

# Beyond Borders

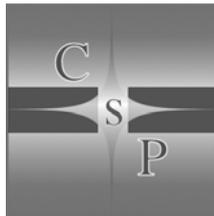


# **Beyond Borders**

## **Fresh Perspectives in History of Science**

Edited by

Josep Simon and Néstor Herran  
with Tayra Lanuza-Navarro, Pedro Ruiz-Castell  
and Ximo Guillem-Llobat



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with Tayra Lanuza-Navarro, Pedro Ruiz-Castell and Ximo Guillem-Llobat

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# INTRODUCTION

JOSEP SIMON AND NÉSTOR HERRAN

In the last fifty years the history of science has experienced a profound renovation in relation to its methods, its subject of study and its place in the map of scientific and humanistic knowledge. These changes, while reinforcing its institutional and disciplinary identity, have also produced an undesired fragmentation. Perception of disciplinary crisis is apparent behind calls for the search of new “big pictures” and their implementation in teaching and communicating the history of science to wider audiences.<sup>1</sup>

From the perspective of scholars entering the discipline, this situation is both a cause for concern and an opportunity. It is a matter of concern because it affects the growth and health of our favourite intellectual subject, as well as its capability to excite wider interest. But it is an opportunity because it allows for critical creativity and fresh intellectual challenges. In this perspective, this book stands as a contribution made by postgraduate students – many of whom have completed their PhDs in the course of its preparation – in their attempt to identify historiographical problems in the course of their research, and to contribute in their own right with potential solutions and fresh perspectives based on their growing historical expertise.

As the reader can infer from an inspection of the table of contents, the collection of papers selected engage with a diversity of subjects and periods, and a wide range of approaches. From studies of astrological texts in the sixteenth century to contextual analysis of X-ray spectroscopy in the twentieth century, the contributions to this volume reflect the rich variety of themes and questions characteristic of our discipline. It has been far from our pretensions to be comprehensive or even uniform in our approach to creating this collection. However, its conception has sought to go beyond a simple harvest of recent contributions to the field. Rather, we aim to create synergies connecting particular case studies to the questions we perceive as the most fertile in reacting to the current major challenges of our discipline.

This introduction provides the background to the papers and essay reviews which are presented in the book. Accordingly, we first highlight

the major problems that, in our opinion, are afflicting history of science and causing its fragmentation. Subsequently, we propose solutions and connect them with the structure, contents and major arguments of the book. As we will explain in the following paragraphs, in our opinion the highest priority involves providing space for international – and also transnational – approaches, privileging well-defined comparative studies and conceptualizing the role of communication in science in a systematic manner.

### **A fragmented and parochial discipline?**

In the last two decades, historians of science, technology and medicine have increasingly expressed their concern over the perceived lack of a well-defined and consistent, over-arching framework in our field. From the late 1980s, scholars from various traditions have communicated their displeasure about the confrontation that philosophers and sociologists of science have caused in the history of science playground. Instead of disputing about whether science is a cognitive or a social fact, they have pleaded for a genuinely historical approach and some reflection on the making of history of science narratives.<sup>2</sup>

In parallel, the debates on how history of science should be written have translated into general agreement about the need for a larger picture in our discipline. This concern is still felt today.<sup>3</sup> The need for a large-scale synthesis arises not only for conceptual reasons, but also for practical motivations in relation to the teaching of history of science in universities, and the role that historians of science could and should play in the “popular science” publishing market. Considering the fragmentation of the discipline by temporal and spatial discontinuity, synthesis, introductory texts and companions are fundamental in defining the place of history of science in society and to shape future research directions undertaken by prospective students.<sup>4</sup> Writing a synthetic account requires the selection of facts and the construction of historiographical themes and arguments, as well as a narrative style and an intended readership. Thus, the intersection of practical necessity and fundamental reflection is a crucible for general historiographical debates.

In the 1990s, John Christie illustrated the forced pragmatism which historians of science had to exploit in defining the reading lists for their courses. A combination of “older big pictures” with more recent “little and middle sized ones” has arguably been the most commonly adopted formula. Furthermore, as one of the editors of the *Companion to the History of Modern Science*,<sup>5</sup> Christie recalled that this reference work was

motivated by the lack of more up-to-date big pictures. At the same time, however, he confessed to the awkward practicalities that such project would have had to face, and admitted the temporal, thematic and conceptual heterogeneity that did finally characterize this reference work.<sup>6</sup> The “Leeds” Companion was presented by its editors as a complement to Charles Gillispie’s *Dictionary of Scientific Biography*. Gillispie – the author of one of the major older big pictures<sup>7</sup> – accepted this characterization and gave it a positive review in *Isis*. The Companion has now been a useful reference work for several generations of students and researchers.<sup>8</sup>

Even so, this epitome of the history of science was also criticized at the time of its publication. José M. López Piñero expressed his profound discontent about the general orientation of works such as the Companion and Gillispie’s Dictionary.<sup>9</sup> López Piñero was a privileged and experienced observer of the development of our discipline. Trained as a historian of medicine in 1960s Germany, he had subsequently played a major role in the articulation of history of science as a professional discipline in Spain.<sup>10</sup> His critique was built on what he considered were two of the major failures in the prevalent historiography of science at that moment: on the one hand, the lack of integration between history of science and history of medicine, and on the other, the loss of international perspective.<sup>11</sup> López Piñero, like Martin Rudwick, Robert Fox and other scholars, had an international training and knew various national historiographies in different languages.<sup>12</sup> This background had convinced him that a major force in the constitution of history of science as an international academic discipline had been the migration and circulation of scholars between Europe and America between the two World Wars.<sup>13</sup>

As an illustrative example of these two historiographical aspects, López Piñero commented on the “discovery” of Ludwik Fleck’s work by the English-reading historian of science. Fleck’s *Entstehung und Entwicklung einer wissenschaftlichen Tatsache* was published in 1935 and translated into English in 1979 with a preface by Thomas S. Kuhn. According to López Piñero, it was a sad episode in the historiography of science that Fleck’s work had been presented simply as an early precursor of Kuhn’s *The Structure of Scientific Revolutions* and of social construction.<sup>14</sup> Fleck’s book had had an important impact in the German-speaking world at the time of its publication, and in the 1960s it was still a recommended text in history of medicine programmes. The loss of internationality and of integration between history of science and history of medicine had led many scholars to ignore the rich historiographical legacy of central European history of medicine – the context for Fleck’s

work – and its international significance for the development of history of science as a discipline.<sup>15</sup> The misrepresentation of Fleck's work was also pinpointed by other scholars at the time, although they did not attempt to investigate its causes, nor did they see in it an illustration of historiographical and professional crisis.<sup>16</sup>

Several decades later, it is fair to say that Fleck's work has found its place in history of science,<sup>17</sup> its intrinsic value has been recognized,<sup>18</sup> and the use of its English translation by historians of science has contributed to produce original historiographical work.<sup>19</sup> However, López Piñero's criticism is still compelling. The lack of integration between history of science and history of medicine can now be seen as a subset of the general problem of specialization that has fragmented our professional context into compartments defined by historical periods and sciences.<sup>20</sup> This fragmentation goes together with a large imbalance in the distribution of historians among periods and subdisciplines.<sup>21</sup> In addition, as recently recalled by Robert Fox,<sup>22</sup> there is also fragmentation based on geography, nation and language. As we shall argue in the following paragraphs, our discipline has increasingly become national and even local in its approaches and writing.

