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Vol. I: Cultures and Politics of Research
from the Early Modern Period to the Age of Extremes

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Science as Cultural Practice

Volume I:
Cultures and Politics of Research from the Early Modern Period to the Age of Extremes

Edited by
Moritz Epple and Claus Zittel

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Moritz Epple and Claus Zittel

Introduction

Eighteen years ago when Andrew Pickering opened his widely read collection *Science as Practice and Culture* with an essay reviewing the various trends in the field of science studies since the formation of a sociology of scientific knowledge in 1970's, he entitled his reflections "From science as knowledge to science as practice", and he summarised the "key advance" inspiring his collection in the sentence:

> "This [advance] is the move toward studying scientific practice, what scientists actually do, and the associated move toward scientific culture, meaning the field of resources that practice operates in and on" (Pickering 1992: 2).

A lengthy footnote explained the sense in which the two terms 'practice' and 'culture' were to be understood: scientific practice was explained as a kind of work composed of "acts of making (and unmaking)", and culture was defined to be the "field of resources that scientists draw upon in their work" (Pickering 1992: 2-3).

If our collection now bears the title "Science *as* cultural practice" one may rightfully wonder whether there is much of a difference in approach in comparison with Pickering's volume, and if so, what that difference would be. Perhaps the simplest way to put it is to say that while most if not all of the studies presented in this volume would subscribe to a view of science as a kind of practice – and in this sense there is no need to reinvent the wheel – there is also a consensus that the practices of science should not be viewed separately from cultural practices but rather as a particular *subset* of these practices. This shift in perspective may seem slight, and indeed we deviate from Pickering's notion of 'culture'[1] quoted above more strongly than from the understanding of science advocated in his volume. The articles presented here argue for, and present examples of, the notion that scientific practices participate in the production of the web of meanings given by a society to 'nature' and to the actions of its members, in other words, to the production of a culture, if one is willing to accept – as many authors in this volume would do – a largely Geertzian notion of culture (Geertz 1973). Pickering's idea of cultural 'resources' can be embedded in such a view in a more symmetrical fashion: which cultural practices play the role of resources for the practices of scientists, or which cultural practices draw on the resources offered by scientific practices, may vary and can be left open to historical investigation – there is nothing that would place scientific practice in an asymmetrical position in this respect.

Understanding science as one cultural practice among others – or rather, as a whole array of cultural practices intertwined with other such practices – offers both methodological and

1 Pickering's understanding of culture in relation with the history of science has been discussed critically by Jan Golinski in chapter 6 "Culture and Construction" of (Golinski 1998), see also (Dear 1995a); (Zittel 2002).

thematic advantages. On the side of methodology the relation between the historiography of science and other fields of cultural study such as anthropology, literary studies, art history, 'Bildwissenschaft', cultural and social history broadly conceived, political and religious studies, becomes more symmetrical as well. Rather than 'applying' the methods of these fields to the purportedly singular subject of science, one finds oneself immersed in a broader field of available methods in which the historical topic rather than a preconceived 'approach' can be given weight in selecting appropriate tools of investigation. There is, then, no longer a fundamental difference between a historian of mathematics, say, using anthropological research techniques and an anthropologist making use of the history of arithmetics in studying the counting and calculating practices of a given population.[2]

On the topical side, viewing scientific practices as part of the larger field of social practices in which cultural meaning is produced enables one to understand the core of scientific practice, i.e., the generation of both ideals of scientific knowledge and fragments of knowledge satisfying these ideals as a process not separated from the social production of knowledge in general and the formation of norms and values regulating social and cultural life. Just like other cultural practices, the activities of scientific research *give sense* to certain areas of perceived reality; the generation of knowledge and the production of cultural meaning are inextricably linked. Even if one might hope that such a remark would no longer be necessary it must be pointed out that from this point of view, the old and – unfortunately – repeatedly recurring opposition between internalist and externalist approaches to science turns out to be just a pair of partial and, in the best of all worlds, complementary perspectives on a subject matter which is more complex than each of these partial perspectives is able to encapsulate alone.[3]

Two further facets of viewing scientific practices as special kinds of cultural practice are that this view invites us to ask *comparative* questions that cut across traditional disciplinary boundaries, and that it offers the possibility to place our efforts in the continuing discourse of what has recently become known under the name of historical epistemology. In which ways can the visual techniques of scientists be compared with the visual techniques of painters or of other groups engaged in the production of visual media?[4] In what ways are the political strategies of scientific collectives similar to or different from the political strategies of other social groups?[5] To ask questions such as these becomes necessary on the premises which the studies in this volume advocate.

Finally, and as indicated at the beginning, we see the emphasis of this collection as reinforcing and hopefully advancing the discussion of a stringently historicized epistemology which began around 1900 (at the latest) and culminated in the contributions of authors such

2 One striking example for the establishment of the cultural approach to science are the entries in the *Neues Kindler Literaturlexikon*, where not only many scientific texts but also books such as Shapin and Schaffer's *Leviathan and the Air-Pump* are now treated as part of the canon of the history of literature.

3 For further discussion of similar points, see also (Biagioli 2009).

4 Here one may point to studies such as (Bredekamp 2007) or (Biagioli 1999a,b, 2006).

5 A political history of science has of course long been in the interest of some contributors to the field, including Paul Forman or Donald MacKenzie, among others, see e.g. (Forman 1971, 1987); (MacKenzie 1981, 1990). In recent years, the interest in such issues has increased. From a wealth of publications let us mention (Forman, Sánchez-Ron 1996); (Kaufmann 2000); (Galison, Gordin, Kaiser 2001); (Pestre 2003); (Dahan, Pestre 2004); (Nye 2004); (Schiebinger, Swan 2004); (Sachse, Walker 2005); (MacKenzie 2006).

as Ludwik Fleck, Gaston Bachelard, Karl Mannheim and Edgar Zilsel in the 1920's and 1930's before the turmoil of World War II interrupted this most productive exchange – an interruption that was only very slowly ended in the second half of the last century. Here viewing science as a cultural practice becomes reflexive – and indeed the historiography of science is a cultural practice as well, intertwined in its own way with general history and cultural trends. For this reason among others several essays in this volume address issues concerning the history of this historiography in the last century.[6]

*

The present volume collects studies whose topics range from the early modern period to very recent times. A recurrent argument is that the modern sciences, which have grown to social networks of substantial size, are not only shaped by the social and cultural conditions under which they exist, but also generate their own patterns of social and cultural behaviour that tie in with the patterns of social life at large. In this way, one or several scientific sub-cultures are formed in any given period, and indeed these sub-cultures immersed in a society generate their own *politics* as well.

Investigating these sub-cultures and the politics of scientific practice in society, determining the ways in which they partake in weaving the cultural web of meanings as well as in the shaping of the material life of society still represents a formidable task for historical research. While this task cannot be coped with in the short run, we hope that the present volume offers a modest contribution to a better understanding of the complex issues involved in such a task. A second volume *Science as Cultural Practice 2: Modernism in the Sciences, ca. 1900-1940* (edited by Moritz Epple and Falk Müller) will address the particular period and topic of scientific modernity and investigate the analogies, interrelations, similarities and differences between it and the cultural trends of the same period.

This first volume is divided into two parts. The first half collects case studies ranging from the 17th to the 19th century which illustrate how the formation of scientific concepts, of experimental practice, of scientific rationality, of research strategies were connected with broader cultural patterns and political issues. The contributions in the second half are grouped under the title *Cultures and politics of research in the 20th century*. Most of these contributions arose from talks in a lecture series organised in Frankfurt in the winter of 2005/2006 under the same title. Some guiding topics of this series were the hybrid nature of research constellations in a period of accelerated modernisation, two World Wars, and extreme political and cultural tensions. How did experimenters and theoreticians, engineers and philosophers of science act and interact with other groups in their respective 'trading zones', in a world of rapid social change (here Galison's fitting notion must be understood in its widest possible sense)? It turns out that a particular strand in these inquiries is devoted to *reflexive* efforts and their history. Scientists, as well as their philosophical, historical and political observers, have been challenged to rethink the idea of science and scientific research in what we have come to call the age of extremes, and 20th century history is marked by significant cultural and even political responses to the changes in scientific practice and its reflexive analysis.

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6 See (Rheinberger 2007) for a concise introduction to this topic.

