Topics of eighteenth-century medical writing with triangulation of methods: LMEMT and the underlying reality

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Abstract

This chapter deals with the most important developments within society and the medical discourse community in the eighteenth-century Britain. It applies several methods by way of triangulation to probe into relevant aspects of the history of medicine and medical writing between 1700 and 1800. The first part provides a comprehensive overview, mostly based on the previous literature, giving pertinent background information to the corpus and its text selection. The second part contains the first large-scale mapping of medical writing in the late modern period as an interdisciplinary enterprise between computer science, medical history, and linguistics with a Digital Humanities application. The results of empirical bottom-up quantitative assessments with Topic Modeling and Kernel Density Estimation applications reveal what changes and what remains constant in this period. The programs also indicate which texts were important as forerunners of innovative ideas and which adhered to the old patterns of thought. The third part quotes pertinent text extracts for illustration and applies discourse analytical methods for a qualitative assessment. These passages show how the developments towards more modern approaches progressed and how linguistic practices reflect increasing professionalization in the field.

1   Introduction

This chapter presents an interdisciplinary study at the interface between medical history, computer science, and corpus-based discourse analysis, using methods from Digital Humanities. It discusses eighteenth-century medical writing with a novel agenda, as its purpose is to verify to what extent the results achieved by different methodologies agree and what new aspects this triangulation can reveal. As a point of departure, we shall rely on how researchers have described the developments of eighteenth-century medical science and practice and how they have related its changes to previous centuries and to the following periods. The eighteenth century in medicine has been described as a fallow period lying between the innovations of the Royal Society (1662–) with its new ways of doing science, and the nineteenth-century achievements of clinical and laboratory medicine. It has been a relatively neglected period in the historiography of medicine and remains fairly underexplored, and

drawing an outline of the growing medical literature poses a challenge.

Our primary aim is to achieve a multi-faceted but balanced description of eighteenth-century medical writing. We shall also take a narrative perspective and pay special attention to continuities and changes over time with an analytical approach that takes the full variety of texts and genres with their dynamics into account. At the same time, this chapter will illuminate the background for our corpus text selection that was carried out in consultation with medical historians. The empirical part of this chapter relies on data-driven methods: Topic Modeling and Kernel Density Estimation. These methods have earlier been successfully applied to interdisciplinary research questions (see Murakami, Thompson, Hunston and Vajn 2017). The linguistic approach is that of historical pragmatics with a focus on contextual analysis, taking authors and audiences into account, and casting some new light on the dissemination of knowledge.

Our specific questions are: What does our data-driven method reveal about the eighteenth century? Do any conspicuous features of medical discourse emerge? How do the results compare with the previous literature? Are we able to come up with a shortlist of these features? And further, how well can we map these features onto the "reality" of medical history as it has been established so far. The topics will be discussed in a sociohistorical frame, paying attention to patterns of linguistic use; thus, the study also serves as a linguistic-stylistic assessment and as a methodological test in three disciplines.

2 Background and what the earlier literature tells us about eighteenth-century medicine

2.1 From medieval to early modern

According to the general lines of development, the Galenic doctrine of humoralism prevailed in medicine from Antiquity through the Middle Ages, surviving the arrival of medical humanism, Vesalian anatomy, and Paracelsianism, but was it still round in the eighteenth century and in what form? Scholasticism developed to its height in monolingual Latin surroundings at universities, the highest institutes of learning, from the twelfth century onwards. Ancient authorities were the source of knowledge,

science was logocentric and aimed at constructing the original meanings of texts.[1] Learned texts were translated into English with the pan-European vernacularization boom from the end of the fourteenth century onwards. In the sixteenth century, the old humoral theory came under various challenges from within medicine, and with the discoveries of new continents and new *materia medica*, the attitudes towards authorities became more skeptical. Observation taught otherwise and, as a consequence, the newly emergent genre of *historia* began to collect observations systematically in the sixteenth century (see Pomata and Siraisi 2005). These were observations not just of natural happenings but of medical interventions, the experience of patient cases undertaken by the practitioner. These were expected to harness the results of experience and thus to form a basis for new knowledge, gathered empirically. In the British context, this kind of data gathering as a means of creating new and justified knowledge of the world was championed by Francis Bacon, who wrote most of his philosophical works in Latin, but not the first and best known, *The Advancement of Learning* (1605). The Royal Society, founded in 1662, adopted the Baconian programme for acquiring knowledge and introduced novel ways of doing and writing science, and the new way of thinking gained ground. It was based on "natural-philosophical" inquiries and found expression mainly in *The Philosophical Transactions* (1665–; PT here after) during the last decades of the seventeenth and in the eighteenth century (Iliffe 2003: 271; Porter 1995: 63).

2.2 To the eighteenth century

At the turn of the eighteenth century, the scene was very different from the previous period, as the above-mentioned fundamentally new principles had already become well established in the latter half of the seventeenth century. The influence of the newly-founded and reformed institutions was remarkable. Elite physicians of the Royal College of Physicians contributed to its programme through individuals like Sir Hans Sloane, who eventually served as president of both societies. The mission of the Royal Society was avowedly to promote experimental science instead of preconceived so-called *a priori* knowledge. Empirical evidence further enforced the

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[1] The top genre was the commentary, introduced in vernacular writing in the late medieval period, but a fully-fletched form is found only at the end of the sixteenth century (Walter Bailey 1588). Compilations were next and became partly merged with commentaries. Other important genres in the early period were case studies, recipes, teaching dialogues, prognostications, and charms (see Taavitsainen 2016 and 2018).

renunciation of authorities, mentioned as one of the characteristics of eighteenth-century medicine (see Cunningham and French 1990)[2], but several other paradigm shifts also took place. The Matter-of-Fact principle underlies the new requirements of replicability, objectivity, and credible witnessing that were vital to establishing matters of fact via experience in medicine as in natural philosophy. These requirements were generally accepted and serve as an undercurrent that comes to the surface in some LMEMT texts with explicit statements like:

> (1) Before I come to Prove the Charge of Uncertainty on our Knowledge of Med'cines, 'twill be Necessary to lay down some Rules that may be Useful in examining the Matter of Fact. And these shall be taken from the descriptions of Two different Sorts of Knowledge a Physician is said to have; viz. Experimental and Scientifical; or, a Knowledge of Experience and Science.
>
> (Cockburn, *The present uncentainty in the knowledge of med'cines*, 1703: B1)

The change from logocentric scholasticism to observation as the mode of knowing had already taken place in the top layers of science, and it is also connected with objectivity and the above-mentioned Matter-of-Fact principle according to which everybody could verify what was happening, although the causes could be debated (Schaffer and Shapin 1985). The following extract illuminates the current scientific practices:

> (2) Because Experience is equally the Foundation and Touchstone of all reasoning in Physick, we will here submit our Solution to common Observations, and try whether every thing proposed in it, does not exactly answer Matters of Fact, and the visible Operations of Nature.
> (Cockburn, *The practice of purging and vomiting medicines* 1705: 2)

New instruments played an important role in helping approaches to science establish a different basis. The aristocratic Robert Boyle (1627–1691) had introduced the use of the air-pump to investigate physiology and the "weight of air". Nehemiah Grew (1641–1712), an honorary fellow of the Royal College of Physicians, introduced the use of the microscope into the study of plants. This instrument opened up new visions in an unprecedented way and made novel observations on living organisms and human anatomy possible. Scientists of the Royal Society felt inspired by the

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[2] Cunningham and French (1990: 1–3) mention most of the changes discussed below. We shall, however, elaborate on these points and show how the changes came about and spread, and we shall also demonstrate how the old persisted in the more popular layers of literature.

incredible detail that opened up new universes nobody knew about. Observations on butterfly wings prompted Henry Power, a physician and one of the first Fellows of the Royal Society, to write:

> (3) This Animal might well deserve our Observation without the assistance of a Microscope; for who does not admire the variegated diversity of colours in her expansed wings?…But view them with the Microscope, and you may see the very streaks of the celestial pencil that drew them … (Power, *Experimental philosophy*, 1664: 98)

The above passage shows that there was room for a more "exalted" human response to the wonders of nature in the "plain style" of the Royal Society. When applied to medical science, the feelings of the researcher were skeptical and cautious, taking human limitations into account. Typical genre features of experimental reports abound, with first-person narration and a tentative mode of knowing. The following passage is called "Some Considerations Concerning the Parenchymous parts of the Body" and it was written by "the Inquisitive" Edmund King in 1666:

> (4) … upon examination of those bits, much of which is called Parenchyma, I met in them more Vessels, than I had preserved in the parts whence they came: And though the Portion were never so small, yet my bare eye could make this discovery; much more could I, when assisted by a Microscope, perceive, I had destroyed more Vessels, than preserved, in despight of the exactest care, I was capable to use. And being not a little concern'd, that I should undertake to preserve the Vessels by such a Cause, as I saw plainly to be their destruction (were the part never so big, or never so small) I was both confounded and tired. For I saw (and so must any, that will attemp this work) in my endeavouring to preserve one Vessel of a traceable magnitude, I spoiled an infinite number of others less discernable, which were as truly Vessels, as the other, differing only in size and figure (as to appearance.) Then reviewing what mischief I had done in every place, quite through the whole Tract of my Fingers, Knife, &c. I began to think with my self, That it was not impossible for these parts to consist wholly of Vessels curiously wrought and interwoven (probably for more Uses, than is yet known;) …
>
> (PT 1 (18) 1666: 316; included in EMEMT)

The two passages above give evidence of Royal Society conventions of writing on a fairly broad scale. Both are very different from the present style of writing science in which the object of research is in the forefront and the author remains in the

background. These examples serve to point out some of the fundamental diachronic changes and arouse curiosity about the role of the eighteenth century in the long-term development of scientific writing. The picture is, however, more complex, and the above genres of writing and stylistic features apply to the educated elite in London and other learned centres like Edinburgh. The scene in other parts of the country and at the popular end of the scale was, however, still very different (see below).