Today, most history of science and medicine theses are, in general, case studies of national character. David Kaiser has recently shown how, from the 1980s, the geographical focus of theses written in North America has become less international and more parochial.<sup>23</sup> If we look at the list of theses written in Britain since 1999, the picture is analogous or even more insular. Three-quarters of all British theses in the history of science and medicine deal strictly with British cases. Most theses on other countries are devoted to Africa and India, in relation to the existing institutional programmes on the history of British colonial medicine, and they are typically undertaken by students born in these areas. Furthermore, the number of theses dealing with more than one national context is very low (less than one tenth). These works typically deal with two national contexts (more than two is rare), where the combination of Britain with France or the USA is the most usual, and they are often undertaken by non-British students.<sup>24</sup> The mononational character of history of science theses is similarly very pronounced in many other European countries.<sup>25</sup>

The turn towards the local has often been associated with greater historiographical sophistication that – in spite of the important concerns raised in this introduction – has benefited the discipline in various ways. This phenomenon is certainly also connected to the importance that archival research has acquired in our field,<sup>26</sup> which tends to be almost unaffected by the rise of online digitization projects.<sup>27</sup> It is a matter of fact

that digitization projects are not equally distributed among different countries due to economical, political and cultural factors, and are, in general, constructed under explicit national agendas. They are usually based around major library collections, thus constrained by the relative cosmopolitanism of their holdings but also by selection criteria that in general prioritize a single language and a national cultural heritage. The rhetorical myth of universalism combined with real cultural parochialism surfaces even in major private initiatives with transnational pretensions such as Google Books, which is, in fact, highly biased towards Anglo-American sources. In this sense, the diversification of the field by integration of other projects such as the digitization programme of the French National Library and its promotion of a European digital library could be a valuable counterweight. Surprisingly, the heated debates on digitization and Google Books taking place in Europe have apparently not aroused much interest in the Anglo-American community of historians of science.<sup>28</sup>

### **Caught in a shrinking cultural web**

If the development of history of medicine and science as a discipline during the first half of the twentieth century was predominantly driven by the work of German, French and Italian-speaking scholars, it is indisputable that in the last few decades the discipline has been led by Anglo-American scholarship.<sup>29</sup> Hence, the American and British national history of science societies have attracted a large number of foreign scholars, and they are arguably the most *international* national societies for this discipline. However, the overnationalization of history of science, while securing a prominent position for American and British culture in history of science, has also contributed to the obscuration of the international character of many historical events. While the loss of internationality affects the discipline everywhere with more or less particular emphasis,<sup>30</sup> solving the problem in the Anglo-American axis is particularly crucial. On the one hand, there is solid evidence for the considerable dimensions of the problem in this academic context. On the other, the Anglo-American contribution to the field is currently the largest and best communicated.<sup>31</sup> For this reason, in this introduction we use the Anglo-American focus as the illustration of an exemplary case.

The turn towards the local, brought on by socio-constructivism,<sup>32</sup> has been pinpointed by scholars with different agendas as one of the main reasons for this state of affairs.<sup>33</sup> As a reaction to positivism, socio-constructivists converted the making of any generalization in a national or

international scale into anathema. In challenging science's universality, the field has moved towards the production of microhistories that, while illuminating the role of social processes in the construction of scientific knowledge in local settings, have also obscured the relevance of macrohistorical explanations.<sup>34</sup> Paradoxically, socio-constructivists, like their predecessors, gave an implicit status of universality to a set of categories, in their case stressing the locality of knowledge.<sup>35</sup> Microhistories have had a longer tradition in our field, in particular in the study of the early modern period. But microhistorical analysis is only useful if integrated with macrohistorical parameters and vice versa. Accuracy and generalization require the connection of narratives of the local with the global through comparative analysis and the study of communication in an international perspective.<sup>36</sup> Indeed, in spite of the rise of nation states, from the nineteenth century onwards international communication and transnational comparison were equally central to scientific activity. Assessing internationality is therefore a task that historians cannot evade.<sup>37</sup>

Dealing with internationality, both as a characteristic of science in certain periods, and – in a reflexive way – of the community of historians of science today, is certainly not an easy task. It requires knowledge of several languages, several national historiographies, and the ability to engage in international projects with foreign colleagues. A recent report requested by the European Union has revealed that 56% of Europeans think they can engage (at conversational level) in other language than their native one. Eighteen countries of a group of twenty nine are above this average. English is the most spoken foreign language (38%). The countries with the lowest rate of multilingualism are Turkey (67%), Ireland (66%), and the UK (62%).<sup>38</sup>

In Britain, the critical role of language skills in research has indeed been stressed by scholars such as Martin Rudwick and institutions such as the British Academy.<sup>39</sup> In 2006, concerned about the inadequacy of language training in secondary schools and its consequences for postgraduate research, the British government appointed two commissioners to investigate and report on this issue. The British Academy endorsed the government commission, stating that research on the humanities and social sciences “is becoming increasingly insular in outlook, because PhD students do not have language skills, or the time to acquire them”.<sup>40</sup> In contrast with the major American postgraduate programmes in history of science, British postgraduate students are in general not required to learn foreign languages. Furthermore, the pressure to publish – especially affecting postgraduate students and young scholars

– also contributes to hinder educational opportunities providing professionals with tools to go beyond mono-linguistic and mono-cultural studies.<sup>41</sup> In addition, despite the process of European construction and the funding projects promoted as a part of it, European historians of science are far behind the transnational initiatives exploited and promoted by professionals in other disciplines. Thus, overall it would be desirable that postgraduate programmes and scholarly journals<sup>42</sup> take care of preparing students for the challenges and opportunities of a future professional life, with the international outlook required by scholarship.

