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## **Introduction: Making Sense of Nature in the Premodern World**

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### Abstract

In the premodern era, historical actors saw experience more as a processed and refined product of cognition than as a plain perceptual given. As such, experience was subject to interpretation by practitioners of science and translators alike. In a world of intense cross-cultural exchanges, experience was communicated between languages, between scientific systems and norms, and between verbal and visual systems (such as from language to symbol or from diagram to image). The epistemic processes of refinement, interpretation, and exchange of experience thus went hand in hand, to the extent that they cannot be separated. Together, they shaped scientific experience in its epistemic purpose and in its transformative force for the premodern sciences of the natural world. This raises three interrelated research questions: What counted as experience of the natural world in the premodern era? What impact did such processes of epistemic translation have upon the shape and purpose of experience in the premodern sciences of the natural world? And how did the individual and collective expertise of practitioners in science and translators transform the shape and purpose of experience within those sciences?

When, every year for six years, we watch a pair of eagles hatch one young despite having laid two eggs,<sup>1</sup> how do we make this natural phenomenon part of scientific knowledge? How do we share with others across space and time what we have experienced of nature? Aristotle offered one answer:

So from perception there comes memory, as we call it, and from memory (when it occurs often in connection with the same thing), experience; for memories that are many in number form a single experience. (Aristotle, *Posterior Analytics* II.19,

For Aristotle, perceptions, memories, experiences, and scientific knowledge were all captured in the soul of a single, perhaps ideal scientist. For those who came after him, perceptions, memories, experiences, and scientific knowledge were captured in the souls of many scientists. Equally, they were captured in the voices of many teachers, on the parchment of manuscripts and on printed paper, in the visual imagery of works on cosmology, elements, minerals, plants, animals, and human beings. In short, experience in the premodern world—*empeiria, experientia, tajriba, nissayon*—made its home in many media.<sup>2</sup> The history of that experience and its translations is the history our book will tell.

In the premodern stories related here, experience was a way of encountering, structuring, and probing into nature. But it did that in very different forms—by means of very different mediations between human subjects and artifacts. As our historical actors worked on and with experience, they subjected direct perceptions of nature in the moment, what we call here “live experiences,” to a kind of domestication or cognitive assimilation.<sup>3</sup> Assimilation of this kind was part of premodern science no less than modern science,<sup>4</sup> but scientific knowledge in the premodern era was not subject to the exclusive rule of rationally processed sense perceptions. It was free to domesticate live experiences according to a range of epistemic norms, addressing different objectives and audiences.

Such processes of domestication have momentous consequences. Direct sense perceptions of nature—live experiences—are ephemeral events, if events at all. Only when recorded in a more enduring medium do they lose this ephemerality, and they may lose even more: through attention, even hyper-attention, to just one or some of the qualities present in the event. Some

qualities become more visible, others fade.<sup>5</sup> The cognizing scientist did not simply collect live experiences, but correlated, organized, and refined them into the processed products that have come down to us. That internal processing was inextricable from acts of externalizing, as experience was put down on parchment or paper. It was made to endure and to communicate through media that could extend it beyond a human lifespan or even many lifespans.<sup>6</sup>

When our actors externalized experience in this way, they often did so with the aim of enabling it to be internalized again by audiences in their classrooms, at their desks, or wherever scientists sought to share experience. In their acts of listening and reading,<sup>7</sup> the premodern scientists of the next generation repurposed their predecessors' experiences by performing their own acts of cognition on them. In some (though not all) cases, they added their own, domesticated, live experiences to form a new, combined type of experience that was often more certain and assured. The second, third, fourth, and subsequent generations each began the act of externalization again, initiating yet other cycles of the epistemic translation of experience.

These cycles did not remain within the boundaries of a single language or a locale. No less than the scientists, interlingual translators—who were often scientists themselves—domesticated and repurposed experience. Just like the second-generation scientists, translators took recorded, externalized experience and internalized it, subjecting it to translation between different languages, codifications, and media. Externalizing it again, along with all other scientific knowledge within which recorded experience was embedded, they repurposed it for the third, fourth, fifth, and subsequent generations of audiences across linguistic space.

