

**State-building and the Origins of Disciplinary
Specialization in Nineteenth Century Germany**

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1 February, 2010

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Abstract

Scholars have long debated why the sciences became organized into specialized disciplines during the nineteenth century. The Prussian university reforms and the institutionalization of research in the German universities have occupied a central position in these discussions. Using records of the appointments of full professors in the life sciences at German universities from 1770 to 1880, this paper investigates whether the Prussian and other reforms led professors to specialize into disciplines and universities to hire from an open academic labor market. The results show that the reforms did not encourage competition and disciplinary specialization across the German universities. Until the 1840s, reforms encouraged professors to pursue scientific research to the exclusion of traditional subjects, but not to specialize within single disciplines. Outside of Prussia, Baden, and Bavaria, university hiring practices also continued to favor the internal promotion of students until relatively late in the century. In contrast to theories of disciplinary specialization emphasizing the institutionalization of scientific autonomy through the Prussian university reforms, I argue that the political integration of German territories and the exploding university enrollments of the late nineteenth century were necessary conditions for the initial adoption of disciplinary organization. These changes did not directly follow from the university reforms, but rather were connected to the ongoing political and economic development of German states over the course of the nineteenth century.

Keywords: historical sociology, sociology of knowledge, organizations, discipline formation

Why are the sciences organized into disciplines? Scholars have argued that the way in which scientific work is done today is in many respects an invention of nineteenth century German universities (Ben-David 1971; Radl 1909). Prior to the nineteenth century, natural philosophers conducted scientific work in accordance with the rules of courtly life and gentlemanly behavior. Lives in science were provided for by either independent wealth or the personal support of a wealthy patron, and natural philosophers – the word “scientist” would not have been recognized by them – placed trust in each others’ judgments of fact less as trained specialists than as gentlemen, “free and unconfin’d,” and thus worthy of trust (Shapin 1994: 123). Yet during the nineteenth century, long years of specialized training within organized laboratories and institutes increasingly became the hallmark of a life in science, and many scientists, as they called themselves, spent their entire careers within such sites. Rather than trusting in each others’ virtue as before, they asserted facts based on objective methods and produced through specialized tools and techniques (Daston and Galison 2007; Porter 1996). Contemporary observers as well as later historians singled out the institutes and seminars of the German universities as the origins of these developments. Reformers in Europe and the United States petitioned for imitations to be constructed in their own countries, spreading the new model of scientific work (Graham 1994: 32-55; Kohler 1990; Shils and Roberts 2004; Weisz 1983).

To explain the transformation of scientific work that occurred in the German universities, sociologists have claimed that the university reforms proposed by Wilhelm von Humboldt and undertaken in Prussia during the early nineteenth century first institutionalized the pursuit of scientific work and study independent of other demands, and were a turning point in the organization of scientific work. This argument was first advanced by Ben-David (1971),

building upon Weber's (1958 [1918]) essay, "Science as a Vocation," and it continues to be accepted by many sociologists, either explicitly (e.g., Collins 1998) or implicitly (e.g., Bourdieu 2004 [2002], Charle 2004). The central claim is that the Prussian university reforms in combination with the political decentralization of the German territories guaranteed a degree of relative autonomy for scientists holding professorial chairs by supporting the pursuit of specialized research programs independent of other concerns and fostering the free competition of scientists for university professorships (Ben-David 1971: 109-22). Under these circumstances, scientists organized themselves into disciplinary specialties in order to meet the increasing standards of the scientific community.

Historians have repeatedly challenged this account of how disciplinary specialties developed in the German universities. They have disputed the historical sequence of university reform and disciplinary specialization, noting the existence of reforms well before those of Humboldt, and the persistence of academic divisions of labor not matching the model of one discipline per professor (Turner 1973; Nyhart 1995). Recent scholarship has found that the decades following the Prussian university reforms were characterized by a lack of free competition for scientists between universities and persistent state interference in the affairs of universities faculties within Prussia, and has questioned the notion that other German states and universities followed the lead of Prussian reformers (Kremer 1992; Tuchman 1993). Others have argued that the very ideology of scholarly cultivation (*Bildung*) promoted by Prussian reformers encouraged a resistance to narrow specialization and a valorization of comprehensiveness evident in the natural sciences as late as the early twentieth century (Harwood 1993; Ringer 1969).

These criticisms highlight two weaknesses in Ben-David's argument which have not been sufficiently explored by sociologists. First, it does not provide a clear explanation of why autonomous scientists would choose to form specialized disciplines. Autonomy may very well allow scientists to resist the diminution of their research programs through specialization, as the continued tendency towards comprehensive holism among German scientists seems to suggest, or it may allow them to pursue idiosyncratic specialties, not linked to any disciplinary framework. Second, the apparent weakness of the competitive mechanism among German universities leaves us with little understanding of how scientists came to compete for professorships across different universities. The practice of hiring of new professors from other universities which became commonplace in the nineteenth century stands in contrast to often guild-like solidarity and recruitment from among the students and relatives of faculty which marked the universities of the eighteenth century.

This paper examines the circumstances under which university professors in Germany chose to engage in work defined by specialized disciplines and university faculties chose to hire new faculty from outside the university's own ranks. In doing so, I hope to settle some of the debates over the specific effects of Prussian and other university reforms on the organization of scientific work as well as to open up more fruitful lines of inquiry over what actually occurred to so dramatically change the practice of scientific work during the nineteenth century. I investigate the division of labor and patterns of hiring in the life sciences at all the German universities from 1770, before the series of reforms made by Prussia and several other German states at the start of the nineteenth century, until 1880, by which time there is relative agreement among scholars that disciplinary science had taken root in the German universities, and contemporary observers had already begun clamoring for the adoption of 'German science'

elsewhere. I also compare universities which were contained within states in which university reforms were made in the early nineteenth century to those located in other states, in order to explore what effects, if any, reforms had on the organization of the sciences.

Previous research by both sociologists and historians has emphasized the role played by the creation of new life science disciplines, particularly experimental physiology, in the origins of disciplinarity in the German universities, and therefore this paper focuses on the life sciences (Ben-David 1971; Lenoir 1997; Zloczower 1981). Within the organizational framework provided by the German universities, new programs and lines of inquiry proliferated in the life sciences (Lenoir 1997). A similar process occurred in other fields, particularly in the social sciences, but only at the very end of the nineteenth century, and often drew explicitly on models of specialization derived from the life sciences (Ben-David and Collins 1966; Abbott 1998). The life sciences therefore provide the best point at which to engage with debates over the origins of discipline formation in the German universities, as well as the case which is most likely to offer informative variation.

I propose an alternative account of the origins of disciplinary specialization based on a more complex understanding of the relationship between state actions and professorial conduct. Specifically, I argue that the university reforms of the early nineteenth century played a role in securing the autonomy of university research programs, but were not in themselves sufficient to encourage the adoption of disciplinary organization. Instead, the incorporation of universities into state civil service bureaucracies, political integration of the German territories under Prussian control, and expanding university enrollments due to increased demand for teachers and bureaucrats were necessary conditions for the formation of specialized disciplines. These conditions encouraged disciplinary specialization by restricting the power of university faculties

to resist external influences, and by encouraging the partitioning of established scientific jurisdictions among more and more professors.

I begin by reviewing the relevant literature on discipline formation in order to show the importance of understanding the origins of discipline formation in the German universities, as well as to demonstrate the weaknesses noted by historians in the sociological account proposed by Ben-David and adopted by others. I then show that the university reforms of the early nineteenth century gave professors more local autonomy and support to pursue their own research programs, but did not encourage them to form specialized disciplines. Significant hiring of outside faculty did occur in the early nineteenth century, but it followed the patterns of political integration and the incorporation of universities into civil service bureaucracies rather than decentralization and free competition. In the second half of the nineteenth century, disciplinary specialization and outside hiring became more common in the German professoriate as faculties expanded in step with growing university enrollments. Patterns of outside hiring also became more reflective of disciplinary differentiation rather than political geography. These changes did not directly follow from the university reforms, but rather were connected to the ongoing political and economic development of German states over the course of the nineteenth century.