### **Beyond the local: Comparison, communication and appropriation**

In proposing solutions to the problems perceived to afflict history of science, scholars have rather focused on conceptual and historiographical issues. In many cases their proposals have mainly suggested to put the methodology and approaches characterizing their own current work at the very heart of the discipline. For example, Frederic L. Holmes proposed studying individual investigative pathways and integrating them into a network constituting the moving boundaries of a well defined set of research problems within a scientific field. Casper Hakfoort envisaged the possibility of synthesis through an iterative methodology based on the historical investigation of large epistemological categories such as “scientific knowledge” and their change in time. John Christie suggested pragmatism and building around narratives of power. Robert Köhler has considered drawing on the socio-constructivist legacy by using basic categories such as practice, social role, or credibility and trust. David Kaiser has advocated bringing pedagogy to the centre.<sup>43</sup> All of these approaches provide interesting elements in building a successful programme of historiographical renovation. However, in their current form, they perhaps lack a more ambitious and general force.

In dealing with the aforementioned problems, the most ambitious and innovative proposals have been, in our opinion, raised by James Secord, Margaret Jacob and Lewis Pyenson. By raising the idea of science as “Knowledge in Transit”, Secord has seriously suggested an alternative to previous frameworks: the study of practices of communication of knowledge could be used – if consistently problematized – to build narratives potentially useful for a wide range of scholars and contexts.<sup>44</sup> His previous research on literary replication and on the multifarious ways in which scientific knowledge was appropriated through reading in nineteenth-century Britain,<sup>45</sup> and his most recent emphasis on the role of

conversation in nineteenth-century science,<sup>46</sup> provide good examples of how communication practices can constitute central elements of the historical analysis of science.

Secord's proposal considers that making communication central to our analysis and narratives allows for a better understanding of production, circulation and acquisition of scientific knowledge in local and international contexts. Making communication central and moving the focus from origins and production to audiences and uses<sup>47</sup> allows the historian to blur the distinction between the making and the communication of knowledge and helps us to link practices such as science in the laboratory, science in the field, reading and pedagogy.<sup>48</sup> As has recently been argued by Jonathan Topham, this approach can also be fruitful in rethinking the historiography of science popularization.<sup>49</sup> However, as Secord has recognized, his programme would only be effectively boosted through a better defined conceptualization of geographical and disciplinary boundaries.<sup>50</sup> Indeed, it is still necessary to define more precisely what is "communication", and elucidate how "communication" in local and national contexts relates to international "communication" (is this a transnational phenomenon or can it only be characterized and constrained by local and national parameters?). Therefore, a clear conceptualization of the national and the international is still necessary in order to strengthen the powerful potential of this approach. Indeed, this is an important driving question in this book.

Communication is not a newcomer in history of science. Centre-periphery models and reception studies, despite restricting the focus to producers, placed communication at the centre of historical analysis.<sup>51</sup> What distinguishes new approaches from these old and powerful models is that they give important agency to audiences. An important inspiration here comes from cultural history. In his study of popular culture, Roger Chartier concluded that the "popular" could not be defined through objects or texts, but through the active ways in which those were "appropriated" by different kinds of readers.<sup>52</sup> In the same period, in a now classic paper, Abdelhamid Sabra used the concept of "appropriation" in order to challenge traditional narratives considering that Greek science had been passively received in Medieval Islam.<sup>53</sup> More recently, the concept of appropriation has been used in historical studies on science in the so-called scientific "European periphery", with the collective STEP as an important force behind this movement.<sup>54</sup> The study of the processes of mutual communication between different national contexts has also been central in the study of colonial science,<sup>55</sup> and in the study of cultural transfers in general history. In the latter it has been contended that the study of local

appropriation and international mediation is fundamental to overcome the constriction imposed by the national character of most historiographical frameworks.<sup>56</sup> “Appropriation” thus offers a useful tool allowing analysis of historical phenomena in both local and international contexts, and to produce more balanced and accurate historical accounts by shifting the focus from production to use. In this book, we have deliberately promoted the use of this concept, which in our opinion should be complemented with extensive use of the comparative approach.

This active promotion of comparative history departs from the original “Secordian” approach, as Secord dismisses this method prompted by his perception that it has led to defective results in history of science. His brief survey of the field highlights the fact that many works presented as comparative are in fact compilations of national case studies rather than international synthesis.<sup>57</sup> These studies would therefore not contribute to solving the historiographical problems already described. However, this is only a partial view as there are many other genuine comparative histories highlighting the usefulness of this approach. Its virtues have been stressed by many scholars, including historians of science and medicine such as Margaret Jacob, Lewis Pyenson and Ilana Löwy. Jacob has seen comparative history as the fundamental tool allowing the integration of precise microhistories into the larger scope of macrohistorical frameworks and to formulate more relevant and larger historical questions.<sup>58</sup> In a recent paper providing an analytical overview of twenty years of the journal *Social History of Medicine*, Löwy has stressed the heuristic power of comparison, and its fundamental role in taking properly into account the transnational dimension of medicine, its actors, practice and objects of study.<sup>59</sup> Furthermore, as argued by Pyenson, the comparative approach has in fact led to major historiographical innovations in the history of science.<sup>60</sup> Among the examples raised by Pyenson we can cite, for example, Jack Morrell’s idea of the research school, originating in a comparative study of Thomson and Liebig’s laboratories; Thomas P. Hughes’ concept of technological network, arising from comparison of European and North American electrical supply networks, or even Joseph Needham’s comprehensive – and, to some extent, comparative – survey of Chinese science and technology.<sup>61</sup>

As put by Marc Bloch’s ground-breaking analysis, the comparative method allows history to be intelligible by “establishing explanatory relationships between phenomena”.<sup>62</sup> According to William H. Sewell, the logic of hypothesis testing underlies the comparative method, and provides it with unmatched explanatory power.<sup>63</sup> Comparison allows the historian to discriminate, to synthesize, to challenge and finally to produce an

original perspective as a more satisfactory answer to the problem thus confronted. The challenge to a large amount of current scholarship is therefore to give a wider range to comparative study, in order to go beyond the local and to accurately conceptualize the national and the international.

Comparison has been a central methodological tool in many disciplines since at least the nineteenth century, contributing to create well-defined subfields within subjects such as philology, law, education, anatomy, geology, archaeology, religion studies, anthropology, linguistics, sociology, literature and their associated histories.<sup>64</sup> In general history and literature, comparison was originally seen as a tool that allowed historians to move their historical research beyond national frameworks. In using a comparative approach in history of science for this purpose, we could greatly benefit from the experience accumulated in these disciplines. Needless to say, intellectual and disciplinary pluralism has been and still is one of the best virtues that history of science has to offer.<sup>65</sup> Thus, for instance, we should certainly take into account the criticisms that have already been raised in history and literature against the comparative method, based on the idea that, paradoxically, it can in fact contribute to reinforce national singularities. Positioning a national culture in relation to the others has often rather resulted in stressing differences than commonalities.

