–19.
[115] Hufbauer, *Formation*, 62–69.
[116] For Wiegleb see the comprehensive biographical study by Klosa, *Johann Christian Wiegleb*, 7–42. For Westrumb see Hufbauer, *Formation*, 205–6.
[117] Johann Bartholomäus Trommsdorff, *Geschichte des Galvanismus oder der galvanischen Electricität, vorzüglich in chemischer Hinsicht* (Erfurt: Hennings'sche Buchhandlung, 1803); Trommsdorff, *Versuch einer*

Most apothecaries came into contact with chemistry through apprenticeships in smaller towns rather than through university training, public lectures, or spectacular public demonstrations of chemical phenomena. As indicated above, apprentices spent several years in their master's shop and not all but most German pharmacies were equipped with a laboratory.[118] If the master was interested in chemistry, and particularly if he was an active contributor to the chemical community and published himself, his apprentices gained first-hand exposure in observation-based chemical inquiries. Although eminent apothecary-chemists such as Johann Christian Wiegleb aimed to formalise a pharmacist's education through the foundation of schools, pharmacies were sites of chemical education where the leading pharmacists of the day passed on their knowledge throughout the century. Apprentices eager to increase their knowledge used the opportunity of travelling as journeymen to learn from different pharmacists and sometimes attended university courses too.[119]

Due to their practical education, apothecary-chemists had a particular view of chemistry which captured many aspects and sometimes competing trends of the evolving discipline. On the one hand, their daily laboratory work made many of them staunch defenders of an observation-based approach to their field.[120] On the other hand, they were exposed to – and sometimes contributed to – the revival of alchemist practices which took hold of the German lands during the final decades of the eighteenth century. Ursula Klein has proven this instance by a

---

allgemeinen Geschichte der Chemie. One could even add Friedrich Albert Carl Gren, another pharmacist-turned-professor who attempted a lecture series on the history of science in 1799. Sadly, it remained a fragment due to Gren's premature death, see Friedrich Albert Carl Gren, 'Geschichte der Naturwissenschaft, als akademische Vorlesung vorgetragen', *Annalen der Physik. Angefangen von Friedr. Albr. Carl Gren, fortgesetzt von Ludwig Wilhelm Gilbert* 1 (1799): 167–204. For a comprehensive account of Gren's life and works see Markus Seils, *Friedrich Albrecht Carl Gren in seiner Zeit, 1760 - 1798. Spekulant oder Selbstdenker?*, Heidelberger Schriften zur Pharmazie- und Naturwissenschaftsgeschichte 14 (Stuttgart: Wissenschaftliche Verlagsgesellschaft, 1995).

[118] Ursula Klein, *Technoscience in History. Prussia, 1750-1850*, Transformations: Studies in the History of Science and Technology (Cambridge MA: The MIT Press, 2020), 51; Klein, 'Apothecary-Chemists', 102, 107–9, 113–14.

[119] Nicole Klenke, *Zum Alltag der Apothekergehilfen vom 18. bis Anfang des 20. Jahrhunderts*, Quellen und Studien zur Geschichte der Pharmazie 92 (Stuttgart: Wissenschaftliche Verlagsgesellschaft, 2009), 251–58; Hufbauer, *Formation*, 55–57; Klein, 'Apothecary-Chemists', 109, 112.

[120] Hufbauer, *Formation*, 61.

reading of E.W. Martius' autobiography. Martius reported that, as a journeyman, he worked under two pharmacists who adhered to alchemist ideas. One of them was the apothecary who provided substances to one of the most prominent alchemists of the Enlightenment period, the count Cagliostro.[121] Similarly, Johann Christian Wiegleb was exposed to alchemy in his days as an apprentice by reading books on the topic in his master's library.[122] Such experiences influenced both Wiegleb's scientific positions and his views on chemistry's history.

However, the strong practical aspect of a pharmacist's education in Enlightenment Germany should not lead to the assumption that the profession was somehow distinct from scholars working at universities and academies. Just like their French colleagues, most academics with a position related to chemistry continued to work as pharmacists or government officials. In many cases, they were also giving private or public lessons on topics related to their scholarly interests.[123] To establish themselves at universities, they therefore often accepted minor teaching positions at medical faculties and became members of national and international academies over the course of their careers. Lorenz von Crell, for example, collected memberships in over twenty academies thanks to his wider professional network.[124] The permeable boundaries between chemical practitioners and academics as well as the personal and institutional networks connecting scholars in different parts of the German states explains why it was perfectly normal for German pharmacists in the eighteenth century to contribute to the most advanced debates in chemical theory.

[121] Klein, 'Apothecary-Chemists', 114–15.
[122] Ibid., 101–2.
[123] Hufbauer, *Formation*, 57–60. Good examples are Martin Heinrich Klaproth or Carl Friedrich Wenzel, see Ibid., 197–98, 201–2.
[124] Powers, 'Learning', 163–64; Meinel, 'Artibus Academicis Inserenda', 93–94; Hufbauer, *Formation*, 80.

The Social Dimension of Knowledge Production: Masters and Patronage

Having mapped institutions and career paths of chemists in Germany and France, it is necessary next to assess the social practices which influenced these careers and, ultimately, the production of knowledge in chemistry. Since historians of science began to discuss these matters in their writings from the late 1780s onwards (see chapter 5), it is apt to compare the German and French idiosyncrasies in this matter. However, as in the previous sections, I do not provide an all-encompassing overview of the topic but rather hope to shed light on some crucial mechanisms at play in the working environment of the chemist-historians treated in this thesis.

Patronage in Paris

The idea that the Republic of Letters in general adhered to meritocratic principles was prominent among those scholars who had successfully established themselves in the French capital.[125] In reality, the aforementioned overlapping between members of different academic institutions and their close relationship with royal authority points to the importance of personal networks for scientific success and thus to the omnipresence of patronage in Enlightenment France. Indeed, hierarchies, personal relationships, and institutional settings had a profound impact on individual careers and, at least indirectly, on the popularity of scholarly approaches, too.[126] A case in point for the latter part of this claim will be presented in chapter 4 where I argue that the patronage relationships revolving around Félix Vicq d'Azyr, an anatomist, zoologist and philosopher of science, created a growing intellectual pressure for up-and-coming as

---

[125] Terrall, *Man*, 29–31; Lorraine Daston, 'The Ideal and Reality of the Republic of Letters in the Enlightenment', *Science in Context* 4, no. 2 (1991): 367–86.
[126] Outram, *Georges Cuvier*, 2–3; Terrall, *Man*, 11; Darnton, *Literary Underground*, 21–23.

well as established chemists to reform the nomenclature of their field. In the present section, I shall mainly point out the general nature of such social mechanisms on the basis of the detailed analyses conducted by Dorinda Outram, Pietro Corsi, Emma Spary, and Mary Terrall.

Although patronage can generally be defined as a hierarchical relationship in which an established and ideally wealthy individual offered to support the advancement of a younger individual who in turn provided them with assistance and loyal collaboration, this definition requires further qualification regarding the specific circumstances of Paris in the late eighteenth century.[127] The practice of patronage originated in the political culture of Paris in the *Ancien Régime*. Although relations of patronage were often fostered in salons or *musées*, thus tying the learned world together with the higher echelons of the Parisian society, they were all integrated into the idea of monarchical power. Patronage in the sciences as well as in any other realm of society was always seen as a practice in which individuals exercised royal authority on behalf of the king. Patrons of up-and-coming scholars relied on the king's patronage themselves, with royal ministers as mediators.[128]

Being able to play according to the complex social rules of patronage and complying with its linguistic and social codes was therefore a precondition for institutional success.[129] A good example of a scholar mastering the mechanisms of patronage in the *Ancien Régime* and throughout the revolutionary period is the chemist Antoine de Fourcroy. Fourcroy's biography is of great interest because his historical works, as well as the philosophical claims by his patron, the zoologist Félix Vicq d'Azyr, are discussed at length in chapters 4 and 5 of this thesis.

---

[127] Emma C. Spary, *Utopia's Garden. French Natural History from Old Regime to Revolution* (Chicago Ill: The University of Chicago Press, 2000), 45; Outram, *Georges Cuvier*, 6–7, 189–202, in particular 191 for the definition. For a good example in chemistry see Perkins, 'Chemistry Courses', 42.

[128] Alice Stroup, *A Company of Scientists. Botany, Patronage, and Community at the Seventeenth-Century Parisian Royal Academy of Sciences* (Berkley CA: University of California Press, 1990), 23–26; Spary, *Utopia's Garden*, 35–39. On *musées* and salons see Michael R. Lynn, 'Enlightenment in the Public Sphere. The Musée de Monsieur and Scientific Culture in Late-Eighteenth-Century Paris', *Eighteenth-Century Studies* 32, no. 4 (1999): 463–76; Dena Goodman, 'Enlightenment Salons. The Convergence of Female and Philosophic Ambitions', *Eighteenth-Century Studies* 22, no. 3 (1989): 329–50.

[129] Spary, *Utopia's Garden*, 37, 40, 46–47; Terrall, *Man*, 31.

From a modest background, Fourcroy greatly benefited from the support of Vicq d'Azyr, who ensured that the *Société Royale de Médecine* covered the fees of his medical degree. Over the course of his career, Fourcroy built relationships with a number of influential patrons. Their support allowed him to receive a professorship at the *Jardin du Roi* over his competitor, Claude-Louis Berthollet, even though the latter was an academician. Fourcroy's own election into the Academy in 1785 did not come as a surprise, especially since his collaboration with Lavoisier provided him with the support of yet another powerful patron.[130]

The rivalry between Fourcroy and Berthollet exemplifies that a patron's influence was always determined by other patronage relationships, which in turn points to the dynamic and contested nature of patronage.[131] The crystallographer Jean-Baptiste Louis Romé de l'Isle, for instance, never reached any well-endowed position in a Parisian institution. Since Romé de l'Isle's scientific positions on geological topics were in direct opposition to those maintained by powerful members of the establishment, most notably by Georges-Louis Leclerc, Comte de Buffon, he never succeeded in securing any well-endowed position in a Parisian institution despite the frequent attempts of his patron, the aforementioned head of the *Ecole des Mines,* Balthazar-Georges Sage.[132] The competition between different patrons and the royal veto could even overrule the plans of powerful patrons such as Buffon. When the latter attempted to appoint Félix Vicq d'Azyr as a professor to succeed Antoine Petit in 1775, his attempt failed because Vicq d'Azyr's rival, Antoine Portal, was allied to one of the king's ministers who orchestrated his election.[133] In certain cases, claims for institutional positions could be negotiated by trade-offs which in retrospect may seem unsystematic or even accidental. When the academicians voted for Antoine de Lavoisier as their candidate for the vacant post of *adjoint*

---

[130] Fourcroy's early career is reconstructed in Smeaton, *Fourcroy*, 1–30.
[131] Spary, *Utopia's Garden*, 39–43; Outram, *Georges Cuvier*, 189–202.
[132] Reijer Hooykaas, 'Romé De L'isle (or Delisle), Jean-Baptiste Louis', in *Complete Dictionary of Scientific Biography*, vol. 11 (Detroit MI: Charles Scribner's Sons, 2008), 520–21; Corsi, *Age*, 2.
[133] Spary, *Utopia's Garden*, 43–45.

in chemistry in 1768, the decision was overruled by the court in favour of Buffon's *protégé*, Antoine-Gabriel Jars. To avoid further controversies, Lavoisier was awarded a post as supernumerary adjoint chemist and consoled with the prospect of being promoted to the rank of *associé* as soon as a seat became available.[134]

Notwithstanding its semi-flexible character, the practice of patronage often entrenched wider mechanisms of in- and exclusion rather than helping individuals to overcome them. In the sciences, this is especially true regarding a scholar's gender and their chances to advance institutionally. Of course, women were involved in patronage relationships as well, both as patrons running salons and promoting aspiring scholars and as scientists working under the protection of their own patrons.[135] However, female scientists often suffered from the unequal character of patronage relationships in that they supported their patrons in their scientific efforts but neither received appreciation nor were able to advance institutionally. Marie Geneviève Charlotte Thiroux d'Arconville, a naturalist with wide interests whose history of chemistry will be discussed in chapter 2, is a perfect example of a female scholar whose scholarly work suffered from the intricate exclusionary practices at play in late-eighteenth-century Paris. D'Arconville benefited from attending public courses in a variety of subjects in the natural sciences at Parisian institutions such as the *Jardin du Roi*. She was directly taught by naturalists such as Bernard de Jussieu and the chemists Guillaume-François Rouelle and Pierre-Joseph Macquer. The latter remained her close friend for decades and supported her scientific endeavours in many ways. Her contributions to chemistry and anatomy – both her translations and her investigations into a wide array of topics including putrefaction – received acclaim within the scientific community. However, they were published anonymously because Thiroux

[134] Poirier, *Lavoisier*, 28; Hahn, *Anatomy*, 81.
[135] Leigh Whaley, 'Navigating Enlightenment Science. The Case of Marie Geneviève Charlotte Darlus Thiroux d'Arconville and Gabrielle Émilie Le Tonnelier De Breteuil and the Republic of Letters', in *The Palgrave Handbook of Women and Science since 1660*, ed. Claire G. Jones, Alison E. Martin, and Alexis Wolf (Basingstoke: Palgrave Macmillan, 2022), 47–50; Goodman, 'Enlightenment Salons', 329–50, especially 331-340.

d'Arconville, a wealthy aristocrat, was afraid to be exposed as a female scientist in the public sphere.[136] Hence, she allowed her colleague and collaborator Jean-Joseph Sue to publish their joint works on anatomy – an updated and extended translation of Alexander Monro's textbook on anatomy with added illustrations and a new introduction – under his name.[137] As she reflected in her autobiographical writings in the early 1800s, she appreciated this arrangement 'not from modesty (…) but out of self-interest, in order to avoid a painful embarrassment that would have cut me to the quick. Indeed, any woman who claims to be learned puts her reputation in danger, both because her work is attributed to some man and because other women turn against her.'[138] Since most academies of science categorically refused to admit women throughout the eighteenth century even if their scientific achievements were known to its members, Thiroux d'Arconville did not receive public credit for her works. [139]

While Thiroux d'Arconville remained silent about how she suffered from exclusionist practices throughout her life, other scientists voiced their discontent with growing intensity starting in the 1780s. The mismatch between the egalitarian rhetoric and the experience of many individuals, as well as the lack of paid positions to accommodate the basic financial needs for the growing number of individuals seeking to make a life from intellectual activities, was a

---

[136] Whaley, 'Navigating Enlightenment Science', 51–55; Nina Rattner Gelbart, *Minerva's French Sisters. Women of Science in Enlightenment France* (New Haven CT: Yale University Press, 2021), 214–15, 217–19. For her works on putrefaction see ibid. 232-244.

[137] Gelbart, *Minerva's French Sisters*, 221–26; Whaley, 'Navigating Enlightenment Science', 57–58, the latter also on to the contested authorship of the work.

[138] Marie-Geneviève-Charlotte Thiroux d'Arconville, 'My Memories (Mes souvenirs)', in *Marie-Geneviève-Charlotte Thiroux D'Arconville. Selected Philosophical, Scientific, and Autobiographical Writings*, ed. and trans. Julie Candler Hayes, Other Voice in Early Modern Europe 58 (Toronto: Iter Press, 2018), 206–13, quote on 207. I quote the English translation by Julie Candler Hayes because the original manuscript in French is unpublished.

[139] On the exclusion of women from Academies see Whaley, 'Navigating Enlightenment Science', 47–48 including reference to the relevant literature on the subject. In an unpublished autobiographical essay, Thiroux d'Arconville reported that, when it became public that Sue had put his name under the work of someone else, he was not elected into the *Académie des Sciences* in Paris as expected, see Marie-Geneviève-Charlotte Thiroux d'Arconville, 'The Story of My Writing (Histoire de ma littérature)', in *Marie-Geneviève-Charlotte Thiroux D'Arconville. Selected Philosophical, Scientific, and Autobiographical Writings*, ed. and trans. Julie Candler Hayes, Other Voice in Early Modern Europe 58 (Toronto: Iter Press, 2018), 187–88. The anecdote is referred to in some scholarly writing on the topic, for instance by Margaret Carlyle, 'Entre le Traité d'ostéologie et les Leçons de chimie. Mme d'Arconville, traductrice des Lumières', in *Madame d'Arconville, moraliste et chimiste au siècle des Lumières*, ed. Marc André Bernier and Marie-Laure Girou-Świderski, Oxford University studies in the Enlightenment, 2016:1 (Liverpool: Liverpool University Press / Oxford Voltaire Foundation, 2016), 201–2. Lacking access to the relevant archives, I have been unable to verify it.

source of such discontent.[140] One example of the more and more critical attitude of scholars towards the *status quo* was the writer and historian Sophie de Genlis who during the 1780s included sophisticated criticism of established institutions in her literary writing following the refusal of the *Académie Française* to admit her to its ranks.[141] Intensifying scientific debates spanning the traditional disciplines of natural history, physics, and chemistry further inflamed the atmosphere; many of these will be discussed in greater detail in chapters 3 to 5.[142]

Those scholars in the natural sciences who did not succeed in entering established institutions raised their voices, too. Jean-Claude Delamétherie, a medical man, mineralogist and chemist, who was denied access to institutional positions due to a lack of support by patrons, regularly complained about flawed election procedures and corruption.[143] Another critic was Jacques-Henri Bernardin de Saint-Pierre. An opponent of mechanist ideas, Bernardin fashioned himself as a scientist who resisted the temptation to artificially segment the natural world. Instead, he favoured a sympathetic approach towards nature which ideally resulted in an attitude of pure observation of its harmony. His controversial theories on earth formation and the functioning of tides were refuted by the Parisian establishment. Bernardin, who felt silenced and misunderstood, began to reflect upon the relationship between solitary and institutionalised forms of scholarship, thus pointing to the potential institutional reasons for the validity of scientific positions.[144] Bernardin shared a lot with two further critics, the notorious Jacques-Pierre

[140] Darnton, *Literary Underground*, 21–23; Hahn, *Anatomy*, 140–58.
[141] Anne L. Schroder, 'Going Public against the Academy in 1784. Mme de Genlis Speaks out on Gender Bias', *Eighteenth-Century Studies* 32, no. 3 (1999): 376–82.
[142] For introductions from a very general perspective see Lepenies, *Ende*, 9–105; Foucault, *Les mots et les choses*, 229–313. For the specifically Parisian dynamic of these debates see Stéphane Schmitt, 'From Physiology to Classification. Comparative Anatomy and Vicq d'Azyr's Plan of Reform for Life Sciences and Medicine (1774–1794)', *Science in Context* 22, no. 2 (2009): 145–93; Stephane Schmitt, 'Lacepède's Syncretic Contribution to the Debates on Natural History in France Around 1800', *Journal of the History of Biology* 43, no. 3 (2010): 429–57; Stéphane Schmitt, 'Studies on Animals and the Rise of Comparative Anatomy at and around the Parisian Royal Academy of Sciences in the Eighteenth Century', *Science in Context* 29, no. 1 (2016): 11–54; Corsi, *Age*, 1–39.
[143] Pietro Corsi, 'A Chair for Two. Georges Cuvier and Jean-Claude Delamétherie at the Collège de France', in *Darwin Au Collège de France*, ed. Antoine Compagnon and Céline Surprenant, Passage Des Disciplines (Collège de France, 2020); Hahn, *Anatomy*, 181–82.
[144] Simon Davies, *Bernardin de Saint-Pierre. Colonial Traveller, Enlightenment Reformer, Celebrity Writer*, Oxford University Studies in the Enlightenment, 2021:01 (Liverpool: Liverpool University Press / Oxford Voltaire Foundation, 2021); Jean-Michel Racault, 'Le solitaire contre les „Corps". L'imaginaire politique de Bernardin de

Brissot and Jean-Paul Marat, whose innovative ways of assessing the history of science will be discussed in chapter 5. Marat in particular complained throughout the 1780s that his scientific career was jeopardised by members of the Parisian Academy whose patronage he lacked.[145]

While patronage relationships were omnipresent in Enlightenment Paris, they were arguably even more important for chemists than for scholars in other disciplines. A botanist could work without much equipment; chemists, however, relied heavily on laboratories with precision instruments and materials that were often expensive and rare. A patron could help their *protégé* in this regard through a combination of financial support, introducing them to other patrons, securing institutional membership, and sharing their own resources.[146] Fourcroy, for example, supported the young chemist Henri Gosse not only by introducing him to his colleague, Jean Baptiste Michel Bucquet, but also by providing him with unrestricted access to his private library and laboratory. As was customary in such patronage relationships, Gosse reciprocated the favours and became what could anachronistically be called a research and teaching assistant to both of them.[147]

Institutional membership often went along with the opportunity to use a laboratory at the cost of a patron or the state. It was particularly convenient if one such place was attached to an institution as it was the case with the Parisian *Académie*. Antoine de Lavoisier is the best example of a chemist whose institutional affiliation, together with his positions in the state administration and the enormous wealth which he drew from them, gave him almost unlimited

---

Saint-Pierre et la fin de l'Ancien Régime [2010]', in *Bernardin de Saint-Pierre. Pour une biographie intellectuelle*, Les dix-huitièmes siècles 185 (Paris: Honoré Champion, 2015), 69–93; Jean-Michel Racault, 'Géologie, Vulcanologie, et imaginaire chez Bernardin de Saint-Pierre [2007-2011]', in *Bernardin de Saint-Pierre. Pour une biographie intellectuelle*, Les dix-huitièmes siècles 185 (Paris: Honoré Champion, 2015), 299–312.

145 For Marat's intellectual biography and his dispute with leading academicians in Paris see Gillispie, *Science Old Regime*, 290–329.

146 Matthew Daniel Eddy, 'Society and Environment. Chemistry and Daily Life during the Eighteenth Century', in *A Cultural History of Chemistry in the Eighteenth Century*, ed. Ursula Klein and Matthew Daniel Eddy, vol. 4, A Cultural History of Chemistry (London: Bloomsbury Academic, 2022), 115; Beretta and Brenni, *Arsenal*, 14 and 73-88 ffor a comparison of laboratory equipment used by Balthazar-Georges Sage, Torbern Bergman, and Antoine de Lavoisier, as well as for a detailed reconstruction of the costs associated with maintaining the latter's laboratory.

147 Perkins, 'Chemistry Courses', 42.

access to experimental sites. In addition to the well-equipped laboratories, he had at his disposal in the *Académie,* the *Arsenal*, and his private home, he accessed dozens of experimental sites across Paris and, indeed, the whole of France. This was facilitated by his good relationships with instrument makers who helped him to construct apparatus to be used while doing field work.[148] Such a wide range of options allowed him to conduct experiments which others could not have realised. Even the famed British experimental chemist Joseph Priestley mourned that the experiments which Lavoisier was able to conduct thanks to this material advantage could not be repeated independently. In fact, his complaint was part of his overall strategy to undermine the philosophy of science championed by Lavoisier.[149] In order to hold his ground, the latter constructed innovative historical narratives, too. This neglected aspect of Lavoisier's intellectual work will be discussed in chapters 3 and 4.

Patronage in Germany

It is vital to underline that patronage relationships were equally important to a scholar's institutional, economic, and scientific success in Germany as in France. Yet, the characteristic career patterns of German chemists meant that patronage relationships were formed in distinct social settings and often to different ends than their French counterparts. Again, this should not imply that the structure of the German academic sphere did not share some aspects with that in France. To perform this comparison, I once again rely on examples which have been unearthed by previous scholarship. The chemist Andreas Sigismund Marggraf, for instance, followed the career path set by his father and became a pharmacist in Berlin. Having been elected a member

---

[148] Beretta and Brenni, *Arsenal*, 50–72.
[149] Golinski, 'Chemistry', 393; John G. McEvoy, 'The Enlightenment and the Chemical Revolution', in *Metaphysics and Philosophy of Science in the Seventeenth and Eighteenth Centuries. Essays in Honour of Gerd Buchdahl*, ed. Roger Stuart Woolhouse (Dordrecht: Kluwer Academic Publishers, n.d.), 314–17. For further reference and literature on the topic see chapter 3 of this thesis.

of the Berlin Academy in 1738, he benefited from the fact that Frederick II sponsored the foundation of a chemical laboratory. Thanks to the king's direct patronage, Marggraf became its head, taking residence in its buildings. This was not the end of his ascent, for Marggraf also became the head of the physical class in the Academy.[150] Although Marggraf's career had parallels with the scientific biographies of successful Parisian chemists, his education – and the form of patronage he experienced in its course – were different. Whereas most French chemists in the eighteenth century attended university courses early in their careers – the notable exception being Bernard-Louis Guyton de Morveau – Marggraf was introduced to chemistry through a pharmaceutical apprenticeship and never earned a university degree.[151] As already mentioned above, this educational pattern was far from unusual among the German chemists of interest to this thesis.

The kind of patronage relationship experienced by young apprentices in a German pharmacy was quite different to the aristocratic mechanisms and court culture which were predominant in Paris. Of course, this should not imply that German aristocrats did not shape the careers of their *protégés* in the chemical disciplines, too. For instance, Carl August, Duke of Sachsen-Weimar-Eisenach not only financed the university education and subsequent *tour d'Europe* of the pharmacist Johann Friedrich August Göttling but also equipped the latter's laboratory after having appointed him to a professorship in Jena, granting him additional access to the chemical facilities in the Jena residence.[152] Yet, in particular during the early stages of a chemical career, the master pharmacists – and not the Parisian *salonnières* or lecturers at the *Jardin du Roi* – exercised by far the greatest influence on aspiring pharmaceutical apprentices. Indeed, the latter depended entirely on their superior's support and good will. Johann Christian Wiegleb, for example, remembered having been treated very badly by his master who used his staff without

[150] Klein, 'Apothecary-Chemists', 124–25; Hufbauer, *Formation*, 180.
[151] Klein, 'Apothecary-Chemists', 124. On Guyton see footnote 76.
[152] Jan Frercks, 'Techniken der Vermittlung. Chemie als Verbindung von Arbeit, Lehre und Forschung am Beispiel von J. F. A. Göttling', *Naturwissenschaften, Technik und Medizin* 16, no. 3 (2008): 283–84.

nurturing his interests in chemistry. Later, as the owner of his own pharmacy, Wiegleb seemed to have been more supportive of his pupils, one of whom was Göttling.[153] The case of Göttling and Wiegleb testifies that, in Germany too, patronage relationships were formed to the mutual benefit of both the patron and the *protégé* in Germany, for Wiegleb regularly published in the chemical journal edited by his former apprentice.[154]

In yet another regard, a positive relationship with an influential apothecary who was himself contributing to the learned discourse in the field was central to making a career as a chemist in Germany, for laboratories attached to pharmacies were the prime sites for chemical investigation. If the apothecary also had access to the laboratory of a university or an academy, the apprentice could learn even more, since there seems to have been no sharp distinction between private-commercial and governmental-academic laboratories.[155] If the apprentice did not receive what they had hoped for, however, the compulsory period as a journeyman offered possibilities to make up for this. The career of the aforementioned Johann Friedrich August Göttling only took off after he had moved from provincial Langensalza to Weimar where his new master, Sebastian Buchholz, forged his introduction at the court.[156] By the end of the eighteenth century, patronage was also exercised through those informal networks which German chemists had begun to form through several periodicals and individual correspondences in the preceding decades. A case in point is the biography of Friedrich Albert Carl Gren. Having served as an apprentice and journeyman in Bernburg and Offenbach, Gren was forced by the death of his last employer in Erfurt, Wilhelm Bernhard Trommsdorff, in 1782, to look for another position. It was Lorenz von Crell, the professor at the University of Helmstedt and

[153] Klein, 'Apothecary-Chemists', 101–2, 107; Hufbauer, *Formation*, 56–57.
[154] Klein, 'Apothecary-Chemists', 120.
[155] Ursula Klein, 'The Laboratory Challenge. Some Revisions of the Standard View of Early Modern Experimentation', *Isis* 99, no. 4 (2008): 775–78; Klein, 'Apothecary-Chemists', 107, 109, 127–28.
[156] Frercks, 'Techniken', 283.

successful editor of the *Annalen,* who made sure that Gren received a stipend to join him at the university in exchange for supporting him with the publication of his journal.[157]

Laboratories, Instruments, Communication: How to Establish a Chemical Fact

The process of evoking the sensation of a chemical phenomenon in the mind and of systematically recording such observations required numerous steps. Indeed, creating chemical knowledge through experimentation very much depended on the material preconditions of laboratories and involved a number of cultural and social practices.[158] The final section of this chapter is therefore dedicated to a genealogy of how chemical facts were created in eighteenth-century chemical laboratories and their aligned spaces. Rather than providing a precise case study, I synthesise the findings of previous research on the topic to construct an *Idealtypus* which covers different facets of the process, making no distinction between France and Germany.

The fact that the laboratory was the natural home for Enlightenment chemists is vindicated on a semantic level too. Throughout the eighteenth century, the term was used exclusively to denote pharmacological and chemical practices.[159] Here, the chemists applied a variety of techniques to gain insight into the composition and interrelation of different substances, using apparatus which was essentially unchanged between the late sixteenth and the eighteenth centuries.[160] Before the intensified study of pneumatic chemistry required scholars to construct

[157] Hufbauer, *Formation*, 209; Seils, *Friedrich Albert Carl Gren*, 27–60.
[158] The first scholar to point out this issue with respect to eighteenth-century chemistry was Jon Eklund, *The Incompleat Chymist. Being an Essay on the Eighteenth-Century Chemist in His Laboratory, with a Dictionary of Obsolete Chemical Terms of the Period*, Smithsonian Studies in History and Technology 33 (Washington DC: Smithsonian Institution Press, 1975), 1–2. For the current state of research see Marco Beretta, 'Laboratories and Technology', in *A Cultural History of Chemistry in the Eighteenth Century*, ed. Ursula Klein and Matthew Daniel Eddy, vol. 4, A Cultural History of Chemistry (London: Bloomsbury Academic, 2022), 71–91.
[159] Klein, 'The Laboratory Challenge', 770–71.
[160] Holmes, *Eighteenth-Century Chemistry*, 17–18.

more complex instruments from the 1760s onwards, most laboratories were equipped with a furnace, a number of vessels, balances, cloths, and paper, as well as the substances which were needed to produce artisanal substances but could also be used to perform experiments.[161] Even at the end of the century, the introduction of expensive precision instruments into chemical studies was not uncontroversial at all and sparked major epistemological debates.[162] Presumably, the sudden diversification of laboratory equipment was also the prompt for Christian Ehrenfried von Weigel to publish a series of articles which inquired into the history of the blowpipe in the *Annalen der Chemie* in 1790 and 1791.[163] However, in stark contrast to the historical works which are treated in this thesis, Weigel's historical essay did not spark a methodological controversy nor was it perceived as a scientific intervention by his contemporaries. As a result, it was mostly referenced in handbooks or compendia.[164]

Handling instruments and materials correctly to produce a certain reaction required not only persistence but, above all, experience. The regulation of heat, which featured in most chemical experiments in one way or another, exemplifies this claim. Chemists needed to know which combustible to use in order to create the desired temperature in different parts of a furnace: charcoal, for instance, allowed for high temperatures which wood fires could not produce. Moreover, most eighteenth-century chemists had to make informed choices on the exact level of temperatures since thermometers were not perfectly reliable let alone standardised and easily

[161] Eklund, *The Incompleat Chymist*, 3–15. The impact of pneumatic chemistry on instrument-making in Parisian circles has been investigated by Beretta and Brenni, *Arsenal*, 17, 29–30, 31–41.
[162] Jan Golinski, 'Precision Instruments and the Demonstrative Order of Proof in Lavoisier's Chemistry', *Osiris* 9 (1994): 30–47. For an extensive discussion of the topic see chapter 3.
[163] Weigel, Christian Ehrenfried von. 'Versuch einer Geschichte des Blaserohres und seiner Anwendungen [4 parts]' *Chemische Annalen für die Freunde der Naturlehre, Arzneygelahrtheit, Haushaltungskunst, und Manufakturen* 4, no. 3 (1790) 262–283; *Chemische Annalen...* 4, no. 4 (1790), 393–419; *Chemische Annalen...* 5, no. 1 (1791), 6–24; *Chemische Annalen...* 5, no. 2 (1791), 198–226.
[164] Sigismund Friedrich Hermbstädt, *Systematischer Grundriß der allgemeinen Experimentalchemie zum Gebrauch bey Vorlesungen und zur Selbstbelehrung beym Mangel des mündliichen Unterrichts*, 3rd ed. (Basel und Leipzig: Heinrich August Rottmann, 1812), 71–72; Johann Rudolph Meyer, *Systematische Darstellung aller Erfahrungen in der Naturlehre. Ersten Theiles dritter Band* (Arau: Heinrich Remigius Sauerländer, 1808), 173–74.

available.[165] Additionally, experienced experimentalists took into account the microclimate of a laboratory which could vary considerably depending on the location of the building and a given laboratory's position within it. Marie Thiroux d'Arconville, for example, noted that the results of the same experiments varied if she performed them in her laboratory in Paris, located on the first floor, or in her countryside villa in Crosne where she experimented on the ground floor.[166] Macquer even reflected upon the impact of a building's architecture the later editions of his *Dictionnaire de Chimie*, the first of edition of which was published in 1766.[167] The intuition and experience needed to handle the complexity of a chemical laboratory in the Enlightenment period explains why practitioners such as apothecaries were at the forefront of chemical scholarship. Since they had practical know-how on the procedural and material dimension of chemical substances and reactions as part of their daily work, the more aspiring of them could easily perform experiments whose publication ensured status within the transnational community.[168]

The special material dimension of laboratories naturally had an impact on the procedures of chemistry as a science. Macquer complained that all chemists had to intermit their work regularly to clean the equipment, mourning that 'ces choses sont bien capables de réfroidir, de retarder la marche du génie'.[169] Such complaints seem rather mild when considering the fate of Heinrich Martin Klaproth, who in 1801 took over the laboratory previously used by

---

[165] Eklund, *The Incompleat Chymist*, 7; Holmes, *Eighteenth-Century Chemistry*, 18. For an in-depth analysis of the thermometer in eighteenth-century chemistry see Jan Golinski, '"Fit Instruments". Thermometers in Eighteenth-Century Chemistry', in *Instruments and Experimentation in the History of Chemistry*, ed. Frederic Lawrence Holmes and Trevor Harvey Levere, Dibner Institute Studies in the History of Science and Technology (Cambridge MA: MIT Press, 1999), 185–210.
[166] Gelbart, *Minerva's French Sisters*, 239.
[167] Maurice Crosland, 'Early Laboratories c.1600-c.1800 and the Location of Experimental Science', *Annals of Science* 62, no. 2 (2005): 244.
[168] Klein, 'The Laboratory Challenge', 774–77; Hufbauer, *Formation*, 61.
[169] Pierre-Joseph Macquer, *Dictionnaire de Chymie, contenant la Théorie & la Pratique de cette Science, son application à la Physique, à l'Histoire Naturelle, à la Médicine & à l'Economie animale; avec l'explication détaillée de la vertu & de la maniere d'agir des Médicamens Chymiques. Et les principes fondamentaux des Arts, Manufactures & Métiers dépendans de la Chymie*, 1st ed., vol. 2 (Paris: Lacombe, 1766), 9. Also quoted in Eklund, *The Incompleat Chymist*, 4.

Franz Carl Achard, his predecessor at the Berlin Academy. The latter had turned the laboratory into a site to extract sugar from sugar beets and had replaced its original equipment with special machinery. Having succeeded, he moved to Silesia to set up his own factory, unfortunately without restoring the Berlin laboratory to its original state. The extent of the damage made it necessary to rebuild the laboratory, with Klaproth initially having to resort to his own, privately owned apparatus.[170]

What united most eighteenth-century laboratories despite the varying standards of equipment was that they were also spaces for social interaction. Without a doubt, the most famous example for this observation was the interdisciplinary circle of scholars which Antoine de Lavoisier and Marie-Anne Paulze-Lavoisier gathered around them from the 1770s onwards. Here, the boundaries between a salon and a laboratory became blurred.[171] The Faustian image of a scholar, solitarily experimenting alone in their study, therefore reflects an exception rather than the rule in eighteenth-century chemistry. Only those who protected their anonymity for social reasons – such as Marie Thiroux d'Arconville – chose to conduct most experiments themselves without any assistants or spectators.[172] As I shall show in chapter 5, the question of how different forms of social interaction could either inhibit or foster scientific progress entered historical writing in the 1790s.

The collaborative dimension of scientific investigation in eighteenth-century chemistry is also obvious in the case of several large-scale experiments performed by French scholars. A good example is the series of trials on the evaporation of diamonds conducted by a group of Parisian chemists in the 1770s, which has been reconstructed by Christine Lehman. Her investigations highlight that the production of a scientific fact in chemistry underwent several stages which involved different participants. Some were occupied with preparations, others conducted

---

[170] Klein, *Technoscience in History*, 27–29, 32.
[171] Antonelli, 'Becoming Visible', 227–37.
[172] Gelbart, *Minerva's French Sisters*, 214–15, 217.

the experiment, some served as eye witnesses, and yet others took notes in laboratory diaries.[173] In the case of Lavoisier, a considerable number of the experiments recorded were written by his wife, Marie-Anne Paulze Lavoisier, who was also present at the bulk of Lavoisier's public performances, in part to help convince the opponents of his ideas.[174] The couple developed a standardised type of record-keeping which allowed for a swift translation of observations into writing and gave a reliable framework to the previously unstandardised practice of experimentation and the contingent results it produced. Laboratory diaries thus served as the material link between the experimental dimension of chemistry and the publication of results.[175] The act of interpreting, too, was often enough the result of a joint effort, as Lavoisier's own collaboration with the mathematician Simon de Laplace on measuring and interpreting the phenomenon of heat goes to show.[176]

[173] Lehman, 'Pierre-Joseph Macquer: Chemistry', 254–60.
[174] Francesca Antonelli, 'Madame Lavoisier and the Others. Women in Marie-Anne Paulze-Lavoisier's Network (1771–1836)', *Notes and Records of the Royal Society of London* 77, no. 2 (2023): 285–92.
[175] Beretta and Brenni, *Arsenal*, 49.
[176] An in-depth analysis of their various collaborations has been provided by Henry Guerlac, 'Chemistry as a Branch of Physics. Laplace's Collaboration with Lavoisier', *Historical Studies in the Physical Sciences* 7 (1976): 193–276.

Chapter 2: History-Writing in Chemistry (1750–1780)

Introduction

Mid-eighteenth-century chemists drafted historical narratives to stage a rupture with the discipline's alchemical past: this position is common currency in historical scholarship.[177] While agreeing with this position in principle, the present chapter offers an analysis of the chemists' historical writing which aims to go beyond the general nature of such claims. It is grounded in the observation that, up until the 1770s, the greatest challenge for chemists was to convince their peers that chemistry's idiosyncratic techniques to assess the nature of substances were in line with the epistemological ideals maintained and propagated by other branches of inquiry in the natural sciences.[178] I would argue that histories of chemistry were a crucial tool to achieve this goal. The practice of writing histories was an element in the dynamic methodological discourse on chemistry's status as a science as well as its idiosyncratic and sometimes contested methodologies. I shall explore this topic in two case studies, one covering France and the other Germany.

The first part centres on French chemists within the tightly knit circles of the Parisian elite between circa 1720 and 1770. As we shall see, the radical Baconianism, which was propagated by the Academy's leaders such as Bernard le Bovier de Fontenelle in the first decades of the century, was often at odds with the chemists' practices of systematisation. However, a shift in the philosophy of science which revalued hypotheses and conjectures as legitimate

---

[177] Bensaude-Vincent, 'Culture', 98–99; Beretta, 'Historiography of Chemistry'.
[178] Christoph Meinel, 'Reine und angewandte Chemie. Die Entstehung einer neuen Wissenschaftskonzeption in der Chemie der Aufklärung', *Berichte zur Wissenschaftsgeschichte* 8 (1985): 28–31; Roberts, 'Setting the Table', 101; Principe, 'Revolution', 10–11.

methods from 1740 onwards[179] opened a door for chemists to make a credible case for the rationality of their approaches to taxonomy and theory formation. I argue that writing histories was a popular means to highlight how chemistry's methods conformed with this strand in the philosophy of the natural sciences. To assign greater credibility to their historical assumptions, chemists selectively appropriated the methods and concepts of *histoires de l'esprit*. Thus, they aligned their historical inquiries with what was by far the most popular narrative framework to present the overall history of human knowledge in Enlightenment France.[180] The histories of chemistry written by Gabriel-François Venel (1753), Marie-Geneviève Thiroux d'Arconville (1759), and Pierre-Joseph Macquer (1766) will be the case studies treated to substantiate this claim.

The second part of the chapter focuses on the role of historical inquiries within controversies on the feasibility of alchemy, in the contemporary meaning of metallic transmutation, which resurfaced in Germany during the 1770s.[181] Although the scholars on the different sides of the debate shared a common interest in the chemistry of metals, they rooted their arguments in contrasting philosophies of science. When, in 1775, the Marburg professor of medicine Joseph Friedrich Wilhelm Schröder in 1775 reiterated the traditional arguments of hermetic philosophy according to which superior knowledge on natural processes was to be found in a secret textual transmission, the Thuringian pharmacist Johann Christian Wiegleb countered such claims with a long treatise on the history of alchemy. To defend the fundamentals of an observation-based approach to chemistry, he resorted to the most up-to-date methods of

---

[179] For an overview see Jeff Loveland, *Rhetoric and Natural History. Buffon in Polemical and Literary Context*, Oxford University Studies in the Enlightenment, 2001:03 (Oxford: Voltaire Foundation, 2001), 100–114. With respect to chemistry: Bernard Joly, 'Was Early Eighteenth-Century Chemistry an Empirical Science?', in *What Does It Mean to Be an Empiricist? Empiricisms in Eighteenth Century Sciences*, ed. Siegfried Bodenmann and Anne-Lise Rey, Boston Studies in the Philosophy and History of Science 331 (Cham: Springer International Publishing, 2018), 203–13.

[180] The most comprehensive accounts of the genre are Jean Dagen, *L'histoire de l'esprit humain dans la pensée française de Fontenelle à Condorcet*, Bibliothèque française et romane. Série C, Etudes littéraires 60 (Paris: Klincksieck, 1977); Georges Gusdorf, *De l'histoire des sciences à l'histoire de la pensée*, Les sciences humaines et la pensée occidentale 1 (Paris: Payot, 1966), 43–92.

[181] Principe, *Secrets*, 89–92.

Enlightenment history-writing and thus greatly extended the repertoire available to future historians of his discipline. Attentive readers quickly discovered the argumentative weight which Wiegleb put on the shoulders of the historical inquiry and asked if it was not too heavy. What remained as a key legacy of this debate, to reappear in subsequent chapters of this thesis, was a certain enthusiasm for as well as some doubts about the possibility of using historical arguments to intervene in scientific debates.

In the French and the German controversies, the chemists pursued different goals. Yet, on a methodological level, they shared one striking similarity: they put great faith both in the technique of conjecturing and in related mental operations such as hypothesising. Making informed inferences based on probabilistic thinking was a method of reasoning which spanned different realms in Enlightenment thought from mathematical probability to writing the history of human society.[182] The debates on chemistry's rational character led to the adoption of such conjectural techniques on different levels of the historical inquiry. While the French chemist-historians identified conjectural techniques to form theories as a major driving force of scientific progress itself, Wiegleb applied them to make informed speculations about chemistry's early history. Such examples highlight that eighteenth-century histories of chemistry were integral features of scientific debates based on an advanced methodology.

Finally, a short terminological clarification. The reader will have observed already that I abstain from using the commonly used term 'empiricism' to grasp a philosophy of science which prioritises observation as a means to acquire knowledge of the natural world.[183] I have made this choice consciously since, as has recently been pointed out by Marc Ratcliff, the attribute 'empirique' was used in a derogatory way in most eighteenth-century naturalist

---

[182] Lorraine Daston, *Classical Probability in the Enlightenment*, New ed. (Princeton NJ: Princeton University Press, 1996); Avi Lifschitz, 'Genesis for Historians. Thomas Abbt on Biblical and Conjectural Accounts of Human Nature', *History of European Ideas* 41, no. 5 (2015): 605–18.

[183] See for example Jessica Riskin, *Science in the Age of Sensibility. The Sentimental Empiricists of the French Enlightenment* (Chicago Ill: The University of Chicago Press, 2002), 1.

writings, in particular to criticise scholarly approaches for not being grounded in profound intellectual reflection.[184] To do as much justice as possible to the Enlightenment discourse, I therefore resort to the positively connotated concept of 'observation' as well as the neologism of 'observationalism'.[185] I shall further elaborate upon this choice in the following section.

[184] Marc Ratcliff, 'Fictitious Empiricism, Material Experiments. Conditions for Thinking the Enlightenment "Issue of Empiricism"', in *What Does It Mean to Be an Empiricist? Empiricisms in Eighteenth Century Sciences*, ed. Siegfried Bodenmann and Anne-Lise Rey, Boston Studies in the Philosophy and History of Science 331 (Cham: Springer International Publishing, 2018), 31–35.
[185] On the history of observation as a concept and method in the sciences see Lorraine Daston, 'The Empire of Observation', in *Histories of Scientific Observation*, ed. Lorraine Daston and Elizabeth Lunbeck (Chicago Ill: University of Chicago Press, 2011), 81–113.

Chapter 2, Part 1: French Histories of Chemistry between Observationalism and the Human Spirit, 1750–1770

Mid-Eighteenth-Century Observationalism: Facts, Systems, and Conjecture in History

Ever since the foundation of the Parisian *Académie des Sciences* in the seventeenth century, chemistry's position within the institution and the wider Parisian naturalist circles remained somewhat contested.[186] While the semantic distinction between alchemy and chemistry had been successfully established in the 1720s,[187] it was more difficult to showcase the rational character of the field's methods, especially when it came to practices of systematisation. Eighteenth-century chemists operated with a great diversity of incommensurable ontological categories and taxonomic representations which always relied on conjectures as well as hypotheses.[188] An example is the different categories to systematise substances such as salts, acids, and metals. On the one hand, eighteenth-century chemists analysed them as compounds, a concept which was developed against the backdrop of experiences in the laboratory. On the other hand, this did not mean that the traditional, speculative ontological categories of chemical philosophy – such as atoms or elements – were abandoned. Especially in their textbooks, the chemists pondered different smallest particles or principles which could take their cue from various ancient or early modern sources as well as from corpuscular theories or those fashionable in neighbouring fields of natural history.[189] That a single substance could have several names which were used in different contexts of chemical practice added to the impression of the

---

[186] Principe, 'End of Alchemy', 102–3.
[187] Newman and Principe, 'Alchemy vs. Chemistry'. See also chapter 1 of this thesis for further reference.
[188] Klein and Lefèvre, *Materials*, 3, 75–76.
[189] Ibid., 61–62. Roberts, 'Setting the Table', 103–6 makes a similar argument using the example of Etienne-François Geoffroy's writings.

preliminary character of chemical systems.[190] However, this nomenclatural diversity was not a disadvantage but a crucial feature of chemistry's position at the intersection between the artisanal and the academic worlds.[191] By accepting the co-existence of different descriptive registers, even if they were hypothetical, academic chemists could benefit from the observations which artisans made in their daily practice. Nomenclatural diversity was therefore not necessarily an obstacle to chemistry's advancement since it facilitated exchanges between the practical and more academic realms of chemistry. As discussed in chapter 1, this knowledge transfer from mines and manufacturing to the academicians' laboratory was key for chemistry's growth in the Enlightenment.

Chemical affinity tables are a good example which further illustrate the omnipresence of conjectures and preliminary hypotheses in chemical system formation. Geoffroy's *Table des différents rapports observés entre differentes substances* was presented to the *Académie* in 1718. His aim was to systematically grasp the chemical processes at play when two substances were brought together and performed what can anachronistically be called a 'reaction'. Geoffroy inferred that each substance was composed of different substance components which stuck together due to naturally predetermined affinities. In a reaction, their components regrouped according to their degrees of affinity, thus forming a third substance which could be decomposed into its original components by the same mechanism.[192] This 'affinity table' exemplified material composition by visualising the various affinities between different substances and

---

[190] Wolfgang Lefèvre, 'The Méthode de Nomenclature Chimique (1787). A Document of Transition', *Ambix* 65, no. 1 (2018): 13–14, footnote 15; Klein and Lefèvre, *Materials*, 91.

[191] Klein and Lefèvre by contrast maintain that the co-existence of different nomenclatures became a burden throughout the eighteenth century which made it a necessity to reform the 'mess of names.' Thus, they somehow contradict their own argument of a fruitful diversity of chemical taxonomies in the eighteenth century. See Klein and Lefèvre, *Materials*, 91–92, quote on 92.

[192] Kim, *Affinity*, 132–39; Klein and Lefèvre, *Materials*, 56–58, 64, 149–50. There has been much debate in scholarship on the originality of these approaches, on their potential indebtedness to seventeenth-century chemistry, as well as on the continuities and discontinuities between Homberg's and Geoffroy's approaches. For a summary of the debate with references to the relevant literature see Kim, *Affinity*, 142–46.

received widespread attention across the continent. This was not least because it gave practising chemists a tool to foresee the reaction process and its result.[193]

Yet, while there is no doubt that affinity tables facilitated chemical experimentation, the underlying theoretical framework was met with sharp criticism by those thinking about science from a philosophical perspective. Affinity tables resembled contemporary reflections of mathematical probability in that they should provide a tool which, using an expression by Lorraine Daston, aimed at 'maximising expectation' of an experiment's outcome.[194] However, Geoffroy was well aware that the concept of affinity could be understood as a reiteration of outdated ideas on sympathetic forces which were considered speculative by the early eighteenth century.[195] Moreover, his table exposed that the very act of systematising necessarily involved criteria which could not be deduced from the observation itself.[196] Similar arguments could be made against Stahl's description of an invisible 'phlogiston' which Geoffroy equated with the equally conjectured 'sulphurous principle'.[197]

For the academic chemists, such insight caused discomfort, at least in as much as their efforts to argue for the respectability of their field were intimately entwined with the claim that chemistry – in contrast to alchemy – had firm roots in observational investigations. Theorising composition and drafting affinity tables could be seen as a departure from the firm basis of Baconianism, in particular given the fact that Fontenelle had urged the academicians in 1699 not to succumb to the temptation of premature systematisation.[198] Although Fontenelle himself

---

[193] Kim, *Affinity*, 113, 137–38, 166–67; Joly, 'Was Early Eighteenth-Century Chemistry an Empirical Science?', 204. For a list of affinity tables created throughout the eighteenth century see A. M. Duncan, 'Some Theoretical Aspects of Eighteenth-Century Tables of Affinity-I', *Annals of Science* 18, no. 3 (1962): 177–94.
[194] Kim, *Affinity*, 113, 137–38. On conjectures and probability in eighteenth-century mathematics see Daston, *Classical Probability*, 49–57, quote on 57.
[195] Joly, 'Was Early Eighteenth-Century Chemistry an Empirical Science?', 205–6; Duncan, 'Theoretical Aspects', 182.
[196] Joly, 'Was Early Eighteenth-Century Chemistry an Empirical Science?', 206–7, 209; Kim, *Affinity*, 141–42.
[197] Kim, *Affinity*, 146–51.
[198] Thierry Hoquet, 'Buffon's Natural History. The Catalogue of Facts and the Temptation of System', in *What Does It Mean to Be an Empiricist? Empiricisms in Eighteenth Century Sciences*, ed. Siegfried Bodenmann and Anne-Lise Rey, Boston Studies in the Philosophy and History of Science 331 (Cham: Springer International Publishing, 2018), 145.

somehow nuanced this view throughout the coming decades,[199] the fact that affinity tables were suspicious in this regard is still visible in his *éloge* on Geoffroy in 1731. Thirteen years after the latter had presented his work, Fontenelle still could not help but point his audience to its potential pitfalls. Before admitting the usefulness and ingenuity of the tables, he pointed out that 'ces affinités firent de la peine à quelques-uns, qui craignirent que ce ne fussent des Attractions déguisées, d'autant plus dangereuses, que d'habiles gens ont déja sçû leur donner des formes séduisantes'.[200] Against this backdrop, it is clear why Geoffroy repeatedly insisted on the purely observational basis of the table as well as its preliminary character.[201]

Support, however, was soon to come from a shift in the philosophy of the natural sciences which I shall subsume under the label of 'mid-eighteenth-century observationalism.' In the 1740s, scholars such as Emilie du Châtelet, Étienne Bonnot de Condillac, and Jean-Jacques d'Ortous de Mairan, the perpetual secretary of the *Académie des Sciences*, began to shed renewed light on the problem of how observations of natural processes can be interpreted and systematised. In championing a philosophy of science which identified the process of system formation as an integral part of the naturalists' work itself, these authors re-evaluated conjectures and hypotheses. Indeed, such operations came to be viewed as crucial scientific devices which allowed scholars to bridge the gap between observation and systematisation or, to borrow a formulation from Mary Poovey, 'to generate knowledge that was simultaneously true to nature and systematic.'[202]

---

[199] See Luc Peterschmitt, 'Fontenelle et la chimie. La recherche d'une « loi fondamentale » pour la chimie', *Methodos* 12, no. 12 (2012): Online Journal Without Pagination.
[200] Bernard le Bovier de Fontenelle, 'Eloge de M. Geoffroy', *Histoire de l'Académie Royale des Science avec les Mémoires de Mathématique & de Physique, pour la même année* Année 1731 (1734): 93–100, quote on 99. Also quoted by Peterschmitt, 'Fontenelle et la chimie', who gives a slightly different interpretation of the passage.
[201] See Joly, 'Was Early Eighteenth-Century Chemistry an Empirical Science?', 206–8.
[202] Ellen McNiven Hine, 'Dortous de Mairan and Eighteenth Century "Systems Theory"', *Gesnerus* 52, no. 1–2 (1995): 54–65; William Randall Albury, 'The Logic of Condillac and the Structure of French Chemical and Biological Theory, 1780-1801' (The Johns Hopkins University, 1972), 7–9; quote in Mary Poovey, *A History of the Modern Fact. Problems of Knowledge in the Sciences of Wealth and Society* (Chicago: The University of Chicago Press, 1998), 3.

Moreover, this observationalist philosophy of science put strong emphasis on the idea of using previous observations to create hypotheses for renewed investigations, a framework which resulted in a dialectic process of observation and reflection.[203] For example, Buffon insisted in his extensive writings on natural history that by comparing observed facts, a scholar could create general systems which not only unveiled the relationship between different objects of inquiry but also paved the way for elaborate explanations of natural processes.[204] Jeff Loveland has rightly cautioned that the extent of the change happening in the 1740s should not be overestimated. Even if the idea of systems in science and the use of hypotheses had had a negative press within anti-Cartesian circles around 1700, many notable naturalists such as René Antoine Ferchault de Réaumur had continued to stress their importance in observational settings. Others, in the meantime, simply remained silent about just how present hypotheses were in their actual scholarly practice. What happened around 1740, therefore, amounted less to a change in the naturalists' approach than to a shift in the rhetorical dimension of the discourse: a wide array of semantically undetermined concepts related to the systematic thinking was given greater emphasis and credibility.[205]

The fact that the implications of mid-eighteenth-century observationalist rhetoric for practical scholarship were vague made it a very attractive point of reference for the chemists. A novel way of arguing for the rationality of conjectural practices, which was publicly championed by the local academic élite, was precisely what they were in need of. Due to the revaluation of conjecturing, comparing, and creating analogies as methods of scientific inquiry, all those operations that were important for chemistry's manifold taxonomical practices were given greater credibility. Thus, a positive view of the process of system formation became firmly entrenched in the identity of chemistry as a discipline in the latter half of the eighteenth

[203] Daston, 'Empire of Observation', 104.
[204] Hoquet, 'Buffon's Natural History', 154–67.
[205] Loveland, *Rhetoric*, 100–114, in particular 103-104.

century.[206] Crucially, the three historians of chemistry treated in this chapter – Gabriel-François Venel, Pierre-Joseph Macquer, and Marie-Geneviève Thiroux d'Arconville – were all familiar with the revalidation of conjectures and hypotheses because of the Parisian networks which they were part of. All three were trained in Paris in the 1740s, where they were taught by the same chemist at the *Jardin du Roi*, Guillaume-François Rouelle. While Macquer already entered the *Académie* in 1745, which made him a direct colleague of the aforementioned advocate of observationalism, d'Ortus de Mairan, Venel was a member of the Encyclopedist circles until he left Paris in the late 1750s. And although Thiroux d'Arconville was not allowed to pursue a career in the Academy due to her gender, she was nevertheless integrated into the debates of the day, in particular through her friendship with Macquer.[207]

It is crucial to point out that the shift in the assumptions of observationalist philosophy affected historical thinking as well. If systems were historically contingent constructions by the individual mind which had to be constantly revised once new evidence arose,[208] this gave rise to questions about the historical relationship between facts and systems and thus about the history of the natural sciences in general. Of course, this offered a chance for chemists to reinterpret the allegedly dubious past of their own discipline, and to discuss the evolution of their methods from a novel perspective. In order to do so, they adopted the historical views championed by mid-eighteenth-century observationalism whose chronological and conceptual framework was clearly spelled out in the genre of *histoires de l'esprit*. Using Alembert's *Discours Préliminaire* to the *Encyclopédie* (1751), as well as the lesser-known yet widely read historical

---

[206] As late as 1777, Antoine de Lavoisier warned his audience in his famous *Mémoire sur la Combustion en Général* that scientists might 'former encombrement dans la Science' if they did not apply the necessary care to ordering observational data. Accordingly, he presented 'les systêms en Physique' as proper scientific 'méthodes d'approximation qui nous mettent sur la voie de la solution du problème' which were – together with observational practices – at the heart of any promising inquiry into the natural world, see Antoine de Lavoisier, 'Mémoire sur la combustion en général, 5 September 1777', *Histoire de l'Académie Royale des Sciences avec Mémoires, Mémoires* Année 1777 (1780): 592–600, both quotes on 592. His reconsideration of systems and their potential pitfalls in the 1780s will be discussed in chapters 3 and 4.

[207] For the biographies see Smeaton, 'Gabriel-François Venel'; Gelbart, *Minerva's French Sisters*, 217–18.

[208] Ernst Cassirer, *Die Philosophie der Aufklärung*, ed. Claus Rosenkranz, Philosophische Bibliothek 593; New Edition of "Ernst Cassirer. Gesammelte Werke, Bd. 15" (Hamburg: Verlag Felix Meiner, 2007), 76–83.

works by the mathematician, Alexandre Savérien, as case studies, I shall give a brief overview of the main implications of this genre for writing the history of a science. On this basis, I will move on to showing how the chemists adopted this framework for their own purposes.

"Histoires de l'esprit" and the Evolution of the Natural Sciences

While the historical writings of many Enlightenment philosophers engaged with the evolution of the natural sciences as part of society's overall progress, it was without a doubt d'Alembert's *Discours Préliminaire* to the first volume of the *Encyclopédie* (1751) that gave the genre of *histoires de l'esprit* its most comprehensive form.[209] Indeed, the text exemplifies how a particular historical framework emerged to support the presumptions of the observation-alist approach. The present section thus exhibits how the *Discours*, together with other works in the tradition of *histoires de l'esprit*, established a rich methodological toolbox to write the history of all natural sciences during the 1750s and 1760s, which could easily be applied by the chemists to reinterpret the evolution of their field.

D'Alembert identified a difference between the exact sciences and the descriptive nat-uralist disciplines that impacted their respective historical evolution. The former, in which he included subfields of mathematics as well as astronomy, he took to be rooted in 'principes nécessairement vrais et évidens par eux-mêmes' thanks to the simplicity and universality of those principles. The history of these branches of inquiry was therefore one of constant accu-mulation and refinement. Since ancient times, they had been 'déstinées par leur nature à aller toûjours en se perfectionnant de plus en plus.'[210] In the years which followed the publication

[209] Dagen, *Histoire de l'esprit humain*, 493. For an overview and examples see Alastair Cameron Crombie, *Styles of Scientific Thinking in the European Tradition. The History of Argument and Explanation Especially in the Mathematical and Biomedical Sciences and Arts*, vol. 3 (London: Duckworth, 1994), 1594–1603.

