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Scientific translation

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Addressing research questions and issues relevant to scientific translation requires reflection on two key concepts, science and translation. The concept of translation is critically examined in a variety of ways by translation scholars who seek greater understanding of the place of translation in the world. The concept of science, no less complex, receives abundant critical examination in a different body of scholarship. The overlapping fields of science studies, science and technology studies (STS), and science, technology and society (also STS) are concerned with greater understanding of the place of science in the world. Both science studies and translation studies are inherently interdisciplinary and employ a wide range of theoretical and empirical approaches to address historical, philosophical, social, cultural and political questions. Our understanding of the place of scientific translation in the world may therefore benefit greatly from scholarship at the confluence of these two disciplines.

Perspectives on science

In the European and Anglophone context, philosophers of science began to address the cultural significance of science in the inter-war years and after World War II (Turner 2008), but the seminal work of Thomas Kuhn in the 1960s paved the way for the more extensive development of social studies of science during the 1970s and beyond. Kuhn (1962, 1970) was interested in how scientific communities are organized and how scientific knowledge evolves through different periods of scientific revolution or paradigm shifts. His and subsequent contributions, which approached the concept of science from historical and sociological perspectives, increasingly challenged assumptions of scientific realism. Alternative, often constructivist, understandings of science emerged through critical analysis of the doing of science and of the relations between science and society. Challenges to post-positivist epistemology included rejection of the assumptions that science is unitary and universal, i.e. that there would be no culturally distinctive differences between different scientific disciplines or between science performed in different institutional settings, or in how knowledge is shaped by and shapes the society in which it develops (Harding 1998:3).

Constructivism contrasted with positivism and logical empiricism in focusing on how sciences and cultures are co-constitutive and co-evolving. Studies undertaken through the 1970s and 1980s focused on how science is shaped by the interests of relevant social groups (Bloor 2001) or how scientific knowledge is locally negotiated by scientists through their practices (Latour and Woolgar 1979; Travek 1988), among other questions. This understanding of science as practice and as culture (Pickering 1992) shifted researchers' interest away from science as the pursuit of universal truths and towards a focus on studying what scientists do and the enculturation of those situated knowledge practices (Franklin 1995). Science was no longer presumed to be universal, disinterested and value-free. Instead, researchers seek to understand the culture of the lab and the local strategies of sense-making, as well as the embeddedness of those local scientific cultures in wider cultural meanings (ibid.).

It could be argued that scholarship on scientific translation is following a similar trajectory, though with an interlude of some decades. The majority of publications that focused on scientific translation prior to the 2000s aimed to serve as guides to translators or translation students. Early contributions reflected an underlying conception of science as knowledge and of scientific discourse as communication of invariant referential meaning. Manuals produced during the 1960s, 1970s and 1980s were designed and used as practical guides to scientific and/or technical translation (Jumpelt 1961; Maillot 1969, 1981; Finch 1969; Pinchuck 1977; Bédard 1986, 1987). Many fulfilled their didactic function through a strong normative emphasis on techniques for achieving terminological accuracy and precision of expression. A small number of contributions focused on the translator's development of conceptual scientific knowledge and understanding (Hann 1992, 2004). Since the turn of the century, guides to scientific translation have reflected a growing understanding of the social and cultural importance of scientific translation as part of scientific practice, and increasingly offer a much more contextualized view of scientific communication, providing insights into the activities of professional scientific and technical communication and/or focusing on specific scientific genres (Schmitt 1999; Byrne 2006; Scarpa 2001; Montalt and González Davies 2007; Scarpa 2008; Stolze 2009; Byrne 2012; Olohan 2016).

Aligned with universalist and positivist views of science, many of the earlier contributions on scientific translation that involved textual analysis were limited by an understanding of scientific texts as serving primarily informative or referential functions, a view that is reflected in Ortega y Gasset's (1937/2000:50) assertion that scientific translation is easier than translation of literary texts, due to a perceived universality of the language of science and/or of scientific thought. This perspective overlooks the significant expressive and operative functions of scientific discourse, as the means by which authors construct meanings, make claims, challenge others, enrol allies and pre-empt contestation, seek to build consensus within a scientific community, exclude or include non-members of that and other communities and establish and drive research agendas (Latour 1987; Myers 1990; Swales 1990, 2004). Failure to acknowledge these social and rhetorical functions of scientific discourse can lead to a focus on precision of terminology and accuracy of description, and moreover a consideration of both as somehow culturally invariant. This conceptualization of science, in turn, may be responsible for the relative lack of attention to scientific translators' social and textual practices, compared to

the breadth and depth of research on their counterparts in literary domains. The typical backgrounds of translation researchers, for example in literary and linguistic studies, may also mean that they are less prepared to engage with scientific disciplines, ideas and discursive practices.