In order to solve this problem, the diachronic study of cultural transfers was proposed in the 1980s.<sup>66</sup> Other historians have drawn on anthropology, and proposed an explanation of cultural change based on the study of cultural encounters, in which all interacting parts matter. Although, echoing anthropology, this approach has traditionally been applied to the confrontation between the European metropolis and its colonies, it might prove useful in a wider range of contexts including European states themselves.<sup>67</sup> More recently, a new proposal termed the “transnational turn” has shaken academic literature and history in the USA, and is progressively making its way in Europe and on other continents. Influenced in part by awareness of the effects of globalization and multiculturalism, this approach contends that many historical phenomena transcend the boundaries of the nation state. Transnational history thus offers a further challenge to the analytical framework of the nation. Hence, the intention is to focus on transnational historical objects, phenomena and actors, which are considered to have been left out by the paradoxical reification of national boundaries effected by international comparison, even when complemented with the study of cultural transfers. In spite of its deconstruction and dismissal of the nation, writing transnational history still involves the use of international comparison and

the assessment of the circulation of knowledge, objects and actors in an international perspective. In addition to its critical contribution to the recasting of the nation as just another historical parameter, one of its major values resides in its promotion of internationality and interdisciplinarity.<sup>68</sup>

In brief, a major aim of the editors of this book has been to problematize the local, the national and even the international through comparison and through the assessment and analysis of communication practices within these contexts and across them. This has a double intention in relation to the current configuration of history of science as outlined in this introduction. On the one hand, it intends to enrich its historiography by diversifying the national character impressed through its compilation of case studies. Through comparison, the different case studies presented in this book aim at providing the tools for a more fruitful integration and diversification of national case studies in our field. The use of sources belonging to different national historiographies and published in different languages and media platforms express our conviction of the need of promoting internationality in history of science as a requisite of outstanding scholarship. On the other hand, the five parts constituting this book pay important attention to the study of the practices of communication in different periods and in local, national and international contexts. Studying and conceptualizing these practices, their agency in linking local and global contexts and cultures, and their contribution to the making of scientific knowledge, is a first step towards the writing of a big-picture history of science that will satisfactorily assess the complex diversity of science as a human practice.

### **A fresh perspective in history of science**

The structure of this book – as one of the results of a generalist international postgraduate conference – emerged through a combination of pragmatism and intellectual debate.<sup>69</sup> The meeting in València in November 2005 brought together a group of postgraduate students and young researchers from different countries and with various educational experiences, whose work dealt with different scientific disciplines, historical periods and national contexts. This diversity is reflected in the range of topic and period across this monograph. The time scope is broad, from the early modern period to the twentieth century, although nineteenth- and twentieth-century case studies are predominant, which is a particular reflex of participation in the València conference, but also a reflex of larger international developments of the discipline at the moment.<sup>70</sup> In spite of the generalist character of the meeting, the generous

and dynamic participation of all its contributors coalesced in the identification of critical topics and historiographical challenges to our discipline. The subsequent configuration of a historiographical project, aimed at debating these issues in the context of the research of each of the authors, has resulted in the publication of this book.

In an effort to transgress boundaries and connect with topical issues in the discipline, the editors of this book have worked in three parallel directions. Authors were encouraged to use the tools of comparative history in their analyses, and to connect their local case studies with issues relevant in an international or transnational level. Furthermore, a conscious effort was made to diversify the use of literature in linguistic, cultural and historiographical terms. Finally, the book was structured through a series of central themes and questions in the discipline, defined by an essay preceding the papers in each of the parts. The five parts of this book are thus devoted respectively to the early modern map of knowledge, the pedagogy of science, the popularization of science, the tension between science and nation, and the geography of scientific centres and peripheries. A brief introduction to the major narrative lines and themes articulating the book and its parts occupies the next paragraphs as a closure to this introduction.

The first part of this book is devoted to the early modern period, contrasting in various ways with the rest of the book, which is focused on the modern period. The practices of science and its communication have changed enormously since the “Scientific Revolution”, a core event in the original conceptualization of our discipline, for which early positivistic agendas considered science as universal knowledge circulating without constraints.<sup>71</sup> In fact, as exposed in this book, in spite of the more fluid boundaries of the early modern state, mathematics and astrology were practiced in different ways in various places in this period. Nonetheless, pedagogical programmes had a privileged role in the communication of scientific knowledge throughout Europe. But the purposes and modes of this communication varied in different institutions which contributed to encourage and at the same time to constrain the practice of science across different kingdoms, through their political, social, cultural and pedagogical aims. Pedagogical tools such as school books and teaching treatises were fundamental to ensure the communication of new outlooks that contributed to changing the place of subjects such as mathematics, its subdisciplines, and its practitioners, within European culture and society. In this process, translation had a fundamental role, displaying the tension between the global and the local through the dialogue between Latin and vernacular languages such as French.

The second part of this book precisely stresses the role of translation (into vernacular) and pedagogy as driving agents of the international communication of science during the eighteenth and nineteenth centuries. Textbooks played a fundamental role in the organization of national systems of formal education and the integration of science in the school curriculum taking place in this period. As privileged communicators of scientific and pedagogical knowledge, their circulation contributed to determine the configuration of educational and scientific practices, and consequently of disciplines within and across nation states. Through the international circulation of booksellers and students, and the spread of scientific education, textbooks emerged in the nineteenth century as a well-defined genre. The national character of educational systems in Europe was defined through mutual observation, comparison and appropriation of other cultures in an international perspective. In their communicative agency, textbooks intersected and fruitfully interacted with other genres of communication also contributing to the definition of science as a discipline in this period such as journalism, public lecturing and social conversation.

The third part of this book is especially devoted to study this diversity of communicational genres gathered under the umbrella of the phenomenon conventionally termed “science popularization”. These modes of communication and appropriation of knowledge were increasingly developed in the nineteenth century with purposes not restricted to this period but accentuated in the action of science and its practitioners in society. Disciplinary formation, professional aspirations, political dominance, social control and national construction intersected in the shaping of discourses and programmes aimed at communicating science to a wide range of audiences. The communication of science across society pervaded cultural practices in different countries, and the increasing centrality of science in society shaped science popularization as a powerful communicational tool that supported programmes of local, national and international range.