Let us briefly survey the different alternatives available for reacting, at a methodological level, to these issues. One option certainly continues to be an analysis of the 'extra scientific' social and educational backgrounds and motives of influential individual scientists, in particular if it is possible to highlight crucial features of a scientist's research activities in this way. In her analysis of Robert Boyle's education Catherine Wilson illustrates how 'romantic' motives came to be important to him that would later shape his scientific practice, prompting him to harmonise scientific evidence and Christian revelation, rather than setting them in opposition to each other.

The complex motives of scientific research can also be considered from a perspective that leans more to social anthropology than to biography. Indeed Simon Schaffer proposes viewing core practices in the 'hard sciences' – such as astronomy and astrophysics – very much like the field work of anthropologists. Just like anthropologists in the field, scientists in their observatories and laboratories have to establish local socio-technical and political networks of support while at the same time acting in larger communication networks; they have to prudently integrate local and global knowledge. Juxtaposing anthropology and astrophysics in India in the 19th and early 20th centuries in this way, Schaffer throws an interesting light on the formation of a colonial science in the British Empire.

Friedrich Steinle's and Moritz Epple's contributions seek to provide an analysis of cultural elements in the generation of experimental and mathematical knowledge, respectively. Steinle's account of explorative inquiries into the nature of electricity at the beginning of the 18th century, and in particular in the work of Charles Dufay, points to the essential role of initial concept formation when making an inroad into a new field of experimental inquiry. Here concept formation is found to be a creative activity, and indeed first and foremost a creation of new language (rather than a refinement of long-standing ideas) that makes it possible to express things differently than before and thus may completely reorder the cosmos that the experimenters see. This linguistic and conceptual creativity participating in the genesis of facts makes the scientist similar to a poet or writer; both change not merely our language but also what it can be used to express and explore.

From a broader perspective, Moritz Epple's essay aims at determining certain patterns in which the production of knowledge may be linked with extra-scientific cultural activities. He argues that while sophisticated histories of experimentation have exhibited such patterns in many interesting cases, room still exists for pursuing a similar analysis in histories of mathematical research practice. Just like experimental practices, research practices in this scientific field draw on a wide variety of resources, they condense in mathematical ways of life, and they experience what Rheinberger has termed 'conjunctures', indeed conjunctures with episodes of cultural activities far beyond mathematics.

The papers of Lorraine Daston, Sven Dierig and Norton Wise, in turn, engage with the aesthetic dimension of research practices, another area in which it turns out to be impossible to separate scientific practice from its cultural embedding. Discussing the travels, visions and research practices of Alexander von Humboldt, Daston shows how a new image of nature became possible on the basis a tightly-knit fabric of cooperation between researchers and travellers, observation skills, means of transport and communication, and by integrating an aesthetic model of the perception of nature with strategies of exact measuring and detailed description. A key role is played here by Humboldt's vision of combining an attention

to local variation with the idea of universal laws, and indeed of doing so for both nature and culture. Consequently, Humboldt's integrated *cosmos* required a corresponding integration of practices in which 'scientific' and 'cultural' aspects became inseparable.

Another ideal that linked aesthetics, humanist *Bildung* in Wilhelm v. Humboldt's sense and scientific research was Emil du Bois-Reymond's programme of *Bildung durch Wissenschaft*, located by Sven Dierig in du Bois-Reymond's practice of experimentation. Rather than a creative, aesthetic view of nature, in this programme the beauties of an artistically arranged experiment and the aesthetic experiences it allowed were intended to educate the subject. Dierig interprets Du Bois-Reymond's series of plates that show a youthful Apollo while performing experiments, as *'Bildungsbilder'*, because these drawings offer a corrective of Wilhelm v. Humboldt's one-sided humanist outlook by bringing to the fore the education of the senses and of the body in scientific experimentation.

Norton Wise takes up another facet of the topics addressed by Daston and Dierig. His paper analyses a bourgeois fashion of the 1830's and 1840's that ran through art, architecture and, so Wise claims, in the end science: the art of drawing curved lines. Noting occasional earlier instances, Wise still sees in this fashion the reason for a significant surge in the use of a technique that became widespread in all areas of mathematics and mathematised science, the technique of representing processes of nature or of society by means of curve diagrams. Once again, Emil Du Bois-Reymond is the crucial actor, and once again the scientific and bourgeois culture of early 19th century Berlin provides the setting in which this fashionable link could be forged. Wise's essay leads us to a wealth of paintings and drawings, pointing out that these cultural practices obviously informed the cognitive practices of arranging scientific knowledge.

The second part of our volume is opened by Hans-Jörg Rheinberger's survey of his analysis of experimental systems in molecular biology. Viewing the experimental systems of mid-20th century biological research as particular forms of what Paul Rabinow has termed 'assemblages', i.e., constellations of actors, things and institutions that allow certain things to happen (and at times in unexpected ways), Rheinberger draws attention to the extraordinarily contingent and involved processes in which objects of scientific research and experimental techniques as well as laboratory set-ups co-evolve. Of particular importance in the context of this volume is Rheinberger's emphasis on the open boundaries of laboratory research – on the technical level, elements from other experimental and technological domains were integrated including those related to warfare, while on the practical level, scientific activity appears as a 'practice of art', and on a moral or political level, motivations from medical policies were incorporated as well as visions of a reshaping of the living organism – including the human one. Comparing this analysis with the contributions in the first part of our volume the reader will find that many strands in the discussions of early modern and 19th century scientific practices are again found in those of the 20th century, a century, however, in which the consequences of any social activity – including scientific activity – could have repercussions on human life on an unprecedented scale.

The possibility of these repercussions was also felt where 20th century scientists engaged with the epistemology and historiography of their disciplines, acknowledging in various forms and in different social and scientific circumstances that scientific research needs to be understood as a changing *assemblage*. From this perspective, Claus Zittel and Mary Jo Nye

discuss some of the most influential theories of the cultural and social production of scientific knowledge and try to show how these theories themselves were both anchored in, and the bearers of, political implications for the convoluted history of the age of extremes. Claus Zittel makes clear how Fleck's theory of thought styles and thought collectives is marked by an inner tension between the relativistic connotations of his account of the social genesis of scientific knowledge – and 'facts' – in situated, collective practices of research and communication on the one hand, and his overarching programme of a comparative, scientific analysis of thought styles on the other. The tendency toward the latter, moving more and more to the foreground of Fleck's epistemological writings in the mid-1930's, clearly has political overtones resonating with a universalism of knowledge that went against some of the more fanatic relativisms of those years.

Similarly, by sketching the social and cultural landscapes in which Karl Popper, Michael Polanyi and Thomas S. Kuhn turned to the history and epistemology of science Mary Jo Nye shows to what extent their endeavours were shaped by political impulses. While for the first two, the experience of emigration and the breakdown of the 'republic of science' (Polanyi) in both National Socialism and Stalinism provided a strong motive for engaging with epistemology, the latter turned to the history of science in the context of post-war general education in the US. It will remain a task for future meta-historians of science to determine the degree in which all these major contributions to our field remained under the spell of the social, cultural and political contexts in which they emerged.

The last two contributions move very close to our present. Both Evelyn Fox Keller and Dominique Pestre try to investigate mutual dependencies of recent developments in the sciences and in social and political life. Looking at the increasing cooperation between physical, biological and engineering sciences, Fox Keller discusses how seemingly reliable and long-standing boundaries such as that between machines and organisms, artificial and natural bodies are gradually given up – not just given up as the simple popular catchwords by which they have long been identified, but right in the involved technical debates of recent research on complex structures and (self-)organization. If she is right, then we are led to a similar point to that in Rheinberger's account of molecular biology – what will, in some not very distant future, be called 'life' or 'human life' may well depend on the strategies and technologies available to scientists and engineers investigating and engineering them.

Dominique Pestre raises the question whether such developments – tied in with hybrid, large scale institutional networks of technoscientific research – mark the advent of a new 'regime of knowledge production'. And – he reflects – would it not be necessary to conceive of perspectives of democratic control, of open access and the pursuit of sensible alternatives (including small scale, distributed research) in our buzzing world of scientific research?