The new era of science built on several milestones: empiricist epistemology was presented as a philosophical construction in John Locke's (1632–1704) *Essay on Human Understanding* (1690) but the physical basis is not much discussed, despite the fact that Locke was a physician by training and had some practical experience in medicine as well. The Lockean *tabula rasa* approach to building knowledge did not have much to say about the way sense data is absorbed by the faculties and processed in the brain. Instead, Locke's interests lay in the mind, and post-Lockean empiricism and sensationalism paid attention to the passions and saw them as products of conditioning open to investigation and amenable to change (Olson 2003; Porter 1995: 72). Other key figures of the new era include Francis Bacon (1561–1626), René Descartes (1596–1650), and above all, Isaac Newton (1642–1727), who raised the status of eighteenth-century medicine to science (Porter 1995: 54). Learned professionals based their work increasingly on observation and experiment, but popular medical and astrological literature still preserved the old humoral basis (see below).

The new and increasing professionalism can be witnessed in the new medical literature of improvement, based on experimental evidence in the laboratory and the clinic, but aiming to persuade practitioners of medicine or health consumers of the benefits to be had from changing practices. The change has been described in terms of the rational doctor, pursuing his new interests with rising trends of interventionalist medicine and medicalization of normal life (Porter 1995: 63). In terms of medical improvements, the most important change was the success of smallpox inoculation, but also advances in clinical practice more broadly contributed to changing medical thinking (Porter 1995: 55). James Jurin (1684–1750), secretary of the Royal Society, showed the superior benefits of smallpox inoculation by providing numerical figures, and several other pioneers of the statistical method emerge especially in the latter half

of the century. Jurin relied on the collection of what we now call data, and its interpretation in terms of statistical models; the novel practice also assumed a new relationship between medical expertise and political and civic authority. William Black (*An arithmetical and medical analysis of the diseases and mortality of the human species*, 1789) surveyed London Bills of Mortality with some correlations plotted against variables such as the seasons and the environment. Medical thinking was entering a new phase little by little, and innovative thoughts can be detected e.g. in the progress of a statistical worldview with probabilities being applied to medicine. Parallel changes took place on several fronts.[3] For example, epidemics caused "mortality crises" in the army and the navy and observations on them in numerical terms helped to predict epidemic outbreaks, which seemed to come in waves (Porter 1995: 39). William Cullen's (1710–1790) disease-distribution map was challenged by John Brown's (1735–1788) counter-insistence upon the unitary nature of medicine (see Bynum 1994: 16–17). The Brunonian system (1780) with a disease barometer built upon a single arithmetic scale, and its axis translated illness into an objective, quantifiable entity. Therapeutics could at its simplest be boiled down into dosage size (Porter 1995: 60).

The beginning of the eighteenth century was also a period of "iatromechanism" as medical theorists in their search for the origins of diseases began to pay attention to solids. Fibre theory became an important concept and was first formulated in the late seventeenth and beginning of the eighteenth century (see Ishizuka 2012). It may make sense to see iatromechanism, solidism, and fibres as amounting to much the same thing, i.e. an approach to medicine relying very much on the properties of minute physical things.[4] The new doctrine of solidism spread at the turn of the century, and was particularly influential from *c*. 1700 to 1740. Fibres were conceived as the minimum bodily components. The core idea was that they were united into larger wholes of membranes and vessels in various textures. Fibre, with its innate property of elasticity, played an indispensable role in understanding how health was maintained or disturbed: free circulation of the fluids through the solids meant health, whereas an obstruction of some sort could cause putrefaction and disease

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[3] Cf. the development of case studies from single to multiple, paving the way to generalized accounts and likely courses of illnesses (see Chapter5 in this volume).

[4] Cf. Edmund King's report and the role of the microscope in opening up a new universe of minute detail.

(Lawlor 2006: 45). Several authors of texts included in LMEMT are mentioned as subscribers to the fibre theory, e.g. George Cheyne's health advice with therapeutic activities,[5] John Arbuthnot, and Herman Boerhaave, who is said to have systematized fibre-solid pathology in his *Boerhaave's aphorisms* from 1715 (Ishizuka 2012: 571–575).

2.3 Society-based changes in the eighteenth century

There were also more society-based changes in the developments of the professional tasks and divisions of labour between various groups active in medicine. In particular, embryology was an area of competing views and ideological standings, and childbirth started to be treated as a medical event for the first time (Cunningham and French 1990: 1–3; see also the category description of MIDWIFERY). The rise in esteem was partly due to male practitioners, who became active in the field that had earlier been dominated by midwives. The new man-midwife category paid attention to the current scientific method and initiated institutional developments within the profession. The fibre theory was influential in embryology with explanations of fetus growth within the preformationist framework of embryonic development from pre-existing animalcules (Ishizuka 2012: 577). The fibre theory was also applied to individual constitutions and differences of gender and social rank (Ishizuka 2012: 579–581). The belief that social distinctions were physiologically embedded was implicit in the system. Towards the end of the century, the differences within specific groups of people were taken as biological anatomical differences in the nervous system and other systems of the body (Porter 1995: 69).

The second half of the century from the 1740s onwards adhered to a different doctrine, although there had been signs of the medico-cultural myth of nervous sensibility even earlier. An emergent cultural concern with the sensible body preceded the rise of the nervous system in medical theory (Ishizuka 2012: 597). George Cheyne coined the phrase "the English malady" in his 1733 book title for a special kind of anxiety and depression that bore a formal resemblance to traditional melancholy, but in opposition to the image of a melancholic figure as an outsider, the sufferer from the

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[5] Fibre-based therapeutics followed the lines of traditional non-naturals with air, bodily motion, food and drink, excretion and retention, passions, sleep, walk, and diet (see Ishizuka 2012: 574; see also Chapter 6 in this volume).

English malady was a creature of society: mobile, affluent, urban, i.e. very much a product of polite society (Porter 1995: 66). By this time the nerves became "medicalized, academized, globalized, climatized, electrified, genderized and sexualized" (Rousseau 1999: 221). The consequences of the new doctrine reflect on the social history as seen in the literature of the time. Nerves were understood to differentiate between social classes, and e.g. spas and resorts became a feature of upper and upper middle-class culture.[6]

Another prominent trend in the latter half of the eighteenth century was philanthropy. Public health and welfare issues of hygiene and sanitation started to attract attention. The public good was the leading motivation of the initiatives to found charitable institutions to provide medical care for the poor. The trend can be noticed both in local initiatives and national patriotism. Several hospitals and dispensaries were established in London and elsewhere in the country.[7] Concomitant was also the rise of national feeling. The widening of the British Empire gave an incentive for improvements in the army and the navy – new therapeutic measures were detected for scurvy, for example. Pride in being an Englishman can be seen, for instance, in the Letters to the Editor in *The Gentleman's Magazine* that sometimes acquired even xenophobic overtones (see Chapter 7 in this volume).

Many of the above features applied to the practices of the medical elite, i.e. only a small minority. Most parts of the country showed a more mixed scene. According to some empirical evidence from Bristol, for example:

> No hard and fast lines are evident between fringe and orthodoxy in the areas of therapeutic efficacy, choice of remedial methods, or involvement in trade and the marketplace. The complexity of the medical scene, and the importance of lay patronage, within a generally agreed framework of medical ideas, barred the establishement of a clear distinction between an orthodox profession and fringe practitioners. There is no evidence that the commercial quacks offered any coherent alternative to the medical cosmology of ordinary practitioners, and every sign that they sought to imitate those elements of orthodox practice which attracted lay respect.   (Barry 1987: 29)

The situation that followed has also been described in terms of "proliferation of systems" (e.g. Cunningham and French 1990: 1–3; Ishizuka 2012: 563–564). The

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[6] For example, characters like Mrs. Bennet in Jane Austen's *Pride and Prejudice* are in accordance with this trend, and reflect her social aspirations in a satirical vein.