The fourth part of this book focuses on the tension between the national and the international in history of science. In spite of the nineteenth-century rise of the nation state and the associated construction of national identities, as shown in this part, the national unit is too often taken for granted by historians of science. Nations are not homogeneous entities and scientific practices were often more defined by local institutional, disciplinary and pedagogical cultures. Furthermore, a national spirit is always built across time in relation to other nations. The national character of science is thus fragmented in its unit and pervaded by

the international in its essence. On the other hand, scientific internationalism can be seen as a powerful ideological force aimed at increasing communication over national barriers, through disciplinary, technological, economical, intellectual and moral interests. These interests coalesce on certain occasions to form transnational entities whose presence in the local and the international sphere is not essentially driven by the nation state.

The fifth and last part of this book stresses again the importance of the conceptualization of communication in national, international and transnational contexts in order to map the structure of science and its practice and to build the big picture. In this context it is particularly important to diversify the number of national cases configuring the constructed archive of evidence in our discipline. As shown in this part, countries conventionally considered peripheral in the development of science in fact offer original insights into the constitution of scientific disciplines and the role of communicational practices. Furthermore, the overarching notion of periphery and centre fails to account for national heterogeneity and for the diachronous character of historical phenomena. Its unidirectional conception of communication is inaccurate as communication always involves interaction and mutual dependence between at least two active agents, whether in teaching, in popularizing, in writing and reading, or in national and international construction, and in science practice in general.

In February 2006, at a roundtable discussion of Martin Rudwick's *Bursting the Limits of Time* at Leeds, Jack Morrell, with his characteristic humour, emphasized the advantages of the condition he shared with Rudwick – being a septuagenarian and thus being free of academic affiliations – offered to their work in terms of intellectual freedom. At the other end of the line, postgraduate students are often subjected to various pressures related to prospective professional opportunities and to their integration into and their interaction with the established community of scholars. This book – with all its failures and work-in-progress virtues – is nonetheless an indication that postgraduate students and young researchers can engage in independent, original and productive research ventures.

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Leucha Veneer, a history of science postgraduate student at Leeds, who carried out an excellent revision of the whole manuscript. The cover of the book was designed by Virginia Vinagre, a design student in València, whom we would like to thank for her generous and enthusiastic collaboration. This project has also benefited from sincere encouragement by several scholars, and we therefore wish to express our heartfelt thanks to José Ramón Bertomeu, Jon Topham, Pepe Pardo, Antonio García-Belmar, Agustí Nieto-Galan, Robert Fox, James Sumner and Greg Radick.

## Notes

<sup>1</sup> Instead, for Steven Shapin and other scholars the problem does not lie in the lack of “big pictures”, but in the impoverishment of our narratives, writing styles and readerships, as a result of the constitution of an “hyperprofessionalized” discipline that has become almost self-referential. Although a major focus of this book is cutting across national and ideological boundaries within the discipline, we agree with Shapin that it is equally important to cut across social and cultural boundaries within local contexts. Shapin, S. (2005). “Hyperprofessionalism and the Crisis of Readership in the History of Science”. *Isis* 96 (2): 238-243.

<sup>2</sup> Rossi, P. (1986). *I ragni e le formiche: Una apologia della storia della scienza*. Bologna: Il Mulino; Garber, E. (1990). “Introduction”. In Garber, ed. *Beyond History of Science. Essays in Honor of Robert E. Schofield*. Bethlehem: Lehigh University Press, pp. 7-20; Hakfoort, C. (1991). “The Missing Syntheses in the Historiography of Science”. *History of Science* 29: 209-216, on pp. 211-3; Holmes, F. L. (1993). “Justus Liebig and the Construction of Organic Chemistry”. In Mauskopf, S. H., ed. *Chemical Sciences in the Modern World*. Philadelphia: University of Pennsylvania Press, pp. 119-35, on pp 119-21; López Piñero, J. M. (1993). “La tradición de la historiografía de la ciencia y su coyuntura actual: los condicionantes de un congreso”. In Lafuente, A.; Elena, A., and Ortega, M. L., eds. *Mundialización de la ciencia y cultura nacional*. Madrid: Ediciones Doce Calles, pp. 23-49, on p. 47; Harris, S. J. (1998). “Introduction: Thinking Locally, Acting Globally”. *Configurations* 6 (2): 131-9; Jacob, M. C. (1999). “Science Studies after Social Construction: The Turn toward the Comparative and the Global”. In Bonnell, V. E., and Hunt, L., eds. *Beyond the Cultural Turn: New Directions in the Study of Society and Culture*. Berkeley: University of California Press, pp. 95-120, on pp. 95, 99-101; Heilbron, J. L. (November 2002). “Science as a subject of history”. [Conference at the Palau de la Generalitat]. *VII Trobada d'Història de la Ciència i de la Tècnica*. Barcelona: SCHCT; Warner, J. H. (2004). “Grand Narrative and its Discontents: Medical History and the Social Transformation of American Medicine”. *Journal of Health Politics, Policy and Law* 29 (4-5): 757-80; Fox, R. (2006). “Fashioning the Discipline: History of Science in the European Intellectual Tradition”. *Minerva* 44: 410-432, on pp. 426-7.

<sup>3</sup> Holmes. “Justus Liebig”; Jacob. “Science Studies after Social Construction”; Hakfoort. “The Missing Syntheses”; Secord, J., ed. (1993). “The Big Picture”. Special issue. *British Journal for the History of Science* 26: 387–483; Köhler, R., ed. (2005). “Focus: The Generalist Vision in the History of Science”. *Isis* 96 (2): 224-51; Pickstone, J. V. (2007). “Working Knowledges Before and After circa 1800: Practices and Disciplines in the History of Science, Technology, and Medicine”. *Isis* 98 (3): 489-516, on p. 490.

<sup>4</sup> Hakfoort. “The Missing Syntheses”; Secord. “The Big Picture”; Christie, J. (1993). “Aurora, Nemesis and Clio”. *British Journal for the History of Science* 26: 391-405; Harris. “Thinking Locally, Acting Globally”, pp. 136-8.

<sup>5</sup> Olby, R., Cantor, G. N., Christie, J. R. R., and Hodge, M. J. S. (1990). *Companion to the History of Modern Science*. London: Routledge.

<sup>6</sup> Christie. “Aurora, Nemesis and Clio”, pp. 401, 394.

<sup>7</sup> Gillispie, C. C. (1960). *The Edge of Objectivity: An Essay in the History of Scientific Ideas*. Princeton: Princeton University Press.

<sup>8</sup> Gillispie, C. C. (1991). “Review: Scholarship Epitomized”. *Isis* 82 (1): 94-8; Basalla, G. (1992). “[Review of *An Encyclopaedia of the History of Technology* by Ian McNeil]”. *Isis* 83 (1): 115-7; Fyfe, A. (2005). “[Review of *The Oxford Companion to the History of Modern Science*, by J. L. Heilbron, ed.]”. *British Journal for the History of Science* 38 (3): 349-73.