[210] Jean le Rond d'Alembert, 'Discours Préliminaire des éditeurs', in *L'Encyclopédie ou dictionnaire raisonné des sciences, des arts et des métiers, par une société de gens de lettres*, ed. Jean le Rond d'Alembert and Denis

of the *Discours*, a number of works such as Jean-Étienne Montucla's *Histoire des mathématiques* (1754) and Jean-Sylvain Bailly's *Histoire de l'astronomie* (1778–1783) turned this idea into voluminous histories of progress.[211] It even received a visual depiction in the works of Aléxandre Savérien, whose *Histoire de l'esprit humain dans les sciences exactes* (1766) included an engraving by Jean Massard (see fig. 1). Here, Clio, the muse of history, engraves the names of famous mathematicians – shown to her by Prometheus – on a column. The temporal order on the shaft is such that it begins on the top with Archimedes and proceeds towards the broadening basis, marked by the names of Descartes, Newton, and Leibnitz. As Savérien explained in the prologue, progress was accumulative since each discipline formed 'une chaîne de vérités immuables & éternelles', striving towards its perfection.[212]

Diderot, vol. 1 (Paris: Briasson, David l'aîne, le Breton, Durand, 1751), viii, xxxi, xxxv, first quote on viii, second quote on xxxi; Laudan, 'Histories of Science', 5.

211 Dagen, *Histoire de l'esprit humain*, 62–66; Gusdorf, *De l'histoire des sciences*, 65–69; Daniel Špelda, 'The History of Science as the Progress of the Human Spirit. The Historiography of Astronomy in the Eighteenth Century', *Studies in History and Philosophy of Science* 63 (2017): 48–57, in particular 49, 52; Noah M. Swerdlow, 'Montucla's Legacy. The History of the Exact Sciences', *Journal of the History of Ideas* 54, no. 2 (1993): 299–328.

212 Alexandre Savérien, *Histoire des progrès de l'esprit humain dans les sciences exactes et dans les arts qui en dépendent* (Paris: Lacombe, 1766), vii–viii. On the popularity of this metaphor in eighteenth-century historical writing on the sciences see Dagen, *Histoire de l'esprit humain*, 424; Špelda, 'History of Science', 52.

Illustration 1: Frontispice to Alexandre Savérien's *Histoire des Sciences Exactes* by Jean Massard[213]

In contrast were those branches of inquiry which, even if they operated with mathematical methods, were not rooted in immutable axioms but 'appuyées sur des principes physiques, c'est à dire, sur des vérités d'expérience ou sur de simples hypothèses'. In these realms, a scholar could merely gain 'une certitude d'expérience ou même de pure supposition'.[214] At a later point in the *Discours*, d'Alembert clarified that this was the case with all natural sciences such as natural history, medicine, physics, and chemistry.[215] The reliability of their postulates was determined by the methodology they applied. Indeed, d'Alembert reiterated on several

[213] The image is taken from the copy owned by the Bibliothèque Nationale in Paris and digitised on https://gallica.bnf.fr/ark:/12148/bpt6k96274508/f12.item (accessed on 30.8.2024). The Frontispice does not seem to feature in all copies of the original edition, as it is not to be found in the copies which I have consulted, i.e. those owned by the Bodleian Library, Oxford, or the ETH Bibliothek, Zurich.
[214] d'Alembert, 'Discours préliminaire', viii.
[215] Ibid., xxxi.

occasions that a philosophical and thus rational approach to the natural world necessarily had to be grounded in the observation of nature.[216]

As a result, the history of all disciplines within the natural sciences followed a different chronology than the exact sciences. D'Alembert painted an ambivalent picture of Antiquity in its pursuit to investigate nature. Although he claimed that Greek and Roman philosophers had definitely been thinking about natural phenomena in one way or another, they had undoubtedly shown higher skills in the fine arts. Crucially, most of their discoveries were lost over time or altered in the course of their transmission.[217] D'Alembert's view on the Middle Ages was worse. With scholasticism dominating, the study of nature had made no progress in these 'siecles d'ignorance'. He saw the reason for this in the fact that the study of nature had not been conducted on the basis of observation, but by examining a body of mutilated Aristotelean writings. Thus, wrong assumptions and prejudices had survived for centuries.[218]

Most histories of the spirit postulated that, for the natural sciences, the crucial juncture arrived in the seventeenth century, and d'Alembert's *Discours* was no outlier in this regard.[219] Alongside Kepler, Galileo, and the later-born Newton, Francis Bacon was hailed as a key figure in this process who, as emphasised by Anne Robert Jacques Turgot in the *Tableau Philosophique des progrès successifs de l'esprit humain* (1750), 'a tracé à la posterité la route qu'elle doit suivre'.[220] D'Alembert added that, being the first real enemy of scholasticism, Bacon had insisted upon the necessity of studying nature through observation and had pointed out

---

[216] Ibid., vi, xxiv, xxxi.
[217] Ibid., xxiii.
[218] Ibid.; Gregorio Piaia, 'The History of Philosophy in the "Encyclopédie"', in *Models of the History of Philosophy. Vol. III: The Second Enlightenment and the Kantian Age*, ed. Gregorio Piaia and Giovanni Santinello, trans. Hilary Siddons, 2015th ed., International Archives of the History of Ideas 216 (Dordrecht: Springer Netherlands, 2015), 16–17.
[219] Alexandre Savérien, *Histoire des progrès de l'esprit humain dans les sciences naturelles et dans les arts qui en dépendent* (Paris: Lacombe, 1775), vii–viii; Anne Robert Jacques Turgot, 'Tableau philosophique des progrès successifs de l'esprit humain. Discours prononcé en latin dans les écoles de Sorbonne, 11 décembre 1750', in *Oeuvres de Turgot et documents le concernant*, ed. Gustave Schelle, vol. 1 (Paris: Félix Alcan, 1913), 233; d'Alembert, 'Discours préliminaire', xxiv; Gusdorf, *De l'histoire des sciences*, 55.
[220] Turgot, 'Tableau philosophique', 233; Engelhardt, *Historisches Bewußtsein*, 41–42.

the potential value of experimental inquiries.[221] Indeed, many of d'Alembert's fellow historians agreed with his opinion that with Bacon and Descartes, a new ideal for conducting investigations into natural processes had taken hold which enabled later generations of scholars to accumulate facts, to connect them, and to slowly replace speculative attempts with a reliable description of the natural world.[222]

These assumptions had profound consequences for the historical method. The narrative presented by the *Discours* annihilated differences in the evolution of different branches of the natural sciences. The works of Bacon himself, Réné Descartes, Isaac Newton, and John Locke were presented as part of a transitional period in which scholars of all disciplines attempted to realise the idea of non-speculative investigations, rooted in experiments and observation.[223] Herman Boerhaave – the early-eighteenth-century chemist who came to be viewed as a founding father of the discipline by his successors – was identified by d'Alembert as an integral member of this group of geniuses who had all helped to lift 'un coin du voile qui nous cachoit la vérité'.[224] This historical narrative was very attractive to chemists for two reasons. First, in postulating a joint evolution of all natural sciences from irrational beginnings towards perfection and celebrating chemists such as Boerhaave, chemistry no longer appeared as an outlier which alone had to grapple with an irrational heritage. If seen from such a historical perspective, it had simply co-evolved with the other branches of natural history, facing the same obstacles as any other field. Second, the *Discours* made clear that, while observation was key as a scholarly methodology, it alone was not sufficient to grasp complex natural processes. Although d'Alembert excoriated 'des hypothèses vagues & arbitraire', he also insisted that 'l'étude réfléchie des phénomènes, par la comparaison que nous ferons des uns avec les autres' had to complement observations of nature. A positive connotation of conjectures can also be found in

[221] d'Alembert, 'Discours préliminaire', xxiv.
[222] Dagen, *Histoire de l'esprit humain*, 424–26.
[223] d'Alembert, 'Discours préliminaire', xxiv–xxviii; Piaia, 'History of Philosophy', 18–19.
[224] d'Alembert, 'Discours préliminaire', xxviii.

his characterisation of Bacon.[225] Just like many other historians of the spirit, d'Alembert thus held that observations had to go hand in hand with careful scholarly generalisations in order to propel progress in the natural sciences.[226] Such statements were valuable to the chemists who hoped to vindicate the rationality of their taxonomic exercises.

Before we can explore in greater detail how Venel, Macquer, and Thiroux d'Arconville adopted this idea, it is vital to point out another fundamental feature of *histoires de l'esprit*: their exclusive focus on male 'grands hommes' who alone personified scientific progress.[227] The question of their individual circumstances was not of interest to the eighteenth-century historian of science for, as the first conjectural account of the origins of human knowledge in the first part of the *Discours* made clear, it was a natural capacity of humans to investigate any aspect of nature and thus to acquire lasting insights.[228] As a result, the various social practices and institutional hierarchies – whose impact on the production of knowledge about nature and the criteria of scientific judgement in the eighteenth century has been discussed in chapter 1 of this thesis – were neglected by the historical analysis. Some institutions, such as scientific academies and their journals, were portrayed as necessary pre-conditions for successful observation-based investigations.[229] Yet, there was no mid-eighteenth-century account focusing on the exact procedures which guided the members of academies – or, indeed, solitary geniuses – in their production of knowledge or in their discussions of the appropriate criteria to judge the publications of others. By contrast, histories of the spirit inextricably linked academies, journals, and observationalism with each other, without further qualifying their relationship through a contextual analysis. Indeed, fights for access and acknowledgement, scientific

---

[225] Ibid., vi, xxiv, quote on vi.
[226] See Engelhardt, *Historisches Bewußtsein*, 68–70.
[227] For instance in d'Alembert, 'Discours préliminaire', xxviii. See also Piaia, 'History of Philosophy', 16; Engelhardt, *Historisches Bewußtsein*, 56–61.
[228] d'Alembert, 'Discours préliminaire', ii–iv. On the relationship between the two parts see Dagen, *Histoire de l'esprit humain*, 387–96.
[229] d'Alembert, 'Discours préliminaire', xxxiii; Maria Pia Donato, '"Faire corps". Les académies dans l'ancien régime des sciences (xviie-xviiie siècle)', in *De la Renaissance aux Lumières*, ed. Stéphane van Damme, Histoires des Sciences et des Savoirs 1 (Paris: Seuil, 2015), 103–4; Engelhardt, *Historisches Bewußtsein*, 61–63.

controversies, or economic struggles – all of these problems which had been recurring since the foundation of the *Académie des Sciences* in Paris in particular were not treated by the mid-eighteenth-century histories of science.[230] As we shall see in chapter 5 of this thesis, Jean-Paul Marat and Jacques-Pierre Brissot would take issue with this methodological deficiency in their general critique of the scientific establishment by revisiting the history of science from a contextualising perspective.

French Histories of Chemistry, 1750–1770

Mid-eighteenth-century histories of chemistry blended the narrative framework of *histoires de l'esprit* with the assumptions of the contemporary philosophy of observationalism to portray the discipline's methods in a favourable light. Before turning to the sources to discuss this claim, a word on the notion of genre might be useful. Curiously, none of the three texts identified as 'histories' in this sub-chapter even bore this label and each of them featured in a different type of publication on chemistry. Gabriel-François Venel's article 'Chymie ou Chimie' was a contribution to the third volume of the *Encyclopédie* (1753) and aimed at convincing a wide audience that chemistry should be regarded as a legitimate branch of inquiry independent from both medicine and physics.[231] Marie-Geneviève Thiroux d'Arconville wrorte her historical piece as a *Discours préliminaire* to her translation of Peter Shaw's Chemical Lectures, which had first appeared in English in 1734. It was aimed at an audience with a comprehensive knowledge of chemistry who were interested in – and capable of – repeating the countless

[230] See the overview by Hahn, *Anatomy*, 140–58.
[231] Gabriel-François Venel, 'Chymie ou Chimie', in *L'Encyclopédie ou dictionnaire raisonné des sciences, des arts et des métiers, par une société de gens de lettres*, ed. Jean le Rond d'Alembert and Denis Diderot, vol. 3 (Paris: Briasson, David l'aîne, le Breton, Durand, 1753), 408–37.

experiments contained in the main body of the work.[232] Finally, Macquer's essay preceded the 1766 edition of his *Dictionnaire de Chimie* and thus had yet another function. The *Dictionnaire* – and its predecessor, the *Élemens de chymie* (1749) – were the first French textbooks available to students of chemistry since the final editions of Nicolas Leméry's and of Jean-Baptiste Sénac's works were published in 1716 and 1723 respectively. Macquer therefore responded to the challenge of synthesising the increasing body of observations on chemical substances and reactions while also reflecting upon the theoretical contributions which foreign chemists – especially Boerhaave and Stahl – had made to the field.[233] Notwithstanding such differences, the three authors were united not just in their educational background in elitist Parisian circles but also in their aim to highlight that history vindicated the rational character of chemistry's contemporary methodology and its diverse taxonomic principles. In a joint analysis of the three texts at hand, I shall show how the chemist-historians integrated chemistry into the wider evolution of all natural sciences while also highlighting its idiosyncrasies. The fact that the historical narratives were not separated from but integrated into such a diverse set of publications is a first piece of evidence for my overall claim that the practice of writing histories was not separate from other chemical investigations.

At the core of the three historical works was a complex understanding of the notion of science. In tracing the co-evolution of a modern notion of science in all naturalist disciplines through the lens of chemistry, the latter's evolution was linked to its wider academic environment. Venel was very explicit in this regard: in their 'maniere (sic!) de philosopher', the

---

[232] Marie-Geneviève-Charlotte Thiroux d'Arconville, 'Discours préliminaire du traducteur', in *Leçons de Chymie, propres à perfectionner la physique, le commerce et les arts. Par M. Pierre Shaw, Premier Médecin du Roi d'Angleterre*, trans. Marie-Geneviève-Charlotte Thiroux d'Arconville (Paris: Jean Thomas Herissant, 1759), i–xciv. Members of the Parisian scientific community beyond narrow group of Thiroux d'Arconville's teachers and friends knew about her role as the translator of Shaw's piece, see Whaley, 'Navigating Enlightenment Science', 54–55, 57.

[233] Pierre-Joseph Macquer, *Dictionnaire de Chymie, contenant la Théorie & la Pratique de cette Science, son application à la Physique, à l'Histoire Naturelle, à la Médicine & à l'Economie animale; avec l'explication détaillée de la vertu & de la maniere d'agir des Médicamens Chymiques. Et les principes fondamentaux des Arts, Manufactures & Métiers dépendans de la Chymie*, 1st ed., vol. 1 (Paris: Lacombe, 1766); Kim, *Affinity*, 163–64, 201–12.

chemists who had begun conquering such a vast territory of the natural world had not been any different from scholars such as Aristotle or Newton.[234] Chemistry was therefore no longer an outlier, but the perfect example for the development of a rational discipline according to the postulates of mid-century observationalism and in line with the narrative framework of *histoires de l'esprit*. The historicity of scientific practices and of science as an idea was the guiding principle for the analysis on three levels. First, the phenomenon of science was itself the result of a historical development. In contrast to earlier histories which found chemistry's roots in Antiquity (which I will come back to in the second part of this chapter), Venel, Macquer, and Thiroux d'Arconville unanimously held that the science of chemistry resulted from the breakthrough of observation-based investigations in the seventeenth century. Thiroux d'Arconville's treatment of the topic is exemplary in this respect. At the outset of her essay, she claimed that chemistry was conducted in a rational way 'depuis près d'un siècle'. The heroes of this story were 'les Becher, les Boerhaave, les Stahl, les Homberg, les Leméry, les Geoffroi & plusieurs d'autres' whom Thiroux d'Arconville credited for having mis 'fin à son (i.e. chemistry's, KE) roman, & ont commencé son histoire.'[235] As we have seen above, all of the scholars included in this list championed an ideal of chemistry which complemented observations of nature with conjectural operations. For Thiroux d'Arconville, this heritage was part of the identity of contemporary chemistry.

Second, after the seventeenth century, the methods of observation and conjecturing themselves became driving forces in the history of mankind's quest for knowledge. Chemist-historians argued that the rigour of experience-based investigations enabled geniuses to draft interpretative systems, thus implying that certain non-experiential operations had always been an essential feature of chemistry as a rational science. As Macquer explained, 'expériences'

[234] Venel, 'Chymie ou Chimie', 415.
[235] Thiroux d'Arconville, 'Discours préliminaire', iv, quotes ibid. See also Venel, 'Chymie ou Chimie', 430–37; Macquer, *Dictionnaire de Chymie*, 1766, 1:xx–xxii.

and 'raisonnement' formed a dialectical relationship. Theory, understood by Macquer as a synthesis made by the reasonable scholar, was valuable only if it was rooted in observational discoveries ('les expériences déja faites') and vice versa: 'Si l'expérience qui n'est point dirigée par la théorie est toujours un tâtonement aveugle, la théorie sans l'expérience n'est jamais qu'un coup d'oeil trompeur & mal assuré.'[236] The positive reading of the systematisation practices postulated by mid-eighteenth-century observationalism was thus used by the chemist-historians to define what true science was and to show that chemistry naturally corresponded to this notion. They argued that this understanding of science was itself the result of a long historical process. From Macquer's perspective, a sound scientific approach had only been implemented when the scattered bits of factual knowledge had been 'recueillies, examinées, comparées par des hommes d'un genie assez étendu & assez profonde pour les rassembler toutes, en découvrir les principes, en saisir les rapports, les réunir en un corps de doctrine raisonné, & poser véritablement les fondemens de la Chymie considerée comme science.'[237] Thiroux d'Arconville underlined this point in discussing why chemists for a long time had not been able to systematically understand the process of fermentation: 'les regles de l'Analogie auroient dû servir de guide à ces nouveaux observateurs, & diminuer leur étonnement: mais pour rapprocher des faits, & les comparer, il faut des principes & de la méthode, & ces noms mêmes étoient ignorés des premiers hommes'.[238] Venel did not deny the value of conjectures and hypotheses either, insisting that a chemist's overall approach had to be 'tant théorique que pratique'.[239] Accordingly, he presented the concept of chemical affinities as being superior to any mechanist explanation of chemical phenomena because it matched the number of existing observations much more precisely.[240]

---

236 Macquer, *Dictionnaire de Chymie*, 1766, 1:xxii–xxiii, quote on xxiii.
237 Ibid., 1:xx.
238 Thiroux d'Arconville, 'Discours préliminaire', xlii.
239 Venel, 'Chymie ou Chimie', 414.
240 Ibid., 415.

Finally, the normative understanding of science was used as an analytical category to structure the history of chemistry since its beginnings. After all, if the criterion for any branch of discovery to be considered scientific was determined by the apt interplay between facts and interpretation, the question of their relationship before the seventeenth century naturally arose. In this regard, our three historians of chemistry agreed that the pre-scientific era of chemistry was characterised by numerous factual discoveries which had laid the groundwork for chemistry's later flourishing. In full alignment with the tradition of conjectural histories, Thiroux d'Arconville argued that early humans had made discoveries on chemical phenomena either to satisfy basic needs or by mere coincidence.[241] Macquer added that by the sixteenth century, 'les différentes parties de la Chymie existoient, mais la Chimie n'existoit point encore'.[242] The accumulation of factual knowledge was therefore a necessary precondition of chemistry's emergence as a science which however must not be confounded with the science itself. As Venel insisted, 'ces arts ne supposent pas la science. La théorie de la Teinture est bien postérieure à l'art. On fondoit les métaux à-travers les charbons, long-tems avant que Stahl donnât l'admirable théorie à cette opération.'[243]

Chemistry therefore evolved in three stages: the techniques developed by the ancients formed the basis for later attempts to gain deeper insight into their material. The following transitional period – at the end of which a scientific approach emerged – was characterised both by continued material discoveries and by many types of irrational speculation. While Thiroux d'Arconville did not offer a precise chronology,[244] both Venel and Macquer agreed that this second period of chemistry had extended for several centuries. In the words of Macquer, individual scholars 'ont parlé un peu moins obscurément de certaines expériences, ont fourni

---

[241] Thiroux d'Arconville, 'Discours préliminaire', vii–xvi.
[242] Macquer, *Dictionnaire de Chymie*, 1766, 1:xviii.
[243] Venel, 'Chymie ou Chimie', 425.
[244] Thiroux d'Arconville, 'Discours préliminaire', ii–iii.

quelques lumieres' ever since the attempts of the medieval Arabic scholar Geber.[245] Yet, the path of chemistry towards a true science had been intricate and arduous, including long detours into alchemical territory. Mentioning Arnauld de Villeneuve and Raymond Lullius as examples, Macquer added that the scholars who worked during this period belonged to 'une espéce (sic!) moyenne entre les savans & les artisans' in that they had tried to establish reasonable interpretations which however entirely failed to grasp the nature of things.[246] Well into the seventeenth century, many scholars were also held back by their alchemistic misbeliefs despite their good intentions which made them 'moitié Chymistes raisonnables, moitié Alchymistes'.[247] For Venel, an additional feature of this era was that the chemists adopted numerous approaches from other disciplines before they finally realised that the nature of their study objects required them to develop an idiosyncratic methodology. For a long time, chemistry 'a reçu les systèmes de physique régnans, qu'elle est devenue successivement Cartésienne, corpusculaire, Newtonienne, académique ou expérimentale'.[248]

Although I have so far mainly pointed out the various similarities between the three historians of chemistry, I do not mean to imply that their histories were uniform. In fact, each of them emphasised different aspects of chemistry's evolution. Venel, whose main goal was to distinguish chemistry from other branches of inquiry, was given a lot of space in the *Encyclopédie* to develop his historical narrative. Methodologically, he made a significant step towards describing chemistry's modern history as a process of disciplinary differentiation and cooperation. On the one hand, chemists had to fend off the attempts of physicists to apply mechanist theories to chemistry.[249] On the other hand, they could rely on techniques developed in other branches of inquiry in order to abandon the purely speculative systems of alchemy.

---

[245] Macquer, *Dictionnaire de Chymie*, 1766, 1:xiv.
[246] Ibid., 1:xii–xiv, quote on xiii.
[247] Ibid., 1:xix–xx, quote on xx.
[248] Venel, 'Chymie ou Chimie', 409.
[249] Venel discussed the relationship between the two disciplines at numerous occasions both on a systematic and a historical level, cf Ibid., 409, 415–16, 432, 435.

Within this context, Venel emphasised the importance of medical research for the amelioration of chemical techniques. Following Paracelsus' lead, physicians had contributed to the proper study of chemical substances, a tendency strengthened by the fact that such questions had featured in their academic training since the mid-seventeenth century. Venel went as far as to claim that 'la *Chimie* philosophique est sortie du sein de la Medicine' as part of a greater process in which 'les sciences se sont répandues comme par une sorte de débordement'.[250] Observational discoveries, theoretical refinement, interdisciplinary cooperation, and disciplinary differentiation were intertwined in a highly complex process.

Thiroux d'Arconville, by contrast, displayed a greater interest in chemistry's earliest history. Her *Discours préliminaire* gave an overview of various phenomena, materials, and techniques of interest to chemistry, from the production of glass and porcelain to the discovery of salts, and asked how the humans had encountered them for the first time. For this purpose, she relied on conjectures, since 'les faits sont si peu certains & si peu détaillés'. Using this key technique of Enlightenment historical methodology enabled her to make the aforementioned assumptions about how the various faculties of the mind had allowed humans to lay the foundations for the later evolution of chemistry as a rational science.[251] Macquer, finally, succeeded in condensing the various claims he made into a concise work of only nineteen pages. The text thus had a strong educational purpose in that it was supposed to advise the readers of his handbook to abstain from speculation without a sound experiential basis.

While the concept of a science served as a historical category in many ways, it is striking that the chemist-historians did not assess the contextual factors which had led to the rise of chemistry as a science since the early modern period. Thiroux d'Arconville did not engage with the topic at all, while Venel only made a few unsystematic remarks, for instance on the potential

[250] Ibid., 431–32, quote on 431.
[251] See for instance the discovery of metallurgy in Thiroux d'Arconville, 'Discours préliminaire', vii–xxviii, quote on vii.

positive impact which the establishment of university chairs dedicated to the study of iatro-chemistry had had. Yet, those were apodictic postulates rather than systematic inquiries from a historical perspective.[252] In line with the model set by *histoires de l'esprit*, Macquer simply noted that academies, journals, and royal patronage all had been favourable to progress, without scrutinising their relationship to chemical inquiries.[253] As a result, both the emergence of and the concrete practices implied by scientific observationalism seemed to be the natural result of the spirit's evolution. Mid-eighteenth-century histories of chemistry did not offer any thick descriptions of how facts could be produced in laboratories, how scholars transformed them into tables and systems, and how the results were validated and contested by the scientific community. What is more, the mechanisms of in- and exclusion which determined a scholar's position within the Republic of Letters, their economic background, and their individual relationships were excluded from historical assessments. This is remarkable insofar as the various social, institutional, and material factors had shaped the scholarly activities and scientific biographies of Thiroux d'Arconville, Macquer, and Venel in different ways, as we have seen in chapter 1 of this thesis. The historical concept of science was therefore thoroughly decontextualised and stood in stark contrast to the daily experience of those who practised it.

It should be sufficiently clear by now that chemist-historians blended the historical assumptions of mid-eighteenth-century *histoires de l'esprit* and observationalist philosophy to construct a narrative of chemistry's evolution in the modern age which was stripped of most contextual references. If we take into account that all three chemists in question were fully conversant with the literary and scientific methods of their time, we must assume that their approach was the result of an active and careful choice. Indeed, eighteenth-century history-writing offered a rich stock of alternative modes to investigate the past. To assess the

---

[252] Venel, 'Chymie ou Chimie', 431.
[253] Macquer, *Dictionnaire de Chymie*, 1766, 1:xxiii–xxiv.

emergence of modern chemical facts, theories, and institutions, chemists could have applied the techniques of historians such as Montesquieu who paid careful attention to the economic, social, or religious context of historical phenomena.[254] Indeed, a geographical perspective on the topic could have led to a type of history which emphasised the differences in chemistry between European states. Yet any such manner of approaching the history of chemistry through the lens of nations emerged only in the second half of the nineteenth century.[255] French chemist-historians in the Enlightenment period strongly emphasised the transnational movement of the *ésprit* towards perfection and hailed Englishmen, Dutchmen, and Germans alongside the French as chemistry's founding fathers. Portraying chemistry's historical path as a natural feature of the evolving transnational Republic of Letters was yet another facet of the chemist's aim to vindicate that chemistry was a proper discipline just like any other branch of natural history. Meanwhile, however, their German colleague, Johann Christian Wiegleb, was faced with a different epistemological challenge, in response to which he resorted to a different methodology to investigate and write the history of chemistry. His work and its wider context will be discussed in the second part of the chapter.

---

[254] For a good introduction to the topic see Guido Abbatista, 'The Historical Thought of the French "Philosophes"', in *The Oxford History of Historical Writing. Volume 3, 1400-1800*, ed. José Rabasa et al. (Oxford: Oxford University Press, 2012), 406–27.
[255] Meinel, 'Demarcation Debates', 154–56. On nineteenth-century historical writing in chemistry see also Beretta, 'Changing Role'.

Chapter 2, Part 2: Hermeticism – Observationalism – History. The Debate between Johann Christian Wiegleb and Joseph Friedrich Wilhelm Schröder (1770-1780)

Introduction

Writing the history of chemistry along the lines of *histoires de l'esprit* became popular in the second half of the eighteenth century among German scholars as well. For example, the preface to Johann Christian Polycarp Erxleben's popular textbook *Anfangsgründe der Chemie* (1775) followed the same chronological and conceptual cornerstones as its French predecessors.[256] What is more interesting, however, is the curious use of historical arguments within a debate on alchemy, here understood as the feasibility of metallic transmutation and gold-making, which took place in the 1770s. Its protagonists, the Marburg professor of medicine, Joseph Friedrich Wilhelm Schröder and Johann Christian Wiegleb, the pharmacist, took contradictory stances on this matter and others. Indeed, the debate also exposed differing philosophies of science which made it difficult for the discussants to find any common ground. While Schröder was aligned with the hermetic tradition, which will be discussed in the first section, Wiegleb was a staunch defender of an observation-based approach. As we shall see, he took Schröder's attack on observationalism as a paradigm seriously, for his biography had made him alert to the allure of hermeticism, in particular to young scholars. To refute Schröder's claims, Wiegleb resorted to numerous methods which were popular among Enlightenment historians working on other topics such as cultural or environmental history. Although the debate is known in

[256] Johann Christian Polykarp Erxleben, *Anfangsgründe der Chemie* (Göttingen: Johann Christian Dieterich, 1775), 6–8.

scholarship,[257] the innovative character of Wiegleb's approach to historical inquiry and history-writing has not been sufficiently acknowledged. Since his very distinct ideas on the matter came to influence later historians, the debate deserves to be discussed in detail.

Before I outline the fundaments of historical hermeticism, it is worth briefly reconsidering the problem of alchemy. After all, it might come as a surprise that this concept and its implications reappear in this thesis, given that, as discussed in chapter 1, the semantic distinction between rational chemistry and irrational alchemy had been firmly established as early as the 1720s. Yet, recent scholarship has unveiled that alchemy had somewhat of a revival in the second half of the eighteenth century. This pertains not only to secret societies such as the Rosicrucians who claimed to have mastered the practice of gold-making,[258] but, crucially, also to the standard bearers of observationalism in chemistry. French chemists such as Jean Hellot, Guillaume-François Rouelle, and even Pierre-Joseph Macquer followed Boerhaave in investigating the transmutation of metals in experimental settings, albeit without making their efforts public. Their dedication is striking inasmuch as they all were bred by the very Parisian circles which had established the sharp semantic divide between alchemy and chemistry. Macquer's secret engagement with *chrysopoeia*, which has survived in archival sources only, is particularly noteworthy since it stood in stark contrast to his blatant criticism of alchemy in the *Dictionnaire de Chimie*.[259] Christine Lehman has ascribed this renewed interest in transmutation to the theoretical framework under which the composition of metals was investigated from circa 1750 onwards. The idea that metals were compounds of earth and phlogiston paved the way for experimental inquiries into whether the constituents could be reassembled into a

[257] Principe, *Secrets*, 89–92; Klosa, *Johann Christian Wiegleb*, 200–202; Redies, *Friedrich Joseph Wilhelm Schröder*, 142–47.
[258] Christopher McIntosh, *The Rose Cross and the Age of Reason. Eighteenth-Century Rosicrucianism in Central Europe and Its Relationship to the Enlightenment*, Brill's Studies in Intellectual History 29 (Leiden: Brill, 1992), 75–90.
[259] Principe, 'End of Alchemy', 98, 107–16; Lehman, 'Alchemy Revisited', 165–67, 182–90.

different visible material such as gold.[260] Such an interest was far from being confined to Parisian circles. Indeed, several of Wiegleb's publications throughout the 1770s show that he endorsed the experimental assessment of transmuting metals on the basis of similar theoretical presuppositions.[261] Scholars such as Schröder, too, believed in artificial gold-making. Yet, they did so rooted in the different scientific paradigm of hermeticism which I shall portray in the coming section, which is a summary of the research conducted by scholars such as Florian Ebeling and Esteban Law. Based on a brief reconstruction of how scholars affiliated with the hermeticist philosophy had made use of historical arguments and methods since the seventeenth century, I shall analyse the positions maintained by Schröder in his *Geschichte der ältesten Chemie und Filosofie oder sogenannten Filosofie der Egyptier* (1775).[262] This will be followed by an assessment of how Wiegleb deployed the arsenal of critical Enlightenment techniques of historical analysis in his *Historisch-kritische Untersuchung der Alchemie, oder der eingebildeten Goldmacherkunst, von ihrem Ursprunge sowohl als Fortgange, und was nun von ihr zu halten* (1777) to counter the philosophical foundations of hermeticism and to underline the rationality of the observation-based approach.[263]

[260] Lehman, 'Alchemy Revisited', 181.
[261] Klosa, *Johann Christian Wiegleb*, 200–201, 203–4.
[262] Friedrich Joseph Wilhelm Schröder, 'Geschichte der ältesten chemie und filosofie, oder sogenannten fillosofie der Egyptier', *Neue Sammlung der Bibliothek für die höhere Naturwissenschaft und Chemie* 1, no. 1 (1775): 89–430.
[263] Johann Christian Wiegleb, *Historisch-kritische Untersuchung der Alchemie, oder der eingebildeten Goldmacherkunst von ihrem Ursprunge sowohl als Fortgange, und was nun von ihr zu halten sei* (Weimar: Carl Ludolf Hoffmann, 1777).

Hermeticism and History-Writing: Joseph Friedrich Wilhelm Schröder and his Predecessors

The distinction between an observation-based Baconian ideal of science and hermeticism is not an analytical invention of modern scholarship but guided debates in the seventeenth and eighteenth centuries, too. While being united in the goal to unveil the secrets of nature, they exposed fundamental divergences in their – implicit and explicit – philosophies of science. Sketching their most radical forms as *Idealtypen* in the Weberian sense of the word will serve to mark a spectrum within which the historical works at hand can be situated.

As we have seen in the first part of this chapter, eighteenth-century observationalists agreed that observation and experiment were the foundation for producing reliable knowledge about nature. Theories, systems, hypotheses, and conjectures further propelled progress, yet only if they were grounded in sensual experiences. The hermetic tradition, by contrast, assumed that observation only touched on the surface of natural processes while only God had knowledge of the hidden mechanisms in nature, making higher knowledge a gift of divine revelation.[264] Drawing on a rich tradition which dated back to Late Antiquity, early modern scholars explored the idea that such a body of divine knowledge had been revealed to Hermes Trismegistos in humanity's earliest times and had been conserved in a corpus known as the 'hermetic' texts.[265] Renaissance scholars identified numerous writings of varying descent whose often enigmatic content was supposed to transmit the divine messages. Among other texts, the *Corpus Hermeticum*, which was translated from Byzantine Greek into Latin by the Florentine

---

264 Florian Ebeling, *The Secret History of Hermes Trismegistus. Hermeticism from Ancient to Modern Times*, trans. David Lorton, 1st ed. (Ithaca NY: Cornell University Press, 2007), 74, 81 Jan Assmann, 'Foreword', in: ibid., ix.

265 Esteban Law, 'Die hermetische Tradition. Wissensgenealogien in der alchemischen Literatur', in *Konzepte des Hermetismus in der Literatur der Frühen Neuzeit*, ed. Peter-André Alt and Volkhard Wels, Berliner Mittelalter- und Frühneuzeitforschung 8 (Göttingen: V&R Unipress, 2010), 37; Ebeling, *Secret History*, 1–8. The intellectual history of hermeticism before the early modern period has been reconstructed by the same authors, see Law, 'Hermetische Tradition', 40–57; Ebeling, *Secret History*, 37–58.

humanist Marsilio Ficino and published in 1463, formed a reference point for the theological and philosophical strand of hermeticism in the Renaissance.[266]

For the history of medicine, alchemy, and chemistry, another hermetic work, the *Tabula Smaragdina*, a cosmological treatise, was of still greater importance, though. Late-medieval scholars such as Bernardus Trevisanus interpreted the *Tabula*'s content as a guide to producing the philosopher's stone. They supplemented its content with a genealogical narrative according to which Hermes Trismegistus had found the seven tables containing divine knowledge of chemistry after the deluge near Adam's grave, thus making it available to mankind in an encrypted form.[267] While such writings provided the main source of insight into the inner workings of nature to humans, Trevisanus and others insisted that God had inspired scholars throughout history with the result that alchemical teachings were constantly reinstated and enriched.[268] The hermetic text corpus became relevant to chemistry via its argumentative usage in seventeenth-century medical discourse. Followers of Paracelsus such as Joachim Tancke, who championed the approach of iatrochemistry against the Galenian-Aristotelian tradition, proposed variants of the hermetic legend to argue that their pharmacological practices were in fact rooted in divine revelation. Within this context, Paracelsus was sometimes identified by his followers as the modern German embodiment of Hermes.[269]

This line of argumentation was influential for the seventeenth- and eighteenth-century chemical discourse in several respects. First, proponents of the Paracelsian tradition mostly took it for granted that the transmutation of metals into gold and silver was possible since such

---

[266] Ebeling, *Secret History*, 9–11, 59–61; Law, 'Hermetische Tradition', 26–33.
[267] Ebeling, *Secret History*, 49–50; Law, 'Hermetische Tradition', 57–58, also for further information on the disputed origins and transmission history of the text.
[268] Law, 'Hermetische Tradition', 40, 58. See also Hanegraaff, *Esotericism*, 198–99.
[269] Carlos Gilly, 'Vom ägyptischen Hermes zum Trismegistus Germanus. Wandlungen des Hermetismus in der paracelsischen und rosenkreuzerischen Literatur', in *Konzepte des Hermetismus in der Literatur der Frühen Neuzeit*, ed. Peter-André Alt and Volkhard Wels, Berliner Mittelalter- und Frühneuzeitforschung 8 (Göttingen: V&R Unipress, 2010), 76–90; Peter-André Alt and Volkhard Wels, 'Einleitung', in *Konzepte des Hermetismus in der Literatur der Frühen Neuzeit*, ed. Peter-André Alt and Volkhard Wels, Berliner Mittelalter- und Frühneuzeitforschung 8 (Göttingen: V&R Unipress, 2010), 14; Law, 'Hermetische Tradition', 59–60; Ebeling, *Secret History*, 72–74.

positions were firmly entrenched in the written tradition of hermeticism.[270] Second, iatrochemical theories laid the foundation for a particular idea of alchemy as a science which ran counter to the equally evolving Baconian paradigm which prioritised observation to inquire nature. In 1729, the Leipzig professor of medicine Benedikt Nikolaus Petraeus argued that alchemical practices could succeed if only they were rooted in the careful exegesis of hermetic texts. Conversely, however, experiments could never be profound enough to prove wrong the implications of such writings, including the theoretical feasibility of metallic transmutation. Such assumptions became common currency in alchemist circles throughout the seventeenth century, very much to the annoyance of those championing an observation-based approach.[271]

Yet the fact that hermeticists referred to historical concepts such as the origin and transmission of alchemical practices to substantiate their positions in chemistry in turn made historico-philological inquiries a convenient device for their critics. Already in 1614, Isaac Casaubon used the methods of philological and textual criticism to show that the *Corpus Hermeticum* did not transmit oriental wisdom, nor was it written by a mythical Hermes but by Christian authors in Late Antiquity.[272] The ensuing debate which spanned Europe turned to the problem of alchemy in 1648 when Hermann Conring the professor of medicine at Helmstedt resorted to the arsenal of philological and historical criticism to examine the hermeticists' sources, denying any divine revelation and dating the emergence of alchemy to Late Antiquity. While Conring's position was supported by Athanasius Kircher, the Danish scholar Olaus Borrichus presented philological evidence in favour of the pre-diluvian origin of chemistry in 1668.[273]

---

[270] Robert Halleux, 'La Controverse sur les origines de la chimie, de Paracelse a Borrichus', in *Acta Conventus Neo-Latini Turonensis. Troisième congrès international d'études néo-latines, Tours, Université François-Rabelais 6-10 septembre 1976*, ed. Jean-Claude Margolin, vol. 2, De Pétrarque à Descartes 38 (Paris: J. Vrin, 1980), 807–8.
[271] Ebeling, *Secret History*, 102–3, 107–8.
[272] Ibid., 91–92; Hanegraaff, *Esotericism*, 204.
[273] Ferdinando Abbri, 'Alchemy and Chemistry. Chemical Discourses in the Seventeenth Century', *Early Science and Medicine* 5, no. 2 (2000): 218–20; Allen G. Debus, 'The Significance of Chemical History', *Ambix* 32, no. 1 (1985): 1–2; Law, 'Hermetische Tradition', 65–70; Ebeling, *Secret History*, 97–100; Weyer, *Chemiegeschichtsschreibung*, 17–24.

However, as Fernando Abbri has pointed out, Borrich was not an opponent of experimental investigations despite his stance in the debate but considered philological, historical, and observational evidence equally essential for the proper investigation of chemical processes.[274] Since Conring had written his text to pursue an anti-iatrochemical agenda, the controversy thus elucidates how the question of chemistry's and alchemy's origins was closely linked to practical problems of medical treatment as well as to the philosophy of nature in the late seventeenth century.[275] Over the subsequent decades, both critics and supporters of hermeticism continued to publish on the joint history of alchemy and chemistry without reaching common ground.[276]

It was within this tradition of this ongoing controversy that a German professor of medicine at the University of Marburg, Joseph Friedrich Wilhelm Schröder, made a renewed attempt to legitimise alchemy through a historical inquiry in the 1770s. After having studied at Halle and later at Erlangen during the 1750s, he worked as a medical doctor in Wernigerode and Kassel before being appointed professor at the University of Marburg in 1764.[277] According to a biographical essay which appeared in 1770 based on Schröder's own recollections, he was appalled by the 'Ungewißheit der Medicinischen Wissenschaften' given their reliance on 'Erfahrungen und weitläufige Geschichtskenntnisse'.[278] Since he also became a member both of the local Freemason lodge and of a secret Rosicrucian society,[279] it is hardly surprising that Schröder was fascinated by alchemy and the hermetic tradition. From 1771 to 1774, he edited a journal, *Neue alchymistische Bibliothek*, followed by the *Neue Sammlung der Bibliothek für die höhere Naturwissenschaft und Chemie* (1775–1776). They contained eclectic collections

[274] Abbri, 'Alchemy and Chemistry', 219–20.
[275] Debus, 'Significance', 2–4; Weyer, *Chemiegeschichtsschreibung*, 17–18.
[276] Vladimir Karpenko, 'Die Edelgeborne Jungfer Alchymia. The Final Stage of European Alchemy', *Bulletin for the History of Chemistry* 25, no. 1 (n.d.): 51–56; Hanegraaff, *Esotericism*, 240–42; Ebeling, *Secret History*, 120–21; Weyer, *Chemiegeschichtsschreibung*, 24–25. For context see also McIntosh, *Rose Cross*, 82–87..
[277] Redies, *Friedrich Joseph Wilhelm Schröder*, 25–44.
[278] Ernst Gottfried Baldinger, ed., 'Untitled Biography of Friedrich Josef Wilhelm Schröder', in *Aerzte und Naturforscher in und ausser Deutschland*, vol. 1,2 (Jena: Johann Wilhelm Hartung, 1770), 227. Redies claims that Schröder was the author of the essay, see Redies, *Friedrich Joseph Wilhelm Schröder*, 3.
[279] Redies, *Friedrich Joseph Wilhelm Schröder*, 50–63; McIntosh, *Rose Cross*, 50–51.

of older writings on alchemy, practical advice on how to perform experiments with relevance for hermetic philosophy, and a comprehensive history of Egyptian philosophy.[280]

In the latter work, Schröder reiterated the core beliefs of hermeticism, framing his work as a continuation of Borrich's criticism of Conring although this debate had taken place almost a hundred years earlier.[281] Notwithstanding this affiliation, Schröder's work exposes his familiarity with current discourses on the philosophy of the natural sciences. His critique of the reliance of mid-century observationalism on conjectures and hypotheses is especially noteworthy. Observation-based inquiries into chemistry merely scratched the surface of natural processes, for they grasped the nature of substances 'nur in ihren Wirkungen und äusseren Erscheinungen durch Erfahrungen oder geträumte Hypothesen auf eine sehr unbestimmte und ungewisse Weise'.[282] Schröder thus reiterated the cautious stance towards hypothesising and conjecturing in the sciences which had been voiced by scholars such as Fontenelle earlier in the century, presenting what he called the 'höhere Naturwissenschaft' as an alternative. By pursuing it, scholars could gain insight into the 'versteckten und verborgenen Kräfte, die geheimen Triebfedern der Natur'.[283]

Against this backdrop, Schröder sought to convince his audience to engage with the hermetic tradition in greater detail; yet his work did not contain any practical advice on how initiates could transmute metals or manufacture the philosopher's stone, although he agreed that this was the ultimate goal of hermeticism.[284] Rather, he constructed a historical narrative which had the epistemic function of showcasing the general feasibility of such processes. Those who were doubtful of alchemy's validity could be convinced 'entweder durch die hinlaenglich

---

[280] Redies, *Friedrich Joseph Wilhelm Schröder*, 44–45, 87–117.
[281] Schröder, 'Geschichte der ältesten Chemie', 91–95; Redies, *Friedrich Joseph Wilhelm Schröder*, 90–93..
[282] Schröder, 'Geschichte der ältesten Chemie', 90–91, 96–97.
[283] Friedrich Joseph Wilhelm Schröder. 'Nachricht zum ersten Bande dieser Bibliothek', *Neue Sammlung der Bibliothek für die höhere Naturwissenschaft und Chemie* 1, no. 1 (1775): [viii]. This preface has no pagination. I refer to the first page of the preface which starts with the address 'Sire' as page [i].
[284] Schröder, 'Geschichte der ältesten Chemie', 90–91.

beurkundeten geschichten oder durch eigene chemische einsicht von der wahrheit der verbesserung und verwandlung der metalle und des beruechtigten Steins der weisen'.[285] Thus, the work made assumptions about what counted as valid scientific evidence: the exegesis of historical documents was a legitimate method to establish firm knowledge of nature for those who were not able to witness the miracles of Egyptian philosophy first-hand. Indeed, Schröder stressed that 'nichts kann für die Naturforscher und Chemisten wichtiger seyn, als die gewissheit dieser geschichte', thus suggesting that a truthfully reconstructed historical narrative in fact superseded experiences and observations as methods of the scientific discourse.[286]

On such grounds, Schröder took pains to reiterate the traditional narrative of hermeticism over several hundred pages, without adding much to existing works on the topic. Hermetic knowledge had been a divine gift to chosen men – above all to Hermes, whom he identified with Abraham, Zoroaster, and Mercurius –, and he insisted on its secretive character. Only a few initiates possessed the ability to decipher the lessons of *Höhere Naturwissenschaft* from hieroglyphic inscriptions on columns and tables. This skill had been passed on from generation to generation within secret societies and castes.[287] While the ancient Greeks and Romans, as well as medieval philosophers, had vainly refrained from acknowledging the higher insight of hermetic philosophy, its wisdom was restored across Europe thanks to the efforts of Paracelsus. During his travels, he had painstakingly created a collection of previously hidden or lost hermetic fragments, thus initiating a tradition which was upheld by the Rosicrucians alone at that time.[288]

Conring and Casaubon, as well as Johann Jacob Brucker, author of a critical history of philosophy, served Schröder as strawmen who personified the philosophical ineptitude of the established sciences. To counter the idea that any successful transmutation of metals would

---

[285] Ibid.
[286] Ibid., 89, footnote.
[287] Ibid., 99–101, 129–31, 140–43, 158–60, 199, 221–22, 370–71.
[288] Ibid., 239–48, 316–36, 404–9, 427–30.

have caused a stir among the ancients and thus would have left considerable traces in historical sources, Schröder invoked numerous passages in ancient texts which, in his eyes, proved that the abundance of gold in Egypt was not the result of skilled mining or trade but had to be the product of humans practising a secret art.[289] Conring was also without sufficient knowledge of textual transmission across centuries: according to Schröder, he failed to acknowledge that hermetic writings had been stored in the Library of Alexandria and, after its destruction, had been spread by looting soldiers and preserved by secret societies.[290]

Notwithstanding his allegiance to the hermetic tradition, Schröder did not invoke its key texts such as the *Tabula Smaragdina* to strengthen his claims, but instead referenced biblical sources and the Church fathers, as well as Greek and Roman writers such as Herodotus and Pliny the Elder.[291] This was most certainly part of a strategy to substantiate his claims with reference to a widely revered literary tradition. This also explains why he invoked the Dutch chemist Herman Boerhaave, who was identified as one of the initiators of a rational, observation-based approach to chemistry by historians of chemistry in the observationalist tradition, as a witness for his own opposing views. Indeed, Boerhaave's engagement with the chemistry of metals initially took its cue from the alchemical tradition.[292] Yet Schröder surely exaggerated when he suggested in the introduction to the volume that Boerhaave had been an ardent believer in his very own interpretation of hermeticism.[293]

---

[289] Ibid., 340–89. Attacks on Brucker, Conring, and Casaubon can for example be found ibid., 92-95, 149, 160 165.
[290] Ibid., 339–41, 391–93, 416–21.
[291] Ibid., 98, 105–6, 118–20, 134.
[292] On Boerhaave's evolving relationship with the alchemical tradition see John C. Powers, *Inventing Chemistry. Herman Boerhaave and the Reform of the Chemical Arts* (Chicago Ill: The University of Chicago Press, 2012), 170–91, particularly 178-183.
[293] Schröder, 'Nachricht', [viii]–[ix].

Despite being mostly a reiteration of traditional hermeticist arguments, Schröder's work is still noteworthy because of its reception. In fact, the apothecary and well-regarded chemist Johann Christian Wiegleb saw Schröder's views on alchemy as part of a wider and intensifying clash between irrational hermeticism and rational observationalism. Wiegleb's first strike was a review in the *Allgemeine Deutsche Bibliothek* which reproached Schröder, together with all those who searched for metallic transmutation, for departing from what Wiegleb considered to be the rational approach to investigating nature.[294] In 1777, he wrote an entire book, the *Historisch-kritische Untersuchung der Alchemie, oder der eingebildeten Goldmacherkunst, von ihrem Ursprunge sowohl als Fortgange, und was nun von ihr zu halten sey*, to engage critically with Schröder's views on the history of alchemy and to provide an alternative story. Assessing what motivated Wiegleb, a man who was proud to be at home in the laboratory, to dedicate so much time to writing a historical inquiry sheds light on the status of chemistry as an emerging discipline in late-eighteenth-century Germany. Moreover, a close reading of his work is instructive to highlight the role which a historical narrative could play in defining and defending the paradigmatic assumptions of scientific observationalism in the Enlightenment.

It was against the backdrop of the discrepancy between an anti-alchemist rhetoric and the experimentally still pending question of whether metallic transmutations were possible that Wiegleb became wary of any approach which offered a simple solution to a complex problem. This was precisely what Schröder did in vindicating the possibility of gold-making by reading ancient texts instead of experimenting.[295] Yet, Wiegleb would probably not have written 400

---

[294] Johann Christian Wiegleb, 'Dr Friedr. Jos. Wilh. Schroeders neue Sammlung der Bibliothek für die höhere Naturwissenschaft und Chemie. Ersten Bandes erstes Alphabet... (Review)', *Allgemeine Deutsche Bibliothek* 27, no. 1 (n.d.): 39–55; Klosa, *Johann Christian Wiegleb*, 201–2. I follow Klosa in identifying Wiegleb as the author of this review and the one quoted below.

[295] Johann Christian Wiegleb, 'Die völlig eröffnete Alchemie oder höhere Naturwissenschaft, in einer deutlichen Anweisung, als ein Anhang der neuen alchemistischen Bibliothek; herausgegeben von D. Fr. Jos. Wilh. Schroeder

pages if he had not linked the problem to what he perceived as the disastrous state of the education of up-and-coming chemists.[296] As discussed in chapter 1, young German chemists received their initial training in the field either as part of their medical studies at universities or when joining a pharmacy as an apprentice, both of which caused Wiegleb considerable concern.[297] In an autobiographical sketch, probably written in 1767 and published by a friend as part of his obituary in 1800, he recalled that he had found a number of alchemical works in the library of his master. Lacking any guidance by a superior, he innocently started to believe all of the suppositions in them and admitted 'daß derjenige bey mir nicht viel gewonnen hätte, der mir die Wahrheit der Alchemie bestritten hätte. (…) Es gehörten dazu noch einige Erfahrungen und mehrere Aufklärungen, als ich ehemals besaß, denn Unwissenheit ist die leibliche Mutter der Alchemie'.[298] In his 1777 book on alchemy, he expressed precisely this fear regarding the impact which Schröder's work could have on inexperienced and credulous people. The renaissance of alchemy was a threat, for it was taught 'auf hohen Schulen und in chemischen Lehrbüchern'. In Wiegleb's eyes, universities formed hubs where students acquired their opinions before taking them to their future positions and swiftly spreading their newly acquired knowledge. Professors such as Schröder therefore had a great impact on the paradigms according to which up-and-coming scholars pursued the study of medicine and chemistry.[299] It is no coincidence that Wiegleb founded his school shortly after the publication of the *Untersuchung*.[300] Both projects were part of his didactic endeavour to equip young scholars with the necessary tools to establish a rational approach to pharmaceutical and chemical investigations.

(Review)', *Allgemeine Deutsche Bibliothek* 26, no. 2 (1775): 523–24. See also Klosa, *Johann Christian Wiegleb*, who has reconstructed the chronology of Wiegleb's changing stances towards the idea of metallic transmutation.

[296] On Wiegleb as a reformer of pharmaceutical education see Klosa, *Johann Christian Wiegleb*, 321–24, 341–50. Klosa, however, does not link Wiegleb's anti-alchemical historical works to his efforts as an educational reformer.

[297] See Klein, 'Apothecary-Chemists' and the literature quoted in chapter 1.

[298] Friedrich Christian Stoeller, 'Nekrolog Johann Christian Wiegleb', *Allgemeines Journal der Chemie* 4 (1800): 690–93, quote on 693. See also Klein, 'Apothecary-Chemists', 101–2; Klosa, *Johann Christian Wiegleb*, 7–9, the latter for further reference on the publication history.

[299] Wiegleb, *Historisch-kritische Untersuchung*, 87–89, 379–82, quote on 380.

[300] While the school's precise opening date is uncertain, the period between 1779 and 1782 is most likely, see Klosa, *Johann Christian Wiegleb*, 344.

In recounting his own conversion from a believer in the limitless transformability of metals to its critic, Wiegleb underlined the educational impetus of his work right at its outset.[301] The conceptual dichotomy between observation-based chemistry and alchemy as an occult practice which assumed divine inspiration and relied on books for evidence served as his analytical framework.[302] On such grounds, Wiegleb pursued two goals. For one, he refuted Schröder's assumption according to which the reading of historical documents allowed scholars to make reliable claims on natural laws which surpassed inquiries grounded in observation. To do so, Wiegleb sought to beat Schröder at his own game. He applied a critical type of historical writing to shake the fundamentals of hermetic arguments, to inhibit its further spread, and to ensure that chemistry could exclude any alchemist remnants from its theories. In addition to this critical or deconstructive thrust, the historical account had a second, explicative function. Wiegleb also sought to clarify both the presence of gold in Antiquity and the emergence of alchemy as a fiction among humans. Tracing alchemy's genealogy in greater detail exposed the profane and natural basis of alchemist teachings and served to illustrate the persistence of wrong assumptions and beliefs within society to facilitate their future abandoning in favour of more rational thinking.[303] From this perspective, a historical narrative formed an explicative and epistemological intervention to expose, as Wiegleb phrased it in almost Kantian terminology, the 'Ursprung des Begriffs von der Möglichkeit einer Goldmacherkunst'.[304]

This twofold aim of deconstruction and explanation translated into a peculiar textual structure. The work begins with a long account on metallurgy in Antiquity, which is followed by eight chapters, each discussing a part of Schröder's argument. This unusual format has led to some negative judgements in twentieth-century historiography regarding Wiegleb's abilities

---

[301] Wiegleb, *Historisch-kritische Untersuchung*, [iii]-[iv]. The pagination of non-numbered pages starts with the title page as p. [i]. See also Dietlinde Goltz, 'Alchemie und Aufklärung. Ein Beitrag zur Naturwissenschaftsgeschichtsschreibung der Aufklärung', *Medizinhistorisches Journal* 7, no. 1/2 (1972): 46–47.
[302] Wiegleb, *Historisch-kritische Untersuchung*, [iii]-[iv], 14-15, 18-19, 382-384.
[303] Ibid., [xi]-[xvi].
[304] Ibid., [xi].

as a historian.[305] Such verdicts overlook that, in his attempt to uncover the rational reasons for chemistry's early history within its historical circumstances, Wiegleb was one of the first historians of chemistry to adopt a range of historical methods which were common currency among German historians during the Enlightenment period. For his endeavour of historicising alchemy as a superstition and of assessing its joint evolution with chemistry, the tradition of *historia philosophiae* was an important source of inspiration to Wiegleb. He was particularly indebted to the works of Johann Jakob Brucker whom he quoted frequently, presumably to rehabilitate Brucker following Schröder's hefty attacks.[306] Furthermore, in his comparison of competing narratives, in his assessments of the trustworthiness of witnesses based on existing literature, in his focus on translations and the meaning of individual words in their original language, as well as in his extensive reliance on footnotes to visually substantiate his claims, Wiegleb also signalled his indebtedness to the tradition of Casaubon and Conring and, more generally, to the genres of *historia literaria* and *historia critica*.[307]

Wiegleb combined these traditions which all had roots in Renaissance humanism with the framework of conjectural histories to assess chemistry's and alchemy's origins and early development. Conjectural historians from the Scotsman Adam Smith to the German Thomas

---

[305] Goltz, 'Alchemie und Aufklärung', 33, 37–38. For a detailed summary of the *Untersuchung* which focuses on Wiegleb's treatment of alchemy between the Middle ages and the eighteenth century see Klosa, *Johann Christian Wiegleb*, 206–26.

[306] Wiegleb, *Historisch-kritische Untersuchung*, 172–73, 209, 211, 220–21. For an analysis of Brucker's works and methodology see Wilhelm Schmidt-Biggemann, 'Jacob Bruckers philosophiegeschichtliches Konzept', in *Jacob Brucker (1696-1770). Philosoph und Historiker der europäischen Aufklärung*, ed. Wilhelm Schmidt-Biggemann and Theo Stammen, Colloquia Augustana 7 (Berlin: Akademie Verlag, 1998), 113–34; Mario Longo, 'Geistige Anregungen und Quellen der Bruckerschen Historiographie', in *Jacob Brucker (1696-1770). Philosoph und Historiker der europäischen Aufklärung*, ed. Wilhelm Schmidt-Biggemann and Theo Stammen, trans. Helga Zurhausen-Bamberg, Colloquia Augustana 7 (Berlin: Akademie Verlag, 1998), 159–86.

[307] Anthony Grafton, *The Footnote. A Curious History*, (Revised Edition. Cambridge MA: Harvard University Press 1997), 195–201; Ulrich Muhlack, 'Von der philologischen zur historischen Methode', in *Theorie der Geschichte*, ed. Christian Meier and Jörn Rüsen, Beiträge zur Historik, 5: Historische Methode (Munich: Deutscher Taschenbuchverlag, 1988), 161–64; Merio Scattola, '"Historia literaria" als "historia pragmatica". Die pragmatische Bedeutung der Geschichtsschreibung im intellektuellen Unternehmen der Gelehrtengeschichte', in *Historia literaria. Neuordnungen des Wissens im 17. und 18. Jahrhundert*, ed. Frank Grunert and Friedrich Vollhardt (Berlin: Akademie Verlag, 2014), 37–64. For a full account on *historia critica* in the early modern period see Anthony Grafton, *What Was History? The Art of History in Early Modern Europe* (Cambridge: Cambridge University Press, 2007).

Abbt held that humans shared a number of inherent mental faculties based on which they reacted to impulses from their changing natural and social environment. Methodologically, assuming such a stability of human nature across time allowed historians to make informed conjectures on how early societies had evolved, even in the absence of textual evidence and moreover without invoking the divine will.[308] It must not come as a surprise that this naturalistic framework was attractive to Wiegleb in his refutation of Schröder's hermeticism. Early on in his work, he made clear that his conjectures – he called them 'meine muthmaßlichen Gedanken' – were not mere speculation but resulted from a comparison between the past and 'unserer Erfahrung und gegenwärtiger Beobachtung'.[309] To explain how early humans were able to discover a variety of chemical processes such as fermentation, distillation, and dyeing, Wiegleb pointed to necessity ('Nothdurft') and reason ('Vernunft') as basic human features which, together with pure chance ('Zufall'), naturally prompted them to engage with the physical environment.[310] Humans thus slowly but steadily acquired rudimentary knowledge on metallurgy as well as the key techniques and instruments to smelt metals.[311]

Wiegleb also drew on the 'actualist' approach which was common in Enlightenment environmental histories. Actualists held that those natural laws which contemporary scholars could observe were inalterable, and could thus be applied to analyse historical events. In Wiegleb's intellectual environment in Thuringia, the doctor and amateur geologist Georg Christian Füchsel concomitantly pursued such positions.[312] It is unknown whether Wiegleb and Füchsel knew each other. Wiegleb probably became familiar with the actualist approach through

---

[308] Silvia Sebastiani, 'Conjectural History vs. the Bible. Eighteenth-Century Scottish Historians and the Idea of History in the "Encyclopaedia Britannica"', *Lumen* 21 (2002): 218–20; Avi Lifschitz, *Language and Enlightenment. The Berlin Debates of the Eighteenth Century*, Oxford Historical Monographs (Oxford: Oxford University Press, 2012), 3–6; Lifschitz, 'Genesis', 605–6; Poovey, *History*, 215–16.
[309] Wiegleb, *Historisch-kritische Untersuchung*, 21–23, quotes on p. 22.
[310] Ibid., 1–12, quotes on 2; Goltz, 'Alchemie und Aufklärung', 38.
[311] Wiegleb, *Historisch-kritische Untersuchung*, 15–18, 20–72.
[312] David Schulz, *Die Natur der Geschichte. Die Entdeckung der geologischen Tiefenzeit und die Geschichtskonzeptionen zwischen Aufklärung und Moderne*, Ordnungssysteme. Studien zur Ideengeschichte der Neuzeit 56 (Munich: De Gruyter Oldenbourg, 2020), 113–17, especially 115.