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Catherine Wilson

Some Motives and Incentives to the Study of Natural Philosophy

Robert Boyle's thoughtfulness and insightfulness as a metaphysician and epistemologist, as well as a natural philosopher, are increasingly recognized. Many ideas supposedly original with Locke – the doctrine of primary and secondary qualities, nominal and real essences, concepts made by the mind, the bounds of knowledge and about personal identity, are derived from his reading of and sometimes his reaction to, Boyle. Boyle's own moral and philosophical writings are concerned to a large extent with Epicureanism, the ancient philosophy of materialistic atheism, and Epicurism – the dedication to sensory pleasure. References to the philosophy and to the mode of life associated with it appear in virtually every one of Boyle's essays.[1]

Both Epicureanism and Epicurism were topics of some ambivalence where Boyle was concerned. For Boyle subscribed – in a highly qualified way to be sure – to the corpuscularian or mechanical philosophy of Epicurus and Lucretius, and his earlier writings reveal him as a kind of aesthete – though often a self-censoring and even censorious one – *avant la lettre*. To reconcile his scruples with his attractions to both Epicureanism and Epicurism, Boyle invented and commended to his readers the figure of the Christian Virtuoso, and he endowed the Boyle Lectures to confute atheists and libertines. The creation of this model figure, and the subsequent defense of the corpuscularian or mechanical philosophy as intellectually more supportive of the Christian religion than scholastic philosophy, helped to secure legitimacy for the somewhat insecure enterprises of the early Royal Society.

The recovery and interpretation of some of Boyle's many lost and suppressed manuscripts confirms the suggestion that the Christian Virtuoso is an imaginary figure created for a purpose, regardless of the tendency to identify the Christian Virtuoso simplistically with Boyle himself. Michael Hunter – no friend to conspiracy theories – maintains that Oldenburg, Glanvill, Burnett, and Birch contrived an image of Boyle as "a paragon of civility and moderation with a clear and unproblematic strategy for the vindication of a mechanistic view of nature by profuse experimentation, and an accompanying combination of deep piety [...]" (Hunter 2000: 8). Boyle was, Hunter suggests, more "mixed-up" than this, – though in a way that leaves our respect for his intelligence and moral qualities unimpaired. This paper will explore the more and less successful features of this construction in the hope of shedding slight on the larger issue of the revival of Epicureanism and Epicurism in a Christian culture in which Augustinian renunciation of the world remained a powerful motive.

Epicureanism was already recognized as a powerful intellectual force and extensively condemned by Edward Stillingfleet in his *Origines Sacrae* of 1662. "That which makes the most noise in the world [...] is," he says, "the Atomical or Epicurean Hypothesis" (Stil-

1 See (MacIntosh 1991).

lingfleet 1662: 282), and he refers suspiciously to "modern philosophers" as its exponent and to the "late sedulous Vindicator" (Hobbes) of the despised philosophy. Boyle's own concerns were engaged at several levels. First, he was troubled by his adoption of a corpuscularian *ontology* associated with atheism and libertinage. Second, Boyle was troubled by the naturalist's evaluation of the material objects of this world as *worthy* of sustained attention and the utilitarian, this-world focus of the experimental philosophy. Third, he was bothered by the discrepancy between the standards of *evidence* employed in the theological realm and those employed in the experimental realm.

1. Corpuscles, Laws of Nature, and Divinity

According to the Epicureans, matter and void had existed from all eternity, *cosmoi* came into being spontaneously and perished, and animals and men alike had material and perishable souls composed of especially fine and mobile atoms. There was no supervisory Providence or creative and directive intelligence in control of the universe. The atheistic atomism of Epicurus and Lucretius was decisively recast by Pierre Gassendi into a theomechanical system that preserved the atomists' ontology and their insistence that the entanglement, motion, and interaction of invisible corpuscles was the basis of all phenomena, while rejecting their denial of divine creation, providence, and the immortality of the human soul. Gassendi adopted the doctrine of atoms but added to it a God, divine creation *ex nihilo*, a system of laws of nature ordained by God, and an incorporeal immortal human soul above and beyond a corporeal animal soul.[2] This theomechanical system, another version of which was presented by Gassendi's rival René Descartes in his *Principles of Philosophy*, was absorbed by Boyle,[3] and is articulated in his more programmatic writings:

> "I plead onely [...] for such a Philosophy as reaches but to things purely Corporeal, and distinguishing between the first original of things, and the subsequent course of Nature, teaches [...] not onely that God gave Motion to Matter, but that in the beginning He so guided the various Motions of the parts of it, as to contrive them into the World. [...] (furnished with the Seminal Principles and Structures or Models of Living Creatures,) and established those Rules of Motion, and that order among things Corporeal, which we are wont to call the Laws of Nature [...]; the Phaenomena of the World thus constituted, are Physically produc'd by the Mechanical affections of the parts of Matter, and [...] operate upon one another according to Mechanical Laws" (Boyle 1674: 104).

Boyle thus evaded Stillingfleet's blanket condemnation[4] of atomistic mechanism and insisted repeatedly that it implied the existence and activity of a God "[A] Machine so Immense, so Beautiful, so well-contrived, and, in a word, so Admirable as the World cannot

2 See, on his substantial emendations (Johnson 2003); also (Osler 2003).

3 Through the mediation of Walter Charleton, whose *Physiologia Epicuro-Gassendo-Charletoniana* appeared in 1654. See (Kargon 1964).

4 "We must wholly alter the present stage of the world, and crumble the whole Universe into little Particles; we must grind the Sun to Powder, and by a new way of Internment turn the earth into Dust and Ashes, before we can so much as imagine how the World could be framed" (Stillingfleet 1662: 238).

have been the effect of mere Chance, or Tumultuous Justlings and Fortuitous Concourse of Atoms, but must have been produced by a Cause exceedingly Powerful, Wise, and Beneficent" (Boyle 1690: 299-300). "God," he said, anticipating the accusation of deism, "hath not Abandoned a Masterpiece so worthy of him, but does still Maintain and Preserve it" (Boyle 1690: 300). Boyle termed his theory of nature 'Anaxagorean' to distinguish it from classical atomism and also from the Cartesian version, which, though it introduced God as the cause and maintainer of corpuscular motions, nevertheless held that the cosmos, and plant and animal life, had emerged spontaneously.[5] According to the doctrine of Anaxagorean mechanism, the frame of the world, and its original plants and animals, or at least their "seeds or seminal principles," had been intelligently and beneficently designed and created, though thereafter, the laws of motion, the structure of objects, and the dispositions of seeds sufficed for the production of all, or almost all effects.[6]

This Anaxagorean system, one might think, reconciled religion and natural philosophy easily, provided one accepted the notion that the laws of nature could in some sense be prescribed to and obeyed by inanimate particles, and provided one was not troubled by the paradoxes of division and composition which militated against material atoms and the void. Yet Boyle was often troubled by his adoption of large parts of a pagan and aggressively anti-theistic system. He believed himself to be living in an exceptionally dissolute age, and he considered the neo-Epicurean threat to religion and morals more serious and less easily defended against than other atheistic and mortalist versions of Aristotelianism and pagan naturalism, such as those represented by Pomponazzi and Vanini. "Libertines," he says, "own themselves to be so upon the account of the *Epicurean* or other *Mechanical Principles of Philosophy*" (Boyle 1675a: 237), and they fail to pay due regard to Aristotle, Scotus, Aquinas and Augustine. He complained of being taken for an Epicurean himself (Boyle 1663: 354). Yet one cannot say Boyle shows much deference to Aristotle or to his scholastic followers. By contrast, there are over one hundred references to Epicurus and Lucretius and quotations of the latter in his writings. If Boyle was sincere in maintaining that he had read little of Lucretius and lacked conversancy with Epicureanism in 1663,[7] he made up for his neglect later.

Two points relentlessly driven home by Lucretius are that the gods – who are conceived as happy immortals existing in the intermundial spaces between *cosmoi* – do not concern themselves with affairs on our earth and that fear of the gods is an oppressive and needless burden. They cannot help us and they cannot harm us either. This view was at odds with the Christian commitment to divine and demonic intervention in historical processes and personal life. According to Boyle's account of his religious history, he had been roused as a boy from religious indifference by a terrifying thunderstorm (Boyle 1744a: 12), and he thereafter perceived the saving intervention of God in several astonishing escapes, when he was nearly killed by horses, collapsing bedroom walls, and poisoned by a careless apothecary.

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5 The term 'Anaxagorean' appears in the suppressed or discarded sections of the *Inquiry into the Received Notion of Nature*, HD 14:148.