<sup>9</sup> López Piñero, J. M. (1992). “La historia de la ciencia como disciplina”. *Saber Leer* 55: 8-9; on p. 9.

<sup>10</sup> The constitution of history of science as a professional discipline in 1970s Spain, is a phenomenon that still needs research, and especially taking into account the promising development of the subject in the 1930s, broken by the Spanish Civil War. See for example, Bujosa Homar, F. (1990). “Histoire de la médecine en Espagne”. In Bernes, A. C., eds. *Nouveaux enjeux de l'histoire de la médecine*. Strasbourg: Institut Pasteur, pp. 7-27, on pp. 21-4; López Piñero, J. M. (1988). “The History of Science Unit of the Institute of Science Studies (Valencia, Spain)”. *Nuncius* 3 (2): 193-207; Nieto Galan, A. (2008). “La memoria histórica de la ciencia en España”. *Claves de Razón Práctica* [forthcoming]; Asociación Española de Historiadores de la Ciencia Española. (1935). *Estudios sobre la ciencia española del siglo XVII*. Madrid: Gráfica Universal, pp. vii-xiv.

<sup>11</sup> The first aspect has also been in the last decade recurrently stressed by John Pickstone, and the second aspect has recently been emphasized by James Secord, Martin Rudwick and Robert Fox. See Pickstone, J. V. (2000). *Ways of Knowing: A New History of Science, Technology and Medicine*. Manchester: Manchester University Press, and (2007). “Working Knowledges Before and After circa 1800”; Secord, J. A. (2004). “Knowledge in Transit”. *Isis* 4 (95): 654-72; Rudwick, M. J. S. (2005). *Bursting the Limits of Time: The Reconstruction of Geohistory in the Age of Revolution*. Chicago: University of Chicago Press, pp. 3-4; Fox. “Fashioning the Discipline”.

<sup>12</sup> But, paradoxically, only a small amount of López Piñero's extensive work was published in other languages than his mother tongue (Spanish). This has been – and still is – a characteristic phenomenon in general history in many European countries. Besides the question of language skills (see n. 38), the availability of considerably large national readerships for history is one of the reasons of this phenomenon. In addition, this disciplinary field offers a more diverse publishing scene than history of science in terms of language, with specialized publishers and journals whose major focus is almost exclusively national. For journals see European Science Foundation (2007). *European Reference Index for the Humanities (ERIH)*; *ERIH Initial List: History (2007)*, and *ERIH Initial List: History and Philosophy of Science (2007)*. Strasbourg: European Science Foundation [www.esf.org/erih].

<sup>13</sup> López Piñero. “La tradición de la historiografía de la ciencia”, pp. 27-41. See also Pickstone, J. V. (2005). “Review Article: Medical History as a Way of Life”. *Social History of Medicine* 18 (2): 307-23, and Homburg, E. (2008). “Boundaries and audiences of national histories of science: insights from the history of science and technology of the Netherlands”. *Nuncius* [forthcoming]. We would like to thank Ernst Homburg for sending us a copy of his paper before publication.

<sup>14</sup> See Trenn, T. J. (1979). “Preface”. In Fleck, L. *Genesis and Development of a Scientific Fact*. Chicago: The University of Chicago Press, pp. xiii-xxii, on pp. xiii and xviii.

<sup>15</sup> López Piñero. “La tradición de la historiografía de la ciencia”, pp. 48-9.

<sup>16</sup> Gutmann Rosenkrantz, B. (1981). “[Review of *Genesis and Development of a Scientific Fact* by Ludwik Fleck]”. *Isis* 72 (1): 96-9; Lenoir, T. (1984). “[Review of *Ludwik Fleck: Erfahrung und Tatsache* by L. Schäfer and T. Schnelle, eds.]”. *Isis* 75 (4): 724-5; Harwood, J. (1986). “Review: Ludwik Fleck and the Sociology of Knowledge”. *Social Studies of Science* 16 (1): 173-87.

<sup>17</sup> Although it is still most often integrated within the mainstream of socio-constructivism. See Golinski, J. (1998). *Making Natural Knowledge. Constructivism and the History of Science*. Cambridge: Cambridge University Press, on pp. 27-46.

<sup>18</sup> See for instance Bonah, C. (2002). “‘Experimental Rage’: The Development of Medical Ethics and the Genesis of Scientific Facts“. Ludwik Fleck: An Answer to the Crisis of Modern Medicine in Interwar Germany? Society for the Social History of Medicine Millennium Prize Essay 2000. *Social History of Medicine* 15 (2): 187-207.

<sup>19</sup> See for example Olesko, K. (2006). “Science Pedagogy as a Category of Historical Analysis: Past, Present, and Future”. *Science and Education* 15: 863-80; Topham, J. R. (2008). “Rethinking the History of Science Popularization/Popular Science”. In Papaneloupoulou, F.; Nieto-Galan, A., and Perdiguerro, E., eds. *Popularising Science and Technology in the European Periphery, 1800-2000*. Aldershot: Ashgate.

<sup>20</sup> This problem is currently perceived as a major obstruction to the creation of “big pictures” in history of science. See Kohler, R. (2005). “A Generalist's Vision”. *Isis* 96 (2): 224-9, on p. 224; Kaiser, D. (2005). “Training and the Generalist's Vision in the History of Science”. *Isis* 96 (2): 244-51.

<sup>21</sup> If the “Scientific Revolution” constituted the developing core of the discipline, and the history of physics was certainly the most actively researched area for most of the twentieth century, in the last few decades, biology has been attracting the largest number of new scholars. In addition, as pinpointed by David Kaiser (see n. 19), the modern period has attracted the highest number of students in the last two decades with an important growth of studies on twentieth century science. Studies on periods previous to the nineteenth century have a stable number of students but are in the minority. Heilbron. “Science as a subject of history”.

<sup>22</sup> Fox. “Fashioning the Discipline”, p. 412.

<sup>23</sup> Kaiser. “Training and the Generalist's Vision”, p. 249. Kaiser's numbers show however that, at the moment, North-American history of science scholarship is arguably the most international in the Western world. The increase of theses on American topics has gone together with the rise of the history of twentieth-century science in America, and has come to balance a research output which was in previous decades predominantly oriented towards European topics.

<sup>24</sup> To produce these statistics, we have analysed the list of theses provided by the British Society for the History of Science. Although the list is not complete and our analysis is a rough approximation (alas, mainly based on thesis titles), it is still useful for qualitative purposes. [[www.bsos.org.uk/hstml/list\\_of\\_theses/](http://www.bsos.org.uk/hstml/list_of_theses/)] (accessed 26 September 2007). See also the *International Bibliography of History of Science, Technology, and Medicine* (HistSciTechMed).