Johann Gottlob Krüger's *Geschichte der Erde in den allerältesten Zeiten* (1746) of which he owned a copy.[313] Here, Krüger suggested that one could find reliable proof ('Beweise') for writing the history of the earth which nature itself had inscribed 'mit unauslöschlichen Buchstaben in das innerste der Erde'.[314] Wiegleb applied this perspective to uncover the natural reasons for the abundance of precious metals among ancient peoples. Iron, in his view, did not have the same shape and appearance it had had in Antiquity. Since it changed its form and appearance over time due to chemical reactions – Wiegleb invoked the process which we would today call oxidation – it had simply been more visible and accessible in ancient time compared to his time. In addition, geological catastrophes had mixed iron with all kinds of substances over time making it more difficult to trace.[315] Similarly, the abundance of gold in ancient Egypt had not been the result of a secret art; rather, Wiegleb hypothesised, it had been scattered across the earth's surface and had thus been easily collected by the earth's inhabitants at the beginning of time.[316]

Conjectures on the mental faculties of humans and natural processes in the environment also served as methods to portray the vexed aspects of chemistry's and alchemy's joint evolution. The abundance of metals and gold had sparked the curiosity of certain individuals who had started searching for ways to use them.[317] Humankind thus entered a circular process in which each discovery widened its intellectual horizon. Yet, these early attempts of metallurgists had been marked by coincidences, failures, and unplanned successes and thus stood in sharp contrast to the systematic character of modern scientific approaches, an argument which his French colleagues made, too (see part 1 of this chapter).[318] The history of alchemy thus

[313] Cf the inventory of Wiegleb's books in Klosa, *Johann Christian Wiegleb*, 394.
[314] Johann Gottlob Krüger, *Geschichte der Erde in den allerältesten Zeiten* (Halle: Lüderwaldische Buchhandlung, 1746), [ix]. The pagination of non-numbered pages starts with the title page as p. [i].
[315] Wiegleb, *Historisch-kritische Untersuchung*, 22–23.
[316] Ibid., 108–9, 125.
[317] Ibid., 67–68.
[318] Ibid., 12–16.

offered a cautionary tale in the *historia literaria* tradition. Since early humans had lacked the 'gründlichen Einsichten und kunstmäßigen Regeln', they could not interpret what they saw 'in einem systematischen Zusammenhange'.[319] Lacking a body of reliable systematic knowledge to approach future discoveries, they had necessarily been prompted by their direct experiences of the natural world to engage in speculation. According to Wiegleb, it was in this state of semi-advanced knowledge that irrationalism had taken root, a position which shows parallels with Etienne-Bonnot de Condillac's famous conjectural history of scientific nomenclature in the *Logique* (1780; see chapter 4 of this thesis).[320] In Late Antiquity, Wiegleb argued, the imperfect state of metallurgy had prompted curious humans to develop the idea of metallic transmutation. Metallic substances, having been smelted, changed their shape and colour, as a result of which observers started to believe one metal had been transformed into another. The process could even be observed on a semantic level, for the concept of alchemy had not been used before the fourth century CE.[321] Wiegleb thus postulated that, to a certain extent, language mirrored the state of human knowledge, 'denn es musste nothwendig vor dem Begriff von einer metallischen Verwandlungskunst eine Erfindung vorhanden seyn, woraus sich eine solche Einbildung folgern liesse'.[322]

Establishing the natural reasons for alchemy's emergence enabled Wiegleb to draft a nuanced view of the history of humankind's inquiries into the material world. The modern science of chemistry and the 'vorgebliche Wissenschaft' of alchemy shared their origins in ancient metallurgy.[323] He conceded that the pursuit of alchemy had prompted scholars throughout history to invent certain chemical techniques. The separation of mineral salts, for instance,

---

[319] Ibid., 13.
[320] Etienne Bonnot de Condillac, *La Logique ou les premiers développemens de l'art de penser* (Paris: Librairie l'esprit; Librairie Debure, 1780), 102–5.
[321] Wiegleb, *Historisch-kritische Untersuchung*, 165–66, 187–92, 202–6. See also Goltz, 'Alchemie und Aufklärung', 35.
[322] Wiegleb, *Historisch-kritische Untersuchung*, 189. See also Goltz, 'Alchemie und Aufklärung', 35 who quotes the same passage.
[323] Wiegleb, *Historisch-kritische Untersuchung*, 27; 71–72, 82–83, quote on 72.

was a legacy of alchemy. Notwithstanding all its merit, this discovery also gave way to renewed speculation of a general transmutability of substances and caused a revival of alchemy in the Middle Ages. For Wiegleb, this was just another example of how a sensual observation could lead to wrong conclusions as long as chemistry had not evolved into the philosophically reliable system into which it grew in the seventeenth century.[324] Given their co-evolution, even the writings of admirable modern chemists such as Boerhaave, Becher, and Stahl contained positions which were influenced by alchemist speculation.[325] Such examples cautioned aspiring chemists not to believe any scientific position merely because it was postulated by an authority but always to resort to critical observation.[326]

Conclusion

Since the 1750s, using historical narratives to substantiate scientific positions became common currency in the discourse on chemistry in both France and Germany. As the two case studes in this chapter have exhibited, the writing of historical narratives was particularly attractive for the chemists when it came to treating matters of epistemology. As a result, it was uncommon to question whether it was appropriate to assign so much argumentative weight to a literary practice which was unrelated to the usual observational and experimental inquiries of chemistry. An exception was Christian Polycarp Erxleben, notably himself the author of a short history of chemistry. He began his review of Wiegleb's *Untersuchung* by emphasising the necessity of refuting Schröder's claims and by congratulating Wiegleb for his thorough work.[327] With a

[324] Ibid., 197–202. Further examples can be found ibid. on 234 where Wiegleb highlights the ambivalent role of Paracelsus, and ibid. on 302-303 where he acknowledges the alchemists' contributions to the invention of porcelain manufacturing.
[325] Ibid., 85–86.
[326] Ibid., 318–19; Klosa, *Johann Christian Wiegleb*, 202.
[327] Johann Christian Polykarp Erxleben, 'Historisch-kritische Untersuchung der Alchemie oder der eingebildeten Goldmacherkunst; vom ihrem Ursprunge sowohl, als Fortgange, und was nun von ihr zu halten sey (Review)',

sharp eye, he pointed out that Wiegleb's account was circular in that it presupposed the impossibility of gold-making before using the historical inquiry to prove it. If one considered that the problem of gold-making could only be tackled in experiments, 'so kömmt es im Wesentlichen vom Inhalte des Buches nicht so sehr auf die Prüfung der Glaubwürdigkeit der beygebrachten Erzählungen an'. One therefore had to admit that Wiegleb had ,in der Hauptsache sein Ziel verfehlt'.[328]

In this pointed critique, however, Erxleben was the exception rather than the rule. By the 1770s, the chronological and conceptual narrative of chemistry's history, developed by the authors treated in this chapter, had become firmly entrenched in a wide array of publications, spanning independent monographs, dictionary articles, and introductions to handbooks, which accorded with the principles of the observationalist philosophy of science. To realise such writings, the chemist-historians representative of this tradition creatively adopted the methods of historical writing and inquiry which were provided by Enlightenment *histoires de l'esprit*, conjectural histories, or the rich tradition of *historia literaria.*

Yet, the implications of histories of chemistry written alongside these lines remained intact only as long as the observationalist philosophy and its implications for chemical practice were unquestioned. This, however, radically changed in the 1780s, when the problem of the appropriate methodology to observe, interpret, and categorise chemical phenomena arose anew, in particular in relation to the discourse on pneumatic chemistry. As part of these intricate epistemological controversies which involved famous scholars such as Antoine de Lavoisier or Joseph Priestley, but also one of the heroes of the present chapter, Johann Christian Wiegleb, history-writing yet again played a crucial argumentative role. Indeed, the chemists became embroiled in a transnational controversy as part of which they created contrasting accounts of

---

Physikalische Bibliothek oder Nachricht von den neuesten Büchern, die in die Naturkunde einschlagen 4, no. 2 (1777): 179–86.
328 Ibid., 186–89, quotes on 186 and 189.

chemistry's evolution to bolster their respective epistemological claims. It will be the purpose of the following chapters to analyse this development in greater detail, paying particular attention to both continuities between the mid-eighteenth-century techniques of historical investigation and writing discussed in this chapter, and the innovations which the chemist-historians developed in the face of a changing institutional and intellectual landscape during the revolutionary era.

Chapter 3: Progress Revisited. Historicising Chemical Facts and Theory, 1780-1800

Introduction

During the final two decades of the eighteenth century, the field of chemistry experienced profound theoretical shifts that it has become customary to refer to this period as the 'Chemical Revolution'. While, in the tradition of Thomas Kuhn, the term originally denoted the profound discontinuity between pre- and post-Lavoisian chemistry, scholars have become much more cautious in this regard since the 1990s.[329] Having abandoned the somewhat simplistic idea of a paradigm shift in chemistry as well as the traditional focus on Lavoisier, they have instead unearthed a great diversity in competing scholarly approaches within eighteenth-century chemistry. If seen from this perspective, what defines the Chemicial Revolution is the rich debate on the epistemological foundations of the field, which transcended national borders over the two decades between 1780 and 1800.[330]

The present chapter concentrates on one aspect of these debates, namely the problem of facticity. The concept refers to the criteria and procedures which scholars are required to agree upon in order to determine whether any observation can be considered reliable and thus factual. Debates on facticity can centre on a number of issues including, but not limited to, the function of instruments in experimental settings, the mental operations at play when an

[329] For a detailed reconstruction of the shifting approaches to the Chemical Revolution in scholarship see McEvoy, *Historiography*.
[330] For instance, this perspective guides the excellent case study by Jan Golinski on Lavoisier and British chemistry: Jan Golinski, *Science as Public Culture. Chemistry and Enlightenment in Britain, 1760-1820* (Cambridge: Cambridge University Press, 1992), 129–52.

observation is generalised (for instance to make claims on matters of ontology or taxonomy), or the classic problem of induction versus deduction in science.[331]

It is the purpose of section 1 to explain how these debates arose in chemistry from circa 1780 onwards and why many chemists considered the drafting of historical texts as an appropriate means to address such complex issues. On the basis of existing scholarship, I reconstruct the rise of studies in pneumatic chemistry since the 1750s and the ensuing epistemological debate on how the observations made could be vindicated and interpreted. In section 2, I will move on to showing how Antoine de Lavoisier presented a radical reinterpretation of chemistry's history to substantiate his claims on pneumatic chemistry and, more generally, his approach to chemistry in two of his most popular publications, *Réflexions sur le Phlogistique* (1783/1786) and *Traité élémentaire de Chimie* (1789).

Analysing German publications on chemistry's history published throughout the 1790s is an opportunity to de-centre our focus from reception of Lavoisier's theory across the Rhine, a perspective which has dominated scholarly inquiries thus far.[332] As I shall discuss in section 3, the German chemists understood Lavoisier's theories and their philosophical implications as only one of several available options available to them. Indeed, they deliberately marked their positions in the wider epistemological debate which had previously been championed by British and French chemists, using both the form and content of histories as part of their argumentative strategy. The voluminous histories published by the pharmacist Johann Christian Wiegleb in 1790 and 1791, whom we met in chapter 2, and the Göttingen professor Johann Friedrich Gmelin (published between 1797 and 1799), will be my cases in point for this claim. Due to

[331] My understanding of facticity as a fluid category in eighteenth-century chemistry is informed by Golinski, 'Precision Instruments'. and McEvoy, 'Enlightenment'. For a different approach to facticity in eighteenth-century chemistry see Jan Frercks, 'Demonstrating the Facticity of Facts. University Lectures and Chemistry as a Science in Germany around 1800', *Ambix* 57, no. 1 (2010): 64–83. On facticity as a changing historical category from a general perspective see Poovey, *History*, 1–4.
[332] For decades, the most influential study has been Hufbauer, *Formation*, 96–144. With minor qualifications, Hufbauer's analytical framework continues to be reproduced by contemporary scholarship, for example by Frercks, 'Kommentar', 313–33. See the third section of this chapter for further reference.

the varying context, the different publication dates, and the scope of Wiegleb's and Gmelin's histories of chemistry – the former's book amounted to almost 800 pages, the latter's to over 2,800 pages, both excluding the attached indices – I shall assess them separately in sections 4 and 5, respectively.

Airs and Acids, Experiments and Epistemology – Pneumatic Chemistry, 1770-1790

It is fair to say that studying air became the hot topic in late-eighteenth century chemistry. As decades of scholarly inquiry have shown, the initially limited disagreements on the categorisation of airs developed into a wider debate on the ontological status of many chemical substances as well as on the philosophical question of how to establish firm scientific evidence in the 1780s.[333] On the basis of existing scholarship, the present section reconstructs these debates.

Changes in the communication patterns between chemists which gained pace in the second half of the eighteenth century were one crucial precondition for the emergence of such a multi-layered controversy.[334] The number of book translations in chemistry increased after circa 1750. At the same time, scholars working at different sites of chemical inquiry more regularly engaged in letter exchanges. Additionally, travelling amateurs provided their professional colleagues with novelties from abroad.[335] Periodicals also played an important role in strengthening the ties between different scholars working on chemistry. From 1771 onwards, the Abbé François Rozier transformed the *Observations et mémoires sur la physique, sur l'histoire naturelle, et sur les arts et métiers* into a forum for discussing recent discoveries on a

---

[333] See Golinski, 'Precision Instruments'.
[334] This aspect of the Chemical Revolution has been acknowledged by scholarship only recently. See for instance Seligardi, 'The Italian Network', 427.
[335] Patrice Bret, 'Formes et fonctions de la correspondance scientifique autour de la Révolution. Lavoisier, Guyton de Morveau et Berthollet, chimistes et epistoliers (1772-1822)', *Gazette des archives* 179, no. 1 (1997): 379; Bret, 'Letter', 124, 133–34, 137; Poirier, *Lavoisier*, 51–53.

monthly basis. Pneumatic chemistry quickly became the focal point of the journal.[336] In the German-speaking part of the Republic of Letters, Lorenz Crell founded the *Chemische Annalen* in 1778 with a similar intention.[337] As Patrice Bret has shown, such journals abandoned the previously established practice of publishing short summaries of experimental reports in favour of full translations. A considerable part of this work was carried out by women such as Claudine Picardet and Marie-Anne Paulze-Lavoisier, both of whom also translated monographs on chemistry into French.[338]

While some scholars hold that written publications – just like public lectures – served to spread information on chemical matters passively,[339] Bret has proposed that translating works on and experimenting with airs and gases were two entwined practices. In particular, he has pointed out that full translations of experimental accounts – both in books and journals – enabled scholars to double-check a colleague's proposals by way of replicating their investigations in the laboratory. He concluded that prompt cross-border interactions through translations 'became directly relevant in current scientific debates' during the Chemical Revolution, and that the phenomenon thus had an 'epistemic role in building science.'[340] This argument can be further extended. The changing medial environment of chemistry sharpened the chemists' awareness of discrepancies between the growing number of experimental findings and their interpretation. The thicker communicative networks thus created the medial precondition

---

[336] Henry Guerlac, 'Joseph Priestley's First Papers on Gases and Their Reception in France', *Journal of the History of Medicine and Allied Sciences* 12, no. 1 (1957): 7–9; E. W. J. Neave, 'Chemistry in Rozier's Journal I. The Journal and Its Editors', *Annals of Science* 6, no. 4 (1950): 416–17; Bret, 'Letter', 125.
[337] Hufbauer, *Formation*, 68–71.
[338] Patrice Bret, 'Les promenades littéraires de Madame Picardet. La traduction comme pratique sociale de la Sscience au XVIII siècle', in *Traduire la science. Hier et aujourd'hui*, ed. Pascal Duris (Pessac: Maison des Sciences de l'homme d'Aquitaine, 2008), 125–52; Keiko Kawashima, 'Madame Lavoisier et la traduction française de l' "Essay on Phlogiston" de Kirwan', *Revue d'histoire des sciences* 53, no. 2 (2000): 235–63; Bret, 'Letter', 125, 131–32.
[339] Perkins, 'Chemistry Courses', 39.
[340] Bret, 'Letter', 127, 138–41, quotes ibid. on 125 and 141.

for intensified debates on the interrelation between novel observations and theoretical matters, and not, as Bernadette Bensaude-Vincent has argued, the other way around.[341]

It was within this altered medial environment that the debates on pneumatic chemistry and its epistemic consequences took place from the 1770s onwards. The participating chemists could draw on a rich tradition of inquiries with roots in the previous decades. British scholars – most notably Robert Boyle, Stephen Hales, William Cullen, and Joseph Black – had already established a conceptual and methodological framework to investigate air in experimental settings. In 1756, Black observed that, under elevated temperatures, the weight of *magnesia alba* decreased while the reaction freed a gaseous substance (fixed air).[342] Of equal importance, yet even less palpable than fixed air was the concept of phlogiston introduced by the German Georg Ernst Stahl. He identified it as a widely dispersed principle which took part in combustion reactions as well as the process of metal calcination. Stahl did not define phlogiston more precisely, nor was his observational evidence enough to support the concept's existence.[343] Perhaps because of this theoretical underdetermination, phlogiston became a cornerstone for most ensuing debates across Europe on combustion and calcination, as well as on the physical and chemical nature of heat and light. Consensus on its nature and properties was, however, not reached let alone did any chemist succeed in isolating phlogiston.[344]

---

[341] See Bernadette Bensaude-Vincent, 'Introductory Essay. A Geographical History of Eighteenth-Century Chemistry', in *Lavoisier in European Context. Negotiating a New Language for Chemistry*, ed. Ferdinando Abbri and Bernadette Bensaude-Vincent (Canton MA: Science History Publications, 1995), 10. Bensaude-Vincent describes the medial changes as the result of – and not the precondition for – the debates on the nomenclature reform in the late 1780s. Further evidence for my claim comes from Bret's argument that key actors of the Chemical Revolution, in particular Guyton de Morveau and his colleagues in Dijon as well as Mme de Lavoisier played a crucial role both in realising quick translations and in reflecting the theoretical dimension of chemistry, see Bret, 'Letter', 129–32, Antonelli, 'Becoming Visible', and Antonelli, 'Madame Lavoisier'.

[342] Golinski, 'Chemistry', 383–84, 388–89; Bensaude-Vincent, *Lavoisier Mémoires*, 50–59.

[343] Geoffrey Blumenthal and James Ladyman, 'The Development of Problems within the Phlogiston Theories, 1766–1791', *Foundations of Chemistry* 19, no. 3 (2017): 243–46.

[344] Ibid., 246–47. For case studies on Stahl's reception in France see Ku-ming Chang, 'Communications of Chemical Knowledge. Georg Ernst Stahl and the Chemists at the French Academy of Sciences in the First Half of the Eighteenth Century', *Osiris* 29, no. 1 (2014): 141–57; Kim, *Affinity*, 146–51, 206–7, 233–40.

A wave of novel observations led to competing definitions and classifications of air and its function in a number of chemical reactions in the 1770s. Most scholars developed different interpretations of the phlogiston concept for this purpose. A case in point is the British natural philosopher Joseph Priestley. Having observed numerous phenomena of metal calcination and combustion, Priestley developed a taxonomy of different types of air over the course of his career. The decisive criterion was the degree of saturation with phlogiston that they seemingly displayed in experimental settings. Priestley thus christened one of his discoveries dephlogisticated air, a substance which, to modern readers, is known as oxygen. In addition, he adopted the notion of inflammable air from Henry Cavendish to designate the modern hydrogen and defined phlogisticated air to denote the modern nitrogen, while sticking to the traditional notion of fixed air to describe what is today understood as carbon dioxide.[345]

Meanwhile, the young Parisian physicist Antoine de Lavoisier became the first chemist of his generation to describe metal calcination without resorting to the phlogiston concept. He took his cue from the well-known observation that metals gained in weight when exposed to high heat. By the mid-1770s, the most compelling explanation for this process had been proposed by Bernard-Louis Guyton de Morveau who pondered that the special gravitational properties of phlogiston came to play in calcination.[346] By contrast, Antoine de Lavoisier argued in 1772 that in calcination reactions air was absorbed by the metal, which accounted for the increase in its weight. From there, he went on to develop a more comprehensive framework for many related phenomena. It comprised the idea that pure air could be further decomposed into

---

[345] Bernadette Bensaude-Vincent and Isabelle Stengers, *A History of Chemistry*, trans. Deborah van Dam (Cambridge MA: Harvard University Press, 1996), 79–82; Golinski, 'Chemistry', 390–91. For a detailed reconstruction of Priestley's evolving conceptual framework see Frederic L. Holmes, 'The "Revolution in Chemistry and Physics". Overthrow of a Reigning Paradigm or Competition between Contemporary Research Programs?', *Isis* 91, no. 4 (2000): 741–50 and Jost Weyer, *Geschichte der Chemie. Altertum, Mittelalter, 16. bis 18. Jahrhundert*, vol. 1 (Berlin: Springer Spektrum, 2018), 485–89 (the latter including the modern chemical formulae).

[346] Marco Beretta, *The Enlightenment of Matter. The Definition of Chemistry from Agricola to Lavoisier*, Uppsala Studies in History of Science 15 (Canton MA: Science History Publications, 1993), 150; Kim, *Affinity*, 308–9. On the pre-history of weight-gain-experiment in the seventeenth and eighteenth centuries see Bensaude-Vincent, *Lavoisier Mémoires*, 120–21.

fire (which he understood as a physical entity) and a base, the latter of which was fixed in combustion and was thus responsible for the weight gain of one body in such reactions. Evidently, phlogiston no longer featured in this equation. Its omission was legitimised by the equiponderance visible in combustion and calcination reactions – that is that the weight increase in the combusted body was equivalent to the loss of weight in pure air. In 1779, Lavoisier read a paper to the Academy in which he claimed that that pure air was composed of a base called *principe oxygine* and fire as a substance.[347]

Lavoisier's interventions are of particular interest to the present purpose because, as most historians of science agree, they had crucial implications for the chemical taxonomy and theories of chemical composition. In the 1779 paper, for example, he challenged traditional assumptions about acids by claiming that oxygen was instrumental in acid formation.[348] He deployed a similarly radical stance regarding the phenomenon of heat: in collaboration with the mathematician Simon de La Place, they furthered the idea that heat was a material and measurable substance named *calorique*, designing a novel apparatus for their investigations.[349] Such claims stood at odds with the positions held by other chemists. Scheele, for example, understood heat as the combination of *Feuerluft* and phlogiston, a view which was also endorsed by Bergman. In 1778, Macquer's new edition of the *Dictionnaire de Chimie* put forward an interpretation of heat as being induced by the movement of particles.[350] Chemists also disagreed on the nature of water, which had traditionally been seen as an irreducible element.[351] In 1781, Cavendish discovered that, when inflammable air (hydrogen) was combusted in the

---

[347] Bensaude-Vincent, *Lavoisier Mémoires*, 152–54 (the 'principe oxigine is quoted ibid., 153); Golinski, 'Chemistry', 392–93; Guerlac, 'Chemistry', 219–21; Kim, *Affinity*, 308–9, 324–29; Weyer, *Geschichte*, 1:522–24.
[348] Maurice Crosland, 'Lavoisier's Theory of Acidity', *Isis* 64, no. 3 (1973): 307; Golinski, 'Chemistry', 392–93; Kim, *Affinity*, 329; Klein and Lefèvre, *Materials*, 91, 103–4;
[349] Golinski, *Science*, 132–33; Kim, *Affinity*, 343–49 and for a full account of the collaboration Guerlac, 'Chemistry'.
[350] Anders Lennartson, *Carl Wilhelm Scheele and Torbern Bergman. The Science, Lives and Friendship of Two Pioneers in Chemistry*, Perspectives on the History of Chemistry (Cham: Springer International Publishing, 2020), 291–92; Blumenthal and Ladyman, 'Development', 254–55; Weyer, *Geschichte*, 1:490.
[351] Golinski, *Science*, 135; Klein and Lefèvre, *Materials*, 71.

presence of dephlogisticated air (oxygen), pure water was the result. Several years later, he concluded that inflammable air was a composite of water and phlogiston.[352] Richard Kirwan, by contrast, maintained in the *Essay on Phlogiston* (1787) that Cavendish's experiments had given the final proof for the existence of phlogiston, which he equated with inflammable air. He also used this framework to develop an understanding of acidity that ran counter to Lavoisier's oxygen-based approach.[353] When the latter repeated and extended the water experiments in 1783, he stated that water contained both dephlogisticated air (or, in his vocabulary, *oxygène*) and inflammable air, for which he later coined the complementary term of *hydrogène*. The case in point was a trial in which *hydrogène* appeared after acids were dissolved in water. Public follow-up experiments which Lavoisier realised in collaboration with Gaspard Monge and Jean-Baptist Meusnier aimed to show that the reverse operation was possible, too.[354]

In disagreeing on the nature of airs, acids, water, and heat, the different chemists involved in the debate also showcased diverging views on the methods and concepts which were necessary to establish reliable knowledge in chemistry. From the 1780s onwards, such disagreements regularly began to surface, to the point that the debate entered epistemological territory. When assessing the publications made by their colleagues, the philosophical questions of how an observation had been made, and on what grounds a scholar had arrived at an interpretation, creeped into chemical writing. This dimension of the Chemical Revolution has been studied only in the 1990s by scholars such as Jan Golinski, Lissa Roberts, Mi-Gyung Kim, Bernadette Bensaude-Vincent, Marco Beretta, and John McEvoy. I shall synthesise their results here, before turning to the epistemological function of historical arguments in the debate, which has so far been neglected.

---

[352] Blumenthal and Ladyman, 'Development', 259–60; Weyer, *Geschichte*, 1:484–518.
[353] Blumenthal and Ladyman, 'Development', 262–64; Golinski, 'Precision Instruments', 34; Golinski, *Science*, 134–35.
[354] Bensaude-Vincent, *Lavoisier Mémoires*, 184–88; Golinski, 'Chemistry', 393; Golinski, 'Precision Instruments', 34–41; Weyer, *Geschichte*, 1:524.

The controversy can be broken into three intertwined aspects. First, there was disagreement on the criteria which distinguished a fact from a hypothesis or a conjecture. At least in part, this issue resulted from differing views on the use of advanced instruments in experimental settings. Since the early 1780s, Lavoisier used his personal funds to have laboratory tools produced exclusively for him, including vessels, balances, and the famous ice calorimeter. He and his collaborators relied on them to gather observational data on the nature of gases, heat, and water with a granularity hitherto unknown. Crucially, they also used them as objects that performatively represented exactitude and reliability, especially during numerous public demonstrations.[355] The 'facts' produced in this way displayed a great degree of precision, which came in part from the instruments' greater sensitivity. However, they also resulted from probabilistic corrections, by means of which Lavoisier and his collaborators such as the mathematician Simon de La Place intervened after the experiment, for instance to identify the most reliable measurements and exclude the remainder.[356]

Those among Lavoisier's British and French peers who were critical of his claims about water, heat, oxygen, and the non-existence of phlogiston attacked the conditions under which Lavoisier's alleged facts were produced from several perspectives. While Jean-Claude Delamétherie doubted the results of the water experiments by invoking procedural errors,[357] William Nicholson held that the results simply appeared to be too exact to be true. He implicitly accused Lavoisier of confounding facts and hypotheses and interpreted the French scholar's

[355] Bensaude-Vincent, *Lavoisier Mémoires*, 183–88, 202–7, 215; Golinski, *Science*, 137–38; Golinski, 'Precision Instruments', 33–41. For a description of Lavoisier's instruments see also Trevor Harvey Levere, 'Lavoisier. Language, Instruments, and the Chemical Revolution', in *Nature, Experiment, and the Sciences. Essays on Galileo and the History of Science in Honour of Stillman Drake*, ed. Trevor Harvey Levere and William R. Shea, Boston Studies in the Philosophy of Science 120 (Dordrecht: Kluwer Academic, 1990), 217–19.
[356] Bensaude-Vincent, *Lavoisier Mémoires*, 74–79, 209; Golinski, 'Chemical Revolution', 242; McEvoy, 'Enlightenment', 316.
[357] Lissa Roberts, 'Condillac, Lavoisier, and the Instrumentalization of Science', *The Eighteenth Century* 33, no. 3 (1992): 264. On Delamétherie as a critic of Lavoisian chemistry see also Carleton E. Perrin, 'The Triumph of the Antiphlogistians', in *The Analytic Spirit. Essays in the History of Science in Honor of Henry Guerlac*, ed. Harry Woolf (Ithaca NY: Cornell University Press, 1981), 56–57. and Beretta, *The Enlightenment of Matter*, 222–23.

reliance on and propagation of mathematical procedures as part of an argumentative strategy which needed to be opposed.[358] In the 1790s and early 1800s, Joseph Priestley took up these perspectives. In addition to calling out Lavoisier for intervening in his results through calculations after the observation and thus betraying the ideals of any Baconian science, he also framed his criticism within ethical considerations. According to him, the cost of the instruments prevented most scholars from fact-checking the results, which made it somewhat of an intellectual duty for all other members of the Republic of Letters not to adopt the Frenchman's system for the time being.[359]

Secondly, the controversy pertained to the question of the number of experiments that were required for an observation to be acknowledged as a reliable fact. Lavoisier suggested that a few observations sufficed to establish secure knowledge, as long as the careful design of the experimental process ensured that the measurements had been made with the necessary degree of mathematical precision. Kirwan, by contrast, maintained that, once a scholar propagated a position that ran counter to established core assumptions of the discipline their claim had to be grounded in a great number of carefully repeated observations. Priestley shared this position and continued to propagate it throughout the 1790s.[360]

The third layer of the debate centred on the problem of inductive versus deductive reasoning. Although the participants did not use this terminology themselves, it is adequate to describe the problem at hand. Lavoisier's philosophical stance on how chemistry should be practised was modelled upon a mathematical ideal. Influenced by the philosophical stances of Étienne Bonnot de Condillac, Lavoisier invoked the methods of algebra and geometry as ideals

---

[358] Bensaude-Vincent, *Lavoisier Mémoires*, 206–7; Golinski, *Science*, 144; Golinski, 'Precision Instruments', 43; Golinski, 'Chemical Revolution', 242;.
[359] Bensaude-Vincent, *Lavoisier Mémoires*, 206; Golinski, 'Precision Instruments', 44; Golinski, 'Chemical Revolution', 241–42; McEvoy, 'Enlightenment', 314–17.
[360] John G. McEvoy, 'Continuity and Discontinuity in the Chemical Revolution', *Osiris* 4 (1988): 208–9; Beretta, *The Enlightenment of Matter*, 278; Golinski, 'Precision Instruments', 42–43; Golinski, *Science*, 145–46; Golinski, 'Chemical Revolution', 242–43.

in the quest for facts in chemistry. Crucially, this implied that axiomatic assumptions such as the conservation of matter or the equilibrium of opposing forces between reactants had to be taken into account to decide whether an observation was corrupted in any way or reliable.[361] Lavoisier linked this analytical ideal to an idea of systematic harmony. Observations could be factual only if they formed webs of facts interlinked by mathematical and natural axioms that backed each another. Once firmly established on the back of precision measurements, existing knowledge played a crucial role in determining the validity of both novel experimental findings and their interpretation, since no discord between an observation and the system of existing facts could be tolerated in the long term.[362] This point is so important that it needs to be further underlined by a quotation from the *Traité élémentaire de Chimie* (1789). Here, Lavoisier held that the imperfection of contemporary chemistry was precisely due to the existence of 'des lacunes nombreuses qui interrompent la série des faits, & qui exigent des raccordemens embarassans et difficiles.' By contrast, a 'science complette' was one in which 'toutes les parties sont étroitement liées entr'elles.'[363]

The architecture of Lavoisian chemistry, which inextricably – and openly – linked experimental findings and epistemological presumptions, did not escape the attention of the British chemists. James Keir, for instance, objected to the very idea of letting systematic assumptions, which had the of appearance of mathematical rigour, interfere in the process of observational discovery. In suggesting that the interpretation of facts by the scholarly community had to follow the observations, Keir referred to the argumentative resources and ideals of mid-

[361] John McEvoy, 'Priestley Responds to Lavoisier's Nomenclature. Language, Liberty and Chemistry in the English Enlightenment', in *Lavoisier in European Context. Negotiating a New Language for Chemistry*, ed. Ferdinando Abbri and Bernadette Bensaude-Vincent (Canton MA: Science History Publications, 1995), 130; McEvoy, 'Continuity', 205–7; McEvoy, 'Enlightenment', 314–16; Bensaude-Vincent, *Lavoisier Mémoires*, 206, 210–16; Roberts, 'Condillac', 264.

[362] Lissa Roberts, 'A Word and the World. The Significance of Naming the Calorimeter', *Isis* 82, no. 2 (1991): 216–17; Beretta, *The Enlightenment of Matter*, 264–65; Golinski, 'Chemistry', 145; Kim, *Affinity*, 380–81.

[363] Antoine de Lavoisier, *Traité élémentaire de chimie, présenté dans un ordre nouveau et d'après les découvertes modernes* (Paris: Cuchet, 1789), xii–xiii.

eighteenth century observationalism.[364] Up until the early 1800s, Joseph Priestley continued to formulate similar objections. Priestley criticised that Lavoisier's philosophical stance devalued most existing approaches to producing, judging, and discussing chemical knowledge among independent members of the Republic of Letters which had proven successful during the Enlightenment period.[365]

An unacknowledged aspect of the controversy is that assumptions on the historical development of chemistry informed and bolstered the scholars' epistemological positions. In the 1780s, Antoine de Lavoisier in particular made several attempts to substantiate his reform ideas though a novel view of chemistry's evolution, to which other chemists then had to react. This will be the topic of the next section.

On the Perils of Dubious Origins. Lavoisier and the History of Phlogiston and Elements

To identify Lavoisier as an innovator in the history of historical writing seems controversial at first glance. In the introduction to the *Traité élémentaire de Chimie*, he apodictically held that 'c'est ni l'histoire de la science, ni celle de l'esprit humain qu'on doit faire dans un traité élémentaire.'[366] While some scholars have taken this claim at face value,[367] others have noted that some of Lavoisier's key publications in the 1780s made assumptions on chemistry's evolution, without however further assessing their argumentative function.[368] Only Bernadette Bensaude-Vincent has analysed one of his works – the essay *Réflexions sur le phlogistique* (1783/1786)

---

[364] Beretta, *The Enlightenment of Matter*, 289–91; Golinski, 'Chemical Revolution', 243; Golinski, *Science*, 146; Roberts, 'Word', 218–20.
[365] Golinski, *Science*, 148; Golinski, 'Precision Instruments', 36; McEvoy, 'Continuity', 209–11.
[366] Lavoisier, *Traité élémentaire*, xxvii–xxviii.
[367] Robert Siegfried, 'The Chemical Revolution in the History of Chemistry', *Osiris* 4 (1988): 43; Beretta, 'Changing Role', 257–58; Langins, 'Fourcroy', 16.
[368] Arthur Donovan, *Antoine Lavoisier. Science, Administration, and Revolution*, 2nd ed., Cambridge Science Biographies Series (Cambridge: Cambridge University Press, 1996), 170–71; Kim, *Affinity*, 384; Levere, 'Lavoisier', 213.

– regarding its historical content. She concluded that Lavoisier wrote a history of pneumatic chemistry to delegitimise the concept of phlogiston and allow for an alternative way of conceiving combustion reactions. Additionally, she interpreted the publication as the first instance in which the modern concept of a scientific revolution in the Kuhnian sense of the word appeared.[369]

I would argue that Lavoisier resorted to historical narratives for an even wider purpose. The historical approach in the *Réfléxions* and the *Traité* was an integral feature of his argumentative strategy in the debate with his British opponents on the appropriate philosophical principles to guide a chemical investigation. In tracing the intellectual origins and subsequent impact of the concept of phlogiston and the notion of a chemical element, Lavoisier sought to show that observations were unreliable if they were produced and interpreted without a preconceived theory modelled upon the ideal of mathematics. Reading chemistry's history through the lens of its key concepts and their hidden impact thus substantiated his call for altering the methods of chemical reasoning. As will become clear in chapter 4, Lavoisier made a similar claim regarding the historical impact of chemical language and its formation principles as part of his introduction to the nomenclature reform proposed in 1787. If seen from this perspective, a pattern emerges which demonstrates how Lavoisier strategically used a novel view on chemistry's history in several of his key publications during the 1780s.

Early on in the *Réflexions*, Lavoisier asked of his readers 'de se transporter aux temps antérieurs de Stalh [sic], & d'oublier pour un moment, s'il est possible, que sa théorie a existé.'[370] In doing so, they would recognise that, when Stahl coined the concept of phlogiston early in the eighteenth century, hardly any reliable knowledge of combustion phenomena was

[369] Bensaude-Vincent, *Lavoisier Mémoires*, 191–93.
[370] Antoine de Lavoisier, 'Réflexions sur le phlogistique, pour servir de développement à la théorie de la Combustion & de la Calcination, publiée en 1777', *Histoire de l'Académie Royale des Sciences avec Mémoires, Mémoires* Année 1783 (1786): 506.

available. The origins of the concept exposed that it was an unproven conjecture.[371] Crucially, phlogiston's hypothetical character did not remain without consequences since its origins in speculation rather than observation had a negative impact on all subsequent chemists who relied on the concept in their investigations and efforts at systematisation. Phlogiston was an 'opinion' amounting to an 'error funeste à la Chimie' which had 'retardé considérablement les progrès, par la mauvaise manière de philosopher qu'elle y a introduite.'[372]

The subsequent history of pneumatic chemistry revised the framework of *histoires de l'esprit* in the tradition of mid-eighteenth century observationalism.[373] According to Lavoisier, the evolution of the eighteenth-century study of airs and gases was characterised by a discrepancy between discoveries and their interpretation and not, as Enlightenment historians of the sciences had traditionally claimed, by their dialectic co-evolution (see chapter 2). Although Boyle had already noted the weight gain in metal calcination, Lavoisier argued, such discoveries had always resulted in an amendment of the Stahlian notion of phlogiston which, due to its underdetermined character, could be loaded with various and at times even contradictory meanings. This flexibility was what Lavoisier meant by the aforementioned 'mauvaise manière de philosopher'. Crucially, the concept itself carried this implication because it originated in times of few reliable observations beyond the immediately evident. Having described the history of different phlogiston theories in great detail,[374] he summed up that 'les Chimistes ont fait du phlogistique un principe vague qui n'est point rigoureusement défini, & qui, en conséquence, s'adapte à toutes les explications dans lesquelles on veut le faire entrer.'[375] Lavoisier himself featured in his historical account as the exemplary victim for this paradigm: 'quelque démonstratives que fussent les expériences sur lesquelles je m'étois appuyé, on a commencé, suivant

[371] Ibid.
[372] Ibid., 505–6.
[373] This analysis runs counter to Bensaude-Vincent's claim that Lavoisier's view of chemistry's history merely reiterated earlier models of history-writing, see Bensaude-Vincent, 'Culture', 98–99.
[374] Lavoisier, 'Réflexions sur le phlogistique', 507–23.
[375] Ibid., 523.

l'usage, par révoquer les faits en doute.'[376] The existence of a misconceived philosophy, embedded in one of chemistry's key concepts, levered out the previous paradigmatic assumption that, in the natural sciences, facts and preliminary systems emerged in tandem when scholars formulated series of observation-based conjectures and hypotheses. Conversely, Lavoisier's essay exemplified just how necessary it was for chemists to be mindful of the theoretical preconceptions which guided them in interpreting facts and to be equally wary of contradictions between reliable observations and their systematic ordering. Otherwise, Lavoisier's history of phlogiston suggested, the result was not just the proliferation of numerous contradictory theories but also the inability to accept demonstrative facts.

The introduction to the *Traité* further substantiated this position by providing an abbreviated history of the notion of chemical elements along the same lines. Again, Lavoisier took aim at his British critics. The idea of four elements, he claimed, was 'une pure hypothèse imaginée long-tems avant qu'on eût les premières notions de la Physique expérimentale & de la Chimie. On n'avoit pas de faits, & l'on formoit des systêmes.' These speculative origins, however, did not diminish the impact of this 'préjugé qui nous vient originalement des philosophes grecs.'[377] Indeed, its subsequent history was precisely the same as in the case of the phlogiston. Chemists instructed their pupils that four elements existed; in their practical work and experimental records, however, they acknowledged varying numbers of elemental substances. Lavoisier mentioned Stahl and Johann Joachim Becher as examples for this observation. This mismatch between teaching and investigating was the effect of 'l'esprit de leur siècle, qui se contentoit d'assertions sans preuves.'[378] Not surprisingly, the lesson to be learned from this historical précis was again how the lack of a rigid, coherent, and systematic philosophy of science had negatively impacted the field over time. Because of their indebtedness to a non-

[376] Ibid., 511.
[377] Lavoisier, *Traité élémentaire*, xv.
[378] Ibid., xvi.

observational tradition with roots in antiquity, the chemists always had to subordinate facts to their inherited prejudices: 'aujourd'hui que nous avons rassemblé des faits, il semble que nous nous efforcions de les repousser, quand ils ne quadrent pas avec nos préjugés.' If they did not radically change their approach, Lavoisier reasoned, the coming generations would still be negatively affected by such thinking.[379]

By illustrating that the origins and formation principles of any chemical concept had a fundamental impact on chemical development, the pessimistic thread of Lavoisier's historical narrative prompts the question as to how many reliable facts there were at all, if any observation had been produced in an irrational intellectual framework. Lavoisier was surprisingly vague in this respect. Facts were necessarily 'modern', as the full title of the *Traité élémentaire de Chimie, présenté dans un ordre nouveau, et d'après les découvertes modernes*, indicated. In the introduction, he also complained that 'en général, la pratique des expériences, et sur tout des expériences modernes, n'est point assez répandue', thus underlining the teachings of his historical inquiry.[380] Yet, although this was a critique of the investigative approach of his contemporaries, Lavoisier did not go as far as to suggest that he and his colleagues at the Arsenal were the sole chemists to have established any facts at all. Instead, he conceded that only part one of the *Traité* was based on his very own inquiries, while the second part, which dealt with neutral salts, was 'un abrégé très-concis de résultats extraits de différens ouvrages.'[381] Moreover, he had clearly stated in the *Réflexions* that chemistry was continually enriched by novel facts whose number grew on a daily basis.[382]

Given that irrational concepts exercised their impact while chemists made observational progress, Lavoisier perceived the epistemological situation as highly complex and open to

---

[379] Ibid., xv.
[380] Ibid., xxx.
[381] Ibid., xxix. The fact that Lavoisier recommended the works of others in the *Traité* has also been noted by Kim, *Affinity*, 386.
[382] Lavoisier, 'Réflexions sur le phlogistique', 523.

further investigation. In the *Réflexions*, he identified it as a future task for chemists 'de distinguer ce qui est de fait & d'observation d'avec ce qui est systématique ou hypothétique.' He continued by insisting on the necessity of distinguishing facts from speculation: 'enfin de faire en sorte de marquer le terme auquel les connoissances chimiques sont parvenues, afin que ceux qui nous suivront puissent partir de ce point & de procéder avec sûreté à l'avancement de la Science.'[383] What he probably had in mind here was an assessment of existing experiments alongside the imperatives of his own philosophy of science. Yet, the quotation could also be read as an invitation to browse the existing body of chemical publications and to establish the current state of knowledge by way of a historical investigation. This is precisely what the German chemists Johann Christian Wiegleb and Johann Friedrich Gmelin did in the 1790s. In order to understand their motivation, it is necessary to discuss the role of German chemists in the debate on airs and its theoretical and epistemological dimension. This will be the topic of the next section.

The New Chemistry and the German Community of Chemists – A Reinterpretation

In his *Essay on Phlogiston* (1787), Richard Kirwan maintained that one reason to still apply the Stahlian concept of phlogiston was that it had been developed 'in a country in which chymical knowledge then was, and still is, further advanced than in any other part of Europe.'[384] Given the *Essay*'s open anti-Lavoisian thrust, it is tempting to read the statement as a prompt to his German colleagues to finally make their mark in the controversy from which they had

---

[383] Ibid.
[384] Richard Kirwan, *An Essay on Phlogiston, and the Constitutions of Acids* (London: P. Elmsly, 1787), 7–8. Quote on 8.

been largely absent by the time when Kirwan wrote his *Essay*.[385] This status quo changed abruptly in the late 1780s. In the preface to the 7th issue of the *Chemische Annalen* in 1787, Lorenz Crell invoked the 'neugierige Aufmerksamkeit des chemischen Publicum's' regarding the 'Ausgang der gelehrten Streitigkeit' between Lavoisier and his British counterparts on phlogiston, 'denn dieser Streit betrift die wichtigsten Puncte der chemischen Physik, in welche er auf die mannigfaltigste Weise, ein so grossen Einfluß hat.'[386] To facilitate access for German chemists to understand the multi-layered controversy, Crell announced that he would shortly provide not only a full translation of Kirwan's works including the *Essay on Phlogiston*, but also a volume to familiarise the reader with 'Hrn. Kirwan's Streitschriften mit Hrn Cavendish.'[387] Both were published in 1788 and thus before the first full translations of the *Méthode de Nomenclature Chimique* and the *Traité élémentaire de Chimie* appeared, the key texts of Lavoisian chemistry.[388]

From the late 1780s onwards, the Germans were therefore well aware of and interested in the philosophical dimension of the debate made not only by Lavoisier but by the British chemists, too. This observation changes how we perceive of the role played by the German chemists in this second phase of the Chemical Revolution. For a long time, the narrative

---

385 Geoffrey Winthrop-Young, 'Lichtenberg und die Französische Revolution. Zum Verhältnis von Sprache, Naturwissenschaft und Aufklärung' (PhD Thesis, University of British Columbia, 1991), 100; Seils, *Friedrich Albert Carl Gren*, 121.

386 Lorenz von Crell, 'Untitled Preface', *Chemische Annalen für die Freunde der Naturlehre, Arzneygelahrtheit, Haushaltungskunst, und Manufakturen* 2, no. 9 (1787). A note on accessibility: Crell's prefaces to the individual issues are not included in all digital editions. Scholars interested in the text refer to the upload by the *Österreichische Nationalbibliothek* https://digital.onb.ac.at/OnbViewer/viewer.faces?doc=ABO_%2BZ222087505 (accessed on 7.8.2024).

387 Ibid.

388 Richard Kirwan, *Physisch-chemische Schriften*, trans. Lorenz von Crell, vol. 3 (Berlin and Stettin: Friedrich Nicolai, 1788); Richard Kirwan, *Versuch über das Phlogiston und die Bestandtheile der Säuren*, trans. Lorenz von Crell (Berlin and Stettin: Friedrich Nicolai, 1788). For the German translations of the *Méthode* and the *Traité* see Ferdinando Abbri and Marco Beretta, 'Bibliography of the "Méthode de Nomenclature Chimique" and of the "Traité Élémentaire de Chimie" and Their European Translations (1787-1800)', in *Lavoisier in European Context. Negotiating a New Language for Chemistry*, ed. Ferdinando Abbri and Bernadette Bensaude-Vincent (Canton MA: Science History Publications, 1995), 284–85, 290–91; Peter Laupheimer, *Phlogiston oder Sauerstoff. Die Pharmazeutische Chemie in Deutschland zur Zeit des Übergangs von der Phlogiston- zur Oxidationstheorie*, Quellen und Studien zur Geschichte der Pharmazie 63 (Stuttgart: Wissenschaftliche Verlagsgesellschaft, 1992), 58–63; Frercks, 'Kommentar', 318–19.

established by Karl Hufbauer has shaped scholarly analyses of the topic. Hufbauer argued that the German community experienced a clash between the traditional, dominant phlogiston theory and Lavoisier's oxygen theory. Using religious concepts such as 'orthodoxy', 'sectarianism', and 'conversion', he traced how the phlogistonists slowly morphed into antiphlogistonists between 1785 and 1796.[389] For Hufbauer, 'cultural nationalism', rather than scientific concerns, explains why it took the Germans so long to adopt the Lavoisian system.[390] More recently, historians have criticised this explanatory framework for its teleological implications and its overestimation of nationalistic beliefs among the chemists, instead emphasising the dynamic character of Lavoisier's reception across Europe.[391] What is more, several historians have acknowledged that German naturalists such as Georg Christoph Lichtenberg engaged with the philosophical presumptions of Lavoisier's writings.[392]

However, by focusing solely on the reception of Lavoisier in Germany, scholars have lost sight of the fact that the writings by the British naturalists circulated within the German community, too. This has led to a simplification of the debate. In reality, the Germans did not have only two paradigms to choose between but faced a complex, pre-structured discourse in which disagreements based on observational findings were entwined with contrasting views on how to establish a chemical fact. Since these problems had far-reaching consequences for chemical terminology, the ontology of substances, and the practice of conducting chemical

---

389 Hufbauer, *Formation*, 96–144, quotes on 103, 141.
390 Ibid., 96–97, 104–5, quote on 104.
391 See Bensaude-Vincent, 'Introductory Essay' and the studies on the reception of the nomenclature reform across Europe in the same volume. With respect to Germany: Gerd Fritz, 'Controversy and Conversion. Friedrich Albert Carl Gren and the Phlogiston Controversy (1790-96)', in *Historical Pragmatics of Controversies. Case Studies from 1600 to 1800*, ed. Gerd Fritz, Thomas Gloning, and Juliane Glüer, Controversies 14 (Amsterdam: John Benjamins Publishing Company, 2018), 297–337; Frercks, 'Kommentar', 318–33; Seils, *Friedrich Albert Carl Gren*, 120–34, 153–70, 178–87. Reill, *Vitalizing Nature*, 104–18 offers an interesting perspective which situates Lavoisier's reception in Germany as part of a wider clash between vitalistic and mechanistic philosophies of science spanning many branches of natural history. The tendency to explain scientific positions by referring to the concept of nationalism has been criticised by Meinel, 'Demarcation Debates', 149 and Seils, *Friedrich Albert Carl Gren*, 167–68.
392 Alfred Nordmann, 'The Passion for Truth. Lavoisier's and Lichtenberg's Enlightenments', in *Lavoisier in Perspective*, ed. Marco Beretta (Munich: Deutsches Museum, 2005), 109–28; Winthrop-Young, 'Lichtenberg', 108–87.

investigations in the laboratory, German chemists quickly felt the need to position themselves. For example, in 1793, the pharmacist Johann Friedrich Westrumb expressed the fear that German chemistry would fall behind its European neighbours if its members did not engage in the reform of chemical nomenclature.[393] This general concern was shared by the two authors treated in the following sections, Johann Christian Wiegleb and Johann Friedrich Gmelin. By the mid-1790s, Wiegleb had specified his position regarding most of the contested issues, including the existence of phlogiston, and the nature of acids, heat, and water. Having added his own experimental observations to the debate, he opted to support Richard Kirwan's and later Friedrich Albert Carl Gren's theoretical syntheses.[394] In the mid- to the late-1790s, Gmelin publicly endorsed similar positions in several articles.[395]

Yet, substantiating such positions was a challenge. Many key members of the German chemical community (especially provincial doctors and pharmacists) did not have the funds to acquire the precision instruments deployed by Lavoisier,[396] and thus faced the serious threat of no longer being able to contribute to the scientific enterprise from their provincial positions. They therefore resorted to all available literary tools to mark their positions on the epistemological problems in question, with history-writing being one of them. Ever since Wiegleb's critical use of history-writing to defend the principles of observationalism against hermetic philosophy (see chapter 2), the German community of chemists was familiar with the potential

---

[393] Johann Friedrich Westrumb, *Versuch eines Beytrages zu den Sprachbereicherungen für die deutsche Chemie*, Kleine Physikalisch-Chemische Abhandlungen vol 3, part 2 (Hannover: Gebrüder Hahn, 1793), 14.

[394] See the thorough reconstructions by Laupheimer, *Phlogiston*, 77–121; Klosa, *Johann Christian Wiegleb*, 95–100, 105–21.

[395] To my knowledge, no comprehensive reconstruction of Gmelin's chemical teachings exists. For a very short summary of his positions in the late 1780s see Reill, *Vitalizing Nature*, 113–14. For a more comprehensive perspective see Johann Friedrich Gmelin, 'Winke an seine Zeitgenossen, den Streit über den Brennstoff betreffend', *Chemische Annalen für die Freunde der Naturlehre, Arzneygelahrtheit, Haushaltungskunst, und Manufakturen* 1, no. 4–6 (1795): 287–302, 391–409, 479–99. and Johann Friedrich Gmelin, 'Beitrag zur Geschichte der chemischen Kenntnis der sogenannten Gasarten aus früheren Zeiten', *Göttingisches Journal der Naturwissenschaften* 1, no. 4 (1798): 1–22.

[396] Frercks, 'Kommentar', 219–20, 324.

interventionist character of chemical histories. Hence, it is no surprise that Wiegleb resorted to the same tool again in the 1790s-debate, as did Gmelin.

In addition to the literary tradition of their own field, the chemist-historians could draw on the tradition of *Historiae Literariae.* Scholars affiliated with this tradition reconstructed the achievements of scholarship over time in order to educate readers and to remove any belief considered irrational or immoral, in a variety of fields including religion, politics, and philosophy. Notwithstanding their often compilatory character, *historiae literariae* deployed the methodological arsenal of criticism not only to create records of knowledge *ex post*, but often to intervene in scholarly debates of the day.[397] Both Wiegleb and Gmelin testified to their allegiance to the *historia literaria* tradition in the introductions to their histories written in the 1790s, although they did not mention the concept explicitly.[398] For a chemist, affiliating oneself with the *Historia literaria* tradition could already be interpreted as an implicit positioning against Lavoisier. As we have seen above, Lavoisier's historical essays outlined how hard it was to find reliable facts in the thickets of existing chemical scholarship. He thus cast doubt on the idea that sifting through records of the past might help scholars eliminate prejudices, a position which ran counter to the very idea of *historiae literariae*. For Wiegleb and Gmelin, there was no doubt that progress had been made in chemistry and that it offered valuable lessons to all chemists. Investigating chemistry's history exposed the co-existence of facts and prejudices, and the slow victory of the former over the latter thanks to the efforts of individuals and the favourable wider context during the eighteenth century.[399]

---

[397] Frank Grunert and Friedrich Vollhardt, 'Einleitung', in *'Historia literaria'. Neuordnungen des Wissens im 17. und 18. Jahrhundert*, ed. Frank Grunert and Friedrich Vollhardt (Berlin: Akademie Verlag, 2014), vii–x; Martin Gierl, 'Historia literaria. Wissenschaft, Wissensordnung und Polemik im 18. Jahrhundert', in *Historia literaria. Neuordnungen des Wissens im 17. und 18. Jahrhundert*, ed. Frank Grunert and Friedrich Vollhardt (Berlin: Akademie Verlag, 2014), 115, 119–25; Scattola, 'Historia literaria', 38–42.

[398] Gmelin, *Geschichte der Chemie*, 1797, 1:v–vi, 6; Wiegleb, *Geschichte des Wachsthums*, 1790, 1/part 1: [i]–[iii]. Volume 1 of Wiegleb's book appeared in two separate parts which I indicate in the footnotes to make them easy to identify.

[399] Wiegleb, *Geschichte des Wachsthums*, 1791, 2:[i]–[iii]; Gmelin, *Geschichte der Chemie*, 1797, 1:6–8.

The next two sections assess the philosophy of science championed by Wiegleb's *Geschichte des Wachsthums und der Erfindungen in der Chemie, in der neuern Zeit* (2 volumes 1790 and 1791) and Gmelin's *Geschichte der Chemie seit dem Wiederaufleben der Wissenschaften bis an das Ende des achtzehnten Jahrhunderts* (3 volumes, 1797–1799) in greater detail. Both works were designed to endorse the philosophical positions championed by Lavoisier's British critics such as Priestley and Kirwan. In their content and literary form, they showcased the discoveries and theoretical advances achieved by the chemists ever since they had committed to an observation-based approach in the seventeenth century. Recording and explaining the field's incremental progress served to counter Lavoisier's call for a comprehensive reform of chemical methodology which was grounded in a contrasting view of history.

Notwithstanding such similarities, Gmelin's and Wiegleb's works diverged in how they adopted existing approaches to history-writing. Such differences can be attributed to the institutional circumstances in which the two chemists were working. After he had published his book on alchemy in the late 1770s, Wiegleb had remained a local apothecary in the town of Langensalza and had thus not been under the direct and constant influence of any novel school of historical inquiry or philosophy.[400] Therefore, the methodology of the 1790 history most likely was the result of his own reading of historical works, based on which he considered how to best approach the epistemological intricacies of the chemical debate. Gmelin's case was different. As a professor at Göttingen, Gmelin was a direct colleague of one of Lavoisier's most ardent German critics, the aforementioned Georg Friedrich Lichtenberg. He was also familiar with the innovations in historical methodology introduced by his Göttingen colleagues such as Johann Christoph Gatterer in the second half of the eighteenth century.[401] Gmelin's history was

---

[400] For Wiegleb's biography see Klosa, *Johann Christian Wiegleb*, 7–42.
[401] For Gmelin's Biography see Hufbauer, *Formation*, 202. On Gatterer and the Göttingen school of history in the late-eighteenth century see Martin Gierl, *Geschichte als präzisierte Wissenschaft. Johann Christoph Gatterer und die Historiographie des 18. Jahrhunderts im ganzen Umfang*, Fundamenta historica 4 (Stuttgart-Bad Cannstadt: Frommann-Holzboog Verlag, 2012).

even institutionally linked to the Göttingen school since it was one of the first contributions to the series *Geschichte der Künste und der Wissenschaften seit der Wiederherstellung derselben bis an das Ende des achtzehnten Jahrhunderts*, initiated by the theologian Johann Gottfried Eichhorn in 1796.[402] As I shall show, this affiliation was also mirrored by Gmelin's methodological approach, which was indebted to the analytical framework established by Eichhorn.

The Chronicle of Knowledge. Johann Christian Wiegleb's "Geschichte der Chemie" (1790–1791)

In his obituary of Wiegleb, the chemist Albert Nikolaus Scherer could not abstain from making a short critical remark. Notwithstanding the deceased chemist's crucial contributions to scholarship and teaching, Scherer considered Wiegleb a poor historian. In the 1790 history, Scherer could find but a collection 'an wichtigen literarischen Notizen' in chronological order. Its lack of a decent literary form led him to the conclusion that 'Wiegleb war nicht ganz in der Lage, ein Werk dieser Art, das alle Rücksichten völlig befriedigen konnte, zu liefern.'[403]

Had he bothered to compare Wiegleb's 1790–1791 history of chemistry to his earlier history of alchemy, Scherer might have come to a different conclusion, given their notable literary and methodological differences. As discussed in chapter 2, the work on alchemy both set out to explain the emergence of hermetic belief systems and to deconstruct them via a

[402] For an overview of Eichhorn's project including a list of the initially planned and finally realised volumes see Dirk van Miert, 'Structuring the History of Knowledge in an Age of Transition. The Göttingen Geschichte between Historia Literaria and the Rise of the Disciplines', *History of Humanities* 2, no. 2 (2017): 392–94, 396–401.
[403] Albert Nikolaus Scherer, 'Vollständige Uebersicht der literarischen Verdienste Wiegleb's, entworfen vom Herausgeber', *Allgemeines Journal der Chemie* 4 (1800): 701–20, here 719. The passage is also quoted by Fritz Krafft, 'Johann Christian Wiegleb und seine Rolle bei der Verwissenschaftlichung der Pharmazie', in *Apotheker und Universität. Die Vorträge der Pharmaziehistorischen Biennale in Leipzig vom 12. bis 14. Mai 2000 und der Gedenkveranstaltung »Wiegleb 2000« zum 200. Todestag von Johann Christian Wiegleb (1732–1800) am 15. und 165. März 2000 in Bad Langensalza*, ed. Christoph Friedrich and Wolf-Dieter Müller-Jahncke, Veröffentlichungen zur Pharmaziegeschichte 2 (Stuttgart: Wissenschaftliche Verlagsgesellschaft, 2002), 178.

historical critique. For this purpose, Wiegleb blended methods from the tradition of *historia philosophiae* and *historia literaria* – such as source criticism and the critical comparison of competing narratives, ostentatiously substantiated by long footnotes – with the Enlightenment approach of conjectural history. This led to an idiosyncratic and sometimes meandering textual structure. That the 1790/1 history of chemistry considerably departed from this framework accounts for its different function. Indeed, I would argue that it set out to defend the philosophical and chemical positions championed by the likes of Joseph Priestley using an elaborate literary form. Three aspects of the work vindicate this claim.

