

1. Introduction: Science and Medicine – Two Cultures Lost in Translation?

In 2008, science reporter Declan Butler published a piece in *Nature* about the current state of biomedicine titled “Crossing the Valley of Death”. The article talks about how in recent decades there has been a growing concern that the vast expenditures in biomedical research no longer add up to the expected health care returns. While researchers have made “huge strides [...] in understanding disease mechanisms”, these have not resulted “in commensurate gains in new treatments, diagnostics and prevention” (Butler 2008: 840). The main reason for this crisis in biomedical productivity seems clear: “Over the past 30 or so years, the ecosystems of basic and clinical research have diverged” (ibid.). Put differently, there has been a growing tension between the cultures of laboratory science and clinic medicine. As agencies for medical research across the globe “are experiencing a similar awakening” (ibid.), they are making efforts to solve the problem of the ruptured relationship between the two cultures.

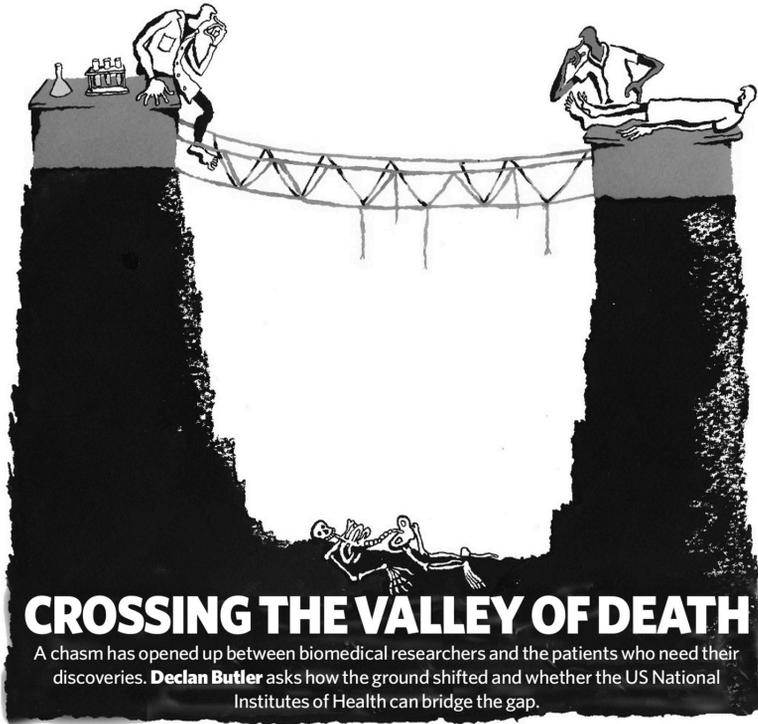
The article goes on to explain how the National Institutes of Health (NIH) in the United States, under the auspices of Elias Zerhouni, a radiologist and director of the NIH since 2002, designed a new vision of biomedicine to confront the troubles in the system. Zerhouni and the NIH consulted with “over 300 of the nation’s biomedical leaders from academia, government, and the private sector” (Zerhouni 2003: 63) about the challenges facing biomedical research in the twenty-first century. In 2003, Zerhouni announced “The NIH Roadmap”, a trans-institutional conceptual framework to be launched the following year, which resulted in the sweeping reorganization of the agency’s institutional and operational structures as well as its funding schemes (Zerhouni 2003). A signature feature of “The NIH Roadmap”, as Butler notes, is the attempt at “bridge-building” between basic science and clinical medicine (Butler 2008: 840). In this context, the concept of translational research, which has since also developed into a key component of the biomedical enterprise as such, has played an important role. Translational research (sometimes alternatively called “translational science” or “translational medicine”) is a broad term comprising different organizational concepts for transforming knowledge from basic research into tangible clinical approaches (van der Laan/Boenink 2015, Blümel et al. 2015). With “The NIH Roadmap”, the

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agency fostered the establishment of a network of translational research “hubs” and launched the Clinical and Translational Science Awards to encourage close collaboration between scientists and clinicians amongst others.¹

However, Butler’s *Nature* article is not only important as a contemporary testimony on biomedicine. It also showcases an iconic depiction of the cleavage between the cultures of basic research in the lab and patient care in the clinic. The image, which is meant to illustrate the biomedical situation and the need for translational efforts “between bench and bedside”, is valuable because it provides a deeper look at the somewhat conflicting understandings of biomedicine that exist today. The image features the cartoon of two figures standing on opposing edges, connected merely by a rundown and rather untrustworthy rope bridge (figure 1.1.). Between them is the eponymous “valley of death”, the “chasm” that “has opened up between biomedical researchers and the patients who need their discoveries” (Butler 2008: 840). The figure on the left represents the lab researcher; on the right side is the clinician. Both appear to be looking at each other in doubt. As the researcher puts one foot out to check the bridge’s suspension, both are questioning whether it is a safe passage to deliver his/her message across to the clinician, who appears to be treating a patient with an unhappy expression on his/her face. At the bottom of the valley of death, in the middle, is a human skeleton; a stark reminder that “neither basic researchers, busy with discoveries, nor physicians, busy with patients, are keen to venture there” (ibid.). So, where is the conflict in this depiction of biomedicine?

1 <https://ncats.nih.gov/ctsa/about> (accessed March 9, 2022).



NIH stands for the National Institutes of Health, not the National Institutes of Biomedical Research, or the National Institutes of Basic Biomedical Research.” This jab, by molecular biologist Alan Schechter at the NIH, is a pointed one. The organization was formally established in the United States more than half a century ago to serve the nation’s public health, and its mission now is to pursue fundamental knowledge and apply it “to reduce the burdens of illness and disability”. So when employees at the agency have to check their name tag, some soul searching must be taking place.

There is no question that the NIH excels in basic research. What researchers such as Schechter are asking is whether it has neglected the mandate to apply that knowledge. Outside



the agency too there is a growing perception that the enormous resources being put into biomedical research, and the huge strides made in understanding disease mechanisms, are not resulting in commensurate gains in new treatments, diagnostics and prevention.

“We are not seeing the breakthrough therapies that people can rightly expect,” says Schechter, head of molecular biology and genetics at the National Institute of Diabetes and Digestive and Kidney Diseases in Bethesda, Maryland.

Medical-research agencies worldwide are experiencing a similar awakening. Over the past 30 or so years, the ecosystems of basic and clinical research have diverged. The pharmaceutical industry, which for many years was expected to carry discoveries across the divide, is now hard pushed to do so. The abyss

left behind is sometimes labelled the ‘valley of death’ — and neither basic researchers, busy with discoveries, nor physicians, busy with patients, are keen to venture there. “The clinical and basic scientists don’t really communicate,” says Barbara Alving, director of the NIH’s National Center for Research Resources in Bethesda.

Alving is a key part in the NIH’s attempt to bridge the gap with ‘translational research’. Director Elias Zerhouni made this bridge-building a focus in his signature ‘roadmap’ for the agency, announced in 2003 (see *Nature* 425, 438; 2003). Spearheading the NIH effort will be a consortium of 60 Clinical and Translational Science Centers (CTSCs) at universities and medical centres across the country, which will share some US\$500 million annually when they are all in operation by 2012. Late last month, the NIH doled out the most recent grants in

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Figure 1.1: First page of Declan Butler’s article in *Nature* with a depiction of the “valley of death” in biomedicine. (Source: Declan Butler. 2008. *Translational Research: Crossing the Valley of Death*. *Nature* 453 <https://www.nature.com/articles/453840a> [accessed March 9, 2022]).