[7] The Foundling Hospital in London was founded in 1741 by Captain Coram (see the cover image).

issue is complex as even the ways of articulating these competing trends may have changed. The "gap" may have been filled with new kinds of mixed discourses, but the literature gives us only vague indications. We do, however, have some clues to follow, such as the improvements we have already mentioned that were so important in the eighteenth century. The period has been called the medical "Enlightenment" (Cunningham and French 1990: 1–3), with changes taking place on a broad front. Porter (2000: 14) defines the period as a whole in sociohistorical terms:

> In Britain, at least, The Enlightenment was thus not just a matter of pure epistemological breakthroughs; it was primarily the expression of new mental and moral values, new canons of taste, styles of sociability and views of human nature. And these typically assumed practical embodiment: urban renewal; the establishment of hospitals, schools, factories and prisons; the acceleration of communications; the spread of newspapers, commercial outlets and consumer behavior; the marketing of new merchandise and cultural services. All such developments repatterned the loom of life, with inevitable repercussions for social prospects and agendas of personal fulfillment.   (Porter 2000: 14)

Of the above items, several are of direct concern for our task. Urban renewal has to do with the utilitarian attitude and the emerging concerns for hygiene. Several institutions founded in this century give evidence of a public spirit to help the poor and promote welfare (see Chapter 8 in this volume). Newspapers and magazines delivered medical news to a widening readership, and the rise of consumerism can be seen in medical advertisements and promotional literature of spas, for example.

One of the fundamental changes in the early modern period had been the gradual change in worldview. The old religious system of medicine, inherited from medieval times, was played down and replaced by a secular outlook. [8] By the eighteenth century, literacy had spread more widely in society and more people had received some kind of basic education, which contributed to the dissemination of knowledge across a wider spectrum of society. This improvement also diminished the role of superstition in people's lives. One of the accompanying changes can be seen in attitudes to the human body: it came to be seen in a new light as a mechanical system, more in its own right and less as the instrument of the soul with religious connotations.

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[8] A simple test gives us evidence of the shift. Individual word searches can easily verify such hypotheses: *evil* occurs 1,066 times in EMEMT and 319 times in LMEMT; *god* occurs 1,265 times in EMEMT and 266 times in LMEMT. Chi-square significance tests can be adduced to show that the frequency of these two examples differs with very high significance (p<0.001) between the periods.

Professionalization of medical practice has been mentioned as one of the trends, as medical practice became more rationalized (see above and Cunninham and French 1991: 1–3), but it is counterbalanced by the popular end of medical literature. A completely different characterization of the period can be found in Roy Porter's coinage "The golden age of quackery" (Porter 1993: 40). He defined quacks as those whose practices were encouraged by the plural offerings of the "medical marketplace".[9] More recently, the term has been applied to the normative framework for understanding eighteenth-century medicine (Brown 2011: 5), and we use it here to describe the unstructured nature of medical care available to the population at large. The term refers to practices that concern lay people seeking advice in health care, an issue that received a great deal of attention in eighteenth-century professional literature. Quackery is what respectable physicians liked to call their less respectable competition and their language of disapproval is probably just as violent as that of the so-called quacks (see GENERAL TREATISES category description). Quacks made their profits by selling commodities, above all, nostrums, rather than by giving advice on medical matters or by bedside attendance (Porter 1995: 41).

2.4 Aftermaths of the old ways of thinking

Yet the old did not vanish; instead it came to cater for other needs and purposes. Features of earlier top science found their way into writings targeted at heterogeneous audiences and the humoral system persisted in the more popular literature (Taavitsainen 2009, 2017, 2018; Taavitsainen and Schneider 2019), where the old scholastic patterns of argumentation continued for centuries. For example, in *Aristotle's Masterpiece*, the pattern was used for moralistic purposes, and this work also contained superstitious lore about monsterous births (see below).[10] The book was very popular and underwent several reprints in the eighteenth century. Other examples of similar kinds of literature have also survived, e.g. a case study relating the narrative of a woman who gave birth to fourteen rabbits and survived without food or water was published in 1727 (St. André, *A short narrative of an extraordinary*

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[9] Originally the term was coined in the 1980s for the early modern period and gained multiple uses (see Jenner and Wallis 2007).

[10] This book with very wide circulation belongs to the most "vulgar" type of writing that survives from the early and late modern periods. A whole section is devoted to the topic "Monsterous births", a recurring theme in medical news even in the eighteenth century. Religious argumentation is part of the manipulation strategy and name-dropping of ancient authorities, like Aristotle in the title, lends an aura of learning to the often superstitious claims (see Taavitsainen 2017: 262–264).

delivery of rabbets; see MIDWIFERY category description). The story shows a strange mixture of the genre with newspaper discourse, enhancing the truth value of the story by providing eye-witness reports.[11] This kind of "wonder literature", together with traces of astrological medicine,[12] counterbalances the above rationalization claim based on professional medical practices of the more elite circles. Between the top and the bottom layers, however, there is a larger area that has until recently received less attention.[13] The situation with various old traits and new trends has been described in vivid terms:

> Galenic, Hippocratic, chemical and iatro-mechanical systems all jostled for acceptance and were combined eclectically by each physician … in a mixture of theoretical discussion and empirical narrative.   (Barry   1987: 32)

In the late medieval period, the genre hierarchy had been clear (see note 1), but when the basis of knowledge shifted from inherited wisdom to empirical evidence acquired by experimentation, the whole situation was revolutionized and the genre map underwent dramatic changes. The genres of experimental reports and essays were created for the use of the new discourse community, the Royal Society, reflecting the new philosophy of science with its new principles. These novel genres occupied the top place in the hierarchy of scientific writing. The earlier genres had been in high regard at their prime in the medieval period, but they slipped down the scale and continued in print in popular guidebooks like the *Masterpiece* and in works now counted as pseudoscience. The status of alchemy and astrology had earlier been prominent among the sciences, and important applications to medicine were counted as core branches of the discipline during the early modern period. Astrological medicine, the mainstream form of medicine in Elizabethan times, continued at first, but began to decline when chemistry and astronomy developed on different and more rational bases at the end of the seventeenth and at the beginning of the eighteenth century. The status of these former branches of science deteriorated into pseudoscience, and astrological medicine is not much present in eighteenth century

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[11] The delivery was "perform'd by Mr. John Howard surgeon at Guilford" and written by Nathanael St. André in 1727 (London: John Clarke). Eye-witness reports are appended to the book.

[12] Medical magic and superstitious lore declined after the mid-seventeenth century but residues survived orally till the nineteenth century (Porter [1987]1995). Notes 16 and 17 below show that the old beliefs also continued in print and their afterlives in the popular press are much longer than recorded in the earlier literature.

[13] This parallels Barry's claims (1994) about the sociohistorical situation: the aristocracy and the paupers have been objects of interest, but "the middling sort" had remained fairly neglected.

medicine. Nevertheless the old "horoscope" literature with some medical calendar items, dating from the late medieval period, was reprinted in *The Book of Knowledge* in 1726.[14] Its first part contains astrological prognostications with nativities according to the moon (see Taavitsainen 1988).[15] Other texts in this part teach how to recognize various types of temperaments and prevailing humours in people, and an undercurrent of physiognomical literature is also present.[16] *Erra Pater* books with astrological prognostications, weather lore, and similar materials circulated in identical forms already in the late medieval period.[17] Such perpetual prognostications continued in print throughout the eighteenth century, and a copy of *Erra Pater* from 1775 bound together with popular Chapbooks showed that these texts also had some entertainment value.[18] Besides medieval weather and thunder lore, this book gives "most excellent and approved Rules for Preserving the Body in Health" and forms a link with regimen literature.[19]

3   From words to topics with Topic Modeling

In this section, we discuss two computational data-driven methods and their yield to the study of eighteenth-century medicine, Kernel Density Estimates (Section 3.1) and Topic Modeling (in Section 3.2 we present the method, which we then apply in Section 3.3). In the sections above, we have outlined what medical historians have said about the topic in the previous literature and what we have learned in the course

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[14] *The Book of Knowledge Shewing the Wisdom of the Ancients*, … Written by Erra Pater, a Jewish Doctor… made English by William Lilly. 1726?. Gosport: J. Phillpot (CUL class mark 7180.e.18).
[15] They continue in the old form, e.g. "To be born on the first Day of the New Moon, is very fortunate…" (p. 5).
[16] This is also a pseudoscience which goes far back in time. See e.g. Anon., *Physiognomy*, *or the Corresponding Analogy between the Conformation of the Features, and the Ruling Passions of the Mind*, translated from the French version by Samuel Shaw in *c*. 1800. (London: H.D. Symonds) (CUL class mark 8180.d.33). *The Book of Knowledge* also contains texts on physiognomy and palmistry together with the signification of moles and interpretations of dreams.
[17] Medical texts include a *homo signorum* account, and nativities according to the signs of the zodiac "He that is born under Aries is of a nature hot and dry, of a loud voice, inclined to Choler…" (p. 5). Its second part contains "Prognostications forever, necessary to keep the Body in Health: with several choice Receipts in Physick and Surgery" … "As I have found in the Astrological Science, there be four different sorts of Humours in the body of Man, of which the four Complexions are formed…" (p. 16), "Of the disposition of the Humours in the Body of Man in the Winter Quarter, under the Signs…" (p. 39). The Vein Man with directions for bloodletting is also given.
[18] E.g. *Lilly's New Erra Pater; or, A Prognostication for Ever*. 1775. London: printed in Aldermary Church Yard *(*CUL signum SSS.25.29).
[19] "Physick in January. Drink white wine often fasting, for 'tis good/As doctors say, to rectify the blood: …" (p. 17).

of the corpus compilation work. Next, we shall explain our method and overview the results that have been obtained by applying them to our electronic data. Most importantly, we want to find concrete textual evidence for the changes in medical writing and its underlying thought styles.