For our actors, then, interlingual and intermedial translations of experience were not sharply

separated, but part of a continuum of epistemic acts and processes.<sup>8</sup> For this reason, we propose the broad analytic category of “epistemic translation,” which usefully embraces the many different acts of translation, with their multiple purposes, that emerge in this book.<sup>9</sup> Beginning with ancient researchers into nature, most of the premodern actors we present domesticated and repurposed experience without elevating it to a universal concept. They seem to have tacitly agreed that the realm of the mind is separated from the realm of the senses by an invisible ontological line. Curiously perhaps to our modern eyes, this division extended to all the media by means of which experience could be externalized. Whether in terms, arguments, tables, diagrams, or images, experience (direct or indirect) and universal concepts were regarded as playing in separate leagues. During the many processes of translation that premodern experience underwent, it maintained its core epistemic character: as a kind of knowledge that did not immediately fulfill the highest epistemic ideals of truth and certainty, but remained tied to the conditions of time and space. This is not to say that experience could not overturn universal judgments, if they were wrong—but it is to say that the epistemic relationship between experience and the universal was such that in most cases, and in different ways, the universal ranked above experience.

This hierarchy did not prevent experience from taking a central place in the study of natural phenomena. Our volume investigates processes of translation that elicited and extricated certain qualities of experience, mentally fixing or ontologizing them (or certain of their properties) as a way to approach the natural world.<sup>10</sup> We thus ask: What kinds of acts were available for translating live experiences into the experience captured on parchment and paper? How did these acts of translating, in their own configurations, impact upon what was attended to in experience and what was lost?<sup>11</sup>

This approach is partly inspired by discussions on the ontology of scientific objects, described by Annemarie Mol: “It is possible to refrain from understanding objects as the central points of focus of different people’s perspectives. It is possible to understand them instead as things manipulated in practices. If we do this—if instead of bracketing the practices we foreground them—this has far-reaching effects. Reality multiplies.”<sup>12</sup>

The multiplication of reality is key to our broad analytic conception of translation. Rather than on objects manipulated in practices, however, we focus on experience manipulated in epistemic translation. In the premodern sciences of nature as in other scientific settings, experience is manipulated both as object of knowledge and as instrument for knowledge-making.<sup>13</sup> That accords ample space to types of experience that are empirical in the Baconian and post-Baconian sense of the word: direct access to nature, embodied practices of systematic observation, new sense-enhancing instruments and record-keeping technologies, induction from collected observations, work in the laboratory or the field, and many more.

But at the same time—and this is crucial—it opens up a space to integrate other types of experience, ones that are empirical beyond the methodological practices usually associated with early modern science and natural philosophy in Western Europe. For instance, it includes sense perceptions of spoken words: hearing the voice of the teacher in the classroom is a perceptual act giving rise to mediated cognitions in the student that might cover the entire epistemic spectrum of perceptions, images, memories, experiences, and universals. This conception of experience gives rise to the two new questions that this collection raises: What is experience in the premodern sciences of the natural world? And: How, and to what ends, was experience used in them? By responding to these questions, the papers and introductions aim to contribute to a new field in the history of experience in

premodern science.

We focus on four media in which experience was domesticated and repurposed through translation in the broad sense we set out above: terms, arguments, pictorial formats, and expertise—a list by no means intended to exhaust the possible places where premodern experience found an intellectual home.<sup>14</sup> How experience endured as a way to probe nature in these various forms is a common thread running through the studies collected here. They reveal that experience’s instrumentality sometimes meant a direct relationship between the natural object under investigation and the scientist pursuing that investigation. At other times, and perhaps more often, experience played a part in more indirect relations between the object of nature and the scientist. Such indirect relationships included the scientist’s acts of imagination and memories in the absence of the object, acts of reading or listening to witnessed experiences, and acts of passing on and sharing experiences along with wider corpora of scientific knowledge. In these cases, experience was crystallized—even ontologized—into an empirical impression and expression, but not into an empirical method that was deliberately shared qua method, with its own epistemic standards of constituted facts, induction founded on collection and comparison, and so on.