Upon closer inspection, the article with its imagery is ambivalent about what constitutes the normal and what the exceptional relationship between laboratory research and clinical care – an impression that nicely sums up general lines of argument in the literature. On the one hand, it presents the exceptional state of the successful connection of science and clinical practice across the divide as the norm – something, which derives from what I in chapter 6 call the *linear legacy* of biomedicine, i.e., the culmination of scientific expectations in the conviction that “laboratory research on basic biological mechanisms in almost any organism has potential medical relevance” (Scheffler/Strasser 2015: 664). On the other hand, the picture is clearly dominated by the considerable cleavage between the two cultures, something that appears as “natural” or literally set in (mountain) stone. Stated differently, the idea of mending the gap with the help of translational research implies a “broken middle” in the biomedical system (Mittra 2016: 57). This is indicated by the belied expectations in health care returns, which point to problems with the transmission of basic research results to clinical practice. And since this problem has supposedly only occurred recently, there is an inclination to accept that the normal state of biomedicine must be that of a harmonious relationship between the two cultures; one where – to keep with the imagery – a steel-enforced concrete bridge, instead of a rugged one, allows for a smooth connection between the lab and the clinic.

Much of the sociological and historical literature on the topic gives off this impression. Here, a crucial pier of that supposedly sturdy bridge is seen to have emerged through molecular biology. In their pathbreaking book *Biomedical Platforms*, for instance, historian Peter Keating and sociologist Alberto Cambrosio argue that “since World War II, biology and medicine have come together both institutionally and intellectually, in a hybrid practice that is neither syncretic nor synthetic” (Keating/Cambrosio 2003: 1, see also 330f.). Their study is a major contribution to the history and sociology of biomedicine, serving as the authoritative source on the topic for many other authors (e.g., Bruchhausen 2011, Crabu 2018, Löwy 2011, Qurike/Gaudillière 2008 Scheffler/Strasser 2015, Strasser 2014). The main reason for this new level of communication between the laboratory and the clinic is taken to lie especially in the “molecularization” of biology and medicine (Chadarevian/Kamminga 1998), which has allowed both cultures to become aligned with each other, i.e., to communicate with each other through “entities and tools” that are intelligible to both (Keating/Cambrosio 2004). In this part of the literature, biomedicine is consequently portrayed as coinciding “with the appearance of a new system

of medical innovation in relation to biology and health policy” (Quirke/Gaudillière 2008: 445). Its central promise is that basic biological research will eventually lead to significant improvements in health care.

However, the image of a bridge connecting the peak of science to that of the clinic – whether stable or volatile – rather indicates that it is the divide between the cultures of science and medicine itself that constitutes the normal condition. The relationship between basic laboratory research and clinical practice is far more contested and precarious from this perspective. In this relation, the *Nature* article gives a different story of the molecular turn in biology and medicine. Butler explains that “basic and clinical research were fairly tightly linked in agencies such as the NIH” in the 1950s and 1960s. But with the “explosion of molecular biology in the 1970s”, basic and clinical research have been separating, “and biomedical research emerged as a discipline in its own right, with its own training” (Butler 2008: 841). This left the enterprise in short supply of clinician-scientists, those medical professionals understood as straddling research at the lab bench and patient care at the bedside, who have become closely linked to the idea of translational research (Hendriks/Simons/Reinhart 2019).

Looking at the problem historically, the precarious image of the relation between science and medicine becomes dominant. As historian Steve Sturdy has noted: “One recurring theme” in the historical literature on science and medicine “has been to highlight instances of tension and conflict between medical science and clinical practice, or between medical scientists and clinical practitioners” (Sturdy 2011: 739). A central question therefore is why our society has today grown accustomed to the harmonious image, in which biology and clinical medicine are closely connected, instead of to the picture of a cultural divide. I will show that this has much to do with the history behind the narrative provided by biomedicine’s *linear legacy*.

When medical research began to become professionalized in the nineteenth and early-twentieth century, though, the cultures of laboratory science and clinical practice were still largely distinct. Discrepancies (and even animosity) governed the relationship between the practicing physician and the laboratory researcher during that time, as studies in the social history of science and medicine have shown (e.g., Geison 1979, Lawrence 1985, Maulitz 1979, Warner 1991, 1992). In the post-Civil War United States, for instance, the appearance of the laboratory was initially perceived as a threat to the professional identity of the medical practitioner, who defined himself through the interaction with patients, and not through a devotion to scientific study (Warner 1986, 1992, see also Geison 1979). Keating and Cambrosio (2004) furthermore argue that eminent figures,

such as the French physiologist Claude Bernard or the German pathologist Rudolf Virchow, who attempted to bridge the disparate scientific and clinical cultures, nevertheless retained an experimental and institutional division. Even those actors mentioned by Butler, who emerged in the early-twentieth century and who were socialized in natural science as well as clinical care, distinguished their research culture of clinical science – as I will show later in chapter 7 – clearly from that of the medical lab researcher, who dominated medical schools and research institutes (Kohler 1982: 221).

I. Towards a Historical Sociology of Medicine’s Disciplinary Identity

How, then, can the idea of biomedicine as a hybrid of biological research and clinical practice be reconciled with the notion of an institutional and practical division between science and medicine? How has the exceptional state of bridging basic research and health care turned into our normal and deep-seated expectation of biomedicine, concealing the considerable divisions between lab and clinic? What are the consequences of this popular narrative for the organization of science and medicine as academic institutions and practices? And what did the public, politicians or society more generally expect of science in medicine and health care in the past?

This book tries to give answers to these questions by examining the changing understandings of science’s role for medicine since the emergence of the modern research university circa 1800. It aims to show how our society’s expectations of science and medicine have evolved and how they have shaped the social, cultural and epistemic constitution of academic medicine. For this purpose, I will trace the development of medical science as a modern institution from nineteenth-century Germany through to the rise of biomedicine in the postwar USA and to its current state at the start of the twenty-first century. Rather than working out the peculiarities of a given period, therefore, my study uses a long timescale that will allow to integrate specific historical phenomena into a general idea of the long-term developments of academic medicine² (Pickstone 2000: 5f.). This will help focusing on the tensions between change and continuity inherent to the modern history of medical science. Science seems to have been important for medicine throughout modernity. But how have research

2 I use the terms “academic medicine” and “medical science” interchangeably here.

practices and the ideas about their utility for medical purposes changed over time?

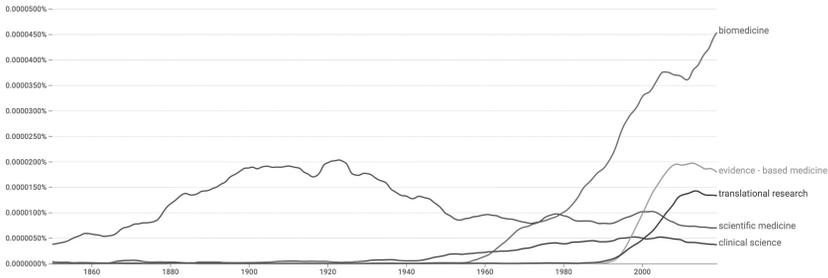


Figure 1.2: Word frequencies of key medical concepts, 1850–2010. (Source: Google Books Ngram Viewer https://books.google.com/ngrams/graph?content=scientific+medicine%2Cbiomedicine%2Cclinical+science%2Cevidence-based+medicine%2Ctranslational+research&year_start=1850&year_end=2010&corpus=26&smoothing=3&direct_url=t1%3B%2Cscientific%20medicine%3B%2Cc0%3B.t1%3B%2Cbiomedicine%3B%2Cc0%3B.t1%3B%2Cclinical%20science%3B%2Cc0%3B.t1%3B%2Cevidence%20-%20based%20medicine%3B%2Cc0%3B.t1%3B%2Ctranslational%20research%3B%2Cc0 [accessed March 9, 2022]).

