

# Knowledge Transfer and Science Transfer

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We are all familiar with stories of the daring voyages of discoverers and researchers who braved the seas and severe privation in the service of truth and enlightenment. The title of this article, "Knowledge Transfer and Science Transfer", and the fact that it is included in the "Europe and the World" thread may conjure up similar images but hopefully also the counter reaction: these clichés, which are deeply rooted in the cultural memory of Europe, have lately been fundamentally questioned and replaced by more nuanced concepts of knowledge transfer. On the one hand, this article sketches the history of this change; and, on the other hand, it offers some general principles for approaching the topic of knowledge transfer and science transfer. The article not only discusses the relevant concepts and the historical delineations associated with the topic, but provides a broader perspective including diverse phenomena of knowledge transfer which go beyond the more limited concept of "science transfer". As the primary impetus for more recent literature on the topic, postcolonial theory and its methodological implications are also discussed. Here George Basalla's model of knowledge transfer is taken as the starting and focal point.

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## Introduction

Knowledge transfer and science transfer are ubiquitous processes, which can be identified in almost all temporal and spatial contexts.<sup>1</sup> For example, a history of knowledge transfer could begin roughly 10,000 years ago with the early phase of the Neolithic Revolution (that is, the transfer of knowledge of the production methods involved in crop cultivation and livestock farming)<sup>2</sup> and continue up until the present day, including examples as varied as the internationalization of research practice or the use (and exploitation) of indigenous knowledge in commercial, ethnopharmacological knowledge transfer.<sup>3</sup> Between these poles are transfer processes as varied as the Asiatic-European knowledge exchange in Hellenism,<sup>4</sup> knowledge transfer in pre-Columbian America,<sup>5</sup> the ideal of a European republic of scholars in the early modern period,<sup>6</sup> as well as the export of the European sciences in the context of colonialism (→ Media Link #ac).<sup>7</sup> Among the classic "sites" of the historical study of knowledge transfer are the research voyages of the early modern period, the Jesuit order and its worldwide networks (→ Media Link #ad), the promotion of science by empires and nations, as well as the central importance of trade for colonial knowledge transfer. In terms of disciplines, the focus has primarily been on cartography, technology and medicine, as well as the botanical study of medicinal plants and plants suitable for cultivation as cash crops.

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However, given the ubiquity of forms of knowledge transfer, this selection of topics and disciplines is by no means the only possible selection; rather it reflects the interests and perspectives of the researching historians. This highlights the methodological problem that a comprehensive universal history of knowledge transfer is not a realistic goal, and the selection of specific case studies is itself dependent on changing historiographical trends. For example, early studies on knowledge transfer were predominantly limited to science transfer, which was understood as the export of the modern European sciences to "non-scientific cultures". Accounts glorifying the achievements of the great research voyagers predominated initially, while the focus shifted to institutional and political aspects of the export of European science from the 1960s. Theoretical developments – in particular, post-colonialism (→ Media Link #af) – have since led to another

shift in perspective, and present-day research pays increased attention to indigenous forms of knowledge, as well as connections between indigenous and European knowledge systems. Thus, a complex picture emerges, in which the thematic extent of knowledge transfer and science transfer varies depending on historiographical interests and standards.

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## Knowledge Transfer – Science Transfer: Conceptual Problems

The close connection between historical research on the transfer of knowledge and science and methodological debates results from the ubiquity of such transfer processes and from the necessity of placing the selection of specific case studies in historical context. However, the inevitable conceptual ambiguities that arise hamper communication. Concepts such as "knowledge", "science" and "transfer" are not delimited in their meaning, and there have been heated debates about the appropriateness of using these terms.

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Numerous philosophers and researchers of science and knowledge have attempted to establish a typology of knowledge – i.e., a categorization of that which is recognized as knowledge. A comparison of the resulting typologies of knowledge further demonstrates how complex and inconsistent the various phenomena connected with knowledge are. For example, knowledge researchers differentiate between everyday knowledge, practical knowledge, expert knowledge, theoretical knowledge, available knowledge (*Verfügungswissen*) and orientational knowledge (*Orientierungswissen*).<sup>8</sup> One approach which is often cited differentiates between explicit and implicit knowledge ("tacit knowledge").<sup>9</sup> This concept has proved productive for the discipline of knowledge research because it enables one to challenge concepts of knowledge as a purely rational and cognitively fully communicable consciousness.