6 On Boyle's theory of generation, see (Anstey 2002).

7 "If you knew how little Conversant I have been with Epicurean authors," says the Boylean chemist to his interlocutor, and "how great a part of Lucretius himself I have not yet had the curiosity to read, you would be free of this suspicion" (Boyle 1663: 354).

"*Philaretus*," Boyle says, "would not ascribe any of these rescues unto chance, but would be still industrious to perceive the hand of heaven in all these accidents; and he indeed would profess, that in the passages of his life, he had observed so gracious and so peculiar a conduct of providence, that he should be equally blind and ungrateful, should he not both discern and acknowledge it" (Boyle 1744a: 8).

All his life, however, Boyle was troubled by religious doubts. He read many pagan authors, including Seneca, whom he admired.[8] And when the young Boyle visited a Carthusian monastery in the wild mountains near Grenoble, he was nearly driven to suicide by brooding on the fate of St. Bruno.[9] After months of "tedious perplexity," God restored "the withdrawn sense of his favour," and Boyle came to see "these impious suggestions, rather as temptations to be suppressed, than doubts to be resolved; yet never after did these fleeting clouds cease now and then to darken the clearest serenity of his quiet." They were he says, like a toothache – very troublesome, though not fatal. But they were chronic, "a disease to his faith" (Boyle 1744: 12). Hunter has provided transcripts of Boyle's end of life confessions to Gilbert Burnet, Bishop of Salisbury, in which he refers to the "Impious or Blasphemous Suggestions or Injections," which Burnet reassured him were "mere Effects of Distempers of the Body or the Brain [...] Mechanical Effects" (Hunter 2000: 90). To be sure such doubts can be construed as tests of faith for a convinced Christian, or as temporary derangements. Yet in a true condition of doubt, the doubter must necessarily wonder whether he is only suffering from a distemper or being provoked by a demon, or whether his doubt has arisen from a veridical glimpse of things as they are – the *rerum natura*, for example, as described by Lucretius, in which the religious imaginary is a source of needless torment. When a clerical career was proposed to him at the age of thirty-three, he realized that he was not called by the Holy Ghost.[10]

In his tract on "The Christian Virtuoso," Boyle explains that an experimental philosopher is not "a libertine, though ingenious, a sensualist, though curious," or a mere empiric or a "vulgar chemist." His engagement with the material world leads his mind to higher things:

> "[T]he study of the creatures may justly produce in a *virtuoso*, 1st, a profound *admiration* of the majesty, and some of the attributes of God. Secondly, An external *celebration* of him, for them, by hymns and praises. Thirdly, a deep *humility* in the view of his immense greatness and majesty, and the distance of our nature, as we are human creatures, from his gratitude and trust follow" (Boyle 1744b: 481).

But Boyle was concerned to distinguish the physico-theology of the Christian from that of the pagan nature-worshipper. In his famous treatise on the human body, Galen combined detailed descriptions of the functions and uses of its parts with praise for the skill, wisdom, economy, and foresight of the designing intelligence behind them. Galen sometimes directed

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8 Seneca insists in his *Questiones Naturales* than thunderstorms have no theological significance and are naturally caused.

9 "[T]he devil taking advantage of that deep raving melancholy, so sad a place, his humour and the strange stories and pictures he found there of Bruno, the father of that order, suggested such strange and hideous thoughts, and such distracting doubts of some of the fundamentals of Christianity, that, though his looks did little betray his thoughts, nothing but the forbiddenness of self-dispatch hindered his acting it" (Boyle 1744: 12).

10 (Boyle 1744a: 37).

his worshipful attitude to "the Creator," but more usually to "Nature," whom he apotheosized, as Boyle was fully aware, as a goddess.[11] This worship of divine or semi-divine "Natura," the "filia Dei, semper [...] actuosa," as Comenius calls her,[12] was easily amalgamated with the Venusian paratheology of Lucretius, who, without suggesting that the goddess Venus controls or constructs things out of atoms, nevertheless presents her as a principle of life and renewal (Lucretius 1992: I 1-9; 225-238). Boyle's purpose in writing his *Free Inquiry into the Received Notion of Nature* had been to show that such pagan nature-worship was to be disdained as idolatrous nonsense (Boyle 2000: vol. 14, 446-447), and the Christian Virtuoso makes this point in a positive way.

However, Boyle still needed to provide reasons for accepting the Christian message of the Fall of Man, the Redemption of the World through Christ's martyrdom, and the existence of Heaven and Hell. For reasons to be discussed below, Boyle could not endorse a religion that did not posit an afterlife or recognize what he called "intermeddlings" of the deity with the corporeal world. The revisions of Anaxagorean mechanism were of no help in this task. His ontology had to be carefully fabricated to accommodate these possibilities, and his epistemology enlarged beyond the plain experimental method. There were really three worlds, Boyle decided. Besides the corporeal world, and the present state of things, consisting of "objects proportioned to our unassisted sight," there was a "dioptrical world [...] which consists of all those creatures, that lay concealed, in former ages, from mortal eyes, and are not now discovered, without dioptrical glasses," and also a spiritual world of "good angels, and other intelligent beings, as devils, and separate human minds, that have either no bodies, or none that we can see" (Boyle 1744b: 502). How this world was to be accessed, and how far it could be accessed, without flying in the face of sense and reason – for Boyle disdained fideism – was a problem he addressed in many of his essays, with the results summarized in Section III below.

2. Pleasure and the Material World

Thomas Birch explained Boyle's choice of an occupation as motivated by his desire to divert the upper classes from their customary pursuits and to improve them and the nation:

> "He set himself to phylosophise, and to persuade the nobility and gentry of the nation, who had the means and leisure to pursue such sorts of studies, to follow his example. He was convinced, that it would be of inestimable use to mankind to engage them in these enquiries; it would divert them from those impertinent and criminal amusements, with which most of them busied themselves, and would make them not only better Christians, but likewise more useful members of society" (Birch 1744: 33).

Other studies such as Hooykaas's, have emphasized the physico-theological over the moral and socially altruistic motive (Hooykaas 1997). But the motives and incentives that led

11 (Galen 1968). See for example I: 274.

12 (Comenius 1657: 449). Under the heading "What is Nature?" Comenius lists 14 axioms about nature's ways of acting.

Boyle to adopt the experimental life were far more personal and circumstantial than his rationales. The experimental life was, first and foremost, a source of pleasure for him, relatively free of the guilt and distaste that attached to other sources of pleasure. Relatively free – because Boyle, always a moralist, experienced periods of self-doubt and ambivalence in which he was inclined to trivialize his beloved occupation.

The young Boyle was a tender youth with a rich and romantic imagination.[13] His account of his childhood is a surprisingly unguarded account of his experiences of being indulged by his elders, and of gustatory pleasures, and temptations. One of his first memories is of eating half a score of plums. Little Boyle was given balls and tops, fruits and sweetmeats, instructed in an "affable, kind and gentle way," and cajoled into love of study by Mr. Harrison. "He would often as it were cloy him with fruit and sweetmeats, and those little dainties, that age is greedy of [...] He would sometimes give him unasked play-days and oft bestow on him such balls, and tops, and other implements of idleness [...]" (Boyle 1744a: 8). But Boyle always understood the importance of moderation and self-control. He tells a number of stories in which, when Philaretus, the young lover of virtue, is faced with some delicious but wrong prospect, his inner self-restraint triumphs.

> "During his stay at Stalbridge all [one] summer, his father, to oblige him to be temperate, by freely giving him the opportunity to be otherwise, trusted him with the keys of all his gardens and orchards. And indeed Philaretus was very little given to greediness, either in fruits or sweetmeats; in the latter he was almost abstemious, and in the former, he was very moderate: so valuing such niceties and dainties, that although he enjoyed them with delight, he could want them without the least regret" (Boyle 1744a: 10).

His ascetic tendencies again came into play when the sweetmeats of adolescence dangled before him. "[T]hough his boiling youth did often very earnestly solicit to be employed in those culpable delights, that are usual in, and seem so proper for that season; and have repentance adjourned till old age; yet did its importunities ever meet with denials" (Boyle 1744a: 12). He visited brothels – and brothel imagery reappears in his later writings – but remained aloof.