My investigation takes on the form of a historical sociology of medical science. But I will not be telling a linear story. The aim is rather to highlight crucial episodes and to reconstruct important events in the institutional development of medicine as an academic science and in the organization of medical research. I will be focusing on professional trajectories and organizational programs that have significantly shaped academic medicine in the nineteenth and twentieth century. Germany and the USA are my national foci. Both countries were in their own ways and at different times in history crucial for the development of medical science, as I will show.³ I argue that these developments can only be understood properly if academic medicine is observed in terms of a genuine scientific discipline. The historical and sociological literature on science and medicine, however, has

3 Michel Foucault's (1976) pioneering work on the medical gaze, in contrast, has put France in the spotlight for the development of modern medicine. However, Foucault emphasizes how especially the science of pathological anatomy enabled a conception of modern clinical practice. My concern is more broadly with the overall idea of medical science.

largely overlooked the *disciplinary* identity of medicine. Instead, medicine is treated mostly as a profession, connected to the university only through the academic training of physicians; and science features here mainly as an emblem of professional authority, rather than as a pursuit of its own (e.g., Starr 1982). Medical scientists, in turn, are viewed as “generally inclined to pursue their own independent research programmes”, separated from clinical medicine (Sturdy 2011: 744). Consequently, the history of medical science has been told mainly as a pre-history to the history of biology and the biosciences (e.g., Zammito 2018). What precisely is meant by disciplines and disciplinary identity will be explained in the next chapter.

A possible reason why medicine’s disciplinary identity has remained obscure in the literature is because the academic discipline of medical science – in contrast to other disciplines like biology, chemistry or physics – did not always go by the same name.⁴ In fact, I will show how the designation has changed significantly. The most prominent semantic shift is that from “scientific medicine” in the nineteenth and early-twentieth to “biomedicine” in the second half of the last century, but also others have emerged over time, like clinical science or evidence-based medicine (figure 1.2). I will demonstrate the importance these different concepts have had to reformulating the disciplinary identity of medical science. To reveal the history of medicine as the social history of an academic discipline thus constitutes a necessary, albeit neglected, task of the social study of science.

The changing names for academic medicine from roughly 1800 until today provide an access point to the social history of medical science as a discipline and organize my investigation accordingly. They point to intellectual, professional and institutional programs through which actors tried to ensure the formation, growth and maintenance of an academic discipline of medicine in its own right, with its own research and training. I am interested in how these heterogeneous and conflicting programs have over time contributed to the formation of medicine’s disciplinary identity. I thereby try to go beyond more traditional ideas of disciplines as the formal organization of scientific activity and scholarly education compartmentalized into university departments or institutes, or as institutions defined by special intellectual paradigms and practices (Roth 2022). Instead, my analysis employs an understanding of disciplines as products of cultural activity (Gieryn 1995, 1999, Lenoir 1997, Schweber 2006, Shapin 1992). Following sociologist Thomas Gieryn, they can be viewed as nothing “but a [cultural]

4 The term “biology”, for example, appeared in 1800 and has since denoted the academic field (Nyhart 1995, Zammito 2018).

space". He argues that "Science is a kind of spatial 'marker' for cognitive authority, empty *until* its insides get filled and its borders drawn amidst context-bound negotiations over who and what is 'scientific'" (Gieryn 1995: 405, see also 1999: 18ff.). And it is within this space that Gieryn sees boundary work abound, i.e., discursive demarcations about what defines science in contradistinction to other cultural activities (Gieryn 1999: 12).

Another, complementary way of putting it, is to conceive of science as comprising a "supercategory". With linguist Roy Harris these function "to integrate what would otherwise be separate activities and inquiries; and the result of that integration is to re-draw the map of the intellectual world that society as a whole adopts" (Harris 2005: xi).⁵ Taken together, what belongs to medicine as a scientific discipline happens through acts of symbolic integration and demarcation; through repeated discursive negotiations over what types of practices, actors, institutions, concepts, instruments and other elements are granted or denied authority over academic issues of disease, life and health – i.e., the cultural space of "medical science". And it just as much includes the ideologies, ideals, desires and expectations attached to these elements and to science and medicine as a whole. This moves my investigation away from concerns with specific scientific practices or theories to the realm of their cultural representations. However, a supercategory does not necessarily need to denote a specific discipline. As will become clear when I discuss the concept of biomedicine in later chapters, it can also act as a label that groups heterogeneous practices, research cultures and scientific epistemologies together in a manner that they conflict with each other and with established disciplinary identities. The result, as I will show, is an ambiguous notion of what a vast enterprise like medical science is expected to deliver to society.

Libby Schweber (2006) offers a good example of examining the institutional history of disciplines through the frame of "cultural space" in her comparative historical sociology of demography and vital statistics in nineteenth-century England and France. She emphasizes her study as one concerned with disciplinary *activity*. By this she means that proponents of demography and vital statistics in the nineteenth century attempted to insert themselves discursively into the context of governmental and scientific requirements by challenging existing academic and administrative orders

5 Incidentally, Gieryn calls the demarcation of science from other cultural phenomena (what he defines as "boundary work") "cultural cartography" (Gieryn 1999: 12 *passim*). The idea to combine the integrating and demarcating aspects of semantics of science comes from Kaldewey (2013: 105ff.).

and by negotiating “new disciplinary categories and projects” (Schweber 2006: 2). To pursue her vague and shifting object, she draws on what she calls “minimal definitions” of both disciplines, which include “the historic use of terms and labels to delineate a type of [...] knowledge activity” and “the professional trajectories of key figures identified with those labels” (Schweber 2006: 9). This allows her to trace the developments of demography and vital statistics as the competition between different styles of doing science in the broader institutional contexts that determined the place and role of the disciplines. My own historical sociology, instead of adhering to the conventional periodization of medical historiography, tries to follow those actors and the “professional trajectories” that have significantly reformed the understanding of science’s role for medicine. These include those trajectories established by institutional actors like the NIH and other agencies. As Schweber notes, such an approach seems akin to Bruno Latour’s (1987) call to “follow the scientists” to explore the assemblage of elements involved in creating scientific “facts”. But like her work, my own investigation diverges from Latour’s program insofar as it follows these actors “to explore the institutional contexts in which scientists promoted their projects and sought recognition” (Schweber 2006: 10).

In my case, however, the changing names of academic medicine represent more than professional trajectories of medical science. Categories like “scientific medicine” and “biomedicine” also constitute key concepts in academic and science policy discourses (Kaldewey/Schauz 2018). While Schweber is mostly interested in how the scientific styles and topics of demography and vital statistic reflected given social and political contexts, it would be too narrow to understand the academic discipline of medicine only as the result of the rhetorical and ideological positioning of medical science in a cultural space vis-à-vis social and political demands. As basic concepts in public discourses, these medical categories necessarily also constitute seemingly “objective” descriptions through which people in our society understand and communicate about science and medicine. In other words, not only have they been shaped by historical circumstance, but they also condition our expectations of academic medicine because of the co-production of science and social order (Jasanoff 2004). In other words, terms like “scientific medicine” or “biomedicine” have attached to them promises – or at least ideas – of what science and medicine, both together and individually, can do. One aim of this book, therefore, is to grant insights into a tacit dimension of our current, vibrant discourse on biomedicine and the relationship between medicine and science more generally, especially given the overgrown expectations and corresponding

disappointments in current academic and science policy debates over stem cells, genomics and other high-tech applications of research to medical problems.