3.1 Detecting similar and period-specific words with Kernel Density Estimates

As a first step to the comparison of LMEMT (1700–1800) to its previous period, which is represented by the EMEMT (1500–1700) corpus, we shall study differences in the vocabulary. In order not to be misled by spelling varaints, we have used spelling-normalized versions of EMEMT and LMEMT, using VARD.[20] Looking at individual words is tedious and bears an enormous risk of oversight. Fully data-driven methods can be used: in Taavitsainen and Schneider (2019), we present the use of Document Classification, a method that is popular in media content analysis (Grimmer and Stewart 2013). We employ logistic regression to predict whether a given text comes from EMEMT or LMEMT, and we show how discriminating lexical features can be interpreted. The approach of comparing the ranked list of word features, showing most overrepresented words in either corpus, allowed us to use a semi-automated procedure and interpret the texts in a new way. The accuracy of the classification is very high (97%), which also confirms that the documents from the two periods are consistently different in style and content. As an example, the strongest word features for LMEMT are shown in Table 1, where important keywords are highlighted.

Table 1. The strongest negative features in EMEMT SPECIFIC TREATISES (SPECIFIC TREATISES, SPECIFIC METHODS, SPECIFIC THERAPEUTIC SUBSTANCES, and PLAGUE) texts, i.e. positive features of LMEMT

Feature	Frequency	Feature Influence
in	235	-14.00147601
has	37	-11.37059592
the	236	-9.498242582
on	158	-8.883026034
are	210	-8.513940795
finis	2	-7.982584424

[20] The most recent version is 2.5.4 (freely available), see Alistair Baron and Paul Rayson (2008) on http://ucrel.lancs.ac.uk/vard/about/. Accessed 19 June 2018.

who	127	-7.807009726
for	228	-7.611752673
mankind	17	-7.596432756
their	204	-7.491350792
itself	3	-7.355891227
and	235	-7.073453748
paul	5	-6.82108125
become	36	-6.673857502
mere	10	-6.631327306
attended	12	-6.406940771
dr	17	-6.276771059
whole	105	-6.246628637
line	3	-6.228183819
children	48	-6.184208958
notes	12	-6.131866836
shades	0	-6.085500702
justice	5	-6.063952712
pleasure	20	-6.035040443
every	156	-5.922912936
hall	3	-5.892030301
horizontal	0	-5.886914666
health	75	-5.803031449
spanning	0	-5.723428836
than	89	-5.684348223
page	13	-5.683215475
human	11	-5.678482595
well	187	-5.632353804
myself	0	-5.615042473
case	59	-5.582499516
means	115	-5.555272569
left	62	-5.533731083
body	13	-5.529522739
entirely	4	-5.426140064
same	191	-5.386707536
at	215	-5.342362485
inoculated	0	-5.339998551
individuals	0	-5.330471522

Table 1 reveals changes in medical content, in particular where new medical topics and methods are introduced (*inoculated* for treating smallpox) and public good concerns are enhanced (*human*, *mankind* instead of *man*, *health*). Medical practices were changing (*dr.*) and address terms with professional titles were frequently used. Linguistic changes can, however, also be detected, e.g. complex prepositional

constructions (*unto*, *into*, *whereof*, *thereof*) are replaced by simpler constructs in LMEMT.

Such ranked lists of words enable linguists and historians to obtain more systematic insights and minimize the risk of oversights, or in computational terms, they reduce the recall error rate. They are still far from optimal, for at least three reasons. First, as the lists are very long – in the example of EMEMT/LMEMT document classification there were over 10,000 features – and since many historically, stylistically, or linguistically important features appear a good bit below the top, reading them still takes time, and the precision is low. Second, building a bridge from words to concepts and topics by which we could describe the history of ideas, is intricate and laborious and demands careful interpretation of the long lists. Words that are conceptually close appear far away from each other in the lists. Further, many of the differences are more linguistic than conceptual or cultural in nature: words are replaced by near-synonyms over time, and function words tend to show stylistic rather than cultural differences (*in*, *on* show more complex NPs). Third, data-driven methods, in general, demand a high amount of interpretation, as they fully depend on the idiosyncrasies of the data (Tognini-Bonelli 2011). In particular, as most words are rare (Zipf 1949), statistical models using them are also in greater danger of suffering from sparse data effects, i.e. random fluctuations of rare events, than models aiming for a higher level of abstraction. An approach which detects words that are typical of a period but also semantically closely associated could address the first two points, and bring us a step further towards our goal.

While corpus-driven approaches pose the potential problem that the patterns we are looking for may be difficult to discern, they also offer the opportunity to profit from other intricate patterns that natural language is known to exhibit. Firth (1957) and Harris (1968, 1970) noticed that words which frequently co-occur, or which occur in similar contexts, are similar or related in meaning.[21] For example, *horses*, *saddle*, and *ride* appear mostly in the same locus, both in the real world in large collections of materials with detailed descriptions and render varied perspectives in sufficiently large corpora. If we calculate mutual co-occurrences across texts we obtain a data-driven measure of similarity. Kernel Density Estimates are a function of mutual co-

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[21] An easily accessible introduction to distributional semantics from a linguistic perspective is given in Sahlgren (2006).

occurrence learnt from corpus data. The main reason why an approximating function instead of the lexical overlap is used is simply that one wants to obtain smoother results, glossing over data fluctuations.[22] We are using the *textplot* library to create the pairwise matrix.[23] In order to focus on sociohistorical developments, we have filtered function words in this approach.

Visualizations of similarities of words are typically done in the form of networks, which are sometimes also known as conceptual maps. We use the *gephi* program (Bastian et al. 2009) for our visualization. The problem of displaying pairwise information (where a pair consists of two word types) is a well-known problem in graph visualization. Every word is linked to each other word. Words that are closely related get short links, less related words longer links, below a certain threshold the link is dropped. The ensuing map can be seen as a conceptual map of the text, a mental map of its central word types, arranged like towns that are connected to nearby towns. These maps are popular in Digital Humanities.[24] We will now apply the method to EMEMT and LMEMT.

The conceptual map of the 200 most frequent content words in EMEMT and LMEMT is given in Figure 1. In order to ease orientation, we have included basic meta-information words like *ememt* and *lmemt* (marking the overall position of EMEMT and LMEMT, respectively)*,* so that they also appear in the conceptual map*.* The corpus of *ement* (close to the top left) is very closely linked to terms such as *evil* and *humours* (see above)*,* and also *god* and and the authorities (*called*) are also near. In the centre of the map we find the meta-information *txt*, which every text contains, but also generally frequent words like *time*. Recipes at the top left are visible as a distinct topic, which is slightly closer to EMEMT (*flowers*, *herb*, *wine*, *mix*, …)*.* Childbirth (*women*, *children*, *child*, *pain*) is also visible as a topic in the mid-left, and is important in both periods. Moving down towards *lmemt* we find *surgeon*, *patient*, *care*, *degree*, and closely linked to *lmemt* at the bottom, we find *practice* and doctor (*dr*), terms that indicate the increasing professionalization of the field. We equally find *animal* testing, *observed* facts and *effects*, *symptoms*, and *method*, which witness

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[22] The detailed mathematical background is e.g. explained in Silverman (1986), and a very accessible explanation is given at http://dclure.org/essays/mental-maps-of-texts/. Accessed 19 June 2018.
[23] David McClure (2015) on https://github.com/davidmcclure/textplot. Accessed 19 June 2018.
[24] See, for example, Micki Kaufman (2015) on http://blog.quantifyingkissinger.com. Accessed on 19 June 2018.

the shift from scholastic thinking to empirical science.