The Sociology of Discipline Formation

Before proceeding, it is necessary to clarify what is meant by a discipline. Following Abbott (2001: 122-44), I define a discipline as consisting of *a group of people with a shared claim to an intellectual problem or task based upon a set of canons, practices, or evidentiary conventions, and controlling positions dedicated to work based upon that shared claim.*

Disciplines are thus a means of organizing the division of academic labor around scholars' claims to specialized competence at a particular intellectual task. However it is not sufficient to define a discipline simply in terms of a jurisdictional claim and the existence of permanent positions for research and teaching. Disciplines consist of *communities* of scholars, however weak or fractious, sharing a claim to the same intellectual task as defined by the scholars themselves. Disciplinary communities are held together across distant locales by what is usually described as the academic labor market, but which is more precisely what anthropologists term a system of generalized exchange (Levi-Strauss 1969 [1949]). Although in the United States this system is ordered primarily through labor market institutions such as job searches and interviews, this is not always the case elsewhere.¹ Instead, as in other cases of generalized exchange, the key feature of academic exchange is that universities give new PhDs to each other, without the expectation of receiving something back in return.

Thus the same specialties must exist across multiple organizations in order for disciplinary practitioners to exist and be perpetuated. While the establishment of a first professorial chair or research laboratory may mark a nascent discipline or disciplinary project – and indeed, such incidents usually figure prominently in celebratory histories of disciplines (e.g., Rothschild 1973) – the existence of a single position does not in itself indicate the successful creation of a discipline. Within any particular organization, a discipline is represented as a social synecdoche, to use White's (2008) phrasing: the local department, chair, or division serves to represent the discipline as whole, which is often much larger than the host organization itself (263-7; Mohr and White 2008). Disciplines are thus dually institutionalized as both divisions within organizations and connections between persons across locales.

¹ See for instance McClelland (1980) for Germany and Weisz (1983) for France.

A great deal has been written on discipline formation, yet it has proven difficult to identify the processes which have driven the sciences into specialized disciplines. This is because in most cases the origins of a discipline are to be found in another, already existing discipline. Scholars and scientists have often used existing disciplines as a springboard for launching new ones, or have attempted to define new disciplines within existing ones (e.g., Clarke 1973; Kohler 1982; Nyhart 1995; Abr-Am 1984, 1987; Ben-David and Collins 1966; Mullins 1972). Furthermore, there is good reason to believe that the very prevalence of disciplinary organization may encourage any new research orientation to adopt the trappings of disciplinarity. Institutional theory suggests that organizations seek legitimacy by copying the routines or practices of other organizations in the same field of activity (DiMaggio and Powell 1983, Meyer and Rowan 1977). The replication of organizational divisions across multiple sites, a defining characteristic of disciplines, lends itself well to precisely these kinds of mimetic processes.² Disciplines can be expanded by grafting them on to organizations supporting other disciplines, or through cloning and the founding of new organizations. Scholars have suggested the clarity and simplicity of these processes help explain the rapid diffusion of disciplinary specialization worldwide in the late nineteenth century, as well as the resilience of many disciplines in the face of low demand for their services and economic hardship (Abbott 2001:122-3; Kohler 1990).

The Origins of Disciplinary Specialization

Because of the widespread effects the current prevalence and resilience of disciplinary organization may have on the formation of new disciplines, it is useful to examine the origins of

² These dynamics have been observed in economics, African-American studies, and computer science (Fourcade 2006; Rojas 2003, 2006).

the earliest scientific disciplines in order to understand the processes underlying disciplinary specialization. While research examining later efforts to form new disciplines has emphasized efforts to build a sense of community or shared identity across or within disciplines based on a common intellectual problem or task (Crane 1972; Lenoir 1997: 45-74; Frickel 2004; Mullins 1983), sociologists examining the formation of the earliest disciplines have instead emphasized the creation of institutions insulating competition among scientists from external forces and guaranteeing scientists' autonomy to specialize.

These authors have long paid particular attention to the development of the German universities during the nineteenth century (Ben-David 1971, Weber 1958 [1918], Zloczower 1981). Explaining why the sciences had undergone pervasive specialization in preceding decades, Weber (1958 [1918]) emphasized the importance of “the tradition of the Germany universities,” which cultivated in budding scholars “a capacity to put on blinders, so to speak, and to come up with the idea that the fate of his soul depends on whether or not he makes the correct conjecture at this passage of this manuscript” (134-5). Ben-David (1971) argued that two specific features of the German universities in the nineteenth century encouraged the development of this tradition. The first was the 1809 Prussian educational reforms made by the minister of education, Wilhelm von Humboldt,³ which created a new model university in Berlin and institutionalized research in the German universities in the form of expanded teaching in the sciences and state-financed seminars in science and philosophy, and thereby allowed professors to pursue organized research programs with their students in relative isolation from other concerns (Ben-David 1971: 109-22). The second was the political decentralization of the German lands. The existence of many universities in rival states acted as a brake on the

³The reforming spirit was extended to secondary education institutions in 1811 and 1812 with the general implementation of a final exam and credential, the *Abitur*, and the introduction of certification for secondary school teachers.

oligarchic tendencies of university faculties by creating a competitive labor market for professorships at various universities and thus rewarded innovative research (Ibid: 122-3). These conditions encouraged high standards for research and increasing specialization, while at the same time ensuring the freedom of scientists to create their own research programs.

Later sociologists have distanced themselves from parts of Ben-David's framework, criticizing his treatment of science as a relatively unchanging social function rather than the product of ongoing struggles (e.g., Bourdieu 2004: 67-8), but they have for the most part accepted his assessment of the historical process. Collins (1998) has described the Prussian university reforms as the first battle in an academic revolution during which intellectual seized control of their own means of production, and which resulted in the universities overshadowing other bases for scientific work through the cultivation of new scientific specialties (618-687, especially 614, 644). Bourdieu (2004: 45-55) has argued that the institutionalization of disciplines in the universities was a key stage in struggles over the autonomy of science because it constituted disciplinary practitioners as distinct groups and raised the costs of entry into scientific work. Both authors see disciplinary specialization as the direct result of competition among scientists who have achieved some degree of autonomy and insulation from external interference through their control of higher education organization.

Specialization and Exchange

These are crucial insights. Yet as an account of the process by which ongoing disciplinary specialization was achieved it has two important shortcomings. The first involves the development of disciplinary specialization, and the second involves the emergence of the

generalized exchange of new scientists among universities, *i.e.* the creation of the academic labor market.

Disciplinary specialization and its alternatives. It remains unclear why in the wake of university reforms professors chose to specialize, and why they chose to specialize together in the form of shared disciplines. Freed from other demands within university faculties, several different intellectual strategies may be compatible with increased autonomy. Autonomy may well encourage scholars and scientists to claim as much intellectual territory as possible. The ideology of the university reforms, as Collins (1998) has noted, was not sober specialization, but a totalizing philosophical Idealism. In the natural sciences, it was expressed as *Naturphilosophie*, an intellectual tradition which favored bold assertions of universal laws governing organic matter and form, and was well represented in the early nineteenth century at prominent universities such as Jena in the Duchy of Saxe-Weimar (Collins 1998: 628). Harwood (1993) has argued that even at the start of the twentieth century, a “comprehensivist” style of thought characterized the majority of German biologists, shaped in part by a broad appreciation for learned cultivation among the German educated middle classes (Ringer 1969). Specialization however requires not only autonomy, but also heteronomy to the assertions and jurisdictional claims of other scientists.