Works in a relatively recent interdisciplinary field of social and historical research, which studies the conceptual language of science, technology and innovation, have shown how key terms in academic and science policy discourses like “pure science”, “technology” or “basic and applied research” were in fact hotly contested and the product of historical contingency (e.g., Godin 2017, Kaldewey 2013, Phillips 2012, Schatzberg 2018, Schauz 2020). As identity-markers for specific professional self-images, it is apt to assume that concepts like “scientific medicine” or “biomedicine” were constructed in discussions over the social attributes and expectations of medical science and endowed with special values and motives. The sociologist David Kaldewey (2013) coined the notion of “identity work” to describe these discursive practices: in order to sustain their scientific pursuits, researchers over the centuries balanced their professional autonomy with the expectations and values of stakeholders in society. Applied to the notion of disciplinary identity, this means that I will need to examine the professional trajectories behind basic concepts like “scientific medicine” for their integration of institutional and epistemic autonomy with simultaneous displays of practical and societal usefulness. Consequently, “scientific medicine” and “biomedicine” not only embody given institutional contexts, but they have also since conditioned how and what to expect of science and medicine.

In her study of demography and vital statistics, Schweber's main motivation is to disassociate the idea of discipline formation from its more traditional sociological conception as university-centered and intellectually autonomous. She instead places the histories of demography and vital statistics into the context of state policy and administration, showing that disciplinary activity was mainly driven by problem-oriented questions and the need to develop statistics as a tool to be applied for public health or population governance (Schweber 2006: 128ff.). This is quite novel, given the often-biased understanding of disciplines in the literature that associates them with self-centered “silos”, ignorant of any practical problems or applied concerns (Jacobs 2013). My own investigation, though, seeks to place medical science – and its disciplinary activities – into the *academic* context of Germany and the USA. I share Schweber's emphasis on disciplines as also shaped by practical concerns. But I am interested in asking how conflicting notions of medical science as a place of “pure” inquiry conditioned the formation of the academic discipline, next to con-

cerns with “applied” problems. Authors have dubbed this “a symmetrical approach that avoids any bias towards specific notions and valuations of either side of the [pure/applied] distinction” (Schauz/Kaldewey 2018: 7). The idea of an autonomous and self-centered discipline, in other words, is not more ideological than the notion of a discipline oriented to practical problems. Accordingly, I ask: what symbolic acts, basic concepts and discursive practices did protagonists employ in order to integrate the understanding of an autonomous scientific discipline with the orientation of medical science towards practical problems of clinical medicine? How did this tension between an intellectually “pure” science and societal expectations of usefulness reflect in the representations of research practices and epistemologies in medical science as well as the self-understanding of medical scientists? How has this influenced the organization of medical science as an academic institution?

By observing the disciplinary identity work (Roth 2022) of medical science, I will show how actors grappled with the issue of linking their discipline to the needs of medical practice in various ways. The tensions that developed between their ideals of an autonomous academic science and the visions for a science serving society’s requirement for health care, has in popular discourses dominantly – so I argue – shaped the identity of modern academic medicine.⁶ The culmination of these efforts, as Butler rightly suggests in his *Nature* article, is our modern discipline of biomedical science, although its origins lie further back than the emergence of molecular biology in the mid-20th century. I want to show how, over time, the actions of disciplinary identity-making produced semantic layers that still inform our understanding of science and medicine today. The name “biomedicine”, as already indicated, transports the sense of a necessary connection between the production of biological knowledge and the application of that knowledge in clinical settings. Biomedicine has developed the ability to include in its meaning a range of different – and conflicting – scientific engagements in clinics, laboratories, hospitals and research institutions across the world. The aim of my historical sociology of medicine as a scientific discipline is to give a genealogy of this ability;

6 This approach is not meant to deny the significance of the medical practitioner’s perspective. It is undoubted that for the patient this constitutes the crucial view. But it is meant to suggest that if we want to understand the general idea of academic medicine, we need to apply a sociological perspective to the institutions of *scientific* practice in medicine, rather than to those for the actions of medical practitioners.

to expound what I call biomedicine's *linear legacy*, and to explain why the idea of biomedicine appears to need repairing in the present discourses.

II. *The Forgotten Disciplinary Identity of Medicine*

Why has the sociological and historical literature up until now mostly turned a blind eye on medicine as a modern academic discipline? Answering this question has to do with how authors have portrayed the institutional relationship between the culture of medical science and the clinical profession in the transition from a medieval and early modern to a modern society. Their portrayals all revolve around constructing a more or less sharp distinction between the professional interests of science and medicine (Sturdy 2011). As historian Thomas Broman persuasively argues in his book *The Transformation of German Academic Medicine*, around 1800, “the medical profession became in effect two different occupations, one pursuing research in academic institutions, the other filling roles as district and town medical officers and bedside healers” (1996: 161, see also Broman 1989). But as our discussion of translational research indicates, their relationship is far more ambivalent. Nevertheless, a general tendency in the literature is to use this separation as an indicator for the reduction of medicine's identity to that of a modern profession, while outsourcing the history of medical science to that of the biosciences. Here, I want to briefly highlight representative works from the sociological and historical literature to demonstrate how their explanations of the differentiation of science and medical practice largely obscures the disciplinary identity of medicine.

From the Middle Ages until early Modernity medicine was one of the three higher faculties together with law and theology. The pre-modern or early modern university was one oriented mostly towards vocational education in the disciplines of the higher faculties, while the scientific subjects of the faculty of philosophy were offered as propaedeutics (Stichweh 1994: 281).⁷ During this time, physicians – just like jurists and theologians

⁷ It should be noted that, although directed at vocational training, education in the three higher faculties was nevertheless highly academic. The aim for medicine was to make students proficient in the ways of academic discourse on medical topics, not in clinical practice. As Broman notes: “the centerpiece of medical education [in the eighteenth century] remained the spoken and written word” (Broman 1996: 30).

– were both researchers and practitioners, who contributed to academic discourses and treated patients (French 2003).⁸ In contrast to the large share of practitioners of craft medicine, who did not enjoy a university education, these actors belonged to the small elite of learned professions that remained closely tied to the university, particularly as readers and professors of academic medicine (Broman 1996: 26ff.). As I will explain in more detail later in chapter 3, during this time, physicians regarded themselves foremost as scholars devoted to academic subjects, and only secondarily as practitioners. Stated differently, a major part of their professional identity was determined by academic rather than clinical credentials.