These indirect relationships between nature and the scientist have long been subsumed under what some prominent sixteenth- and seventeenth-century thinkers, endeavoring to break from the past, denigrated as “bookish knowledge.”<sup>15</sup> But this was, and is, a constructed divide between what is empirical about experience (most evidently the visual: what we sense before us) and what is not empirical about it (most evidently the oral: what others have told us that they sensed). Criticism of indirect, bookish knowledge—or rather “inscribed experience,” as we might more appropriately call it—promoted certain empirical practices and demoted

others, in order to establish particular methods of investigating and cognizing the natural world. It was a handy device to concentrate the experience relevant to science into a tighter definition (the empirical method) than its previously multifarious meanings. When the methodological approaches to experience were poured into this form, as Lorraine Daston and Elisabeth Lunbeck have eloquently put it, experience was “shaped and sharpened to scientific ends.”<sup>16</sup> It was honed down to particular epistemic norms, chief among them respect for direct sense perception and objective verification. This is doubtlessly true for the period we have come to know as “early modern.”

There was a price to pay for the empirical bent that insists on a direct sensory relationship with the object as the precondition for making scientific knowledge: the sidelining of other types of experience, that mediated between scientist and object in other ways. Following the early modern proponents of the empirical method who defined scientifically relevant experience in this way, present-day historians of science, too, have often insisted in one way or another on the lasting epistemic hegemony of early modern empirical practices of science such as direct sense observation, systematic recording, induction, and verification.<sup>17</sup>

The practical turn in the history of science has complicated that picture, particularly with respect to the many roles and types of direct experience at work in investigating, sensing, and observing nature and in communicating and verifying natural knowledge.<sup>18</sup> Nevertheless, there is more to be said about the range of possible relationships between scientist and object through the medium of experience, for both the premodern world and contemporary science. Three examples must suffice to make this point. First, experience as live experience of an object (sensory perception), as event, practice, routine, aesthetic act, and work, remains part and parcel of the various ontologies of experience—yet many of these ontologies have been

somewhat downplayed in discussions of scientific experience, because we tend to focus on the epistemic features in scientific practices that resemble empirical methods.<sup>19</sup> Second, the personal and professional experiences that we use without theorizing them remain key to the making of science in the twenty-first century—but still await more attention from historians to note, collate, and assess them.<sup>20</sup> Third, inscribed experience undergoes significant, and epistemically functional, transformations during its rewriting—but the work of tracking those changes has only just begun.<sup>21</sup> The present collection takes up that challenge, opening the field to problems that still intrigue the history of science *tout court*.

Our history of premodern experience in translation studies those epistemic acts of domestication and repurposing that are related to the evidently empirical, but also those that may seem unempirical to our modern eyes. Precisely in those spaces where our perception differs from that of our historical actors', we find experience being put to use and rendered epistemically functional for scientific knowledge of nature. To perform that function, experience was carefully selected, positioned, framed, and shaped by our historical actors—even though, or perhaps because, it was only gradually structured systematically into methodological practices.

Perhaps one reason for this was premodern science's trust in the ideal scientist or expert. Well trained in logical reasoning, often also as physicians, scientists knew how to internalize experience from any given source, integrate it into the science they already possessed inside themselves, and repurpose it to fulfill a panoply of epistemic functions. Scientists acted as epistemic translators of experience, and so did interlingual translators in their own distinctive ways. What we see today on parchment and paper are the externalizations of these acts of trust, testifying to their stability even at a time when premodern epistemic norms of certainty



and truth were already undergoing a profound reevaluation. But when trust in the epistemic powers of the scientist faltered to a large degree, new mechanisms and reorientations of experience arose, creating an experience that was more sharply delimited, actively regulated by norms of reason, and increasingly standardized in form and function.<sup>22</sup>

The issue of trust recurs throughout the book, but we focus on the scope of premodern experience in translation in four different media across time and space. These ontologizations of experience are chosen to highlight the similarities and differences in the preservation and transformation that each medium brings forth, on its own account and through the experiences it inscribes into science.<sup>23</sup> They mean that our book can be neither chronological in its structure nor comprehensively global in its coverage.

To narrow down the immense field of premodern experience in translation, we take as our starting point scientific practices around the *corpus Aristotelicum* and the sciences that twined about it. The science of medicine centering on the works of Galen and Avicenna arose in dialogue with Aristotle's writings, as did the evolving early modern sciences of nature. By focusing on closely related "epistemic cultures," to apply Karin Knorr Cetina's term to our own inquiry,<sup>24</sup> we are able to overcome the boundaries of periodization and localization that are still commonly applied to the premodern world.<sup>25</sup> What once was divided by the labels "ancient," "medieval," "early modern," and various "area studies" here comes together under the two prisms of the premodern world and the epistemic cultures clustering about the *corpus Aristotelicum*.