First, it is noteworthy that Wiegleb chose the annalistic form over a literarily more compelling narrative or a more analytically structured approach. This choice was informed by his wish to make a point regarding the philosophical question of whether an observation needed to be part of a harmonious system, based on a priori defined and philosophically derived criteria, to be considered a fact. As shown above, Lavoisier had complained in the *Traité* that the 'série des faits' in chemistry was still interrupted by 'des lacunes nombreuses' which had had a detrimental impact on the field.[404] The annalistic order of Wiegleb's work, as well as the arrangement of the relevant events in each year, was an indirect critique of this claim. The visual presentation showcased that no such thing as theoretical consistency was necessary for reliable knowledge on chemical problems to be produced. The *Geschichte* presented the incremental progress of chemistry, propelled by chemists working independently and on unrelated topics, which could be taken up by others over time.

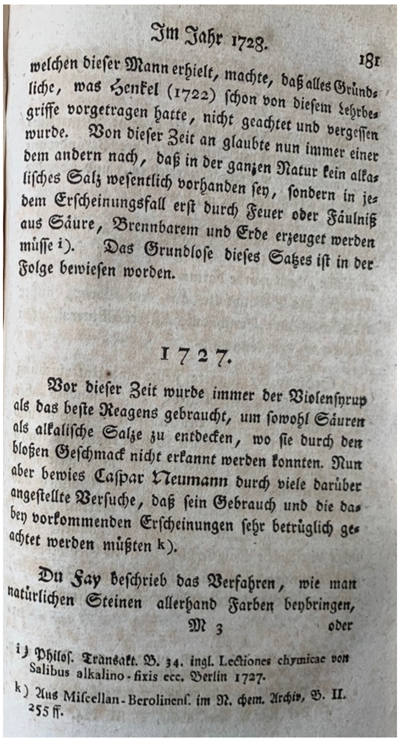
A good example is Wiegleb's presentation of Stephen Hales' *Vegetable Staticks*, a landmark work in the history of pneumatic chemistry published in 1727.[405] Although Wiegleb conceded the foundational character of the work for the 'in der neueren Zeit so wichtig gewordene

[404] Lavoisier, Traité, pp. xii-xiii.
[405] On Hales see Golinski, 'Chemistry', 383.

Lehre von den verschiedenen Luftarten', it was not assigned an outstanding position in the section.[406] Before summarising Hales' publication, Wiegleb reported the discoveries made by Johann Caspar Neumann, Nicolas Leméry, Étienne-François Geoffroy, Charles François de Cisternay du Fay, and Louis-Claude Bourdelin on a variety of topics ranging from the nature of salts to more practical issues such as the production of colours or essential oils.[407] In this way, each year represented a panorama of coinciding discoveries exposing how individual fragments of reliable knowledge were produced independently of each other and without being grounded in any preconceived theoretical framework other than pure observation. Visually, Wiegleb further supported this thrust by treating each discovery or publication in an individual paragraph, leaving considerable space between them (see Illustration 2).

---

[406] Wiegleb, *Geschichte des Wachsthums*, 1790, 1/part 2:183–84.
[407] Ibid., 181–84.


Im Jahr 1728. 181

welchen dieser Mann erhielt, machte, daß alles Gründliche, was Henkel (1722) schon von diesem Lehrbegriffe vorgetragen hatte, nicht geachtet und vergessen wurde. Von dieser Zeit an glaubte nun immer einer dem andern nach, daß in der ganzen Natur kein alkalisches Salz wesentlich vorhanden sey, sondern in jedem Erscheinungsfall erst durch Feuer oder Fäulniß aus Säure, Brennbarem und Erde erzeuget werden müsse i). Das Grundlose dieses Satzes ist in der Folge bewiesen worden.

1727.

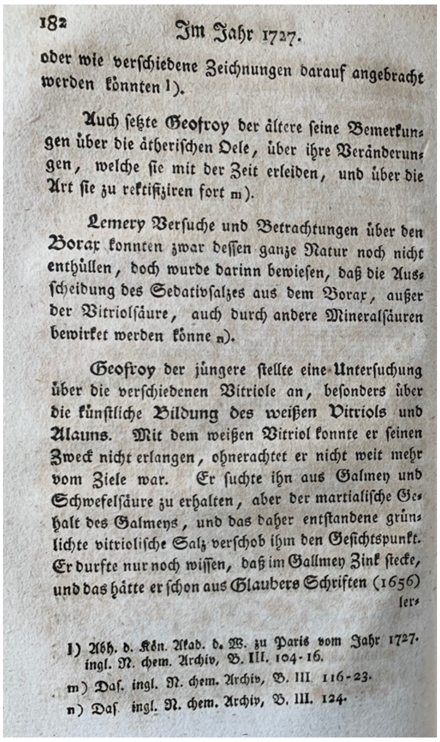
Vor dieser Zeit wurde immer der Violensyrup als das beste Reagens gebraucht, um sowohl Säuren als alkalische Salze zu entdecken, wo sie durch den bloßen Geschmack nicht erkannt werden konnten. Nun aber bewies Caspar Neumann durch viele darüber angestellte Versuche, daß sein Gebrauch und die dabey vorkommenden Erscheinungen sehr betrüglich geachtet werden müßten k).

Du Fay beschrieb das Verfahren, wie man natürlichen Steinen allerhand Farben beybringen,

M 3 oder

i) Philos. Transakt. B. 34. ingl. Lectiones chymicae von Salibus alkalino-fixis ecc. Berlin 1727.

k) Aus Miscellan-Berolinens. im N. chem. Archiv, B. II. 255 ff.


182 Im Jahr 1727.

oder wie verschiedene Zeichnungen darauf angebracht werden könnten l).

Auch setzte Geofroy der ältere seine Bemerkungen über die ätherischen Oele, über ihre Veränderungen, welche sie mit der Zeit erleiden, und über die Art sie zu rektifiziren fort m).

Lemery Versuche und Betrachtungen über den Borax konnten zwar dessen ganze Natur noch nicht enthüllen, doch wurde darinn bewiesen, daß die Ausscheidung des Sedativsalzes aus dem Borax, außer der Vitriolsäure, auch durch andere Mineralsäuren bewirket werden könne n).

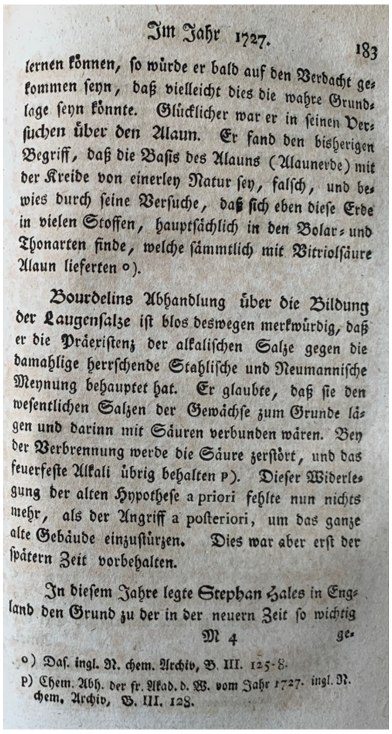
Geofroy der jüngere stellte eine Untersuchung über die verschiedenen Vitriole an, besonders über die künstliche Bildung des weißen Vitriols und Alauns. Mit dem weißen Vitriol konnte er seinen Zweck nicht erlangen, ohnerachtet er nicht weit mehr vom Ziele war. Er suchte ihn aus Galmey und Schwefelsäure zu erhalten, aber der martialische Gehalt des Galmeys, und das daher entstandene grünlichte vitriolische Salz verschob ihm den Gesichtspunkt. Er durfte nur noch wissen, daß im Gallmey Zink stecke, und das hätte er schon aus Glaubers Schriften (1656)

ler-

l) Abh. d. Kön. Akad. d. W. zu Paris vom Jahr 1727. ingl. N. chem. Archiv, B. III. 104-16.

m) Das. ingl. N. chem. Archiv, B. III 116-23.

n) Das. ingl. N. chem. Archiv, B. III. 124.


Im Jahr 1727. 183

lernen können, so würde er bald auf den Verdacht gekommen seyn, daß vielleicht dies die wahre Grundlage seyn könnte. Glücklicher war er in seinen Versuchen über den Alaun. Er fand den bisherigen Begriff, daß die Basis des Alauns (Alaunerde) mit der Kreide von einerley Natur sey, falsch, und bewies durch seine Versuche, daß sich eben diese Erde in vielen Stoffen, hauptsächlich in den Bolar- und Thonarten finde, welche sämmtlich mit Vitriolsäure Alaun lieferten o).

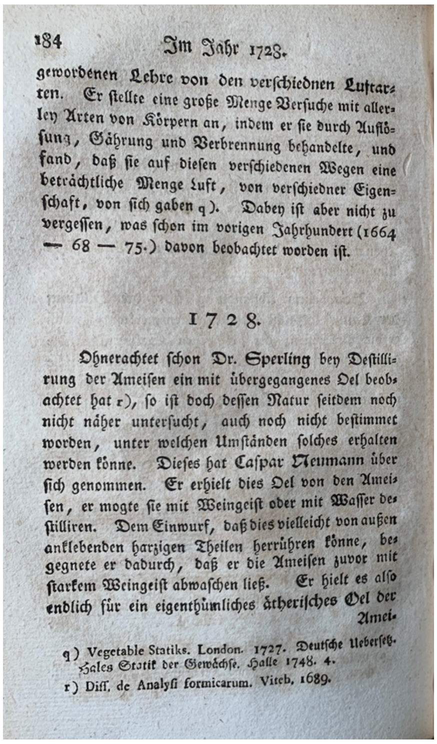
Bourdelins Abhandlung über die Bildung der Laugensalze ist blos deswegen merkwürdig, daß er die Präexistenz der alkalischen Salze gegen die damahlige herrschende Stahlische und Neumannische Meynung behauptet hat. Er glaubte, daß sie den wesentlichen Salzen der Gewächse zum Grunde lägen und darinn mit Säuren verbunden wären. Bey der Verbrennung werde die Säure zerstört, und das feuerfeste Alkali übrig behalten p). Dieser Widerlegung der alten Hypothese a priori fehlte nun nichts mehr, als der Angriff a posteriori, um das ganze alte Gebäude einzustürzen. Dies war aber erst der spätern Zeit vorbehalten.

In diesem Jahre legte Stephan Hales in England den Grund zu der in der neuern Zeit so wichtig

M 4 ge-

o) Das. ingl. N. chem. Archiv, B. III. 125-8.

p) Chem. Abh. der fr. Akad. d. W. vom Jahr 1727. ingl. N. chem. Archiv, B. III. 128.


184 Im Jahr 1728.

gewordenen Lehre von den verschiednen Luftarten. Er stellte eine große Menge Versuche mit allerley Arten von Körpern an, indem er sie durch Auflösung, Gährung und Verbrennung behandelte, und fand, daß sie auf diesen verschiedenen Wegen eine beträchtliche Menge Luft, von verschiedner Eigenschaft, von sich gaben q). Dabey ist aber nicht zu vergessen, was schon im vorigen Jahrhundert (1664 — 68 — 75.) davon beobachtet worden ist.

1728.

Ohnerachtet schon Dr. Sperling bey Destillirung der Ameisen ein mit übergegangenes Oel beobachtet hat r), so ist doch dessen Natur seitdem noch nicht näher untersucht, auch noch nicht bestimmet worden, unter welchen Umständen solches erhalten werden könne. Dieses hat Caspar Neumann über sich genommen. Er erhielt dies Oel von den Ameisen, er mogte sie mit Weingeist oder mit Wasser destilliren. Dem Einwurf, daß dies vielleicht von außen anklebenden harzigen Theilen herrühren könne, begegnete er dadurch, daß er die Ameisen zuvor mit starkem Weingeist abwaschen ließ. Er hielt es also endlich für ein eigenthümliches ätherisches Oel der

Amei-

q) Vegetable Statiks. London. 1727. Deutsche Uebersetz. Hales Statik der Gewächse. Halle 1748. 4.

r) Diss. de Analysi formicarum. Viteb. 1689.

Illustration 2: Pages 181–184 of Johann Christian Wiegleb's *Geschichte*, vol. 1/2 (1790), The Bodleian Libraries, University of Oxford, 193 e.241 (2 v. in 1) (Box B000000209390), CC-BY-NC 4.0.

This peculiar structure calls to mind the periodical, one of the Enlightenment's preferred publishing formats. Martin Gierl has underlined the proximity between the project of *Historiae literariae* and learned journals, which extended to the point that the former's compilatory approach was often seen as an integral aspect of producing a periodical.[408] Wiegleb made use of this intellectual affinity for a different purpose. Modelled after the literary form of the journal, the *Geschichte* illustrates that chemical progress was nourished by the scholarly culture of the Republic of Letters. It portrays the egalitarian, de-centralised nature of the learned world which, according to its defenders, allowed scholars to make their individual discoveries known for the sake of the common good, regardless of their geographical position, institutional affiliation, or biography.[409] As we have seen above, the idea of scholarly egalitarianism was championed by Priestley who objected to Lavoisier's a priori of systematics and precision instruments not only on scientific grounds, but also from an ethical perspective. Priestley particularly stressed just how necessary both the accessible and non-hierarchical character of the European chemical community were for its progress.[410] Wiegleb made the same argument using a more elaborate literary technique.

In addition, the *Geschichte* recorded the persistent scholarly efforts to improve knowledge in chemistry's numerous fields of inquiry over time. Neither temporal interruptions nor the community's geographical dispersion seemed to pose any obstacles to the continuous accumulation of knowledge. To create this effect within the annalistic structure, prolepses and analepses were the literary tools of choice for Wiegleb.[411]

---

[408] Gierl, 'Historia literaria', 125–26; Martin Gierl, 'Kompilation und die Produktion von Wissen im 18. Jahrhundert', in *Die Praktiken der Gelehrsamkeit in der Frühen Neuzeit*, ed. Helmut Zedelmaier and Martin Mulsow (Tübingen, 2001), 69–70.
[409] On the intellectual history of the Republic of Letters as a concept see Daston, 'Ideal and Reality' and chapter 1 of this thesis.
[410] See footnote 359.
[411] On the terminology see Gérard Genette, *Figures III* (Paris: Seuil, 1972), 90, 105.

Again, the episode concerning Stephen Hales is a good case in point. Having summarised the content of the *Vegetable Staticks*, Wiegleb added that Hales' works had roots in efforts made in the seventeenth century, indicating the respective years (and sometimes the page numbers) in the main body of the text. When following the prompt, the reader is directed to the works of Robert Boyle, the seventeenth-century British natural philosopher.[412] Similar cross-references are found in the section on the year 1772 in which numerous important publications on pneumatic chemistry were made. Here, Hales and Joseph Black are highlighted as the relevant predecessors who had laid the foundation for later achievements.[413] Wiegleb also deployed prolepses to exhibit how a discovery could lay the foundation for the deconstruction of a chemical hypothesis. Having hailed the insight gained by Bourdelin's works on salts and alkalis, he summarised that they overthrew older hypotheses 'a priori' but did not undertake the attack 'a posteriori, um das ganze alte Gebäude einzustürzen. Dies war aber erst der spätern Zeiten vorbehalten.'[414] In such cases, the reader saw in action the dialectic interplay between observations and hypotheses over long periods of time. The *Geschichte* thus exhibited the validity of a key assumption made by mid-century observationalism.

Secondly, Wiegleb used his history to review Lavoisier's claim that, due to the flawed epistemological basis of existing chemical practices, reliable facts had been discovered only very recently. If read in isolation, the two prefaces to the *Geschichte* seem to suggest that Wiegleb concurred with Lavoisier's position. In introducing the first volume, Wiegleb defined the goal of his work as making a comparison between the seventeenth and the eighteenth centuries in order 'zu entscheiden, in welchem von beyden überhaupt, und in welcher Periode derselben insbesondere, die stärksten Fortschritte gemacht worden sind.'[415] The comparison

[412] Wiegleb, *Geschichte des Wachsthums*, 1790, 1/part 2:184. For the summaries of Boyle's works see Wiegleb, *Geschichte des Wachsthums*, 1790, 1/part 1:18–19, 24, 49.
[413] Wiegleb, *Geschichte des Wachsthums*, 1791, 2:115.
[414] Wiegleb, *Geschichte des Wachsthums*, 1790, 1/part 2:183.
[415] Wiegleb, *Geschichte des Wachsthums*, 1790, 1/part 1:[vii]–[viii].

evidenced beyond a doubt that the second half of the eighteenth century had by far outpaced previous periods regarding the growth in chemical knowledge. This was mostly thanks to the uptick in inquiries in substances such as airs, fire, and minerals. As a result, chemistry as a science (*Wissenschaft*) had assumed 'eine ganz andere Gestalt, einen größeren Umfang, aber auch mehr Achtung und Anhänger'. However, even the years after 1750 were not characterised by a uniform, linear progress. For example, periods of rapid advances were interrupted by phases of stagnation, while the degree of progress made also varied between countries.[416]

Notwithstanding such chronological similarities with Lavoisier's view of the discipline's history, Wiegleb offered a contrasting explanation for chemistry's recent progress. As we have seen above, Lavoisier identified a radical rupture with previous scholarly practices as the sole reason for the newly gained reliability of observations and experiments. Wiegleb, by contrast, saw the slow spread of the observationalist approach, which individual scholars had pursued since the seventeenth century, over hermetic speculation as the main reason for chemistry's advances.[417] True observationalism and its rational implications did not appear out of the blue but were the result of the arduous work of previous generations to which contemporary chemists were still indebted. Wiegleb used the metaphor of a growing tree to characterise this continuity. The teachings of Marggraf and Neumann, for example, began to strike root in the middle of the eighteenth century, but 'konnten erst in der Folge bessere Früchte bringen.'[418]

While choosing a novel literary form for his *Geschichte*, Wiegleb thus endorsed the conceptual framework of *histoires de l'esprit* in the tradition of Macquer, Venel, or Thiroux d'Arconville – an apt choice, given that he championed their scientific ideals too. Wiegleb's history therefore exhibited the long-standing coexistence of a few reliable facts and numerous prejudices which disappeared only when the community began to strictly pursue the practice

---

[416] Wiegleb, *Geschichte des Wachsthums*, 1791, 2:[i]–[vi], quote on [vi].
[417] Ibid., [ii]–[vi].
[418] Ibid., [ii].

‘freyer Prüfung.’[419] Throughout the text, he also insisted on the great importance of debates in which scholars had corrected previous mistakes by debating hypotheses and existing opinions based on observational inquiries. By no means did such older systematic assumptions form an obstacle to scientific progress, as Lavoisier suggested.[420] In this way, the *Geschichte* highlighted that the ideal of mid-eighteenth-century observationalism and its practical implications on scholarly work continued to exercise a profoundly positive influence on chemistry.

At the same time, the balanced yet overall positive interpretation of chemistry’s history also insinuated that Lavoisier’s system and its implications for the nature of gases, acids, heat, and water should be rejected. This third intervention in the philosophical debates on chemical practices is visible in those sections of the *Geschichte* which capture chemistry between 1770 and the time of writing. One of Wiegleb’s strategies was to downplay the importance of Lavoisier by assigning important discoveries to his opponents. From the *Geschichte*, it appears that all relevant advances in pneumatic chemistry had been made by those scholars who publicly championed the traditional ideals of observationalism. Again, the year 1772 is a case in point. According to Henry Guerlac’s classic study, Lavoisier had laid the foundation for most of his later achievements in this ‘crucial year’.[421] Wiegleb agreed that 1772 was a landmark in the history of chemistry but for a different reason: it marked the moment in which Joseph Priestley had published a novel taxonomy of airs. Wiegleb recounted the episode in a way that illustrated the potency of the observationalist approach in all its facets. Hales and Black were identified as those who had provided the initial observations on the matter decades earlier; having added experiments himself, Priestley succeeded in creating a more consistent taxonomy whose systematic assumptions (*Lehrbegriffe*) inspired others to make further inquiries into the

[419] Ibid., [iii].
[420] See for example the debate on heat and calcination in the 1760s in ibid., 139–143, 165.
[421] Henry Guerlac, *Lavoisier - The Crucial Year. The Background and Origin of His First Experiments on Combustion in 1772*, Reprint, Classics in the History and Philosophy of Science 5 (New York: Gordon and Breach, 1990).

matter.[422] Thus, intellectual authority was assigned to Lavoisier's opponents, in particular to Priestley. He remained the undisputed hero of pneumatic chemistry throughout the *Geschichte*, with his works mentioned no fewer than 16 times in the second volume. In roughly a third of these instances, Wiegleb added remarks on the quality or positive impact of his discoveries or treatises.[423] There was only one section in which Wiegleb added a slightly negative tack to an otherwise positive account of the British naturalists' work.[424]

When it came to assessing the works of Lavoisier, Wiegleb simply could have chosen to omit them from the account. His strategy, however, was much more sophisticated. Lavoisier's twenty-five appearances in the *Geschichte* can be divided into two categories. Whenever recounting an experimental discovery by the French scholar, Wiegleb dutifully noted it and acknowledged its value, but he silently translated the vocabulary used by Lavoisier into the phlogistic nomenclature. Lavoisier's investigations were disentangled from their wider, philosophical implications while being portrayed as regular contributions of a member of the Republic of Letters to chemistry.[425] Having thus separated epistemology, theory, and observation from each other, Wiegleb used every opportunity to criticise Lavoisier for his excurses into the philosophy of science and the vain conclusions which he drew from them. Just like William Nicholson and Joseph Priestley, he was concerned about mathematical interventions in experimental practice and doubted the alleged degree of precision displayed in Lavoisier's reports. Having summarised the latter's experiments on hydrogen and oxygen, he lamented that his conclusions seemed to be too far-reaching, 'der weitläufigen genauen Berechnung ohngeachtet (…), indem hierbey nichts leichter, als Fehlen, bey solch kleinen Mengen möglich ist.'[426]

---

[422] Wiegleb, *Geschichte des Wachsthums*, 1791, 2:115–16, quote on 116.
[423] Explicitly positive statements on Priestley's works: ibid., 109, 115, 170, 360, 517–18; neutral accounts: ibid., 155, 227–28, 246–47, 296, 309, 358, 442, 467–68, 532.
[424] Ibid., 109.
[425] See for example ibid., 185–86, 262–63, 291, 319–20.
[426] Ibid., 343. Similar ibid., 262.

Another point of concern for Wiegleb was that Lavoisier applied deductive reasoning to make fundamental claims on the nature of chemical substances. From the *Geschichte*, the reader gets the impression that in interpreting his observations, Lavoisier all too often reasoned 'nach seiner eigenen Theorie'.[427] Since Wiegleb accused no other chemist of this mistake it appeared as if Lavoisier was the only scholar (mis-)guided by theoretical reasoning while everybody else stood on the firm ground of observationalism and its cautious use of observations and preliminary hypotheses. The most extreme example of this argumentative tactic is found in Wiegleb's discussion of the phlogiston controversy. He portrayed the *Réflexions sur le phlogistique* as a work 'über das brennbare Wesen (…), worinn er solches ganz verleugnete und aus der Natur weg zu demonstrieren suchte'.[428] Rejecting the existence of phlogiston thus did not appear as a legitimate argument but as a forceful act of overruling observations by means of a demonstration, a point which at the same time was frequently made by Priestley.[429] Finally, and again in line with the British chemists, Wiegleb insisted on the preliminary character of Lavoisier's claims, even if they were presented as facts by their author. Already in the section that covered Lavoisier's experiments on the weight gain in metal calcination, Wiegleb informed the reader that the French chemists had built numerous hypotheses on them. However, 'bey alle dem lassen sich gegen alle gemachte Folgerungen noch mancherley nicht unbeträchtliche Einwendungen machen, die erst abgelehnt werden müssen, ehe man jenen vollkommenen Beyfall ertheilen kann'.[430]

While Wiegleb thus dissected Lavoisier's works into usable facts and superfluous theoretical conclusions, the *Geschichte* also illustrated the rational attitude with which the transnational community was able to handle the far-reaching claims of one individual without neglecting what was really at the heart of chemical investigations, namely incremental advances

[427] Ibid., 319, 343. The quote is identical both pages.
[428] Ibid., 320.
[429] On Priestley Golinski, *Science*, 147–48.
[430] Wiegleb, *Geschichte des Wachsthums*, 1791, 2:148–49.

based on the sharing of individually made observations. Crucially, it was not the narrator of the *Geschichte* who voiced criticism against those of Lavoisier's publications which contained the most far-reaching claims on how the science of chemistry should be changed. Instead, Wiegleb noted the general rejection of the positions postulated both by the nomenclature reform of 1787 and the *Traité* and quoted selected, apodictic critiques of these works by esteemed scholars across the continent, such as Thomas Beddoes.[431] The final year of the book read as if the controversy had already ended, although, as previously discussed, it was only then that it gained momentum in Wiegleb's native Germany. By contrast, Wiegleb held that Priestley's latest experiments 'sind für das antiphlogistische System nicht günstig ausgefallen', before he pointed out the consistence of the British scholar's explanations on various phenomena of combustion and acidity.[432] If seen through the lens of Wiegleb's history, Lavoisier's appearance on the stage of chemistry did not herald a revolution in chemistry. On the contrary, the theory's emergence and reception evidenced – to borrow a concept from Thomas Kuhn – nothing else than the continuity of Enlightenment 'normal science'.[433]

Chemical Controversy and Göttingen History: Johann Friedrich Gmelin's "Geschichte der Chemie" (1797-1799)

Just like with the previous examples, it might at first glance appear odd to argue that Gmelin's *Geschichte der Chemie* served to intervene in the philosophical debates on chemistry let alone to reject the positions which Lavoisier maintained in the controversy. When introducing the French chemist in the third volume, Gmelin credited him for his achievements and even entitled the chapter covering the period after 1775 the 'Age of Lavoisier', thus putting him on equal

[431] Ibid., 413, 481, 502.
[432] Ibid., 517–18, quote on 517.
[433] Kuhn, *Structure*, 23–42.

footing with the likes of Georg Ernst Stahl and Robert Boyle.[434] On such grounds, Peter Hanns Reill has argued that Gmelin's large body of historical writing was not aimed at Lavoisier. In presenting the debates between Lavoisier and professional chemists across the continent as a regular feature of the community of chemists, he exhibited the rational character of chemistry as an academic discipline.[435]

I would argue that this perspective underestimates Gmelin's in-depth knowledge of the discourse on chemistry as well as his scientific trajectories. He was not just aware of the theoretical and philosophical issues at stake but actively contributed to the controversy during the 1790s. In order to appreciate the *Geschichte der Chemie* as a sophisticated intervention in the debate, it is necessary to take into account several of Gmelin's lesser-known articles which were published in the *Chemische Annalen* and the *Göttingisches Journal der Naturwissenschaften* between 1795 and 1798.[436] Here, Gmelin tested the feasibility of a historical perspective to voice his strict opposition against all aspects of Lavoisier's philosophy of science, and to re-establish the principles of traditional observationalist philosophy. These shorter pieces thus prepared the approach of the *Geschichte*, which he was working on in parallel.

The article *Ueber die neue Chemie* (1798) is a good case in point. In it, Gmelin brought a historical argument into position to argue against deductive reasoning in chemistry. One of his gravest concerns was that scholars who approached natural phenomena based on theoretical presuppositions suffered from the 'einseitigen Art, womit sie ihren Gegenstand betrachten'. This put the scholar in danger of neglecting observational findings in favour of the overall architecture of a theory. Gmelin explicitly mentioned Lavoisier as his example for a scholar having taken the wrong path in this respect.[437]

---

[434] Gmelin, *Geschichte der Chemie*, 1799, 3:277–79 and the table of contents in Gmelin, *Geschichte der Chemie*, 1797, 1: 11–12.
[435] Reill, *Vitalizing Nature*, 112–13.
[436] Johann Friedrich Gmelin, 'Ueber die neue Chemie', *Göttingisches Journal der Naturwissenschaften* 1, no. 1 (1798): 10–86; Gmelin, 'Beitrag'; Gmelin, 'Winke'.
[437] Gmelin, 'Ueber die neue Chemie', 11–12 quote on 12.

The history of the natural sciences offered numerous cautionary tales which, or so Gmelin hoped, might prevent chemists from uncritically adopting the Frenchman's philosophy of science. Franciscus Sylvius de la Boë, an early advocate of the iatrochemical approach in the seventeenth century, was another example of a scholar whose view had been blurred by his own system, so that he had become unable to take into account the critical feedback by his peers. Due to Sylvius' eloquence and reputation, the impact of his misguided system had been so profound that only a highly gifted scholar such as Herman Boerhaave was able to eradicate it.[438] The negative effects of the deductive approach were visible in the struggles of contemporary chemistry, too. Gmelin criticised the polarisation of the community that resulted from the 'Sprache des despotischen und unduldsamen Hyper-Orthodoxen' who had established the sharp distinction between Stahlians and adherents of the Lavoisian new chemistry in the first place. By forcing scholars to choose between two paradigms, they intimidated the members of the community, thus forgetting that truth could 'im alten oder im neuen System oder zwischen oder neben beiden liegen'. In combining an epistemic claim on the preliminary nature of any insight in the tradition of eighteenth-century observationalism with the accusation of Lavoisier having violated the 'Geseze der Urbanität', Gmelin additionally aligned his historical sketch with the moral criticism of Lavoisier's reasoning which Priestley concomitantly voiced.[439]

The *Geschichte der Chemie*, published in three volumes between 1797 and 1799, built upon this perspective. In its content, literary form, and explicit claims on scientific progress, the work served the twofold purpose of disproving Lavoisier's historical assumptions which substantiated his philosophical claims, and of reinforcing the positions held by British chemists as well as the general ideals of mid-eighteenth-century observationalism. To reach this target, Gmelin designed a new type of history-writing which centred on chemistry's roots in the

---

[438] Ibid., 12–13.

[439] All quotes in ibid., 69, footnote y. The footnote starts on the previous page. On Priestley see Golinski, *Science*, 147–48.

artisanal and industrial world, a topic which had been completely neglected by previous historians of the field. In the introduction to the *Geschichte*, Gmelin claimed that a thorough historical analysis vindicated how chemistry had been 'der Schlüssel zu manchen Geheimnissen der Natur; der ausgewählte Leitstern im Labyrinth zahlloser Gewerbe, die Menschen und Staten ernähren, beglücken, bereichern, die vernünftige Grundlage des Hüttenwesens, vieler Fabriken, Künste und Handwerker'.[440] For Gmelin, the true nature of chemistry could not be grasped by a narrow focus on those who called themselves professional chemists. Rather, one had to consider artisanal practices such as mining, dyeing, and brewing as well as chemical knowledge production in other academic disciplines such as pharmacy, medicine, and natural history to get a full picture. Beyond a mere thematic shift, this perspective countered one of Lavoisier's key assumptions, namely that scientific progress was driven – or inhibited – by philosophical concepts alone. Gmelin's history, by contrast, demonstrated that scientific advancements depended on the everyday activities of numerous agents in a wide array of professions, both practical and academic.

By illustrating both the value of existing chemical practices, rooted above all in the discipline's great diversity, and the potential pitfalls of any attempt to change this culture and its implications, Gmelin's history countered two further key assumptions of the Lavoisian philosophy of science and additionally revisited the question of Lavoisier's position in the history of the field. In the following, I shall analyse how the overall structure, explicit arguments, and literary form of the *Geschichte* all served this purpose. First, Gmelin rejected the idea that chemistry's progress was a recent phenomenon. In arguing that some scholars were 'geblendet von den hellen Stralen, welche unser Zeitalter über die Wissenschaft verbreitete' and thus ignorant of their predecessors' achievements, he clearly took issue with the rhetoric displayed by Lavoisier and his colleagues. By contrast, a close look at the manifold publications that had

[440] Gmelin, *Geschichte der Chemie*, 1797, 1:1–3, quote on 2.

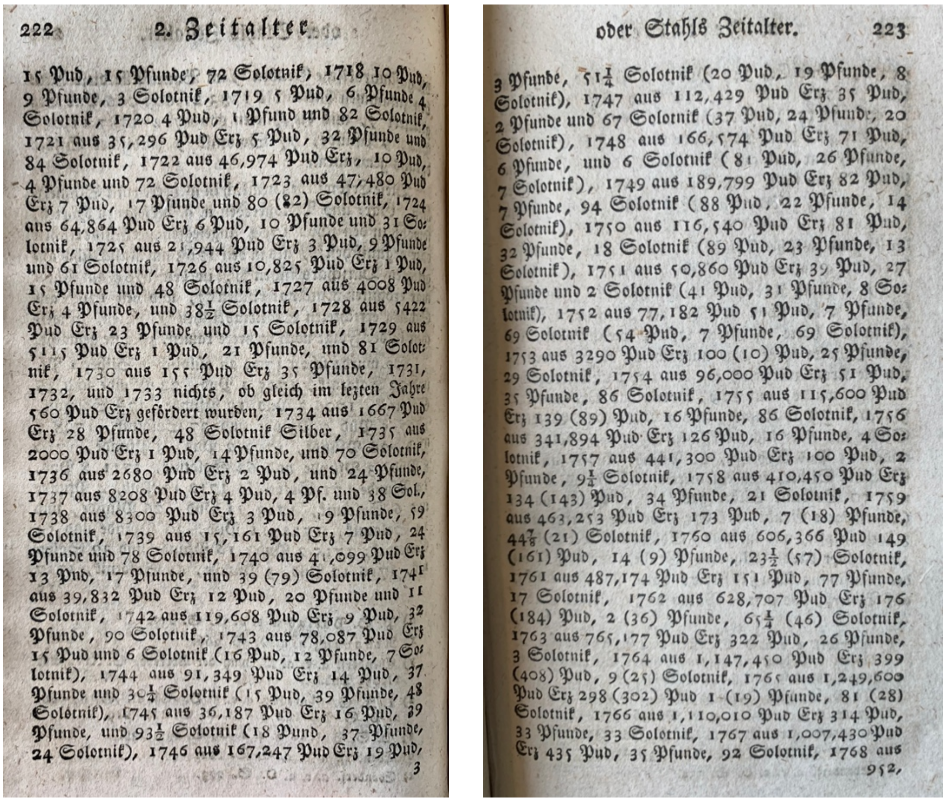
been made over the past centuries evidenced that 'manche Entdeckung, womit sich unser Zeitalter brüstet, und zu brüsten Ursache hat, wenigstens in ihrem Keime schon in ihren Schriften liegt'.[441] Again, Gmelin had tested this historical perspective in an earlier essay on pneumatic chemistry before deploying it on a larger scale in the two final volumes of the *Geschichte*. His *Beitrag zur Geschichte der chemischen Kenntnis der so genannten Gasarten aus früheren Zeiten* (1798) showcased that engineers and physicians had already amassed considerable knowledge on the nature of airs well before the advent of modern pneumatic chemistry. The explanation for this was mundane: they had come in contact with the effects of gases through the mining industry, where workers experienced sudden explosions and suffered from the consequences of breathing in certain gases.[442] Recording early discoveries of chemical phenomena in practical realms was a key objective of the *Geschichte*, too. To display them, Gmelin applied a simple narrative pattern. After summarising the advances made in a particular field, he went on to present extensive indices of the contributors to this field. An example from the second volume might suffice to illustrate this observation. Having stated that both pharmacists and medical doctors had made important contributions to the discipline in the early eighteenth century by writing pharmaceutical handbooks, inventing novel treatments, and discovering poisons, he went on to list their names over the following seventy-one pages. The footnotes dutifully displayed their publications and often indicated the precise topic of a scholar's discovery.[443]

This approach explains the peculiar and almost unreadable structure of the *Geschichte*. Over almost three thousand pages, Gmelin's text exhibited both the establishment of factual observations in a practical context and systematic advances. Individual sentences, spanning

---

[441] Gmelin, *Geschichte der Chemie*, 1797, 1:vi.
[442] Gmelin, Beitrag, 8–12.
[443] Gmelin, *Geschichte der Chemie*, 1798, 2:354–425.

several pages, often only listed the names of individual scholars who had worked on a particular topic (see Illustration 3).


222 2. Zeitalter

15 Pud, 15 Pfunde, 72 Solotnik, 1718 10 Pud, 9 Pfunde, 3 Solotnik, 1719 5 Pud, 6 Pfunde 4 Solotnik, 1720 4 Pud, 1 Pfund und 82 Solotnik, 1721 aus 35,296 Pud Erz 5 Pud, 32 Pfunde und 84 Solotnik, 1722 aus 46,974 Pud Erz, 10 Pud, 4 Pfunde und 72 Solotnik, 1723 aus 47,480 Pud Erz 7 Pud, 17 Pfunde und 80 (82) Solotnik, 1724 aus 64,864 Pud Erz 6 Pud, 10 Pfunde und 31 Solotnik, 1725 aus 21,944 Pud Erz 3 Pud, 9 Pfunde und 61 Solotnik, 1726 aus 10,825 Pud Erz 1 Pud, 15 Pfunde und 48 Solotnik, 1727 aus 4008 Pud Erz 4 Pfunde, und 38½ Solotnik, 1728 aus 5422 Pud Erz 23 Pfunde und 15 Solotnik, 1729 aus 5115 Pud Erz 1 Pud, 21 Pfunde, und 81 Solotnik, 1730 aus 155 Pud Erz 35 Pfunde, 1731, 1732, und 1733 nichts, ob gleich im lezten Jahre 560 Pud Erz gefördert wurden, 1734 aus 1667 Pud Erz 28 Pfunde, 48 Solotnik Silber, 1735 aus 2000 Pud Erz 1 Pud, 14 Pfunde, und 70 Solotnik, 1736 aus 2680 Pud Erz 2 Pud, und 24 Pfunde, 1737 aus 8208 Pud Erz 4 Pud, 4 Pf. und 38 Sol., 1738 aus 8300 Pud Erz 3 Pud, 19 Pfunde, 59 Solotnik, 1739 aus 15,161 Pud Erz 7 Pud, 24 Pfunde und 78 Solotnik, 1740 aus 41,099 Pud Erz 13 Pud, 17 Pfunde, und 39 (79) Solotnik, 1741 aus 39,832 Pud Erz 12 Pud, 20 Pfunde und 11 Solotnik, 1742 aus 119,608 Pud Erz 9 Pud, 32 Pfunde, 90 Solotnik, 1743 aus 78,087 Pud Erz 15 Pud und 6 Solotnik (16 Pud, 12 Pfunde, 7 Solotnik), 1744 aus 91,349 Pud Erz 14 Pud, 37 Pfunde und 30¼ Solotnik (15 Pud, 39 Pfunde, 48 Solotnik), 1745 aus 36,187 Pud Erz 16 Pud, 39 Pfunde, und 93½ Solotnik (18 Pund, 37 Pfunde, 24 Solotnik), 1746 aus 167,247 Pud Erz 19 Pud,

3

oder Stahls Zeitalter. 223

3 Pfunde, 51¼ Solotnik (20 Pud, 19 Pfunde, 8 Solotnik), 1747 aus 112,429 Pud Erz 35 Pud, 2 Pfunde und 67 Solotnik (37 Pud, 24 Pfunde, 20 Solotnik), 1748 aus 166,574 Pud Erz 71 Pud, 6 Pfunde, und 6 Solotnik (81 Pud, 26 Pfunde, 7 Solotnik), 1749 aus 189,799 Pud Erz 82 Pud, 7 Pfunde, 94 Solotnik (88 Pud, 22 Pfunde, 14 Solotnik), 1750 aus 116,540 Pud Erz 81 Pud, 32 Pfunde, 18 Solotnik (89 Pud, 23 Pfunde, 13 Solotnik), 1751 aus 50,860 Pud Erz 39 Pud, 27 Pfunde und 2 Solotnik (41 Pud, 31 Pfunde, 8 Solotnik), 1752 aus 77,182 Pud 51 Pud, 7 Pfunde, 69 Solotnik (54 Pud, 7 Pfunde, 69 Solotnik), 1753 aus 3290 Pud Erz 100 (10) Pud, 25 Pfunde, 29 Solotnik, 1754 aus 96,000 Pud Erz 51 Pud, 35 Pfunde, 86 Solotnik, 1755 aus 115,600 Pud Erz 139 (89) Pud, 16 Pfunde, 86 Solotnik, 1756 aus 341,894 Pud Erz 126 Pud, 16 Pfunde, 4 Solotnik, 1757 aus 441,300 Pud Erz 100 Pud, 2 Pfunde, 9¼ Solotnik, 1758 aus 410,450 Pud Erz 134 (143) Pud, 34 Pfunde, 21 Solotnik, 1759 aus 463,253 Pud Erz 173 Pud, 7 (18) Pfunde, 44⅞ (21) Solotnik, 1760 aus 606,366 Pud 149 (161) Pud, 14 (9) Pfunde, 23½ (57) Solotnik, 1761 aus 487,174 Pud Erz 151 Pud, 77 Pfunde, 17 Solotnik, 1762 aus 628,707 Pud Erz 176 (184) Pud, 2 (36) Pfunde, 65¼ (46) Solotnik, 1763 aus 765,177 Pud Erz 322 Pud, 26 Pfunde, 3 Solotnik, 1764 aus 1,147,450 Pud Erz 399 (408) Pud, 9 (25) Solotnik, 1765 aus 1,249,600 Pud Erz 298 (302) Pud 1 (19) Pfunde, 81 (28) Solotnik, 1766 aus 1,110,010 Pud Erz 314 Pud, 33 Pfunde, 33 Solotnik, 1767 aus 1,007,430 Pud Erz 435 Pud, 35 Pfunde, 92 Solotnik, 1768 aus

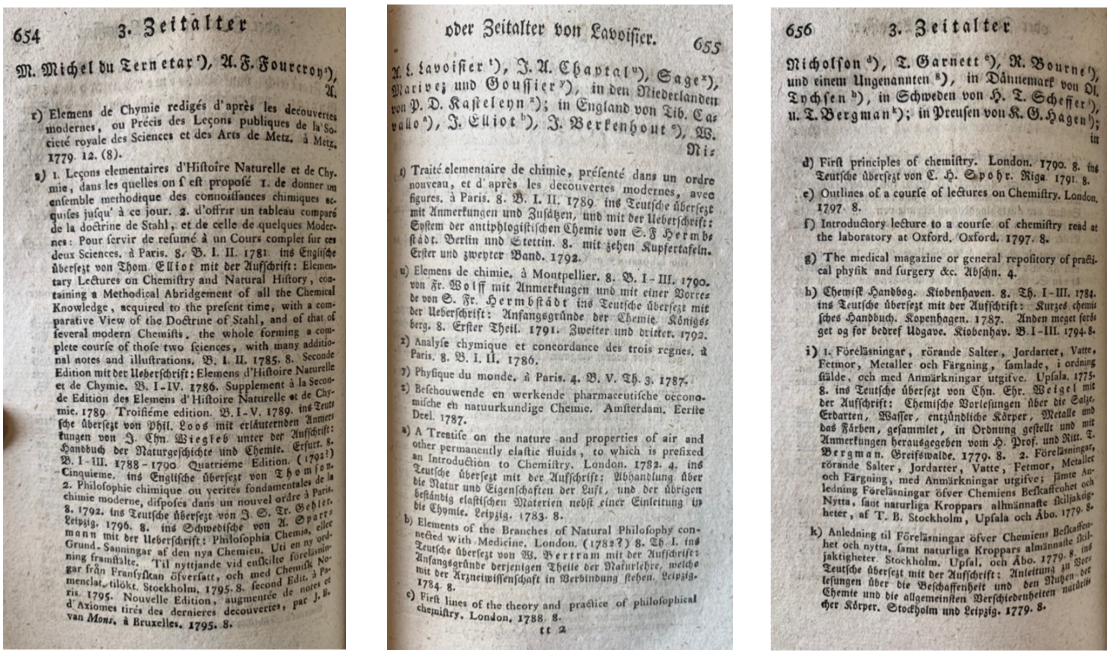
952,

Illustration 3: Pages 222–223 of Johann Friedrich Gmelin's *Geschichte*, vol. 3 (1799), The Bodleian Libraries, University of Oxford, 8° SIGMA 749 (Bd.3), CC-BY-NC 4.0.

In the most extreme cases, Gmelin simply recounted technical details such as the amount of a particular metal quarried in a particular mine during a given period. Thus, the *Geschichte* often resembles a lexical index more than a sophisticated narrative account.[444] This effect is even amplified by the excessive use of footnotes that often cover more space on a page than the main text (see Illustration 4). Gmelin's choice of this approach over a literarily more compelling narrative thus had a performative dimension. On a visual level, the text demonstrated that 'die Fortschritte der Neueren' were grounded in the multi-generational, arduous, and decentralised

[444] For example Gmelin, *Geschichte der Chemie*, 1799, 3:221–225.

endeavour of gaining knowledge about substances in mines, workshops, or pharmacies, rather than in a philosophical innovation.[445]



654 3. Zeitalter

M. Michel du Tennetar r), A. F. Fourcroy s), A.

r) Elemens de Chymie redigés d'après les decouvertes modernes, ou Précis des Leçons publiques de la Société royale des Sciences et des Arts de Metz. à Metz. 1779. 12. (8).

s) 1. Leçons elementaires d'Histoire Naturelle et de Chymie, dans les quelles on s'est proposé 1. de donner un ensemble methodique des connoissances chimiques acquises jusqu' à ce jour. 2. d'offrir un tableau comparé de la doctrine de Stahl, et de celle de quelques Modernes: Pour servir de resumé à un Cours complet sur ces deux Sciences. à Paris. 8. B. I. II. 1781 ins Englische übersezt von Thom. Elliot mit der Aufschrift: Elementary Lectures on Chemistry and Natural History, containing a Methodical Abridgement of all the Chemical Knowledge, acquired to the present time, with a comparative View of the Doctrine of Stahl, and of that of several modern Chemists, the whole forming a complete course of those two sciences, with many additional notes and illustrations. B. I. II. 1785. 8. Seconde Edition mit der Ueberschrift: Elemens d'Histoire Naturelle et de Chymie. B. I-IV. 1786. Supplement à la Seconde Edition des Elemens d'Histoire Naturelle et de Chymie. 1789. Troisiéme edition. B. I-V. 1789. ins Teutsche übersezt von Phil. Loos mit erläuternden Anmerkungen von J. Chn. Wiegleb unter der Aufschrift: Handbuch der Naturgeschichte und Chemie. Erfurt. 8. B. I-III. 1788-1790. Quatrieme Edition. (1792?) Cinquieme. ins Englische übersezt von Thomson. 2. Philosophie chimique ou verités fondamentales de la chimie moderne, disposés dans un nouvel ordre à Paris. 8. 1792. ins Teutsche übersezt von J. S. Tr. Gehler. Leipzig. 1796. 8. ins Schwedische von A. Sparrmann mit der Ueberschrift: Philosophia Chemia, eller Grund-Sanningar af den nya Chemien. Uti en ny ordning framställte. Til nyttjande vid enskilte föreläsningar från Fransyskan öfversatt, och med Chemisk Nomenclat. tilökt. Stockholm. 1795. 8. second Edit. à Paris. 1795. Nouvelle Edition, augmentée de notes et d'Axiomes tirés des dernieres decouvertes, par J. B. van Mons. à Bruxelles. 1795. 8.

oder Zeitalter von Lavoisier. 655

A. L. Lavoisier t), J. A. Chaptal u), Sage x), Marivez und Goussier y), in den Niederlanden von P. D. Kastelenn z); in England von Tib. Cavallo a), J. Elliot b), J. Berkenhout c), W. Ni-

t) Traité elementaire de chimie, présenté dans un ordre nouveau, et d'après les decouvertes modernes, avec figures. à Paris. 8. B. I. II. 1789. ins Teutsche übersezt mit Anmerkungen und Zusätzen, und mit der Ueberschrift: System der antiphlogistischen Chemie von S. F. Hermbstädt. Berlin und Stettin. 8. mit zehen Kupfertafeln. Erster und zweyter Band. 1792.

u) Elemens de chimie. à Montpellier. 8. B. I-III. 1790. von Fr. Wolff mit Anmerkungen und mit einer Vorrede von S. Fr. Hermbstädt ins Teutsche übersezt mit der Ueberschrift: Anfangsgründe der Chemie. Königsberg. 8. Erster Theil. 1791. Zweiter und dritter. 1792.

x) Analyse chymique et concordance des trois regnes. à Paris. 8. B. I. II. 1786.

y) Physique du monde. à Paris. 4. B. V. Th. 3. 1787.

z) Beschouwende en werkende pharmaceutische oeconomische en natuurkundige Chemie. Amsterdam. Eerste Deel. 1787.

a) A Treatise on the nature and properties of air and other permanently elastic fluids, to which is prefixed an Introduction to Chemistry. London. 1782. 4. ins Teutsche übersezt mit der Aufschrift: Abhandlung über die Natur und Eigenschaften der Luft, und der übrigen beständig elastischen Materien nebst einer Einleitung in die Chymie. Leipzig. 1783. 8.

b) Elements of the Branches of Natural Philosophy connected with Medicine. London. (1782?) 8. Th. I. ins Teutsche übersezt von W. Bertram mit der Aufschrift: Anfangsgründe derjenigen Theile der Naturlehre, welche mit der Arzneiwissenschaft in Verbindung stehen. Leipzig. 1784. 8.

c) First lines of the theory and practice of philosophical chemistry. London. 1788. 8.

tt 2

656 3. Zeitalter

Nicholson d), T. Garnett e), R. Bourne f), und einem Ungenannten g), in Dännemark von Ol. Tychsen h), in Schweden von H. T. Scheffer i), u. T. Bergman k); in Preusen von K. G. Hagen l); in

d) First principles of chemistry. London. 1790. 8. ins Teutsche übersezt von C. H. Spohr. Riga. 1791. 8.

e) Outlines of a course of lectures on Chemistry. London. 1797. 8.

f) Introductory lecture to a course of chemistry read at the laboratory at Oxford. Oxford. 1797. 8.

g) The medical magazine or general repository of practical physik and surgery &c. Abschn. 4.

h) Chemisk Handbog. Kiobenhaven. 8. Th. I-III. 1784. ins Teutsche übersezt mit der Aufschrift: Kurzes chemisches Handbuch. Kopenhagen. 1787. Anden meget forøget og for bedref Udgave. Kiobenhav. B. I-III. 1794. 8.

i) 1. Föreläsningar, rörande Salter, Jordarter, Vatte, Fetmor, Metaller och Färgning, samlade, i ordning ställde, och med Anmärkningar utgifve. Upsala. 1775. 8. ins Teutsche übersezt von Chn. Ehr. Weigel mit der Aufschrift: Chemische Vorlesungen über die Salze, Erdarten, Wasser, entzündliche Körper, Metalle und das Färben, gesammlet, in Ordnung gestellt und mit Anmerkungen herausgegeben vom H. Prof. und Ritt. T. Bergman. Greifswalde. 1779. 8. 2. Föreläsningar, rörande Salter, Jordarter, Vatte, Fetmor, Metaller och Färgning, med Anmärkningar utgifve; jämte Anledning Föreläsningar öfver Chemiens Beskaffenhet och Nytta, samt naturliga Kroppars alhmännaste skiljaktigheter, af T. B. Stockholm, Upsala och Åbo. 1779. 8.

k) Anledning til Föreläsningar öfver Chemiens Beskaffenhet och nytta, samt naturliga Kroppars almännaste skiljaktigheter. Stockholm. Upsal. och Åbo. 1779. 8. ins Teutsche übersezt mit der Aufschrift: Anleitung zu Vorlesungen über die Beschaffenheit und den Nutzen der Chemie und die allgemeinsten Verschiedenheiten natürlicher Körper. Stockholm und Leipzig. 1779. 8.

Illustration 4: Pages 654–656 of Johann Friedrich Gmelin's *Geschichte*, vol. 3 (1799), The Bodleian Libraries, University of Oxford, 8° SIGMA 749 (Bd.3), CC-BY-NC 4.0.

Second, Gmelin's history can be read as a plea for the continuous use of concepts rooted in hypotheses or conjectures, thus reinstating their positive role in the tradition of mid-eighteenth-century observationalism. As shown above, Lavoisier took issue with this stance, highlighting the potentially negative impact of traditional concepts because of their notorious affiliation with irrationalism in general and alchemy in particular. His main case in point was Stahl's concept of phlogiston. By contrast, Gmelin held that systematising advances of individual scholars could contribute to the overall progress of chemistry even if they originated in irrational endeavours such as alchemy. To underline this point, he frequently interrupted the records of artisanal discoveries to shed light on how the more systematic works of academic

[445] Quote in Gmelin, *Geschichte der Chemie*, 1797, 1:vii.

chemists had propelled chemical progress. For example, notwithstanding its obvious imperfection, Stahl's phlogiston had been 'der Anlas zu manchen wichtigen Entdeckungen' for many European chemists.[446] This was the case even if the inventor of a concept had himself hampered progress in another realm of knowledge. Paracelsus was the outstanding example of Gmelin's history of chemistry in this regard. On the one hand, he had made positive contributions to chemistry, in particular by paving the way for pharmacy to overcome the insufficient legacies of Galen and Avicenna. On the other, Paracelsus was partly responsible for the spread of alchemy across Europe in the early modern period through his pupils.[447]

As Gmelin noted in the introduction, the dialectic between irrationalism and rational progress characterised chemistry's evolution.[448] Robert Boyle, hailed by Gmelin as one of the founding fathers of chemistry as an observation-based science, incorporated this ambivalence. Having laid the foundations for future progress on a variety of fundamental substances such as water and salts, he had also demonstrated to the succeeding generations of chemists 'daß nur durch genaue Versuche und Beobachtungen die Natur erforscht, in der Chemie insbesondere vester Grund gelegt werden könne'.[449] The fact that he had held some irrational beliefs himself did not diminish his contribution to the field's overall progress.[450] If seen from a wider perspective, the systematising works of academic chemists were complementary to the factual discoveries made in practical chemistry. Chronologically, Gmelin thus reinstated the traditional idea championed by Venel and Macquer according to which the real take-off in chemistry had happened after the Thirty Years' War and especially thanks to the establishment of scientific academies (see chapter 2). It was during this period that systematic advances had been made by individual chemists on the foundation of previous artisanal discoveries.

[446] Gmelin, *Geschichte der Chemie*, 1798, 2:676.
[447] Gmelin, *Geschichte der Chemie*, 1797, 1:197–251, especially 203–19.
[448] Gmelin, *Geschichte der Chemie*, 1797, 1:3.
[449] Quote in Gmelin, *Geschichte der Chemie*, 1797, 1:10. Gmelin discusses Boyle's works at length in Gmelin, *Geschichte der Chemie*, 1798, 2:35–109.
[450] Gmelin, *Geschichte der Chemie*, 1798, 2:31–34.

Finally, it is worth noting that Gmelin, too, instrumentalised historical writing as a literary means to critically assess the role of Lavoisier's experimental and theoretical works. The comparison to Wiegleb is informative. Gmelin adopted the latter's technique of translating Lavoisier's terminology into the traditional, phlogistic nomenclature and put his experimental achievements into the wider context of investigations into pneumatic chemistry.[451] In his *Beitrag zur Geschichte der chemischen Kenntnis der sogenannten Gasarten*, he even relegated Lavoisier to second rank behind Priestley and Scheele, whom he identified as the main promoters of pneumatic chemistry. In the *Geschichte,* he eventually conceded Lavoisier a place among the four leaders in pneumatic chemistry, the others being Scheele, Bergman, and Priestley.[452]

If seen from this perspective, Lavoisier's system did not overcome the traditional practice of chemistry but appeared as a product of chemistry's well-established scholarly culture. Having selectively summarised some of its facets, Gmelin dutifully recorded the names of those who had accepted or rejected the system.[453] Yet neither Lavoisier's revised approach to investigating chemical phenomena, nor the conclusions he drew on various chemical phenomena, had any wider implications for the community of chemists. A case in point is the controversy in the 1780s concerning the composite nature of water. Here Gmelin once again downplayed the importance of French chemistry by carefully selecting particular events and visually arranging them to support his claims. As discussed at the outset of this chapter, the main actors in the controversy had undoubtedly been Lavoisier, Meusnier, Monge, and Cavendish. Gmelin, however, recorded their works only as part of a four-page catalogue which comprised all works on water from the late 1790s. This list was indiscriminate towards the relevance of each work and ignored disagreements, alliances, and exchanges between the different scholars. The

---

[451] See for example the section on heat in Gmelin, *Geschichte der Chemie*, 1799, 3:300–10.
[452] Gmelin, Beitrag, 22; Gmelin, *Geschichte der Chemie*, 1799, 3:256.
[453] Gmelin, *Geschichte der Chemie*, 1799, 3:276–98.

uninformed reader thus received the impression that there was no such thing as a philosophical controversy but only the regular course of careful, scholarly investigations.[454] Gmelin applied this strategy with respect to all controversial matters in the Chemical Revolution. As a result, the years between 1770 and 1790 did not appear to be a particularly noteworthy period in the history of chemistry beyond the fact that a great number of observations had been published. Rather, the sheer number of topics treated in the third volume of the *Geschichte* suggests that the topics debated in the Chemical Revolution were only a tiny fragment of chemistry's overall endeavour. This effect was exacerbated by the fact that Gmelin also recorded the contributions to chemistry by scholars of non-European origin, albeit from a chauvinistic perspective.[455] All in all, Lavoisier was part of a larger cosmos grounded in the practical sciences. The almost provocative profanity of the book's final sentence is therefore no coincidence. After nearly three thousand pages of dutiful record-keeping, Gmelin's account ends with the words: 'auch Akadien hat an vielen Stellen Eisenerz in Menge'.[456]

Gmelin's history of chemistry therefore celebrated ambivalence, championed a multi-perspective approach, and combined it with the scholarly rigour of evidencing all claims through footnotes. In its literary form, the *Geschichte* exposed the fertility and efficiency of chemistry as a regular scientific discipline in which scholars, undeterred by the regular incursions of irrationalism, had slowly but steadily transformed the fundament laid by the practical arts into reliable chemical knowledge. Thus, the *Geschichte* illustrated that the symbiotic relationship between academics and practitioners continued until the present, rejecting that its progress could be reduced to the philosophical endeavours of academic chemists. Chemistry was so successful because it was as much in the 'bunte Gesellschaft' as it was naturally aligned with its neighbouring disciplines in the academic 'Naturwissenschaften'.[457] Gmelin implied

[454] Ibid., 312–16.
[455] Ibid., 239.
[456] Ibid., 1288.
[457] Quotes in Gmelin, *Geschichte der Chemie*, 1797, 1:3.

that this was the appropriate framework to approach the overall history of science. After all, chemistry was no outlier in the scientific world because ‘im Ganzen hat die Chemie mit den übrigen Naturwissenschaften gleiche Schicksale gehabt’.[458]

In his methodology as a historian, Gmelin was directly influenced by the newly established school of history-writing in Göttingen, an aspect of his work which scholarship has neglected thus far. As a professor in Göttingen since 1773 as well as a member of the local Academy since 1781, Gmelin had witnessed the emergence of the Göttingen approach to history – as well as the controversies which accompanied it – first hand.[459] The Göttingen school of history and its main representatives, Johann Christoph Gatterer and Johann Ludwig Schlözer, championed an approach that abstained from making conjectures and instead propagated rigorous source criticism as the historian's method of choice. Their ideas also informed Johann Gottfried Eichhorn's *Geschichte der Künste und Wissenschaften seit der Wiederherstellung derselben bis an das Ende des achtzehnten Jahrhunderts* (or simply the ‘Göttingen Geschichte’). Eichhorn, a pupil of the philologist Johann David Michaelis, had been a professor of theology at Göttingen for eight years before he published the first volume of the series, which dealt with the history of European literature and culture, in 1796. By 1820, 56 volumes on a wide array of topics ranging from physics to the fine Arts were published.[460]

Eichhorn's approach to history offered a valuable conceptual framework for Gmelin's aim to counter Lavoisier and mark his own position in the debate on facticity. Giuseppe d'Alessandro has underlined that Eichhorn's project had a clear anti-Kantian thrust. Together with

---

[458] Ibid., 6.

[459] For the biographical details see Hufbauer, *Formation*, 202.