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In spite of this, most approaches to the history of knowledge focus on knowledge which is defined, systematized and presented as such – as knowledge – within a society at a particular point in history. The more consciously and abstractly it is formulated, the more likely it is to be considered knowledge. This also makes it easier to use concepts that express the idea that knowledge must be understood as being embedded in larger contexts: concepts such as knowledge order, knowledge regime, episteme and knowledge system also imply that these contexts may include power effects and centralization effects. In contrast, concepts such as stock of knowledge (*Wissensbestand*), knowledge storage and knowledge acquisition imply an understanding of knowledge as a resource.

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All these concepts resonate in a particular way when knowledge is discussed in global contexts. Numerous terms have emerged that are intended to describe the relationship between European science and the knowledge of people outside Europe. Terms such as belief, superstition, traditions, as well as primitive, religious, traditional or indigenous knowledge are used. Terms such as "knowledge system" – e.g., "traditional knowledge systems" and "indigenous epistemologies" – imply a more holistic approach. However, hardly a single term has avoided the accusation that – explicitly or implicitly, intentionally or unintentionally – it reproduces the traditional dichotomy.<sup>10</sup>

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Another complex of problems results from the differentiation between scientific and non-scientific knowledge – a differentiation, which in practice is indistinguishable from the normative elevation or devaluing of particular forms of knowledge. Science historians are therefore not interested in a correct and definitive differentiation between scientific and non-scientific knowledge, but are primarily concerned with the multifarious historical functions and motives of the "boundary works"<sup>11</sup> around the concept of science, whether they be political, ideological, social, cultural or economic in nature. The legitimizing role of such differentiations becomes particularly clear in the global context when the "scientific-ness" of non-European knowledge systems is at issue. Such differentiations were particularly significant, for example, when the existence of a national Indian scientific tradition which predated the colonial era was being asserted. Founding figures of the southern Asian sciences, such as the physicist and botanist Jagadish Chandra Bose (1858–1937) (→ Media Link #ag), explicitly defined their goal as "not to introduce science to India, but to revive Indian science."<sup>12</sup>

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With the emergence of post-colonial theory, it is also becoming clear that the historiography of science transfer cannot be separated from a general history of knowledge. Such a separation would not only lead to a restriction of perspective and remove numerous indigenous knowledge systems from the purview. In addition, a detailed analysis of the interaction of various scientific and non-scientific forms of knowledge is a prerequisite to understanding classic processes of science transfer. The numerous, well-documented influences which indigenous knowledge systems exerted on colonial sciences are examples of this (see sections 3 and 4).

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Ultimately, conceptual differentiations – between indigenous and European knowledge systems, for example – give rise to new conceptual problems, as they appear to imply a distinction between "pure" and "mixed" forms of knowledge. It remains questionable, however, whether it is possible to demarcate individual knowledge forms and knowledge systems in a precise way. Edward Said (1935–2003) (→ Media Link #ah) stated that "[t]he history of all cultures is the history of cultural borrowing."<sup>13</sup>

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The variety and complexity of the conceptual difficulties illustrate once more that the historiographical representation of transfers of knowledge and science must historically contextualize its own selection of case studies and its conceptual assumptions. This has been done in detail in relation to approaches which understand knowledge transfer primarily as science transfer in the sense of the export of the modern European natural sciences. The next section deals with this European science export as an episode in the history of knowledge transfer and as the site of central methodological controversies.

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### Science Transfer as European Science Export?

Even today, some historical discussions of science transfer processes employ the cliché of the great exploring expeditions: in the service of truth, heroes of European scientific history, such as Charles Marie de La Condamine (1701–1774) (→ Media Link #ai) and Alexander von Humboldt (1769–1859) (→ Media Link #aj), braved the most extreme privations in territories beyond Europe in order to subsequently present their revolutionary discoveries at home in Europe. These epic depictions thematize science transfer along a clear line of delineation between the European centre and the non-European periphery. Europe functions not only as the political, but also as the epistemic centre of the world. The voyaging researchers are famous for bringing the European sciences into the most remote corners of the periphery. The fact that their discoveries were often based on the acquisition of indigenous knowledge was ignored.