Given this focus, our book does not and cannot aim to be comprehensive. Quite the contrary. The four case studies in each part, addressing the translation of experience across terms,

arguments, pictorial formats, and expertise, range over many languages, centuries, and continents. They will give only glimpses into the acts and processes of experience in translation. Yet those glimpses can contribute to global histories of science. Looking at translations within and between closely related epistemic cultures, we do not aim to retell older histories of the diffusion of Western science,<sup>26</sup> but neither do we adopt the frameworks of science, empire, and postcolonial studies with their interest in asymmetries between metropolis and colony, indigenous peoples, and hybrid cultural objects. Those dichotomies are not our analytic categories, because they highlight contact zones between epistemic cultures that were worlds apart.<sup>27</sup> Our own interest is in the history of an identifiable set of filiated epistemic cultures as it moves through different linguistic and temporal terrains. We ask how a shared set of epistemic norms—for instance, that science should aim to define and demonstrate things in nature; that science should rely on the scientist and the natural workings of his faculties—guided and framed the epistemic acts performed upon experience, and the epistemic uses and functions that experience was granted in return.<sup>28</sup>

Such a history may also suit other cases where particular scientific corpora were nodes about which epistemic cultures took shape. As such, our book on the *corpus Aristotelicum* and the works that conversed with it may offer a methodological framework for other parts of the world and other historical periods. The transregional expansions of the Confucian or Vedic corpora, along with their related epistemic cultures and scientific practices, are just two examples. In this sense, we hope that our volume will contribute indirectly to the study of other epistemic cultures that do not touch upon European lands at all.<sup>29</sup>

The emphasis on media in this volume may also be favorable for histories after the era of Eurocentric macrohistories and periodizations. As Bernhard Jussen has recently put it, “the

new, mediological orientation in historiography that is currently taking shape looks set to be the most natural and productive path toward a realignment of our material, categories, and questions.”<sup>30</sup> To be sure, only the externalized media of experience have been preserved over time. The subjective media—the sensory and intellectual functions of the scientists—are transmitted only (if at all) indirectly, in the objective media. Whether in terminology, in arguments, in pictorial formats, or in personal expertise, the translations we study are set about with the constraints that we face as historians of science whose scientists are long dead.

That temporal distance comes to center stage with the opening essay of the book, where Markham Geller looks at the role of orality through the lens of Mesopotamian science. In the next piece, Michael Chase introduces key strands in the work of Aristotle and his successors with regard to the status of experience, in a survey that will be particularly relevant to the volume’s studies on terms and arguments. Chase tracks the conflict between reason and experience in Greek thought, from the Presocratics, through the Greek rationalists (Plato, Aristotle and his Peripatetic successors, and the Stoics), to the Roman physician Galen and his reception in the Arabic tradition. Problems of translation, the limits of language and the ineffability of individuals, and the complementary tension between different types of “knowing” turn out to be closely linked throughout the epistemological history he presents.

Following Chase’s paper chronologically, Part II asks how experience is expressed in scientific language, specifically in terms. Papers in this section study the formation, negotiation, and domestication of some key experience terms as they are translated within and across languages. The authors analyze how experience terms altered and preserved their ontologies during such processes, and investigate the impact of cognitive and intellectual practices.

Turning to a larger purview of inscribed experience, Part III addresses the translation of experience into scientific arguments. The four papers present essential features, status, and functions of experience in arguments, and show how these were affected by premodern epistemic translations, whether intralingual or interlingual. They ask how scientific translations of experience changed scientific norms and how, in turn, scientific norms facilitated or limited the possibilities of scientific translations of experience in arguments.

Part IV moves away from experience in letters to experience in pictorial systems. The papers investigate how experience was translated into symbols, tables, and images, and how visual formats of this kind offered different ways of articulating, framing, and standardizing experience than did the verbal systems discussed in the previous two sections. As we will see, pictorial formats followed modes of expression that intertwined imagination with reason, and these different modes of expression generated new experiences and new scientific norms.

The book's most ephemeral and hard-to-access object comes to the fore in Part V: the expertise of the translators. The papers in this section investigate how translations of scientific experience were shaped by the cognitive and intellectual practices, habits, and authority of the translators and their sources. They show that such expertise was inseparable from its agents' social and cultural environments, and that, in turn, these environments shaped and reshaped the transmission of experience in the sciences.