Compared to Table 1, where maximally every second word from the top of the feature lists can be convincingly interpreted, the vast majority of words can be interpreted in the conceptual map. This is partly because we have removed function words, partly because we only use the most frequent words (which alleviates the third criticism of word-based approaches, the sparse data problem), and partly because Kernel Density Estimation groups similar words together. While a full evaluation of the approach is not possible as no "gold standard" exists, we believe that the higher percentage of interpretable words and the easily interpretable clustering show that Kernel Density Estimation leads to an important further and trustworthy perspective on the data.
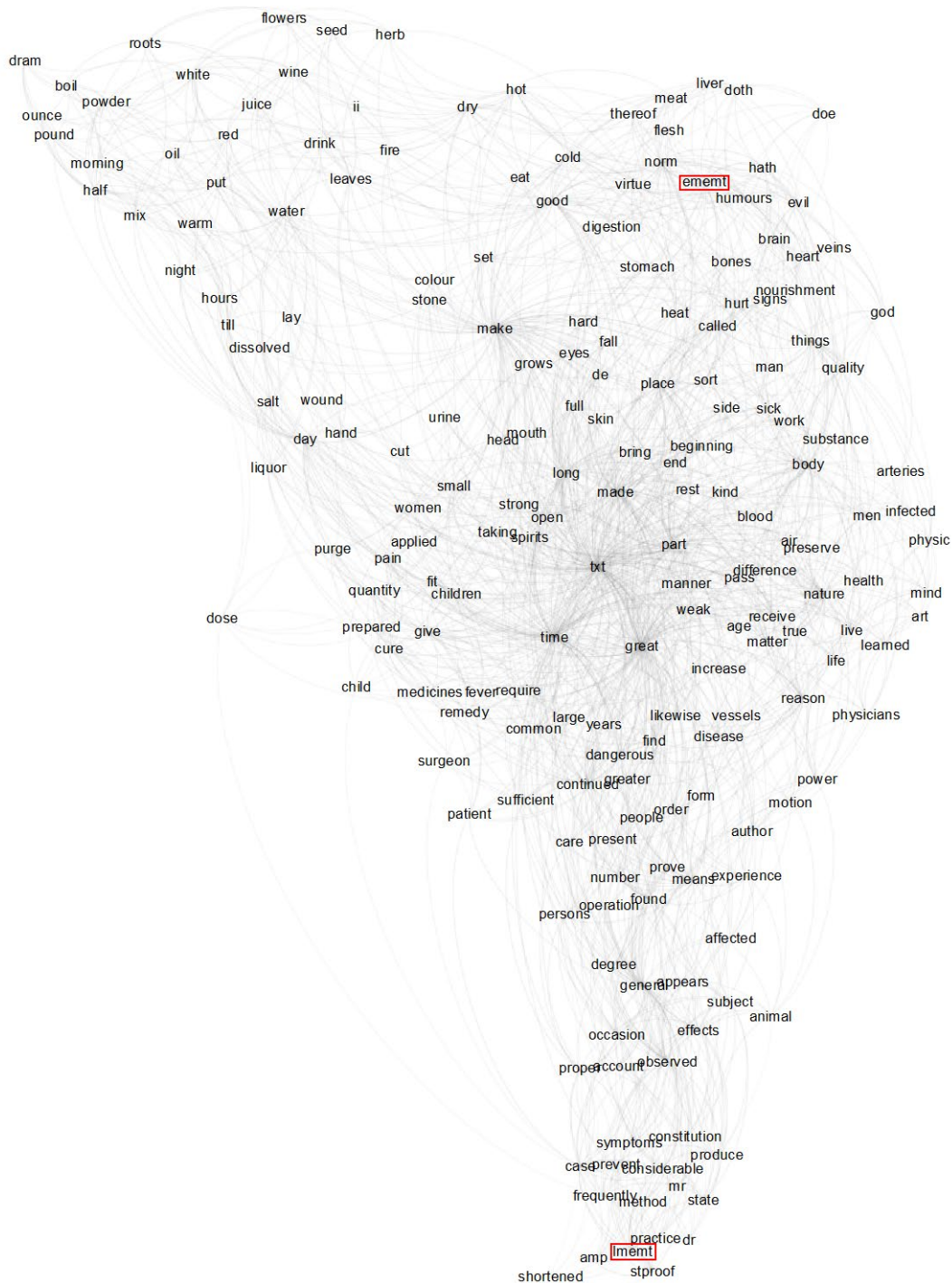
Figure 1. Textplot map of EMEMT and LMEMT

Kernel Density Estimates can be used to detect similar words, but they do not build concepts for us, which still leaves a considerable amount of interpretation to the data analyst. In all applications of distant reading (Moretti 2013), getting acquainted

with the texts and carefully interpreting the data is a prerequisite for successful interpretation, but it would be useful to have a view of the data which stipulates a fixed number of concepts. The criticism of word-based approaches, i.e. that they only detect differences at the word level, can be addressed in several ways. When attempting to build concepts, an obvious problem is that the mapping between word and concepts is not 1:1. On the one hand, the same words may refer to different concepts due to word-sense ambiguity and, on the other hand, different words can be (near-)synonyms or semantically closely related. Topic Modeling goes beyond grouping words that appear close in Kernel Density Estimates, but employs an adaptable method of building concepts, based on the words, but also taking the semantic unity of the document into account. Ranked lists of words (Table 1) minimize the risk of oversights and reduce the recall error rate. A comparison of the early modern and the late modern materials of EMEMT and LMEMT data reveals important changes in their medical contents, in particular in identifying new medical topics and methods: *inoculated* shows a very strong positive value, public good is enhanced, and changing medical practice can be seen in the frequent use of professional titles. Issues of linguistic interest also emerge as e.g. the simpler prepositional constructions.

3.2   The method of Topic Modeling

The above criticism of word-based approaches can be addressed in several ways. One option for mapping words to concepts is to use rule-based systems like *WMatrix*[25]. While this approach performs well on general newspaper texts, specific genres and historical texts often end up with unsatisfactory analyses, as many of the words have undergone strong semantic shifts or have domain-specific readings. A second option for addressing the problem of mapping words to concepts is to use the contexts in a purely data-driven fashion. Distributional approaches have the advantage that they do not depend on present-day uses, but their disadvantage – which is typical of data-driven approaches – is that they require a large amount of data[26] and that they fully

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[25] A web-based corpus processing environment from Computing Department, Lancaster University. See Paul Rayson (2009) on http://ucrel.lancs.ac.uk/wmatrix/. Accessed 19 June 2018.
[26] It is difficult to quantify from which amount of data onwards the approach works "sufficiently" well. Like in the detection of collocations, larger amounts of texts lead to better results, and as most words are rare, small text collections are usually unsatisfactory. As a rule of thumb, from about 100,000 words upwards, results start to fall into convincing patterns. While an evaluation is beyond the scope of

depend on the quality of the corpora. The distributional hypothesis also claims that words which occur frequently in a given document are closely related to its content. They allow us to define topics and concepts by using synonyms, from purely distributional aspects of large text collections. For the present study aims, this is essential.

Topic Modeling has become a central approach for automated content analysis (for a good introduction, see Blei 2012). The tool which we use, MALLET[27] employs a distributional probabilistic model which assumes that documents belong to topics (as in document classification), and that certain words are particularly frequent in certain topics. In terms of conditional probabilities, a topic model maximizes the following probability:[28]

p(topic | document) * p(word | topic)

While the documents and the words are given, the topics emerge during the optimization process. All that the user sets is the number of topics. As a result, the program gives a list of topics, each with its most important keywords, and it also shows the contributions of each document to the topics. These lists allow users to see which topics are present in the document collection, and the contributions of the documents reveal which documents are central to each. In order to see how topics develop over time, we can compare the topics arising in different periods. This gives us a diachronic view, e.g. of changes from Early to Late Modern English.

In an earlier study, we applied topic modeling to the EMEMT corpus and these results can serve as a point of comparison and reveal tendencies and ongoing changes (Taavitsainen and Schneider 2018 forthcoming). Running two separate topic models has given us an overview, but often the alignment of topics is unclear (and if we use more than ten topics, the alignment grows increasingly more difficult). We will, thus, switch to an approach that uses the same topics in both periods in the

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this study, we have checked if several runs lead to very similar results (if they do not, this is a typical warning signal, as Topic Modeling starts from a random state) and if single documents completely dominate a topic (which is a sign of overfitting). Nevertheless, the benefits of more powerful algorithms compared to the parsimony of simpler ones need to be weighed carefully.

[27] A Machine Learning for Language Toolkit, see Andrew Kachites McCallum (2002) on http://mallet.cs.umass.edu. Accessed 19 June 2018.