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The distinction between epistemic centre and periphery also provides the basis for another cliché: the "civilizing mission" of the European sciences. To the extent that the colonial powers claimed for themselves a civilizing duty, the export of science – like the export of technology and medicine – assumed a central ideological role. In relation to the French colonial empire, for example, Lewis Pyenson (\*1947) (→ Media Link #ak) has reconstructed the way in which the natural sciences as a universally valid entity corresponded with the understanding of the *mission civilisatrice* and thus enabled colonial protagonists to view themselves as enlightened and progressive.<sup>14</sup>

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While such transfer processes have long been an essential element of the European self-concept,<sup>15</sup> the problematization of the historiography of global science transfer first began relatively late in the 20th century. George Basalla's controversial article *The Spread of Western Science* (1967) has been of great importance, as it claims to view the development of science not solely from an internal-European perspective, but from a global perspective. However, Basalla remained in thrall to the concept of science transfer as an unidirectional export of science from Europe to the non-European periphery:

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A small circle of Western European nations provided the original home for modern science during the 16th and 17th century: Italy, France, England, the Netherlands, Germany, Austria and the Scandinavian countries. ...

This diffusion process, he further claimed, could be subdivided into three phases, though these phases could not be assigned to particular time periods in a universal way, given that the colonial empires did not develop in a uniform manner.

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According to Basalla, the first phase was characterized by the exploring expeditions of European scientists, who applied their established scientific methods to a new environment and, in this way, generated new knowledge. This phase can be identified in very diverse geographical and temporal contexts, according to Basalla. While some regions had already been "discovered" by voyaging researchers in the early modern period, this process continued into the 20th century in the case of the German colonial empire, for example. In addition to temporal variations, the geographical centres of science transfer also changed; for example, in the 19th century, the cities on the American east coast themselves became centres and served as the departure point for exploring expeditions.

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Basalla described the second phase of science transfer as "colonial science" and states that it was defined by the intellectual (not necessarily political) subordination of the periphery to the European centre. Colonial scientists in the service of a European colonial power, who had been trained in the European centres of science, remained oriented towards Europe as regards the theory and practice of their disciplines. According to Basalla, colonial science was structurally subordinate to European research due to the intellectual and institutional dependence of the former on the latter, although colonial science already contained characteristics of an independent scientific tradition in "embryonic form".<sup>17</sup>

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In the third and final phase, according to Basalla, a separate and independent scientific tradition emerged; the periphery itself became a centre, which participated in reciprocal exchange with other centres. However, by "separate and independent" Basalla did not mean autonomous with respect to the western scientific tradition; on the contrary, he meant the successful adoption of that tradition. According to Basalla, a series of criteria had to be met before this could occur. For example, cultural resistance to the scientific method had to be overcome, and national institutions for research and education had to be established. Basalla discusses the example of Confucianism in China, which – in his view – prevented the development of a modern scientific tradition until the late 19th century.

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What was innovative about Basalla's model was that it did not limit itself to science transfer within Europe, but sought to provide an adequate understanding of global transfer processes. At the same time, however, Basalla's model is problematic in several ways.<sup>18</sup>

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1) Universal applicability. Though Basalla admitted that there were regional differences in the phenomenon of science transfer, he believed that the three-phase model could be applied to widely diverse political, social and cultural contexts. The claim to universality for a model of this kind immediately becomes problematic when one considers how disparate the broader contexts of science transfer were in regions such as Australia, Japan and India. Basalla assumed that the phases of science transfer could be identified regardless of the initial socio-political conditions and that, for example, the diffusion model is equally valid in cases of almost total European hegemony (Australia) and cases where European colonization was absent (Japan).<sup>19</sup>

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2) The colonial scientist. Basalla's generalized description of the "colonial scientist" abstracts the socio-political and cultural context:

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Who is the colonial scientist? He may be native or a transplanted European colonist or settler, but in any case the sources of his education, and his institutional attachments are beyond the boundaries of the land in which

he carries out his scientific work. This pattern is found in 18th and 19th century North and South America, Russia and Japan; in 19th century Australia and India; and in 20th century China and Africa.<sup>20</sup>

In relation to India and colonial scientists, Venni Venkata Krishna identified at least three different archetypes for the period 1876 to 1920.<sup>21</sup> The first was the "gate keeper", who was predominantly of European descent and exercised institutional control over the colonial practice of science. The second, the "scientific soldier" was the colonial scientist, who, having come from Europe in most cases, performed scientific work, but was less involved in the administrative control of colonial scientific practice. The third group emerged as a result of the emergence of Indian nationalism and, in contrast to the first two, overwhelmingly contained people of Indian descent. The development of science in colonial India can only be understood on the basis of an analysis of these three archetypes and the socio-political structure; in particular, the transition from Basalla's second phase to an independent scientific tradition must be viewed in the context of the nationalist ambitions of the third group of scientists.