How does experience take shape in premodern scientific terms and their translations? How is it expressed in scientific arguments? How is it articulated and arranged in pictorial formats? And how are translations of scientific experience molded by the expertise of the translators?

In her epilogue, Lorraine Daston completes the volume's historical arc by tracing these themes around the translocation, transformation, and assimilation of experience up to the science and scholarship of the present day.

## Bibliography

- Allen, Barry. *Empiricisms: Experience and Experiment from Antiquity to the Anthropocene*. Oxford: Oxford University Press, 2021.
- Bacon, Francis. *The New Organon: Or, New Directions Concerning the Interpretation of Nature*. Translated by Jonathan Bennett. Early Modern Texts, 2017, [www.earlymoderntexts.com › assets › pdfs › bacon1620](http://www.earlymoderntexts.com/assets/pdfs/bacon1620).
- Baltuta, Elena, ed. *Medieval Perceptual Puzzles: Theories of Sense-Perception in the 13th and 14th Centuries*. Leiden: Brill, 2019.
- Basalla, George. "The Spread of Western Science." *Science* 156, no. 3775 (1967): 611–22.
- Ben-Chaim, Michael. *Experimental Philosophy and the Birth of Empirical Science*. London: Routledge, 2017.
- Bennett, David, and Juhana Toivanen, eds. *Philosophical Problems in Sense Perception: Testing the Limits of Aristotelianism*. Cham: Springer, 2020.
- Blair, Ann. "Humanist Methods in Natural Philosophy: The Commonplace Book." *Journal of the History of Ideas* 53, no. 4 (1992): 541–51.
- Bleichmar, Daniela. "Pictorial Knowledge on the Move: The Translations of the *Codex Mendoza*." In *Translating Nature: Cross-Cultural Histories of Early Modern Science*, edited by Jaime Marroquín Arredondo and Ralph Bauer, 95–117. Philadelphia: University of Pennsylvania Press, 2019.
- Brentjes, Sonja, and Alexander Fidora, eds. *Premodern Translation: Comparative Approaches to Cross-Cultural Transformations*. Turnhout: Brepols, 2021.
- Burke, Peter, and R. Po-chia Hsia, eds. *Cultural Translation in Early Modern Europe*. Cambridge: Cambridge University Press, 2007.
- Clanchy, M. T. *From Memory to Written Record: England, 1066–1307*. Chichester: Wiley-Blackwell, 2013.

- Cook, Harold, ed. *Translation at Work: Chinese Medicine in the First Global Age*. Leiden: Brill, 2020.
- Daston, Lorraine. “What Can Be a Scientific Object? Reflections on Monsters and Meteors.” *Bulletin of the American Academy of Arts and Sciences* 52 (1998): 35–50.
- Daston, Lorraine, and Peter Gallison. *Objectivity*. New York: Zone Books, 2007.
- Daston, Lorraine, and Elisabeth Lunbeck. *Histories of Scientific Observation*. Chicago: University of Chicago Press, 2011.
- Daston, Lorraine, and H. Otto Sibum. “Introduction: Scientific Personae and Their Histories.” *Science in Context* 16, nos. 1–2 (2003): 1–8.
- Dear, Peter. “The Meanings of Experience.” In *The Cambridge History of Science*, vol. 3: *Early Modern Science*, edited by Katharine Park and Lorraine Daston, 106–31. Cambridge: Cambridge University Press, 2006.
- Derrida, Jacques. *Edmund Husserl’s Origin of Geometry: An Introduction*. Translated by John P. Leavey. Lincoln: University of Nebraska Press, 1978.
- Dupré, Sven. “Introduction: Science and Practices of Translation.” *Isis* 109 (2018): 302–7.
- Eamon, William. *Science and the Secrets of Nature: Books of Secrets in Medieval and Early Modern Culture*. Princeton, NJ: Princeton University Press, 1996.
- Fransen, Sietske, Niall Hodson, and Karl Enenkel, eds. *Translating Early Modern Science*. Leiden: Brill, 2017.
- Gieryn, Thomas. “Boundary Work and the Demarcation of Science from Non-Science: Strains and Interests in Professional Ideologies of Scientists.” *American Sociological Review* 48 (1983): 781–95.
- Glenney, Brian, and José Filipe Silva, eds. *The Senses and the History of Philosophy*. New York: Routledge, 2019.