"As a young man," John Clay remarks, "Boyle started avoiding things." He became more "choosy, fastidious, and pernickety" (Clay 1999: 288). As he approached maturity, he began to write clever, misanthropic satires on foppishness, gaming, flirtation, and the vain and foolish boasting of aristocrats.[14] The *Occasional Reflections* are concerned with pleasure and its regulation, and the sweetmeats theme again appears in an entry on "Sweetmeats offer'd him after a Banquet." As the surfeit of sweets nearly turns his stomach, he decides to "use them, that they shall be ever Noveltys to me; & so, tho' Sensualists enjoy more Pleasure (then I) yet Ile enjoy the Greater, & make amends for their Discontinuance with the Freshnes of my Delihts" (Boyle 1664b: 116). Boyle also expressed scruples against the vivi-

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13 The pioneering research on this subject was that of (Oster 1993); but see also John T. Harwood's introduction to The Early Essays on Ethics of Robert Boyle, Carbondale IL, Southern Illinois University Press, 1991; and (Principe 1994). An entire issue of the *British Journal for the History of Science* 32 (1999) is devoted to the topic of Boyle and psychoanalysis.

14 (Boyle 2000: vol. 13, 141-145); see also (Hunter 1994: 88).

section of animals, though his practice was later at variance with his declarations (Oster 1989; MacIntosh 1996). His tracts against face-painting and décolletage – Oster refers in this connection to a "theatrical imagination that enacts a polarized view of virtue and vice"[15] – suggest that exaggerated femininity was extremely aversive (Oster 1993: 200 ff.), but the homosexual aggression that he experienced in an episode from his childhood was also recollected with a shudder. The common element in these pleadings is heightened sensitivity. Too much visual and emotional stimulation was experienced as deeply unpleasant, and Boyle even ascribed a delicacy and acuity of the senses to dogs and apes (MacIntosh 1996: 447) in a way that is seemingly unparalleled in 17th century philosophy.

Boyle was scholarly. His meditation on "Scaping into his Study out of a Crowd of extraordinarily vaine Company of both Sexes" to the works of Heraclitus, Democritus, Plato, Hermes, Zeno and other ancient writers hinted at a literary career, and indeed Boyle's career turned out to be largely literary. But he needed a via tertia between the "world" – tiresome visits and parties, love affairs, debauchery, idleness, hunting, gambling, swearing, and politics, all of which he despised, or which bored him – and theology, and the study of nature provided it. "The other humane studies I apply myself to," he reported of his time in Stalbridge in 1646-1647, in addition to ethics, "are natural philosophy, the mechanics, and husbandry, according to the principles of our new philosophical college, that values no knowledge, but as it hath a tendency to use" (Boyle 1744: vol. 1, 20). At the age of twenty-two, he set up a laboratory, and reported to his sister that he was now happy:

> "*Vulcan* has so transported and bewitched me, that as the delights I taste in it, make me fancy my laboratory a kind of Elysium, so, as if the threshold of it possessed the quality the poets ascribe to *Lethe* [...] before their entrance into those seats of bliss, and there forgot my Standish and my books" (Boyle 1744a: 27).

Boyle's involvement with Hartlib's group in London and with Wilkins' in Oxford offered a "scape" from ordinary social life and at the same time for conviviality with like-minded persons. He found the members of the Invisible College very impressive, describing them as

> "men of so capacious and searching spirits, that school-philosophy is but the lowest region of their knowledge; and yet, though ambitious to lead the way to any generous design, of so humble and teachable a genius, as they disdain not to be directed to the meanest, so he can but plead reason for his opinion; persons that endeavour to put narrow-mindedness out of their countenance, by the practice of so extensive a charity, that it reaches unto everything called man, and nothing less than an universall good-will can content it. And indeed they are so apprehensive of the want of good employment, that they take the whole body of mankind for their care" (Boyle 1646-1647: 20).

Malcolm Oster, the first historian to try to construct an account of the young Boyle's motives and incentives to natural philosophy has called attention to the importance of this social incentive for Boyle, participation in a friendly group of men. Though Brett Kahr suggests that "one might surmise that [Boyle] felt safe in the predominantly nonhuman envi-

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15 (Oster 1993: 180). The texts are printed as "Letter to Lady Drury" Feb 12 1647 in HD 13:564 and in the following letter on breast-feeding.

ronment of the laboratory" (Kahr 1999: 280), the presence of helpful assistants made it a human environment of a co-operative and often pleasant kind. And the suggestion that scientific pursuits are a substitute for and equivalent to conventional amorous exploits had in any case been laid out very elegantly in Walter Charleton's dialogue on the Epicurean thesis of the mortality of the soul. "Athanasius," the author of an unpopular treatise in natural philosophy corresponding to Charleton's *Physiologia Epicuro-Gassendiana* recalls to the friend of his youth "Lucretius" (John Evelyn) "our ancient Caresses in the days of youth, innocence, and peace." "Since that day I first ventured abroad in to the World," he continues, "I have had no Mistress that held any considerable room in my thoughts but One, and that the very same I have observed you to court with the strongest desires imaginable [...] Her, upon whom women usually transfer the blame for all their imperfections, Nature." "Lucretius" agrees that, although conscious of the vast difference between himself and Nature and his inability to satisfy his desire in the knowledge of the least part of her, still

> "I discover such an infinite variety of fresh beauties and excellencies in her every day, that but to gaze upon them at a distance and view her in the weak and pale reflection made in the glasse of my own Reason, I find the most pleasant and ravishing employment."[16]

Boyle's early moral treatise, the *Aretology*, had not been well-received, dashing his hopes of becoming a major ethical writer. Chemistry enabled Boyle to brush off this disappointment and to forget about the dissonance between his Christian ideals and the behaviour of his social set.[17] It further offered pleasure in producing and experiencing, without the depressing side effects of vulgar hedonism.

Boyle's Epicurist leanings were already evident in his *Aretology* in which he opposed the Platonic doctrine that all pleasure is evil. The Garden of Eden, the original Paradise, he points out, was pleasant, and if pleasure were evil, it would have been no punishment to be thrown out of it. God has "seasoned and as it were sweetened all the Necessary actions of our life with certain pleasures."[18] His hedonism is evident in his *Experiments and Considerations Touching Colours* (1664), written, he says, "to divert and recreate, as well as to excite [...] by the delivery of matters of fact [...]" assisted by experiments that are easy and delightful (Boyle 1664a: 25). The colour essay is a recitation of beautiful experiences and productions, beginning with a description of the glorious colours appearing to persons in a fever or about to suffer a stroke, and lovingly going on to describe the whiteness of beaten eggs, the green of leaves and emeralds, the nap of cornfields and peafields, the colour of heated steel as it changes from yellow, to red, to blue, and the glass that when held at various angles alters from gold to a pale blue or turquoise. There are "experiments" with the juice of blackberries, cochineal and cherries, and the revival of the colour of dried rose leaves fixed with oil of sulphur.

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16 (Charleton 1657: 3-4). In the *Excellency of Theology*, Boyle refers to natural philosophy as a "Mistris," and to the Virtuoso as "(if not a Passionate) an Assiduous Courter of Nature."

17 On this phase of his life, see (Maddison 1963); (Shapin 1993).

18 *Aretology* in (Harwood 1991: 30). Boyle explored the themes of sensibility, folie d'amour, and sex slavery in the remarkable letter he composed as a personal exercise to Joseph from Potiphar's Wife, and in the early suppressed version of *The Martyrdom of Theodora*.