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3) Indigenous knowledge. The diffusion model ignores indigenous knowledge. The European sciences are exported until, in the last phase, they have been fully established and have thus become independent of the old centres. The importation of knowledge into Europe only occurs to the extent that – in the first phase in particular – the European sciences are applied to a new environment, resulting in the production of new knowledge. More recently, research has emphasized the complexity of transfer processes in the colonial context.<sup>22</sup> The history of cartography provides an example of this, with the image of the European cartographer working completely independently being challenged in a number of contexts, such as North America,<sup>23</sup> Latin America,<sup>24</sup> Napoleonic Egypt,<sup>25</sup> and, more recently, India.<sup>26</sup> For example, the map of India created by the British geographer James Rennell (1742–1830) (→ Media Link #al) set new standards in cartography and was superior to all contemporary maps of the British Isles. Rennell stated that he largely received the necessary geographical knowledge from Brahmans. Thus cartography in colonial India cannot be disregarded as a purely European product.

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4) Normative starting conditions. The complete disregard for indigenous knowledge which manifests itself in many works on science transfer is indicative of the image of the European sciences as the universal and epistemologically superior system of knowledge. For example, the science historian Lewis Pyenson already referred to above has argued in relation to French colonialism in the first half of the 19th century that the "exact sciences" may have been used for political purposes, but that they were largely independent of socio-political influence in terms of their universal theoretical content and must therefore be considered a positive "civilizing mission".<sup>27</sup> Numerous other publications are informed by similar opinions, even though the topic is being dealt with in an increasingly sensitive manner.

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## Postcolonial Reorientations

Since the 1970s, the exclusive focus on European science export and the normative description of the European sciences as the universal and epistemologically preferred knowledge system has been criticized, particularly in the context of postcolonial theory. Edward Said's *Orientalism* (1978), which called into question the dichotomy of Occident and Orient by applying Michel Foucault's (1926–1984) (→ Media Link #am) discourse analysis, provided the impetus for many postcolonial debates. According to Said, the representation of the Orient as a cognitive opposite to the Occident is a discursive instrument of power which not only guarantees European hegemony over "the Orient", but also functions as an essential element and affirmation of the European understanding of self: "The Oriental is irrational, depraved (fallen), childlike, 'different'; thus the European is rational, virtuous, mature, 'normal'."<sup>28</sup>

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Said's analysis of the Occident-Orient dichotomy is particularly applicable to the colonial sciences where the European scientific tradition is presented as a manifestation of Occidental rationality and enlightenment. As a corollary of this, non-European knowledge systems have been represented as having a "non-scientific character" which is taken as fundamental proof of the irrationality and inferiority of such systems.<sup>29</sup> Postcolonial theory and studies on science transfer are thus mutually dependent. On the one hand, postcolonial approaches must make reference to science transfers because the European sciences appear as a vehicle and manifestation of the rational superiority of Europe. On the other

hand, historiographies of global science transfer depend on the postcolonial change of perspective to encompass a plurality of knowledge systems. Correspondingly, Nicholas Dirks (\*1950) (→ Media Link #an) has interpreted the question of colonialism as a question of "colonial knowledge":

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In certain important ways, knowledge was what colonialism was all about. Cultural forms in societies newly classified as "traditional" were reconstructed and transformed by and through this knowledge, which created new categories and oppositions between colonizers and colonized, European and Asian, modern and traditional, West and East. Ruling India through the delineation and reconstruction of systematic grammars for vernacular languages, representing India through the mastery and display of archeological memories and religious texts, Britain set in motion transformations every bit as powerful as the better-known consequences of military and economic imperialism.<sup>30</sup>

While Said's critique is certainly important, some of his theses – particularly the hegemony of the European Orientalism discourse – remain controversial. While there is little doubt that efforts to establish such a hegemony and mechanism of exclusion did exist, it is less clear how dominant colonial discourses really were and how much significance should be attributed to non-hegemonic discourses. In particular, the Subaltern Studies Collective, a group of south Asian scientists, called for the reconstruction of marginalized or subaltern forms of knowledge in order to enable critical reactions to a European discourse hegemony. This approach did not remain unchallenged. In her influential essay, Gayatri Chakravorty Spivak (\*1942) (→ Media Link #ao) criticized the assumption of the Subaltern Studies Collective that marginalized forms of knowledge could be reconstructed more or less without problems.<sup>31</sup> According to Spivak, this assumption fails to recognize the mechanisms that not only excluded subaltern perspectives from hegemonic discourses, but also from archives and other documents. The result, according to Spivak, was a fundamental speechlessness of subalterns and, in particular, women, who were subjected to a double marginalization in colonial contexts.