At the same time, even if competition among scientists did encourage professors to adopt narrower areas of expertise, without a pre-existing system of disciplines to work within and build upon, it is not clear why relatively autonomous, unconnected scientists should choose to specialize in the same or similar disciplines. A conceivable alternative would have been to develop distinctive specialties distant from those pursued at other locales and by other research

programs.⁴ Indeed, concentrating talent and resources on a particular intellectual problem at a particular place was the form of specialization promoted by many Enlightenment reformers, and guided the founding of other institutions, such as the French system of *grandes écoles* (Weisz 1983). As much as one tends to think of disciplinary specialization as characteristic of the modern sciences, specialized but non-disciplinary organizations such as the U.S. Department of Energy's national laboratories and the Pasteur Institute remain a persistent alternative to university disciplines, and have often provided a platform for the creation of new disciplines (Morange 1998; Frickel 2004). By comparison, disciplinary specialization is peculiar because it involves both the creation of jurisdictions locally and the joining of a research program to others in distant locales.

Academic exchange and the faculty market. The second problem with the established account of the origins of disciplinarity is that it does not provide a good reason for why universities increasingly competed for faculty with each other. Ben-David argued that this was an accidental result of the political fragmentation of the German lands spurring competition between universities in the wake of the Prussian reforms. Yet historians have claimed that many German universities and ministries of education failed to embrace the Prussian reforms or to support free competition among universities (Nyhart 1995; Tuchman 1993).⁵ Reformist ministers outside of Prussia as well as within Prussia following Humboldt's tenure usually desired to ensure the production of citizens useful to the state rather than uphold Neohumanist ideals of learning and cultivation (Lenoir 1997: 96-130; McClelland 1980: 101-149; Tuchman 1993).

⁴ Organizational ecologists have observed that firms in highly competitive markets specialize precisely for the purpose of differentiating themselves from competitors in order to reduce the dangers of direct competition (e.g., Carroll and Swaminathan 1990). Even if competition among scientists did encourage them to devote their energies to narrower and narrower specialties, it is not clear why these specialties should align into shared disciplines.

⁵ A review of these criticisms can be found in Nyhart (1995: 12-20).

There is also surprisingly little direct evidence of competition among universities before the latter years of the nineteenth century. Based on a study of ministry-faculty relations over petitions for the creation of new physiological institutes in Prussia during the 1830s and 1840s, Kremer (1992) has argued that most proposals for new research institutes emerged not because of competition between universities, but conflicts between local interests within universities, and they were generally not imitated by other universities until the establishment of Carl Ludwig's Physiological Institute at Leipzig in 1869. Zloczower (1981) has found evidence of competition in the hiring of physiologists at German universities, but has no data from before 1860. At least until the middle of the nineteenth century, the interests of state and conflicts within faculties, rather than competition among universities, appear to have been the major forces shaping the organization of academic labor.

The difficulty of linking university reforms to changes in university practices is also reflected in the long historical sequence of university reforms. It is the case that seventeenth and eighteenth century university faculties often embraced their own guild-like qualities, hiring new professors from among their own students and even often their own sons (Clarke 2006; McClelland: 80-88). However, Humboldt's reforms were part of a long series of university reforms movements in which absolutist states attempted to assert greater control of university corporations as a source of both income and trained bureaucrats (Turner 1973). It was the Prussian General Land Law of 1794, for instance, that first made all Prussian universities institutions of state. The University of Berlin was only the last in a series of model universities founded, including the University of Halle in 1694, which was founded by Frederick III of Prussia to guarantee a steady supply of bureaucrats, and the University of Göttingen in 1734, where many later reformers received their own educations (McClelland 1980; Turner 1973).

Similar reforms were made in Catholic southern Germany beginning as early as 1767 with the expulsion of the Jesuits and followed by successive waves of secularization during and after the Napoleonic Wars (McClelland 1980). While Humboldt's reforms did place particular emphasis on the pursuit of original research by professors and students, the patron states of Halle, Göttingen, and several other eighteenth-century universities also attempted to enforce standards of scholarly achievement for faculty and participated in hiring decisions (Clarke 2006). At least in terms of the hiring of faculty, the distinctiveness of the reforms of the early nineteenth century fades when they are put in the context of the long tug-of-war between university corporations and their patrons.

Discipline Formation and State-building

These theoretical lacunae can be addressed through more careful attention to the relationship between the development of the German states and the transformation of the German universities. The state's role as an agent of change, a source of repression, and a fount of resources appears prominently in both Ben-David's theory of disciplinary specialization and the criticisms of it offered by historians. Yet little attempt has been made to resolve either the exact conditions under which disciplinary specialization became the dominant mode of organizing the academic division of labor, or to place this occurrence more clearly in the context of the political development of Germany.⁶ Connecting the precise sequence of disciplinary specialization more specifically to state-building efforts by German bureaucrats may help clarify some of the ambiguities noted in accounts of the origins of discipline formation.

⁶ Kremer (1992) and Tuchman (1993) are important exceptions, but both focus only on relatively narrow cases. Kremer directs his attention to Prussian physiologists in the 1830s and 1840s, while Tuchman studies the relationship between the Badenese ministry of education and the medical faculty of the University of Heidelberg.

The early nineteenth century. University reforms were undertaken by German states at the beginning of the nineteenth century as a part of thoroughgoing transformations of political power and administration (Blackbourn 1997; McClelland 1980). During the Napoleonic wars, many of the nearly three hundred *Kleinstaaterei* were annexed by neighboring states, claims ratified by the *Reichsdeputationshauptschluss* in 1803. The Congress of Vienna in 1815 continued this process, reducing the states of the former Holy Roman Empire to a mere thirty-eight held together in loose Confederation. This consolidation resulted in significant territorial gains for many states, particularly Prussia, Baden, and Bavaria, and was followed with the expansion of territorial bureaucracies to incorporate newly acquired territories (Blackbourn 1997).

Monarchs and ministers reorganized institutions of higher education to reflect current political realities, shuttering superfluous universities and asserting control over those remaining. Prussia began the nineteenth century controlling only three universities: Königsberg, Viadrina University at Frankfurt (Oder), and Halle, plus a small Catholic seminary in Breslau (now Wrocław). As a result of the outcome of the Napoleonic Wars, Prussia gained an additional eight universities, seven of which were closed, their faculties either disbanded or merged into other universities. Bavaria and Baden each acquired two universities while allied to Napoleon, gains which were confirmed by the Congress of Vienna.

In Baden, Bavaria, and Prussia, ministers of education also undertook reform programs to modernize universities and incorporate them more completely into civil service bureaucracies. No states wholly abolished universities as had occurred in France, but only Prussia reshaped them according to a Neohumanist emphasis on learned cultivation, while reformers in Baden and Bavaria embraced a more utilitarian vision of universities as providers of useful knowledge and

skills (McClelland 1980; Tuchman 1993). The Bavarian reforms of Maximilian von Montgelas, for example, secularized the universities, seizing the property of the religious orders, temporarily abolished the division into faculties, and added faculties of cameralistics (statecraft) as well as physically removed the university of Ingolstadt first to Landshut and then to the capital, Munich (McClelland: 106-111). In each case, university professors were provided with new budgets to fund the practice of scientific research and the training of students, but university faculties were placed under greater supervision by the state, which retained financial control and final say over the selection of candidates for academic chairs, a power which at least in Prussia was regularly exercised (Kremer 1992; Tuchman 1993; Turner 1973).⁷

The later nineteenth century. The first half of the nineteenth century was marked by the expansion of state bureaucracies as well as economic stagnation and political repression. However, during the second half of the nineteenth century economic expansion as well as further political and administrative integration produced additional changes in the organization of universities. Most significantly, student enrollments grew tremendously during the late nineteenth century. Figure 1 shows the total number of students enrolled at the German universities from 1815 to 1881, as well as enrollments in the medical and philosophical faculties.⁸ Immediately following the Napoleonic Wars, enrollments were extremely low, and despite a short-lived postwar increase, they remained relatively stagnant until approximately 1860. Enrollments in the medical and philosophical faculties, within which the life sciences were taught, began a slow increase in the 1840s which accelerated after 1860. Increased demand

⁷ Examples of the hiring of professors not among the candidates recommended by the university faculty include Johannes Müller, who petitioned directly to Altenstein, the minister of education, for the professorship of anatomy and physiology at Berlin in 1833, and Purkyně, who was appointed to the chair of physiology at Breslau over the complaints of the faculty, who continued to grumble about his teaching and his poor command of German (Rothschuh 1973; Kremer 1992).