[460] Sjang L. Ten Hagen, ‘How “Facts” Shaped Modern Disciplines’, *Historical Studies in the Natural Sciences* 49, no. 3 (2019): 314–16. For an overview of the Göttingen Geschichte and the diverse approaches taken by its authors between 1796 and 1820 see van Miert, ‘Structuring the History of Knowledge’, 392–94, 396–401. Eichhorn as a cultural historian has been comprehensively analysed in Giuseppe d'Alessandro, ‘Homo historicus. Eichhorns Konzeptualisierung der “Wissenschaft vom Menschen”’, in *Die Wissenschaft vom Menschen in Göttingen um 1800. Wissenschaftliche Praktiken, institutionelle Geographie, europäische Netzwerke*, ed. Hans Erich Bödeker, Veröffentlichungen des Max-Plack-Instituts für Geschichte 237 (Göttingen: Vandenhoeck & Ruprecht, n.d.), 435–53.

several other Göttingen scholars such as Arnold Ludwig Hermann Heeren and in line with Johann Christoph Gatterer's methodology, Eichhorn rejected the idea that historical thought and writing had to be derived from and subservient to a priori philosophical principles. His alternative was a focus on culture.[461] What this could mean for history-writing in the sciences is elucidated in the conceptually and methodologically rich introduction to the first volume of the series, which was only a year before the first volume of Gmelin's *Geschichte* appeared. In it, Eichhorn apodictically stated that the history of arts and sciences could never be separated 'von der Geschichte des gesellschaftlichen Zustandes.' Accordingly, the historian's task was to assess how contextual factors had inhibited or propelled scientific and societal progress alike.[462] Michael Carhart has noted that Eichhorn's advice to the historian to consider contextual influences and focus on the practical realm was a traditional feature of *historia literaria* and thus not particularly innovative.[463] Still, I would suggest that the scope of potential historical agents and contextual factors which Eichhorn mentioned is noteworthy. Indeed, he urged that all history should be written from the perspective of a variety of actors, including town citizens, farmers, aristocrats, and artisans.[464] For the historian, adopting this approach implied that previously neglected fields such as industry, trade, and artisanship had to be considered in historical analyses, for they affected the fate of scientific and artistic disciplines. Moreover, Eichhorn encouraged his peers to abandon their Eurocentrism. Colonial expansion had provided Europeans with countless stimuli both for fruitful speculation and to eradicate prejudices, a contribution which should not go unnoticed.[465] Many aspects of this approach – and in

[461] d'Alessandro, 'Homo Historicus', 439–40, 444.
[462] Johann Gottfried Eichhorn, *Allgemeine Geschichte der Cultur und Litteratur des neueren Europa*, vol. 1 (Göttingen: Johann Georg Rosenbusch, 1796), v–vii, quote on vii.
[463] Michael C. Carhart, 'Historia Literaria and Cultural History from Mylaeus to Eichhorn', in *Momigliano and Antiquarianism. Foundations of the Modern Cultural Sciences*, ed. Peter N. Miller, UCLA Clark Memorial Library Series (Toronto: University of Toronto Press, 2007), 194–95.
[464] Eichhorn, *Allgemeine Geschichte*, 1:lxxv–lxxviii; Carhart, 'Historia Literaria', 194–95.
[465] Eichhorn, *Allgemeine Geschichte*, 1:vi, xxxiv–xxxv.

particular the focus on arts and crafts – were deployed by Gmelin in writing the history of chemistry.

Notwithstanding its association with an innovative project of historical inquiry in the late eighteenth century, Gmelin's history received mixed criticism. Yet, while some reviewers complained about its lack of structure and Gmelin's apparent refusal to distinguish crucial discoveries from less important ones,[466] the work also received praise as an innovative contribution to both science and history-writing. The British *Anti-Jacobin Review* presented Gmelin's history as a fabulous expression of the Göttingen project, a city which he claimed to be the 'second Athens of Germany'. Accordingly, it was 'one of the most curious monuments of the combination of profound and entertaining erudition, with accurate science' and therefore 'absolutely *unique* in the literature of Chemistry'.[467]

Conclusion

The present chapter has shown that historical writing in the late eighteenth century was considered a fruitful and legitimate endeavour to intervene in the epistemological debates at stake in the Chemical Revolution. This is evidenced by the writings of Lavoisier, which applied a new view on the evolution of chemistry to revise traditional notions of facticity, and by the critical German reactions, embodied in the large-scale histories of chemistry written by Wiegleb and Gmelin throughout the 1790s. Indeed, several reviews of the latter works confirm that the wider scholarly community was aware of history's epistemological function, too.

[466] Johann Jacob Hartenkeil, 'Geschichte der Chemie seit dem Wiederaufleben der Wissenschaften bis an das Ende des achtzehnten Jahrhunderts, von Johann Friedr. Gmelin, Zweyter Band (Review)', *Medicinisch-Chirurgische Zeitung,* 4, no. 92 (19 November 1798): 241–50; [anon.], 'Geschichte der Chemie, seit dem Wiederaufleben der Wissenschaften bis an das Ende des achtzehnten Jahrhunderts, von Johann Friedrich Gmelin, Dritter Band (Review)', *Litteratur-Zeitung (Erlangen)*, no. 150 (1 August 1800): 1193–95.

[467] [anon.], 'Geschichte der Chemie, von Joh. Friedr. Gmelin &.c or History of Chemistry, by John Frederick Gmelin, 8vo 3 Vols. (Review)', *The Anti-Jacobin Review and Magazine* 17 (1804): 480–85, quotes on 480, 485.

According to the reviewer of Wiegleb's history in the *Monthly Review*, it rightly demonstrated that aspects of Lavoisier's chemistry were already present in the works of early-eighteenth-century scholars such as John Mayow or Stephen Hales.[468] Lorenz von Crell, too, hailed 'die richtige Schätzung des wahren Erfinders solcher Entdeckungen, welches sich nachher Neuere zugeignet haben' as one of the work's particular advantages.[469]

Attentive readers will have noted that one crucial aspect of debates on facticity has been all but absent from this chapter: the role played by signs and language in observational settings and practices of systematisation alike. Ever since Maurice Crosland's seminal monography on chemical nomenclature was published in 1962, the topic has been at the heart of debates on the Chemical Revolution.[470] As I shall show in the next chapter, assessments of the history of chemical nomenclature were once again a prominent instrument for French and German chemists to substantiate their positions on this matter.

---

468 [anon.], 'Geschichte des Wachsthums und der Erfindungen in der Chemie, &c. i.e. A History of the Progress and Discoveries in Chemistry, by John Christian Wiegleb 8vo. 2 Vols. Berlin (Review)', *The Monthly Review, or Literary Journal* 6 (1791): 546.
469 Lorenz von Crell, 'Geschichte des Wachsthums, und der Erfindungen der Chemie in der neueren Zeit von Joh. Christ. Wiegleb. Erster Band (Review)', *Chemische Annalen für die Freunde der Naturlehre, Arzneygelahrtheit, Haushaltungskunst, und Manufakturen* 2, no. 8 (1790): 151–54, quote on 153.
470 Crosland, *Historical Studies*.

Chapter 4: Words with a Past. Exploring the History of Chemical Nomenclature (1775–1795)

Introduction

While many Enlightenment philosophers shared an interest in the history of language and its impact on human thought,[471] historians of the natural sciences long neglected the role of signs in the formation of their disciplines. Neither the generalising *histoires de l'esprit* nor the histories of chemistry written before 1780 addressed the question of how scientific terminology impacted the Baconian sciences since the seventeenth century. According to mid-eighteenth-century observationalism, progress was determined by the interplay between discoveries and hypotheses alone (see chapter 2). When publicly questioning the existence of phlogiston for the first time in 1777, Antoine de Lavoisier still relied on this explicative pattern of scientific evolution to vindicate the validity of his calls, making no mention of nomenclature.[472] Language, if it was considered at all by historians of the modern natural sciences, functioned as a repository of observations. According to Turgot, signs were nothing more than 'un trésor commun qu'une génération transmet à l'autre, ainsi qu'un heritage toujours augmenté des découvertes de chaque siècle.'[473]

---

[471] Lifschitz, *Language*; Avi Lifschitz, 'The Arbitrariness of the Linguistic Sign. Variations on an Enlightenment Theme', *Journal of the History of Ideas* 73, no. 4 (2012): 537–57.
[472] Lavoisier, 'Mémoire sur la combustion en général', 592. The *Mémoire sur la combustion*, read to the Academy in 1777 and published in 1780. Here, systems and hypotheses alike appeared as 'des méthodes d'approximation' and 'des hypothèses' which could be 'successivement modifiées, corrigées & changées à mesure qu'elles sont démenties par l'expérience' to the end that one day, chemists would have insight into the 'vraies loix de la Nature'. As William Albury has shown, this quote demonstrates the familiarity of Lavoisier with Condillac's early works, in particular the *Traité des Systèmes* (1749), which was a key text for mid-eighteenth-century observationalism. See Albury, 'Logic', 112–16 and chapter 2 of this thesis.
[473] Turgot, 'Tableau philosophique', 215.

Yet, from the 1780s onwards, the role of language and signs in the historical evolution of modern chemistry became a matter of discussion. It was Lavoisier again who used history-writing as an instrument to assess this topic. In his introduction to the *Méthode de Nomenclature Chimique* (1787), he proposed a radical reinterpretation of chemistry's history through the lens of language. The resulting narrative complemented his earlier claims made in the *Réflexions sur le Phlogistique* (1783/1786). And again, the German chemists discussed the Frenchman's approach to history-writing from various angles. As a result, a vivid discourse on the history of chemistry's nomenclature and its overall role for scientific progress emerged early in the 1790s. The purpose of the present chapter is to trace the dynamic of this debate and its relationship with the wider implications of the Chemical Revolution.

Before analysing the argumentative function of historical writing on chemical terminology during the Chemical Revolution, it is necessary to assess how the problem of language entered the philosophical discourse on chemistry in the first place. As discussed in section 1, existing scholarship has identified several scientific developments inside and outside chemistry which put chemistry's existing nomenclature on the scholarly agenda in the 1770s. While, in principle, I agree with the overall conclusions of this internalist account, I argue that a wider Parisian debate on the role of language in all natural sciences was the reason why Lavoisier and five of his colleagues proposed a full-scale revision of chemical nomenclature in 1787. Positioning themselves in this controversy was vital for the chemists, for the allocation of institutional resources to their field was at stake in the debate too.[474] In my view, the role played by zoologist Félix Vicq d'Azyr in pushing the chemists towards reform has been underestimated by scholarship thus far. Being a mentor, patron, and long-standing colleague to four of

[474] Corsi, *Age*, 1–39.

the six authors of the *Méthode*, his opinion influenced their epistemological stances on several levels.[475]

Lavoisier, then, made a virtue out of necessity. Countering the attempts to integrate chemical language into the framework of observationalist histories of chemistry made by Torbern Bergman in the late 1770s and early 1780s (section 2), Lavoisier radically reinterpreted chemistry's history through the lens of language in the *Méthode de Nomenclature chimique* (1787). Analysing this well-known publication from this angle will be the purpose of section 3. Here, I argue that Lavoisier's history of chemical nomenclature formed yet another intervention in the ongoing controversy with his British colleagues on pneumatic chemistry and its theoretical as well as epistemological implications. The historical narrative established in the *Méthode* thus has to be read in tandem with his complementary accounts in the *Réflexions* and the *Traité* (see chapter 3). Taking his cue from the philosopher Étienne Bonnot de Condillac, Lavoisier claimed that the traditional terminology of chemistry induced errors in the chemists' reasoning because of its roots in alchemy. Thus, his historical account implicitly accused the British opponents of his oxygen theory of unwittingly reproducing irrational positions through their nomenclatural choices. Writing the history of chemistry's terminology became entwined with the adoption of a particular position on the philosophy of science.

In a striking parallel to the developments discussed in the previous chapter, several German chemists instantly noted this strategy. Section 4 shows how, in the early 1790s, they debated the extent to which language impacted scientific progress from a general perspective and scrutinised the historical assessment by Lavoisier in great detail. I shall analyse the critical assessments of Lavoisier's positions on the history of chemical terminology by three German chemists, Lorenz Florenz von Crell, the editor of the *Chemische Annalen*; the medical doctor

[475] To my knowledge, William Albury is the only scholar who thought about the potential impact of Vicq d'Azyr on the reform of chemical nomenclature. His approach is discussed below, see especially footnote 493.

Johann Andreas Baptist Scherer; and the pharmacist Johann Friedrich Westrumb. In their publications, which appeared in short succession between 1790 and 1793, they used historical writing to mark their epistemological positions in a lucid and sophisticated way. Studying their texts underlines once more just how actively chemical practitioners participated in the most complicated debates in chemistry in the latter half of the eighteenth century, using historical inquiries as scientific methods.

Reforming Chemical Nomenclature in the Late Eighteenth Century

The chemical nomenclature of the eighteenth century was characterised by its great diversity. Individual names were not coined based on a previously established set of criteria. The names of individual substances could include a variety of attributes referring to their geographical origin, physical appearance, discoverer, or the experiments they were produced in. Denominations were chosen on an ad hoc basis and usually remained in circulation over long periods. Therefore, the names in use greatly varied between the artisanal, industrial, academic, and national sub-communities of eighteenth-century chemistry, which resulted in numerous synonyms and polynyms.[476]

While earlier in the century most chemists had been able to play the different registers without complaining,[477] the terminological diversity of chemistry became an issue in the academic discourse from the 1770s onwards. One reason for this development was that it became challenging to coin adequate names for gases that had been observed in combustion and calcination reactions. In interpreting them, the chemists had to make assumptions not only on the nature of the gases involved but also on the other reactants. The latter were often well-known

[476] Klein and Lefèvre, *Materials*, 78–79, 91; Lefèvre, 'Méthode', 13–14, Footnote 15.
[477] Klein and Lefèvre, *Materials*, 75 and chapter 2 of this thesis.

substances such as certain salts or metals that had been investigated and classified by chemists for a long time. The practices of naming substances and analysing their composition thus became increasingly intertwined.[478] This background surfaces in the terminological reforms proposed by the Swedish naturalist Torbern Bergman and his French colleague, Guyton de Morveau, in the late 1770s and early 1780s. Both scholars, who also corresponded on the matter,[479] implicitly drew on their knowledge of pneumatic chemistry when choosing the new names for chemical substances. For example, Bergman's denomination for a variety of salts rested on his interpretation of the nature of Black's fixed air.[480] Similarly, Guyton abstained from applying Lavoisier's concept of oxygen when naming acids in 1782, thus implicitly marking his position in pneumatic chemistry by way of his nomenclatural choices.[481]

Developments outside chemistry were a factor in the chemists' growing concern for linguistic phenomena, too. From the 1750s onwards, the idea of terminological standardisation was increasingly debated in the wider European naturalist community into which the chemists were integrated. Bergman in particular witnessed the success of the Linnean reform of botanical nomenclature first hand. Having been trained by Carolus Linnaeus in Uppsala, he was

---

[478] Ibid., 91, 103–4. This is the more sophisticated version of the traditional internalist account which, in the tradition of Thomas Kuhn and Wolf Lepenies, postulated that the great number of experimental discoveries made in the eighteenth century put chemistry's terminology on the agenda, for the newly gained data could not be adequately depicted by the traditional phlogistic nomenclature. The most prominent proponent of this explanation has been Beretta, *The Enlightenment of Matter*, 29–30, 47–49, 95–106, 137–57. By contrast, the nexus between pneumatic chemistry and the nomenclature reforms proposed from the 1770s onwards has been questioned by some historians of science: William Arthur Smeaton, 'The Contributions of P.-J. Macquer, T. O. Bergman and L. B. Guyton de Morveau to the Reform of Chemical Nomenclature', *Annals of Science* 10, no. 2 (1954): 96–97; Maurice Crosland, 'Lavoisier's Achievement. More than a Chemical Revolution', *Ambix* 56, no. 2 (2009): 98.

[479] For a detailed analysis of their efforts see Crosland, *Historical Studies*, 142–67; Beretta, *The Enlightenment of Matter*, 137–57, the latter with remarks on the chronology of their correspondence on p. 148.

[480] Crosland, *Historical Studies*, 145.

[481] This claim is further bolstered by the fact that Guyton's reflections on the notion of *air fixe* in his *Mémoire* on the nomenclature reform abstained from mentioning Lavoisier's theory, see Bernard-Louis Guyton de Morveau, 'Mémoire sur les dénominations chymiques, la nécessité d'en perfectionner le systême, & les règles pour y parvenir', *Observations sur la physique, sur l'histoire naturelle et sur les arts* 19 (1782): 381–82. On the close connection of studying acids and pneumatic chemistry in the late eighteenth century see Crosland, 'Lavoisier's Theory of Acidity', 306–25, especially 317-318 where Crosland hints that Guyton's wider understanding of acidity was informed by his views on the nature of fire.

acutely aware of the potential advantages which a standardised nomenclature could bring about, most importantly the possibility for swifter information exchanges between scholars.[482]

Historians of science have argued that Lavoisier used the opportunity of the vibrant controversy on language in science to further his own oxygen theory within the European community of chemists. His joining of forces with Guyton de Morveau and four other chemists to standardise chemical nomenclature thus appears as a conscious, rational, and self-determined intervention in the scientific discourse, clothed in the language of Condillac's *Logique* (1780).[483] However, when considering the epistemological implications of the debate on airs, acids, and water in the 1780s, such explanations appear less convincing. Why should the Parisian chemists add another controversial layer to their already heated controversy with the British colleagues, in particular given that Lavoisier's positions on water, oxygen, and phlogiston were far from being commonly accepted, not in Paris let alone within the European chemical community (see chapter 3)? In this situation, the Parisian chemists were certainly aware that an attempt to establish an entirely new nomenclature would be met with considerable resistance, for it involved the risk that the strong ties between practitioners and academics would eventually be cut.[484] These qualifications highlight that, in the circumstances, a full-scale nomenclature reform could hardly be viewed as a powerful argumentative tool for Lavoisier's contested theory.

---

[482] Crosland, *Historical Studies*, 139–43; Albury, 'Logic', 150–51; Pascal Duris, *Linné et la France (1780-1850)* (Geneva: Librairie Droz, 1993), 122–32. On the advantages provided by Linnaeus' nomenclature see Müller-Wille, 'Names', 109–19; Peter F. Stevens, *The Development of Biological Systematics. Antoine-Laurent de Jussieu, Nature, and the Natural System* (New York NY: Columbia University Press, 1994), 266–67.

[483] Perrin, 'Triumph', 50–57; Klein and Lefèvre, *Materials*, 88; Bernadette Bensaude-Vincent, 'Lavoisier lecteur de Condillac', *Dix-huitième siècle* 42, no. 1 (2010): 473–89.

[484] Indeed, scholars raised this issue immediately after the publication of the *Méthode*, see Bernadette Bensaude-Vincent, 'Languages in Chemistry', in *The Cambridge History of Science. The Modern Physical and Mathematical Sciences*, ed. Mary Jo Nye, vol. 5 (Cambridge: Cambridge University Press, 2003), 179–80; Anne Claire Déré, 'La réception de la nomenclature reformée par le corps médical français', in *Lavoisier in European Context. Negotiating a New Language for Chemistry*, ed. Ferdinando Abbri and Bernadette Bensaude-Vincent (Canton MA: Science History Publications, 1995), 207–24.

On such grounds, I argue that the six chemists surrounding Lavoisier above all propagated a nomenclature reform to cater to a Parisian audience. For reasons which are somewhat idiosyncratic to the French capital and its scientific culture in the late eighteenth century, the question of language in science was debated here with an even greater intensity than elsewhere. Crucially, the controversy was intimately entwined with institutional and personal factors such as the allocation of scarce resources to scientific inquiries and scholarly patronage relationships.[485] In the following, I shall piece together the different facets of this local debate based on existing scholarship. My argument is that the complex dynamic of the controversy exercised intellectual pressure on the chemists to reflect upon their own nomenclatural practices.

Two factors which shaped the Parisian naturalist discourse on language deserve particular attention, the first of which is the role model of botany for other fields of inquiry. While the binominal nomenclature developed by the Swede Carolus Linnaeus in the mid-century had been adopted by many Parisian botanists by the 1770s despite Buffon's objections,[486] the question of its application to other branches of natural history continued to be heatedly debated. Pietro Corsi and Stéphane Schmitt have cautioned that this controversy was not marked by the clash of two irreconcilable paradigms. Instead, some Parisian scientists, such as Bernard Germain de Lacepède, creatively blended aspects of the Buffonian and Linnean approaches.[487] Nevertheless, they conclude that the influence of Linnaeus was growing in Paris throughout the 1780s, both in the perceptible form of his nomenclature principles being adopted by an increasing number of naturalists and as a symbol for a particular way of scientific investigation. A particularly visible effect of this was the foundation shortly before Buffon's death in 1787

---

485 Corsi, *Age*, 1–39.

486 Stevens, *Development*, 23; Müller-Wille, 'Names', 114; Stéphane van Damme, 'In the Name of Linnaeus. Paris as a Disputed Capital of Natural Knowledge (1730-1789)', in *Linnaeus, Natural History and the Circulation of Knowledge*, ed. Hanna Hodacs, Kenneth Nyberg, and Stéphane van Damme, Oxford University Studies in the Enlightenment, 2018:01 (Liverpool: Liverpool University Press / Oxford Voltaire Foundation, 2018), 114–15. For the different stages of Linnaeus' reception in France see Duris, *Linné*, 31–87.

487 Corsi, *Age*, 3–4, 10; Schmitt, 'Lacepède's Syncretic Contribution'.

of the *Société Linnéenne*, whose successor organisation – the *Société d'Histoire naturelle* – counted almost all Parisian naturalists among its members. In many branches of inquiry, scholars thus compared their terminology, its formation principles, and its consistency to the example set by Linnean botany.[488]

Second, the posthumous publication of Étienne Bonnot de Condillac's *Logique*, a work on the philosophy of language with a particular focus on the sciences, reverberated throughout the Parisian community in the 1780s.[489] In it, Condillac argued that the formation principles of any language had a crucial impact both on reasoning itself and on the process of representing an observation on natural processes. As long as experience and observation served as tools of correction, it was possible to align different signs within a semantic web which depicted nature. This had been the case in early human history. Yet, once abstract topics without real-world referents entered a language, it lost its analytical clarity with the result that signs could transmit errors for prolonged periods of time.[490] When assessing the *status quo* in the natural sciences of his day against this backdrop, Condillac painted a dark picture. His overall verdict was that, apart from minor exceptions, the signs used by naturalists of all disciplines 'ont les mêmes défauts que les autres, & de plus grands encore. On les parle tout aussi souvent sans rien dire: souvent encore on ne les parle que pour dire des absurdités; & en général, il ne paroît pas qu'on les parle avec les dessein de se faire entendre.' Such a verdict implied a reform based on preconceived, rational principles.[491]

When individual Parisian naturalists had to decide whether to side with those participants in the debate who supported a reform of nomenclature based on botany and the

[488] Corsi, *Age*, 6–7; Duris, *Linné*, 68–87, 131–51; Beretta, *The Enlightenment of Matter*, 58–61.
[489] Corsi, *Age*, 4; William Randall Albury, 'Introduction', in *Etienne de Condillac. La Logique. Logic*, ed. and trans. William Randall Albury (New York: Abaris Books, 1980), 26–28. For the intellectual roots of Condillac's *Logique* in Charles Michel d'Epée's concept of a sign languages see Sophia A. Rosenfeld, *A Revolution in Language. The Problem of Signs in Late Eighteenth-Century France* (Stanford CA: Stanford University Press, 2001), 92–101.
[490] See the summaries of the work by Albury, 'Logic', 64–74; Albury, 'Introduction', 21–23; Roberts, 'Condillac', 254–56; Beretta, *The Enlightenment of Matter*, 194–98.
[491] Condillac, *Logique*, 102; Beretta, *The Enlightenment of Matter*, 197 quotes parts of the same passage.

philosophy of Condillac, or with the more traditional approach aligned with Buffon's philosophy of science, potential career options played a crucial role. By the 1780s, it had become clear that the era of Buffon's institutional dominance as the head of the *Jardin du Roi* and an opponent of all things Linnean was clearly coming to an end, given his old age. Considerable institutional influence and financial power would become freed at his demise, which eventually occurred in 1788. Thus, positioning oneself in the debate was of great importance, in particular for the young generation of aspiring scholars, from the botanist and zoologist Lamarck to chemists such as Fourcroy.[492]

As we have seen in chapter 1, it was a recipe for institutional success to align one's scientific positions with those of potentially influential patrons. It was precisely for this reason that the chemists could not ignore it when the medic and zoologist, Félix Vicq d'Azyr, presented his views on the impact of language in science in 1786.[493] In this year, Vicq d'Azyr, who was one of the most influential scholars in pre-revolutionary Paris, set out to reform the field of comparative anatomy based on his readings of both Condillac and Linnaeus in the *Traité d'Anatomie et de Physiologie*.[494] Its two introductions can also be read as essays on the philosophy of science underlying all branches of natural history, including chemistry. According to Vicq d'Azyr, any science required a scholar to engage in a range of activities such as observing facts, creating ideas, associating them, and forming classes of objects to ultimately

[492] Corsi, *Age*, 1–6, 14–18.
[493] The only author to have considered the potential impact of Vicq d'Azyr on the reform of chemical nomenclature has been William Albury: Albury, 'Logic', 154–55. Albury suggested that Lavoisier resumed his earlier engagement with Condillac in 1787 because of the publication of Félix Vicq d'Azyr' *Traité d'Anatomie et de Physiologie* (1786) which was grounded in Condillac's *Logique*. Fourcroy, a *protégé* of both scholars, might have pointed Lavoisier to the work of his colleague, if the latter was not aware of it already. From this perspective, it appears as if Lavoisier's Condillacean turn in the nomenclature reform of 1787 was prompted by an amicable intellectual exchange between the two scholars, as part of which Vicq d'Azyr could have provided somewhat of a final nudge for Lavoisier to resort to the philosophy of language in order to realise the full potential of his theory. Crucially, Albury thus does not consider the institutional and intellectual pressure faced by Parisian chemist.
[494] Corsi, *Age*, 26–29; Albury, 'Logic', 95–99. For a reconstruction of Vicq d'Azyr's scientific positions on anatomy and zoology see the latter on 78-95 and Schmitt, 'From Physiology to Classification'.

establish, 'par des paroles et des signes, la nature et les rapports de la pensée.'[495] Yet, it was only based on a sound nomenclature that these activities could be considered rational. Vicq d'Azyr underlined this point by assessing botany as an example. Historically, its language had been full of 'expressions qui n'avoient aucune liaison entre elles' and included 'diverses considérations religieuses, divers sentiments de reconnaissance et d'aimitié' which resulted in 'la liste des productions de la nature surchargée de noms bien étrangers à son culte.'[496] This irregularity hampered botany's progress up to the point in time when Carolus Linneaus' novel nomenclature was accepted by the naturalist community. His approach was the finest example that all other branches had to follow because 'ce grand homme a compris que la base de tout édifice de l'esprit est la science élémentaire des mots, sans laquelle nul genre de connoissances ne peut ni s'élever, ni s'affermir.'[497] With explicit reference to Condillac, Vicq d'Azyr stated that it was only by considering language as a basis for all scientific reasoning and by constructing it with mathematical precision that a naturalist could succeed in describing, comparing, and aligning their observations. Forming a scientific nomenclature had to precede (and not follow) the act of observing.[498] This imperative applied not only apply to anatomy and physiology but also to chemistry. Indeed, Vicq d'Azyr explained that a reform of chemical nomenclature was already under way, without specifying which endeavour he was referring to. Considering that Lavoisier and Guyton did not start their collaboration until a year later, and given Vicq d'Azyr's great familiarity with the ongoing debates in chemistry, it is reasonable to assume that this was a scarcely hidden prompt for the chemists to apply the standards set out in the *Traité* to their own field.[499]

---

495 Félix Vicq d'Azyr, *Traité d'anatomie et de physiologie. Avec des Planches Coloriées.*, vol. 1 (Paris: François Didot, 1786), 47.
496 Ibid.
497 Ibid.
498 Ibid., 1:47–48. For an analysis of how Vicq d'Azyr read Linnaeus through the lens of Condillac and the consequences for the anatomical nomenclature see Albury, 'Logic', 100–105.
499 Vicq d'Azyr, *Traité*, 1:50. For a different interpretation of the passage see Albury, 'Logic', 105–8. On the likely starting date of Guyton's and Lavoisier's collaboration Klein and Lefèvre, *Materials*, 89.

And, indeed, they had to listen to Vicq d'Azyr given his powerful institutional position. Of the six contributors to the new nomenclature, only two – namely Claude-Louis Berthellot and Pierre Adet – did not have strong patronage or amicable bonds with Vicq d'Azyr. The latter's relationship with Lavoisier dated back at least to the mid-1770s. Since then, they had both been members of the *Académie Royale des Sciences* and therefore met on a regular basis. In addition, Lavoisier early in the 1780s became a corresponding member of the *Société Royale de Medicine*. The society had been co-founded by Vicq d'Azyr who also acted as its permanent secretary. As evidenced by their written correspondence, the two naturalists frequently coordinated their administrative actions. At times, they even shared confidential ministerial information with each another, a practice which testifies to their strong personal bonds and mutual trust. Equally, the correspondence vindicates that the two scholars were aware of the latest developments in each other's study fields. For instance, at one point in the 1780s, Vicq d'Azyr asked Lavoisier to enlighten him about the most recent 'découvertes chimiques de feu' by Bergman.[500]

Guyton de Morveau's links to Vicq d'Azyr and Lavoisier were less obvious but nonetheless relevant. By the 1780s, Guyton had doubtlessly become one of the most important chemists in the Republic of Letters. Having left his post in the Royal administration in Dijon in 1782, he aspired to become a professional, full-time chemist. In 1784, following the death of Pierre-Joseph Macquer, who had supported him since the late 1760s, he was arguably on the lookout for further institutional and personal ties in the capital. The fact that Lavoisier and Vicq

[500] Félix Vicq d'Azyr, 'Lettre à Lavoisier, 23 Mars 1785', in *Oeuvres de Lavoisier. Correspondance*, ed. Michelle Goupil, Philippe Savoie, and René Taton, vol. 4 (1784-1786) (Paris: Belin, 1986), 84–85, quote on 84. See also Félix Vicq d'Azyr, 'Lettre à Lavoisier, 15 Septembre 1785', in *Oeuvres. Correspondance*, ed. Goupil, Savoie, and Taton, 4 (1784-1786), 154–55; Félix Vicq d'Azyr, 'Lettre à Lavoisier, 8 Novembre 1785', in *Oeuvres. Correspondance*, ed. Goupil, Savoie, and Taton, 4 (1784-1786), 177–78; Félix Vicq d'Azyr, 'Lettre à Lavoisier, 21 Décembre 1785', in *Oeuvres. Correspondance*, ed. Goupil, Savoie, and Taton, 4 (1784-1786), 194; Antoine de Lavoisier, 'Lettre à Vicq d'Azyr, 18 Décembre 1785', in *Oeuvres. Correspondance*, ed. Goupil, Savoie, and Taton, 4 (1784-1786), 190. Albury, 'Logic', 155 footnote 53; P. Huard and M.J. Imbault-Huart, 'Félix Vicq d'Azyr', in *Complete Dictionary of Scientific Biography*, vol. 14 (Detroit MI: Charles Scribner's Sons, 2008), 14.

d'Azyr orchestrated his election into the *Société* can be seen as a step in this direction and showcases the deepening bonds between the three scientists.[501]

For younger aspiring scholars in chemistry, the patronage of both Vicq d'Azyr and Lavoisier proved even more attractive in the 1780s. Antoine de Fourcroy, whose entire career was somewhat steered by Vicq d'Azyr and his protection, already served as an example in chapter 1.[502] By the mid-1780s, Vicq d'Azyr, Lavoisier, and their protégé Fourcroy regularly met not only in the Académie or the *Société de Médicine* but also in the very active *Société d'Agriculture de la Généralité de Paris*, which the three men joined in short succession in 1783 and 1784.[503] Fourcroy's path appears to have been the blueprint for Jean-Henri Hassenfratz, the youngest co-author of the nomenclature, who joined the Lavoisier-Vicq d'Azyr-circle in the 1780s. Hassenfratz, originally a carpenter, tried to prepare his transition from a position in the military into the Parisian academic world by sending numerous *Mémoires* to the *Société de Médicine*, chaired by Vicq d'Azyr. Having found a favourable reception, he was quickly made a corresponding member in 1783 and made the acquaintance of Lavoisier, Fourcroy, and the mathematician Gaspard Monge, who also collaborated with Lavoisier. They admitted him to the Arsenal circle, supported his career in the *École des Mines*, and, eventually unsuccessfully, pushed his candidature for the Academy in 1786.[504] Hence, although Vicq d'Azyr was neither a part of the famous Arsenal group nor one of Lavoisier's experimental collaborators like

---

[501] Kim, *Affinity*, 230, 232, 240; William Arthur Smeaton, 'Louis Bernard Guyton de Morveau, F.R.S. (1737-1816) and His Relations with British Scientists', *Notes and Records of the Royal Society of London* 22, no. 1/2 (1967): 116. The process of Guyton's election can be reconstructed from the following letters: Antoine de Lavoisier, 'Lettre à Guyton de Morveau (avant 24 Juin 1786)', in *Oeuvres de Lavoisier. Correspondance*, ed. Michelle Goupil, Philippe Savoie, and René Taton, vol. 4 (1784-1786) (Paris: Belin, 1986), 223–24; Antoine de Lavoisier, 'Lettre à Vicq d'Azyr, 2 Juillet 1786', in *Oeuvres. Correspondance*, ed. Goupil, Savoie, and Taton, 4 (1784-1786), 229; Antoine de Lavoisier, 'Lettre à Guyton de Morveau, 6 Juillet 1786', in *Oeuvres. Correspondance*, ed. Goupil, Savoie, and Taton, 4 (1784-1786), 231–32; Bernard-Louis Guyton de Morveau, 'Lettre à Lavoisier, 29 Juin 1786', in *Oeuvres. Correspondance*, ed. Goupil, Savoie, and Taton, 4 (1784-1786), 227–28; Bernard-Louis Guyton de Morveau, 'Lettre à Lavoisier et Vicq d'Azyr, 18 Juillet 1786', in *Oeuvres. Correspondance*, ed. Goupil, Savoie, and Taton, 4 (1784-1786), 233–34.
[502] See the section entitled *Patronage in Paris* in chapter 1.
[503] Smeaton, *Fourcroy*, 24.
[504] Emmanuel Grison, *L'étonnant parcours du républicain J.H. Hassenfratz (1755-1827)* (Paris: Presses de l'Ecole des Mines, 1996), 31–35, 42–52, 59–65.

Simon de La Place, Gaspard Monge, and Jean-Baptiste-Michel Bucquet, the personal connections between him and the chemists were very strong. He certainly communicated his normative ideas on the primacy of language in science to the chemists on the occasion of their frequent meetings. Given his role as a patron, and the imminent institutional reshuffling in Paris, his scientific position must have put considerable pressure on the chemists.

In conclusion, I argue that several entwined factors prompted Lavoisier and his colleagues to propose a revamp of chemical nomenclature in the 1780s. While the developments in pneumatic chemistry as well as initial linguistic reform attempts paved the way, it is unlikely that the chemists would have added an additional layer of complexity to their debates with their British colleagues if it had not been for the Parisian debate on the epistemological role of signs in science. Since Félix Vicq d'Azyr, who served as a patron or ally to four of the six authors of the *Méthode*, concomitantly argued for a revamp of comparative anatomy using Condillac's philosophy and the Linnean nomenclature as prompts, the chemists were under pressure to react in order to secure the position of their field within the ranks of Parisian naturalists, as well as their personal career options. Given this complex dynamic, Lavoisier had to look for convincing arguments in favour of the reform. Again, he chose to substantiate his views through a re-assessment of chemistry's history. To fully appreciate this strategy, we have to briefly recapitulate the status of language in chemical history-writing early in the 1780s. This will be the topic of the next section.

Mimetic Signs. Language in Chemical History-Writing, 1778–1787

Lavoisier was not the first chemist to scrutinise the history of chemical language. To understand the radical nature of his claims, one must assess Torbern Bergman's views on the topic, who had preceded Lavoisier and Guyton in suggesting terminological reforms from the late 1770s onwards. An esteemed chemist with a particular expertise in mineralogy, Bergman also showed great interest in the history of chemistry, supervising two doctoral theses on the topic.[505]

In his own writings on chemical terminology, Bergman touched upon historical topics too. Here, he reiterated the ideas about chemistry's evolution according to *histoires de l'esprit,* seeking to integrate the evolution of chemical nomenclature into its narrative and conceptual framework. Bergman first applied this strategy in his *Introitus de indagando vero*. That text, a veritable treatise on the philosophy of science, appeared in 1779 in a collection of Bergman's smaller works and was translated by Guyton into French within a year.[506] While suggesting to apply the Linnean type of binomial nomenclature to the terminology of salts,[507] Bergman's essay also championed a traditional view of the driving forces of scientific progress. In particular, he argued that, as long as they were grounded in experimental work, hypotheses and conjectures played a vital role in the accumulation and refinement of knowledge in chemistry.[508] In the following, he abstained from making any connection between the practices of conjecturing and hypothesising on the one hand and the names of substances on the other hand. He simply pointed out that sticking to 'nomina vaga' generally had a negative impact on scholarly reasoning, an impediment which many of chemistry's neighbouring fields had already addressed successfully.[509] Intellectually, the problem of nomenclature appeared to be confined to the realm of truthful mimesis.

---

[505] In scholarship, these essays are often portrayed as Bergman's own works, see for example Evamarie Wolf, *Über die Anfänge der Pharmaziegeschichtsschreibung. Von Johannes Ruellius (1529) bis David Peter Hermann Schmidt (1835)*, 2nd ed., Quellen und Studien zur Geschichte der Pharmazie 72 (Stuttgart: Wissenschaftliche Verlagsgesellschaft, 1996), 48–52; Strube, *Chemie*, 12. In fact, they were written by two of his students: Jacobus Paulin, *Dissertatio gradualis de primordiis chemiae* (Uppsala: Johan. Edman, 1779); Petrus Afzelius Arvidson, *Dissertatio gradualis sistens chemiae progressu a medio saec. vii a medium saec xvii* (Uppsala: Johan Edman, 1782). The confusion might result from the fact that Johann Christian Wiegleb, perhaps strategically, identified the renowned Bergman as the author when translating them into German in the early 1790s, see the 'Vorrede' of Petrus Afzelius Arvidson and Jacobus Paulin, *Geschichte des Wachsthums und der Erfindungen in der Chemie in der älteste und mittlern Zeit*, trans. Johann Christian Wiegleb (Berlin and Stettin: Friedrich Nicolai, 1792). For the publication history see Klosa, *Johann Christian Wiegleb*, 247–48, 257–58.
[506] On the translation see Bret, 'Letter', 128; Smeaton, 'Contributions', 90.
[507] Crosland, *Historical Studies*, 142, 154.
[508] Torbern Bergman, 'Introitus de indagando vero', Opuscula physica et chemica, pleraque antea seorsim edita, iam ab auctore collecta, revisa et aucta 1 (Holmiae, Upsaliae et Aboae: Magnus Swederus, 1779), iv.
[509] Ibid., xiv.

A few years later, Bergman further developed this position in the *Meditationes de Systemate Fossilium Naturali* (1784) where he set out to standardise most of the denomination principles for minerals.[510] The text is the first attempt of the period to explain the current state of chemical nomenclature through its historical evolution. In it, Bergman identified chemical terminology as a historically contingent phenomenon. The choice of substance denominations as well as their semantic scope resulted from the shifting approaches to chemistry. This stance allowed him to seamlessly integrate chemical nomenclature into the broader chronological framework provided by earlier histories of chemistry and *histoires de l'esprit*. In the dark prehistory of the field, the discoverers of new substances had naturally been unable to form appropriate names because of their ignorance. The alchemists, who had followed them, equally contributed to the growing body of misnomers due to their irrational aim to make gold or to produce the universal remedy. Additionally, some terms had emerged accidentally ('qualibet occasione foruito orta sunt'), which made the linguistic confusion complete.[511] The advent of observational philosophy of science had brought about some relief. Since chemists had started working with a 'sanior theoria' which was 'experiendo fundata', the process of naming substances occurred in a much more rational manner.[512]

With this historical perspective, Bergman not only left the temporal core structure of previous histories of chemistry intact but related nomenclatural efforts to the broader Enlightenment trend of reforming language according to allegedly more rational criteria. Thus, he anticipated a crucial feature of modern attempts to explain how the question of language entered the chemical discourse in the eighteenth century (see previous section). He postulated that chemistry, the 'nobilissima scientia, quae ipsam Philosophiae naturalis quasi medullam

---

[510] See Crosland, *Historical Studies*, 148–52; Bergman, 'Introitus de indagando vero', 147–48. For the publication history, see Lennartson, *Scheele*, 361.
[511] Torbern Bergman, *Meditationes de systemate fossilium naturali* (Florence: Aloysius Carlieri, 1784), 102–3, quote on 103.
[512] Ibid., 103.

constituit', must not stay behind the broader contemporary effort of rationalising even the vernacular languages, notwithstanding how difficult it might be to convince all members of the diverse European community of chemists to use a novel vocabulary.[513] Yet, by making a connection between alchemy and language, he added a significant aspect to traditional narratives. The possibility that alchemical remnants might be present in the contemporary chemical system was a fear which Wiegleb had expressed already in 1777. While Wiegleb had not explained which aspects of the chemists' were still infected, Bergman specified the ontological dimension of these relics by assigning them to the sphere of chemical signs.[514]

Guyton's remarks on the evolution of chemical language were much more selective. In his 1782 proposal on nomenclature reform, Guyton claimed that the traditional, diverse nomenclature was the result of 'des circonstances les plus accidentelles' but abstained from making any claims about the relationship between alchemy and chemical signs.[515] As Maurice Crosland has noted, Guyton's main argument in favour of a thorough revision of chemical terminology lay in his assumption that the number of novel discoveries rendered the existing framework inefficient. The lack of rational principles for naming both existing substances and novel discoveries not only made it hard for chemists to learn and memorise denominations but also hampered communicative exchanges within the community.[516] Thus, Guyton too anticipated a crucial argument which historians of science have made since the 1960s to explain the emerging discourse on chemical nomenclature in the late eighteenth century.

Building upon Crosland's analysis, it is possible to identify a second dimension of how Guyton conceived of the relationship between language and progress. Arguably, the Dijon chemist implicitly constructed a chronological watershed between a more distant past when terminological diversity had been tolerable and the present time when a reform was

[513] Ibid., 103–6, quote on 105.
[514] Ibid., 103–4; Wiegleb, *Historisch-kritische Untersuchung*, 318–19.
[515] Guyton de Morveau, 'Mémoire sur les dénominations', 372.
[516] Ibid., 371–72; Crosland, *Historical Studies*, 156–57.

unavoidable. This diagnosis was linked to the idea that language did not just mirror progress but that, once a large body of observational evidence was available, language itself began to play an active role in chemistry. The observation that 'ses progrès ... ne peuvent êtres rapides, qu'autant que les idées sont représentées par des signes précis & determines' seemed to apply to chemistry's recent history in particular.[517] At least implicitly, Guyton seemed to suggest that the importance of chemical nomenclature as well as its role in the process of gaining reliable knowledge on nature had become much more important with the advent of observation-based inquiries. In his essay, he abstained from further elaborating upon this position and simply outlined the principles according to which he had formed the denominations of the substances at hand.[518]

The idea that signs were not mere passive reflections of observations but active agents in producing knowledge, contemporaneously propelled by Condillac's *Logique*, was to claim centre stage in the chemists' philosophical debates with the publication of the *Méthode de Nomenclature Chimique* in 1787. Guyton's contribution to the volume was a guide to the formation principles for new chemical designations. However, given that the book was the fruit of months of debate between the contributors,[519] it is more than likely that he was also involved in developing the new take on the history of chemical signs which was eventually read to the *Académie* by Lavoisier. The argumentative function of this document will be discussed in the next section.

---

[517] Guyton de Morveau, 'Mémoire sur les dénominations', 371.
[518] On these principles see Ibid., 373–81. and the summary by Crosland, *Historical Studies*, 157–61.
[519] Kim, *Affinity*, 377.

Meaningful Signs. Lavoisier as the Historian of Chemical Terminology

It would go well beyond the scope of this thesis to discuss the technical intricacies of the *Méthode de Nomenclature Chimique* or its relationship with previous taxonomic efforts in eighteenth-century chemistry.[520] It is sufficient to underline that the *Méthode* postulated a standardised procedure of naming substances in accordance with Lavoisier's claims on oxygen and acidity. The denominations of substances were determined by the estimated quantity of oxygen which they contained. Accordingly, a matching suffix was added to the name of each basic unit. This pattern was supposed to be applicable to all substances which were still to be discovered in the future. Within this context, chemists would also identify more than the four irreducible elements which Lavoisier and his collaborators claimed to know already.[521]

Within months after the individual aspects of the reform had been presented in the sessions of the Parisian *Académie* in 1787, a book was published under the same title. It comprised a lexicon comparing traditional and new names, a proposal of chemical signs by Adet and Hassenfratz, a large *Tableau* which visualised the new names in an orderly fashion, and several explanatory essays.[522] In it, Lavoisier and his colleagues avoided any hints to the fact that their work emerged at least in part due to the pressure they felt from their Parisian naturalist peers. By contrast, the *Méthode* is framed as a purely scientific work aimed at the transnational community of chemists. As mentioned above, the six chemists were certainly aware that, in the circumstances, a nomenclature reform with such a clear theoretical grounding would not be adopted without being heavily contested. Indeed, many of them understood the work as a direct contribution to the debate on phlogiston, oxygen, and acidity, and thus as an intervention into

[520] Contrasting views on continuities and discontinuities between eighteenth-century taxonomic practices and the *Méthode* have been postulated by Klein and Lefèvre, *Materials*, 97–115, 179–92; Beretta, *The Enlightenment of Matter*, 203–4, 253–58.
[521] Crosland, *Historical Studies*, 179–83; Beretta, *The Enlightenment of Matter*, 206–14; Klein and Lefèvre, *Materials*, 102–7, 187–88; Weyer, *Geschichte*, 1:557–58.
[522] Crosland, *Historical Studies*, 177. On the *Tableau* see Klein and Lefèvre, *Materials*, 100–101.

the ongoing philosophical epistemological controversy on observation, systematisation, and facticity.[523] As a result, the *Méthode de Nomenclature Chimique* sparked a long controversy both within Parisian naturalist circles and within the European community of chemists whose members had varying educational backgrounds, came from different investigative traditions, and were keenly scrutinising the assumptions underlying the naming substances and their wider implications.[524]

In anticipating this development, Lavoisier wrote an introductory *Mémoire* as a treatise to establish a firm philosophical basis for the following, more technical descriptions. In it, he developed a novel way of assessing the status of chemistry through the lens of language in order to account for the philosophical reliability of his wider theory. He openly declared his allegiance to Condillac's philosophy of language, marking his position within the wider Parisian debate. The *Méthode* reiterated the latter's three-part notion of a 'science physique' as consisting not just of facts and ideas but also of words. With Condillac, Lavoisier abandoned the traditional mimetic function of linguistic signs and insisted on their constructive role in scientific epistemology. Since 'ce sont les mots qui conservent les idées & qui les transmettent', they could encapsulate errors ('impressions fausses') which then negatively affected any scientific endeavour. The latter observation made a reform of chemical language inevitable.[525]

While this adoption of Condillac's sign theory in the *Mémoire* is well known in scholarship, its implications for writing the history of chemistry have not been appreciated thus far. Carving them out, however, is a complicated endeavour. The *Méthode* is a very densely written

---

523 Beretta, *The Enlightenment of Matter*, 240–41; McEvoy, 'Priestley', 124–25, 130–31.

524 For the European reception see the contributions to Abbri and Bensaude-Vincent, *Lavoisier in European Context*; Beretta, *The Enlightenment of Matter*, 245–322.

525 Antoine de Lavoisier, 'Mémoire sur la nécessité de réformer & de perfectionner la nomenclature de la Chimie, lu à l'Académie Royale des Sciences du 18 Avril 1787', in *Méthode de Nomenclature Chimique, proposée par MM. de Morveau, Lavoisier, Bertholet, & de Fourcroy. On y a joint un nouveau systême de Caractères Chimiques, adaptés à cette Nomenclature, par MM. Hassenfratz & Adet* (Paris: Cuchet, 1787), 6–8, 12-14, quotes on 13-14. See also Crosland, *Historical Studies*, 177–79. Lavoisier's reading of Condillac's *Logique* has been vividly debated in scholarship. For different perspectives see Roberts, 'Condillac'; Levere, 'Lavoisier'; Beretta, *The Enlightenment of Matter*, 187–203; Albury, 'Logic', 128–50.

and stylistically advanced piece in which Lavoisier constantly made arguments in passing, only to come back to them in greater detail later in the text. Therefore, the history of chemical language in relation to scientific practice is treated at different points over the course of the essay. Nevertheless, I propose that a careful reading can unveil how Lavoisier constructed several historical arguments to defend his overall philosophy of science, using the topic of language as an additional pillar to the arguments which he had made previously in the *Réflexions*. Writing the history of chemical nomenclature therefore directly responded to the epistemological doubt which had been cast on Lavoisier's works in the controversy of water earlier in the 1780s (see chapter 3).

The historical narrative is grounded in two presumptions on how chemical nomenclature had evolved historically. The first was the already-mentioned idea that a language transmitted errors in line with the principles according to which it was formed. This assumption implicitly denied the possibility of incremental reforms and, in the words of Lavoisier, forced professing chemists to 'ou rejetter la nomenclature, ou suivre irrésistiblement la route qu'elle aura marqueé.'[526] Secondly, and consequently, the historical origins of a terminus must be of great concern to any attentive chemist. In line with Bergman, whose works he was familiar with, Lavoisier held that the implicit philosophies of science pursued by a scholar always left their mark on the discipline's sign system. In chemistry, two groups in particular had loaded chemical terminology with a mass of irrational expressions over time: the alchemists and a vaguely defined group named 'chimistes systêmatiques'.[527] The names that they had added to the body of chemical nomenclature could not have been formed rationally because they were not grounded in a rational approach to science. Lavoisier underlined this point by way of a rhetorical question: 'comment auroit-elle [la nomenclature] pu l'être dans des siècles où la

[526] Lavoisier, 'Mémoire sur la nécessite de réformer', 12.
[527] Ibid., 15–16 quote on 16.

marche de la physique expérimentale n'était point encore connue; où l'on donnoit tout à l'imagination, presque rien à l'observation; où l'on ignoroit jusqu'à la méthode d'étudier?'[528] Due to the capacity of signs to store ideas over long periods of time, such terms were still in use. The heritage of previous ages was therefore more present in chemistry than was acknowledged by the majority of the community.

On such grounds, Lavoisier radically departed from Bergman's perspective on the role of language in modern chemistry. While the latter had held that chemists had been able to coin rational names for chemical substances ever since they had committed to the observationalist philosophy of science, Lavoisier took a different stance. On the initial pages of his 1787 essay, he still appeared to reproduce previous assumptions on the discipline's evolution. Guyton's reform efforts were framed as having happened 'dans une science qui est, en quelque façon, dans un état de mobilité, qui marche à grands pas vers sa perfection, dans laquelle des théories nouvelles se sont elevées.'[529] The change in argumentative gears happened in the following description of Guyton's works. According to Lavoisier, they had remained unfinished because 'il étoit d'une extrême difficulté de former une langue qui convînt aux différens systêmes & qui satisfît à toutes les opinions sans en adopter exclusivement aucune.'[530] Hypotheses, systems, and theories, which most eighteenth-century histories of chemistry had seen as an integral feature of scientific progress, appear here as harmful to the advancement of chemistry because they inhibited the formation of a descriptive language on rational principles.

Together with the *Réflexions* and the *Traité* (see chapter 3), the *Mémoire* thus revised the traditional conceptual patterns in historical writing on the sciences in general and chemistry in particular. By denying the successful interplay between facts and hypothetical systems, the entire period between the middle of the seventeenth century and the late eighteenth century

---

[528] Ibid., 14.
[529] Ibid., 4.
[530] Ibid.

appeared as plagued by the linguistic remainers of irrationalism which were hard to abandon. This negative view of chemistry's recent history corresponds with Lavoisier's suggestive statement that the tentative efforts at reforming chemical nomenclature made by Pierre-Joseph Macquer in the 1760s had happened in a time 'avant que les découvertes modernes eussent donné à la chimie une forme pour ainsi dire nouvelle.[531] Such a clear statement implied that the traditional observationalism which Macquer had championed throughout his life (see chapter 2) could not be the way forward.

Finally, Lavoisier questioned the role of human agency in the progress of chemistry. In traditional *histoires de l'esprit*, the ability of geniuses to amend systems based on observational evidence was identified as a key contributor to scientific advancements. Lavoisier implicitly pitted these conscious efforts of scholars against the prejudices that signs transmitted over the ages, without the knowledge of the people who relied on them. Given the formation principles of a language which connected words, ideas, and facts, it was impossible 'de perfectionner la science, si on n'en perfectionnoit le langage, & que quelque vrais que fussent les faits, quelque justes que fussent les idées qu'ils auroient fait naître, ils ne transmettroient encore que des impressions fausses, si on n'avoit pas des expressions exactes pour les rendre'. Creating a new nomenclature was therefore a precondition for aligning facts and ideas, 'car… ce n'est jamais la nature ni les faits qu'elle présente mais notre raisonnement qui nous trompe.'[532] Again, the historical principles of language formation and its ability to transmit 'préjugés' not only necessitated the nomenclature reform, but also confirmed that any past scientific explanation which was grounded in the traditional terminology had necessarily been misguided.

At first glance, it appears odd that Lavoisier portrayed such a negative view both of even the most recent history of chemistry and of the historical assumptions underlying previous

---

[531] Ibid., 2.
[532] Ibid., 13–14 quotes ibid.

philosophies of observationalism. After all, as highlighted in the introduction to this chapter, he himself invoked the latter's principles as late as 1777 to make a point on combustion.[533] His openly negative attitude towards the progress of chemical language requires additional attention since Félix Vicq d'Azyr, one of the instigators of the 1787 reform, had legitimised his own revamp of zoological terminology with a historical view which was much less controversial. In the two *Discours* introducing his *Traité* of 1786, Vicq d'Azyr constructed a narrative which resembled Bergman's attempt to fit the history of scientific nomenclature into traditional patterns of history-writing. Vicq d'Azyr diagnosed a mismatch between the profound practical and experimental innovations in anatomy which had been made since the early modern period culminating in the works of Albrecht von Haller, and the state of anatomical nomenclature: 'au milieu de ces innovations, l'anatomie seule n'a fait presque aucun changement dans son langage. Comment, avec une nomenclature qui ne s'est presque point enrichie depuis Galien, pourroit-elle suffire à la description de tant d'organes nouveaux?'[534] Yet, he did not insist on the negative impact that traditional terms had had on the progress of comparative anatomy in general, let alone did he suggest that a lack of rational names made all of the existing theoretical systems obsolete. Language was a feature of the more general progress of the spirit, and a full-blown reform was necessary only at times when a great amount of discoveries had been made.[535] Thus, 'la description' and 'la théorie' appeared to be part of a dialectic relationship such that, if they were strictly separated, 'leur valeur réciproque augmentera, l'une gagnant en précision ce que l'autre acquerra de force, de lumière et de simplicité.'[536] Why, then, did Lavoisier not present a similarly conciliatory view of chemistry's past if the nomenclature was to conform with Vicq d'Azyr's philosophy of science? The question is even more pressing given that following the example of Gabriel-François Venel, chemists frequently pointed out the

---

533 See footnote 572.
534 Vicq d'Azyr, *Traité*, 1:1–4, 18–19, 46, quote on 46.
535 Ibid., 1:46.
536 Ibid., 1:50.

interdisciplinary roots of their field in historical narratives (see chapter 2). In 1787, it thus would have been easy for Lavoisier to frame the reform as part of the wider nomenclatural reform efforts endorsed across all branches of natural history.

I would argue that his radical view of chemistry's history was not aimed at the Parisian naturalists siding with Linneaus and Condillac, for this group found many of its presumptions realised in the technical content of the *Méthode*. It was Lavoisier's second audience, namely the wider European chemical community, which needed to be convinced of his overall approach to chemistry and its epistemological basis in the late 1780s. As already discussed in chapter 3, deep methodological and epistemological frictions had emerged in the community as a result of the controversy on the composition of water after 1781. British scholars in particular claimed that Lavoisier drew illegitimate conclusions from his observations. As part of their arguments, Priestley legitimised his adherence to traditional concepts such as phlogiston by claiming that his conclusions stated 'facts' and 'actual observations' as they were. Lavoisier, Priestley implied, had already entered the territory of hypothesising with his claims on the composite nature of water and phlogiston.[537]

The *Mémoire* turned this argument upside down by historicising chemical language: this shift in perspective enabled Lavoisier to attack the argumentative basis of his opponents. Since they had not considered the patterns according to which chemical nomenclature had evolved, the *Mémoire* implied, they had mistaken their conclusions for facts, while, in reality, these alleged facts were nothing more than remnants of irrational thought, encapsulated in language. In view of the roots and evolutionary principles of chemical language, a thorough reform was needed not only of chemistry's language but, indeed, of its entire underlying

[537] Golinski, 'Precision Instruments', 35–36, 42. The original quotes can be found in Joseph Priestley, 'Experiments and Observations Relating to Air and Water, Read 24.2.1785', *Philosophical Transactions of the Royal Society of London* 75 (1785): 280.

philosophy of science. Thus, denominations and observations, facts and systems could be brought back into balance.

As demonstrated by this reading, the *Mémoire* is a rhetorically sophisticated contribution to the philosophy of science in which a particular view of chemistry's history through the lens of language did some of the argumentative heavy lifting. Yet, when Lavoisier suggested that his claims both about the philosophy of language and the history of chemical nomenclature were evident 'sans que nous soyons obligés d'insister sur les preuves', this was either a rhetorical figure or a profound miscalculation.[538] As we shall see in the next section, his fellow chemists on the other side of the Rhine understood the epistemological implications of his historical perspective very well. In response, they created narratives which either contested or bolstered Lavoisier's historical view, depending on their stance in the ongoing debate on the philosophical principles applicable to chemical inquiries.

Do Signs Matter? German Views on the History of Chemical Nomenclature

Thanks to the swift translation of the *Méthode*, the question of chemical nomenclature and its implications for observation-based investigations became contested issues in Germany already by the early 1790s.[539] Two issues were at stake. On the one hand, the wider question arising from Lavoisier's remarks was of course whether the chemical names currently in use could be considered rational or not. Every scholar's reply depended on how they assessed the positions on the philosophy of language and the history of chemical nomenclature formulated in Lavoisier's *Mémoire*. Whichever stance a scholar took on this matter, it informed their decision as

[538] Lavoisier, 'Mémoire sur la nécessite de réformer', 14.
[539] For the translations see Abbri and Beretta, 'Bibliography', 284–85.

to whether the French nomenclature proposal should be accepted, amended, or outright rejected.

The essays on nomenclature written by Lorenz von Crell, Johann Andreas Baptist von Scherer, and Johann Friedrich Westrumb have to be read against this backdrop. Although all of them discussed various examples of old and new denominations in their essays, they pursued different trajectories.[540] On the other hand, the German chemists were well aware of the fact that Lavoisier's historical arguments in the *Mémoire* served to substantiate not only the oxygen theory but also his overall philosophy of science. Crell, Scherer, and Westrumb therefore saw their chance to intervene in the wider epistemological debate on chemistry by discussing Lavoisier's assumptions on the origins and evolutionary patterns of chemical nomenclature. In that, their strategy resembled the one concomitantly deployed by their peers, Wiegleb and Gmelin, in the debate on facticity (see chapter 3). At the heart of the *Méthode*'s reception in Germany was therefore the problem of whether different philosophies of science – here in the form of varying nomenclatures and philosophies of language – influenced scholarly reasoning or not.