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In addition to European attempts to establish hegemony, research also stresses the limits of colonial control.<sup>32</sup> According to Homi K. Bhabha (\*1949) (→ Media Link #ap), the dichotomy between hegemonic and subaltern spaces fails to recognize the fundamental importance of the hybridization that resulted from the influence knowledge systems exerted on one another in border zones.<sup>33</sup> According to Bhabha, it is only possible to comprehend cultural systems by investigating connections and mutual influences, and not by contrasting discourses. However, the concept of hybridity has itself been exposed to criticism. It has been claimed that the hybridity concept does not adequately reflect the hierarchical order of such connections, and that the concept has arisen from a biologicistic discourse which assumes the existence of "pure" races and the "crossing" of these.<sup>34</sup>

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In spite of continuing controversies,<sup>35</sup> the currents described above led to a reorientation of debates about science transfer and of historical-empirical research on this topic. There is no longer a thematic focus on the unidirectional export of European science and technology or on the discovery and exploitation of natural resources outside Europe. Instead, the focus has shifted to the variety of reciprocal influences between different knowledge systems. The classic narrative of science export has in general been replaced by specific case studies which investigate complex transfer processes in specific historical contexts.<sup>36</sup> Such a reorientation also requires a considerable expansion of concepts. From a postcolonial perspective, science transfer cannot be isolated from general knowledge transfer. Restricting oneself to "science transfer" not only excludes indigenous knowledge, but also prevents one from seeing the processes of interaction between knowledge systems.

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## Dimensions of Knowledge Transfer

As demonstrated above, postcolonial approaches have called into question the classic narrative. It is possible to go further and view knowledge transfer as a ubiquitous phenomenon, and not just a phenomenon relevant to colonialism. There have been numerous empirical studies dealing with knowledge transfer that at first glance appear to have little in common with the narrative described above or challenges to that narrative.

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Today, the term "knowledge transfer" is usually applied to transfers between universities and industry, or between experts and non-experts.<sup>37</sup> The focus is frequently on "science management" and on the "Optimierung der Übertragung von Erkenntnissen aus der so genannten Grundlagenforschung in marktorientierte Anwendungsbereiche".<sup>38</sup> Additionally, historians concentrate on the "Übertragung von Wissen, Forschungsmethoden und Technologien über Staatsgrenzen hinweg".<sup>39</sup> Mitchell Ash (\*1948) (→ Media Link #aq) lists three forms of science transfer and a process of knowledge change which always accompanies the three forms: firstly, there is transfer due to the migration of scientists – Ash concentrates on politically forced migration (→ Media Link #ar); secondly, there is transfer as a result of the movement of objects, correspondence and texts; and thirdly, there is transfer due to the movement of instruments and the expertise required to use them.<sup>40</sup>

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From the perspective of historians, of course, we are interested in far more than this: specifically, transfer processes of varying dimensions and types between completely different levels, groups and areas of society, and not just around the globe, but also within nations, regions or in a narrowly defined place. Thus, to take an example from the private sphere, even family upbringing, the passing-on of everyday knowledge about society and environment from one generation to the next, can be considered knowledge transfer. All systems of education and training can be thought of as institutions of knowledge transfer. Knowledge is transferred between different professional and expert groups – for example, between different academic disciplines or institutions,<sup>41</sup> between doctors and health insurance companies – as well as between social classes, such as in educational programmes for the lower social classes. The efforts of academics in the 19th century to teach the rural population about "correct" methods of cultivation as well as how to process and market their agricultural produce in an "economically profitable" way represent attempts (which the initiators usually subsequently considered to have failed) at knowledge transfer. The endeavour to transfer knowledge becomes particularly apparent in all attempts to popularize knowledge, which see experts attempting to influence lay people or scientists attempting to communicate their findings to society. Consultancy activities – from political advisors to the service sector – are also part of the transfers between experts and non-experts.

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In addition to the narrative of the great exploring expeditions, an internal European phenomenon has profoundly shaped the European concept of knowledge transfer: the "republic of scholars" in the early modern period.<sup>42</sup> An understanding of knowledge as mobile, non-place-dependent and connecting developed early on in the context of new institutions of learning, the academies, and their communications media, the academic journals, but in particular due to the intensive and far-reaching correspondence network of scholars (→ Media Link #as). This ideal of scholarly communication was only contextualized in science history later on; for example, in this idealized concept, the colonization of regions beyond Europe was for a long time considered as merely an extension of the correspondence network beyond the European continent.