- Grant, Edward. *Foundations of Modern Science in the Middle Ages*. Cambridge: Cambridge University Press, 1996.
- Hossfeld, Paul. *Albertus Magnus als Naturphilosoph und Naturwissenschaftler*. Bonn: Albertus-Magnus-Institut, 1983.
- Jacquart, Danielle. “Die Medizin als Wissenschaftsdisziplin und ihre Themen.” In *Die Philosophie des Mittelalters*, vol. 4/1, edited by Alexander Brungs, Vilem Mudroch, and Peter Schulthess, 1595–612. Basel: Schwabe, 2017.
- Jalobeanu, Daniela. “Francis Bacon, Early Modern Baconians, and the Idols of Baconian Scholarship.” *Societate si politica* 7, no. 1 (2013): 5–27.
- Jardine, Lisa. *Francis Bacon: Discovery and the Art of Discourse*. Cambridge: Cambridge University Press, 1974.
- Jussen, Bernhard. “Kohärenzinseln: Arbeiten an geschichtswissenschaftlichen Versuchsaufbauten nach dem Ende des Eurozentrismus.” In *Normative Ordnungen*, edited by Rainer Forst and Klaus Günther, 209–32. Frankfurt am Main: Surhkamp, 2021.
- Kaiser, David, ed. *Pedagogy and the Practice of Science*. Cambridge, MA: MIT Press, 2005.
- Kittler, Friedrich. *Discourse Networks, 1800/1900*. Translated by Michael Metteer. Stanford, CA: Stanford University Press, 1990.
- Knorr Cetina, Karin. *Epistemic Cultures: How the Sciences Make Knowledge*. Cambridge, MA: Harvard University Press, 1999.
- Krause, Katja. “Source Mining: Arabic Natural Philosophy and *experientia* in Albert the Great’s Intellectual Practices.” In *Medieval Science between Emergence and Inheritance: Albert the Great and His Arabic Sources*, edited by Katja Krause and Richard C. Taylor, forthcoming.
- Krause, Katja, and Henryk Anzulewicz. “Albert the Great’s *Interpretatio*: Converting



- Libraries into a Scientific System.” In *Premodern Translation: Comparative Approaches to Cross-Cultural Transformations*, edited by Sonja Brentjes and Alexander Fidora, 89–132. Turnhout: Brepols, 2021.
- Kusukawa, Sachiko, and Ian Maclean, eds. *Transmitting Knowledge: Words, Images, and Instruments in Early Modern Europe*. Oxford: Oxford University Press, 2006.
- Landecker, Hannah. “The Matter of Practice in the Historiography of the Experimental Life Sciences.” In *Handbook of the Historiography of Biology*, vol. 1, edited by Michael Dietrich, Mark Borrello, and Oren Harman, 243–64. Cham: Springer, 2018.
- Latour, Bruno. *Reassembling the Social: An Introduction to Actor-Network-Theory*. Oxford: Oxford University Press, 2005.
- Leong, Elaine. *Recipes and Everyday Knowledge: Medicine, Science, and the Household in Early Modern England*. Chicago: University of Chicago Press, 2018.
- Lloyd, Geoffrey. “The Clash of Ontologies and the Problems of Translation and Mutual Intelligibility.” In *Science in the Forest, Science in the Past*, edited by Geoffrey Lloyd and Aparecida Vilça, 1–13. Chicago: HAU Books, 2020.
- MacLeod, Roy, ed. “Nature and Empire: Science and the Colonial Enterprise.” *Osiris* 15 (2001).
- Manning, Patrick, and Abigail Owen, eds. *Knowledge in Translation: Global Patterns of Scientific Exchange, 1000–1800 CE*. Pittsburgh, PA: University of Pittsburgh Press, 2018.
- Marroquín Arredondo, Jaime, and Ralph Bauer, eds. *Translating Nature: Cross-Cultural Histories of Early Modern Science*. Philadelphia: University of Pennsylvania Press, 2019.
- Mol, Annemarie. *The Body Multiple: Ontology in Medical Practice*. Durham, NC: Duke University Press, 2002.