<sup>25</sup> As shown for instance by an analysis of the lists of history of science theses produced in the last decades in France and in Spain. See <http://www.sudoc.abes.fr>, and <http://teseo.mec.es/teseo>.

<sup>26</sup> Kaiser. “Training and the Generalist's Vision”, p. 246.

<sup>27</sup> In the meantime online resources are clearly changing our way of working and writing, particularly through their powerful search engines. Despite their benefits, they have introduced new problems that, if we do not make the effort to conceptualize them, will grow bigger in the near future. Some of these problems are, for example, the loss of contextuality, the loss of the material culture of the book, the definition of online source authority criteria, “copy and paste” and plagiarism, and linguistic determinism based on the illusion of lexicographic omniscience. Despite several conferences having been organized in the last few years around this topic, unfortunately many of them are too often characterized by a lack of reflection and are instead used as platforms to present different history of science web projects to the public.

<sup>28</sup> See Jeanneney, J.-N. (2007). *Google and the Myth of Universal Knowledge. A View from Europe*. Chicago: The University of Chicago Press.

<sup>29</sup> López Piñero. “La tradición de la historiografía de la ciencia”, pp. 27-49.

<sup>30</sup> For instance, Francesc Bujosa observed in 1990 the profound localism afflicting the practice of the history of science and medicine in Spain. Although there is currently an important group of Spanish scholars working in this field at international level, they are a minority. The major reasons suggested by Bujosa (the endogamous and non-democratic nature of the university and research system, the lack of peer review, and parochialism in publication) are still pertinent. This perspective is in agreement with a recent report on the state of teaching and research in the humanities published by the Spanish Foundation for Science and Technology. Localism is also a characteristic of most of the history of science and medicine journals published outside the Anglo-American context, although there are some exceptions, and some of them have large national readerships (see n. 31). Bujosa. "Histoire de la médecine en Espagne", pp. 12-5, 21-3; Spanish Foundation for Science and Technology (2006). *White paper on research in the Humanities*. Madrid: FECYT, pp. 106-66 [<http://www.fecyt.es>], and FECYT (2005). "Informe sobre la investigación en Humanidades. Panel de Historia. [versión 25 de enero de 2005]", pp. 13, 20, 25; European Science Foundation. *ERIH Initial List: History and Philosophy of Science (2007)*, and *ERIH Initial List: History (2007)*.

<sup>31</sup> A recent quantitative and qualitative assessment of history and philosophy of science journals undertaken by the European Science Foundation shows that 53% of the journals in this area are published in English, 36% of which are produced by Anglo-American publishers. Furthermore, all the history of science, medicine and technology journals with the highest international standard (rated "A") are Anglo-American and have British or American editors (with only one or two exceptions). Anglo-American dominance is also the largest in the second group of journals (rated "B") listed by the report (in a global scale of 3 categories: A, B, C). The composition of the editorial boards of these journals is more nationally diverse though. As previously mentioned, in contrast, the linguistic and national distribution of general history journals and publishing media is more diverse. European Science Foundation. *European Reference Index for the Humanities (ERIH)*; *ERIH Initial List: History and Philosophy of Science (2007)*.

<sup>32</sup> We use here Golinski's broad definition of socio-constructivism. See Golinski. *Making Natural Knowledge*.

<sup>33</sup> Jacob. "Science Studies after Social Construction", pp. 96-7, 106-7; Secord. "Knowledge in Transit", pp. 659-60; Harris. "Thinking Locally, Acting Globally", pp. 135-6.

<sup>34</sup> See Jacob. "Science Studies after Social Construction", and Kaiser. "Training and the Generalist's Vision".

<sup>35</sup> See Kohler. "A Generalist's Vision".

<sup>36</sup> Findlen, P. (2005). "The Two Cultures of Scholarship". *Isis* 96 (2): 230-7; Jacob. "Science Studies after Social Construction", pp. 107, 111-6.

<sup>37</sup> This could be analogous to writing the modern history of British politics ignoring its Foreign Office and foreign policy, because its archives talked about foreign cultures and included documents in foreign languages.

<sup>38</sup> Followed by Italy (59%), Hungary (58%), Portugal (58%), Spain (56%), and Romania (53%). TNS Opinion & Social (2006). "Europeans and their Languages". *Eurobarometer* 243/Wave 64.3 (February), pp. 8-13; Wastiau-Schlüter, P., ed. (2005). "Foreign Language Learning: A European Priority". *Eurydyce* 2 (March), p. 3. See [http://ec.europa.eu/public\\_opinion/archives/ebs/ebs\\_243\\_sum\\_en.pdf](http://ec.europa.eu/public_opinion/archives/ebs/ebs_243_sum_en.pdf), and <http://www.eurydice.org/>.

<sup>39</sup> Rudwick. *Bursting the Limits of Time*, p. 4.

<sup>40</sup> Dearing, R.; King, L. (2006). *The Languages Review. Consultation Report: December 2006*. [<http://www.dfes.gov.uk/consultations/downloadableDocs/6869-DfES-Language%20Review.pdf>]; The British Academy. *Response to the Announcement of the Languages Review*. [<http://www.britac.ac.uk/reports/dearing-2006/response-02-07.html>] (accessed 10 September 2007).

<sup>41</sup> Löwy, I. (2007). "The Social History of Medicine: Beyond the local". *Social History of Medicine* 20 (3): 465-81, p. 478.

<sup>42</sup> Ibid.

<sup>43</sup> Holmes. "Justus Liebig"; Hakfoort. "The Missing Syntheses"; Christie. "Aurora, Nemesis, and Clio"; Köhler. "Focus: The Generalist Vision in the History of Science"; Kaiser. "Training and the Generalist's Vision".

<sup>44</sup> Secord, "Knowledge in Transit".

<sup>45</sup> Secord, J. A. (2000). *Victorian Sensation. The Extraordinary Publication, Reception, and Secret Authorship of Vestiges of the Natural History of Creation*. Chicago: The University of Chicago Press.

<sup>46</sup> Secord, J. (2007). "How Scientific Conversation Became Shop Talk". In Fyfe, A., and Lightman, B., eds. *Science in the Marketplace*. Chicago: Chicago University Press, pp. 23-59. We would like to thank Jim Secord for providing us with a copy of his paper before publication.