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Of considerable relevance are the respective techniques of transfer and their history. From verbal to electronic communication, the communications media – writing, print, telecommunications etc. – have profoundly affected the conditions of knowledge production and knowledge transfer, as well as the knowledge content.<sup>43</sup> All these attempts at transfer have one thing in common, they endeavour to overcome a divide between different groups of people, be that divide geographical, educational or social.<sup>44</sup> However, divides are not ordained by nature; they are constructed and they have a history. Attempts at knowledge transfer do not only occur in the context of these divides, they also influence these divides; sometimes strengthening them, sometimes weakening them. Empirical studies which ignore this aspect run the danger of reinforcing these effects.

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However, at both the macro-historical and micro-historical levels, and regionally as well as globally, the danger exists – due not least to the type of sources available – that the focus will predominantly be on transfer processes which occurred from a dominant "knowledge centre" to areas in which a knowledge deficit was believed to exist. And, in the case of studies that are more regional in nature, processes of negotiation and struggles for hegemony in an area of knowledge must be taken into account.<sup>45</sup> For example, the history of midwifery knowledge in the 18th and 19th centuries is an example of the assertion of the epistemic hegemony of academic medicine in the area of childbirth. However, everyday knowledge, patients' knowledge of their own bodies and practical knowledge about midwifery were also incorporated into the – more deliberately and theoretically formulated – expert knowledge.<sup>46</sup> The practical knowledge of

experts in non-academic professions – such as tradesmen, farmers, instrument makers and technicians – found its way into the body of academic knowledge as a result of the varied processes of cooperation, input and assistance which these professionals provided to academics. Thus, even transfer processes within Europe, within individual states or even within small defined regions, can be complex, multi-layered and multifaceted, when one considers all the aspects that can be included and analysed under the heading of knowledge transfer.

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If one observes the same broad spectrum of transfer processes with regard to relations between Europe and the colonies, a number of additional dimensions of complexity arise. In many pre-colonial societies, there were institutions of education, division of labour and communication between different professional groups, and sophisticated media of knowledge transfer long before the European colonial powers arrived and attempted to implant their forms of knowledge transfer.<sup>47</sup> This becomes particularly apparent in the example of medicine. Systems of health care and traditions of knowledge about medicines always belonged to the basic aspects of human coexistence; in pre-colonial societies, the authoritativeness and dissemination of medical knowledge was in most cases strictly controlled. Knowledge transfer in the colonial context can mean many things: the acquisition of "useful knowledge" by the colonizers, colonial education systems, the interest of the colonial state in acquiring data on the colonized population, or the emergence and reshaping of scientific disciplines in the colonies (→ Media Link #at). The conditions of knowledge transfer of the native population must be taken into account in all cases. A symmetric view of the constellations of knowledge transfer enables us to critique the one-sided, narrow focus on the European side, although it must not be forgotten that the constellations themselves have been influenced by asymmetrical power relationships.

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Additionally, it is necessary to differentiate between regions because colonial knowledge transfers were characterized by different emphases in different regions of the world.<sup>48</sup> India is without doubt the best researched arena of colonial science. Here the British colonial power encountered numerous complex, interconnected knowledge traditions and sought decisive support for their rule particularly in the area of knowledge about population and territory. Around 1900, the focus in many African colonies was primarily on knowledge about nutrition, health, manpower and ecology. In the case of settler colonies such as Australia and New Zealand, in which conflicts over property ownership with indigenous populations were commonplace, there was a corresponding need for knowledge that would make settlement easier. Consequently, the disciplines required to research these various aspects in the interests of the respective colonial powers were not considered to be equally important in all regions, and did not always receive the same fundamental transforming and initiating role.

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This brings us to a further differentiating aspect: the disciplines themselves. Knowledge transfers and their conditions vary qualitatively or quantitatively across the various fields of knowledge. This assumption is supported, for example, by the fact that some knowledge – such as that provided by the humanities – is more closely tied to language; it is also supported by the respective object of knowledge. It can be assumed, for example, that European knowledge (that is, knowledge which is denoted as universal) about society in non-European contexts was treated differently to knowledge about flora and fauna or cartography.<sup>49</sup> The ubiquity and multi-faceted nature of knowledge transfer means that a partial aspect – such as, for example, knowledge transfer in the areas of the natural sciences – cannot be dealt with adequately if all other forms of transfer are excluded. On the contrary, the history of knowledge transfer is particularly dependent on interdisciplinary focus and communication between the disciplines.