[28] As one of the reviewers rightly points out, this formula is a simplification for illustrative purposes. The interested reader is referred to Blei et al. (2003) and Blei (2012) and Steyvers and Griffiths (2007) for further mathematical details.

following application of the method.

3.3 Topics in the two medical corpora 1500–1800

3.3.1 Topics in EMEMT

We have set the number of hidden topics to n=10 to get a broad overview of the subject matter of EMEMT. The hidden topics and their keywords are given in Table 2, with the arbitrary topic identification in column 1, the general importance of the topic in column 2, and keywords (most important keywords first) in the third column. We have manually added boldface to easily interpretable keywords that reveal essential topic areas and have given a comment in the fourth column.

Table 2. Hidden topics in EMEMT for n=10

EMEMT TOPIC	WEIGHT	KEYWORDS	COMMENTS
0	0.0448	**moon** day **time mars sun** hour sign days **saturn** past **year venus** min **jupiter** sick night signs noon hours	astrology
1	0.1279	**part parts** called **heart blood bones veins head** wound **brain bone** made great **skin body** side hath flesh man	body parts
2	0.0626	**called leaves** english **herb grows** sea white hath kind colour **seed root tree** stone black dry hot **pepper flowers**	medical herbs
3	0.2418	**man men** hath things great god good **physicians time physic physician** thing make doe nature made medicine medicines **reason**	scholastic
4	0.2180	body **heat** nature **cold hot** doth blood things **humours air** natural **spirits** dry part parts moist bodies hath reason	humours
5	0.0356	ana ii iii lb **ounces ounce** de iiii **oil** wound rec cum wounds **wax** add olei make half **unguent**	recipes
6	0.2028	**disease** blood **diseases** good great **pain cure** head body stomach **patient** time **fever** urine humours doth day **cured** child	diseases
7	0.1566	**water** put **oil half wine make drink powder** good **ounce** white **ounces** morning fire **vinegar juice** warm made till	recipes
8	0.1188	blood made parts found salt spirit acid matter time nature common water sulphur author dr account quantity great vitriol	
9	0.0767	good man water doth thy thou urine stomach herb ye eat great make called hot stone cold flesh meat	

3.3.1. Topics in LMEMT

Likewise, we have set the number of hidden topics to n=10 to get a broad overview of the e subject matter of the LMEMT corpus. In the following, the topics are given in their order of salience.

Table 3. Hidden topics in LMEMT for n=10 (last in importance, Latin terms, not included)

LMEMT Topic	WEIGHT	KEYWORDS	COMMENTS
7	0.3419	**practice nature great medicines physician physicians medicine knowledge diseases time cure art method** made **dr** good make opinion **experience**	professional practice
2	0.2767	body state nature disease parts air animal degree effects diseases motion blood matter great life natural produce nervous system	(diseases)
9	0.1839	time day water years days mr found great small patient cold pain fever hours disease case dr symptoms part	(disease, symptoms)
1	0.1648	**stomach** water **food** great **drink** quantity **diet** blood proper **wine** cold **digestion liquors** strong time good spirits warm **urine**	digestive system
3	0.1276	**man life health nature mind men** make **age** god body children great reason things world **death long** good **live**	health, long life
5	0.1266	**child** head patient operation time eye hand case made part **woman** found **women** stone great **midwife uterus pain** bladder	childbirth
6	0.1058	**london college number hospital** years **public patients persons physicians poor surgeons** country year **apothecaries** present **society** great **hospitals medical**	public good, hospitals
8	0.1040	**vessels blood** part parts glands **arteries** uterus **membrane fluid veins** small **artery** teeth body **wound wounds fibres substance** surface	blood circulation
4	0.0903	**water air** urine **fire** blood quantity particles salt colour part bodies body matter parts heat acid stone **earth** bladder	four elements

3.4 Contributions of EMEMT and LMEMT to common topics

In order to observe to what extent the same topics are found in the two periods, we shall run a model containing both periods and tease out the changes and the contribution that each period makes. Every document that is assigned to one or more topics has a weight value that shows how strong the association of the document to the topic is. We can assess the association of the entire period by overviewing all documents contained in it. We have arranged the topics in order of increasing importance from EMEMT to LMEMT. Results for n=10 are in Table 4. The contribution of a topic to all the documents of the period is given in column 3 for

EMEMT, and column 4 for LMEMT. For example, 8.12% of the texts in EMEMT contribute to the topic with ID 0 (row 1), while only 0.99% of the texts in LMEMT do so. The division of column 3 by column 4 is given in column 1, showing us e.g. that the relative contribution of topic 0 in the EMEMT period was 8.18 times larger in the LMEMT period. Sorting the topics by this relative contribution allows us to arrange the topics in diachronic order, to travel through time from the earliest to the latest topic, as if in a virtual time machine. We have added boldface to important keywords and a comment in the last column. We have highlighted the three most important topics of each period in boldface, in columns 3 and 4. We can see that *humours*, *religion*, *health advice*, and *recipes* were quantitatively the most important topics in EMEMT, while in LMEMT the emphasis turned to diseases, experiments, and professionalized medicine.

**Table 4.** EMEMT and LMEMT topic model, ordered by ascending importance from EMEMT to LMEMT[29]

EMEMT/ LMEMT	TOPIC	EMEMT	LMEMT	KEYWORDS	COMMENTS
8.18	0	8.12%	0.99%	**called** man **herb** good **moon** stone english hath named grows leaves water long white colour day great seed thy	Logocentric science, scholasticism
6.18	2	**20.39%**	3.30%	**body** blood **doth cold good humours** stomach **heat hot nature** dry hath parts things part natural flesh meat moist	Humours
3.70	8	**18.78%**	5.08%	man **hath** things men **god** great **good** body time nature thing doe life make **reason** made **physic physicians** doth	Religion
2.56	3	**15.35%**	6.00%	water **put half oil ounce powder make wine ounces** drink good white morning till juice leaves warm pound vinegar	Health advice, recipes
1.23	9	9.96%	8.12%	part parts **child wound head** made **bones** called side great bone **wounds** hand neck place **woman** left skin small	Surgery, childbirth
0.61	6	4.99%	8.21%	**water** salt **spirit fire** acid quantity **salts** made volatile **urine waters** oil **sulphur** parts tincture wine common **earth** taste	Four elements
0.34	7	7.63%	**22.33%**	time **disease** great day **patient fever** water years days **symptoms pain case** found cold **cure** blood small hours stomach	Time, patients' diseases and symptoms

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[29] The miscellany of Latin items (topic number 4) is ignored.

| 1.81 | 4 | 2.79% | 1.54% | ana ii de iii amp cum est ad vel lib lb rec olei iiii pr dr ol ros ut | Latin terms |

0.30	5	5.13%	**17.12%**	blood **parts body vessels motion air animal** part **nature matter heart** state **glands** action bodies **animals arteries** natural **nerves**	New science, experiments, animal testing
0.25	1	6.85%	**27.30%**	**physicians** great nature **diseases practice physician** time **medicines method** art made **knowledge** general mr **medicine** make **dr** men persons	Professionalized medicine methods
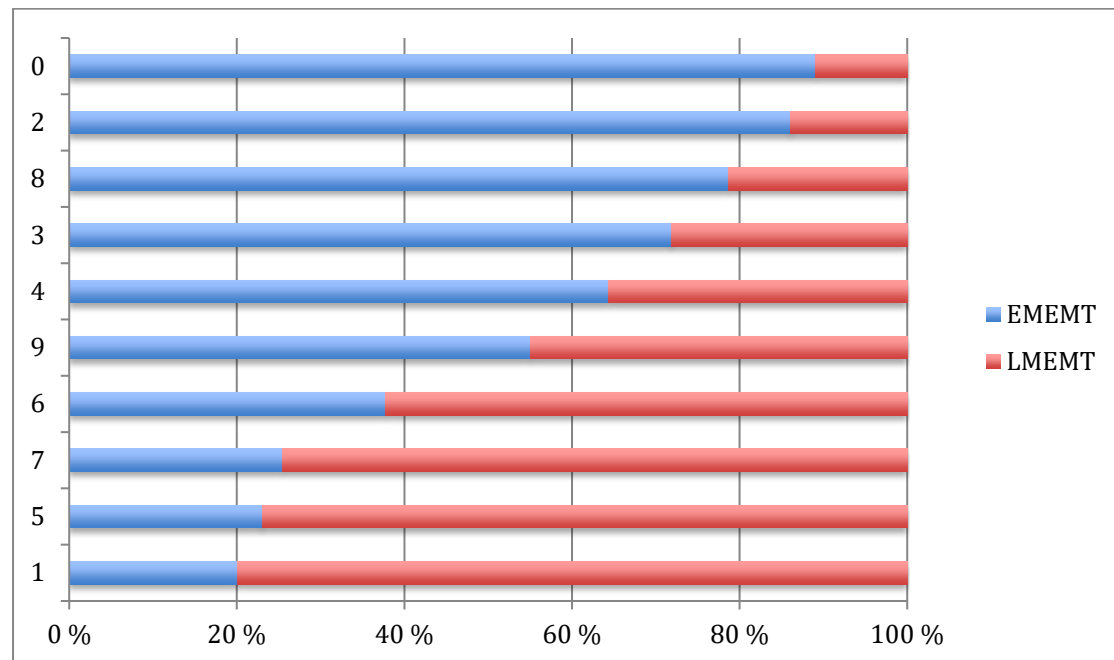
Figure 2. Development of topics from EMEMT to LMEMT, n=10

The texts which are most strongly associated with the respective topics are also given. In the following, we discuss each of the topics in more detail, using prototypical passages from the most strongly associated documents, moving from the earliest topics (i.e. relatively most strongly represented in EMEMT) to the newest topics (i.e. relatively most strongly represented in LMEMT). The ID number of the topic is arbitrary.