Research themes

Among the relatively small number of research contributions on the translation of science, a significant set is historiographical. It is widely acknowledged that translation has played a major role in the production and circulation of scientific knowledge throughout the ages (Salama-Carr 1995). Some historical research therefore takes scientific and technical texts as a basis for in-depth theoretical reflection on the role of translation. A key contribution in this regard is Montgomery's (2000) analyses of translation activity in several periods. A central assumption in this work is that translation is involved in knowledge production at all levels, and Montgomery's case studies serve to illustrate the role of translation in the shaping and reshaping of ideas as they travel between cultural and linguistic contexts. Cases analysed include the history of translating astronomy in Europe from antiquity to the Renaissance, and the translation of science in Japan from the late medieval period into the twentieth century. Other specific cultural contexts and periods in which scientific translation has been examined include Dodson's (2005) research on translation into Indian languages in nineteenth-century colonial India, Raj's work (2007) on collaborative scientific production in India between 1650 and 1900, and Meade's (2011) study of the development of engineering knowledge in early Meiji-era Japan.

The ninth-century, which witnessed a strong movement focused mostly on the translation of ancient Greek texts into Arabic, and the Middle Ages, when a considerable number of translations were carried out from Arabic into Latin, form two periods of translation that have been extensively studied by historians of science and translation scholars, with researchers challenging assumptions about knowledge diffusion and translation as acculturation that underlay traditional accounts. In their reappraisals of the translation of science from Greek to Arabic around the ninth century, Saliba (1994, 2007) and Rashed (2006, 2009b) treat translation, research and learning as being closely linked; translators and their Arabic translations are shown to play crucial roles in the advancement in scientific endeavours and research programmes of the translator-scholars or scholar-translators, their patrons and institutions (Rashed 2006:172). Saliba (2007), for example, argues that the Greek astronomical tradition was assessed critically by translators into Arabic, who reworked and reevaluated the research. Rashed (2009a) examines the case of Thābit ibn Qurra', a Baghdad-based scholar who translated texts by Archimedes, Apollonius and others from Greek into Arabic and revised translations by others, including Euclid's *Elements* and Ptolemy's *Almagest*, during the second half of the ninth century. Thābit ibn Qurra's translation work enabled him and his masters, the Banū Mūsā, to pursue their own research in astronomy, philosophy and geometry (Rashed 2009a:6). Both scholars, Saliba and Rashed, conclude that the translation movement was governed by social conditions of the time and that translation was concomitant with research,

contributing to the development and implementation of new research programmes, often through patronage.

Likewise, Burnett's extensive research (2001, 2005, 2006) on the translation of mathematics and science from Arabic into Latin in the Middle Ages reveals how the preferred translation practices were related to the prestige values attached to the source or target language or culture at particular periods. Gutas (1998, 2006) compares two translation movements – Græco-Arabic and Arabic-Latin – and situates both in their internal and international political and social contexts, thereby observing numerous differences in motivation for the two translation movements. Other scholars have also shown that translation was an essential part of scientific practice during these periods, focusing their attention on the misnomered 'schools' of Baghdad (Salama-Carr 1991, 2006; Gutas 1998) and Toledo (Hernando de Larramendi and Fernández Parrilla 1997; Foz 1998; Pym 2000), respectively.

While these two periods and translation movements garner most attention, the intricate relationship between translation and scientific research has been observed elsewhere too. Jardine and Segonds (1999), for example, discuss how the German astronomer Johannes Kepler reworked, emended and glossed Aristotle's *De caelo*, not for the sake of literary embellishment but so that the text could offer him a basis on which he could present his own work in astronomy. These and other historical cases exemplify the need for research to move beyond the texts to consider the scientific context, the motivations for translation, revision and retranslation, the role of patrons, and many other aspects which help to illuminate the "dialectic of translation and research" (Rashed 2006:193).

Other historical analyses with a strong focus on translation include the work of Wright (1998, 2000) on how Western chemistry travelled in China in the nineteenth century. Wright's interest in the development of concepts and terms is framed by detailed studies of the actors involved in translation activities and their converging and diverging interests, with due attention also to the intellectual and political circumstances in which those activities took place. Further studies of the circulation and construction of knowledge in China include volumes edited by Lackner et al. (2001) and Lackner and Vittinghoff (2004). The anthology of Chinese discourse on translation compiled by Martha Cheung, with extensive editorial apparatus, traces specific translation practices in China; Volume Two in particular, completed by Robert Neather (2017), focuses on the translation from Latin into Chinese of European texts on science and technology. It is useful to read these studies against the backdrop of Needham's substantial series *Science and Civilisation in China* and critics of that project. The series, consisting of seven volumes, each comprising several parts, was published from 1954 onwards, with Needham authoring much of the work himself during his lifetime. Needham's goal was to recognize and acknowledge China's contributions to science but, in doing so, he adhered to mainstream ideas of the time that conceived of modern science as uniquely 'Western', thus perpetuating notions of the divide between so-called Western (modern) science and Chinese (traditional) science (Hart 1999).