⁸ Earlier figures, unfortunately, are not available.

for administrators, teachers, and doctors, the prestige attached to university education, and public assistance to poor students all contributed to the increase in university enrollments. In response, additional professorships were created and research institutes were expanded to meet the needs of greater and greater numbers of students.

[Figure 1 about here]

Further political integration also brought more universities under the control of fewer states, and the remaining states into closer connection with each other under Prussian leadership. Beginning with the Second Schleswig War of 1864, the German states were involved in a series of conflicts, which brought four more universities under Prussian rule, among other things.⁹ In 1866 a new political union, the North German Confederation, was also declared under Prussian leadership. These developments culminated in 1871 with the proclamation of the German Empire with Wilhelm I of Prussia its emperor. Although member states retained control over their own civil service bureaucracies and thus universities, the constitution of the Empire established German citizenship for citizens of all states and a parliament capable of passing legislation binding on all member states.

State-building and discipline formation. These changes suggest that the origins of discipline formation in the German universities may be found in a two-stage process, triggered by responses to two periods of rapid change separated by several decades of relative calm. The university reforms of the early nineteenth century may well have had very different consequences from the university expansion of the late nineteenth century, although these changes have been conflated in previous studies of the origins of discipline formation.

⁹ These were Göttingen and Marburg during the Austro-Prussian War (1866) and Gießen and Kiel following its conclusion.

Differences in the extent of state control and political integration may have also produced differences in university organization and hiring across the nineteenth century.

Specifically, the university reforms of the early nineteenth century likely encouraged professors to pursue organized research programs divorced from traditional university curricula through both ideological intent and the foundation of new research institutes. However there is little reason to suspect that they encouraged professors to pursue particular specialties or to align their own intellectual jurisdictions with professors elsewhere. Instead, specialization and disciplinary alignment are more likely products of the later nineteenth century, which brought more professors into the same intellectual territory through the expansion of university faculties.

In contrast to Ben-David's hypothesis that the political decentralization and fragmentation of the German lands encouraged disciplinary specialization through competition, it is likely that the political integration of the German lands brought university faculties increasingly into contact and competition with one another. German ministries of education and the interior used their control over the universities to break the corporatist tendencies of German universities beginning at least as early as the eighteenth century with the Prussian General Land Law and the secularization campaigns of Bavaria and other Catholic states, a change which was necessary for universities to compete at all. The hiring of faculty should follow patterns of political integration, at least until all German states were pulled into political union with one another. Furthermore, by concentrating support on favored institutions such as the universities of Heidelberg or Berlin, centralization may have siphoned away the most promising students from other universities and thus encouraged other universities to hire new faculty from outside of

their own ranks.¹⁰ By bringing professors increasingly into direct competition with one another, it may have encouraged the adoption of narrower specializations.

Data and Methods

Testing these claims requires direct examination of the division of labor in the sciences at the German universities. The analyses reported here are based on information collected on all full professors (*Ordinarien*) occupying chairs in the life sciences between 1770 and 1880 at all nineteen universities located in Germany and in operation over the course of the nineteenth century.¹¹ They are the universities of Berlin, Bonn, Breslau (Wrocław), Erlangen, Freiburg, Gießen, Göttingen, Greifswald, Halle, Heidelberg, Jena, Kiel, Königsberg, Leipzig, Marburg, Munich,¹² Rostock, Tübingen, and Würzburg. Forty-four German-language universities were in operation at some time between 1770 and 1880. The data exclude the German-language universities of Austria, Switzerland, and Russia as well as the dozen or so small universities that were closed in the early years of the nineteenth century in the wake of the Napoleonic wars and the new territorial settlements which followed. Foreign universities were excluded because they were located outside of the region of political integration and thus not within the population of interest. The historical record for the German universities that closed early in the century is scanty at best, particularly in the decades immediately before their closure. However, what is known suggests that in the early years of the nineteenth century these universities struggled to enroll students, possessed few faculty members, and often functioned primarily as local

¹⁰ This phenomenon has long been noted in the provincial universities of other centralizing states, such as France (Nye 1993).

¹¹ It may be necessary to clarify that even to this day many German universities only appoint one full professor within each discipline, in contrast to American departments. The remainder of these departments consists of adjunct and assistant professors and lecturers.

¹² Located at Ingolstadt until 1800, then Landshut until 1826.

theological seminaries (Jarausch 1982).¹³ It is therefore unlikely that they would have boasted many professors in the natural sciences, and this assumption is borne out by the data collected on similarly small but surviving universities such as Greifswald, which possessed no permanent faculty in the natural sciences until 1808.

Because this paper is concerned with the dynamics of scientific specialization and discipline formation, I examine only the subset of university professors holding positions in life science disciplines, rather than attempting to study all university professors. I also chose to exclude professors specializing in botany and pharmacy, because these disciplines find their origins in the *material medica* of traditional university medical curricula and underwent relatively little change in their organizational boundaries during this time period. The disciplines represented in the data are: anatomy, comparative anatomy, histology, natural history, natural science (*Naturwissenschaft*), pathological anatomy, physiology, rural economy, topographical anatomy, veterinary science, and zoology. The data thus capture many of the disciplines emphasized by scholars studying the eighteenth and nineteenth-century transformations of the sciences (Ben-David 1971; Daston and Galison 2007; Foucault 1970; Zloczower 1981).

Information on full professorships was collected first from Eulner's *Die Entwicklung der medizinischen Spezialfächer an den Universitäten des deutschen Sprachgebietes* (1970), and supplemented with additional information from university commemorative publications and lecture catalogs. Three hundred and one spells of professorship in the listed disciplines were identified between 1770 and 1880, including 221 different professors (many individuals moved between universities in the dataset, or moved into new positions within a single university).

¹³ For example, Jarausch (1982: 28) notes that the once flourishing University of Duisburg enrolled only an average of thirty-eight students during its last decade of existence.

Detailed biographical information was obtained from reference sources including the *Allgemeine Deutsche Biographie* (1875-1912), the *Neue Deutsche Biographie*, (1953-2007), Poggendorf's *Biographisch-Literarisches Handwörterbuch der exakten Naturwissenschaften* (1863), Pagel's *Biographisches Lexikon Hervorragender Ärzte des Neunzehnten Jahrhunderts* (1901), and Gillispie's *Dictionary of Scientific Biography* (1970-1980). Despite relying on published sources, detailed information was obtained for the great majority of persons: for only nineteen was nothing discovered beyond their name and position. Social background information including place of birth and father's occupation as well as career information including positions held and journals edited was obtained; however the following analyses focus primarily on institutions of higher education attended and degrees earned.

I examined the frequencies of different characteristics of professorial chairs and their occupants over time. In order to determine the extent to which the division of academic labor corresponded to disciplinary specialization, I coded the titles assigned to professorships according to names and number of the disciplines included in each title. Disciplines included in titles but outside of the life sciences were further classified as either scientific topics, such as physics or mineralogy, or traditional topics, primarily practical medical subjects such as surgery, therapy, and obstetrics. I also recorded the founding of institutes, laboratories, and museums funded by the state or university and under the directorship of professors included in the same in order to capture the degree to which professorships actually provided significant support for scientific research programs. Outside hiring was measured by the university granting each professor his primary doctoral degree. Usually determining the degree was straightforward, but in some cases professors possessed multiple doctoral degrees. In these cases, I ignored degrees granted *honoris causa* (honorary degrees). Where multiple dissertations were defended, I treated

the last degree earned as the primary degree, based on the assumption that something must have been lacking in the opportunities granted by prior degrees for one to pursue additional degrees. Finally, I classified universities according to whether they were located in Baden or Bavaria, the two southern, Catholic states which undertook university reform programs, located in Prussia (and when they came under Prussian control), or located in one of the other, northern, predominantly Protestant states.