The structural relationship between university, science and professions changed dramatically with the turn from the eighteenth to the nineteenth century. In the process, the university became a place of research and teaching (as opposed to vocational training in law, medicine and theology as well as philosophy and mathematics) and externalized the system of professions (Stichweh 1984, 1994). Sociologist Rudolf Stichweh (1994) examined how these processes of differentiation determined a new relationship between the professions and the emerging academic disciplines. He states that with the turn of the nineteenth century the relationship between the higher faculties and the lower faculty of philosophy was exactly reversed, “by facilitating the formation of a comprehensive system of scientific disciplines and subordinating the professional knowledge systems [of law, medicine and theology] as cases of applying scientific knowledge and of developing practice-oriented bodies of knowledge” (ibid: 282).⁹ At this point, the philosophical faculty and its subject areas of natural history and natural philosophy began to differentiate into modern disciplines like physics, chemistry or biology (Cahan 2003). While these became the occupation of full-time scholars, the three original professions started orienting themselves towards an interaction with clients. This resulted in the

8 Before the nineteenth century, patient care was vastly different from what people are accustomed to today. As part of the learned profession, physicians treated only a small circle of patients of the upper class or nobility. Doctors did not primarily treat acute ailments. They were counsellors in a wide range of physical, dietary and even ethical matters. They maintained close relationships with their elite patients and offered council mainly through the post: “The letters between doctor and his patients exchanged civilities, inquiries after health and doings of friends and family members, notifications of gifts about to be sent and of gifts gratefully received” (Shapin 2012: 308).

9 All translations from the German are my own, unless otherwise indicated.

“professional faculties, even under German conditions, approximating the character of special schools”, according to Stichweh (1994: 282).

Stichweh offers a compelling argument for the close structural relationship between disciplines and professions in the context of the modern research university (something that he bemoaned as lacking in the sociological literature; Stichweh 1994: 278ff). Nevertheless, from his ideas it is difficult to locate what has become of the academic identity of medical actors in the modern university. He explains how special subjects of medicine, like pathology, have constituted themselves as scientific disciplines and how we must furthermore recognize the differentiation of special subjects into clinical and scientific research disciplines (*ibid*: 312). But with the general distinction between practice-oriented and “pure” bodies of knowledge he reiterates the biased understanding of disciplines as places for only those forms of scientific inquiry that operate freely and without any orientation towards clients. “Disciplines are relatively self-sufficient social systems, which are primarily concerned with internal operations and otherwise [spend time] observing their internal scientific environment” (*ibid*: 310). From this it would follow that all non-practically oriented research work, even if conducted in medical schools and faculties of medicine, is performed by scientists with non-medical identities. But is it reasonable to assume that all research conducted without practical aims in medical faculties is done by “outside” researchers who do not identify with medicine? Must we not also grant medical researchers the possibility of assuming “purely” scientific identities? Or, conversely, that researchers on basic mechanisms can also adopt a medical identity?

A different but complementary line of argument can be found in the historical literature. Here, authors see that with the development of the modern university former medical subjects of a “pure” sort now began assuming a biological identity and consequently belonged to the biology departments of the philosophical faculty. Like Stichweh, the explanations here also follow sociological ideas about the institutional separation of theoretical and practical medicine. With it, a modern division of labor between scientific and clinical work was introduced that still defines the medical enterprise today (Bynum 1994: 94f.). The explanation draws on what Broman states about medical practitioners increasingly regarding themselves as belonging to either one or the other sphere and therefore also beginning to operate according to separate principles. Next to the practicing physicians who consulted with patients in matters of illness and health, some doctors now worked only as full-time researchers and academic teachers, and no longer as practitioners of medicine (Broman

1996, see also Fye 1987). The assumption appears to be that since they no longer functioned as active healers, they consequently also shed their medical identity.

As Sturdy observes, in front of this institutional division of labor, historians over the past thirty or forty years have been examining the history of science and medicine with a great deal of scepticism towards the instrumental role of science for clinical practice (see also Warner 1985, 1995). This has had considerable consequences for medical historiography. In his review of the literature, he reflects on several themes through which historians have elaborated on the “inherent tension between the professional interests of science and medicine”, identifying how scholars have mainly taken an “agonistic view of professionalisation and discipline formation” (Sturdy 2011: 743). Most of these works attest to a rather strict separation of the professional trajectories of medical science and clinical practice. “If the proper aim of scientific disciplines is independence, any activities that serve other disciplinary or professional agendas must represent a diversion from that aim” (ibid: 742).

This exclusivity furthermore reveals the rather traditional notion of disciplines underlying the argument. Authors have reflected on the introduction of the culture of laboratory science and experimental techniques into academic medicine as a means for actors to emancipate themselves from practical medicine and to consolidate their independent scientific endeavors:

“Thus[,] early work on the culture of laboratory science sought among other things to elucidate the means by which scientists asserted their independence from medicine [...] and the creation of laboratories, equipped with sophisticated measuring instruments and other technologies of control, as sites both for the pursuit of experimental research and for the reproduction of disciplinary culture through training of new recruits” (ibid: 745).

In this line of argument, the emancipation from clinical practice is taken as the simultaneous emancipation from medicine as such. This has contributed to obscuring medicine’s disciplinary identity by equating the role of non-practicing full-time researchers in medical faculties with the professional trajectories of other disciplines, especially with that of biology.

This effect of changing from a medical to a biological identity is most clearly visible in works dealing with the history of scientific ideas. In the scholarly literature on nineteenth-century science and medicine, actors who employed the laboratory and experiment as a means to distinguish

themselves from the culture of medical practice are presented as the case for an emerging biological identity displacing its medical origins. The transitional period of the German university system around 1800 marks an important episode for historians and philosophers of science, when the old fields of natural history and natural philosophy turned into programs preconfiguring modern day disciplines like chemistry or biology (Cahan 2003, see also Stichweh 1984). In this context, many historians of science and medicine have told the story of physiology, the fundamental field of nineteenth century medical science – which I will be looking at in more detail in chapter 3 – almost exclusively with a view to our present-day life sciences (e.g., Broman 1996, Hagner 2003, Kremer 2009, Zammito 2018, see also Nyhart 1995). This form of presentism, too, has contributed to overshadowing the modern disciplinary identity of medicine.

In in his magnum opus *The Gestation of German Biology*, for example, historian of ideas and philosopher of science John Zammito (2018) traces the maturation of a scientific current over the course of the eighteenth and early-nineteenth century, later to form the basis of the modern life sciences. He argues that the appearance of the term “biology” “around 1800 signaled a theoretical and methodological *convergence* of natural history with medical physiology in comparative (i.e., *zoological*) physiology that resulted in the field of developmental morphology” (Zammito 2018: 2). Natural history was characterized by the method of observation and by the organization and classification of natural objects into a relational order to reveal the similarities and differences between different species and kinds (Pickstone 2000: 10f.). The umbrella term medical physiology, in turn, incorporated two meanings at the turn of the nineteenth century: as anatomy, it meant the study of the structures, and as physiology proper, of the life processes of higher organisms. As I will show later, the strictly physiological approach was traditionally distinguished by its focus on the theoretical reasoning about the (invisible) life processes on the basis of empirical observations made through the practical art of anatomy. Therefore, in the first half of the nineteenth century, physiology and anatomy were not yet clearly distinguished institutionally (Cunningham 2002, 2003).

According to Zammito, as physiology began incorporating “developmental and genetic accounts”, next to its theories of structures and processes, and natural history was reaching beyond classifications “to explain and generalize its findings”, both subsequently merged into the same research questions; namely, relating descent to organic formation in systematic accounts (Zammito 2018: 3). The resulting morphological approach constituted a field of zoology concerned with the scientific investigation of

animal form. It differed from the classificatory method of natural history in that it transcended the mere comparison and descriptions of animals' anatomies and "engaged some of the central philosophical mysteries of biology" (Nyhart 1995: 2).