In assessing the works of Crell, Scherer, and Westrumb, it is vital to point out at the start that they fundamentally agreed on two crucial matters. First, their writings applied the same set of normative criteria as to when a reform of any scientific nomenclature was desirable. Crell and Scherer explicitly developed sets of such criteria – five and three, respectively – which covered the same content. New terms in chemistry were required only in certain cases: if novel discoveries had been made, if names did not depict the ontology of substances appropriately, and if the existing nomenclature was formed without clear principles and therefore

[540] Lorenz von Crell, 'Ueber die Nohtwendigkeit einer chemisch-technischen Sprach-Veränderung, und ihre Gesetze', *Chemische Annalen für die Freunde der Naturlehre, Arzneygelahrtheit, Haushaltungskunst, und Manufakturen* 1, no. 3–4 (1791): 225–39, 327–41; Johann Andreas Scherer, *Versuch einer neuen Nomenclatur für Deutsche Chymisten* (Vienna: Christian Friedrich Wappler, 1792); Westrumb, *Versuch*.

contained misleading synonyms, polynyms, or names of unreasonable length.[541] Although Westrumb did not provide his readers with such a structured, deductive set of criteria, his text showcases that he shared these criteria.[542] The three authors thus also anticipated the analytical framework which historical research in the twentieth century used to explain the need for nomenclature reforms in the sciences.[543]

Secondly, there was unanimity among Crell, Scherer, and Westrumb that language and scientific progress were in one way or another directly related. Crell held that 'den großen Einfluß der Sprache auf die Ausbildung unseres Geistes, und die Erweiterung unserer Einsichten überhaupt, wird Niemand in Zweifel ziehen, noch verkennen; sie wachsen selbst in dem Verhältnisse, wie sich jene vervollkommnet'.[544] Scherer and Westrumb made similar generalising statements matching Crell's positions almost to the word. For Scherer, history taught that 'die Sprache der Scheidekunst mit den Fortschritten und der Cultur derselben in dem genauesten Verhältniße stehet', while according to Westrumb, everyone agreed that the heaven-sent tool of language 'mit der Cultur eines Volkes und seiner Wissenschaft immer gleichen Schritt hält'.[545] The idea of a link between language, progress, science, and culture is found in the writings of many Enlightenment philosophers of language, too.[546]

Beyond these agreements, divergent opinions prevailed. In response to the publication of the *Méthode*, Lorenz Crell used his influential position as the editor of the *Chemische Annalen* to publish an article which argued, already in 1790, against the necessity for any reform of chemistry's nomenclature. His critique evidences his careful reading of the *Méthode*, for Crell quickly realised the opportunity to counter Lavoisier's reform claims by deconstructing

---

[541] Crell, 'Nohtwendigkeit', 229–34. Scherer, *Versuch*, [vii]-[viii]. The pagination of the non-numbered pages in Scherer's work starts with the first page of the *Vorrede* as [i].
[542] Westrumb, *Versuch*, xii, xvi, 10, 18–19.
[543] See section 1 of this chapter.
[544] Crell, 'Nohtwendigkeit', 225–26.
[545] Scherer, *Versuch*, 1; Westrumb, *Versuch*, 3–4.
[546] Lifschitz, *Language*, 89–90.

their underlying historical narrative. A closer look at the history of chemical language informed chemists that the idea of irrational, alchemical remnants in current denominations was absurd. After all, chemistry's current nomenclature was very distinct from the 'Ausdrücke und Bezeichnungsarten der Chemisten der vorigen Jahrhunderte, und selbst der ersten Decennien vom jetztigen'.[547] According to Crell, a fundamental departure from the irrational, traditional nomenclature had already taken place around the middle of the eighteenth century, wiping out any unreasonable relics. Crell presented this shift as a natural result of the intertwined progress of culture, language, and science: 'Die Wissenschaft hat zu große Revolutionen in der Art, sie zu behandeln, und überhaupt zu beträchtliche Erweiterungen und Verbesserungen erlitten, als daß jene Benennungsart [i.e. the traditional nomenclature] irgend noch zureichen sollte.' The last synonyms and polynyms as well as generally unclear names had been abandoned very recently. What current chemists had at their disposal was therefore a language which had been formed by mid-eighteenth-century chemists such as Marggraf, Rouelle, and Bergman, and which therefore was in line with the legitimate philosophy of observationalism.[548]

This historical perspective put Crell in an argumentative position in which he did not have to engage at all with the Condillacean idea of language as a subconscious storage for irrational ideas. In his view, the current chemical nomenclature already was purely observation-based and thus corrupted by neither prejudices nor hypotheses. What was left to assess, therefore, was the question of whether the growth in observations over the past decade or two necessitated slight amendments or additions. To refute even such a minor intervention, Crell took the position which Gmelin would also champion in response to Lavoisier a few years later: important as they had been, the implications of discoveries in pneumatic chemistry were still neither innovative nor comprehensive enough to legitimise any such radical move. For

[547] Crell, 'Nohtwendigkeit', 228.
[548] Quote Ibid. See also ibid, 235-238, 331.

example, there were simply not enough experimental data to solve problem of the composite or elemental nature of water conclusively. And even when reliable observational evidence on the matter was established one day in the future, it would not necessitate a full-blown reform of all existing denominations.[549]

Crell's claims were opposed by Johann Andreas Scherer, who pondered a different view of the origins and the evolution of chemical nomenclature to mark his position in the debate. In 1792, Scherer published a translation of the *Méthode*, which was preceded by a long preface and a history of nomenclature. Scherer countered Crell's narrow focus on the history of chemical nomenclature during the past decades by identifying different stages of its evolution. Chemistry's infancy had been accompanied by raw denominations, as was the following epoch of 'Alchymisterey.' Only during the subsequent 'glückliche Epoche' had chemistry's language been refined to a certain extent.[550] This had been the era of Marggraf, Macquer, Bergman, and Scheele, whose discoveries had sparked awareness among European chemists that 'die damahls gangbaren chymischen Benennungen' were no longer adequate to grasp the observational reality. The adoption of Bergman's nomenclature was the result.[551] This period was followed by an era of even greater progress, in the course of which a deeper understanding of substance composition as well as the discoveries in pneumatic chemistry had prompted Lavoisier and his French colleagues to pursue yet another terminological reform, and, in Scherer's view, rightly so.[552]

At first glance, this conceptual and chronological framework resembles Bergman's attempt made in the early 1780s, with the minor addendum that the reform of 1787 appeared as yet another step of the wider push to rationalise chemistry. Crucially, however, Scherer adopted Lavoisier's and Condorcet's idea of language as a memory for erroneous assumptions and

---

[549] Ibid., 234–35.
[550] Scherer, *Versuch*, 1–2, quotes ibid.
[551] Ibid., [i]–[ii], quote on [i].
[552] Ibid., [ii], 3–4.

combined it with the notion that chemical nomenclature had evolved through different stages.[553] On such grounds, the current problem was not so much the heritage of alchemy but the insufficient character of the reforms made over the past decades. Since any linguistic overhaul was 'in dem jedesmahligen Zustande der Ausbildung der Chymie gegründet',[554] well-intentioned attempts to abandon nebulous expressions unfortunately had often led to the establishment of terms which were 'nicht immer bestimmt genug'. As a result, a contemporary chemist encountered the relics of such attempts 'in unseren heutigen Schriften'.[555] This dark jumble of words was in need of urgent reform not so much because of its potential inaccuracy but because it contained 'unter verführerischen und grade das Gegentheil bedeutenden Nahmen die heftigsten Gifte.'[556] In response to Crell's pointing to the reform efforts made since the mid-century, Scherer thus applied Lavoisier's and Condillac's concept of language to the most recent past. Since chemical culture and knowledge were constantly evolving, its language had to be adjusted on a regular basis, too.

Given his emphasis on the relationship between the state of chemistry's investigative culture and its nomenclature, Scherer presented the historical analysis as an important method for making a philosophically legitimate decision on whether the chemical terms in use could still be considered truly mimetic or not. In the *Vorrede*, he held that careful investigations into the origins of each chemical expression was in itself 'ein nicht geringer Beweis, daß die chymische Sprache bloß etwas, dem jedesmahligen Zustande der Scheidekunst anpassendes ist'. Having established this general pattern, he concluded 'daß wir in unsern Tagen, bey einer Reformation des ganzen chymischen Lehrgebäudes, einer Ausbildung und Verbesserung derselben mehr als jemahls bedürfen, und den ganzen Troß von hypothetischen Benennungen

[553] While not mentioning Condillac explicitly, Scherer chose a similar quote by Horace Bénédict de Saussure as the motto for the book.
[554] Scherer, *Versuch*, p. 2.
[555] Ibid.
[556] Ibid., 7–8.

auszustoßen alles Recht haben'. The historical analysis unearthed valid scientific proof, making it imperative for the Germans to adopt the French nomenclature.[557]

Johann Friedrich Westrumb's search for the origins and evolution of chemical language reiterated much of Scherer's work. Westrumb distinguished five historical periods, demarcated by chronological turning points similar to those applied by Scherer, and insisted that irrational remnants were still very much present in the present nomenclature.[558] Yet, he drew an entirely different conclusion from his assessment than did Scherer: old and new names for each substance should be compared regarding their adequacy. Such an approach resulted in a limited reform of chemical nomenclature which blended several existing systems of denominations with new names.[559]

Scherer and Westrumb disagreed on this matter because of differences in their philosophy of science. They disagreed on the role which theories and hypotheses had historically played in relation to chemical language. While Crell did not mention any active contribution of theoretical beliefs to nomenclature, Scherer identified one singular historical case in which scientific theories had (mis-)guided the transition from observations to signs. He developed this perspective by historicising the European reception of the *Méthode* to gain a higher viewpoint on the matters at stake. Why, he wondered, had the French publication caused such a storm within the Republic of Letters given that Bergman's previous revisions had been welcomed by the very same chemists? 'Worin mag wohl die Ursache dieser zu Bergmanns und Lavoisiers Zeiten so verschiedenen Denkungsart liegen', Scherer wondered, given that there was no doubt about the fact that many significant contributions to chemistry had been made in the meantime.[560] His answer drew on the philosophical positions established by Lavoisier's key writings since the early 1780s. The Stahlian phlogiston theory – he used the term

[557] Ibid., [viii]– [x], quotes on [x].
[558] Westrumb, *Versuch*, 4–13.
[559] Ibid., xi–xii, xvii–xviii.
[560] Scherer, *Versuch*, [i]– [ii], quote on [ii].

'Lehrgebäude' – had not foreseen that experiential findings might necessitate a far-reaching terminological reform. Hence, its followers had been unable to cognitively accept 'die Umänderung der gewöhnlichen Begriffe, die keine unmittelbare Folge aus dem erwähnten Systeme [i.e. Stahl's theory] ist.'[561] Scherer further elaborated this by choosing the metaphor of looking through glasses to illustrate how theoretical assumptions affected the chemist's judgement. Lavoisier and his colleagues had dared to take off 'Stahls Brille', which resulted in them no longer being able to see phlogiston, 'das Ding (…), welches seine Anhänger und Verehrer überall zu sehen glauben'.[562] Scherer thus agreed with Lavoisier's claims in important ways. Both scholars denied the productive role of hypothetical systems for chemistry's progress which had been championed by earlier historians of chemistry, insisting instead on their potentially detrimental character. They also concurred on the philosophical and historical relationship between systems and signs. Just as a misconceived nomenclature could induce errors into chemical practice, so could theoretical presumptions inhibit scholars from taking the necessary steps towards terminological reform.

Scherer's deliberations implied that the theoretical framework for the 1787 reform had been more rational than any of its predecessors, hence the necessity for the Germans to accept its implications. Westrumb took issue with this perspective. He provided several historical examples to demonstrate that chemical language was always and necessarily influenced by theoretical and systematic frameworks to a considerable extent. By no means had the enigmatic language of alchemy evolved by coincidence alone. Of crucial importance had been 'der eingeschränkte Gesichtskreis', because it prompted all sorts of irrational scholarly attitudes such as 'mangelhafte Begriffe, diese abgeschmackten Theorien'. By chasing after foolish aims, an abundance of 'Namen ohne Sinn' had entered the chemical discourse.[563] In his treatment of

---

561 Ibid., [ii]–[iii], quotes ibid.
562 Ibid., [iii].
563 Westrumb, *Versuch*, 7, quotes ibid.

the following, more rational, period in chemistry, Westrumb further elaborated on such intersections. Above all, a scholar's epistemic mindset was responsible for synthesising results into theories, which then led to the formation of particular names. Hence, the advent of observation-based inquiries in modern times allowed for the emergence of 'vernünftige und auf richtige Erfahrung gegründete Theorien. Durch sie wurde die Prahlerey verdrängt und mehr naturgemäße Benennungen der neuentdeckten Stoffe gebildet.'[564]

When approaching his own times towards the end of the historical section, Westrumb presented the lessons to be learned. As will be remembered, he argued in favour of a limited reform that blended traditional with new names. This was the way forward because, as Westrumb implied, neither those who wished to conserve all names nor those who were in favour of adopting the French reform had correctly considered the nature of a scientific nomenclature. Although such terminological systems could certainly be infected by irrational relics and the lack of appropriate names for novel discoveries, it was equally dangerous if they relied too heavily on 'alte und neue Lehrmeinungen und auf die eigenen Lehrsätze ihrer Erfinder'.[565] The mono-theoretical focus of the French nomenclature was thus its major deficiency, as Westrumb postulated, reinterpreting the metaphor of theoretical glasses used by Scherer a year earlier: a novel nomenclature should never be the work of a single individual because 'dieser wird alles einseitig und durch diejenige Brille betrachten, die er sich selbst oder die ihm *Stahl* oder *Lavoisier* haben schleifen laßen'.[566] The omnipresence of theoretical presumptions in the different temporal layers of all nomenclature proposals legitimised his own syncretic approach of comparing and blending different theories to look for the most suitable denominations. According to Westrumb, this was the only way to create a nomenclature which did not draw on unproven hypotheses as its philosophical foundation.[567]

---

564 Ibid., 8.
565 Ibid., 13.
566 Ibid., 15–16, quote on 15; italics in the original.
567 Ibid., xxx–xxxi, 17-18.

Conclusion

This chapter showcased that writing the history of chemical language became a crucial tool for chemists to reflect upon the various epistemological problems that plagued the discipline in the wake of debates on pneumatic chemistry, acids, and water. Thereby, the participating scholars exhibited diverging views on the origins and evolutionary patterns of chemical nomenclature to bolster their positions in the contemporary philosophical debates on the intersection of observations, language, and theory in chemistry.

From a diachronic perspective, the analysis has shown that, in doubting the value of scientific theories, the historical narratives of Lavoisier, Crell, Scherer, and Westrumb fundamentally questioned previous assumptions on the nature of scientific progress. This claim has to be seen against the backdrop of my arguments in the first part of chapter 2. There, I have shown that, in the decades after 1750, chemists identified any preliminary syntheses – from a single conjecture or a hypothesis to an entire system or theory exposing the interconnection of facts – as key drivers of scientific progress, as long as they were based on observations. This previous certainty became contested when the historical role of chemical signs in relation to the wider evolution of the field was re-evaluated from the 1780s onwards. The subsequent, far-flung debates on the historicity of chemical nomenclature as well as the aligned negative view of theories clearly showed that the traditional framework of *histoires de l'esprit* was in need of reform.

Yet, the hope that a historical view on the evolution of chemical nomenclature might provide some clarity on the philosophical issues at stake was dashed by the mid-1790s already. The investigations into the origins and evolution of current chemical nomenclature by Crell, Scherer, and Westrumb came to contrary conclusions. Reconciling them would have required the chemists to establish a consistent methodology to historicise linguistic signs and to demarcate their causal relationship with all other facets of chemical investigations. We can only speculate as to why no late-eighteenth-century chemist embarked on such a substantial and time-consuming endeavour, notwithstanding the philosophical clarity that it might have yielded. One potential reason is that the methodologies of other branches of inquiry, which the chemists often relied upon once they entered non-experimental or philosophical territory, did not offer any immediate help. Indeed, the comparative historical and philological study of signs and language was itself in flux at the time, with contemporary philologists disagreeing on the appropriate approaches to the field.[568]

Yet, at the same time, reaching an impasse in the debates on the historicity of language did not mean that historical thought lost its power as a guide to make philosophical claims on chemical problems. This will become clear in the next chapter which centres on the French scholar, Antoine de Fourcroy. As a long-standing member of the Arsenal group and a co-author of the nomenclature reform, he had been an eyewitness of the argumentative function that constructing historical narratives played in chemistry's epistemological struggles since the 1780s. After the premature death of Lavoisier in 1793, he waited three years to publish a large-scale history of chemistry which defended all aspects of the Lavoisian approach and philosophy of science against its critics. His unique approach to history-writing as well as its wider context will take centre stage in the next, final chapter of this thesis.

[568] See Anna Morpurgo Davies, *History of Linguistics, Vol. 4. Nineteenth-Century Linguistics*, 2nd ed., Longman Linguistics Library (Abingdon: Routledge, 2014), 24–58.

Chapter 5: A Genealogy of Modern Chemistry: Antoine de Fourcroy and the Contextualist Approach to History-Writing

Introduction

In 1798, a contributor to the *Bibliothèque Germanique Médico-Chirurgicale* noted that, over the preceding decade, two entirely different yet equally fruitful approaches to the history of chemistry had emerged. The recently published first volume of Johann Friedrich Gmelin's *Geschichte* represented the genre of erudite German historical investigations. It stood in stark contrast to the attempt made by Antoine de Fourcroy, the Parisian collaborator and *protégé* of Lavoisier, in the *Encyclopédie Méthodique*'s third volume on chemistry (1796). Fourcroy's work, the reviewer noted, differed from Gmelin's compilatory approach in that it was 'riche de ces vues générales et élevées, de ces réflexions critiques, de ces rapprochemens neufs et piquans' thus representing 'cet esprit philosophique' which was distinctively French.[569]

The present chapter analyses the scientific function and literary form of Fourcroy's account which, indeed, stands out among eighteenth-century histories of the natural sciences due to its intricate methodology and far-reaching intellectual ambition.[570] I argue that Fourcroy developed his unique approach to uphold the philosophical principles underlying Lavoisian chemistry. Crucially, he had two different audiences in mind. On the one hand, the work countered the historical narratives of his German colleagues such as Gmelin, Wiegleb, Crell, and

[569] [anon.], 'Histoire de la Chimie, par Joh.Fr. Gmelin, Gottingue, 1797. Premier Extrait' (Review)', *Bibliothèque Germanique Médico-Chirurgicale ou Extrait des meilleurs Ouvrages de Médecine et de Chirurgie publiés en Allemagne* 2 (Germinal An vii = March/April 1798): 440.
[570] Antoine de Fourcroy, 'Chimie', in *Encyclopédie Méthodique, Ou Par Ordre de Matières. Par Une Société de Gens de Lettres, de Savants et Des Artistes. Chimie, Pharmacie et Métallurgie* (Paris: Agasse, 1796), 262-[781]. There is a pagination error in the original print: following page 520, the pagination jumps back to 513 instead of 521. In order to avoid any confusion, all pages with the wrong numbering are quoted as follows: 513 [521], i.e. the incorrect printed page number followed by the correct page number in square brackets.

Westrumb (see chapters 3 and 4). On the other hand, it was designed to defend the philosophical principles underlying Lavoisier's chemistry in the ongoing Parisian debate on the appropriate philosophy of the natural sciences. The debate was closely entwined with the redrafting of the institutional map in Paris and the creation of a new network of patronage relationships. Fourcroy's historical work was thus the intellectual equivalent of his concomitant attempts to secure the future of Lavoisian chemistry in the curricula and projects of post-revolutionary scientific institutions in Paris.[571] In his approach to historical writing, Fourcroy used several aspects of Lavoisier's philosophy of science (see chapters 3 and 4) as conceptual lenses to assess the history of the field. The result was a literarily complex account of circa 400 narrowly printed pages which scrutinised how the intricate interplay between observations, laboratory instruments, nomenclature, and theory had played out throughout the history of chemistry. Notably, Fourcroy also provided a detailed analysis of the potentially positive or negative impact which social, institutional, and communicative factors could have on the formation of scientific theories and their adoption across the Republic of Letters. This contextualising approach of writing the history of the natural sciences was an innovation with roots in the extensive debates on the reform of traditional academic Parisian institutions during the final years of the *Ancien Régime* and the revolutionary years.

This complex setting explains why the structure of the present chapter differs slightly from its predecessors. Since the rise of the contextualising approach has been all but neglected in scholarship, the first parts of the chapter trace its emergence rather than engaging with problems of chemistry. In the first section, I shall discuss how Jacques-Pierre Brissot's *De la vérité* (1782) and Jean-Paul Marat's *Les charlatans modernes* (1782–1783/1791) shed new light on the history of science through the lens of academic institutions in order to intervene in debates

[571] For a detailed picture of the institutional situation in Paris and the wider debate see Corsi, *Age*, 1–39, especially pp. 7-8 on Fourcroy; Outram, *Georges Cuvier*, 51–53; Spary, *Utopia's Garden*, 157–66, 173–92. On Fourcroy's activities as a scientist-administrator during the Revolution with special emphasis on pharmacy see Simon, *Chemistry*, 116–28.

on institutional reform and matters of science alike. By contesting the positive role which traditional *histoires de l'esprit* had assigned to academic institutions in the pursuit of science, they argued that the allegedly rational claims of academicians were in fact heavily influenced by the social processes at play in elitist institutions. The co-existence of chemical theories and the publication of the new nomenclature were cases in point for this claim. When, after 1789, the future of all established institutions was at stake, members of the establishment adopted the contextualising approach for their own purposes. The second section showcases this development, using Marie-Jean-Antoine-Nicolas de Caritat, Marquis de Condorcet's writings on educational reform (1790–1792) as a case in point before turning to Fourcroy. In the third section, I will discuss at length how he combined the contextualising approach with the historicising of several aspects of Lavoisier's philosophy of science to defend its merits in the aforementioned Parisian debate. Fourcroy crafted a unique work on the history of his field which exposed a compellingly complex notion of scientific progress. Thus, Fourcroy not only established the analytical avenues to explore the Chemical Revolution which scholars have followed well into the twentieth century, but he also anticipated ideas on historical epistemology devised by philosophers of science after 1900.

Progress Contested: Brissot, Marat, and the Rise of the Contexualising Approach

Mid-eighteenth-century histories of science promulgated the view that scientific academies had been instrumental in fostering the observationalist approach in the natural sciences.[572] To be sure, there were many instances during the eighteenth century in which scholars, especially those who had been in conflict with the *Académie Royale des Sciences* in Paris, questioned the

[572] Engelhardt, *Historisches Bewußtsein*, 61–63; Donato, 'Faire corps', 103–4.

value of existing elitist institutions dedicated to the study of science altogether.[573] Yet, these grievances did not change the way in which members of the establishment presented the role of academies for the progress of science. D'Alembert, for instance, maintained in the *Discours préliminaire* to the *Encyclopédie* that academies 'ne peuvent manquer de produire dans un état de grands avantages', provided that they were composed in an egalitarian way, did not admit mediocre scholars, let geniuses lead, and paid their members according to their merits.[574] The chemist Pierre-Joseph Macquer, a longstanding member of the Parisian *Académie*, reassured the readers of his popular *Dictionnaire de Chimie* (1766) that the foundation of learned societies in the seventeenth century was instrumental in paving the way for 'la philosophie expérimentale' in the sciences.[575] Academies, most scholars believed, disseminated new discoveries into the most remote corners of the Republic of Letters via their journals which, according to Turgot, had a direct effect on the elimination of errors: 'L'imprimerie, les journaux littéraires et scientifiques, les mémoires des académies, ont augmenté la certitude au point que les seuls détails sont aujourd'hui douteux.'[576] For Macquer, too, contributions to the *Mémoires* of important academies exemplified how savants were to link 'expérience' and 'raisonnement' to contribute to their field. They therefore formed the model which any investigation into the natural sciences should follow.[577]

Yet, such positive connotations came under pressure once scientific outsiders began to reflect upon the role which institutional, political, and social factors played in the evolution of science in the 1780s. Two of the most elaborate and influential publications on this topic in the 1780s were Jacques-Pierre Brissot's *De la vérité* and *Les charlatans modernes* by Jean-Paul

---

573 For examples see Hahn, *Anatomy*, 140–50.
574 d'Alembert, 'Discours préliminaire', xxxiii. A similar stance was taken by Voltaire (François-Marie Arouet), *Siècle de Louis XIV*, ed. Diego Venturino, vol. 6, Les oeuvres complètes de Voltaire 13D (Oxford: Voltaire Foundation, 2016), 4.
575 Macquer, *Dictionnaire de Chymie*, 1766, 1:xxxiii.
576 Anne Robert Jacques Turgot, 'Plan du second discours sur les progrès de l'esprit humain', in *Oeuvres de Turgot et Documents le concernant*, ed. Gustave Schelle, vol. 1 (Paris: Félix Alcan, 1913), 316. The passage is also quoted in Dagen, *Histoire de l'esprit humain*, 426.
577 Macquer, *Dictionnaire de Chymie*, 1766, 1:xxxiii.

Marat. As the studies by Charles Gillispie, Clifford D. Connor, Roger Hahn, and Olivier Coquard have shown, the latter is a perfect example of a natural scientist who lacked a patron and was personally affected by the concealed decision-making processes of the Parisian *Académie*. Marat, a practising medical doctor and political pamphleteer, submitted a work on fire and heat to the Parisian Academy in 1778. As discussed in the previous chapters, this topic was fiercely debated by contemporary scholars, including by academicians such as Lavoisier. After a lengthy back-and-forth between Marat and the academicians in the course of which Marat submitted more observations to the learned institution to gain its approval, he proposed a radical correction of Newton's theory of light. Its ultimate rejection by the Academy's committee on various procedural and scientific grounds was a bitter pill for Marat to swallow. Over the coming years, he continued to gather and publish evidence for his refutation of Newton while at the same time fashioning himself as a misunderstood genius whose works were deliberately suppressed by a jealous elite. He also began to reflect upon the influence of institutional politics on science.[578] The result of these deliberations was published only in 1791 under the title *Les charlatans modernes* although the majority of the essays had already been completed between 1783 and 1785.[579]

Given the popularity of the work in the revolutionary years, *Les charlatans modernes* is an interesting point of departure for the present purpose. *Les charlatans* should be read in tandem with *De la vérité* (1782) by Jacques-Pierre Brissot, who was a close friend of Marat's from 1779 onwards. Early in his career, Brissot nurtured philosophical aspirations himself. For instance, he sought to convince d'Alembert to help him compile a dictionary of scepticism, an offer which the latter politely declined. Having learned of Marat's struggles with the *Académie*,

---

[578] Hahn, *Anatomy*, 150–51; Gillispie, *Science Old Regime*, 302–29. See ibid. 290-302 for Marat's early life and career. Another comprehensive attempt to restore Marat's reputation as a scientist has been made by Clifford D. Conner, *Jean Paul Marat. Scientist and Revolutionary* (Atlantic Highlands NJ: Humanities Press, 1997).
[579] Olivier Coquard, *Jean-Paul Marat* (Paris: Fayard, 1993), 181–83.

Brissot drafted *De la vérité*, a critical essay.[580] Both Brissot's and Marat's works have been thoroughly discussed by modern scholarship. While *De la vérité* is often interpreted as a contribution to philosophical scepticism or a testimony of Brissot's early adoption of republicanism,[581] *Les charlatans* is mostly presented as a blatant pamphlet against the scientific establishment rooted in Marat's biography and, additionally, as a polemic intervention into the debates on educational reform during the early years of the Revolution.[582] From the analyses and summaries of the two works by scholars such as Olivier Coquard and Roger Hahn, we learn that Marat and Brissot weaponised a historical gaze on established institutions to make their claims.[583] My own reading situates such observations within the wider history of historical writing in the sciences and emphasises Marat's and Brissot's radical and conscious departure from older traditions in history-writing. Indeed, Marat and Brissot challenged the allegedly symbiotic relationship between academic institutions and scientific progress which had been a key pillar of traditional *histoires de l'esprit*. In doing so, they not only offered a radical reinterpretation of the history of science since the seventeenth century but also made a critical contribution to the methodological toolbox for future historians by highlighting the embeddedness of all scientific works and judgements in their historical social and institutional context.

Both the *Charlatans modernes* and *De la vérité* were rooted in a pessimistic view of scientific progress which contrasted with the narrative patterns of *histoires de l'esprit*: 'non',

---

[580] Hahn, *Anatomy*, 151–53; Robert Darnton, *Mesmerism and the End of the Enlightenment in France* (Cambridge MA: Harvard University Press, 1968), 92–93; Richard H. Popkin, 'Brissot and Condorcet. Skeptical Philosophers', in *The Skeptical Tradition around 1800. Skepticism in Philosophy, Science, and Society*, ed. Johan van der Zande and Richard H. Popkin, Archives Internationales d'histoire Des Idées 155 (Dordrecht: Kluwer Academic, 1998), 31.

[581] Popkin, 'Brissot and Condorcet', 31–35; Bette Wyn Oliver, *Jacques Pierre Brissot in America and France, 1788-1793. In Search of Better Worlds* (Lanham MD: Lexington Books, 2016), 77; Jonathan Israel, *Revolutionary Ideas. An Intellectual History of the French Revolution from the Rights of Man to Robespierre* (Princeton: Princeton University Press, 2014), 24.

[582] Clifford D. Conner, *Jean Paul Marat. Tribune of the French Revolution*, Revolutionary Lives (London: Pluto Press, 2012), 28; Charles Coulston Gillispie, *Science and Polity in France. The Revolutionary and Napoleonic Years* (Princeton NJ: Princeton University Press, 2004), 190–91.

[583] Coquard, *Jean-Paul Marat*, 184–85; Hahn, *Anatomy*, 151–54.

Marat postulated at the beginning of his first letter, 'il n'est point de progrès pour la raison humaine: l'expérience des peres est perdu pour leurs fils'.[584] In parallel, Brissot explicitly identified his target as those scholars who propagated a progressivist view of science. They claimed 'que c'est le premier des siècles; que l'homme y a perfectionné toutes les sciences, parcouru tous les degrés de leur echelle, (…) que les erreurs ont disparu, que la vérité n'a plus de voiles, que nous sommes au milieu de la lumière', but the contrary was the case: old errors had been replaced with new ones.[585]

This critique had its roots in the idea that scientific progress could be achieved by geniuses alone.[586] Of course, the likes of d'Alembert and Macquer believed in the outstanding importance of gifted individuals for scientific discoveries as well, but, as noted above, they pointed to their enhanced creativity within institutional bodies. Brissot took the opposite stance by tracing the success of scholars such as Blaise Pascal and Pierre Bayle back to the fact that they had not been academicians.[587] To make his attitude towards the existing narratives even clearer, he also attacked Francis Bacon, the hero of conventional histories of science which hailed the latter as one of the key figures in establishing what Macquer called experimental philosophy in the natural sciences. According to Brissot, Bacon had been wrong in believing that 'les livres & les académies servioient à la réforme générale qu'il méditoit' because history had shown that 'la multiplicité des erreurs, le désordre de nos connoissances ne proviennent que de la multiplicité des livres et des académies'.[588]

On such grounds, Brissot and Marat scrutinised the historical role played by scientific corporations in the scientific endeavour. In fact, the very existence of such institutions was at

---

584 Jean-Paul Marat, *Les charlatans modernes, ou lettres sur le charlatanisme académique* (Paris: L'imprimerie de Marat, 1791), 5, 7, quote on 5. See also ibid. 40.
585 Jacques-Pierre Brissot de Warville, *De la vérité ou méditations sur les moyens de parvenir à la vérité dans toutes les connoissances humaines* (Neuchâtel: Imprimerie de la Société Typographique, 1782), 3–4, quote on 3. See also Marat, *Charlatans modernes*, 5–6.
586 Hahn, *Anatomy*, 153; Brissot de Warville, *De la vérité*, 31–34 for examples.
587 Brissot de Warville, *De la vérité*, 177–78. See also Marat, *Charlatans modernes*, 14.
588 Brissot de Warville, *De la vérité*, 30. Brissot's general distaste for periodicals and their negative impact on scientific progress features in his argumentation on several occasions, see for example Ibid., 143–48, 179–80.

odds with what the two scholars considered to be the preconditions for any scientific advancement. Since each century witnessed the birth of a mere four or five geniuses, academies were necessarily dominated by mediocre scholars who silenced their intellectually superior peers. One only had to look to ancient Rome and Athens, Brissot claimed, to see that true philosophy was taught by an ingenious master to his pupils, instead of being performed by an 'aristocratie elective, qui suppose (...) que ces électeurs sont constamment guidés par l'esprit de justice & de vérité'.[589] Scientific institutions were paralysed by their own inhumane aspirations of establishing and spreading truth, with horrendous consequences for the scientific endeavours of both their members and outsiders: 'si ells changeoient d'opinions, ells donneroient des doutes sur leur infaillibilité; elles enseignent donc que leur doctrine est la seule veritable, crient contre l'innovation, l'appelent une hérésie'. This assumption was evidenced by the decade-long rejection of Newton's theories by the Parisian Academy, which made its judgement about scientific theories – especially regarding Marat's works – anything but trustworthy.[590]

Crucially, Marat and Brissot not only countered the progressivist undertone of traditional *histoires de l'esprit* but set out to explain why academies had been unfavourable towards progress. By focusing on the social mechanisms at play in academies over the course of their history, they developed a novel perspective upon the history of knowledge production in the sciences which later influenced both Condorcet and Fourcroy. For reasons of brevity, I shall call this method the 'contextualist approach' in the following. Using select examples from chemistry, the two scholars scrutinised how over time the institutional structures of established institutions and the social practices within then had affected both the investigations of the established scientists themselves and the judgements which they pronounced upon outsiders. What established scientists considered a reliable fact or an adequate interpretative system thus

---

[589] Brissot de Warville, *De la vérité*, 164–65, quote on 165; Hahn, *Anatomy*, 153; Marat, *Charlatans modernes*, 6–7.
[590] Brissot de Warville, *De la vérité*, 167, 172–75, 333, quote on 172. For a similar reading see Hahn, *Anatomy*, 153–54.

appeared as the product of social and institutional factors. Together, *De la vérité* and the *Charlatans modernes* implied that historians of science had to take into account the real-world conditions of human interaction and institutional limits when exploring the history of science instead of portraying progress as the result of a naturally predetermined exploration of the *ésprit scientifique* within the setting of established scientific associations. Admittedly, the idea that institutions and social practices informed knowledge production was very common in eighteenth-century conjectural histories on the early stages of human evolution.[591] Still, Marat and Brissot were arguably the first philosophers to analyse the history of science since the seventeenth century from this viewpoint.

Indeed, a look at the hidden social mechanisms at play in scientific academies seemed to confirm that they had been flawed from their earliest days. Brissot conjectured that the unnamed founder of the first academy might have been driven by the conviction that, by associating those who investigated similar subjects, scientific progress would naturally ensue. This, however, had been a profound miscalculation, for 'il ne savoit pas que, plus que les hommes sont réunis en grandes masses, plus ils se corrempent, & que ce vice inhérent aux grandes sociétés, se retrouve aussi dans les particuliers.' Human nature itself made it impossible for Academies to be places nurturing progress.[592] Marat and Brissot went as far as to claim that the current state of scientific investigations could be explained through the lens of the social environment in which they had been created and taught. Brissot, for example, took issue with the culture of public courses in the French capital which were a vital means for young naturalists in the latter half of the eighteenth century to make a living (see chapter 1). While they had allegedly been designed to educate the public, every teacher used them for the sole purpose of furthering their own particular theory, leading to confusion among the audience. As a result,

---

[591] Lifschitz, 'Genesis'; Lifschitz, *Language*, 3–6.
[592] Brissot de Warville, *De la vérité*, 164; Marat, *Charlatans modernes*, 9; Hahn, *Anatomy*, 153.

‘l’erreur circule ainsi perpétuellement dans la capitale, & de la capitale aux provinces’. Thus, scientific controversies were marked by a dynamic which was determined entirely by social factors. Brissot underlined this with an example from chemistry: ‘l’un crie que le phlogistique existe, & cent plumes écrivent, le phlogistique existe; un autre crie, le phlogistique est un chimere, & deux cents plumes écrivent, le phlogistique est une chimere’.[593]

In the second letter of his *Charlatans modernes,* Marat assessed the issue from a different perspective. He pointed to the alleged discrepancy between narratives of progress and the actual state of science and adduced the vast number of recent theories in pneumatic chemistry as evidence for the flaws in the practices championed by established institutions.[594] Marat maintained that ‘ainsi que les autres corps, l’académie des sciences a ses mœurs, ses usages, son régime, ses maximes et sa politique dont aucun membre peut s’écarter sans se render suspect à tous les autres’. The social pressure resulting from the association of many scholars impacted their thematic and conceptual choices.[595] Moreover, the corrupt recruitment procedure which allowed for the co-optation of disciples implied that the academicians were not only incapable of performing their tasks but were also of a very bad character.[596] As the example of Lavoisier highlighted, this setting directly influenced the theories produced under the auspices of the Parisian *Académie*. Lavoisier’s chemical nomenclature was plagiarised from the insights of others, a practice which was protected by the internal workings of the Academy. Whenever he got wind of a novel idea, he simply recorded it as his own in the *Mémoires* of the Academy, in order to claim authorship of it later.[597] Yet, even as a plagiarist, he was too mediocre to synthesise the stolen goods into a coherent theory. Marat sneered that the famous chemist would ‘change de systême comme de souliers’ which in the end simply made him change

[593] Brissot de Warville, *De la vérité*, 157–59, quote on 159.
[594] Marat, *Charlatans modernes*, 7–8, 17.
[595] Ibid., 32–33, quote on 32.
[596] Ibid., 34–35.
[597] Ibid., 36, footnote 1.

‘le terme d’acide en celui d’oxygine, le terme de phlogistique en celui d’azot, le terme marin en celui de muriatique, le terme nitreux en ceux de nitrique et nitraque’.[598]

The contextualising perspective on the history of science developed by Marat and Brissot was as tangential as it was polemical. Yet still, *Les charlatans modernes* and *De la Vérite* provided a counterpoint to the mainstream narratives of *histoires de l’esprit* with their narrow focus on incremental progress, propelled by the stable landscape of institutionalised science. Thus, they offered a fresh perspective on the history of science as much as they presented a novel method of historical inquiry: if investigations into the natural world were directly affected by politics, institutional structures, and social mechanisms down to the level of theory formation and nomenclature, scientific knowledge and theories had probably evolved in quite a different way than had been acknowledged by scholars thus far. This was an intellectually advanced topic worth exploring.

Progress Reinstated: Condorcet’s Defence of the Academy and the Contextualising Approach

All of these generalising claims on the history of the natural sciences would probably not have led to much repercussion among established scholars if the French Revolution had not put the future of all royal institutions on the agenda. Especially in debates on the imminent educational reform, it was a matter of controversy whether traditional establishments and the realms of knowledge their members investigated could serve post-revolutionary France in their current form, in particular given how costly it was to continue running them.[599] Different

[598] Ibid., 36.
[599] Adrian O’Connor, *In Pursuit of Politics. Education and Revolution in Eighteenth-Century France*, Studies in Modern French History (Manchester: Manchester University Press, 2017), 76–86; Hahn, *Anatomy*, 159–94; Corsi, *Age*, 10–11; Richard W. Burkhardt, *The Spirit of System: Lamarck and Evolutionary Biology* (Cambridge MA: Harvard University Press, 1977), 36–37; Spary, *Utopia’s Garden*, 164–65.

scientific corporations acted differently in the face of the reform challenge. For example, the members of the *Jardin du Roi*, among them Fourcroy, succeeded in transforming their institution into the *Musée d'Histoire Naturelle*, an independent organisation dedicated to the study of nature, which was inspired by the revolutionary values such as equality among its members.[600] The academicians, by contrast, were slower in their response to calls for reform. This was partly due to the fact that the Academy's internal composition had been rearranged four years earlier. The reform of 1785, however, did not touch upon any of the pressing issues of 1789 such as the role of patronage in recruitment procedures, the problem of internal hierarchy including the unequal distribution of voting rights among the Academy's members, or the question of how an institution that was so deeply rooted in the culture of the *Ancien Régime* could serve France after 1789.[601]

To make the case for the continued existence of academic institutions despite their previous close ties with the political elite of the *Ancien Régime*, members of the scientific establishment resorted to various argumentative strategies between 1789 and 1793.[602] It was within this dynamic that the historical role of the Academy became a matter of controversy, not least because traditional histories had inextricably tied the very idea of scientific progress to its existence. On 18 November 1789, Louis Alexandre de La Rochefoucauld d'Enville, honorary member of the Academy, bolstered his proposal for the abolition of different ranks within the corporation with a view of the institution's history deviating from this tradition. La Rochefoucauld questioned whether the Academy could have been 'exempt des principes et des préjugés du siècle qui lui a donné naissance', given that both its regulations and the inequality among its members had been established under the authoritarian reign of Louis XIV. In concluding

600 Spary, *Utopia's Garden*, 159–73; Gillispie, *Science Revolutionary Years*, 167–83.
601 Gillispie, *Science Revolutionary Years*, 186–90; Roger Hahn, 'L'Académie royale des sciences et la réforme de ses statuts en 1789', *Revue d'histoire des sciences et de leurs applications* 18, no. 1 (1965): 17; Hahn, *Anatomy*, 98–102, 166–76, 195–251.
602 Spary, *Utopia's Garden*, 156–57, 162.

that 'sans doute, cette disposition répugnait à l'esprit des sciences qui ne met entre les hommes d'autre différence que celle de leur mérite individuel', he suggested that the political context in which the Academy had emerged directly influenced its scientific decisions.[603] Other members of the establishment remained more conservative in their view on the historical entwinement of science and politics. A week after La Rochefoucault had spoken to his colleagues, Jean-Dominique de Cassini, astronomer and inheritor of the directorship at the Observatory by birth, refused to support the former's ideas. Having raised the rhetorical question as to whether there was something in the Academy's regulations 'qui s'oppose à la perfection et au progrès des sciences', he gave the answer himself: 'non sans doute: j'en atteste l'expérience d'un siècle et plus, de découvertes, de travaux, de succès et de gloire'.[604]

In the ensuing debates until the abolition of the *Académie* in 1793, the critical analyses by outsiders profoundly impacted how members of the establishment reconceptualised their view of the evolution of science and the role which academies had played in this process. Between 1789 and 1793, many publications therefore reflected to some extent upon how such institutions and their internal composition had influenced education and science in the past.[605] Lavoisier, for example, accompanied his plans for a renewed reform of the Academy with considerations of how its traditional structure had facilitated scientific progress to the benefit of the entire nation.[606] The most original and curious attempt to re-write the history of the Academy both as an existing institution and as a more general idea was made by Marie Jean Antoine Nicolas de Caritat, Marquis de Condorcet, the permanent secretary to the *Académie des*

---

[603] Louis Alexandre de la Rochefoucauld d'Enville, 'Mémoire lu à l'Académie des sciences, 18.11.1789', ed. Roger Hahn, *Revue d'histoire des sciences et de leurs applications* 18, no. 1 (1965): 20–23, quote on 21. The text is edited in the appendix of the following article: Hahn, 'Académie royale des sciences'. See ibid., 15-19 for context.

[604] Jean-Dominique Comte de Cassini, 'Mémoire lu à l'Académie des sciences, 25.11.1789', ed. Roger Hahn, *Revue d'histoire des sciences et de leurs applications* 18, no. 1 (1965): 25–27, quote on 25. The text is also edited in the appendix to Hahn's aforementioned article: Hahn, 'Académie royale des sciences'.

[605] For examples see Gillispie, *Science Revolutionary Years*, 152–64.

[606] Antoine de Lavoisier, 'Observations sur l'Académie des Sciences', in *Oeuvres de Lavoisier*, vol. 4: Mémoires et Rapports (Paris: Imprimérie Impériale, 1868), 616–23. See also Gillispie, *Science Revolutionary Years*, 216–17 for context and the exact dates.

Sciences. He turned the method of assessing the social context of knowledge production through a historical lens originally designed by Marat and Brissot to criticise established institutions and their practices into a tool to defend the latter. Thus, one of the most important representatives of the scientific establishment adopted the contextualising approach and popularised it in his own writings.

Condorcet was well aware of the intersections between scientific production and institutional settings. Born into an aristocratic family with roots in the Dauphiné, he was educated at a Jesuit school in Reims and subsequently entered the *Collège de Navarre* in Paris. His climbing of the career ladder is a perfect example of patronage relationships at work. Having discarded the idea of a military career, Condorcet began to submit mathematical *Mémoires* to the Academy from 1761 onwards. Throughout the 1760s, he secured the patronage of Lagrange and especially of d'Alembert, who introduced him into the salons of Mme de Lespinasse and Mme Helvétius. Following the great success of his work on the calculus, Condorcet became an *adjoint* of the *Académie des Sciences* in 1769 and an *associé* in 1771 before d'Alembert successfully arranged for him to become the institution's permanent secretary in 1776 against the strong resistance of Buffon.[607] Frequently representing the Academy in public fora – especially when delivering eulogies on deceased colleagues – Condorcet was one of the most prominent proponents of the idea that the Academy contributed to the advancement of all sciences to the benefit of the entire population before the Revolution. As early as the 1770s, he developed an interest in how philosophical and scientific insight of all sorts could be used to implement political and administrative reforms,[608] a topic which formed the core of his writings on educational reform during the Revolution as well. Having published five *Mémoires* on education between 1790 and 1791, Condorcet became the chairman of the education committee in the

[607] Keith Michael Baker, *Condorcet. From Natural Philosophy to Social Mathematics* (Chicago Ill: The University of Chicago Press, 1975), 1–47; Jacques Roger, *Buffon. un philosophe au jardin du roi* (Paris: Fayard, 1989), 481–84.
[608] Baker, *Condorcet*, 47–82.

National Assembly in 1791. In this capacity, he drafted a comprehensive *Rapport* on the organisational future of education, which he finished in 1792. Here, Condorcet proposed to transform the Academy into an egalitarian *Société Nationale des Sciences et des Arts* which would be even more powerful than its predecessor, for it would control the now state-run primary and secondary education. The text was by far the most influential publication on the topic and continued to be discussed after Condorcet had taken his own life during the Terror.[609]

To legitimise the continued existence of such an elitist body, Condorcet needed to fend off claims by the Academy's critics about the negative role it had historically played. As already hinted above, he did so by adopting the technique of contextualising knowledge production to view the history of the academy to a different end than the method's creators had imagined. There is plenty of evidence showing that, in choosing this approach, Condorcet was replying to Brissot's and Marat's claims. In the *Rapport*, Condorcet pointed to the fact that the current criticism of the Academy was informed by a negative view on the Academy's history. Acknowledging that the old Academy suffered from an 'esprit de corporation si dangereux, mais si naturel dans un temps où tout était privilége', he nevertheless held that even so it had succeeded in judging the merits of all scholarly works that had been submitted for assessment.[610] Although Condorcet did not bother to mention Marat's name here, there can be no doubt that this was an open attack on the latter's critical writings, especially since Condorcet in his capacity as the Academy's permanent secretary had been directly involved in rejecting Marat's scientific ideas.[611] In the case of Brissot, it is notable that he and Condorcet even started corresponding on political matters from 1788 onwards. This makes it likely that Condorcet was

[609] Gillispie, *Science Revolutionary Years*, 120–24; Maurice Crosland, *Science under Control. The French Academy of Sciences 1795-1914* (Cambridge: University Press, 1992), 51–52; Élisabeth Badinter and Robert Badinter, *Condorcet (1743-1794). un intellectuel en politique* (Paris: Fayard, 1988), 395–400.
[610] Marie Jean Antoine Nicolas de Caritat Condorcet, 'Rapport et projet de décret sur l'organisation générale de l'instruction publique', in *Oeuvres de Condorcet*, ed. A. Condorcet O'Connor and M.F. Arago, vol. 7 (Paris: Firmin Didot Frères, 1847), 511, 519, quote on 519. See also Gillispie, *Science Revolutionary Years*, 121.
[611] Baker, *Condorcet*, 76–77.

also aware of Brissot's earlier writings such as *De la vérité*.[612] Given the attention which Condorcet's educational writings have received in modern scholarship,[613] I shall, rather than offering a full summary, focus on his historical legitimation of academies. Analysing them from such a viewpoint might also shed new light on the diversity of Condorcet's historical thought which scholars usually synthesise from reading his posthumously published *Esquisse d'un tableau historique des progress de l'esprit humain* in isolation.[614]

On the surface, the writings on education seem to reproduce the traditional historical narrative according to which academies had fostered the advancement of knowledge. Condorcet reiterated that, if correctly designed, they could enable geniuses to make important discoveries. Also, they served to disseminate the truth across the Republic of Letters using their journals as vehicles for swift communication which contributed to eliminating unreasonable prejudices.[615] This conception of academies rested on the idea that the processes of accumulating observational data, refining methods, and improving generalised systems of description were inseparably intertwined. They were 'susceptibles des mêmes progrès: et plus l'esprit humain aura découvert de vérités, plus il deviendra capable de les retenir et de les combiner en plus grand nombre'.[616]

Whereas Brissot and Marat stressed the negative effects of incorporating scientists in academies, Condorcet sought to unveil the positive impact which the existing structures within

---

[612] On the correspondence see Calogero Alberto Petix, 'Vers le républicanisme. L'évolution de la pensée politique de Condorcet à la lumière de sa correspondence inédite avec Brissot', in *La Correspondance de Condorcet. Documents inédits, nouveaux éclairages. Engagements politiques 1775-1792*, ed. Nicolas Rieucau (Ferney-Voltaire: Centre international d'étude du XVIIIe siècle, 2014), 63–81.
[613] See for example Gillispie, *Science Revolutionary Years*, 110–24; O'Connor, *In Pursuit of Politics*, 98–99, 111–20.
[614] See for example Keith Michael Baker, 'On Condorcet's "Sketch"', *Daedalus* 133, no. 3 (2004): 56–64; Gillispie, *Science Revolutionary Years*, 332–38.
[615] Condorcet, 'Rapport', 501–2, 518; Marie Jean Antoine Nicolas de Caritat Condorcet, 'Cinquième Mémoire – sur l'instruction relative aux sciences', in *Oeuvres de Condorcet*, ed. A. Condorcet O'Connor and M.F. Arago, vol. 7 (Paris: Firmin Didot Frères, 1847), 422–24.
[616] Marie Jean Antoine Nicolas de Caritat Condorcet, 'Premier Mémoire – nature et objet de l'instruction publique', in *Oeuvres de Condorcet*, ed. A. Condorcet O'Connor and M.F. Arago, vol. 7 (Paris: Firmin Didot Frères, 1847), 178–83, quote on p. 183.

scientific corporations and their transnational cooperation had had on science. For this purpose, he stated that 'les véritables progrès des sciences' were not limited to incremental progress, but included sudden leaps which allowed a discipline 'à s'étendre d'advantage autour du même point'.[617] Every discipline, Condorcet added in the *Rapport*, experienced not only moments of spectacular progress but also periods of stagnation which led to it being almost entirely abandoned by scholars. Now the 'talent qui a presque épuisé les méthodes connues' waited for the 'génie' to show them a new approach which renewed the possibility of making a great number of discoveries.[618] In striking resemblance to what Thomas Kuhn would later identify as periods of 'normal science' interrupted by sudden paradigm shifts, Condorcet distinguished between those eras when talents took the lead and the crucial moments in which the geniuses had to take over.[619]

It was the internal structure of Academies that allowed both for the periods of incremental accumulation and for moments of revolutionary paradigm shifts. The *Rapport* evidenced this claim by invoking the fruitful methodological exchanges which had taken place between mathematics and the natural sciences in the Parisian Academy during the eighteenth century. At its outset, the mathematical sciences used the calculus whereas natural scientists relied on pure observation. Thanks to their joint institutional affiliation, the two fields had mutually informed each other so that 'presque toutes, aujourd'hui, peuvent employer ces deux moyens de reculer les bornes des connaissances humaines'. Such examples clearly demonstrated that it was extremely valuable for scientists to assemble in an institution in order to share their methods and help each other. Thus a chemist or a physicist 'empêchent le botaniste de se borner à la simple nomenclature des noms, à la description trop nue des objets, ou rappellent à des travaux très utiles le géomètre qui emploierait ses forces à des questions sur les

[617] Ibid., 180.
[618] Condorcet, 'Rapport', 509.
[619] Kuhn, *Structure*, 35–42, 91–109.

nombres, à des subtilités métaphysiques'.[620] In Condorcet's view, history demonstrated that the internal composition of academies did not lead to corruption and conservativism but to genuine progress due to interdisciplinary cross-fertilisation.

Finally, Condorcet rebuffed criticism according to which the Parisian Academy had exercised too much authority to the detriment of the entire learned world. Whereas Brissot and Marat conceptualised the Academy's judgements as a top-down exercise of power, Condorcet held that the Parisian Academy did not exist in a vacuum but within a lively European community. Echoing the traditional idea of an egalitarian Republic of Letters, he argued that scientists in the French capital had always been subject to the scrutiny of their colleagues abroad. [621] Invoking the 'opinion générale des hommes éclairés de l'Europe' as the 'puissance suprême', Condorcet suggested that the criteria for what was considered true and innovative were ultimately determined by the transnational community of scholars. It was not the political power of kings, the patrons of academies, but the abundant networks of scientific communication that had been the ultimate source of scientific authority over the past century or so.[622]

The intention behind this manoeuvre is evident. By identifying the idea of public opinion – one of the most successful argumentative resources in the Revolutionary era – as the crucial regulative force of scientific discourse already in the *Ancien Régime*,[623] Condorcet hoped to downplay the Academy's entwinement with royal power. This conformed to claims he made in a footnote of the *Rapport* according to which the Academy itself had been a space of liberty rather than an instrument of monarchic rule.[624] Notwithstanding the political intentions behind his claim, this argumentative strategy had important consequences for historical

---

[620] Condorcet, 'Rapport', 502–3, quotes on 503..
[621] Ibid., 520, Footnote. The footnote starts on p. 519.
[622] Ibid., 511, 522, quote on 522.
[623] On the career of the concept see Keith Michael Baker, 'Public Opinion as Political Invention', in *Inventing the French Revolution: Essays on French Political Culture in the Eighteenth Century*, Ideas in Context (Cambridge: University Press, 1990), 167–99.
[624] Condorcet, 'Rapport', 520–21, footnote. The footnote starts on 519.

writing in the sciences. Condorcet suggested that the transnational European discourse on science – and thus another social factor – had a formative impact on actual knowledge production.

Antoine de Fourcroy and the Genealogy of Pneumatic Chemistry

By the mid-1790s, and after the end of the Terror, the institutional situation in Paris had changed once again. In 1795, the *Institut National des Sciences et des Arts* was founded to fill the institutional gap which the abolition of the *Académie* had left in 1793. As was the case for all naturalists, this development was crucial to Parisian chemists because the *Institut* provided for six paid professorships in the subject and thus secured the institutional future of the discipline in Paris.[625] Antoine de Fourcroy, whose 1796 history of chemistry is discussed in this section, was instrumental in this development. In the Committee for Public Instruction, of which he had been a member since 1793, Fourcroy made contributions both to those sections of the 1795 constitution dealing with education, and to designing the internal organisation of the new *Institut*. Following the execution of his colleague and former mentor Lavoisier in 1794, Fourcroy therefore occupied an outstanding position within Parisian intellectual circles and succeeded in accumulating numerous professorships, not only at the *Institut* but also at the *Muséum d'Histoire Naturelle* (the former *Jardin*), the *École Centrale des Travaux Publics*, and the *École de Santé*.[626]

While Fourcroy had sided with Condorcet to ensure the continued existence of scientific institutions in the early 1790s, his main concern shifted after 1794. As already discussed in chapter 4, the Parisian learned world engaged in what Pietro Corsi has called an 'impassioned

[625] Gillispie, *Science Revolutionary Years*, 446–47.
[626] Smeaton, *Fourcroy*, 44–45, 64–65, 68–72; Corsi, *Age*, 8. There has been debate on Fourcroy's actions in the Terror in historiography on Lavoisier since the nineteenth century, in particular regarding his role in the execution of Lavoisier and the death of Vicq d'Azyr, see Gillispie, *Science Revolutionary Years*, 324–26; Smeaton, *Fourcroy*, 53–59.

debate on the reform of *Histoire Naturelle*' which was one reason for the chemists around Lavoisier to propose a reform of chemical nomenclature in 1787.[627] Corsi, who has reconstructed the debate in great detail, showed that the discussions gained renewed traction after the Terror and continued throughout the 1790s. In comparison to the 1780s, however, the status of chemistry had somewhat shifted. Together with Linnean taxonomy and Haüy's approach to crystallography, Lavoisian chemistry – represented by its nomenclature and further philosophical implications alike – had itself become something of a metaphor for Parisian naturalists by the middle of the 1790s. When trying to establish novel approaches in several branches of natural history, including geology, zoology, and even medicine, scholars such Déodat Gratet de Dolomieu, and Pierre Jean Georges Cabanis actively referred to Lavoisian chemistry and its epistemology as their ideal. Others, such as Louis-Jean Marie Daubenton and Jean-Baptiste Lamarck, rejected the Lavoisian philosophy of science and instead proposed the incremental reform of the Buffonian approach to all branches of natural history, emphasising speculative and literary techniques over the mathematico-linguistic philosophy of science championed by Lavoisier and his disciples. They thus joined the choir of Lavoisier's Parisian critics in the realm of chemistry, most notably the editor of the *Annales de Physique,* Jean-Claude Delamétherie, and former academicians, for example Balthazar-Georges Sage and the pharmacist Antoine Baumé. On such grounds, Lavoisian chemistry became the – positive or negative – point of reference to discuss the role of language, mathematics, or precision instruments in several naturalist disciplines.[628]

---

[627] Corsi, *Age*, 23.

[628] Ibid., 9, 20–24, 29–39, quote on 23; Corsi, 'Models', 383–96; Martin S. Staum, *Cabanis. Enlightenment and Medical Philosophy in the French Revolution* (Princeton NJ: Princeton University Press, 1980), 152–58, who shows that Cabanis argued for medicine's reliance on the philosophical of science championed by Lavoisier and Vicq d'Azyr, while at the same time criticising those who made too much use of chemistry's experimental discoveries in the study of human bodies and diseases. On Delamétherie, Sage, and Baumé see Perrin, 'Triumph', 47–50, 52–57, 61–62; Déré, 'Réception de la nomenclature', 216. On Lamarck's criticism of Fourcroy see Beretta, *The Enlightenment of Matter*, 286–88.

The criticism of Lavoisier's approach voiced by some members of the Parisian scientific community therefore shows striking parallels to the attacks launched by the British and German chemical specialists against the same target since the late 1780s (see chapters 3 and 4). After the premature death of Lavoisier in 1794, it was Antoine de Fourcroy who fought for the Lavoisian chemistry and its philosophical assumptions to be accepted, practiced, and taught by as many Parisian naturalists as possible against considerable local opposition. Due to his institutional positions, Fourcroy was fully aware both of the dynamics of the Parisian naturalist debate and of the transnational chemical controversy.[629] Scholarship has shown that, in reaction to the Parisian challenge, Fourcroy used his institutionally outstanding position to assign the relevant teaching positions in Paris to his scientific allies, among them his co-authors of the 1787 nomenclature reform, Guyton de Morveau, Hassenfratz, and Adet, as well as Louis-Nicolas Vaucquelin, his *protégé*.[630] What has never been considered is the fact that, as the co-editor of the *Annales de Chimie* and the author of several textbooks, Fourcroy was also aware of the historical criticism which had been raised against Lavoisian chemistry by the German chemists.[631]

On such grounds, the present section assesses Fourcroy as a historian of chemistry. As I hope to demonstrate, Fourcroy designed his major work of the period – that is, his article 'Chimie' for the *Encyclopédie Méthodique* (1796) – to defend the intellectual foundations of Lavoisian chemistry in front of both the local and the European audience.[632] Crucially, the text

---

[629] On Fourcroy's co-editorship see Crosland, *Shadow*, 105–9.
[630] Corsi, *Age*, 7–8, 10.
[631] Notably, the *Annales* favourably reviewed Wiegleb's *Geschichte* in the early 1790s: [anon.], 'Histoire de la naissance et de ses découvertes dans les siècles modernes, par Wiegleb, première et seconde partie du premier volume, depuis 1651 jusqu'à 1750, à Berlin, 1790 (Review)', *Annales de Chimie et de Physique ou recueil de mémoires concernant la chimie et les arts qui en dépendent* 11 (1791): 108–10.
[632] It is generally acknowledged in scholarship that the volumes on chemistry which Guyton de Morveau and later on Fourcroy had edited for the *Encyclopédie Méthodique* since the early 1780s served the purpose of defending Lavoisian chemistry in general and the new nomenclature in particular, see for example Christabel P. Braunrot and Kathleen Hardesty Doig, 'The Encyclopédie Méthodique. An Introduction', *Studies on Voltaire and the Eighteenth Century* 325 (1995): 24, 37–38. However, the thrust and argumentative function of Fourcroy's work in the ongoing debates on chemistry in Parisian naturalist circles and across the continent has never been assessed in detail.

was not a traditional dictionary entry recapitulating the current state of research but a genealogy of pneumatic chemistry which traced the emergence of the Lavoisian approach to chemistry from various angles. Indeed, the analysis demonstrates Fourcroy's awareness of the developments in historical inquiry discussed in the previous sections. As I shall show in great detail, he merged the contextualising approach with a fresh view on the history of chemical theories and instruments which resulted in a complex genealogy of modern chemistry. Presumably, Fourcroy decided to place the text in a lexicon with a good reputation and high subscription rates instead of publishing it as an independent monograph in order to reach a wide audience which otherwise might not have engaged with a work focused on the history of chemistry. Rewriting the history of the field in the *Encyclopédie Méthodique* can thus be seen as the intellectual equivalent of his concomitant efforts to establish a Lavoisian following within the ranks of the Parisian elite institutions.[633]

Fourcroy grounded his history in a controversial diagnosis: since the early 1770s, chemistry had been in a constant state of crisis.[634] The field was plagued by the continued existence of mutually exclusive theories which, although they were rooted in the same body of observational data, continued to coexist and thus had hampered further progress. To modern readers, this calls to mind Thomas Kuhn's ideas on scientific paradigm shifts which Kuhn claimed to be always preceded by a state of 'pronounced professional insecurity'. Crucially, Kuhn invoked pneumatic chemistry at the end of the eighteenth century as one of his examples.[635] Against this backdrop, Fourcroy's account had a twofold goal. On the one hand, he aimed to explain how chemistry had reached this impasse. Structurally, the implications of Lavoisier's

---

[633] Subscriptions which came from across the continent had peaked at 5,000 in 1789 and still counted 3,000 in 1792 despite the politically tense situation, see Ibid., 9–10, 13.