Topic 0: The logocentric science of scholasticism (EMEMT 8.12, LMEMT 0.99) shows very clearly in texts from the first half of the sixteenth century. Our time travel begins with texts that provide direct continuation from the late medieval period. For example, the definitions of terms are logocentric and list what the plants are called in various languages (see below), but do not describe the plants at all. The text that contributed most to the topic was Turner's text (*Names of herbes*) from 1548. The alphabetical order serves as the text organizing strategy, and within the entries the points are enumerated:

(5) Absinthium
Absinthium **is called** in greke. Apsinthion, in englishe wormwod, in Duche wermout, in french, Absince or Aluyne. There are **three kyndes** of wormwod, beside the commune wormwod, wormwod pontike, **called** in latin Absinthium ponticum, in englishe maye be also **called** wormwod gentle, **it is called** of Mesue and of the Potecaries of Germany Absinthium romanum the Coloners call it graue crut, the Freses call it wylde rosmary. **The beste kynde** of thys wormwode gentle or pontike that I haue sene came from Rome, **an other kynde** of the same is to be had in Anwerp and thorowe al Germany in plentie. **The seconde kynde is called** in latin Absin-thium marinum and Seryphum, it groweth co~monly in diches whereinto, the salte water vseth at certeyne tymes to come, it is plentuous in Northumberlande … **The thirde** …
<div align="right">(Turner, Names of herbes, 1548: ff.A4r–4v)</div>

Among LMEMT texts, Morland (*A rational account of the causes of chronic diseases*, 1774) scored high. In the following passage, Nature is discussed, and besides personification [Nature – *her*] the passage contains rhetorical questions and a reference to Hippocrates, who was one of the most frequently quoted authorities in scholasticism:

(6) ALL arts, whether plastic, mathematical, mechanical, or physical, are but the handmaids and imitators of **Nature**. Most successful is the practitioner who can happily trace her path, and can copy nearest to the divine original: **Who**, knowing her ways, **is able to lend a hand** when she is obstructed; or can render her propitious by gentle and well timed invitations. In the healing art particularly, **it was observed** two thousand years ago by **Hippocrates**, the great father of medical science … (Morland, *A rational account of the causes of chronic diseases*, 1774: B1)

Topic 2: Humours (EMEMT 20.39, LMEMT 3.30). The humoral theory prevailed in the sixteenth and early seventeenth centuries and beyond in texts for heterogeneous readers. Several early texts mention this topic word, most prominently it is present in the health guide *Regimen Sanitatis Salerni* from 1528. The style of writing is in accordance with scholastic conventions: it contains passive voice sentences, an enumerative text strategy and reliance on old authorities:

(7) [Latin] Here **are declared** .iiij. inco~uenientices enge~dred by after none slepe. **Fyrst** the after none slepe causeth and inge~dreth feuers by reason of opilatio~s. For the naturall hete and spirite of man by daye draweth to the outwarde partes of the body: and therfore digestion by day is but feble: … and therfore the nyght is the very season of perfite

digestion: and the vndigested & rawe **humours** are y=e= cause of opilations/ whiche opilations enge~dre feuers/ **as Auicen saythe** in the .j. dist. li. iiij. and chap. of putrifaction. **Secondly** after none slepe causethe man to be slouthfull in his operations & busines/ by the reason afore sayde/ for grosse **humours** and vndigested cause mans spiritis slowelye to moue the bodye: For as a subtile quicke spirite causeth lyghtnes of body/ so a lumpishe spirite causeth a sluggishe body. **Thyrdly**…

(Mediolano, *Regimen salitatis Salerni*, 1528: f.B4v)

Topic 8: Religion (ratio EMEMT 18.78, LMEMT 5.08). The text indicated as the most topical in the early period is Erasmus's (1537) treatise from the EMEMT APPENDIX "Medicine in society". Religious features are also found in LMEMT, though not very frequently, but e.g. the above-mentioned text by Morland from 1774 contains religious considerations:

(8) …of that exquisite mechanism, and innate, energetic principle of self preservation, with which the **CREATOR of man** hath been pleased to endow our bodies: And, by carefully comparing the same sort of distempers, and their various minute motions, in different patients, and all the circumstances … and accidents … which usually preceded and attended them, he could readily foretel an approaching disease, and after its invasion, give a right judgment of the progress and event of it. This surprizing skill of his, … and that of other succeeding physicians who carefully studied and pursued his method, procured them **a kind of religious veneration** among the people, who were wont to look upon them as **prophets inspired by the Gods**, and even as arbiters of life and death.

(Morland, *A rational account of the causes of chronic diseases*, 1774: 6)

Topic 3: Health advice, recipes (ratio EMEMT 15.35, LMEMT 6.00). The word string connected with this topic contains alimentary nouns, including liquids like water, wine, and other drinks. The following passage came up with the keyword *water* and is from one of the early texts in LMEMT:

(9) Nevertheless, the use of things teaches us this change is better perform'd according to the variety of the Food, or the difference of the Preparation from whence these were subject to alter before they enter'd the Body. Hence ripe Corn, dress'd and ground, mix'd with **Water** fermented and boil'd by the Fire, is best for preservation of Health: … Summer Fruits, if ripe, that is soft easily melt or dissolve, so that they need no other preparation or assistance. But **Drink** if from a pure **Water** and running Stream is best crude or raw; if the **Water** is foul from Insects, or their

Eggs floating therein, gently boiling or letting it stand for a time renders it better; but **Drink** made from Corn or Fruits boil'd in **Water** is known to be good: As that which is made from Malt, by steeping in **Water**, then boiling, fermenting and fining it down, which we call Ale or Beer …

(Boerhaave, *Institutions in physick*, 1714: 11–12)

Topic 9: Surgery and childbirth (ratio: EMEMT 9.96, LMEMT 8.12). With this topic, we are approaching a balance between the periods. One obvious reason why this topic is important in both periods is, of course, that women give birth to children in all periods. The most prominent text is, however, one of the earliest in EMEMT, though items like *child* and *woman* are very common in midwifery texts throughout. Surgical operations and anatomy contain many of the semantic string items. The following early text is written in scholastic style with prescriptive phrases and the passive voice:

(10) BY the flankes **ye shall vnd~stande** the nether parte of y=e= bely frome the lappe to the secrete membrys/ & be of .iij. maners/ som holde/ as myrach/ Siphac/ Sirbus/ & the **bonys**/ **som be holden**/ as y=e= semynall vessellys/ the moder or matrix in a **woma~**/ the fu~dament gutt/ the senowes & vaynes y=t= co~meth downwarde. In euery of them is a gryat **bone**/ & they be ordeyned to gyder with a great spo~dyle namyd ossis sacris on the backe **syde**/and on the for parte makyng of y=e= ge~nytour **bone**/ namyd os pectinis. Thus these **bonys** go abrode ouer bothe y=e= **sydes** of y=e= lymmes of the hyppes/
(Brauschweig, *Handy warke of surgeri*, 1525: B4v)

The passage below is from a midwifery text in LMEMT and deals with delivery in a very professional way with new practices created by the introduction of men-midwives in France (cf. above). Several words of the typical string are found in a short extract (notice also the titles Mr. and Dr.):

(11) …Mr. Mauriceau, pag. 89. The **woman** being put into a proper posture, the Surgeon having well greased his **hand**, introduces the end of his fingers into the mouth of the womb, then opens them gently to dilate it, (i.e. by little and little, without either great violence or hurry,) wide enough to admit his whole **hand**; then, if the membranes are not broke, let him break them; then, tho' the **Head** presents, let him search for the feet, and draw it forth by them, because there is better hold, and more easy to deliver by them, than by the **head**, or any other **part** of the body. Dr. Chamberlen …

(Douglas, *A short account of the state of midwifery in London, Westminster*, 1736: 23)