I will not go into any more detail about nineteenth-century physiological science here. It suffices to recognize that the intellectual developments which Zammito describes were indeed marked by a radical shift in disciplinary identities. And after about mid-century, they were followed by the founding of independent professorships for zoology with a morphological approach in the philosophical faculty or in existing natural science departments (Nyhart 1995: 90f.). But his view suggests that a general shift occurred through which physiology, as the fundamental science of academic medicine, completely changed its identity from a medical to a biological research culture. Animal morphologists or morphological zoologists were, in the most part, descendants of medical science, even though they began to receive chairs in the faculty of philosophy after mid-century. However, most of their early proponents did not yet occupy independent zoological chairs. "Instead, they taught physiology in a medical faculty, together with zoology and comparative anatomy" (Nyhart 1995: 98). In other words, before later generations became independent biologists, their precursors retained a medical identity – only some of them would later substitute this for a disciplinary identity in the life sciences. They did so while embracing the new methods of the laboratory sciences and experimental research. But it has remained largely unacknowledged that their heirs today also operate the field of biomedical research.

There is, then, a general bias in the literature that protagonists in the early decades of the century, while still situated under the roof of the medical faculty, had cognitively emancipated themselves from academic medical theory and retained but little (if any) interest in practical matters of medicine. In this regard, Broman speaks of the "professionalization" of "those communities of university-based researchers" in medicine, but he concludes that only the ones pursuing the morphological approach were also the ones defending science against demands for clinical utility (Broman 1996: 194, see also 186ff.). Since all other medical actors must therefore have remained practicing physicians, his conclusion, too, enforces the biased idea of an identity-shift from medicine to biology with the emergence of the modern research university – the thesis of "the decisive continuity", which ran from the founders of zoology in the late-eighteenth century through medical Romantics to the generation of early-nineteenth century physiologists, including Johannes Müller and his

disciples, Matthias Schleiden and Theodor Schwann, the inventors of cell theory, “with whom no one can doubt that biology as a special science had taken form” (Zammito 2018: 340).

Did all medical actors who adhered to laboratory science really shed their medical identities after the mid-nineteenth century? Where was medical science institutionally located after the emergence of modern zoology and morphology? Historian Lynn Nyhart calls our attention to the fact that, before the first chairs of morphological zoology were established after mid-century, we are dealing almost exclusively with medical protagonists. Some had begun specializing in questions of animal morphology after the turn to the nineteenth century, while others later began adhering to physicalist physiology – that is, an approach strongly oriented towards vivisectional experiments and the quantitative measurement of life processes with the aid of physical and chemical techniques (Nyhart 1995: 65–102). Nonetheless, these actors retained their identities as *medical* scientists. Nyhart thus warns her readers of historians’ anachronistic projection that makes these specializations *within* the discipline (of medicine) into competing factions *between* disciplines: “At the time, the difference was seen as one between two approaches within physiology; it was only in the wake of the institutional divisions following the mid-1850s that the story began to be rewritten into one between physiologists and morphologists, that is, between people inside and outside [medical] physiology” (ibid: 74). My book sets out to demonstrate how the experimental researchers with medical identities prevailed also after the 1850s and how they were able to maintain and expand a scientific discipline of medicine. Coming from physiology, this discipline did have a close biological resemblance, but actors painstakingly distinguished it as an autonomous academic endeavor from biology by tailoring it to expectations of medicine and health care. I will show how this tension between science and practice was reinterpreted in changing historical situations, how it has structured the scientific pursuit of medicine and how this is visible in our modern idea of biomedicine.

III. Historical Semantics and Discourse Analysis – Theoretical Approach and Method

I have developed my investigation into case studies organized around the basic concepts that were central for understanding medical science in Germany and the United States in particular eras – medicine as *Wissenschaft*,

wissenschaftliche Medizin, scientific medicine, biomedicine,¹⁰ and evidence-based medicine and translational research. The aim is to examine how these concepts were employed by actors in the historical discourses; how they were aligned programmatically in academic science and medicine; what the cultural backgrounds and interests were of protagonists that employed them; what sort of expectations they generated for the idea of medicine as a scientific discipline vis-à-vis medical practice and education, the clinic, science or society more broadly; and how the concepts were adopted in public and political discourses. I want to show how observing the use and popularization of these categories can point to moments in which some of the central cultural and social structures for academic medicine and for the system of science as we know it today were laid. Things like the requirement for physicians to receive extensive practical laboratory training; the culture of clinical science practiced today in university hospitals and clinical research centers; the rise of government interest in biomedical research; or the belief that advancing investigations into basic biological mechanisms will contribute substantially to the improvement of physical wellbeing.

In contrast to Schweber, my investigation is not strictly a *comparative* study of institutional developments – such as the development of medical specialization in international perspective (e.g., Weisz 2006). While there are of course resemblances in the developments of both countries, I have chosen a focus on Germany and the United States for specific reasons: Germany is arguably the homeland of the modern research university, which emerged at the turn of the nineteenth century (McClelland 1980, Stichweh 1984). It is from here that the idea of medicine as a scientific discipline, as it reflects in contemporary biomedical research, originates. Accordingly, the development of medical science needs to be situated in this context. However, it is from United States policy discourses that the idea of biomedicine emanated, which requires also looking at the social history of the academic system in the United States. According to Stichweh, American Universities went through a similar development as the German ones, only a century later (Stichweh 1994: 282f.). As we will see, US actors took inspiration from the German role model, but created their own idea of academic research institutions. This therefore also requires looking at how the scientific discipline of medicine developed differently in this cultural context at the start of the twentieth century, and how

10 I am keeping with the conventional term here, although the historical phrase – as I will demonstrate in chapter 6 – was “biomedical science”.

it prepared the invention of biomedicine – a category that has become universal today. Beginning in Germany during the Romantic Era, I will first examine the creation of a modern disciplinary identity of academic medicine, which becomes refined around mid-century. European academic ideals are subsequently exported to the United States, where a vastly different American version of scientific medicine forms during the Progressive Era, which then ultimately lays the ground for the discipline of biomedical science in the post-war discourse.¹¹

Methodologically, my study draws on historical semantics (or conceptual history) and discourse analysis. Discourse analysis is the apt approach to deal with such a vast and complex topic because it affords studying the issue of discipline formation from a relatively comfortable distance and without the burden of detailed comprehensiveness. Instead, the specific historical cases, which I examine, are representative of the regularities that governed how social phenomena were perceived and understood at a given time as well as of the hidden strategies that applied to making culturally comprehensible statements. They can therefore reveal the semantic complexity underneath the conceptual condensations, which constitute a society's systems of thought and communication about science and medicine.

One such structuring regularity in scientific discourse, for instance, is “credibility”, as Gieryn (1995, 1999) shows. What constitutes credibility is historically contingent, but in what he calls “boundary work”, scientific actors resort to different discursive strategies to manifest their authority over making truth claims regarding a given phenomenon. “Epistemic authority does not exist as an omnipresent ether, but rather is enacted as people debate (and ultimately decide) where to locate the legitimate jurisdiction over natural facts” (Gieryn 1999: 15). Boundary work gets employed for pursuing professional goals and interests; it is used to demarcate science from religion, technology or “pseudoscience” as well as for distinguishing scientific disciplines, which becomes manifest in antonyms such as “pure” and “applied science” (Schauz 2020: 47, see also Kaldewey 2013: 322ff.). In my book, the dominant form of boundary work is that of assigning credibility to scientific statements and practices concerning clinical facts.