The world of the chemist is a painted and scented world of graceful and protean forms, very unlike the sub-dioptrical world of atoms, possessed of bulk, figure, and motion alone, that characterized Boyle's official ontology. In his reflections "Upon the sight of N.N. making of Syrup of Violets," Boyle reflects that one might suppose N.N. a very great "Friend to *Epicurism.*" His employment seems "wholly design'd to gratifie the senses," as the things "he deals with are Flowers and Sugar" (Boyle 1664b: 148). But regardless of the colour and scent of the one and the sweetness of the other, he is in fact, Boyle insists, making a useful remedy. Flowers, sugar, and sweet-meats – and more generally the colours and textures of things – changeable taffeties, velvet, the blue and golden necks of pigeons, rainbows, little birds and mice – these were the charming components of the experimental life, quite close to the fish, dogs, looking-glasses, clocks, and medicines that Boyle described in his journalistic musings on the trifles of everyday life, the *Occasional Reflections.*

Inevitably, however, guilt attached to these enjoyments. The *Occasional Reflections* often turn to pastoral and natural beauty, but typically in a spirit of self-correction. Describing the paring of an apple ("fresh and lively Vermillion [...] emulation at Rubies themselves [...] the Platonick definition which styles Beauty the *Lustre and Flower of Goodness* [...]"), Boyle reflects that the "gay outside" of the apple is "cut and thrown away" and urges in typical protestant spirit that we "strip and devest [things] of all those flattering Ornaments (or cheating Disguises) which so often conceal or misrepresent their true and genuine nature" (Boyle 1664b: 60-61) – as with the sweetmeats that turned out to be modeled in wax.[19] We must learn to look upon "the curiosest Productions of Nature [...] with a Philosopher's and a Christian's eyes" so that we can gaze on her "bright objects" with pleasure but also turn away our eyes without trouble and disquiet (Boyle 1664b: 60-61). Boyle's appreciation of the conflict between Christian morality and English life was replaced by a more threatening perception of a conflict between Christian theology and the experimental life of involvement not only with small, dirty, and low objects, but with beautiful and transitory ones. This problem had surfaced by 1665 when he composed his paradoxical essay on the *Superiority of Theology over Natural Philosophy.*

Criticism and satire were, meanwhile, severe with regard to the unchristian, frivolous, and self-indulgent character of experiment (Syfret 1950). John Smith, the Cambridge Platonist, maintained in his sermons of the 1640s, that those men who

> "spending themselves about Bodily and Material acts, and conversing only with Sensible things; [...] are apt to acquire such deep Stamps of Material phantasms to themselves, that they cannot imagine their own Being to be any other than Material and Divisible, though of a fine Aetheriall nature: which kind of conceit [...] hath too much prevalencie in Philosophers themselves, their minds not being fully abstracted while they have contemplated the highest Being of all" (Smith 1660: 65).

Thomas Browne's *Religio Medici* (1643) was written to defend doctors from the charge of atheism, but did not defeat the notion that persons who engage too much with the material

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19 (Boyle 1664b: 169). Cf. Bach: "The nature of loathsome sins/Is indeed from outside very beautiful/ But you must/Afterwards with sorrow and frustration/Experience much hardship/ From outside it is gold/But if you want to look more closely/It is shown to be only an empty shadow/And whitewashed tomb [...]" Cantata BWV 54 "Widerstehe doch der Sünde."

world as experimentalists come to attach too much respect to the powers of material things. Kenelm Digby pounced on the book on its first appearance:

> "[It cannot] be expected that an excellent Physitian whose fancy is always fraught with the materiall drugs that hee prescribeth his *Apothecary* to compound his Medicines [...] and whose hands are inured to the cutting up, & eies to the inspection of anatomised bodies; should easily, and with successe, flye his thoughts at so towring a *Game,* as a pure intellect, a Separated and unbodyed Soule" (Digby 1643: A7).

Robert South, the prolific and irascible Canon of Christ Church, and Orator of the University of Oxford, in sermons of the 1660s and 1670s described the Royal Society as "sons of Epicurus, both for Voluptuousness and Irreligion."[20] Though Hobbes was in fact excluded from the Royal Society, South saw it as a hotbed of "Hobbism." He availed himself of the religious contrast between knowledge and love of God and the knowledge and love of World: "although there is vanity, a sorrow and dissatisfaction in the knowledge of created, inferior objects, yet we are assured it is life eternal to know God" (Syfret 1950b: 244). In 1669, Meric Casaubon wrote against experimental philosophy as "very destructive to true Religion and Christianity." "High curiosities" such as human flight, the possibility of which had been proposed by John Wilkins in 1638, may be dangerous and the mind is distracted from higher and nobler entities and mysteries.

> "Men that are very much fixed upon matter and secondary causes and sensual objects, if great care not be taken, may in time [...] and by degrees, forget that there be such things in the world as Spirits, substances really existing and of great power, though not visible and palpable by their nature, forget, I say, and consequently discredit supernatural operations: and at last, that there is a God and that their souls are immortal" (Causabon 1669: 30).

Man, Casaubon said, has a soul as well as a body, and we do not live by bread – the promotion of works and trades alone – but need those studies conducive to virtue and holiness. The reading of histories is "better than attending on furnaces or raking into the entrails of men or beasts to find somewhat which it may be will never make them much wiser when they know it nor prove of any great use."

Henry Stubbes's criticism of the Royal Society focused on Thomas Sprat's provocative remark that, where mastering, naming, and looking into the nature of all Creatures were concerned, "This had been the onely Religion if men had continued innocent in Paradise and had not wanted a Redemption" (Sprat 1667: 349). Sprat had insisted in the same breath that there was no just reason "why an *Experimenter* should be prone to deny the essence and properties of *God*, the universal Sovereignty of his *Dominion*, and his providence over the *Creation*" (Sprat 1667: 348). His involvement with material things, he said, does not lead the experimentalist to oppose invisible beings, but on the contrary "puts his thoughts into an excellent good capacity to believe them." Corpuscularianism expands his imagination and leads his thoughts from unseen atoms to unseen angels:

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20 Quoted in (Syfret 1950b: 234).

> "In every work of nature that he handles, he knows that there is not only a gross substance, which presents itself to all mens eies; but an infinite subtilty of parts, which come not into the sharpest sense. So that what the Scripture relates of the Purity of God, of the Spirituality of his Nature, and that of Angels, and the Souls of men, cannot seem incredible to him, when he perceives the numberless particles that move in everymans Blood, and the prodigious streams that continually flow unseen from every Body" (Sprat 1667: 348).

Nevertheless, Stubbe twisted Sprat's meaning to imply that he thought that Adam's fall was a consequence of his deficiency of natural philosophy and his "not minding the cultivation of the Garden and of natural curiosities" (Stubbe 1670: 38-39). Experimentalism and libertinism remained associated in the minds of critics, enhanced by moral disgust with the behaviour of the King and the aristocracy.

All this put Boyle in a state of conflict, but also afforded an opportunity for him to express the moral-religious side of his personality in a defense of his preferred activities. The difficulty was in finding the language and concepts in which to do so. As Karl Figlio acutely remarks, the problem of the ultimate worth – the destructive potential and resource-consuming wastefulness – of experimental science is one we still face, but financial and institutional power and a developed rhetoric of science have strengthened its position. Boyle had to think out his answers for the first time – and virtually alone (Figlio 1999: 314).

One significant way in which Boyle attempted to resolve the problem presented by the personal and hedonistic incentive to natural philosophy was by insisting that his experimental practice was not accompanied by, but actually served to establish the truth of the Anaxagorean system that he presented in his programmatic works. He was not, he maintained, a mere empirick – even an empirick who happened to be a nobleman, but a philosopher attaining to knowledge of the transempirical world through – somehow – the producing of forms and qualities. The changes of colour and form in the glass had somehow shown him the reality underneath the coloured surface of the world, the latent image of the Creation, and through the vagaries of experiment he had somehow detected the institution of a system of laws of nature.

But was experimentation really worthwhile? In the sketch "Of Naturall Philosophie"[21] of 1649-1653 which rehearses the themes of the later *Usefulness of Natural Philosophy* (1671), Boyle cites as rationales for the pursuit of experimentation, the satisfaction of curiosity, the exciting of devotion, and the applications in physic, husbandry, navigation, and in the useful trades – the latter mainly consisting it seems of solvents and paint-additives (Boyle 2000: vol. 6, 472ff.). He reminds himself that the experimental philosopher must not scorn what seems trivial, or expect too much from experiments, or give way to frustration when they fail. When properly conducted, without excessive fondness and hope, this involvement with mistress Nature is legitimate and productive. But the utilitarian rationale for experimental philosophy was not entirely satisfying to Boyle. His essay on the *Excellency of Theology or the Pre-Eminence of the Study of Divinity above that of Natural Philosophy* written in 1665 is ostensibly addressed to a virtuoso inclined to atheism who, closely involved in experimental practice, sees no need for supplementing his studies with the texts of revealed theol-

21 The text is given in (Hunter 2000: 30-31).

ogy. It is tempting to read this essay not as a reflecting a debate Boyle is having with some unidentified Royal Society colleague, but as a debate he is having with himself. In any case, he acknowledges very strong reasons in favour of the opponent's position, yet comes to the conclusion that the experimentalist needs to and can take on more than a minimal religious commitment to the existence of a wise and provident creator. A remarkable feature of this tract is that every reason Boyle gave for practicing experimental philosophy some years earlier is subverted, and felicity is deemed an effect of theological studies, by contrast with experimental philosophy.