Canonical figures and their scientific works have traditionally tended to be a focal point for historians of science (Jardine 2003:133) and this tendency is also seen in translation research.

One notable example is Darwin's *On the Origin of Species*, which has been studied in relation to its positivistic translation into French (Brisset 2002), the expression of epistemic stance in Dutch translations (Vandepitte et al. 2011) and the handling of unfamiliar Darwinian concepts and terms in Arabic translations and scientific discourse (Elshakry 2008). Other studies of canonical translations include the publishing of Euclid in China (Engelfriet 1998), retranslations of Newton's *Opticks* in French (Baillon 2008) and translations of Linnaeus' *Systema naturae* into French and other languages (Dietz 2016; Duris 2008; Hoquet 2008).

In parallel, historians and translation scholars have also begun to focus on the contributions of women to scientific endeavour through their translation work, which was variously acknowledged or unacknowledged, visible or invisible, cautious or confident. Martin (2011, 2016), for example, explores the contributions of women translators of botany in the early nineteenth century and scientific travel writing in the late eighteenth century; her detailed analyses show how the translators deploy various narrative strategies to mark their involvement in the process of scientific knowledge-making.

While there is near boundless scope for historical accounts of the work of a particular translator of science or the translation of a particular text or its reception in specific times and places, studies that are of particular interest to translation scholars also implicitly or explicitly reflect on underlying conceptualizations of translation. A transmissionist or diffusionist model of translation may treat knowledge as being wrapped, boxed and transported in the translation van before being unpacked, placed and admired in its new location. By contrast, other models may focus on how knowledge is shaped and transformed in and through translation. Increasingly, the cultural and ideological situatedness of scientific translation practice is of interest to scholars. Examples include Somerset's (2011) study of shifts in ideological orientation in the translation of a seminal popular science work of the nineteenth century and Sánchez' (2011, 2014) study of Carmen de Burgos' paratextual and textual interventions as she challenged the misogyny of a scientific treatise by Möbius when translating it into Spanish. Elsewhere, Sánchez (2007) explores how gender is represented discursively in a French edition of a popular science magazine and the Spanish translation of part of the French publication. That analysis contrasts the social constructivist perspectives on gender that are reflected in discursive choices of the French magazine with a foregrounding of biomedical perspectives and biological determinism in the Spanish. In the Spanish translations in particular, through discursive moves that gender the body, the feminine and the masculine are presented as natural and mutually exclusive categories, and "difference replaces differentiation" (Sánchez 2007:191). The respective scientific discourses are thus seen to reflect and participate in contemporary social and legal debates on gender roles and sexual dichotomy.

Any consideration of the translation of science must also consider the issue of the dominance of the "Tyrannosaurus rex" of English (Swales 1997:374) and the implications of this dominance (Montgomery 2009; Gordin 2015). One area of corpus-based study has involved investigating the possible influence of translation on language change, with a strong focus on popular science discourses (House 2002, 2003; Baumgarten et al. 2004; Malamatidou 2013; House 2013). A second area of enquiry has been initiated by Bennett's (2007a, 2007b, 2011) analyses of the

role of translation in reinforcing the hegemony of English and scientific epistemologies of the Anglophone world and undermining or obliterating non-Anglophone epistemologies, drawing on Santos' (1995) use of the term 'epistemicide' to denote the destruction of knowledges by European expansionism and Northern oppression of the South from the sixteenth century onwards. Finally, given that much present-day translation is of popular science discourse, a growing body of work focuses on key features of such texts. In-depth analyses of how translators deal with metaphor (Shuttleworth 2011, 2014, 2017; Manfredi 2014) and other metadiscursive features of reader-writer interaction (Liao 2011) provide important insights into how discursive practices can shape public understanding of science.

Future directions

Translation studies still has a number of blind spots when it comes to scientific translation. There remains considerable scope to develop more complex understandings of the transcultural nature of science (Olohan 2014). Productive approaches from historians of science include Secord's (2004) work on knowledge in transit and Raj's (2007) conceptualization of sites of intercultural contact. These approaches are interested in how scientific knowledge and practices circulate and interact and are influenced by both the processes of circulation and the local conditions in which they are entangled; they require further studies of the socio-cultural and material aspects of scientific translation practice.

Scholarship on scientific translation policies and practices can also be further extended by engaging with approaches to the study of power inequalities that have emerged in areas of science scholarship such as postcolonial science studies and feminist science studies, the latter as exemplified by Sánchez' work (2007, 2011, 2014). An understanding of science as constitutive of colonialism, for example, requires science and colonialism to be studied as co-emergent and co-produced; such studies can then challenge colonial logics, including categories, identities and concepts that have been given epistemic credibility by Eurocentric and modernist science (Hamilton et al. 2017:613). Translation research can continue to play a crucial role in studying how knowledge systems and knowledges are bestowed or denied legitimacy, whether through colonizing projects or the exercise of other forms of epistemological power.

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