11 While I employ a wide temporal scope (from the turn of the eighteenth to the nineteenth century until the present), my study accordingly only highlights important episodes in which the basic understanding of medicine as a scientific discipline was refined in the context of changing institutional or social developments.

Boundary work is a widely used approach in science and technology studies (STS) that can also help explain conflicts over policy influence (e.g., Greenhalgh 2008). As historian Désirée Schauz notes, boundary work discourses help seeing that such demarcations are contested and always up for grabs by the actors involved (Schauz 2020: 47). She also notes how Gieryn, even though his studies include historical cases, is hardly interested “in long-term semantic changes and the specific historical manifestations of demarcation concepts” (ibid.). To meet this interest, therefore, it requires a conceptual history approach, which is compatible with the idea of discourses on boundary work (see also Kaldewey 2013). Conceptual history is a scholarly tradition most closely associated with the historian Reinhart Koselleck (1979, 2006), who in a combination of intellectual and social history investigated how changes in language also reflect historical changes. His aim was to show how key concepts in the modern political and social language of Europe became consolidated between about 1750 and 1850 as expressions of specific experiences in relation to social expectations. The conceptual approach has subsequently been expanded to a variety of different intellectual fields (see Müller/Schmieder 2016, Wimmer 2015).

In the social studies of science, technology and innovation, the methodology has been used to productively show that “concepts such as basic and applied research are heatedly contested, while at the same time remain[ing] indispensable and of persistent relevance for communicating science policy” (Schauz/Kaldewey 2018: 7). With this approach, concepts can be understood as simultaneously embodying “cognitive strategies designed to deal with reality”, and as expressions of human experience like “expectations pointing to desirable or, alternatively, dreaded futures” (ibid: 10). I will show how actors connected to medical science employed their concepts not as neutral categories but rather to define experiences in academic medicine from the background of their values and interests. Fundamental concepts can be seen to have started as subjective categories, used as rallying cries to defend a cause or publicly legitimize the maintenance of a cultural identity. Only upon successful implementation as an accepted category can they be regarded as having received analytical value as an expression of reality. Thus, instead of treating modern concepts as categories, which somehow objectively periodize the history of medicine, I am here instead interested in the question of actors’ perceptions and conceptualizations of the relationship between science, medicine and society more generally. In a very basic sense, therefore, I want to assume

that protagonists deployed new basic concepts to try and force society to comprehend the reality of science and medicine in their terms.

Key concepts in the academic discourses are also crucial for ordering society's understanding and expectations of medical science. On the one hand, as I have noted already, they work to integrate often irreconcilable activities in different disciplines or institutions into Harris' (2005) notion of a supercategory. As science studies scholars employing the conceptual approach have aptly demonstrated, key concepts like "natural science", "pure science", or "basic" and "applied research", provide unifying narratives that work to reconcile into a coherent picture the seeming opposition between the meanings of science as an autonomous *and* as a socially relevant pursuit (Bud 2014, Clarke 2010, Kaldewey 2013: 311–410, Kaldewey/Schauz 2018, Phillips 2012, Schauz 2020). Narratives, such as the one stating that disinterested basic research will at some unspecified time in the future lead to useful outcomes, then incorporate both the self-understanding of academic science as well as attributions stemming from societal expectations.

For me, consequently, this means investigating the key medical categories for the narratives they provide, which paint into a coherent picture the conflicting ideas of what it means to pursue medicine as an autonomous academic science and as a contribution to health care.¹² Since these categories incorporate both the notion of an autonomous academic pursuit and of medical usefulness, they also linguistically integrate both our understanding of medicine as a profession and as a scientific discipline.¹³

More, basic concepts are highly relevant for the organization and categorization of scientific practices and fields. Thus, situated in the discourse opposed to other categories, they are also connected to a dimension of what science studies scholar Steven Shapin calls "metascientific statements": overarching expressions made about the nature and purpose of science, which are generally not defenses of science as a uniform and global operation, but rather "local criticisms of certain tendencies *within* science, or within parts of it – criticisms that are often substantial and

12 I will not be able to consider here how *materiality* plays a crucial role in conditioning these narratives, but only on the narratives themselves. Nonetheless, I find the issue of materiality to be an important question to pursue in future research.

13 Thus, from this integrative perspective, one can understand why our cultural idea of medicine is less shaped by the actions and experiences of medical practitioners than it is by the provisions for medical practice provided by scientific knowledge.

1. Introduction: Science and Medicine – Two Cultures Lost in Translation?

vehemently expressed” (2012: 44, see also Kaldewey 2013: 107, Schauz 2020: 21). The organization and classification of the work conducted under the supercategorical umbrella using scientific or medical categories always also implies situating these activities within a normative hierarchy. Fundamental concepts in the academic and science policy discourses thus ultimately give an indication of “the permanent negotiations over different interests, epistemic and social goals and norms, institutional and financial arrangements and their related expectations and experiences of science” (Schauz 2015: 57). How actors employed key concepts as at the same time discursively reconciling and conflicting linguistic elements accordingly helps observe the distinctions and fault lines, which ran through the academic system at a given moment.

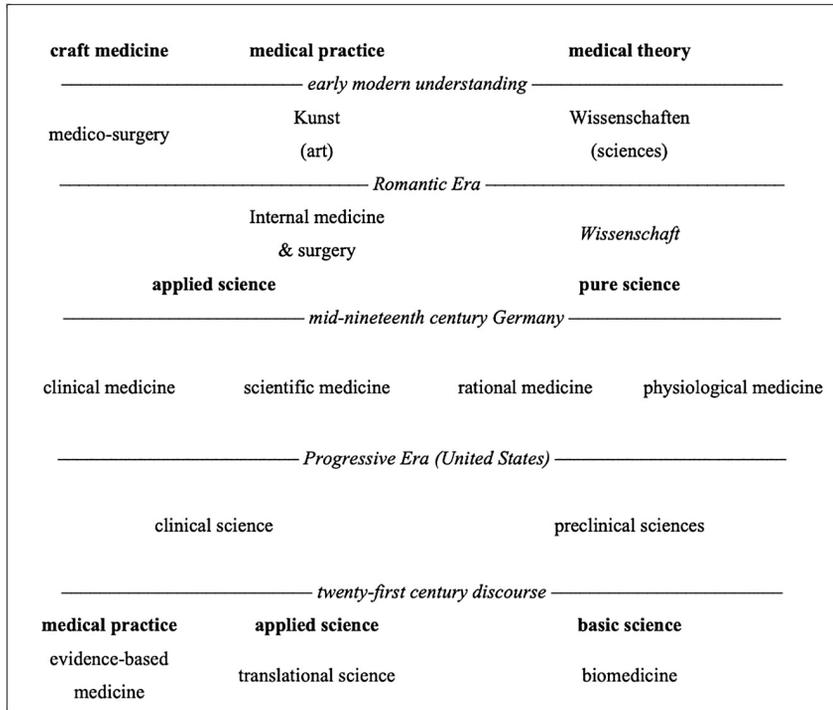


Table 1.3: Semantic field of modern medicine in Germany and the USA in the context of changing ideologies of science (my depiction).