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## Knowledge – Transfer – Knowledge Transfer

The preceding sections have described the expansion of historical research on knowledge transfer and science transfer. While early works focused solely on the export of European science, current research focuses on a wide variety of macro-historical and micro-historical processes of transfer and interaction. However, this raises the question whether it is at all possible to separate knowledge transfer and cultural transfer from one another and what is the relationship between research into knowledge transfer and research into cultural transfer. Looking at general studies on cultural transfer, it becomes apparent that many of them assume a set place of origin, a selection process, a distance that is bridged, a receiving culture, and, finally, the transformation and integration of the received cultural content.<sup>50</sup> This model



derives its linearity from the fact that it has primarily emerged and been applied in the research into binational transfer processes. This linearity has elicited criticism both in cultural transfer research and in knowledge transfer research because it does not do justice to the complexity of multi-layered, two-way effects.<sup>51</sup> In the case of the targeted transfer of information and in binational contexts, this model may be useful for specific examples of knowledge transfer; but in view of the extremely complex initial situations of knowledge transfers, the objection above is as justified as the question whether science transfer and knowledge transfer are merely subcategories of cultural transfer or whether they play an independent role which remains to be more clearly defined. Additionally, most recent approaches have pointed out that the use of the term "cultural transfer" can also have a dividing, connecting, or delineating effect.<sup>52</sup>

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In conclusion, we return to the issue of concepts. Even in the case of terms which stress knowledge transfer and science transfer as processes, it is clear that each of these concepts implies very definite understandings of the process which it attempts to describe. With regard to the implied intrinsic nature of the knowledge involved, it makes a difference whether one speaks of "traveling" or "circulating" knowledge, of "dissemination", "diffusion" or "transport". "Push" and "pull" factors are discussed, as is "knowledge in transit".<sup>53</sup> The many terms used to refer to that which is transferred is also informative: concepts, ideas, theories, practices, dogmas, theses, but also subjects and objects which transfer knowledge, substances, instruments, abilities, skills and technologies. To avoid linear concepts, one could speak of "exchange", in other cases "absorption", "exploitation" or other forms of acquisition may be preferred.<sup>54</sup>

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In summary, centre-periphery effects in the area of knowledge transfer have been relativized considerably, though their existence is generally accepted. More recent approaches stress the local nature of knowledge and also that it is precisely when different epistemologies come into contact and result in the formation of institutions of knowledge that new knowledge can be produced.<sup>55</sup> As mentioned above, models which assume that knowledge can simply be transferred without the knowledge itself being changed in the process are now regarded as problematic. Reference is often made to Bruno Latour's (\*1947) (→ Media Link #av) concept of "translation". With his concept of "immutable mobiles", Latour has also called into question the supposed incommensurability of different knowledge systems. Taking the example of the French sailor Jean-François de Galaup La Perouse (1741–1788) (→ Media Link #aw), Latour has demonstrated how knowledge is transferred between knowledge systems and is "translated" in the process.<sup>56</sup> However, the tension between "restrictive locality" and "problemless passage" in particular demonstrates that one must proceed with an awareness of the intricacies of individual cases, and that not all bodies of knowledge are equally amenable to being simply transported from one place to another.