- Ong, Walter. *Orality and Literacy*. London: Methuen, 1982.
- Pimentel, Juan. "Sighting and Haunting of the South Sea." In *Translating Nature: Cross-Cultural Histories of Early Modern Science*, edited by Jaime Marroquín Arredondo and Ralph Bauer, 27–44. Philadelphia: University of Pennsylvania Press, 2019.
- Pomata, Gianna, and Nancy G. Siraisi, eds. *Historia: Empiricism and Erudition in Early Modern Europe*. Cambridge, MA: MIT Press, 2005.
- Rankin, Alisha. *The Poison Trials: Wonder Drugs, Experiment, and the Battle for Authority in Renaissance Science*. Chicago: University of Chicago Press, 2021.
- Schmidgen, Henning. *Hirn und Zeit*. Berlin: Matthes & Seitz, 2014.
- Shank, Michael H., and David C. Lindberg. "Introduction." In *The Cambridge History of Science*, vol. 2: *Medieval Science*, edited by David C. Lindberg and Michael H. Shank, 1–26. Cambridge: Cambridge University Press, 2013.
- Venuti, Lawrence. *The Translator's Invisibility: A History of Translation*. London: Routledge, 1995.
- Werrett, Simon. *Thrifty Science: Making the Most of Materials in the History of Experiment*. Chicago: University of Chicago Press, 2018.
- Wolfe, Charles, and Ofer Gal, eds. *The Body as Object and Instrument of Knowledge: Embodied Empiricism in Early Modern Science*. Dordrecht: Springer, 2010.
- Yates, Frances A. *The Art of Memory*. London: Bodley Head, 2014.
- Young, Mark Thomas. "Experimentalist as Spectator: The Phenomenology of Early Modern Experimentalism." In *The Past, Present, and Future of Integrated History and Philosophy of Science*, edited by Emily Herring, Kevin Matthew Jones, Konstantin S. Kiprijanov, and Laura M. Sellers, 133–49. Abingdon: Routledge, 2019.

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<sup>1</sup> On this example from Albert the Great's *De animalibus*, see also Harvey in this volume.

<sup>2</sup> Our use of the term "media" starts from the classical Aristotelian sense, of vehicles that carry certain properties of impressions to the senses, but extends it to the linguistic and physical vehicles that carry these properties on to other people. This usage interlocks with some media scholarship (e.g., Kittler, *Discourse Networks*) and history of science that applies insights from media studies (e.g., Schmidgen, *Hirn und Zeit*).

<sup>3</sup> Though our notion of "domestication" is affiliated to that debated in translation studies, for example in the work of Paul Ricoeur, Antoine Berman, and Lawrence Venuti (e.g., Venuti, *Translator's Invisibility*), we use it to describe not interlingual acts, but the epistemic acts in which experience moves from the event of live experience into the cognitive field of the scientist.

<sup>4</sup> "Science" is used here not in the modern sense, but as a variety of practices for organizing and systematizing knowledge of nature. See Gieryn, "Boundary Work."

<sup>5</sup> Recently, historians of philosophy have addressed theories of sense perception in the Aristotelian tradition. See, e.g., Glenney and Silva, *Senses*; Baltuta, *Medieval Perceptual Puzzles*; Bennett and Toivanen, *Philosophical Problems*.

<sup>6</sup> On the role of writing in the transmission of scientific knowledge, see, e.g., Derrida, *Edmund Husserl's Origin of Geometry*.

<sup>7</sup> Classics on this matter are Ong, *Orality and Literacy*; Clanchy, *From Memory to Written Record*; Yates, *Art of Memory*.

<sup>8</sup> Recent work in translation studies has likewise blurred the conventional orders between different types of translation, though without our focus on experience. For an overview, see the Forum on "cultural translation" in *Translation Studies* 2, no. 2 (2009) and 3, nos. 1 and 3 (2010); also Burke and Hsia, *Cultural Translation*; Dupré, "Introduction."

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<sup>9</sup> Writing on the thirteenth-century Latin West, Katja Krause and Henryk Anzulewicz (“Albert the Great’s *Interpretatio*”) show that the Latin term *interpretatio* unified epistemic practices of interlingual translation and commentary on the *corpus Aristotelicum*. Similarly, Daniela Bleichmar (“Pictorial Knowledge”) describes two different meanings of translation in the early modern period, physical movement of things and linguistic movement between languages, and adds a third type, “acts of interpretive translation.” This last category comes closest to our own discussion, but it moves on the textual and material level rather than examining the roles of subjects and their experiential and cognitive inputs.