<sup>47</sup> The move from the context of knowledge production to its context of use has already happened in a wide range of disciplinary fields. The history of popular culture, the theory of education, the history of reading, the history of technology, and science communication studies have all contributed, through their focus on the non-elite members of society, the student, the reader and the user. And by giving communication processes a central place through their conceptualization as interactive and multidirectional phenomena taking into account both ends of the communicative process line. See for example Chartier, R. (1984). "Culture as Appropriation: Popular Cultural Uses in Early Modern France". In Kaplan, S. L., ed. *Understanding Popular Culture*. Berlin: Mouton Publishers, pp. 229-53; Gil-Pérez, et al. (2002). "Defending constructivism in science education". *Science & Education* 11: 557-71; Darnton, R. (1990). "First Steps Towards a History of Reading". In *The kiss of Lamourette: Reflections in Cultural History*. London: Faber & Faber, pp. 154-87; Oudshoorn, N., and Pinch, T. (2003). "Introduction: How Users and Non-Users Matter". In Oudshoorn and Pinch, eds. *How Users Matter: The Co-Construction of Users and Technologies*. Cambridge, Mass.: The MIT Press, pp. 1-25; Hiltgarner, S. (1990). "The Dominant View of

Popularization: Conceptual Problems, Political Uses". *Social Studies of Science* 20: 519-39.

<sup>48</sup> Secord. "Knowledge in Transit", pp. 660-7.

<sup>49</sup> Topham. "Rethinking the History of Science Popularization/Popular Science".

<sup>50</sup> Secord. "Knowledge in Transit", p. 656.

<sup>51</sup> See Gavroglu, K., et al. (2008). "Science and Technology in the European Periphery. Some Historiographical Reflections". *History of Science* 46: 1-23; Dolby, R. G. A. (1977). "The Transmission of Science". *History of Science* 15: 1-43. We would like to thank José R. Bertomeu and Agustí Nieto-Galan for allowing us reading a copy of the STEP paper before its publication.

<sup>52</sup> Chartier, R. "Culture as Appropriation", p. 233, and (1995). "Popular Appropriation: The Readers and Their Books". In *Forms and Meanings: Texts, Performances, and Audiences from Codex to Computer*. Philadelphia: University of Pennsylvania Press, pp. 83-97, on pp. 88-9.

<sup>53</sup> Sabra, A. I. (1987). "The Appropriation and Subsequent Naturalization of Greek Science in Medieval Islam: A Preliminary Statement". *History of Science* 25: 223-43, on pp. 227-8.

<sup>54</sup> Gavroglu. "Science and Technology in the European Periphery".

<sup>55</sup> See Palladino P., and Worboys, M. (1993). "Science and Imperialism". *Isis* 84 (1): 91-102

<sup>56</sup> Espagne, M., and Werner, M. (1987). "La construction d'une référence culturelle allemande en France, genèse et histoire". *Annales ESC* 42 (4): 969-92; Espagne, M. (1999). *Les transferts culturels franco-allemands*. Paris: PUF.

<sup>57</sup> Secord. "Knowledge in Transit", p. 669.

<sup>58</sup> Jacob, M. "Science Studies after Social Construction", pp. 96, 103-16. See also Lloyd, G. E. R. (1997). "The Comparative History of Pre-Modern Science: The Pitfalls and the Prizes". *Studies in History and Philosophy of Science* 28 (2): 363-68.

<sup>59</sup> Löwy. "The Social History of Medicine", pp. 466-7.

<sup>60</sup> Pyenson, L. (2002). "Comparative History of Science". *History of Science* 40: 1-33, on pp. 9-12.

<sup>61</sup> Morrell, J. B. (1972). "The Chemist Breeders: The Research Schools of Liebig and Thomas Thomson". *Ambix* 19: 1-46; Geison, G. L., and Holmes, F. L., eds. (1993). "Research Schools. Historical Reappraisals". *Osiris* 8; Hughes, T. P. (1983). *Networks of Power: Electrification in Western Society, 1880-1930*. Baltimore: The Johns Hopkins Press; Needham, J. (1979). *The Grand Titration: Science and Society in East and West*. Buffalo, NY: University of Toronto Press.

<sup>62</sup> Bloch, M. (1954). *The Historian's Craft*. Manchester: Manchester University Press.

<sup>63</sup> Sewell, W. H. (1967). "Marc Bloch and the Logic of Comparative History". *History and Theory* 6 (2): 208-18.

<sup>64</sup> See Detienne, M. (2002). "L'art de construire des comparables. Entre historiens et anthropologues". *Critique Internationale* 14 (1): 68-78; Saussy, H. (2006).

“Exquisite Cadavers Stitched from Fresh Nightmares: Of Memes, Hives, and Selfish Genes”. In Saussy, ed. *Comparative Literature in an Age of Globalization*. Baltimore: Johns Hopkins University Press, pp. 3-42; Thomas, R. M. (1990). “The Nature of Comparative Education: How and Why are Education Systems Compared”. In Thomas, ed. *International Comparative Education: Practices, Issues & Prospects*. Oxford: Pergamon Press, pp. 1-21.

<sup>65</sup> See for instance Fox. “Fashioning the Discipline”, Pickstone. “Medical History as a Way of Life”, and Rudwick, M.; Coleman, W.; Sylla, E., and Daston, L. (1981). “Review: Critical Problems in the History of Science”. *Isis* 72 (2): 267-83, pp. 268-71. Excellent recent examples of this are Secord. *Victorian Sensation*; Topham, J. R. (2000). “Scientific Publishing and the Reading of Science in Nineteenth-Century Britain: A Historiographical Survey and Guide to Sources”. *Studies in History and Philosophy of Science* 31 (4): 559-612; Rudolph, J. L. (2002). *Scientists in the Classroom: the Cold War Reconstruction of American Science Education*. New York: Palgrave, and Chang, H. (2004). *Inventing Temperature: Measurement and Scientific Progress*. New York: Oxford University Press.

<sup>66</sup> Werner, M. and Zimmermann, B. (2006). “Beyond Comparison: Histoire Croisée and the Challenge of Reflexivity”. *History and Theory* 45 (February): 30-50, pp. 35-6.

<sup>67</sup> See for example Glick, T. F. and Pi-Sunyer, O. (1969). “Acculturation as an Explanatory Concept in Spanish History”. *Comparative Studies in Society and History* 11 (2): 136-54; Raj, K. (2007). *Relocating Modern Science: Circulation and the Construction of Scientific Knowledge in South Asia and Europe, 1650-1900*. Basingstoke: Palgrave Macmillan, pp. 10-4; Buklijas, T. and Lafferton, E. (2007). “Science, medicine and nationalism in the Habsburg Empire from the 1840s to 1918”. *Studies in History and Philosophy of Biological and Biomedical Sciences* 38: 679-86, pp. 679-81.

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