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## Appendix

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## Notes

1. ^ We are grateful to Susane Bauer and Uffa Jensen for their helpful comments on an earlier version of this article.
2. ^ Bellwood, *Farmers* 2004.
3. ^ Brush, *Indigenous Knowledge* 1993.
4. ^ Bugh, *Cambridge Companion* 2006, p. 86.
5. ^ Staller / Carasso, *Foodways* 2009.
6. ^ Harris, *Networks* 2006.
7. ^ Basalla, *Spread* 1967.
8. ^ See, for example, Mittelstrass, *Wissenschaft* 1982.
9. ^ Polanyi, *Personal Knowledge* 1958.
10. ^ On the history of the emergence of the terms "western science" and "indigenous knowledge", cf. Elshakry, *Science* 2010; Tilley, *Global Histories* 2010.
11. ^ Gieryn, *Boundary-Work* 1983.
12. ^ Krishna, *Colonial Model* 1992, p. 60.
13. ^ Quoted from Guttman, *Games* 1996, p. 184.
14. ^ Pyenson, *Science* 1990, pp. 76ff.; idem, *Civilizing Mission* 1993.
15. ^ Terrall, *Heroic Narratives* 1998, p. 242.
16. ^ Basalla, *Spread* 1967, p. 611.
17. ^ *ibidem*, p. 617.
18. ^ Raina, *West* 1999, gives an overview.
19. ^ See Inkster, *Scientific Enterprise* 1985, p. 686; Raina, *West* 1999, p. 508, for critiques of Basalla.
20. ^ Basalla, *Spread* 1967, p. 614.
21. ^ Krishna, *Colonial Model* 1992, p. 69.
22. ^ Macleod, *Visiting* 1982, p. 14.
23. ^ Vorse, *Amerindian Contributions* 1978; Lewis, *Indicators* 1986.
24. ^ Mundy, *Mapping* 1996.
25. ^ Godlewska, *Napoleonic Survey* 1988.
26. ^ Raj, *Relocating* 2007.
27. ^ Pyenson, *Science* 1990 (especially p. 78); idem, *Ideology* 1993. For a critique, cf. Palladio / Worboys, *Science and Imperialism* 1993.
28. ^ Said, *Orientalism* 1978, p. 40.
29. ^ Ballantyne, *Colonial Knowledge* 2008, p. 178.
30. ^ Dirks, *Foreword* 1996.
31. ^ Spivak, *Can the Subaltern Speak?* 1988.
32. ^ For example, Pollock, *Deep Orientalism* 1993; Arnold, *Colonizing* 1993.
33. ^ Bhabha, *Location* 1994.
34. ^ Smyth, *Politics* 2000; Mishra, *Frantz Fanon* 1996.
35. ^ Mishra / Hodge, *Postcolonialism* 2005.
36. ^ Cf. Ballantyne, *Colonial Knowledge* 2008; Lölke, *Modelle* 2008.
37. ^ In recent times, a veritable separate discipline dealing with transfer has emerged; see Antos / Wichter, *Wissenstransfer* 2005. On the international technology transfer in the chemical industry, see Petri, *Technologietransfer* 2004; Mayntz, *Wissensproduktion* 2008.
38. ^ Ash, *Wissens- und Wissenschaftstransfer* 2006, p. 181 ("optimizing the transfer of knowledge from the so-called fundamental research to market-oriented areas of application", transl. by N.W.); cf., for example, the influential article by Argote / Ingram, *Knowledge Transfer* 2000.
39. ^ Cf. Kernbauer, *Wissenschaftstransfer* 1992 (quoted from Ash, *Wissens- und Wissenschaftstransfer* 2006, p. 182, "transfer of 'knowledge, research methods and technologies across state borders", transl. by N.W.).






40. ^ Ash, Wissens- und Wissenschaftstransfer 2006, p. 182f.
41. ^ For example, in Reinhardt, Wissenstransfer 2006.
42. ^ Harris, Networks 2006.
43. ^ On this topic, see the special issue of *Historische Sozialforschung* vol. 35, 2010 no. 1.
44. ^ Ash, Wissens- und Wissenschaftstransfer 2006, p. 186.
45. ^ Raphael, Verwissenschaftlichung 1996; Vogel, Wissensgeschichte 2004.
46. ^ Labouvie, Zur Aneignung 2007.
47. ^ Long before this, significant knowledge transfers had occurred from non-European regions to Europe, which Western historiography has for a long time ignored or integrated into the history of the European sciences in an teleological fashion; on this, see the special issue of *Isis* 101 (2010): Tilley, *Global Histories* 2010.
48. ^ Ballantyne, *Colonial Knowledge* 2008, p. 185; Schiebinger, Introduction p. 53.
49. ^ On the transfer of social theories, see Keim, *Disziplin* 2008.
50. ^ Espagne, *Transferts* 1999; Midell, *Kulturtransfer* 2000.
51. ^ Ash, Wissens- und Wissenschaftstransfer 2006, p. 186.
52. ^ See the conference "Transfer in Dispute. Controversial Representations of Cultural Borrowings", Humboldt University, Berlin, 26–28/11/2009, on: <http://hsozkult.geschichte.hu-berlin.de/termine/id=11889>; <http://www.sfb-repraesentationen.de/veranstaltungen/tagungen-und-workshops/konferenz-transfer-in-dispute> [03/11/2011].
53. ^ Secord, *Knowledge* 2004.
54. ^ Ash, Wissens- und Wissenschaftstransfer 2006, p. 181.
55. ^ See, for example, MacLeod, *Nature and Empire* 2000; cf. Lölke, *Modelle* 2008, p. 42.
56. ^ Latour, *Visualisation* 1986; idem, *Science in Action*, 1987. La Perouse travelled the Pacific with the task of compiling an accurate map. He integrated the geographical knowledge of Chinese people, who had no physical maps themselves, into his map. The occurrence of similar processes of integration has since been proved in the case of many encounters between Europeans and "indigenous" peoples.

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