<sup>10</sup> Work on translation in the history of science has mainly applied hermeneutic or semantic approaches to the epistemic acts performed on knowledge. See, for instance, Brentjes and Fidora, *Premodern Translation*; Fransen, Hodson, and Enenkel, *Translating Early Modern Science*; Cook, *Translation at Work*; Manning and Owen, *Knowledge in Translation*.

<sup>11</sup> Empiricism is one example of loss through attention, as Bruno Latour indicates (alluding to Whitehead): “Empiricism, conceived as a clear-cut distinction between sensory impressions on the one hand and mental judgment on the other, cannot certainly claim to be a complete description of what ‘we should be attentive to in experience.’” Latour, *Reassembling the Social*, 110.

<sup>12</sup> Mol, *Body Multiple*, 4, also quoted by Lloyd, “Clash of Ontologies.” See also Daston, “What Can Be a Scientific Object?”

<sup>13</sup> We dispute the conventional exclusion of premodern science from such wider currents, often made on the basis that premodern scientific experience is not an empirical method. See, e.g., Hossfeld, *Albertus Magnus*; Jacquart, “Die Medizin”; Dear, “Meanings of Experience.”

<sup>14</sup> Other media, at different levels of resolution, could also be studied in this way—for instance, particular theories (as media on the meso level) or even entire systems of sciences (on the macro level).

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<sup>15</sup> Francis Bacon famously declared that natural knowledge needed new methods of direct perception, observation, recording, and verification: “We can’t do without experience; but so far we haven’t had any foundations for experience, or only very weak ones.” *New Organon* I, aph. 98. On Bacon’s method, see Jardine, *Francis Bacon*; Jalobeanu, “Francis Bacon”; on “bookish knowledge” more generally, Blair, “Humanist Methods.”

<sup>16</sup> Daston and Lunbeck, *Histories of Scientific Observation*, 2.

<sup>17</sup> This critique is voiced by Ben-Chaim, *Experimental Philosophy*; Dear, “Meanings of Experience”; Grant, *Foundations of Modern Science*, 159–60.

<sup>18</sup> Examples are Eamon, *Science*; Pomata and Siraisi, *Historia*; Kusukawa and Maclean, *Transmitting Knowledge*; Young, “Experimentalist as Spectator.”

<sup>19</sup> For instance, Rankin, *Poison Trials*; Werrett, *Thrifty Science*; Krause, “Source Mining.”

<sup>20</sup> Many biographical studies of scientists do address their personal and professional experiences (e.g., Daston and Sibum, “Scientific Personae”), but a more inclusive history of reading and writing practices in the modern sciences is still required. See Landecker, “Matter of Practice,” 259–60. Some of Landecker’s desiderata have already been applied, e.g., Kaiser, *Pedagogy and the Practice of Science*.

<sup>21</sup> See, e.g., Krause, “Source Mining”; Leong, *Recipes*.

<sup>22</sup> See, e.g., Daston and Lunbeck, *Histories of Scientific Observation*, 2; Wolfe and Gal, *Body as Object*; Allen, *Empiricisms*.

<sup>23</sup> This approach also brings some recent trends in the history of science—visual studies and global history—into conversation with the more traditional approaches of textual study and the history of ideas.

<sup>24</sup> Knorr Cetina, *Epistemic Cultures*. Her view of “culture” differs from that in most other studies on translation in the history of science, such as Burke and Hsia, *Cultural Translation*.

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<sup>25</sup> A paper where this common practice is usefully problematized, but nevertheless applied for lack of a better solution, is Shank and Lindberg “Introduction.”

<sup>26</sup> Basalla, “Spread of Western Science.”

<sup>27</sup> Valuable historical studies on such contact zones can be found in Marroquín Arredondo and Bauer, *Translating Nature*. See also Lloyd, “Clash of Ontologies.”

<sup>28</sup> For an insightful discussion on norms and normativity in history and how they evolve, see Daston and Gallison, *Objectivity*.

<sup>29</sup> On localizing Europe, see MacLeod, “Nature and Empire”; Pimentel, “Sighting and Haunting.”

<sup>30</sup> Jussen, “Kohärenzinseln,” 232.