The University Reforms and Disciplinary Specialization

Figure 2 shows the number of university research institutes, including laboratories and research collections, and the number of full professors occupying single-discipline chairs in the life sciences for each year from 1780 to 1880. The first excludes private seminars and collections directed by professors but without permanent support from the university, while the second excludes professorships in the life sciences covering multiple subject matter areas. The total number of professors in the life sciences for all years from 1780 to 1880 at the German is also shown. The graph indicates that beginning in 1810 the number of university research institutes began growing, and continued to do so to the end of the period of observation, with more rapid increases from 1830 to 1840 and 1860 to 1880. The number of professors covering single subjects grew more slowly until the 1850s, after which it rapidly increased. The proportion of single subject professors among all professors in the life sciences increased from less than half in 1840 to nearly three-quarters by 1880. These trends hold across Prussia, Baden, Bavaria, and all other universities (results available upon request).

[Figure 2 about here]

The results indicate that the university reforms of the early nineteenth century likely had an effect at both reformed universities and provided a model that was adopted at other universities as well. The increase in university research institutes began at the time of the Prussian university reforms (indeed, two were created with the founding of the University of Berlin in 1810). It continued as Prussian, Badenese, and Bavarian universities added institutes, and other old and well-funded universities such Göttingen and Leipzig also came to do so. Some of these additions were the result of negotiations between university professors and state ministers, as in the case of Carl Ludwig's Physiological Institute at Leipzig or Purkinje's institute at Breslau, but others, particularly in the 1840s, were created when professors died and left their own personal collections and equipment to the university, as in the case of the Blumenbach collections at Göttingen (Kremer 1992; Lenoir 1997).

However, the creation of single-subject professorships lagged behind the creation of research institutes until the 1850s. It is not unexpected under any theory of discipline formation that the number of single-subject professorships should be lower than the number of research institutes. Ben-David noted that many institutes were started under the direction of adjunct faculty (*Extraordinarien*), who were only gradually promoted as their work proved the quality of their research program, as Ben-David in fact suggested (1971: 122). But it is surprising that single-subject professorships remained a minority in the life sciences until more than forty years after the initial university reforms, even as the founding of institutes increased in the 1830s. Single-subject professorships did not begin to replace broader professorships until enrollments in the philosophical and medical faculties until the enrollment expansion of the late nineteenth century. The period immediately following the university reforms appears to have been one of

increasing institutionalization of scientific work, but lagging institutionalization of disciplinary specialization.

Figure 3 provides greater insight into changes in the division of labor within university faculties. It shows the average number of subject areas in the sciences held by professors as well as the average number of total subject areas controlled by a single professor. Where these numbers differ, it is because professors also held subjects tied to the traditional curricula of the university faculties, including topics such as surgery and obstetrics in the medical faculty, or cameralistics in the philosophical faculty. It also shows the average number of professors included in the sample per university (note that this is just a rescaling of the year totals in Figure 2, because the number of universities does not change).

[Figure 3 about here]

The average number of subjects held by professors in the life sciences also shows that discipline formation occurred later than is usually suggested. In the decades of the university reforms in Prussia, Baden, and Bavaria, many professors appear to have quickly abandoned practical and philosophical topics, as is consistent with increased autonomy. In the late eighteenth century, the most common combination in the sample was anatomy with one or more practical medical subjects such surgery, obstetrics, or ophthalmology. However following the university reforms, professors maintained or expanded jurisdictions over multiple scientific subjects, combining for instance anatomy and physiology or physiology and zoology into the same chair. In the 1840s, the average number of subjects began to drop, only falling towards one subject per professor as more professorships were created in the 1850s.

The results suggest that early disciplinary specialization was accomplished through the subdivision of existing chairs rather than the development and promotion of entirely new

research fields. In 1840, while the average number of professors in the life sciences per university was about 2.3, the average number of life science disciplines per university (calculated as average number of disciplines multiplied by average number of professors) was about 3.8. By 1860, the average number of professors had increased to 2.9, the average number of disciplines remained about 3.8. To investigate the way in which different subjects in the life sciences were divided up among professors, we turn to Table 1a. Table 1a cross-tabulates subject matter areas by subject matter areas in 1840 and 1880, and provides counts of the number of times each possible overlap occurred within the data. In 1840, overlaps are common and also very diverse. The two most common classes of overlaps both involve the same subject, physiology, attaching it to either anatomy or comparative anatomy, which themselves only are only shared by the same professor twice. Professors not only held multiple subjects, but the precise division of subjects was also quite diverse locally. By 1880, the sharing of multiple subjects has become extremely rare, and half of all such cases are of the same form, attaching pathological anatomy to pathology, listed as “other” for subjects not selected for in sampling.

[Table 1a about here]

Table 1b gives us some sense of the degree to which specialization occurred through the steady subdivision of professorships along already well-established subject matter areas. It provides counts of each type of single-subject professorship for four years: 1810, 1840, 1860, and 1880. Most single-subject professorships were created in anatomy, natural history, zoology, physiology, and pathological anatomy. All of these subjects were relatively common within the sample as early as 1840 and indeed were relatively widespread as early as the late eighteenth century (Eulner 1970).¹⁴ However it should be noted that the dominant methods within each

¹⁴ For example, the term physiology was promoted by Albrecht von Haller for the study of “anatomy in motion” in the mid eighteenth century, and pathological anatomy Giovanni Battista Morgagni at nearly the same time.

discipline often changed greatly over time. As the Breslau physiologist Purkinje wrote to the Prussian minister of culture, Altenstein,

The physiology of the last century was little more than a spiritual commentary on anatomy, and in the beginning of this century it followed *Naturphilosophie* to another extreme, raising itself to an almost supernatural independence. Now it steps down from its former heights to natural and material, albeit organic and living undertakings (“Purkinje,” *Allgemeine Deutsche Biographie*).

New wines were poured into old skins, but specialties aligned for the most part across the different German universities because they were built within the existing framework for teaching and research.

[Table 1b about here]

Nevertheless, not all single-subject professorships conformed to this model. Several subjects commonly taught in the early nineteenth century disappeared during the second half of the century. All natural history professorships disappeared by 1880 as they were converted into chairs for zoology, botany, or mineralogy, while comparative anatomy never separated from completely from other subjects, and failed to achieve a single-subject chair before nearly disappearing by 1880. More importantly, entirely new subjects began to appear within the sample between 1860 and 1880 as single-subject professorships, indicating that at least a few professors achieved success by pursuing relatively idiosyncratic specializations. Some of these subjects, such as rural economy and hygiene spread to other universities in the 1890s and became new disciplines, while others, such as topographic anatomy and histology, were for the most part absorbed by other existing disciplines (Eulner 1970).

Structuring the Academic Labor Market

Next let us turn to patterns in the hiring of new faculty in the life sciences. Table 3a cross-classifies faculty hiring decisions based on the university which granted the professor’s

doctoral degree, the hiring university, and the year of hiring. Professors are classified based on whether the hiring university was also the degree-granting university, and universities are classified by whether they fell within Prussia, the southern states of Baden and Bavaria, or neither following the Congress of Vienna in 1815. The first time period, 1770-1839, covers the full reform era of the late eighteenth and early nineteenth century beginning before the expulsion of the Jesuits in 1776 to several decades after the last Prussian university reforms. The second time period extends until 1865, just before the Austro-Prussian War and the creation of the North German Confederation, while the last period covers the years during which the German states became unified under Prussian leadership.

[Table 3a about here]

The results show that Prussian, Badenese, and Bavarian universities were more likely to hire from outside of their collegial ranks far earlier than other universities. Chi-squares tests were used to assess the degree of association between origin of doctoral degree and time period for each region. These tests indicate that while outside hiring was frequent in Prussia, Baden, and Bavaria, there is no evidence it became more or less frequent in these states over time. In contrast, a significant increase in the proportion of outside hires appears to have occurred over time in the non-Prussian northern universities. These results are consistent with the hypothesis that early state intervention in Prussia, Baden, and Bavaria encouraged outside hiring, while outside hiring lagged elsewhere until much later. They are not consistent with the decentralization hypothesis, since it is precisely in the region of greatest political fragmentation that we see the least outside hiring.