The first part of the treatise takes seriously the naturalist's tendency to skepticism and his lack of concern for Christian doctrine. The philosopher who values the study of nature and its canons of evidence will wonder, Boyle agrees, about the warrant for claims concerning supersensible beings and the events and promises recorded in Scripture. Was Christ's sacrifice necessary? Might not God might have remitted all the penalties of sin? Does the soul remain in suspension until judgement day or go immediately to heaven or hell? Will we know one another and see our mistresses, relatives, princes and subjects? Or be annihilated (Boyle 1671: 27-28)?

"Reason is not much to be trusted when she wanders far from Experiments." Boyle had remarked in "Of Naturall Philosophie" (Hunter 2000: 31). He shrewdly notes that Descartes was unconvinced by his own arguments for the immortality of the soul, those cited so favourably by John Smith, for Descartes himself wrote sarcastically to Elizabeth:

> "my knowledge of [eternal life] is far inferiour to that of Monsieur [he means Sir Kenelm] Digby. For, setting aside that which Religion teaches us of it, I confess, that by meer Natural Reason we may indeed make many conjectures to our own advantage, and have fair *Hopes*, but not any Assurance" (Boyle 1671: 24-25).

The Cartesian argument for the incorporeality of the soul, Boyle notes, is telling against Epicureans and atheists who consider the soul to be a modification of the body, but doesn't prove immortality.

> "Meer Reason," Boyle agrees, "cannot inform us what will become of [the soul] in her separate state, whether she will be vitally united to any other kind of Body or Vehicle; and if to some, of what kind that will be, and upon what terms the Union will be made. For possibly she may be united to an unorganiz'd or very imperfectly organiz'd body, wherein she cannot exercise the same Functions she did in her Humane Body."[22]

Just as the soul's incorporeality does not guarantee her immortality, Boyle recognizes, her immortality does not guarantee the possibility of happiness. What if the soul is later installed in a body that only feels pain and cannot move? How can such a soul experience felicity?

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22 (Boyle 1671: 25). For Charleton, as for Stillingfleet, it was not the existence of God, but the immortality of the soul that was the "the grand Base of Religion", the keystone of its arch. "For if the Soul be mortal & subject to utter dissolution with the body: to what purpose doth all Piety and religion serve? What issue can we expect of all our prayers, of all our Adorations, of all our Self-denying acts of obedience, of all our unjust sufferings? Why should we worship God at all? Nay more, why should we consider whether there be a God or no?" (Charleton 1657: 59).

Philosophers from Aristotle to Descartes had maintained that even a disembodied, unsensing soul can be happy because she can always think and contemplate, and those are her most favoured activities. But, says Boyle, men would grow weary of thinking

> "if they received no supply of Objects from without, by Reading, Seeing, or Conversing; and if they also wanted the opportunity of executing their thoughts, by moving the Members of their Bodies, or of imparting them, either by Discoursing, or Writing of Books, or by making of Experiments" (Boyle 1671: 26).

He describes the unfortunate case of a nobleman who was imprisoned for a year in Spain with a diet fitting his station, but without books, light, or company. The prisoner could reminisce and contemplate without interruption but fell a victim to extreme melancholy: his chief impulse was to drink himself into a stupor and fall asleep (Boyle 1671: 26).

Happiness, as proponents of the mechanical philosophy implied or insisted, comes from engagement with material *things* that can be seen, tasted, handled, and from investigating these things and discoursing of them with others. The worry Boyle places in the mouth of the naturalist is a serious one:

> "Among thinking men, whose thoughts run much upon that future state, which they must shortly enter into, but shall never pass out of; there will frequently and naturally arise a distrust, which, though seldom owned, proves oftentimes disquieting enough. For such men are apt to question, how the future condition, which the gospel promises, can afford them so much happiness as it pretends to; since they shall in heaven but contemplate the works of God, and praise him and converse with him; all which they think may, though not immediately be done by men here below, without being happy."

So Boyle suggests that in heaven we must not only meet our relatives and lovers, and converse with God, the saints, and the angels, but also our friends and colleagues. The ordinary naturalist who subscribes to the Epicurean doctrine of universal destruction faces the loss of "the pleasure of his knowledge, by losing those Senses and that World, which are the Instruments and Object of it," as well as facing the threat of eternal misery, while the pious naturalist is not only "freed from the wracking Apprehensions of having his soul reduc'd to a state of Annihilation or cast into Hell [...]" (Boyle 1671: 51) but can look forward to even better working conditions: "Those things, that do here most excite our Desires, and quicken the Curiosity and Industry of our searches, will not onely there Continue, but be Improv'd to a far greater measure of Attractiveness and Influence" (Boyle 1671: 51). We will be free of those interests, and passions, and lusts, that here below impede us in these pursuits. In *Seraphic Love*, Boyle had argued that the Beatific Vision of God would not as was sometimes suspected, bore us with its monotony, but stimulate us with iridescence and sparkle, since it would offer "Variety in further knowledge of the fixed object such as arises from the fixt Beholding of the changing-necks of Doves, or such as we may see in the Diversifie'd Refractions of the same sparkling Diamond" (Boyle 1659: 129).

Part Two of the *Excellency*, however, seems infected by second thoughts. Rather than reinstalling the laboratory in heaven and lending an element of materiality to the beatific vision, Boyle seeks to persuade his imaginary naturalist that the laboratory is not so heavenly.

> "I shall, without Preamble," Boyle says, "begin this Discourse, by considering the Delightfulness of Physicks, as the main thing, that inveigles your Friend, and divers other Virtuosi, from relishing as they ought, and otherwise would, the pleasantness of Theological Discoveries" (Boyle 1674: 55).

The experimental life brings, indeed "sincerer Pleasures, than those the more undiscerning part of Mankind is so fond of," but it is still inferior to a life of devotion and theological study and Boyle now sets out to "weaken the Argument, that is drawn from delightfulness" by showing the inconveniencies of natural philosophy.

The utilitarian argument for experiment and the devotion to the common good that he had cited earlier are considerably discounted in this tract. "The boasted use of Natural Philosophy, by its advancing Trades and Physick," he says, "will still be to serve the Body, which is but the Lodging and Instrument of the Soul" (Boyle 1674: 62). Even if the chemist were to discover a stone capable of transmuting gold, this would not benefit mankind by much; the discovery of the Americas has enriched Spaniards but made many multitudes of men miserable for working in mines (Boyle 1674: 62). Prolongation of life is small in relation to eternity:

> "all the Remedies, and Reliefs, and Pleasures, and Accommodations that Philosophical Improvements can afford a man, will not keep him from the Grave, (which within a few days will make the body of the greatest *Virtuoso* as hideous and loathsome a Carcase, as that of any ordinary man [...])" (Boyle 1674: 64).

The practice is full of frustration, as the naturalist is dependent on "such a variety of mechanick people", as distillers, druggists, smiths turners, &c." He must seek out apparatus, wait upon tradesmen, and repair losses from his own pocket (Boyle 1674: 57). Natural philosophy is not a good way to get fame and reputation either. It is subject to fashion, "wanes and eclipses," vicissitudes and prejudices (Boyle 1674: 85). It is difficult to make new discoveries, hard to be right. The virtuoso is bothered by visits and letters and acquires a bad reputation if he puts people off. It is hard to write books (Boyle 1674: 82-83).

Nevertheless, the choice of the experimental life seems to solve the problem of an innocent and benevolent occupation for humans, diminishing the urgency of the Christian message to repent and reform. That message is more compelling when one is faced with a stark choice between gaming, wenching, and ruthless striving for power and devotional activities. Boyle might have gone down the road evidently traveled by Thomas Sprat, but he did not. Instead, in this context he downgrades the experimental life as useless and uncertain, setting aside both charitable and physico-theological motives, purely in order to correct the view that it is a good and innocent life, one that needs no supplementation through a study of what he will later characterize as the world of bodiless intelligent agents, and the secrets of the future state. The use of the word "mere" is instructive in this respect. Boyle refers repeatedly to "mere Reason" "mere Matter," and to the "merely Corporeal," to "mere Naturalists," and the Phaenomena of "meer Nature." Yet, this downgrading is at the same time an ennobling. In part by seeming to diminish nature and the activities of the naturalist and portraying corporeal nature as supplemented and patterned by spiritual agents and her investigator as necessarily led to appreciate the mysteries of theology, Boyle conferred dignity and worth on these objects and roles.