[634] Antoine de Fourcroy, 'Chimie', in *Encyclopédie Méthodique, ou par ordre de matières. Par une société de gens de lettres, de savants et des artistes. Chimie, Pharmacie et Métallurgie*, vol. 3 (Paris: Agasse, 1796), 342, 414. Notably, Lavoisier already had pursued this strategy in the *Réflexions sur le Phlogistique* a decade before Fourcroy, see Bensaude-Vincent, *Lavoisier Mémoires*, 195.

[635] Kuhn, *Structure*, 66–76, quote on 67-68. The parallel has also been noted by Langins, 'Fourcroy', 21.

philosophy of science served as a conceptual toolbox which could be used to shed light on the history of chemistry. In highlighting 'jusqu'où l'esprit humain avoit pu pénétrer, sans les méthodes & les instrumens trouvés depuis', the historical account unveiled the deficiencies of any approach which did not conform to the Lavoisian principles.[636] On the other hand, Fourcroy reconstructed the genesis of Lavoisier's approach to underline why it was superior to any contesting theory. To this end, he adopted the contextualising approach.

This twofold aim explains the intricate structure of Fourcroy's work. The text is subdivided into eight chapters which Fourcroy somewhat confusingly entitled *époques*, the first five of them tangentially cover chemistry's history up until the seventeenth century in just 38 pages. *Époque* six, by contrast, discusses the modern history of chemistry on 350 narrowly printed pages.[637] In its eight sub-sections which Fourcroy somewhat misleadingly called *périodes*, he abandoned the chronological structure in favour of an analytical approach which focused on different aspects of chemistry as a scientific discipline. Here, he deployed different philosophical, material, and communicative factors at play in chemistry's recent history as lenses to uncover the factors which had historically produced the objectionable theoretical diversity (*périodes* 1–3). The following *périodes* sought to convince the reader how Lavoisier had crafted a more rational approach against all odds and how it had become the acknowledged standard in the European community of chemists (*périodes* 4–8).[638] This brief overview already shows that Fourcroy's work cannot be considered a mere continuation of Enlightenment *histoires de l'esprit*, as some scholars hold.[639] By contrast, he crafted a novel view of writing the history of the field which offered a striking counter point to the German histories of the 1790s.[640]

---

[636] Fourcroy, 'Chimie', 344.
[637] *Epoques* seven and eight present the current state of chemical investigations which is why they will not be discussed in detail.
[638] Fourcroy inserted a chapter overview of the *périodes* Fourcroy, 'Chimie', 344.
[639] Langins, 'Fourcroy', 15–17; Patrice Bret, 'Les chimies de l'Encyclopédie méthodique. Une discipline académique en révolution et des traditions d'atelier', in *L'encyclopédie méthodique (1782-1832). Des lumières au positivisme*, ed. Claude Blanckaert and Michel Porret, Bibliothèque des Lumières 68 (Geneva: Droz, 2006), 530.
[640] As for Fourcroy's historical oeuvre, close readings of the text are scarce. Most historians have confined themselves to short summaries, adding that the main purpose of Fourcroy's text was to promote Lavoisian chemistry,

In *périodes* 1 to 3, Fourcroy historicised two aspects of Lavoisier's philosophy, using them as analytical lenses to explain the lamentable emergence of theoretical diversity in chemistry between circa 1650 and 1770. First, he extensively discussed the role of advanced precision instruments in creating factual knowledge, a problem which had been controversially discussed both within Parisian naturalist circles and within the European community of chemists since the 1780s (see chapter 3).[641] Without mentioning any names, Fourcroy implicitly criticised his fellow chemist-historians for not having paid sufficient attention to this topic. The historian who simply recorded facts 'sans décrire ou au moins indiquer les machines inventées pour connoître les forces & les propriétés des corps, ne seroit pas entendu ou le seroit mal'.[642] This was an ill-concealed critique of Wiegleb and, possibly, also of Gmelin's 1795 article on heat in which he had explored his compilatory method for the first time.[643] In Fourcroy's eyes the history of modern chemistry demonstrated that the invention of precision instruments had been one of several necessary pre-conditions for the emergence of a reliable chemical theory. Although artisans could establish factual knowledge on simpler matters, it was only through the use of particular precision instruments in a dedicated experimental setting that any deeper insight could be derived.[644]

On such grounds, Fourcroy argued that factual observations and observational instruments formed a dialectical relationship in which advances in one area begged the same in the

---

see for example Beretta, 'Changing Role', 5–7; Bensaude-Vincent, *Lavoisier Mémoires*, 358–60; Smeaton, *Fourcroy*, 75, 188–90. Exceptions are Janis Langins and Alexey Levin, who have assessed the role of Fourcroy's history in the intellectual history of the concept of the Chemical Revolution in the late eighteenth century, see Langins, 'Fourcroy'; Levin, 'Venel', 312–14. Siegfried, 'Chemical Revolution', 43–47 has summarised Fourcroy's other historical essays in his textbooks, the Leçons élémentaires d'histoire naturelle et de chimie (1782) and the Systême des connoissances chimiques (1800) while omitting the article in the Encyclopédie méthodique.

641 For an overview see Golinski, 'Precision Instruments' and the literature discussed in section 1 of chapter 3 of this thesis.

642 Fourcroy, 'Chimie', 389–90, quote on 390.

643 I am referring to Wiegleb, *Geschichte des Wachsthums,* 1790–1791, and Gmelin, 'Winke'. See chapter 3 of this thesis.

644 Fourcroy, 'Chimie', 318–19, 344, 410–13.

other.[645] He tasked any historian of science with assessing 'les differences, les nouveautés, les améliorations, qui ont été adoptées dans les appareils chimiques à mesure que les découvertes se sont succédées; si les faits nouveaux les ont paits naître, ou en ont indispensablement crée l'idée & l'execution; une fois trouvés & employés dans les experiences, ces appareils neufs ont à leur tour fait naître des faits nouveau'.[646] The history of pneumatic chemistry was exemplary in this regard. In the early eighteenth century, laboratory equipment had been constructed so poorly that it had entirely failed to grasp the object of analysis. Due to the lack of such a regulative tool, contradictory opinions on calcination had proliferated, for scholars had been unable to align observations and interpretations.[647] Chemistry had continued to suffer from this obstacle for a long time. The instruments developed by scholars such as Otto von Guericke, Robert Boyle, and Stephen Hales, were cases in point: their material imperfection had made it impossible for their originators to develop a consistent system. History thus taught that the perfection of 'l'art experimental (…) devoit nécessairement précéder et amener la creation de la doctrine nouvelle'.[648] And, indeed, the required technical advancements had been made over the past decades, in particular by scholars such as Rouelle and Priestley.[649]

To account for the proliferation of contradictory theories, Fourcroy elaborated upon a second aspect of the Lavoisian philosophy of science. Concurring with Lavoisier's position voiced in the 1780s, he argued that theories unconsciously guided scholarly reasoning. In the twentieth century, the bacteriologist and philosopher, Ludwik Fleck, coined the concept of *Denkstil* to describe this epistemic problem.[650] Fourcroy introduced his perspective on the

---

645 Trevor Harvey Levere, 'Balance and Gasometer in Lavoisier's Chemical Revolution', in *Lavoisier et la révolution chimique. Actes du colloque tenu à l'occasion du bicentennaire de la publication du Traité élémentaire de Chimie 1789*, ed. Michelle Goupil, Patrice Bret, and Francine Masson (Paris: SABIX-Ecole Polytechnique, 1992), 313 has also noted this facet of Fourcroy's work without further assessing it.
646 Fourcroy, 'Chimie', 389.
647 Ibid., 345–48, 409.
648 Ibid., 348–59, quote on 348.
649 Ibid., 407–14, especially 409.
650 Ludwik Fleck, *Entstehung und Entwicklung einer wissenschaftlichen Tatsache. Einführung in die Lehre vom Denkstil und Denkkollektiv*, 12th ed. (Frankfurt am Main: Suhrkamp, 2019), 109–29.

problem based his deliberations on early modern pneumatic chemistry which culminated in the work of Stephen Hales. The latter had been prevented by his prejudiges and opinions from drawing the right conclusions from his observations. This was a recurring topic even in chemistry's recent history: 'une longue habitude d'explications & de théorie ancienne ont de même empêché plusieurs chimistes modernes, d'ailleurs très-habiles gens, de croire aux nouvelles découvertes & plus encore à la verité aux résultats nouveaux qu'on en a tirés, & qui ne sont cependantes que des consequences immédiates des experiences'.[651] A long succession of British and French scholars, from Joseph Black and Gabriel François Venel in the middle of the eighteenth century to Priestley and Cavendish at its end had shown promising attempts to draft a coherent theory and had thus laid the foundations for later achievements. Yet, the absence of a truly philosophical methodology had prevented them from successfully synthesising their otherwise laudable experimental observations and technical contributions. Priestley in particular had made a vast number of discoveries and had showed interesting theoretical considerations. Still, he had not managed to form a convincing 'liaison' between the facts.[652]

However, the prime example for the ongoing negative impact of wrongly constructed theories was set by the Germans. In rejecting Black's innovative idea of fixed air, Johann Carl Friedrich Meyer had proposed 'une doctrine toute entière et entièrement différente (…) sur les mêmes matières & sur les mêmes faits' as a result of which Meyer's concept of fat acid (*acidum pingue*) was merged with Stahl's phlogiston theory.[653] The resulting theoretical construct had had a devastating impact on the subsequent generation of chemists. The writings of the Luxembourgian-Austrian scholar Heinrich Johann Nepomuk von Crantz served as an example for Fourcroy: 'l'esprit préocuppé de ce systême, Crans ait absolument refusé tout accès dans son

[651] Fourcroy, 'Chimie', 359–60.
[652] Ibid., 362–71, 376–89, quote on 384.
[653] Ibid., 371–74, quote on 371. The term *acidum pingue* is introduced ibid., 372.

intelligence aux faits les plus puissans, aux raisonnemes les plus clairs & que le préjugé en faveur de l'opinion qu'il vouloit soutenir, l'ait empêché de reconnaître la route de la vérité'.[654]

A close look at the Crantz passage enables us to see Fourcroy the historian at work. His reconstructions drew heavily on the *Précis historique* in Lavoisier's *Opuscules Physiques et Chimiques* (1774), the work in which the latter had famously begun to develop his theory of air. The *Précis* is a minute reconstruction of both observations in pneumatic chemistry and the diverging interpretations which they had sparked in scholarship. In juxtaposing them, Lavoisier sought to demonstrate the inconsistencies of all existing theories in pneumatic chemistry in order to bolster his own conclusions.[655] Fourcroy copied most of the account verbatim, but added numerous philosophical considerations on the impact of theoretical thought in chemical reasoning. By inserting the later stages of Lavoisian chemistry – i.e. its philosophical considerations from the 1780s – into one of Lavoisier's earlier works, Fourcroy created a pastiche of different periods in his teacher's intellectual development. To the reader, this gave the impression that Lavoisier had always followed the same rational trajectory. At the same time, the passage implied that the insufficiency of competing systems emanated from their inconclusive and fluid character.[656]

In *périodes* 4 to 8, Fourcroy shifted gears to describe the advent of the 'grande révolution' staged by Lavoisier between 1769 and 1792.[657] He set himself the task of reconstructing the emergence of Lavoisier's philosophy of science to account for its superiority over competing approaches. The contextualising approach of writing history, developed by Marat, Brissot, and Condorcet, was key in realising this goal. Fourcroy argued that the social, institutional, and

---

[654] Ibid., 374–75, quote on 375.
[655] Antoine de Lavoisier, *Opuscules physiques et chimiques*, vol. 1 (Paris: Durand, Didot, Esprit, 1774), 1–175. A good summary of the work and its relevance is given by Kim, *Affinity*, 311–21, with further reference to the large body of scholarship. For the wider context of the debate see also chapter 3 of this thesis.
[656] Compare the episode on Meyer and Crantz in Lavoisier, *Opuscules*, 1:71–86. with Fourcroy, 'Chimie', 372–76.
[657] Fourcroy, 'Chimie', 304. See ibid., p. 426 for the timeframe.

communicative context of pre-revolutionary Paris had formed a unique environment for Lavoisier to rationalise chemistry by integrating the perspectives from chemistry's neighbouring disciplines, most notably geometry and physics. Yet, it was not the official Academy but the semi-private space inhabited by the Arsenal group which Fourcroy focused on. The painstaking reconstruction of the intellectual circles which Lavoisier had worked in exemplified just how fruitful the interdisciplinary exchange between mathematics and the disciplines investigating nature could be for science. Tracing such collaborations had a twofold argumentative function. It offered a point of reference to all those scholars in the Parisian debate who argued in favour of applying the Lavoisian philosophy of science to other branches of natural history instead of returning to the Buffonian ideal. At the same time, the interdisciplinary genealogy of Lavoisier's theory was aimed at the European critics of Lavoisier who neglected that chemistry had to resort to mathematics or the philosophy of language to establish reliable facts. Ultimately, by arguing that Lavoisier's theory had its most important roots in his private circles and his laboratory, Fourcroy refuted the premises of Marat's criticism according to which the elitist Parisian institutions, most notably the Academy, had hampered the architecture of the new nomenclature.

To scrutinise the evolution of Lavoisier's theory, Fourcroy focused on the palpable environment of the laboratory as a prime spot for intellectual exchanges. After his initial publications, Lavoisier had founded an intellectual circle in the 1770s which scholars from different disciplines had become part of and which in modern scholarship is often referred to as the Arsenal group. The circle had quickly become a vibrant spot of transdisciplinary cooperation. In addition to chemists such as Claude-Louis Berthollet, the mathematicians and physicists Simon de Laplace, Joseph-Louis Lagrange, and Jean-Baptiste Meusnier were frequent visitors, with whom Lavoisier discussed the most fundamental questions such as the relationship between 'les théories' and 'les expériences'. The circle formed a forum in which Lavoisier could test concepts which were contradictory to the chemical tradition, and where he received feed-back on the philosophical reliability of his alternative proposals. Foreign scholars – including Joseph Priestley – frequently joined the group's discussions when visiting Paris and therefore made contributions, too.[658] The close reading thus exposes certain parallels with Bruno Latour's and Steve Woolgar's twentieth-century attempts to understand how social practices in laboratories affected scientific output.[659]

In what followed, Fourcroy scrutinised the intertwined advances which Lavoisier and his collaborators made in their quest to rationalise the philosophical fundaments of chemistry. In order to create a theory which was 'si différente de ce qu'elle étoit, & si supérieure en même temps à tout ce qu'on avoit coutume d'employer jusque-là dans le langage & la théorie de la chimie', [660] it had been necessary at first to change the way of reasoning in chemistry. The interdisciplinary circle had prompted a convergence between 'la manière de raisonner des géomètres & celle des physiciens', allowing chemists to merge the experimental method with the rigour of mathematical thinking for the first time.[661] Fourcroy used Lavoisier's and La-place's joint analyses of heat as an example to emphasise how powerful the new theory had become due to its interdisciplinary basis: in the course of their collaboration, they had devel-oped the famous 'calorimètre' to account for the palpable nature of heat in accordance with Lavoisier's oxygen theory.[662]

Creating a rational basis for the analysis and description of chemical phenomena also paved the way for a reform in chemical nomenclature. Fourcroy recounted the story of the collaboration between himself, Lavoisier, Berthollet, and Guyton, and summarised the

---

[658] Ibid., 425–26, quote on 425.
[659] Bruno Latour and Steve Woolgar, *Laboratory Life. The Social Construction of Scientific Facts*, Sage Library of Social Research 80 (Beverly Hills CA: Sage, 1979).
[660] Fourcroy, 'Chimie', 426, quote ibid.
[661] Ibid., 425, quote ibid. According to Fourcroy, the debates had also been a chance for mathematicians to reflect their own methodologies, see Ibid., 425–26.
[662] Fourcroy, 'Chimie', 440–41. On the history of the calorimeter and the curious history of its denomination see Roberts, 'Word'.

terminology's principles mostly in line with the arguments which had already been made in 1787.[663] Strangely, however, Fourcroy abstained from making any reference to Condillac's language philosophy which, as discussed in chapter 4 of this thesis, had been instrumental in legitimising the nomenclature reform of 1787. Instead, the genesis of the new nomenclature appeared to be the natural consequence of Lavoisier's earlier collaboration with physicists and mathematicians such as the aforementioned la Place and Meusnier, as well as Jacques Antoine Joseph Cousin, Gaspard Monge, and Alexandre-Théophile Vandermonde who had 'contribué par leurs propres pensées à édifier les bâses de cette nouvelle théorie'.[664] Arguably, this was a reaction to the heavy criticism of the nomenclature's reliance on abstract principles of language philosophy, instead of the practical tradition of chemistry which accompanied its reception in the 1790s.[665] Linking the nomenclature's origins to the cooperation of scholars working in Lavoisier's laboratory probably seemed to provide a more compelling argument in these circumstances.

Having accounted for the evolution of the Lavoisian chemistry, Fourcroy was additionally concerned with reframing the debate which followed its publication in the 1780s and 1790s. Crucially, his account strategically omitted how heavily Lavoisian chemistry and its epistemological fundamentals had been criticised by European chemists such as Priestley, Nicholson, Wiegleb, and Gmelin, as well as by the Parisian naturalist audience (see above and chapters 3 and 4). Instead, Fourcroy took the superiority of Lavoisier's system for granted and asked why some scholars still hesitated to adopt it despite its evident scientific superiority. In his eyes, allegiance to outdated theories was a crucial factor once again. He underlined this claim in a detailed survey of the works of Torbern Bergman, Carl Wilhelm Scheele, and Joseph Priestley in the 1780s.[666] Their stubborn conservatism showed that 'une des plus grandes

[663] Fourcroy, 'Chimie', 426–427, 562 [570]–565 [573].
[664] Ibid., 562 [570].
[665] See Beretta, *The Enlightenment of Matter*, 282–322.
[666] Fourcroy, 'Chimie', 500–501, 517 [525]–541 [549], 565 [573]–566 [574].

difficultés que la théorie pneumatique a rencontrées' was 'la resistance que lui opposèrent les préjugés, l'habitude, quelquefois malheureusement l'amour propre, & souvent aussi le doute philosophique.'[667]

His second line of explaining the resistance towards Lavoisier's system in chemistry's recent history was more innovative. Again, Fourcroy deployed the contextualising approach, this time further developing Condorcet's reflections on the role which the wider European scholarly community played in establishing scientific standards. For him, the political, institutional and geographical conditions of information circulation were factors to be considered by historians of science. Because Bergman lived in remote Sweden for all of his life, he had not known about Lavoisier's investigations, which explained the gaps in his system.[668] In addition, as professors in Uppsala, both Bergman and Scheele had held very important institutional positions in Northern European science. Hence, their neglect of Lavoisier's works had inhibited the establishment of the French theory of combustion across the region.[669] Ultimately, Fourcroy identified the Napoleonic Wars, and the interruption in scholarly communication which they had caused, as a decisive factor in the survival of the phlogiston theory. After all, some of its advocates had merely rudimentary knowledge about it due to the war.[670] No longer was the progress of science dictated by the almost mystical *esprit humain*: rather, it took place in the real world, propelled and inhibited by actual human beings.

[667] Ibid., 500; see also 542 [550].
[668] Ibid., 520 [528].
[669] Ibid., 502.
[670] Ibid., 567 [575]–568 [576], 683 [691], 711 [719].

Conclusion

It has been the purpose of the present chapter to trace the evolution of the contextualist approach to history-writing and its application to chemistry by Antoine de Fourcroy during the final decades of the eighteenth century. In order both to intervene in the controversy on the Lavoisian epistemology in chemistry and to defend the approach of his teacher in Parisian naturalist circles, Fourcroy created a unique form of history-writing and historical inquiry. He adopted the contextualist approach to writing the history of the sciences which had been crafted by Marat and Brissot in the 1780s and further developed by Condorcet in the early 1790s as part of the Revolutionary debate on education reform. The vexed history of the approach has escaped scholarly attention so far because Marat's, Brissot's, and Condorcet's works are usually not considered contributions to historical writing but, rather, as texts with a political thrust. Thus, the chapter offers a cautionary tale of what might escape scholarly attention if a narrow understanding of history-writing as a literary genre is maintained. At the same time, I hope to have showcased that it is often impossible to understand the historical methodology deployed by scientists without contextualising their work in its respective intellectual and institutional environment.

Given its complex trajectory, numerous intellectual affiliations, intricate methodology, and meandering literary form, it must not come as a surprise that Fourcroy's approach to history-writing remained unique in its time. Neither chemists nor naturalists used his work as a blueprint to develop their own historical narratives. Indeed, those of his French colleagues who also wrote histories of the sciences around the turn of the century, for example Jean-Baptiste Biot and Georges Cuvier, assessed the topic from a more general point of view without getting themselves into the thickets of genealogical reconstruction and contextualisation in Fourcroy's tradition.[671] As discussed in the previous chapters, the German chemists concomitantly developed equally complex forms of history-writing, whose differing form and method were informed by their opposition to Lavoisian chemistry. Together with them, Fourcroy's account exhibits how widespread history-writing was as a tool of scientific intervention for naturalists in the late eighteenth century.

While Fourcroy did not have any immediate followers who adopted his methodology, the work's long-term impact was greater. Beyond the simple fact that some later scholars relied on Fourcroy's account as a source for their own reconstructions,[672] his framework for telling the story of the Chemical Revolution came to be influential. Of course, such a claim would have to be substantiated by a thorough and methodologically reflected study of the direct and indirect ways in which Fourcroy's account might have impacted scholarship.[673] Here, I have to confine myself to outlining two parallels for future investigations. First, if one ignored Fourcroy's complex epistemological assessments on the nature of scientific progress and only followed his larger narrative, the history of late eighteenth-century chemistry could be grouped around a clear focal point, that is, pneumatic chemistry as it was investigated by Lavoisier's interdisciplinary Parisian circle. Studies of the Chemical Revolution have long reiterated this pattern while the geographically and thematically much broader approach to history-writing which was concomitantly developed by Wiegleb and Gmelin did not impact modern scholarship. Second, Fourcroy's omissions were just as impactful for twentieth-century scholarship. Neither the numerous artisan instrument makers, nor the female members of the Arsenal group – most notably Marie-Antoinette Paulze Lavoisier – were mentioned by Fourcroy regarding their crucial contributions to the Chemical Revolution.[674] As Lavoisier's close colleague since

---

[671] Jean-Baptiste Biot, *Essai sur l'histoire générale des sciences pendant la révolution française* (Paris: Duprat/Fuchs, 1803); Georges Cuvier, *Rapport historique sur les progrès des sciences naturelles depuis 1789, et sur leur état actuel* (Paris: Imprimérie impériale, 1810).
[672] See for example Perrin, 'Triumph', 40–43; Guerlac, 'Joseph Priestley's First Papers', 10.
[673] Such a study could follow the example set by Meinel, 'Demarcation Debates'.
[674] See Antonelli, 'Becoming Visible'; Beretta and Brenni, *Arsenal*.

1785, Fourcroy was aware of their impact and relevance, yet he still chose to not to include them in his account.

It is thus fair to say that later generations of historians generalised Fourcroy's careful reconstructions, which were born out of the complex intellectual situation in the 1790s and used many aspects of his overall narrative as signposts for their own historical inquiries. His heritage has therefore been implicitly present in many scholarly approaches to the Chemical Revolution published up until the 1990s.[675]

[675] See McEvoy, *Historiography*, 23–126.

Conclusion

In his *Weltgeschichtliche Betrachtungen*, the Swiss historian Jacob Burckhardt celebrated the distant yet respectful relationship between the natural sciences and the discipline of history. In contrast to theology or law, the natural sciences did not interfere in the historical discourse. As a result, there was 'Freundschaft' between the historians and the scientists, 'weil die Naturwissenschaft allein verlangt nichts von der Geschichte'.[676] Over the second half of the nineteenth century, many of Burckhardt's colleagues concurred with such views. In 1864, Heinrich von Sybel held that the sciences and the field of history focused on objects of a different nature, notwithstanding their mutually shared target of unveiling truth. While the natural scientist measured, weighed, isolated, and multiplied 'Gegenstände sinnlicher Wahrnehmung', the historian engaged with the 'Stimmungen, Motive und Tendenzen der handelnden Personen' which could only be accessed through 'geistiges Verständnis'.[677] Since their objects of inquiry were ontologically distinct, the two realms had to rely on different approaches and methodologies. Implicit in such claims was the assumption that historical research was alien to the endeavour of the natural sciences, just like staging an experiment was not considered by the leaders of the emerging academic discipline of history to be a valid method. Over time, it became common currency to deny that investigating the past could in any way exercise an argumentative function for the natural sciences.

The thesis offers a counterpoint to this idea of mutual disinterest and separation. It centres on the sprawling tradition of history-writing in the sciences since the mid-eighteenth century which had been eradicated from the memory of scientists and historians alike. Using chemistry in Germany and France between circa 1750 and 1800 as my case study, I have had as goal

[676] Jacob Burckhardt, *Über das Studium der Geschichte. Der Text der 'Weltgeschichtlichen Betrachtungen' auf Grund der Vorarbeiten von Ernst Ziegler nach den Handschriften*, ed. Peter Ganz (Munich: C.H. Beck, 1982), 150.
[677] Heinrich von Sybel, *Ueber die Gesetze des historischen Wissens* (Bonn: Max Cohen & Sohn, 1864), 5.

to showcase that writing the history of science was not a leisure activity, separated from stern experimental research. Rather, the main representatives of Enlightenment chemistry considered historical inquiries to be a valid method for intervening in the most pressing scientific debates of the day. This stance was shared by a wide array of scholars, regardless of whether they were based in the vibrant environment of the French capital or in a provincial German town. History-writing particularly proved its value as a versatile argumentative resource in the prolific controversies concerning the epistemological foundations of the nascent field and their methodological implications. In late eighteenth-century chemistry, such discussions either emerged from disagreements on experimental findings or they were imported to the discipline from the wider naturalist discourse on the philosophy of science. By way of a historical account, such problems were reframed for a discussion from a more general point of view. This made the choice of historical methods and concepts, as well as the literary form of history, a matter of careful consideration, for they were closely aligned with the scientific position which scholars set out to defend. To give greater legitimacy to their claims, these chemist-historians often borrowed methods and concepts from the broader Enlightenment discourse on history-writing in other fields and adopted them for their own purposes. As a result, ardent defenders of Baconian inductivism, champions of a hermetic revival, and savants with a deep interest in epistemology and language philosophy alike all engaged in the historical discourse which led to the emergence of an astonishing diversity of texts.

In chemistry, the fashion of historical writing for scientific purposes gained traction around the middle of the eighteenth century. As examined in chapter 2, mid-eighteenth-century chemists in Paris assessed the evolution of their discipline in order to demonstrate that their methods conformed with the observationalist philosophy of science. Their ultimate goal was to secure the important institutional position which the field had acquired in Paris over the preceding decades. Meanwhile, their German colleagues sifted through historical sources to debate the implications of hermeticism and its discarding of a purely observation-based approach to chemistry. To do so, they weaponised the arsenal of Enlightenment history-writing, applying methods such as source criticism or conjecturing to their object of controversy.

During the Chemical Revolution, too, historical writing remained a popular means to address matters of epistemology. Chapter 3 explored how Lavoisier scrutinised the imperceptible yet profound impact exercised by preconceived theories on the chemists' reasoning through a historical lens. He developed this novel view in response to the doubts which his British colleagues had cast on his methodology in the debate on the nature of airs, acids, water, and heat since the early 1780s. The German chemists, who had not participated in the controversy in its early stages, countered Lavoisier's claims by crafting large-scale histories of chemistry in the 1790s. Johann Christian Wiegleb and Johann Friedrich Gmelin, in particular, resorted to contemporary theories and methods in history-writing to mark their position through the content and form of their works.

Arguments on the evolution of chemistry featured in the debates on chemical nomenclature too. As shown in chapter 4, the growth in chemical observations as well as a novel stance on the function of language in the natural sciences pressured the Parisian chemists to attempt a large-scale reform of chemical terminology in 1787. Lavoisier, one of its main contributors, once again applied a historical gaze to the subject, using the history of chemical language as an argument against his British critics. In Germany, the reform proposal led not only to a vivid debate on the current state of chemical nomenclature and the overall necessity of reform, but, crucially, also to a controversy on its historical evolution. Several German chemists wrote essays on chemistry's history through the lens of language in order to stake their claim in the ongoing epistemological debates of the 1790s.

Chapter 5 focused on Antoine de Fourcroy who crafted a particularly complex approach to the recent history of the field in 1796. After Lavoisier's death, Fourcroy defended

Lavoisier's system and its philosophical stances both within the ongoing Parisian controversy on the natural sciences and in response to its German and British critics. For this purpose, he not only presented a complex view of chemistry's evolution through the lens of Lavoisier's philosophy but also traced the roots of the Lavoisian approach in the informal, interdisciplinary exchanges between Parisian elite naturalists before the Revolution. This method of social contextualisation in the history of science had a curious pre-history: it had been developed by Jean-Paul Marat and Jacques-Pierre Brissot as a means to criticise members of this very establishment, before scholars such as Marie Jean Antoine Nicolas de Caritat, Marquis de Condorcet adopted it in the debates on educational reform early in the 1790s.

Histories of chemistry are only a tiny fragment of a much larger body of works written on the evolution of the natural sciences between the mid-eighteenth century and the early nineteenth century. In the nascent field of biology, renowned professors such as Georges Cuvier, the French naturalist, but also lesser-known scholars including Johann Baptist von Spix, Friedrich Kasimir Medikus, and Kurt Sprengel engaged in the writing of histories around the turn of the century.[678] The same can be said about the discipline of physics.[679] I hope that the present study has shown how promising it would be to examine such works by way of contextualising them within their intellectual and institutional environment and to assess their potential scientific thrust. A comprehensive study on several fields in the natural sciences could elucidate general trends in historical writing and methodology which could then be compared to

[678] Medicus, *Geschichte der Botanik*; Spix, *Geschichte und Beurtheilung aller Systeme in der Zoologie nach ihrer Entwiklungsfolge von Aristoteles bis auf die gegenwärtige Zeit*; Kurt Sprengel, *Geschichte der Botanik, neu bearbeitet*, 2 vols (Altenburg und Leipzig: Brockhaus, 1817). Sprengel had already published a Latin edition of the work entitled *Historia rei herbariae* in 1807/1808.

[679] Johann Wilhelm Ritter, *Die Physik als Kunst. Ein Versuch, die Tendenz der Physik aus ihrer Geschichte zu deuten. Zur Stiftungsfeyer der Königlich-Baierischen Akademie der Wissenschaften am 28ten März 1806* (Munich: Joseph Lindauer, 1806); Johann Carl Fischer, *Geschichte der Physik seit der Wiederherstellung der Künste und Wissenschaften bis auf die neuesten Zeiten*, 8 vols (Göttingen: Johann Friedrich Röwer, 1801). Fischer's text was part of the Eichhorn project (see chapter 3). The different volumes are published under changing names. See van Miert, 'Structuring the History of Knowledge', 400–401 for the complex publication history.

contemporary approaches in studying the history of philosophy, culture, or politics. Such a work would greatly enrich our general understanding of history-writing as a cultural practice.

In addition, it is worth noting that chemists continued to engage in the topic well into the nineteenth century. Jöns Jörn Berzelius, Hans Christian Ørsted, and Thomas Thomson, all of whom made crucial contributions to the methodological discourse of the field after 1800, also published on various aspects of chemistry's history.[680] Moreover, it has already been remarked by scholarship that some historians of the field – notably Johann Bartholomäus Trommsdorff – engaged with the concepts provided by German Romantic *Naturphilosophie* in their historical works.[681] Further exploring this avenue might unveil how chemist-historians might have made a thus far underappreciated contribution to setting the stage for nineteenth-century historicism. Perhaps, chemistry and history might therefore have had more in common than Jacob Burckhardt and Heinrich von Sybel were willing to admit.

---

680 Hans Christian Ørstedt, 'Betrachtungen über die Geschichte der Chemie. Eine Vorlesung', *Journal für die Chemie und die Physik und* 3, no. 2 (1807): 194–231; Jöns Jörn Berzelius, *View of the Progress and Present State of Animal Chemistry*, trans. Gustavus Brunnmark (London: J. Skriven, 1813); Thomas Thomson, *The History of Chemistry*, 2 vols (London: Henry Coolburn and Richard Bentley, 1830).

681 Strube, 'Zur Stellung', 157–58.

Bibliography

1. Primary Sources

Afzelius Arvidson, Petrus. *Dissertatio gradualis sistens chemiae progressu a medio saec. vii a medium saec xvii*. Uppsala: Johan Edman, 1782.

Afzelius Arvidson, Petrus, and Jacobus Paulin. *Geschichte des Wachsthums und der Erfindungen in der Chemie in der älteste und mittlern Zeit*. Translated by Johann Christian Wiegleb. Berlin and Stettin: Friedrich Nicolai, 1792.

Alembert, Jean le Rond d'. 'Discours Préliminaire des éditeurs'. In *L'Encyclopédie ou dictionnaire raisonné des sciences, des arts et des métiers, par une société de gens de lettres*, edited by Jean le Rond d'Alembert and Denis Diderot, 1:i–xlv. Paris: Briasson, David l'aîne, le Breton, Durand, 1751.

[anon.]. 'Geschichte der Chemie, seit dem Wiederaufleben der Wissenschaften bis an das Endedes achtzehnten Jahrhunderts, von Johann Freidrich Gmelin, Dritter Band (Review)'. *Litteratur-Zeitung (Erlangen)*, no. 150 (1 August 1800): 1193–95.

[anon.]. 'Geschichte der Chemie, von Joh. Friedr. Gmelin &.c or History of Chemistry, by John Frederick Gmelin, 8vo 3 Vols. (Review)'. *The Anti-Jacobin Review and Magazine* 17 (1804).

[anon.]. 'Geschichte des Wachsthums und der Erfindungen in der Chemie, &c. i.e. A History of the Progress and Discoveries in Chemistry, by John Christian Wiegleb 8vo. 2 Vols. Berlin (Review)'. *The Monthly Review, or Literary Journal* 6 (1791): 543–47.

[anon.]. 'Histoire de la Chimie, par Joh.Fr. Gmelin, Gottingue, 1797. Premier Extrait' (Review)'. *Bibliothèque Germanique Médico-Chirurgicale ou Extrait des meilleurs Ouvrages de Médecine et de Chirurgie publiés en Allemagne* 2 (Germinal An vii): 439–56.

[anon.]. 'Histoire de la naissance et de ses découvertes dans les siècles modernes, par Wiegleb, première et seconde partie du premier volume, depuis 1651 jusqu'à 1750, à Berlin, 1790 (Review)'. *Annales de Chimie et de Physique ou recueil de mémoires concernant la chimie et les arts qui en dépendent* 11 (1791): 108–10.

Baldinger, Ernst Gottfried, ed. 'Untitled Biography of Friedrich Josef Wilhelm Schröder'. In *Aerzte und Naturforscher in und ausser Deutschland*, 1,2:225–50. Jena: Johann Wilhelm Hartung, 1770.

Bergman, Torbern. 'Introitus de Indagando Vero', i–xvi. *Opuscula Physica et Chemica, Pleraque Antea Seorsim Edita, Iam Ab Auctore Collecta, Revisa et Aucta* 1. Holmiae, Upsaliae et Aboae: Magnus Swederus, 1779.

———. *Meditationes de systemate fossilium naturali*. Florence: Aloysius Carlieri, 1784.

Berzelius, Jöns Jörn. *View of the Progress and Present State of Animal Chemistry*. Translated by Gustavus Brunnmark. London: J. Skriven, 1813.

Biot, Jean-Baptiste. *Essai sur l'histoire générale des sciences pendant la révolution française*. Paris: Duprat/Fuchs, 1803.

Brissot de Warville, Jacques-Pierre. *De la vérité ou méditations sur les moyens de parvenir à la vérité dans toutes les connoissances humaines*. Neuchâtel: Imprimerie de la Société Typographique, 1782.

Burckhardt, Jacob. *Über das Studium der Geschichte. Der Text der 'Weltgeschichtlichen Betrachtungen' auf Grund der Vorarbeiten von Ernst Ziegler nach den Handschriften*. Edited by Peter Ganz. München: C.H. Beck, 1982.

Cassini, Jean-Dominique Comte de. 'Mémoire lu à l'Académie des sciences, 25.11.1789'. Edited by Roger Hahn. *Revue d'histoire des sciences et de leurs applications* 18, no. 1 (1965): 25–27.

Condillac, Etienne Bonnot de. *La Logique ou les premiers développemens de l'art de penser*. Paris: Librairie l'esprit; Librairie Debure, 1780.

Condorcet, Marie Jean Antoine Nicolas de Caritat. ‘Cinquième Mémoire – sur l’instruction relative aux sciences’. In *Oeuvres de Condorcet*, edited by A. Condorcet O’Connor and M.F. Arago, 7:412–37. Paris: Firmin Didot Frères, 1847.

———. ‘Premier Mémoire – nature et objet de l’instruction publique’. In *Oeuvres de Condorcet*, edited by A. Condorcet O’Connor and M.F. Arago, 7:169–228. Paris: Firmin Didot Frères, 1847.

———. ‘Rapport et projet de décret sur l’organisation générale de l’instruction publique’. In *Oeuvres de Condorcet*, edited by A. Condorcet O’Connor and M.F. Arago, 7:494–573. Paris: Firmin Didot Frères, 1847.

Crell, Lorenz von. ‘Anzeige chemischer Schriften’. *Chemische Annalen für die Freunde der Naturlehre, Arzneygelahrtheit, Haushaltungskunst, und Manufakturen* 1, no. 6 (1793): 561–68.

———. ‘Geschichte des Wachsthums, und der Erfindungen der Chemie in der neueren Zeit von Joh. Christ. Wiegleb. Erster Band (Review)’. *Chemische Annalen für die Freunde der Naturlehre, Arzneygelahrtheit, Haushaltungskunst, und Manufakturen* 2, no. 8 (1790): 151–54.

———. ‘Ueber die Nohtwendigkeit einer chemisch-technischen Sprach-Veränderung, und ihre Gesetze’. *Chemische Annalen für die Freunde der Naturlehre, Arzneygelahrtheit, Haushaltungskunst, und Manufakturen* 1, no. 3–4 (1791): 225–39, 327–41.

———. ‘Untitled Preface’. *Chemische Annalen für die Freunde der Naturlehre, Arzneygelahrtheit, Haushaltungskunst, und Manufakturen* 2, no. 9 (1787).

Cuvier, Georges. *Rapport historique sur les progrès des sciences naturelles depuis 1789, et sur leur état actuel*. Paris: Imprimérie impériale, 1810.

Dalberg-Acton, John Emerich Edward. ‘German Schools of History’. *The English Historical Review* 1, no. 1 (1886): 7–42.

Eichhorn, Johann Gottfried. *Allgemeine Geschichte der Cultur und Litteratur des neueren Europa*. Vol. 1. Göttingen: Johann Georg Rosenbusch, 1796.

Erxleben, Johann Christian Polykarp. *Anfangsgründe der Chemie*. Göttingen: Johann Christian Dieterich, 1775.

———. ‘Historisch-kritische Untersuchung der Alchemie oder der eingebildeten Goldmacherkunst; vom ihrem Ursprunge sowohl, als Fortgange, und was nun von ihr zu halten sey (Review)’. *Physikalische Bibliothek oder Nachricht von den neuesten Büchern, die in die Naturkunde einschlagen* 4, no. 2 (1777): 179–86.

Fischer, Johann Carl. *Geschichte der Physik seit der Wiederherstellung der Künste und Wissenschaften bis auf die neuesten Zeiten*. 8 vols. Göttingen: Johann Friedrich Röwer, 1801.

Fontenelle, Bernard le Bovier de. ‘Eloge de M. Geoffroy’. *Histoire de l’Académie Royale des Science avec les Mémoires de Mathématique & de Physique, pour la même année* Année 1731 (1734): 93–100.

Fourcroy, Antoine de. ‘Chimie’. In *Encyclopédie Méthodique, ou par ordre de matières. Par une société de gens de lettres, de savants et des artistes. Chimie, Pharmacie et Métallurgie*, Vol. 3. Paris: Agasse, 1796.

Giesebrecht, Wilhelm von. ‘Die Entwicklung der modernen deutschen Geschichtswissenschaft’. *Historische Zeitschrift* 1 (1859): 1–17.

Gmelin, Johann Friedrich. *Allgemeine Geschichte der Pflanzengifte*. 2nd ed. Nürnberg: Raspesche Buchhandlung, 1803.

———. *Allgemeine Geschichte der thierischen und mineralischen Gifte. Mit einer Vorrede von Johann Friedrich Blumenbach*. Erfurt: Friedrich August Knick, 1806.

———. ‘Beitrag zur Geschichte der chemischen Kenntnis der sogenannten Gasarten aus früheren Zeiten’. *Göttingisches Journal der Naturwissenschaften* 1, no. 4 (1798): 1–22.

———. *Geschichte der Chemie seit dem Wiederaufleben der Wissenschaften bis an das Ende des achtzehnten Jahrhunderts*. Geschichte der Wissenschaften seit der Wiederherstellung

derselben bis an das Ende des achtzehnten Jahrhunderts. Von einer Gesellschaft gelehrter Männer ausgearbeitet, 8/II. 3 vols. Göttingen: Georg Rosenbusch, 1797–1799.
———. 'Ueber die neue Chemie'. *Göttingisches Journal der Naturwissenschaften* 1, no. 1 (1798): 10–86.
———. 'Winke an seine Zeitgenossen, den Streit über den Brennstoff betreffend'. *Chemische Annalen für die Freunde der Naturlehre, Arzneygelahrtheit, Haushaltungskunst, und Manufakturen* 1, no. 4–6 (1795): 287–302, 391–409, 479–99.
Gren, Friedrich Albert Carl. 'Geschichte der Naturwissenschaft, als akademische Vorlesung vorgetragen'. *Annalen der Physik. Angefangen von Friedr. Albr. Carl Gren, fortgesetzt von Ludwig Wilhelm Gilbert* 1 (1799): 167–204.
Guyton de Morveau, Bernard-Louis. 'Lettre à Lavoisier, 29 Juin 1786'. In *Oeuvres de Lavoisier. Correspondance*, edited by Michelle Goupil, Philippe Savoie, and René Taton, 4 (1784-1786):227–28. Paris: Belin, 1986.
———. 'Lettre à Lavoisier et Vicq d'Azyr, 18 Juillet 1786'. In *Oeuvres de Lavoisier. Correspondance*, edited by Michelle Goupil, Philippe Savoie, and René Taton, 4 (1784-1786):233–34. Paris: Belin, 1986.
———. 'Mémoire sur les dénominations chymiques, la nécessité d'en perfectionner le systême, & les règles pour y parvenir'. *Observations sur la physique, sur l'histoire naturelle et sur les arts* 19 (1782): 370–82.
Hartenkeil, Johann Jacob. 'Geschichte der Chemie seit dem Wiederaufleben der Wissenschaften bis an das Ende des achtzehnten Jahrhunderts, von Johann Friedr. Gmelin, Dritter Band (Review)'. *Medicinisch-Chirurgische Zeitung,* 3, no. 66 (19 August 1799): 257–62.
———. 'Geschichte der Chemie seit dem Wiederaufleben der Wissenschaften bis an das Ende des achtzehnten Jahrhunderts, von Johann Friedr. Gmelin, Zweyter Band (Review)'. *Medicinisch-Chirurgische Zeitung,* 4, no. 92 (19 November 1798): 241–50.
Hermbstädt, Sigismund Friedrich. *Systematischer Grundriß der allgemeinen Experimentalchemie zum Gebrauch bey Vorlesungen und zur Selbstbelehrung beym Mangel des mündliichen Unterrichts*. 3rd ed. Basel und Leipzig: Heinrich August Rottmann, 1812.
Kirwan, Richard. *An Essay on Phlogiston, and the Constitutions of Acids*. London: P. Elmsly, 1787.
———. *Physisch-chemische Schriften*. Translated by Lorenz von Crell. Vol. 3. Berlin and Stettin: Friedrich Nicolai, 1788.
———. *Versuch über das Phlogiston und die Bestandtheile der Säuren*. Translated by Lorenz von Crell. Berlin and Stettin: Friedrich Nicolai, 1788.
Krüger, Johann Gottlob. *Geschichte der Erde in den allerältesten Zeiten*. Halle: Lüderwaldische Buchhandlung, 1746.
Lavoisier, Antoine de. 'Lettre à Vicq d'Azyr, 18 Décembre 1785'. In *Oeuvres de Lavoisier. Correspondance*, edited by Michelle Goupil, Philippe Savoie, and René Taton, 4 (1784-1786):190. Paris: Belin, 1986.
———. 'Lettre à Guyton de Morveau (avant 24 Juin 1786)'. In *Oeuvres de Lavoisier. Correspondance*, edited by Michelle Goupil, Philippe Savoie, and René Taton, 4 (1784-1786):223–24. Paris: Belin, 1986.
———. 'Lettre à Vicq d'Azyr, 2 Juillet 1786'. In *Oeuvres de Lavoisier. Correspondance*, edited by Michelle Goupil, Philippe Savoie, and René Taton, 4 (1784-1786):229. Paris: Belin, 1986.
———'Lettre à Guyton de Morveau, 6 Juillet 1786'. In *Oeuvres de Lavoisier. Correspondance*, edited by Michelle Goupil, Philippe Savoie, and René Taton, 4 (1784-1786):231–32. Paris: Belin, 1986.
———. 'Mémoire sur la combustion en général, 5 September 1777'. *Histoire de l'Académie Royale des Sciences avec Mémoires, Mémoires* Année 1777 (1780): 592–600.
———. 'Mémoire sur la nécessité de réformer & de perfectionner la nomenclature de la Chimie, lu à l'Académie Royale des Sciences du 18 Avril 1787'. In *Méthode de Nomenclature Chimique,*

proposée par MM. de Morveau, Lavoisierr, Bertholet, & de Fourcroy. On y a joint un nouveau système de Caractères Chimiques, adaptés à cette Nomenclature, par MM. Hassenfratz & Adet. Paris: Cuchet, 1787.

———. 'Observations sur l'Académie des Sciences'. In *Oeuvres de Lavoisier*, 4: Mémoires et Rapports:616–23. Paris: Imprimérie Impériale, 1868.

———. *Opuscules physiques et chimiques*. Vol. 1. Paris: Durand, Didot, Esprit, 1774.

———. 'Réflexions sur le phlogistique, pour servir de développement à la théorie de la Combustion & de la Calcination, publiée en 1777'. *Histoire de l'Académie Royale des Sciences avec Mémoires, Mémoires* Année 1783 (1786): 505–538.

———. *Traité élémentaire de chimie, présenté dans un ordre nouveau et d'après les découvertes modernes*. Paris: Cuchet, 1789.

Macquer, Pierre-Joseph. *Dictionnaire de Chymie, contenant la Théorie & la Pratique de cette Science, son application à la Physique, à l'Histoire Naturelle, à la Médicine & à l'Economie animale; avec l'explication détaillée de la vertu & de la maniere d'agir des Médicamens Chymiques. Et les principes fondamentaux des Arts, Manufactures & Métiers dépendans de la Chymie*. 1st ed. 2 vols. Paris: Lacombe, 1766.

Marat, Jean-Paul. *Les charlatans modernes, ou lettres sur le charlatanisme académique*. Paris: L'imprimerie de Marat, 1791.

Medicus, Friedrich Casimir. *Geschichte der Botanik unserer Zeiten*. Mannheim: Schwan und Götz, 1793.

Meyer, Johann Rudolph. *Systematische Darstellung aller Erfahrungen in der Naturlehre. Ersten Theiles dritter Band*. Arau: Heinrich Remigius Sauerländer, 1808.

Ørstedt, Hans Christian. 'Betrachtungen über die Geschichte der Chemie. Eine Vorlesung'. *Journal für die Chemie und die Physik und* 3, no. 2 (1807): 194–231.

Paulin, Jacobus. *Dissertatio gradualis de primordiis chemiae*. Uppsala: Johan. Edman, 1779.

Priestley, Joseph. 'Experiments and Observations Relating to Air and Water, Read 24.2.1785'. *Philosophical Transactions of the Royal Society of London* 75 (1785): 279–309.

Pulteney, Richard. *Historical and Biographical Sketches of the Progress of Botany in England from Its Origin to the Introduction of the 'Linnaean' System*. 2 vols. London: T. Cadell, 1790.

Ritter, Johann Wilhelm. *Die Physik als Kunst. Ein Versuch, die Tendenz der Physik aus ihrer Geschichte zu deuten. Zur Stiftungsfeyer der Königlich-Baierischen Akademie der Wissenschaften am 28ten März 1806*. Munich: Joseph Lindauer, 1806.

Rochefoucauld d'Enville, Louis Alexandre de la. 'Mémoire lu à l'Académie des sciences, 18.11.1789'. Edited by Roger Hahn. *Revue d'histoire des sciences et de leurs applications* 18, no. 1 (1965): 20–23.

Rosenbusch, J.G. 'Nachricht über die in meinem Verlage erscheinende Geschichte der Künste und Wissenschaften seit der Wiederherstellung derselben bis an das Ende des Achtzehnten Jahrhunderts'. *Intelligenzblatt der Allgemeinen Litteratur-Zeitung* 187 (12 November 1800): 1561–64.

Savérien, Alexandre. *Histoire des progrès de l'esprit humain dans les sciences exactes et dans les arts qui en dépendent*. Paris: Lacombe, 1766.

———. *Histoire des progrès de l'esprit humain dans les sciences naturelles et dans les arts qui en dépendent*. Paris: Lacombe, 1775.

Scherer, Albert Nikolaus. 'Vollständige Uebersicht der literarischen Verdienste Wiegleb's, entworfen vom Herausgeber'. *Allgemeines Journal der Chemie* 4 (1800): 701–20.

Scherer, Johann Andreas. *Versuch einer neuen Nomenclatur für Deutsche Chymisten*. Vienna: Christian Friedrich Wappler, 1792.

Schröder, Friedrich Joseph Wilhelm. 'Geschichte der ältesten chemie und filosofie, oder sogenannten fillosofie der Egyptier'. *Neue Sammlung der Bibliothek für die höhere Naturwissenschaft und Chemie* 1, no. 1 (1775): 89–430.

Schröder, Friedrich Joseph Wilhelm Schröder. 'Nachricht zum ersten Bande dieser Bibliothek'. *Neue Sammlung der Bibliothek für die höhere Naturwissenschaft und Chemie* 1, no. 1 (1775): [v-xi].

[Sénac, Jean Baptiste de]. *Nouveau Cours de Chymie, suivant les principes de Newton & de Sthall. Avec und Discours Historique sur l'Origine & les progrez de la Chymie*. Paris: Jacques Vincent, 1723.

Spix, Johannes. *Geschichte und Beurtheilung aller Systeme in der Zoologie nach ihrer Entwiklungsfolge von Aristoteles bis auf die gegenwärtige Zeit*. Nürnberg: Schrage'sche Buchhandung, 1811.

Sprengel, Kurt. *Geschichte der Botanik, neu bearbeitet*. 2 vols. Altenburg und Leipzig: Brockhaus, 1817.

Stoeller, Friedrich Christian. 'Nekrolog Johann Christian Wiegleb'. *Allgemeines Journal der Chemie* 4 (1800): 684–700.

Sybel, Heinrich von. 'Über den Stand der neueren deutschen Geschichtsschreibung [1859]'. In *Kleine historische Schriften*, 343–59. Munich: Literarisch-Artistische Anstalt der J.G. Cotta'schen Buchhandlung, 1863.

———. *Ueber die Gesetze des historischen Wissens*. Bonn: Max Cohen & Sohn, 1864.

Thiroux d'Arconville, Marie-Geneviève-Charlotte. 'Discours préliminaire du traducteur'. In *Leçons de Chymie, propres à perfectionner la physique, le commerce et les arts. Par M. Pierre Shaw, Premier Médecin du Roi d'Angleterre*, translated by Marie-Geneviève-Charlotte Thiroux d'Arconville, i–xciv. Paris: Jean Thomas Herissant, 1759.

———. 'My Memories (Mes souvenirs)'. In *Marie-Geneviève-Charlotte Thiroux D'Arconville. Selected Philosophical, Scientific, and Autobiographical Writings*, edited and translated by Julie Candler Hayes, 206–13. Other Voice in Early Modern Europe 58. Toronto: Iter Press, 2018.

———. 'The Story of My Writing (Histoire de ma littérature)'. In *Marie-Geneviève-Charlotte Thiroux D'Arconville. Selected Philosophical, Scientific, and Autobiographical Writings*, edited and translated by Julie Candler Hayes, 184–96. Other Voice in Early Modern Europe 58. Toronto: Iter Press, 2018.

Thomson, Thomas. *The History of Chemistry*. 2 vols. London: Henry Coolburn and Richard Bentley, 1830.

Trommsdorff, Johann Bartholomäus. *Geschichte des Galvanismus oder der galvanischen Electricität, vorzügllich in chemischer Hinsicht*. Erfurt: Hennings'sche Buchhandlung, 1803.

———. *Versuch einer allgemeinen Geschichte der Chemie. In drei Abtheilungen*. Erfurt: Hennings'sche Buchhandlung, 1806.

Turgot, Anne Robert Jacques. 'Plan du second discours sur les progrès de l'esprit humain'. In *OEuvres de Turgot et Documents le concernant*, edited by Gustave Schelle, 1:298–323. Paris: Félix Alcan, 1913.

———. 'Tableau philosophique des progrès successifs de l'esprit humain. Discours prononcé en latin dans les écoles de Sorbonne, 11 décembre 1750'. In *Oeuvres de Turgot et documents le concernant*, edited by Gustave Schelle, 1:214–35. Paris: Félix Alcan, 1913.

Venel, Gabriel-François. 'Chymie ou Chimie'. In *L'Encyclopédie ou dictionnaire raisonné des sciences, des arts et des métiers, par une société de gens de lettres*, edited by Jean le Rond d'Alembert and Denis Diderot, 3:408–37. Paris: Briasson, David l'aîne, le Breton, Durand, 1753.

Vicq d'Azyr, Félix. 'Lettre à Lavoisier, 23 Mars 1785'. In *Oeuvres de Lavoisier. Correspondance*, edited by Michelle Goupil, Philippe Savoie, and René Taton, 4 (1784-1786):84–85. Paris: Belin, 1986.

———. 'Lettre à Lavoisier, 15 Septembre 1785'. In *Oeuvres de Lavoisier. Correspondance*, edited by Michelle Goupil, Philippe Savoie, and René Taton, 4 (1784-1786):154–55. Paris: Belin, 1986.

———. ‘Lettre à Lavoisier, 8 Novembre 1785’. In *Oeuvres de Lavoisier. Correspondance*, edited by Michelle Goupil, Philippe Savoie, and René Taton, 4 (1784-1786):177–78. Paris: Belin, 1986.

———. ‘Lettre à Lavoisier, 21 Décembre 1785’. In *Oeuvres de Lavoisier. Correspondance*, edited by Michelle Goupil, Philippe Savoie, and René Taton, 4 (1784-1786):194. Paris: Belin, 1986.

———. *Traité d’anatomie et de physiologie. Avec des Planches Coloriées.* Vol. 1. Paris: François Didot, 1786.

Weigel, Christian Ehrenfried von. ‘Versuch einer Geschichte des Blaserohres und seiner Anwendungen [4 parts]’ *Chemische Annalen für die Freunde der Naturlehre, Arzneygelahrtheit, Haushaltungskunst, und Manufakturen* 4, no. 3 (1790) 262–283; *Chemische Annalen...* 4, no. 4 (1790), 393–419; *Chemische Annalen...* 5, no. 1 (1791), 6–24; *Chemische Annalen...* 5, no. 2 (1791), 198–226.

Westrumb, Johann Friedrich. *Versuch eines Beytrages zu den Sprachbereicherungen für die deutsche Chemie*. Kleine Physikalisch-Chemische Abhandlungen vol 3 (2). Hannover: Gebrüder Hahn, 1793.

Wiegleb, Johann Christian. ‘Die völlig eröffnete Alchemie oder höhere Naturwissenschaft, in einer deutlichen Anweisung, als ein Anhang der neuen alchemistischen Bibliothek; herausgegeben von D. Fr. Jos. Wilh. Schroeder (Review)’. *Allgemeine Deutsche Bibliothek* 26, no. 2 (1775): 523–24.

———. ‘Dr Friedr. Jos. Wilh. Schroeders neue Sammlung der Bibliothek für die höhere Naturwissenschaft und Chemie. Ersten Bandes erstes Alphabet... (Review)’. *Allgemeine Deutsche Bibliothek* 27, no. 1 (n.d.): 39–55.

———. *Geschichte des Wachsthums und der Erfindungen in der Chemie, in der neueren Zeit*. 2 vols. Berlin and Stettin: Friedrich Nicolai, 1790–1791.

———. *Historisch-kritische Untersuchung der Alchemie, oder der eingebildeten Goldmacherkunst von ihrem Ursprunge sowohl als Fortgange, und was nun von ihr zu halten sei*. Weimar: Carl Ludolf Hoffmann, 1777.

2. Secondary Sources

Abbatista, Guido. ‘The Historical Thought of the French “Philosophes”’. In *The Oxford History of Historical Writing. Volume 3, 1400-1800*, edited by José Rabasa, Masayuki Satō, Edoardo Tortarolo, and D. R. Woolf, 406–27. Oxford: Oxford University Press, 2012.

Abbri, Ferdinando. ‘Alchemy and Chemistry. Chemical Discourses in the Seventeenth Century’. *Early Science and Medicine* 5, no. 2 (2000): 214–26.

Abbri, Ferdinando, and Marco Beretta. ‘Bibliography of the “Méthode de Nomenclature Chimique” and of the “Traité Élémentaire de Chimie” and Their European Translations (1787-1800)’. In *Lavoisier in European Context. Negotiating a New Language for Chemistry*, edited by Ferdinando Abbri and Bernadette Bensaude-Vincent, 279–91. Canton MA: Science History Publications, 1995.

Albury, William Randall. ‘Introduction’. In *Etienne de Condillac. La Logique. Logic*, edited and translated by William Randall Albury, 7–34. New York: Abaris Books, 1980.

———. ‘The Logic of Condillac and the Structure of French Chemical and Biological Theory, 1780-1801’. The Johns Hopkins University, 1972.