The gradual expansion of Prussian territories creates two possible complications, however. First, the high number of outside hires in the first time period may be a result of

universities not yet incorporated into Prussia. However, all new hires in the life sciences at universities listed as Prussian before 1804 took place at the University of Halle, which had been in Prussia since its foundation in the late seventeenth century. Second, universities listed as non-Prussian after 1866 may in fact have been incorporated into Prussia at this time. If the four universities captured by Prussia following the Austro-Prussian War are recoded as Prussian for the final time period only, the significance of the association in the non-Prussian table is reduced ($p=.029^*$), but this is consistent with a positive effect of political integration on outside hiring, since it indicates that universities not incorporated into Prussia became more likely to hire outside the university, and universities absorbed into Prussia became even more likely to do so.

Political integration also suggests that the hiring of professors from outside the university ought to occur more frequently within political regions than between, as states invested resources in the training of potential faculty at their own universities. Table 2b cross-classifies faculty hired from outside the university by the region of the university which granted their degree and the region of their hiring university. Before 1840, 40 percent of all outside hires (16 of 20) occurred within regions. Surprisingly, however, 43 percent of all outside hires (17 of 20) were professors trained in the non-Prussian north and employed in Prussia, Baden, or Bavaria. Between 1840 and 1865 however, more than half of all outside hires occurred within regions (33 of 56), although now Prussian professors appear somewhat more likely to be hired in Baden and Bavaria. Finally, after 1866 no pattern is apparent, which is expected since the German states were joined in political union during this period.

[Table 2b about here]

A closer examination of hiring patterns helps explain this apparently puzzling pattern. Figures 4a and 4b provide counts of the number of outside hires made *from* each German

university, divided into two time periods, from 1770 to 1839 and 1839 to 1880. They also divide professorial hiring by the subject into which each professor was appointed. The same professor may thus be counted more than once in the bar graphs should he be hired multiple times at different universities, or appointed to multiple subjects within a single university. The figures nevertheless give some indication of whether hiring decisions were shaped by the prestige of particular universities or programs.

[Figure 4a about here]

Before 1840, a large proportion of faculty hired from outside universities received their doctoral degrees at the University of Jena. Jena was the home of Goethe's intellectual circle from the 1770s until his death in 1832, and it attracted a number of prominent philosophers and intellectuals from across Germany (Collins 1998: 626-28). Jena provided the largest number of new hires in all disciplines before 1840, even in generally non-overlapping fields such as natural history and anatomy. It appears that a status ordering did exist among German universities, perhaps extending to even before the university reforms.¹⁵ However, this status order was not differentiated across different disciplines, and universities in centralizing states, such as Prussia, Baden, and Bavaria appear to have been more likely to recruit from prestigious universities like Jena than, as indicated by the high totals for Prussia and southern universities in the non-Prussian universities row of Table 2b, 1770-1839.

Figure 4b indicates that after 1840 the status order of the German universities was transformed. The University of Jena became marginal and the University of Berlin became by far the most common source of new faculty hires. The University of Berlin was the centerpiece of the Prussian university reforms, and was both well-funded and extremely large. By 1830, it

¹⁵ Turner's (1973) discussion of the place of Göttingen among the eighteenth-century German universities suggests this was in fact the case.

was enrolling two thousand students in a given year, an enormous number at the time (Jarusch 1982: 30). Berlin graduates were not only hired within Prussia (although some Prussian provincial universities such as Breslau hired Berlin graduates nearly exclusively), but also elsewhere, suggesting that after 1840 Berlin had taken the top of the university status hierarchy in Germany. Indeed, Berlin was the only university to increase the proportion of its own students hired over time, hiring in the life sciences only its own graduates from 1856 through the end of observation.

[Figure 4b about here]

There was also greater differentiation in the number of outside hires from each university across disciplines after 1840. While Berlin provided the most outside hires in every discipline, the second highest university is different in each discipline. Göttingen provided nearly as many outside hires as Berlin in zoology, but very few in all other subjects. Bonn provided the second largest number of outside hires in physiology, but Leipzig and Würzburg are tied for the second largest number of outside hires in pathological anatomy. In anatomy, the status order of the university appears weakest, with Berlin providing six outside hires, and Bonn, Heidelberg, Marburg, and Würzburg each providing three. As disciplines became more differentiated from each other, so did the status ordering of universities in each discipline. It may be that as universities found themselves increasingly in competition with each other for faculty during the second half of the nineteenth century, states and universities themselves tended to specialize, directing resources towards particular programs rather than competing with Berlin across all subjects. It also suggests that disciplinary divisions became more salient in hiring decisions after 1840 than they were before.

Discussion

The results described above indicate that disciplinary specialization in the German universities occurred in two stages. Following the university reforms in Prussia, Baden, and Bavaria, professors active in the life sciences appeared to have gained greater autonomy for their studies, and they abandoned subjects from the traditional university curriculum in favor of subjects in the sciences. However, rather than specializing in single subjects, most professors claimed several topics for their intellectual jurisdictions, and the precise configuration of these jurisdictions varied greatly between universities. At the same time, state ministries in Prussia, Baden, and Berlin undermined the autonomy of universities as collective agents by incorporating them into state civil services and regularly interfering in hiring decisions. The pattern of these hiring decisions did suggest the existence of a prestige hierarchy of universities across the decentralized German lands, but comprehensiveness and local accommodation, rather than disciplinary specialization, remained the dominant style of organizing academic labor.

In the second half of the nineteenth century, continuing political integration and economic development promoted further changes in the division of academic labor. As enrollments swelled, more full professors were added to university rosters, dividing the same intellectual territories between more and more occupants. For the most part these divisions followed the organization of established teaching subjects, and the dividing up of subjects across greater numbers of professors increased the alignment of subject matter organization across universities around single-subject professorships. Nevertheless, the promoters of new research programs and occasionally entirely new subject matter areas were able to take advantage of the expanding number of professorships to institutionalize their programs within the walls of an increasing number of universities. The political integration of the German territories appears to

have spurred not only competition among professors but also competition among universities. Disciplinary programs within universities achieved different degrees of success in getting their students hired at other universities, reducing the overall alignment in the university prestige hierarchy across subject matter areas.

The results suggest a relationship between the intellectual strategies successfully pursued by professors and the institutional environment of the universities. It is instructive to consider what occurred in the German universities following the period under study. In the 1880s, the number of professorships slowed their increase, even as increases in student enrollments accelerated. Ministers of state began to worry that the ever growing number of university graduates was a threat to social order, and chose to invest state money and resources in the founding of vocational schools and technical academies (*technische Fachhochschulen*) rather than universities (Jarausch 1982:34-35; McClelland 1980)).¹⁶ University enrollments nevertheless continued to grow, increasing the ranks of non-faculty lecturers (*Privatdozenten*) supported only by lecturing fees. At the same time, historians have noted a return to the comprehensiveness and scholasticism that characterized the professoriate of the *Vormärz* period (Harwood 1993; Ringer 1969). As opportunities to pursue a full professorship in a new specialization again declined, professors again demonstrated a tendency towards comprehensive noted in the early nineteenth century.

These developments illustrate the complexity of the relationships between universities, states, and societies. The evidence presented here does not negate the importance of the institutionalization of scientific autonomy within the framework of the German universities emphasized in previous research. However, it does suggest that the institutionalization of

¹⁶ In the 1890s and 1910s, however, many of these institutions were granted full degree-granting status as universities, although they retained their emphasis on the applied sciences (McClelland 1980).

autonomy was not sufficient to explain the features of disciplinary specialization that came to characterize the organization of scientific work in universities. Specialization and disciplinary integration became a dominant intellectual strategy when university expansion created new opportunities and university faculties increasingly hired from outside their own ranks. To the extent that the exchange of faculty conformed to the expectations of an academic labor market, it followed patterns laid down by political integration and the incorporation of universities into civil service bureaucracies. In Germany, the direct effects of state education reforms as well as the indirect effects of state-led development provided the additional conditions necessary for discipline formation.