The concepts in the historical discourses of medicine that form the subject of my investigation are related to each other synchronically and diachronically.

ically in a wider semantic field (Kaldewey 2013: 176–185, see also figure 1.3). The theory of semantic fields holds that meaning is not reducible to single words but that it constitutes itself in the way that concepts relate to each other in similarity, in opposition, or in hierarchies of sense. Therefore, my book not only examines the key concepts that characterize the discourses themselves, but also looks at important categories that relate to these, such as other basic concepts like “pure science” or “basic research”, various notions of scientific and clinical method, medical (sub-)disciplines like physiology or pathology, the scientific discipline of biology, the clinic and others.

To grasp the relations between these meanings and terms, however, it requires to differentiate linguistically between a level of expression and a level of content. For this purpose, conceptual history employs an *onomasiological* perspective on the one side and *semasiological* one on the other (Koselleck 1979: 121). The rationale behind this distinction is that only looking at changes in linguistic meanings of single terms over time would constitute an insufficient analysis of the history of fundamental concepts. Rather, I also consider how *different* designations at various times meant the same thing factually. This is somewhat akin to Schweber’s minimal definitions of vital statistics and demography. “The onomasological approach assumes that there is a given phenomenon or idea that has been described with different terms in the course of history in different contexts” (Kaldewey 2018: 163f.). From this angle, it becomes apparent how, in a diachronic perspective, ideas have prefigured or resembled the concepts, which have only subsequently become coined as the terms of interest for my analysis. For instance, the changing description of medicine from the Latin *scientia* to the German *Wissenschaft* reveals the “general cultural shift” (ibid.), which substituted the idea of medicine as a premodern body of philosophical knowledge with the idea of medicine as a modern scientific institution.

The semasiological approach, in contrast, enables an examination of “what a given term denotes in different contexts and how its meaning changes over time” (ibid.). It lets me perceive how actors employed the same term to express different things in different periods; for example, that the term “medicine” could mean a practical art for medieval and a scientific discipline for modern actors, while it is understood mostly as a professional practice in the present. In relation, the translation of a term also alters its meaning across the concerned language boundaries. Historian Denise Phillips (2015) alludes to how the rendering of the German “Wissenschaft” into the English word “science” in the second half of the

nineteenth century changed the meaning of the word significantly due to the cultural and political differences between actors in Germany and Great Britain.¹⁴ The sense of the word “*wissenschaftliche Medizin*” or “scientific medicine” varied considerably with the change from the German to the American cultural context, as I will show in chapters 4 and 5. In sum, a look at the semantic field surrounding key concepts allows for studying the changing disciplinary identity of medicine through the changing designations, meanings and tropes with which the idea of medicine as a science was inscribed into the scientific system. The analysis is about discourses on how different institutions of medical science and neighboring fields were related or conflicted with each other, how they were organized in the academic system and how they were legitimized in front of society.

Empirically, my research draws on a mix of primary and secondary sources. It concerns the discursive identity work of actors in and around academic medicine in Germany and the USA. I accordingly investigate historical sources that offer programmatic statements about the role and purpose of science for medicine and health care and that have popularized the use of key concepts, such as “scientific medicine”, “clinical science” or “biomedical science”. My investigation concentrates on documents that contain depictions by actors involved in the construction of academic medicine’s self-understanding and public image. In analogy to Schauz’ pursuit of the meaning of the natural sciences over the centuries, I want to regard that “[a]ll discourses are principally relevant in which expectations on science [and medicine] are expressed, be it that societal actors addressed them to scientists [directly] or that researchers have communicated them with a view to their own work” (Schauz 2020: 43). For this purpose, I have selected those sources in which the historical discourse can be said to have become condensed. My investigation draws on documents that were at the center of crucial semantic transitions – important and influential historical texts in specialized journals, innovative speeches and memoranda or policy papers about standpoints in medicine with respect to science.

My study is then also aided by the available historiographical literature that has reconstructed the state of German and US science and medicine. I have consulted texts that examine them especially in the academic context of the two countries. Naturally, it would be quite impossible for me to work through all the relevant historical data spanning two centuries and

14 The most striking difference is that “*Wissenschaft*” has a far more encompassing meaning, which includes humanities next to the natural sciences, whereas “science” is restricted to natural science fields.

two countries that a myriad of historical studies has brilliantly processed. For this reason, I have not only restricted myself to specific time periods to design the individual cases of my study, but also mainly analyzed “newer” historiographical literature on medicine in Germany and the USA for their contribution to a conceptual and institutional history of medical science as a discipline. Especially the works that have developed since the 1970s and 1980s, when the history of medicine increasingly became a domain of professional historians, has proven as relevant to my questions about the production of medicine’s disciplinary identity (Löwy 2011, see also Rheinberger 2009).

However, my research design requires applying a certain measure of caution to the literature. We cannot trust at the outset that historians always reflect on the semantic heritage of the key concepts they themselves employ. Like the historical actors they study, their work is also conditioned by prevailing social values and conventions. For example, Harris shows in his book that the term “science” became widely used only in the seventeenth century, but that it is “applied retrospectively” to describe many forms of scholarly activity since at least the time of Aristotle (Harris 2005: 25). Through this practice, however, premodern concepts get endowed with modern characteristics that were still largely foreign to them, thereby also ignoring the cultural shifts that accompanied the use of new vocabularies. So, when historians employ terms like “biomedical” in the context of nineteenth-century academic medicine, it needs to be remembered that they are not referring to the postwar category. Instead, they are anachronistically projecting our present understanding of science and medicine back onto the past, distorting the meaning of the concept at hand.

The same caution also holds for the analytical categories that historians use. A salient example is the concept of “scientific medicine”, which, next to biomedicine, plays a central role in my book. Historians of science and medicine in the 1970s and 1980s began composing nuanced studies about the ideological, cultural, professional, social, political and economic role of science in medicine. These were intended to revise the rather positivistic ideas of science and medicine of their predecessors (see Warner 1985). One unintended consequence of this new current in medical historiography was the transformation of scientific medicine from a concept used by historical actors at a given time and in a specific place into a universal category. As historian John Harley Warner stated in an extensive review-essay of the Anglo-American medical history literature, published in the 1995 volume of *Osiris*, it was perceived, at the time, that “the notion

of *scientific medicine* stands among the sturdiest bastions of presentism in the field” (Warner 1995: 188, see also 1985: 50, 57). The complaint arose from the term being, to a large extent, used in the literature to describe only that form of “medicine rooted in experimental laboratory science” (ibid.). The impulse of revisionists was that the idea of medicine as being “scientific” should be applied equally to all understandings in which medical actors at different times and in different places referred to scientific practices. For Anglo-American historians the idea of scientific medicine thus comprises a broad understanding of science-based medical practices no longer concurrent with the historical concept, which indeed describes a laboratory-centered program.

Finally, next to providing a new perspective on the current biomedical discourse, my project also wants to contribute to the historical sociology of scientific disciplines. For this purpose, I will develop a new model of disciplines in the next chapter that combines elements worth preserving from two competing scholarly discourses – science and technology studies and “classical” sociology of science – and puts it to the test in the subsequent chapters. This model, I intend to show, on the one hand, can reveal the more fragmented and messier dimension of science that is truer to how it is practiced “on the ground”. On the other, it helps preserve those important insights explaining structural aspects, which allow conceptualizing the growth and institutional differentiation of science as well as the intimate – and sometimes obscured – relation between academic education and specialized research. A view of disciplinary structures shaped as the result of discursive activities borne by professional interests in specific historical contexts, so I hope, may also provide an example for other cases to shed some new light on sciences with a long historical tradition, or also help explain how in more recent experiences the practices of actors form institutional structures.