Alessandro, Giuseppe d’. ‘Homo historicus. Eichhorns Konzeptualisierung der “Wissenschaft vom Menschen”’. In *Die Wissenschaft vom Menschen in Göttingen um 1800. Wissenschaftliche Praktiken, institutionelle Geographie, europäische Netzwerke*, edited by Hans Erich Bödeker,

435–53. Veröffentlichungen des Max-Plack-Instituts für Geschichte 237. Göttingen: Vandenhoeck & Ruprecht, n.d.
Alt, Peter-André, and Volkhard Wels. 'Einleitung'. In *Konzepte des Hermetismus in der Literatur der Frühen Neuzeit*, edited by Peter-André Alt and Volkhard Wels, 7–22. Berliner Mittelalter- und Frühneuzeitforschung 8. Göttingen: V&R Unipress, 2010.
Antonelli, Francesca. 'Becoming Visible. Marie-Anne Paulze-Lavoisier and the Campaign for the "New Chemistry" (1770s-1790s)'. *Ambix* 69, no. 3 (2022): 221–42.
———. 'Madame Lavoisier and the Others. Women in Marie-Anne Paulze-Lavoisier's Network (1771–1836)'. *Notes and Records of the Royal Society of London* 77, no. 2 (2023): 283–302.
Assmann, Jan. 'Foreword'. In *The Secret History of Hermes Trismegistus. Hermeticism from Ancient to Modern Times*. By Florian Ebeling. Translated by David Lorton, vii-xiii. 1st ed. Ithaca NY: Cornell University Press, 2007.
Badinter, Élisabeth, and Robert Badinter. *Condorcet (1743-1794). un intellectuel en politique*. Paris: Fayard, 1988.
Baker, Keith Michael. *Condorcet. From Natural Philosophy to Social Mathematics*. Chicago Ill: The University of Chicago Press, 1975.
———. 'On Condorcet's "Sketch"'. *Daedalus* 133, no. 3 (2004): 56–64.
———. 'Public Opinion as Political Invention'. In *Inventing the French Revolution: Essays on French Political Culture in the Eighteenth Century*, 167–99. Ideas in Context. Cambridge: University Press, 1990.
Beiser, Frederick C. *The German Historicist Tradition*. Oxford: Oxford University Press, 2011.
Belhoste, Bruno. *Paris Savant: Capital of Science in the Age of Enlightenment*. Translated by Susan Emanuel. New York, NY: Oxford University Press, 2011.
Bensaude-Vincent, Bernadette. 'A Founder Myth in the History of Sciences? The Lavoisier Case'. In *Functions and Uses of Disciplinary Histories*, edited by Loren R. Graham, Wolf Lepenies, and Peter Weingart, 53–78. Sociology of the Sciences 7. Dordrecht: D. Reidel, 1983.
———. 'Culture and Science. Chemistry in Its Golden Age'. In *A Cultural History of Chemistry in the Eighteenth Century*, edited by Ursula Klein and Matthew Daniel Eddy, 4:93–112. A Cultural History of Chemistry. London: Bloomsbury Academic, 2022.
———. 'Introductory Essay. A Geographical History of Eighteenth-Century Chemistry'. In *Lavoisier in European Context. Negotiating a New Language for Chemistry*, edited by Ferdinando Abbri and Bernadette Bensaude-Vincent, 1–17. Canton MA: Science History Publications, 1995.
———. 'Languages in Chemistry'. In *The Cambridge History of Science. The Modern Physical and Mathematical Sciences*, edited by Mary Jo Nye, 5:174–90. Cambridge: Cambridge University Press, 2003.
———. 'Lavoisier lecteur de Condillac'. *Dix-huitième siècle* 42, no. 1 (2010): 473–89.
———. *Lavoisier. Mémoires d'une reévolution*. Paris: Flammarion, 1993.
Bensaude-Vincent, Bernadette, and Christine Lehman. 'Public Lectures on Chemistry in Mid-Eighteenth Century France'. In *New Narratives in Eighteenth-Century Chemistry : Contributions from the First Francis Bacon Workshop, 21-23 April 2005, California Institute of Technology, Pasadena, California*, edited by Lawrence Principe, 77–96. Dordrecht: Springer, 2007.
Bensaude-Vincent, Bernadette, and Isabelle Stengers. *A History of Chemistry*. Translated by Deborah van Dam. Cambridge MA: Harvard University Press, 1996.
Beretta, Marco. 'Laboratories and Technology'. In *A Cultural History of Chemistry in the Eighteenth Century*, edited by Ursula Klein and Matthew Daniel Eddy, 4:71–91. A Cultural History of Chemistry. London: Bloomsbury Academic, 2022.
———. 'The Changing Role of the Historiography of Chemistry in Continental Europe Since 1800'. *Ambix* 58, no. 3 (2011): 257–76.

———. *The Enlightenment of Matter. The Definition of Chemistry from Agricola to Lavoisier*. Uppsala Studies in History of Science 15. Canton MA: Science History Publications, 1993.
———. 'The Historiography of Chemistry in the Eighteenth Century. A Preliminary Survey and Bibliography'. *Ambix* 39, no. 1 (1992): 1–10.
Beretta, Marco, and Paolo Brenni. *The Arsenal of Eighteenth-Century Chemistry: The Laboratories of Antoine Laurent Lavoisier (1743-1794)*. Nuncius Series : Studies and Sources in the Material and Visual History of Science 10. Leiden: Brill, 2022.
Berger, Stefan. 'The Invention of European National Traditions in European Romanticism'. In *The Oxford History of Historical Writing. Volume 3, 1400-1800*, edited by José Rabasa, Masayuki Satō, Edoardo Tortarolo, and D. R. Woolf, 19–40. Oxford: Oxford University Press, 2012.
Blumenthal, Geoffrey, and James Ladyman. 'The Development of Problems within the Phlogiston Theories, 1766–1791'. *Foundations of Chemistry* 19, no. 3 (2017): 241–80.
Boantza, Victor D. 'The Rise and Fall of Nitrous Air Eudiometry: Enlightenment Ideals, Embodied Skills, and the Conflicts of Experimental Philosophy'. *History of Science* 51, no. 4 (2013): 377–412.
Bordoni, Stefano. *When Historiography Met Epistemology. Sophisticated Histories and Philosophies of Science in French-Speaking Countries in the Second Half of the Nineteenth Century*. History of Modern Science 2. Leiden: Brill, 2017.
Braunrot, Christabel P., and Kathleen Hardesty Doig. 'The Encyclopédie Méthodique. An Introduction'. *Studies on Voltaire and the Eighteenth Century* 325 (1995): 1–152.
Bret, Patrice. 'Formes et fonctions de la correspondance scientifique autour de la Révolution. Lavoisier, Guyton de Morveau et Berthollet, chimistes et epistoliers (1772-1822)'. *Gazette des archives* 179, no. 1 (1997): 355–79.
———. 'Les chimies de l'Encyclopédie méthodique. Une discipline académique en révolution et des traditions d'atelier'. In *L'encyclopédie méthodique (1782-1832): des lumières au positivisme*, edited by Claude Blanckaert and Michel Porret, 521–52. Bibliothèque des Lumières 68. Genève: Droz, 2006.
———. 'Les promenades littéraires de Madame Picardet. La traduction comme pratique sociale de la Sscience au XVIII siècle'. In *Traduire la science : Hier et aujourd'hui*, edited by Pascal Duris, 125–52. Pessac: Maison des Sciences de l'homme d'Aquitaine, 2008.
———. 'The Letter, the Dictionary and the Laboratory: Translating Chemistry and Mineralogy in Eighteenth-Century France'. *Annals of Science* 73, no. 2 (2016): 122–42.
Briggs, Robin. 'The Académie Royale Des Sciences and the Pursuit of Utility'. *Past & Present*, no. 131 (1991): 38–88.
Brock, W. H. *The Norton History of Chemistry*. 1st American edition. Norton History of Science. New York NY: W.W. Norton, 1993.
Brockliss, Laurence W. B. *Calvet's Web. Enlightenment and the Republic of Letters in Eighteenth-Century France*. Oxford: Oxford University Press, 2002.
Brockliss, Laurence W.B. 'Starting-Out, Getting-On and Becoming Famous in the Eighteenth-Century Republic of Letters'. In *Scholars in Action: The Practice of Knowledge and the Figure of the Savant in the 18th Century*, edited by André Holenstein, Hubert Steinke, and Martin Stuber, 1:71–100. History of Science and Medicine Library 34/1. Leiden: Brill, 2013.
Bumann, Waldtraut. 'Der Begriff der Wissenschaft im deutschen Sprach- und Denkraum'. In *Der Wissenschaftsbegriff. Historische und systematische Untersuchungen. Vorträge und Diskussionen im April 1968 in Düsseldorf und im Oktober 1968 in Fulda*, edited by Alwin Diemer, 64–75. Meisenheim am Glan: A. Hain, 1970.
Burkhardt, Richard W. *The Spirit of System: Lamarck and Evolutionary Biology*. Cambridge MA: Harvard University Press, 1977.
Caradonna, Jeremy L. *The Enlightenment in Practice: Academic Prize Contests and Intellectual Culture in France, 1670-1794*. Ithaca N.Y: Cornell University Press, 2012.

Carhart, Michael C. ‘Historia Literaria and Cultural History from Mylaeus to Eichhorn’. In *Momigliano and Antiquarianism. Foundations of the Modern Cultural Sciences*, edited by Peter N. Miller, 184–206. UCLA Clark Memorial Library Series. Toronto: University of Toronto Press, 2007.
Carlyle, Margaret. ‘Entre le Traité d’ostéologie et les Leçons de chimie. Mme d’Arconville, traductrice des Lumières’. In *Madame d’Arconville, moraliste et chimiste au siècle des Lumières*, edited by Marc André Bernier and Marie-Laure Girou-Świderski, 183–210. Oxford University studies in the Enlightenment, 2016:1. Liverpool: Liverpool University Press / Oxford Voltaire Foundation, 2016.
Cassirer, Ernst. *Die Philosophie der Aufklärung*. Edited by Claus Rosenkranz. Philosophische Bibliothek 593; New Edition of "Ernst Cassirer. Gesammelte Werke, Bd. 15". Hamburg: Verlag Felix Meiner, 2007.
Chang, Ku-ming. ‘Communications of Chemical Knowledge. Georg Ernst Stahl and the Chemists at the French Academy of Sciences in the First Half of the Eighteenth Century’. *Osiris* 29, no. 1 (2014): 135–57.
Christie, John R.R. ‘Historiography of Chemistry in the Eighteenth Century. Hermann Boerhaave and William Cullen’. *Ambix* 41, no. 1 (1994): 4–19.
Cohen, I. Bernard. *Revolution in Science*. Cambridge MA: Belknap Press of Harvard University Press, 1985.
Conner, Clifford D. *Jean Paul Marat. Scientist and Revolutionary*. Atlantic Highlands NJ: Humanities Press, 1997.
———. *Jean Paul Marat. Tribune of the French Revolution*. Revolutionary Lives. London: Pluto Press, 2012.
Coquard, Olivier. *Jean-Paul Marat*. Paris: Fayard, 1993.
Corsi, Pietro. ‘A Chair for Two. Georges Cuvier and Jean-Claude Delamétherie at the Collège de France’. In *Darwin Au Collège de France*, edited by Antoine Compagnon and Céline Surprenant. Passage Des Disciplines. Collège de France, 2020.
———. ‘Models and Analogies for the Reform of Natural History. Features of the French Debate, 1790-1800’. In *Lazzaro Spallanzani e la bioologia del settecento. Teorie, esperimenti, istituzioni scientifiche. Atti del convegno di studi Reggio Emilia, Modena, Scandiano, Pavia 23-27 marzo 1981*, edited by Giuseppe Montalenti and Paolo Rossi, 381–96. Florence: Leo S. Olschki, 1982.
———. *The Age of Lamarck. Evolutionary Theories in France, 1790-1830*. Translated by Jonathan Mandelbaum. Berkeley CA: University of California Press, 1988.
Crombie, Alastair Cameron. *Styles of Scientific Thinking in the European Tradition. The History of Argument and Explanation Especially in the Mathematical and Biomedical Sciences and Arts*. Vol. 3. 3 vols. London: Duckworth, 1994.
Crosland, Maurice. ‘Early Laboratories c.1600-c.1800 and the Location of Experimental Science’. *Annals of Science* 62, no. 2 (2005): 233–53.
———. *Historical Studies in the Language of Chemistry*. 2nd ed. New York: Dover Publications, 1978.
———. *In the Shadow of Lavoisier. The ‘Annales de Chimie’ and the Establishment of a New Science*. BSHS Monographs 9. Oxford: British Society for the History of Science, 1994.
———. ‘Jean Antoine Chaptal’. In *Complete Dictionary of Scientific Biography*, 12:198–203. Detroit MI: Charles Scribner’s Sons, 2008.
———. ‘Lavoisier’s Achievement. More than a Chemical Revolution’. *Ambix* 56, no. 2 (2009): 93–114.
———. ‘Lavoisier’s Theory of Acidity’. *Isis* 64, no. 3 (1973): 306–25.
———. *Science under Control. The French Academy of Sciences 1795-1914*. Cambridge: University Press, 1992.

Dagen, Jean. *L’histoire de l’esprit humain dans la pensée française de Fontenelle à Condorcet*. Bibliothèque française et romane. Série C, Etudes littéraires 60. Paris: Klincksieck, 1977.
Damme, Stéphane van. ‘In the Name of Linnaeus. Paris as a Disputed Capital of Natural Knowledge (1730-1789)’. In *Linnaeus, Natural History and the Circulation of Knowledge*, edited by Hanna Hodacs, Kenneth Nyberg, and Stéphane van Damme, 113–35. Oxford University Studies in the Enlightenment, 2018:01. Liverpool: Liverpool University Press / Oxford Voltaire Foundation, 2018.
———. ‘The Academization of Parisian Science (1660–1789). Review Essay on a Spatial Turn’. In *The Institutionalization of Science in Early Modern Europe*, edited by Mordechai Feingold and Giulia Giannini, 20–51. Scientific and Learned Cultures and Their Institutions 27. Leiden: Brill, 2020.
Darnton, Robert. *Mesmerism and the End of the Enlightenment in France*. Cambridge MA: Harvard University Press, 1968.
———. *The Literary Underground of the Old Regime*. Cambridge MA: Harvard University Press, 1982.
Daston, Lorraine. *Classical Probability in the Enlightenment*. New ed. Princeton NJ: Princeton University Press, 1996.
———. ‘The Empire of Observation’. In *Histories of Scientific Observation*, edited by Lorraine Daston and Elizabeth Lunbeck, 81–113. Chicago Ill: University of Chicago Press, 2011.
———. ‘The Ideal and Reality of the Republic of Letters in the Enlightenment’. *Science in Context* 4, no. 2 (1991): 367–86.
Davies, Anna Morpurgo. *History of Linguistics, Vol. 4. Nineteenth-Century Linguistics*. 2nd ed. Longman Linguistics Library. Abingdon: Routledge, 2014.
Davies, Simon. *Bernardin de Saint-Pierre. Colonial Traveller, Enlightenment Reformer, Celebrity Writer*. Oxford University Studies in the Enlightenment, 2021:01. Liverpool: Liverpool University Press / Oxford Voltaire Foundation, 2021.
Debus, Allen G. ‘The Significance of Chemical History’. *Ambix* 32, no. 1 (1985): 1–14.
Déré, Anne Claire. ‘La réception de la nomenclature reformée par le corps médical français’. In *Lavoisier in European Context. Negotiating a New Language for Chemistry*, edited by Ferdinando Abbri and Bernadette Bensaude-Vincent, 207–24. Canton MA: Science History Publications, 1995.
Donato, Maria Pia. ‘“Faire corps”. Les académies dans l’ancien régime des sciences (xviie-xviiie siècle)’. In *De la Renaissance aux Lumières*, edited by Stéphane van Damme, 87–109. Histoires des Sciences et des Savoirs 1. Paris: Seuil, 2015.
Donovan, Arthur. *Antoine Lavoisier. Science, Administration, and Revolution*. 2nd ed. Cambridge Science Biographies Series. Cambridge: Cambridge University Press, 1996.
Duncan, A. M. ‘Some Theoretical Aspects of Eighteenth-Century Tables of Affinity-I’. *Annals of Science* 18, no. 3 (1962): 177–94.
Duris, Pascal. *Linné et la France (1780-1850)*. Geneva: Librairie Droz, 1993.
Ebeling, Florian. *The Secret History of Hermes Trismegistus. Hermeticism from Ancient to Modern Times*. Translated by David Lorton. 1st ed. Ithaca NY: Cornell University Press, 2007.
Eddy, Matthew Daniel. ‘Society and Environment. Chemistry and Daily Life during the Eighteenth Century’. In *A Cultural History of Chemistry in the Eighteenth Century*, edited by Ursula Klein and Matthew Daniel Eddy, 4:113–36. A Cultural History of Chemistry. London: Bloomsbury Academic, 2022.
Eklund, Jon. *The Incompleat Chymist. Being an Essay on the Eighteenth-Century Chemist in His Laboratory, with a Dictionary of Obsolete Chemical Terms of the Period*. Smithsonian Studies in History and Technology 33. Washington DC: Smithsonian Institution Press, 1975.
Engelhardt, Dietrich von. *Historisches Bewusstsein in der Naturwissenschaft. Von der Aufklärung bis zum Positivismus*. Orbis academicus. Sonderband 4. Freiburg/Breisgau: Karl Alber, 1979.

Farber, Eduard. ‘Historiography of Chemistry’. *Journal of Chemical Education* 42, no. 3 (1965): 120–26.

Fleck, Ludwik. *Entstehung und Entwicklung einer wissenschaftlichen Tatsache. Einführung in die Lehre vom Denkstil und Denkkollektiv*. 12th ed. Frankfurt am Main: Suhrkamp, 2019.

Fors, Hjalmar. *The Limits of Matter. Chemistry, Mining, and Enlightenment*. Chicago: The University of Chicago Press, 2015.

Foucault, Michel. *Les mots et les choses. Une archéologie des sciences humaines*. Editions des sciences humaines. Paris: Gallimard, 1969.

Frercks, Jan. ‘Demonstrating the Facticity of Facts. University Lectures and Chemistry as a Science in Germany around 1800’. *Ambix* 57, no. 1 (2010): 64–83.

———. ‘Kommentar’. In *Lavoisier. System der Antiphlogistischen Chemie. Mit einem Geleitwort von Friedrich Steinle*, edited by Jan Frercks and Jürgen Jost, 2nd ed., 181–411. Berlin: Springer Spektrum, 2023.

———. ‘Techniken der Vermittlung. Chemie als Verbindung von Arbeit, Lehre und Forschung am Beispiel von J. F. A. Göttling’. *Naturwissenschaften, Technik und Medizin* 16, no. 3 (2008): 279–308.

Fritz, Gerd. ‘Controversy and Conversion. Friedrich Albert Carl Gren and the Phlogiston Controversy (1790-96)’. In *Historical Pragmatics of Controversies. Case Studies from 1600 to 1800*, edited by Gerd Fritz, Thomas Gloning, and Juliane Glüer, 297–337. Controversies 14. Amsterdam: John Benjamins Publishing Company, 2018.

Gelbart, Nina Rattner. *Minerva’s French Sisters. Women of Science in Enlightenment France*. New Haven CT: Yale University Press, 2021.

Genette, Gérard. *Figures III*. Paris: Seuil, 1972.

Gierl, Martin. *Geschichte als präzisierte Wissenschaft. Johann Christoph Gatterer und die Historiographie des 18. Jahrhunderts im ganzen Umfang*. Fundamenta historica 4. Stuttgart-Bad Cannstadt: Frommann-Holzboog Verlag, 2012.

———. ‘Historia literaria. Wissenschaft, Wissensordnung und Polemik im 18. Jahrhundert’. In *Historia literaria. Neuordnungen des Wissens im 17. und 18. Jahrhundert*, edited by Frank Grunert and Friedrich Vollhardt, 113–28. Berlin: Akademie Verlag, 2014.

———. ‘Kompilation und die Produktion von Wissen im 18. Jahrhundert’. In *Die Praktiken der Gelehrsamkeit in der Frühen Neuzeit*, edited by Helmut Zedelmaier and Martin Mulsow, 63–94. Tübingen, 2001.

Gillispie, Charles Coulston. *Science and Polity in France. The End of the Old Regime*. Princeton NJ: Princeton University Press, 2004.

———. *Science and Polity in France. The Revolutionary and Napoleonic Years*. Princeton NJ: Princeton University Press, 2004.

Gilly, Carlos. ‘Vom ägyptischen Hermes zum Trismegistus Germanus. Wandlungen des Hermetismus in der paracelsischen und rosenkreuzerischen Literatur’. In *Konzepte des Hermetismus in der Literatur der Frühen Neuzeit*, edited by Peter-André Alt and Volkhard Wels, 71–132. Berliner Mittelalter- und Frühneuzeitforschung 8. Göttingen: V&R Unipress, 2010.

Golinski, Jan. ‘Chemistry’. In *The Cambridge History of Science*, edited by Roy Porter, 4:375–96. Cambridge: Cambridge University Press, 2003.

———. ‘“Fit Instruments”. Thermometers in Eighteenth-Century Chemistry’. In *Instruments and Experimentation in the History of Chemistry*, edited by Frederic Lawrence Holmes and Trevor Harvey Levere, 185–210. Dibner Institute Studies in the History of Science and Technology. Cambridge MA: MIT Press, 1999.

———. *Making Natural Knowledge. Constructivism and the History of Science*. Cambridge History of Science. Cambridge: University Press, 1998.

———. ‘Precision Instruments and the Demonstrative Order of Proof in Lavoisier’s Chemistry’. *Osiris* 9 (1994): 30–47.

———. *Science as Public Culture. Chemistry and Enlightenment in Britain, 1760-1820*. Cambridge: Cambridge University Press, 1992.
———. 'The Chemical Revolution and the Politics of Language'. *The Eighteenth Century* 33, no. 3 (1992): 238–51.
Goltz, Dietlinde. 'Alchemie und Aufklärung. Ein Beitrag zur Naturwissenschaftsgeschichtsschreibung der Aufklärung'. *Medizinhistorisches Journal* 7, no. 1/2 (1972): 31–48.
Goodman, Dena. 'Enlightenment Salons. The Convergence of Female and Philosophic Ambitions'. *Eighteenth-Century Studies* 22, no. 3 (1989): 329–50.
Grafton, Anthony. *The Footnote. A Curious History*. Revised Edition. Cambridge MA: Harvard University Press, 1997.
———. *What Was History? The Art of History in Early Modern Europe*. Cambridge: Cambridge University Press, 2007.
Grison, Emmanuel. *L'étonnant parcours du républicain J.H. Hassenfratz (1755-1827)*. Paris: Presses de l'Ecole des Mines, 1996.
Grunert, Frank, and Friedrich Vollhardt. 'Einleitung'. In *'Historia literaria'. Neuordnungen des Wissens im 17. und 18. Jahrhundert*, edited by Frank Grunert and Friedrich Vollhardt, vii–xi. Berlin: Akademie Verlag, 2014.
———, eds. *Historia literaria. Neuordnungen des Wissens im 17. und 18. Jahrhundert*. Berlin: Akademie Verlag, 2014.
Guerlac, Henry. 'Chemistry as a Branch of Physics. Laplace's Collaboration with Lavoisier'. *Historical Studies in the Physical Sciences* 7 (1976): 193–276.
———. 'Joseph Priestley's First Papers on Gases and Their Reception in France'. *Journal of the History of Medicine and Allied Sciences* 12, no. 1 (1957): 1–12.
———. *Lavoisier - The Crucial Year. The Background and Origin of His First Experiments on Combustion in 1772*. Reprint. Classics in the History and Philosophy of Science 5. New York: Gordon and Breach, 1990.
Guichard, Charlotte, Anne-Solenn Le Hô, and Hannah Williams. 'Prussian Blue. Chemistry, Commerce, and Colour in Eighteenth-Century Paris'. *Art History* 46, no. 1 (2023): 154–86.
Gusdorf, Georges. *De l'histoire des sciences à l'histoire de la pensée*. Les sciences humaines et la pensée occidentale 1. Paris: Payot, 1966.
Hagen, Sjang L. Ten. 'How "Facts" Shaped Modern Disciplines'. *Historical Studies in the Natural Sciences* 49, no. 3 (2019): 300–337.
Hahn, Roger. 'L'Académie royale des sciences et la réforme de ses statuts en 1789'. *Revue d'histoire des sciences et de leurs applications* 18, no. 1 (1965): 15–28.
———. 'Scientific Careers in Eighteenth-Century France'. In *The Emergence of Science in Western Europe*, edited by Maurice Crosland, 127–38. London: Macmillan, 1975.
———. *The Anatomy of a Scientific Institution. The Paris Academy of Sciences, 1666-1803*. Berkeley CA: University of California Press, 1971.
Halleux, Robert. 'La Controverse sur les origines de la chimie, de Paracelse a Borrichus'. In *Acta Conventus Neo-Latini Turonensis. Troisième congrès international d'études néo-latines, Tours, Université François-Rabelais 6-10 septembre 1976*, edited by Jean-Claude Margolin, 2:807–19. De Pétrarque à Descartes 38. Paris: J. Vrin, 1980.
Hanegraaff, Wouter J. *Esotericism and the Academy. Rejected Knowledge in Western Culture*. Cambridge: Cambridge University Press, 2012.
Heilbron, John Lewis. 'Physics and Its History at Göttingen around 1800'. In *Göttingen and the Development of the Natural Sciences*, edited by Rupke Nicolaas, 50–71. Göttingen: Wallstein, 2022.
Hine, Ellen McNiven. 'Dortous de Mairan and Eighteenth Century "Systems Theory"'. *Gesnerus* 52, no. 1–2 (1995): 54–65.

Holmes, Frederic L. 'The "Revolution in Chemistry and Physics". Overthrow of a Reigning Paradigm or Competition between Contemporary Research Programs?' *Isis* 91, no. 4 (2000): 735–53.
Holmes, Frederic Lawrence. *Eighteenth-Century Chemistry as an Investigative Enterprise. Five Lectures Delivered at the International Summer School in History of Science, Bologna, August 1988*. Berkeley Papers in History of Science 12. Berkeley: Office for History of Science and Technology, University of California at Berkeley, 1989.
Homburg, Ernst. 'Two Factions, One Profession. The Chemical Profession in German Society 1780– 1870'. In *The Making of the Chemist. The Social History of Chemistry in Europe 1789–1914*, edited by David Knight and Helge Kragh, 39–76. Cambridge: Cambridge University Press, 1998.
Hooykaas, Reijer. 'Romé De L'isle (or Delisle), Jean-Baptiste Louis'. In *Complete Dictionary of Scientific Biography*, 11:520–24. Detroit MI: Charles Scribner's Sons, 2008.
Hoquet, Thierry. 'Buffon's Natural History. The Catalogue of Facts and the Temptation of System'. In *What Does It Mean to Be an Empiricist? Empiricisms in Eighteenth Century Sciences*, edited by Siegfried Bodenmann and Anne-Lise Rey, 139–1687. Boston Studies in the Philosophy and History of Science 331. Cham: Springer International Publishing, 2018.
Huard, P., and M.J. Imbault-Huart. 'Félix Vicq d'Azyr'. In *Complete Dictionary of Scientific Biography*, 14:14–17. Detroit MI: Charles Scribner's Sons, 2008.
Hufbauer, Karl. *The Formation of the German Chemical Community (1720-1795)*. Berkeley CA: University of California Press, 1982.
Israel, Jonathan. *Revolutionary Ideas. An Intellectual History of the French Revolution from the Rights of Man to Robespierre*. Princeton: Princeton University Press, 2014.
Joly, Bernard. 'Was Early Eighteenth-Century Chemistry an Empirical Science?' In *What Does It Mean to Be an Empiricist? Empiricisms in Eighteenth Century Sciences*, edited by Siegfried Bodenmann and Anne-Lise Rey, 203–13. Boston Studies in the Philosophy and History of Science 331. Cham: Springer International Publishing, 2018.
Karpenko, Vladimir. 'Die Edelgeborne Jungfer Alchymia. The Final Stage of European Alchemy'. *Bulletin for the History of Chemistry* 25, no. 1 (n.d.): 50–63.
Karstens, Bart. 'The Peculiar Maturation of the History of Science'. In *The Making of the Humanities. The Modern Humanities*, 3:183–204. Amsterdam: Amsterdam University Press, 2014.
Kawashima, Keiko. 'Madame Lavoisier et la traduction française de l' "Essay on Phlogiston" de Kirwan'. *Revue d'histoire des sciences* 53, no. 2 (2000): 235–63.
Kelley, Donald R. *The Descent of Ideas. The History of Intellectual History*. Aldershot: Ashgate, 2002.
Kim, Mi Gyung. *Affinity, That Elusive Dream. A Genealogy of the Chemical Revolution*. Transformations: Studies in the History of Science and Technology. Cambridge MA: MIT Press, 2003.
Kinzel, Katherina. 'Geschichte ohne Kausalität. Abgrenzungsstrategien gegen die Wissenschaftssoziologie in zeitgenössischen Ansätzen historischer Epistemologie'. *Berichte zur Wissenschaftsgeschichte* 35, no. 2 (2012): 147–62.
Klein, Ursula. 'Apothecary-Chemists in Eighteenth-Century Germany'. In *New Narratives in Eighteenth-Century Chemistry. Contributions from the First Francis Bacon Workshop, 21-23 April 2005, California Institute of Technology, Pasadena, California*, edited by Lawrence Principe, 18:97–137. Archimedes. Dordrecht: Springer, 2007.
———. *Technoscience in History. Prussia, 1750-1850*. Transformations: Studies in the History of Science and Technology. Cambridge MA: The MIT Press, 2020.
———. 'The Chemical Workshop Tradition and the Experimental Practice. Discontinuities within Continuities'. *Science in Context* 9, no. 3 (1996): 251–87.
———. 'The Laboratory Challenge. Some Revisions of the Standard View of Early Modern Experimentation'. *Isis* 99, no. 4 (2008): 769–82.

Klein, Ursula, and Matthew Daniel Eddy. 'Introduction. The Core Concepts and Cultural Context of Eighteenth-Century Chemistry'. In *A Cultural History of Chemistry in the Eighteenth Century*, edited by Ursula Klein and Matthew Daniel Eddy, 4:1–21. A Cultural History of Chemistry. London: Bloomsbury Academic, 2022.

Klein, Ursula, and Wolfgang Lefèvre. *Materials in Eighteenth-Century Science. A Historical Ontology*. Transformations: Studies in the History of Science and Technology. Cambridge MA: MIT Press, 2007.

Klenke, Nicole. *Zum Alltag der Apothekergehilfen vom 18. bis Anfang des 20. Jahrhunderts*. Quellen und Studien zur Geschichte der Pharmazie 92. Stuttgart: Wissenschaftliche Verlagsgesellschaft, 2009.

Klosa, Achim M. *Johann Christian Wiegleb (1732-1800). Eine Ergobiographie der Aufklärung*. Quellen und Studien zur Geschichte der Pharmazie 88. Stuttgart: Wissenschaftliche Verlagsgesellschaft, 2009.

Koselleck, Reinhart. 'Vergangene Zukunft in der Frühen Neuzeit'. In *Vergangene Zukunft. Zur Semantik geschichtlicher Zeiten*, 8th ed., 17–37. Frankfurt am Main: Suhrkamp, 2013.

———. 'VI. Geschichte als moderner Leitbegriff'. In *Geschichtliche Grundbegriffe. Historisches Lexikon zur politisch-sozialen Sprache in Deutschland*, edited by Otto Brunner, Werner Conze, and Reinhart Koselleck, 2:691–715. Stuttgart: Klett-Cotta, 1975.

Krafft, Fritz. 'Johann Christian Wiegleb und seine Rolle bei der Verwissenschaftlichung der Pharmazie'. In *Apotheker und Universität. Die Vorträge der Pharmaziehistorischen Biennale in Leipzig vom 12. bis 14. Mai 2000 und der Gedenkveranstaltung »Wiegleb 2000« zum 200. Todestag von Johann Christian Wiegleb (1732–1800) am 15. und 165. März 2000 in Bad Langensalza*, edited by Christoph Friedrich and Wolf-Dieter Müller-Jahncke, 151–95. Veröffentlichungen zur Pharmaziegeschichte 2. Stuttgart: Wissenschaftliche Verlagsgesellschaft, 2002.

Kraft, Alexander. 'On the Discovery and History of Prussian Blue'. *Bulletin for the History of Chemistry* 33, no. 2 (2008): 61–67.

Kragh, Helge. *An Introduction to the Historiography of Science*. Cambridge: Cambridge University Press, 1987.

Kuhn, Thomas. *The Structure of Scientific Revolutions*. International Encyclopaedia of Unified Science 2/2. Chicago: The University of Chicago Press, 1962.

Langins, Janis. 'Fourcroy, Historien de la révolution chimique'. In *Lavoisier et la révolution chimique. Actes du colloque tenu à l'occasion du bicentennaire de la publication du Traité élémentaire de Chimie 1789*, edited by Michelle Goupil, Patrice Bret, and Francine Masson, 13–33. Paris: SABIX-Ecole Polytechnique, 1992.

Latour, Bruno, and Steve Woolgar. *Laboratory Life. The Social Construction of Scientific Facts*. Sage Library of Social Research 80. Beverly Hills CA: Sage, 1979.

Laudan, Rachel. 'Histories of the Sciences and Their Uses. A Review to 1913'. *History of Science* 31, no. 1 (1993): 1–34.

Laupheimer, Peter. *Phlogiston oder Sauerstoff. Die Pharmazeutische Chemie in Deutschland zur Zeit des Übergangs von der Phlogiston- zur Oxidationstheorie*. Quellen und Studien zur Geschichte der Pharmazie 63. Stuttgart: Wissenschaftliche Verlagsgesellschaft, 1992.

Law, Esteban. 'Die hermetische Tradition. Wissensgenealogien in der alchemischen Literatur'. In *Konzepte des Hermetismus in der Literatur der Frühen Neuzeit*, edited by Peter-André Alt and Volkhard Wels, 23–70. Berliner Mittelalter- und Frühneuzeitforschung 8. Göttingen: V&R Unipress, 2010.

Lefèvre, Wolfgang. 'The Méthode de Nomenclature Chimique (1787). A Document of Transition'. *Ambix* 65, no. 1 (2018): 1–29.

LeGrand, Homer E. 'Chemistry in a Provincial Context. The Montpellier Société Royale Des Sciences in the Eighteenth Century'. *Ambix* 29, no. 2 (1982): 88–105.

Lehleiter, Christine. ‘Introduction. Fact and Fiction. Literary and Scientific Cultures in Germany and Britain – Thoughts on a Contentious Relationship’. In *Fact and Fiction. Literary and Scientific Cultures in Germany and Britain*, edited by Christine Lehleiter, 1–30. Toronto: University of Toronto Press, 2018.

Lehman, Christine. ‘Alchemy Revisited by the Mid-Eighteenth Century Chemists in France. An Unpublished Manuscript by Pierre-Joseph Macquer’. *Nuncius* 28, no. 1 (2013): 165–216.

———. ‘Innovation in Chemistry Courses in France in the Mid-Eighteenth Century. Experiments and Affinities’. *Ambix* 57, no. 1 (2010): 3–26.

———. ‘Pierre-Joseph Macquer. An Eighteenth-Century Artisanal-Scientific Expert’. *Annals of Science* 69, no. 3 (2012): 307–33.

———. ‘Pierre-Joseph Macquer. Chemistry in the French Enlightenment’. *Osiris* 29, no. 1 (2014): 245–61.

Lehman, Christine, and Bernadette Bensaude-Vincent. ‘Public Demonstrations of Chemistry in Eighteenth Century France’. *Science & Education* 16, no. 6 (2007): 573–83.

Lennartson, Anders. *Carl Wilhelm Scheele and Torbern Bergman. The Science, Lives and Friendship of Two Pioneers in Chemistry*. Perspectives on the History of Chemistry. Cham: Springer International Publishing, 2020.

Lepenies, Wolf. *Das Ende der Naturgeschichte. Wandel kultureller Selbstverständlichkeiten in den Wissenschaften des 18. und 19. Jahrhunderts*. München: Hanser, 1976.

Levere, Trevor Harvey. ‘Balance and Gasometer in Lavoisier’s Chemical Revolution’. In *Lavoisier et la révolution chimique. Actes du colloque tenu à l’occasion du bicentennaire de la publication du Traité élémentaire de Chimie 1789*, edited by Michelle Goupil, Patrice Bret, and Francine Masson, 313–25. Paris: SABIX-Ecole Polytechnique, 1992.

———. ‘Lavoisier. Language, Instruments, and the Chemical Revolution’. In *Nature, Experiment, and the Sciences. Essays on Galileo and the History of Science in Honour of Stillman Drake*, edited by Trevor Harvey Levere and William R. Shea. Boston Studies in the Philosophy of Science 120. Dordrecht: Kluwer Academic, 1990.

Levin, A. ‘Venel, Lavoisier, Fourcroy, Cabanis and the Idea of Scientific Revolution. The French Political Context and the General Patterns of Conceptualization of Scientific Change’. *History of Science* 22, no. 3 (1984): 303–20.

Lifschitz, Avi. ‘Genesis for Historians. Thomas Abbt on Biblical and Conjectural Accounts of Human Nature’. *History of European Ideas* 41, no. 5 (2015): 605–18.

———. *Language and Enlightenment. The Berlin Debates of the Eighteenth Century*. Oxford Historical Monographs. Oxford: Oxford University Press, 2012.

———. ‘The Arbitrariness of the Linguistic Sign. Variations on an Enlightenment Theme’. *Journal of the History of Ideas* 73, no. 4 (2012): 537–57.

Longo, Mario. ‘Geistige Anregungen und Quellen der Bruckerschen Historiographie’. In *Jacob Brucker (1696-1770). Philosoph und Historiker der europäischen Aufklärung*, edited by Wilhelm Schmidt-Biggemann and Theo Stammen, translated by Helga Zurhausen-Bamberg, 159–86. Colloquia Augustana 7. Berlin: Akademie Verlag, 1998.

Loveland, Jeff. *Rhetoric and Natural History. Buffon in Polemical and Literary Context*. Oxford University Studies in the Enlightenment, 2001:03. Oxford: Voltaire Foundation, 2001.

Lynn, Michael R. ‘Enlightenment in the Public Sphere. The Musée de Monsieur and Scientific Culture in Late-Eighteenth-Century Paris’. *Eighteenth-Century Studies* 32, no. 4 (1999): 463–76.

———. *Popular Science and Public Opinion in Eighteenth-Century France*. Studies in Early Modern European History. Manchester: Manchester University Press, 2006.

Mafarette-Dayries, Pascale. ‘L’Académie royale des sciences et les grandes commissions d’enquête et d’expertise à la fin de l’Ancien Régime’. *Annales historiques de la Révolution française* 320, no. 1 (2000): 121–35.

McClellan III, James E. *Science Reorganized. Scientific Societies in the Eighteenth Century*. New York NY: Columbia University Press, 1985.
McEvoy, John. 'Priestley Responds to Lavoisier's Nomenclature. Language, Liberty and Chemistry in the English Enlightenment'. In *Lavoisier in European Context. Negotiating a New Language for Chemistry*, edited by Ferdinando Abbri and Bernadette Bensaude-Vincent, 123–42. Canton MA: Science History Publications, 1995.
McEvoy, John G. 'Continuity and Discontinuity in the Chemical Revolution'. *Osiris* 4 (1988): 195–213.
———. 'The Enlightenment and the Chemical Revolution'. In *Metaphysics and Philosophy of Science in the Seventeenth and Eighteenth Centuries. Essays in Honour of Gerd Buchdahl*, edited by Roger Stuart Woolhouse, 307–25. Dordrecht: Kluwer Academic Publishers, n.d.
———. *The Historiography of the Chemical Revolution. Patterns of Interpretation in the History of Science*. London: Routledge, 2016.
McIntosh, Christopher. *The Rose Cross and the Age of Reason. Eighteenth-Century Rosicrucianism in Central Europe and Its Relationship to the Enlightenment*. Brill's Studies in Intellectual History 29. Leiden: Brill, 1992.
Meier-Oeser, Stefan, and Helmut Hühn. 'Wissenschaft. I. Der Klassische Wissenschaftsbegriff. Antike bis 19. Jahrhundert'. In *Historisches Wörterbuch der Philosophie*, edited by Joachim Ritter, Karlfried Gründer, and Gottfried Gabriel, 12:902–20. Basel: Schwabe, 2004.
Meinel, Christoph. '"Artibus Academicis Inserenda." Chemistry's Place in Eighteenth and Early Nineteenth Century Universities'. *History of Universities* 7 (1988): 89–115.
———. 'Demarcation Debates. Lavoisier in Germany'. In *Lavoisier in Perspective*, edited by Marco Beretta, 147–60. Munich: Deutsches Museum, 2005.
———. 'Die Rolle der Chemiegeschichte in der Wissenschaftskommunikation'. In *Zwischen Faszination und Verteufelung. Chemie in der Gesellschaft*, edited by Marc-Denis Weitze, Joachim Schummer, and Thomas Geelhaar, 85–102. Berlin: Springer Spektrum, 2017.
———. 'Reine und angewandte Chemie. Die Entstehung einer neuen Wissenschaftskonzeption in der Chemie der Aufklärung'. *Berichte zur Wissenschaftsgeschichte* 8 (1985): 25–45.
———. 'Theory or Practice? The Eighteenth-Century Debate on the Scientific Status of Chemistry'. *Ambix* 30, no. 3 (1983): 121–32.
Miert, Dirk van. 'Structuring the History of Knowledge in an Age of Transition. The Göttingen Geschichte between Historia Literaria and the Rise of the Disciplines'. *History of Humanities* 2, no. 2 (2017): 389–416.
Muhlack, Ulrich. 'Von der philologischen zur historischen Methode'. In *Theorie der Geschichte*, edited by Christian Meier and Jörn Rüsen, 154–80. Beiträge zur Historik, 5: Historische Methode. Munich: Deutscher Taschenbuchverlag, 1988.
Müller-Wille, Staffan. 'Names and Numbers. "Data" in Classical Natural History, 1758–1859'. *Osiris* 32, no. 1 (2017): 109–28.
Neave, E. W. J. 'Chemistry in Rozier's Journal I. The Journal and Its Editors'. *Annals of Science* 6, no. 4 (1950): 416–21.
Newman, William R., and Lawrence M. Principe. 'Alchemy vs. Chemistry. The Etymological Origins of a Historiographic Mistake'. *Early Science and Medicine* 3, no. 1 (1998): 32–65.
Nordmann, Alfred. 'The Passion for Truth. Lavoisier's and Lichtenberg's Enlightenments'. In *Lavoisier in Perspective*, edited by Marco Beretta, 109–28. Munich: Deutsches Museum, 2005.
O'Connor, Adrian. *In Pursuit of Politics. Education and Revolution in Eighteenth-Century France*. Studies in Modern French History. Manchester: Manchester University Press, 2017.
Oliver, Bette Wyn. *Jacques Pierre Brissot in America and France, 1788-1793. In Search of Better Worlds*. Lanham MD: Lexington Books, 2016.
Outram, Dorinda. *Georges Cuvier. Vocation, Science, and Authority in Post-Revolutionary France*. Manchester: Manchester University Press, 1984.

Passeron, Irène, René Sigrist, and Siegfried Bodenmann. 'La république des sciences. Réseaux des correspondances, des académies et des livres scientifiques'. *Dix-huitième siècle* 40, no. 1 (2008): 5–27.
Peiffer, Jeanne, and Jean-Pierre Vittu. 'Les journaux savants, formes de la communication et agents de la construction des savoirs (17e-18e siècles)'. *Dix-huitième siècle* 40, no. 1 (2008): 281–300.
Perkins, John. 'Chemistry Courses, the Parisian Chemical World and the Chemical Revolution, 1770-1790'. *Ambix* 57, no. 1 (2010): 27–47.
———. 'Creating Chemistry in Provincial France before the Revolution. The Examples of Nancy and Metz. Part 1. Nancy'. *Ambix* 50, no. 2 (2003): 145–81.
———. 'Creating Chemistry in Provincial France before the Revolution. The Examples of Nancy and Metz. Part 2 Metz'. *Ambix* 51, no. 1 (2004): 43–75.
Perrin, Carleton E. 'Revolution or Reform. The Chemical Revolution and Eighteenth Century Concepts of Scientific Change'. *History of Science* 25, no. 4 (1987): 395–423.
———. 'The Triumph of the Antiphlogistians'. In *The Analytic Spirit. Essays in the History of Science in Honor of Henry Guerlac*, edited by Harry Woolf, 40–63. Ithaca NY: Cornell University Press, 1981.
Peterschmitt, Luc. 'Fontenelle et la chimie. La recherche d'une « loi fondamentale » pour la chimie'. *Methodos* 12, no. 12 (2012): Online Journal Without Pagination.
Petix, Calogero Alberto. 'Vers le républicanisme. L'évolution de la pensée politique de Condorcet à la lumière de sa correspondence inédite avec Brissot'. In *La Correspondance de Condorcet. Documents inédits, nouveaux éclairages. Engagements politiques 1775-1792*, edited by Nicolas Rieucau, 63–81. Ferney-Voltaire: Centre international d'étude du XVIIIe siècle, 2014.
Piaia, Gregorio. 'The History of Philosophy in the "Encyclopédie"'. In *Models of the History of Philosophy. Vol. III: The Second Enlightenment and the Kantian Age*, edited by Gregorio Piaia and Giovanni Santinello, translated by Hilary Siddons, 2015th ed., 3–46. International Archives of the History of Ideas 216. Dordrecht: Springer Netherlands, 2015.
Pocock, J. G. A. *The Ancient Constitution and the Feudal Law. A Study of English Historical Thought in the Seventeenth Century*. Cambridge: Cambridge University Press, 1957.
Poirier, Jean-Pierre. *Lavoisier. Chemist, Biologist, Economist*. Translated by Rebecca Balinski. Chemical Sciences in Society Series. Philadelphia PA: University of Pennsylvania Press, 1996.
Pomata, Gianna, and Nancy G. Siraisi, eds. *Historia. Empiricism and Erudition in Early Modern Europe*. Transformations. Cambridge MA: MIT Press, 2005.
———. 'Introduction'. In *Historia. Empiricism and Erudition in Early Modern Europe*, edited by Gianna Pomata and Nancy G. Siraisi, 1–39. Transformations. Cambridge MA: MIT Press, 2005.
Poovey, Mary. *A History of the Modern Fact. Problems of Knowledge in the Sciences of Wealth and Society*. Chicago: The University of Chicago Press, 1998.
Popkin, Richard H. 'Brissot and Condorcet. Skeptical Philosophers'. In *The Skeptical Tradition around 1800. Skepticism in Philosophy, Science, and Society*, edited by Johan van der Zande and Richard H. Popkin, 31–41. Archives Internationales d'histoire Des Idées 155. Dordrecht: Kluwer Academic, 1998.
Powers, John C. *Inventing Chemistry. Herman Boerhaave and the Reform of the Chemical Arts*. Chicago Ill: The University of Chicago Press, 2012.
———. 'Learning and Institutions. Didactic Chemistry and Practical Instruction'. In *A Cultural History of Chemistry in the Eighteenth Century*, edited by Ursula Klein and Matthew Daniel Eddy, 4:157–74. A Cultural History of Chemistry. London: Bloomsbury Academic, 2022.
Principe, Lawrence. 'A Revolution Nobody Noticed? Changes in Early Eighteenth-Century Chymistry'. In *New Narratives in Eighteenth-Century Chemistry. Contributions from the First*

Francis Bacon Workshop, 21-23 April 2005, California Institute of Technology, Pasadena, California, edited by Lawrence Principe, 18:1–22. Archimedes. Dordrecht: Springer, 2007.
———. *The Secrets of Alchemy*. Chicago, Ill: The University of Chicago Press, 2013.
———. *The Transmutations of Chymistry. Wilhelm Homberg and the Académie Royale Des Sciences*. Synthesis. Chicago: The University of Chicago Press, 2020.
———. 'Transmuting Chymistry into Chemistry. Eighteenth-Century Chrysopoeia and Its Repudiation'. In *Neighbours and Territories. The Evolving Identity of Chemistry. The 6th International Conference on the History of Chemistry. Proceedings*, edited by José Ramon Bertomeu-Sanchez, Duncan Thorburn Burns, and Brigitte van Tiggelen, 21–34. Louvain-la-neuve: Mémosciences asbl, 2008.
Principe, Lawrence M. 'The End of Alchemy?' *Osiris* 29, no. 1 (2014): 96–116.
Racault, Jean-Michel. 'Géologie, Vulcanologie, et imaginaire chez Bernardin de Saint-Pierre [2007-2011]'. In *Bernardin de Saint-Pierre. Pour une biographie intellectuelle*, 299–312. Les dix-huitièmes siècles 185. Paris: Honoré Champion, 2015.
———. 'Le solitaire contre les „Corps". L'imaginaire politique de Bernardin de Saint-Pierre et la fin de l'Ancien Régime [2010]'. In *Bernardin de Saint-Pierre. Pour une biographie intellectuelle*, 69–93. Les dix-huitièmes siècles 185. Paris: Honoré Champion, 2015.
Ratcliff, Marc. 'Fictitious Empiricism, Material Experiments. Conditions for Thinking the Enlightenment "Issue of Empiricism"'. In *What Does It Mean to Be an Empiricist? Empiricisms in Eighteenth Century Sciences*, edited by Siegfried Bodenmann and Anne-Lise Rey, 31–43. Boston Studies in the Philosophy and History of Science 331. Cham: Springer International Publishing, 2018.
Redies, Stefan. *Friedrich Joseph Wilhelm Schröder. Ein Rosenkreuzer an der Universität Marburg*. Wissenschaft in Dissertationen 266. Marburg: Görich & Weiershäuser, 1997.
Reill, Peter Hanns. *Vitalizing Nature in the Enlightenment*. Berkeley CA: University of California Press, 2005.
Rheinberger, Hans-Jörg. *On Historicizing Epistemology. An Essay*. Stanford CA: Stanford University Press, 2010.
Riskin, Jessica. *Science in the Age of Sensibility. The Sentimental Empiricists of the French Enlightenment*. Chicago Ill: The University of Chicago Press, 2002.
Roberts, Lissa. 'A Word and the World. The Significance of Naming the Calorimeter'. *Isis* 82, no. 2 (1991): 198–222.
———. 'Condillac, Lavoisier, and the Instrumentalization of Science'. *The Eighteenth Century* 33, no. 3 (1992): 252–71.
———. 'Setting the Table. The Disciplinary Development of Eighteenth-Century Chemistry as Read Through the Changing Structure of Its Tables'. In *The Literary Structure of Scientific Argument*, edited by Peter Dear, 99–132. Philadelphia PA: University of Pennsylvania Press, 2015.
Roche, Daniel. *Le siècle des lumières en province. Académies et académiciens provinciaux, 1680–1789*. Vol. 1. 2 vols. Paris: Mouton, 1978.
Rocke, Alan J. 'History and Science, History of Science. Adolphe Wurtz and the Renovation of the Academic Profession in France'. *Ambix* 41, no. 1 (1994): 20–32.
Roger, Jacques. *Buffon. un philosophe au jardin du roi*. Paris: Fayard, 1989.
Rosenfeld, Sophia A. *A Revolution in Language. The Problem of Signs in Late Eighteenth-Century France*. Stanford CA: Stanford University Press, 2001.
Russell, Colin A. 'Presidential Address. "Rude and Disgraceful Beginnings". A View of History of Chemistry from the Nineteenth Century'. *The British Journal for the History of Science* 21, no. 3 (1988): 273–94.
Scattola, Merio. '"Historia literaria" als "historia pragmatica". Die pragmatische Bedeutung der Geschichtsschreibung im intellektuellen Unternehmen der Gelehrtengeschichte'. In *Historia*

literaria. Neuordnungen des Wissens im 17. und 18. Jahrhundert, edited by Frank Grunert and Friedrich Vollhardt, 37–64. Berlin: Akademie Verlag, 2014.
Schmidt-Biggemann, Wilhelm. ‘Jacob Bruckers philosophiegeschichtliches Konzept’. In *Jacob Brucker (1696-1770). Philosoph und Historiker der europäischen Aufklärung*, edited by Wilhelm Schmidt-Biggemann and Theo Stammen, 113–34. Colloquia Augustana 7. Berlin: Akademie Verlag, 1998.
Schmitt, Stéphane. ‘From Physiology to Classification. Comparative Anatomy and Vicq d’Azyr’s Plan of Reform for Life Sciences and Medicine (1774–1794)’. *Science in Context* 22, no. 2 (2009): 145–93.
Schmitt, Stephane. ‘Lacepède’s Syncretic Contribution to the Debates on Natural History in France Around 1800’. *Journal of the History of Biology* 43, no. 3 (2010): 429–57.
Schmitt, Stéphane. ‘Studies on Animals and the Rise of Comparative Anatomy at and around the Parisian Royal Academy of Sciences in the Eighteenth Century’. *Science in Context* 29, no. 1 (2016): 11–54.
Schroder, Anne L. ‘Going Public against the Academy in 1784. Mme de Genlis Speaks out on Gender Bias’. *Eighteenth-Century Studies* 32, no. 3 (1999): 376–82.
Schulz, David. *Die Natur der Geschichte. Die Entdeckung der geologischen Tiefenzeit und die Geschichtskonzeptionen zwischen Aufklärung und Moderne*. Ordnungssysteme. Studien zur Ideengeschichte der Neuzeit 56. München: De Gruyter Oldenbourg, 2020.
Sebastiani, Silvia. ‘Conjectural History vs. the Bible. Eighteenth-Century Scottish Historians and the Idea of History in the “Encyclopaedia Britannica”’. *Lumen* 21 (2002): 213–31.
Seils, Markus. *Friedrich Albrecht Carl Gren in seiner Zeit, 1760 - 1798. Spekulant oder Selbstdenker?* Heidelberger Schriften zur Pharmazie- und Naturwissenschaftsgeschichte 14. Stuttgart: Wissenschaftliche Verlagsgesellschaft, 1995.
Seligardi, Raffaella. ‘The Italian Network and the European Network. Scientific Journals and the Chemical Revolution’. *Archives Internationales d’histoire Des Sciences* 63, no. 170–171 (2013): 427–54.
Sheppard, Kenneth. ‘J.G.A. Pocock as an Intellectual Historian’. In *A Companion to Intellectual History*, edited by Richard Whatmore and Brian W. Young, 113–25. Blackwell Companions to History. Chichester: John Wiley & Sons, 2016.
Siegfried, Robert. ‘The Chemical Revolution in the History of Chemistry’. *Osiris* 4 (1988): 34–50.
Simon, Jonathan. *Chemistry, Pharmacy and Revolution in France, 1777-1809*. Science, Technology, and Culture, 1700-1945. Aldershot: Ashgate, 2005.
———. ‘Pharmacy and Chemistry in the Eighteenth Century. What Lessons for the History of Science?’ *Osiris* 29, no. 1 (2014): 283–97.
Sloan, Phillip R. ‘The Buffon-Linnaeus Controversy’. *Isis* 67, no. 3 (1976): 356–75.
Smeaton, William Arthur. *Fourcroy. Chemist and Revolutionary, 1755-1809*. Cambridge: Heffer’s, 1962.
———. ‘Gabriel-François Venel’. In *Complete Dictionary of Scientific Biography*, 13:602–4. Detroit MI: Charles Scribner’s Sons, 2008.
———. ‘Jean-Baptiste Sénac’. In *Complete Dictionary of Scientific Biography*, 12:302–3. Detroit MI: Charles Scribner’s Sons, 2008.
———. ‘L.B. Guyton de Morveau (1737-1816). A Bibliographical Study’. *Ambix* 6, no. 1 (1957): 18–34.
———. ‘Louis Bernard Guyton de Morveau, F.R.S. (1737-1816) and His Relations with British Scientists’. *Notes and Records of the Royal Society of London* 22, no. 1/2 (1967): 113–30.
———. ‘Pierre-Joseph Macquer’. In *Complete Dictionary of Scientific Biography*, 8:618–24. Detroit MI: Charles Scribner’s Sons, 2008.
———. ‘The Contributions of P.-J. Macquer, T. O. Bergman and L. B. Guyton de Morveau to the Reform of Chemical Nomenclature’. *Annals of Science* 10, no. 2 (1954): 87–106.

Spary, Emma C. *Utopia's Garden. French Natural History from Old Regime to Revolution*. Chicago Ill: The University of Chicago Press, 2000.
Špelda, Daniel. 'The History of Science as the Progress of the Human Spirit. The Historiography of Astronomy in the Eighteenth Century'. *Studies in History and Philosophy of Science* 63 (2017): 48–57.
Staum, Martin S. *Cabanis. Enlightenment and Medical Philosophy in the French Revolution*. Princeton NJ: Princeton University Press, 1980.
Stevens, Peter F. *The Development of Biological Systematics. Antoine-Laurent de Jussieu, Nature, and the Natural System*. New York NY: Columbia University Press, 1994.
Stichweh, Rudolf. *Zur Entstehung des modernen Systems wissenschaftlicher Disziplinen. Physik in Deutschland 1740-1890*. Frankfurt/Main: Suhrkamp, 1984.
Stroup, Alice. *A Company of Scientists. Botany, Patronage, and Community at the Seventeenth-Century Parisian Royal Academy of Sciences*. Berkley CA: University of California Press, 1990.
Strube, Wilhelm. 'Der Beginn der Chemiegeschichtsschreibung im 18. Jahrhundert in Deutschland'. In *Beiheft zur Schriftenreihe für Geschichte der Naturwissenschaften, Technik und Medizin. Zum 60. Geburtstag von G. Harig*, 154–63. Leipzig: Teubner, 1964.
———. *Die Chemie und ihre Geschichte*. Berlin: Akademie-Verlag, 1974.
———. 'Zur Stellung und Bedeutung des chemiehistorischen Werkes von Johann Bartholomäus Trommsdorf'. *Beiträge zur Geschichte der Universität Erfurt (1392-1816)* 16 (1971-1972): 149–64.
Svojtka, M. 'Scherer, Johann Baptist Andreas Ritter von'. In *Österreichisches Biographisches Lexikon, Online Edition*, 2nd ed. Accessed 22 August 2024. https://www.biographien.ac.at/oebl/oebl_S/Scherer_Johann-Baptist-Andreas_1755_1844.xml.
Swerdlow, Noah M. 'Montucla's Legacy. The History of the Exact Sciences'. *Journal of the History of Ideas* 54, no. 2 (1993): 299–328.
Terrall, Mary. *The Man Who Flattened the Earth. Maupertuis and the Sciences in the Enlightenment*. Chicago Ill: The University of Chicago Press, 2002.
Toews, John. 'Historicism from Ranke to Nietzsche'. In *The Cambridge History of Modern European Thought*, edited by Warren Breckman and Peter E. Gordon, 301–29. Cambridge: Cambridge University Press, 2019.
Tomory, Leslie. 'Trade and Industry. An Era of New Chemical Industries and Technologies'. In *A Cultural History of Chemistry in the Eighteenth Century*, edited by Ursula Klein and Matthew Daniel Eddy, 4:137–56. A Cultural History of Chemistry. London: Bloomsbury Academic, 2022.
Weyer, Jost. *Chemiegeschichtsschreibung von Wiegleb (1790) bis Partington (1970). Eine Untersuchung über ihre Methoden, Prinzipien und Ziele*. Hildesheim: Verlag Dr. H. A. Gerstenberg, 1974.
———. *Geschichte der Chemie. Altertum, Mittelalter, 16. bis 18. Jahrhundert*. Vol. 1. 2 vols. Berlin: Springer Spektrum, 2018.
Whaley, Leigh. 'Navigating Enlightenment Science. The Case of Marie Geneviève Charlotte Darlus Thiroux d'Arconville and Gabrielle Émilie Le Tonnelier De Breteuil and the Republic of Letters'. In *The Palgrave Handbook of Women and Science since 1660*, edited by Claire G. Jones, Alison E. Martin, and Alexis Wolf, 47–66. Basingstoke: Palgrave Macmillan, 2022.
Whatmore, Richard. 'Quentin Skinner and the Relevance of Intellectual History'. In *A Companion to Intellectual History*, edited by Richard Whatmore and Brian W. Young, 97–112. Blackwell Companions to History. Chichester: John Wiley & Sons, 2016.
Winthrop-Young, Geoffrey. 'Lichtenberg und die Französische Revolution. Zum Verhältnis von Sprache, Naturwissenschaft und Aufklärung'. PhD Thesis, University of British Columbia, 1991.

Withers, Charles W. J. *Placing the Enlightenment. Thinking Geographically about the Age of Reason*. Chicago Ill: University of Chicago Press, 2007.
Wolf, Evamarie. *Über die Anfänge der Pharmaziegeschichtsschreibung. Von Johannes Ruellius (1529) bis David Peter Hermann Schmidt (1835)*. 2nd ed. Quellen und Studien zur Geschichte der Pharmazie 72. Stuttgart: Wissenschaftliche Verlagsgesellschaft, 1996.
Ziche, Paul. 'Science and the History of the Sciences. Conceptual Innovations Through Historicizing Science in the Eighteenth Century'. *Berichte zur Wissenschaftsgeschichte* 35, no. 2 (2012): 99–112.