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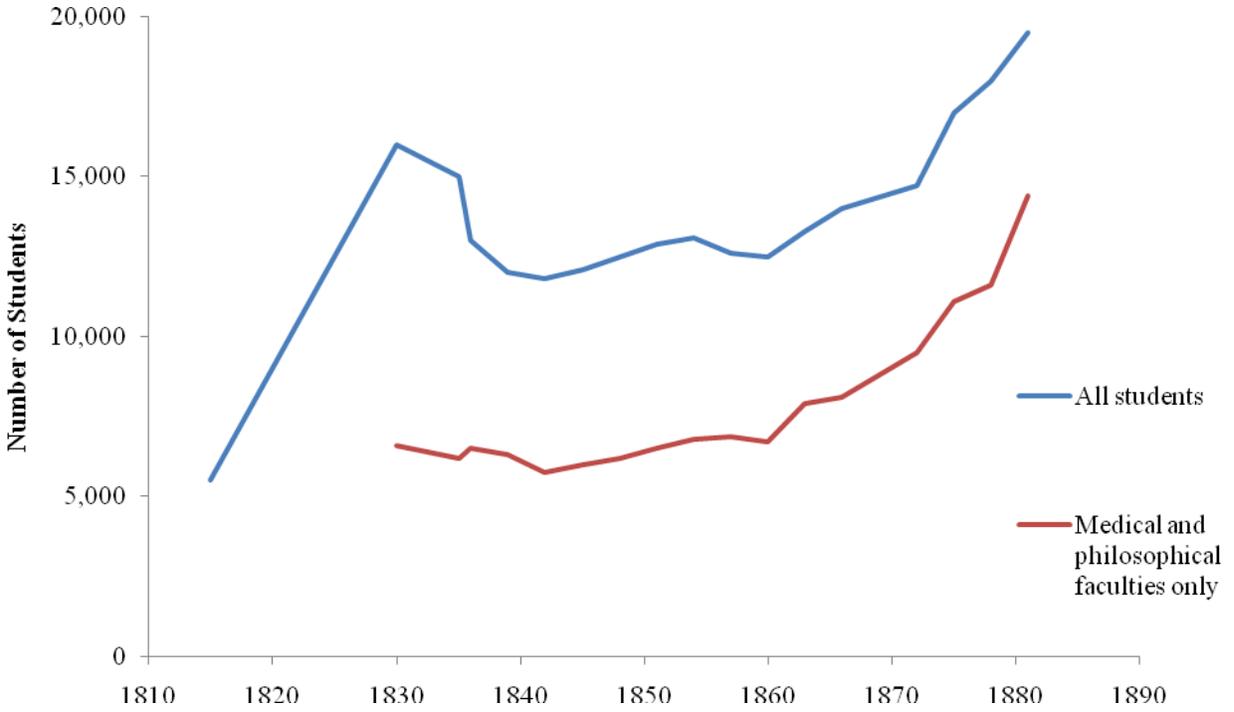
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Figure 1: Enrollments at the German Universities, 1815-1881



Data from Eulenberg, Franz. 1994 [1904]. *Der Frequenz der deutschen Universitäten von ihrer Gründung bis zur Gegenwart*. Berlin: Akademie Verlag.

Figure 2: Life Science Professorships and Institutions, 1780-1880

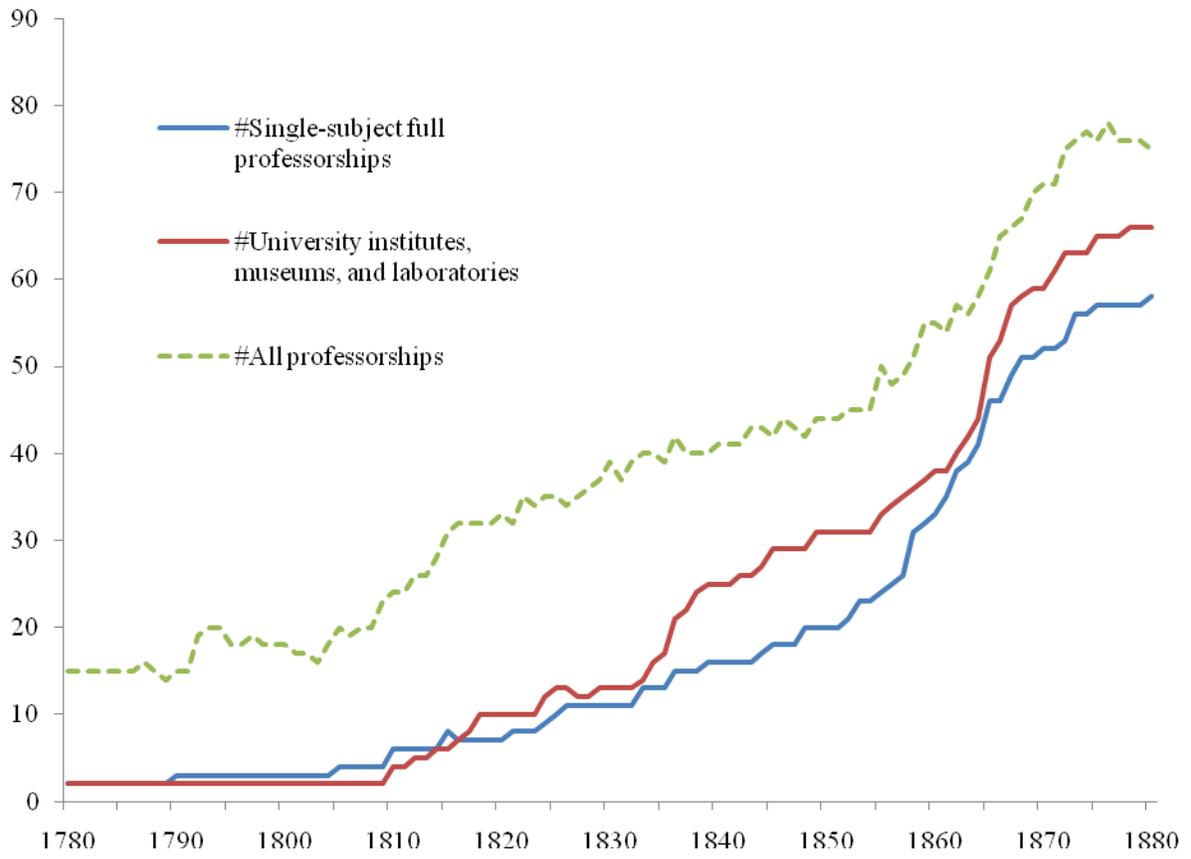


Figure 3: Average Subjects Held per Professor, Number of Professors in the Life Sciences, 1780-1880