In the second part of the *Christian Virtuoso*, published in the last years of Boyle's life, the attempt to represent heaven as a superiour form of earth and heavenly intercourse as a superiour form of human sociability are abandoned. Years of trouble with his eyesight and perhaps some degree of social fatigue were perhaps as much responsible as increasing philosophical sophistication. In the future state, "the nature of things corporeal, may be very differing from those that obtain in the present worlds [sic]" and our science may be accordingly useless (Boyle 1744b: 521). God, he says, can give the soul a purely rational form of happiness "though it have no remembrance or knowledge of the world or any corporeal creature." The sweetness of life will have come to seem insipid to it and its former inquiries into nature worthwhile only insofar as they involved "laudable industry" (Boyle 1744b: 521).

3. Evidence and Belief

Boyle insisted that God cannot have made our salvation dependent on our acceptance through faith alone of some manifest irrationality. But he also insisted that we should not reject claims merely because they seem contrary to reason. He also claimed that Scripture contains matters of fact, known by experience and through testimony that carries authority (Boyle 1690: 308-309). This triad of beliefs was not easy to maintain consistently.

For the harmonization of standards of evidence in science and religion, Boyle employed various strategies including concession, ad hominem attacks, prudential reminders, and metaphysical and epistemological arguments. He argued that some doubts were excusable, since the doctrines had not been clearly delivered in Scripture or proved (Boyle 1675a: 284-285), and he charged that Epicurean atheists were biased by their sensuality, lust, and passion (Boyle 1690: 294). He insisted that God can change or neglect to uphold the laws of nature (Boyle 1675a: 251). He pointed out that the dictates of prudence mostly coincide with divine command, and that self-interest might encourage us to require a lower standard of proof when eternal life was at stake (Boyle 1675a: 282-285). He argued that competent testimony can compensate for apparent irrationality; many initially implausible things reported by travellers and experimenters have turned out since to be well grounded in fact (Boyle 1690: 309ff.). He informed readers that the experimental philosophy had revealed many surprising things concerning the magnet, and that instruments like the telescope had revealed much that was previously unknown (Boyle 1675a: 275ff.). He showed that despite powerful objections from Epicureans who believed that the atoms of soul and body dispersed after death, doctrines such as the resurrection were actually supported by observation of plants and animals and experiments involving the redintegration of chemical substances (Boyle 1675b: 305ff).

But since the realm of souls was an incorporeal and invisible world, the experimental method was somewhat difficult to apply to the investigation of the future state, its different corporeal order, and it's possibly nonsensing minds. Boyle tried to turn a minus into a plus: we do not need, he said "anatomical knives, or geometrical globes, or optical telescopes or microscopes, or [...] elaborate instruments" (HD 2000: vol. 8, 305f.) to explore theological questions. But what do we need? Boyle was not very clear on this subject. The experimental life implies the imposition of strict standards for distinguishing competent from the ubiquitous doubtful testimony surrounding it. Hunter rightly points to "the ingenuity Boyle dis-

played in devising and executing trials" (Hunter 1999: 263), but Boyle could not settle on a method for the investigation of incorporeals. As a kind of epistemological last resort he looked for evidence of angelic, demonic and ghostly activity in the world; if these beings were not to be captured and proved in the laboratory, at least their effects might be witnessed outside it.

One might suppose that Boyle's early religion was replaced over time by a more mechanical view of causation and signification, one in which chance might indeed play a role, and particular, as opposed to general providence could not be so easily inferred – or at least not so many instances of particular providence as he had noted in the course of one small person's early life. The dominant position in his *Free Inquiry* resembles the views of Malebranche and Leibniz. The universe is a perfectly working clock, and God does not need to intervene in the ordinary course of nature since he clearly discerns "what would happen in consequence of the Laws by Him establish'd, in all the possible Combinations of Them, and in all the Junctures of Circumstances wherein the Creatures concerned in them may be found" (Boyle 1686: 567). A secondary theme is however that God Himself causes "many Irregularities and Exorbitances" and extends favour and punishment to individuals (Boyle 1686: 518-529). Anyone of a certain age, he remarks sagely in the *Christian Virtuoso*, who has escaped the perils and misfortunes that befall so many, must realize his indebtedness to God "for particular and personal preservations" (Boyle 1744b).

Jan Wojcik has argued that we ought to read Boyle not as a "confident and single-minded advocate both of the corpuscularian philosophy and rational religion," but as a philosopher who expected to keep running up against the limits of knowledge.[23] Boyle's mature position was perhaps that more typically ascribed to Locke, and deriving from Gassendi via Charleton; the powers of human reason do not extend as far as might be thought, either in natural philosophy or in theology, and our best course of action is "nobly attempting to surmount Difficulties that are superable, and wisely submitting [...] to those that our not so" (Boyle 1675c: 159). We cannot fully understand our own minds, and the Book of Nature is, he said, like a Romance – a mystery novel whose "parts have such a connection and relation to one another, and the things we would discover are so darkly or incompletely knowable by those that precede them, that the mind is not satisfied till it come to the end of the Book" (Boyle 1674: 57) – though we cannot in fact do so. In the last pages of *The Christian Virtuoso*, he appears even to approach to the position of Immanuel Kant or even William James in his references to an "extrinsick Motive," meaningful in the present order of things, for belief. The excellence of religion, he says there, consists in the fact that, regardless of the truth-status of its claims, faith and religious contemplation and study make this life agreeable. If, (however implausibly) "all those *great and precious promises* [...] should prove illusory," if he can only set aside his doubts, the experimentalist will "sweeten all his hardships and sufferings in this life."[24]

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23 (Wojcik 1997: 212). Cf. (Boyle 1744b: 475).

24 (Boyle 1744b: 511); see also (Boyle 1675a: 282).

4. Conclusion

The *Christian Virtuoso* followed the pattern of earlier tracts written specifically for the confutation of those given to "Prophane Discourses and Licentious Lives," the "bad men" amongst the Virtuosi, and as a literary scourge to those occupied by "Secular Affairs and Sensual Pleasures" (Boyle 1690: 284-285). Yet Boyle himself was passionately occupied with the secular and sensual things. He insisted that the appreciation of the complexity of natural machines and their beauty was a form of sincere worship, and his discovery of the manifold of qualities producible by his efforts enhanced the naturalist's admiration for God's power, wisdom, and benevolence, though true happiness did not require either sensation or memory – nor life as we know it. The *Christian Virtuoso* constructed by Boyle and presented to the world was at once a reproach to his more light-minded colleagues, the "erring Virtuosi," a figure of the experimental philosopher answering the charge that the experimental philosophy undermined society and morals, and an idealized version of Boyle himself, one free of the doubts and conflicts that are expressed elsewhere in his essays and autobiographical writings. His attempt to reconcile reason and religion, the experimental life with the devotional life, was protracted and intelligent, if not altogether consistent or convincing to the modern eye. He was moreover chronically unable to banish all dangerous ideas from his own mind.

As a young man, Boyle had worried about his tendency to give way to "roving" or "raving,"[25] and it is perhaps significant that his paper on the "Atomicall Philosophy", for all its seemingly innocuous theomechanical content, was amongst the papers Boyle ordered to be destroyed, along with all his papers concerning the romance of Theodora. Boyle wanted to assure us that he was not a friend to Epicureanism – nor to Epicurism. "Corpuscularian Principles," he never tired of insisting, "may not only be admitted *without* Epicurean Errors, but be employ'd *against* them" (Boyle 1675b: 297). Scholasticism, he assured his readers, was closer to pagan naturalism and to materialism than the atomical hypothesis of the moderns. But his own complex reactions to the possibility that Epicurean mortalism was true and to the question of the permissibility of Epicurist sensual enjoyment cannot be read off from his portrayal of the *Christian Virtuoso*, regardless of the degree to which this imaginary figure's beliefs and motives in their certitude, fixity, and purity represented an intellectual and personal ideal to him.

25 (Harwood 1991: xlviii ff.) Cf. ibid.: 192.