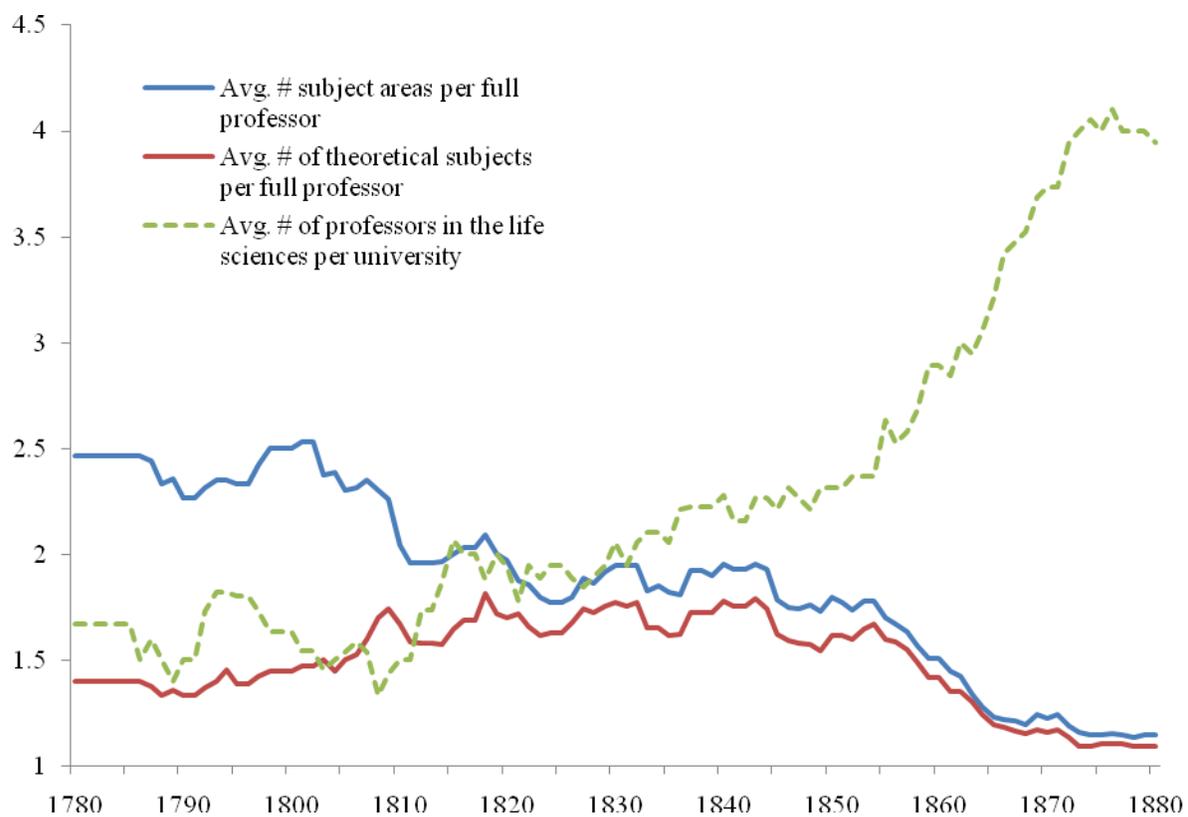


Table 1a: Subject Matter Overlap, 1840 and 1880

1840							
Subject by subject	Nat. History	Zoology	Physiol.	Pathol. Anatomy	Comp. Anatomy	Vet. Science	Other
Anatomy	0	2	9	3	2	0	3
Natural History		0	1	0	1	1	2
Zoology			3	0	2	1	3
Physiology				3	6	0	3
Pathological Anatomy					1	0	1
Comparative Anatomy						1	2
Veterinary Science							0

1880						
Subject by subject	Zoology	Physiol.	Pathol. Anatomy	Comp. Anatomy	Other	
Anatomy	0	1	0	0	0	
Zoology		0	0	1	1	
Physiology			0	0	0	
Pathological Anatomy				1	4	
Comparative Anatomy					0	

Table 1b: Single-subject Professorships, 1810-1880

Subject	1810	1840	1860	1880
Anatomy	3	3	8	14
Natural History	2	5	3	0
Zoology	1	2	9	14
Physiology	0	3	9	16
Pathological Anatomy	0	0	2	15
Topographic Anatomy	0	0	0	1
Histology	0	0	0	1
Hygiene	0	0	0	1
Rural Economy	0	0	0	1

Table 2a: Origins of Professors by Degree-Granting Institution

	Doctorate	1770-1839	1840-1865	1866-1880	X^2 test
Prussian universities (1815) ^a	From hiring university	7	9	2	p=.356
	From different university	22	15	10	
Other northern universities (1815) ^b	From hiring university	24	11	7	p=.004**
	From different university	19	26	26	
Southern universities ^c	From hiring university	8	12	4	p=.619
	From different university	26	28	17	

a: Berlin, Bonn, Breslau, Greifswald, Halle, and Königsberg.

b: Göttingen, Marburg, Gießen, Jena, Kiel, Leipzig, Rostock, and Tübingen.

c: Erlangen, Freiburg, Heidelberg, Munich, and Würzburg.

Table 2b: Origins and Destinations of Professors Hired from Outside by Region 1770-1839

Degree-Granting Institution	Hiring Institution		
	Prussia	North	South
Prussia	6	1	3
North	9	6	8
South	2	1	4

1840-1865

Degree-Granting Institution	Hiring Institution		
	Prussia	North	South
Prussia	15	4	9
North	2	7	2
South	1	5	11

1866-1880

Degree-Granting Institution	Hiring Institution		
	Prussia	North	South
Prussia	5	10	6
North	2	7	7
South	4	5	1

Note: Column totals in this table are lower than cell totals in Table 3 because not all professors included in Table 3 graduated from a university within the sample.

Figure 4a: Origins of Professors Hired Outside by Degree-Granting University, 1770-1839

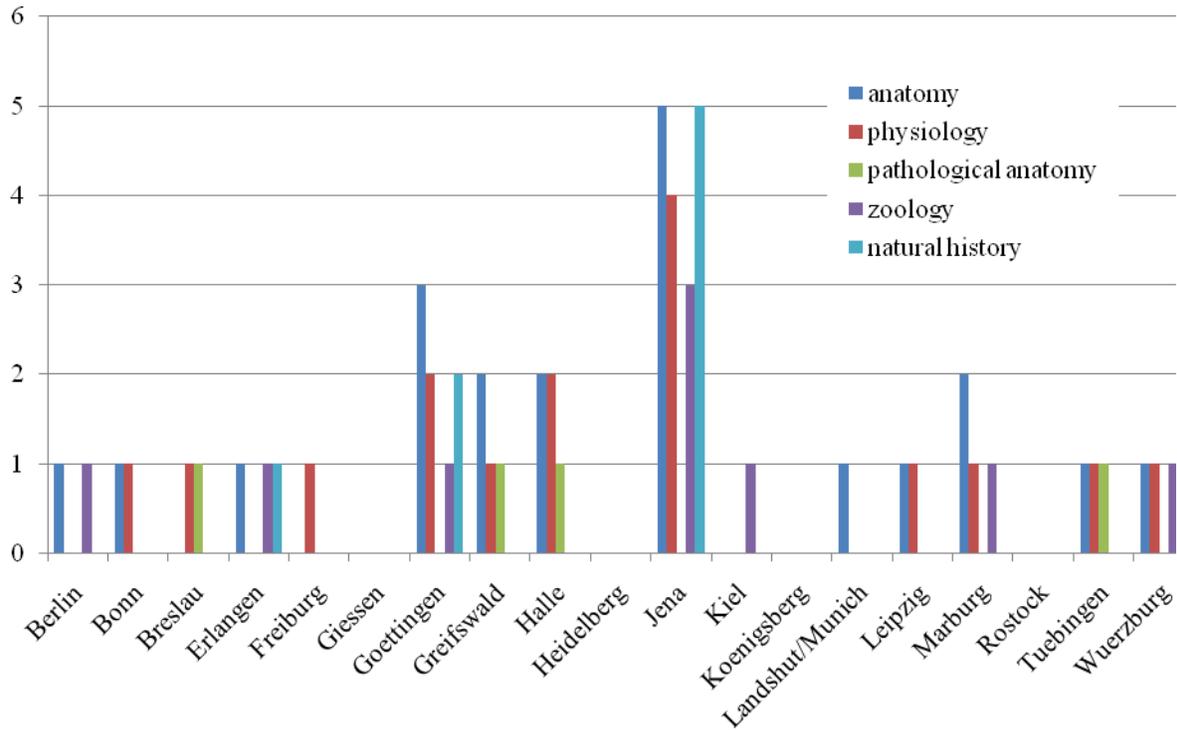


Figure 4b: Origins of Professors Hired Outside by Degree-Granting University, 1840-1880