Topic 6: The four elements (ratio: EMEMT 4.99, LMEMT 8.21). Topic 6 is the first topic that is more strongly present in LMEMT than in EMEMT. It is, nevertheless, important in both periods. The most prominent contribution is by Hales from 1740 (*Statistical essays: containing hæmastatics*). It is noteworthy that the text pertains to experimental science, and thus water, fire, and air are meant literally. It is an account of testing and provides an excellent example of the items in this semantic field. In the vivid description of the process itself, the researcher and his feelings are not mentioned:

> (12) 1. I Put into a Florence Flask full of cold **water**, a small round redish gravel stone, about … of an inch diameter, and also a piece of a very hard Calculus; and having suspended the flask over a **fire**, when the **water** boiled, **air** arose in plenty from the gravel, whereby it was raised up in the **water**, and much agitated to and fro; so that it looked like the Nucleus of a comet, with its long train of **air**-bubbles arising from it.
> (Hales, *Statistical essays: containing hæmastatics*: Experiment IX, 1740: 223)

In many of the earlier texts, the four elements are referred to in their alchemical reading, going back to Greek philosophy:

> (13) There be in the bodie of man, the force of foure elementes, **fire** and **aire**, **water** and **earth**, and the pith of their primitiue, & principall qualities, heat and couldnesse, moysture and drynesse, which the Physicians call the similarie partes … (Mulcaster, *Training vp of children*, 1581: 43)

We can, thus, see a fundamental change happening within the same topic – it epitomizes the change from alchemy to chemistry. The lexical string for topic 5 also includes the word *nerve*, which signposts the change towards sensibility.

Topic 7: Time, patients (ratio: EMEMT 7.63, LMEMT 22.33). A late text from EMEMT, Willis's *Plague treatise* from 1691, contains most of the semantic items in a short passage and shows a smooth transfer to the following period; similar examples are even more abundant in LMEMT.

(14) In **time** of Sweating, give the **Patient** Posset Drink made with Pestilential Vinegar; boyl in the Milk Scordium or Marigold Flowers; if he is very dry, boyl Medesweet, or Wood Sorrel; if he is ill at **Stomach**, and apt to vomit or faint, give Claret Wine burnt with Cinnamon … which kind of Medicines should be given likewise after Sweating is over, once in three or four **hours**, of one or other, to refresh the Spirits, and to keep the Malignity from the Heart. Give him no cold Beer in two or three **days**. After Sweating wash the Mouth with White-wine Vinegar and Rose **Water** … (Willis, *Plague treatise*, 1691: 48–49)

Topic 5: New science (ratio: EMEMT 5.13, LMEMT 17.12). The following passage is from the last decade of the eighteenth century and contains references to one of the most important tenets of the new science, namely the Matter-of-Fact principle. References are given to contemporary authors, and Edinburgh was a leading centre of medical science at the time:

(15) AS there is no medical theory, formed from induction, to enable us to detect **what is erroneous or false in the accounts of facts**, or to direct us in the treatment of new cases; the following attempt to connect with an important organ many otherwise loose **facts**, may tend to facilitate the recollection and application of them, and thus abridge the range of **inquiry**. … Many authors, as Vanhelmont, Rega, Bordeu, Lacaze, Barthez, Fouquet, and particularly **Mr.** Hunter, lean, in their useful writings, to the opinion held in this summary, which was meant as part of heads of lectures on Materia Medica, read in Edinburgh several years ago. The farther application of the doctrine to practice, will probably appear soon.
(Webster, *Facts, tending to show the connection of the stomach with life*, 1793: i)

Topic 1: Professionalization (ratio EMEMT 6.85, LMEMT 27.30). The text that made the greatest contribution to this topic deals with the profession itself. It is a polemical text describing the institutional state of affairs in legalizing medical pracititioners, a privilege granted to an institute with elitist practices. The author's aim was to advocate change and promote a more open policy. This text belongs to the new category of PUBLIC HEALTH and the style shows the influence of the legal register:

(16) … at the close of the eighteenth century, in the enlightened metropolis of Great Britain. But, extraordinary and disgraceful as it is, a great majority of the **physicians** of London, equal in talents, education, acquirements, skill, and conduct, to any body of the faculty in Europe, are only tolerated and licensed to **practise** under the authority and controul of a narrow corporation. The College of **Physicians**, originally founded for the most beneficent and liberal purposes, for the security of

the public, and the advantage of the faculty of physic, by restraining illiterate and unprincipled practitioners, and by distinguishing and rewarding skilful and upright **physicians**, is now in the possession of an inconsiderable and interested party. …
(Stanger, *A justification of the right of every well educated physician*, 1798: B1)

3.5   *Assement by categories*

The above assessment takes us through three hundred years of medical writing from 1500 to 1800, with the focus on the last century. To draw some pertinent lines of development more clearly in LMEMT 1700–1800, we shall next focus on individual corpus categories.[30] The aim of the following survey is to highlight some of the rising eighteenth-century features of medical writing that succeeded in breaking new ground for the future. Three categories that show rising trends are of particular interest: the first category of GENERAL TREATISES, the second of SPECIFIC TREATISES is one of the loci of increasing professionalism, and PUBLIC HEALTH opens up a novel area of social medicine. In contrast, the remaining three categories (MEDICAL RECIPE COLLECTIONS, REGIMENS, and SURGICAL AND ANATOMICAL TEXTS) build on long traditions: recipes as well as surgical and anatomical writings have predecessors in previous periods, and the tradition of health guides also dates from the medival period.

3.5.1   GENERAL TREATISES

We shall first zoom in on GENERAL TREATISES and its most pertinent features. The graphical representation of the topic model of EMEMT and LMEMT GENERAL TREATISES is shown in Figure 3. Unlike in the full corpus, looking at only GENERAL TREATISES leads to a clear separation between the two periods – no single topic is equally present in both periods, as Figure 3 shows. Reasons for this clearer separation are, on the one hand, that there are fewer mixed topics, like childbirth (9) and the four elements (6), which showed a fundamental change inside a topic. On the other hand, the fact there are fewer documents also increases the danger that topics overadapt to documents.

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[30] Categories seven and eight, SCIENTIFIC PERIODICALS and GENERAL PERIODICAL, are not included in this study.
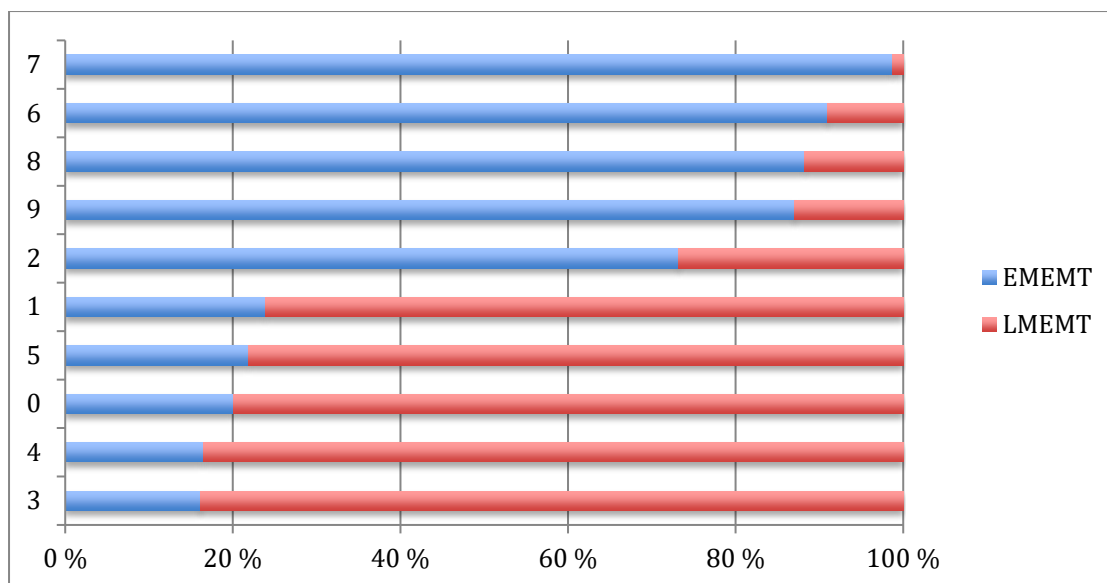
Figure 3. Development of topics from EMEMT to LMEMT for GENERAL TREATISES, n=10

The most striking differences are found at the top, in topic 7, recipes, but that may be more haphazard than real, and cannot be taken as a true indication of a difference (see below). Instead, the other topic areas show more reliable trends of development. As discussed above, humours, elements, and religion have stronger associations to EMEMT and show diminishing traits in eighteenth-century medicine. The bars in the middle with greater values in LMEMT are also good indicators of changes. They are, however, somewhat miscellaneous and pertain to medical practitioners and places, and general health advice.

The strings pertaining to GENERAL TREATISES reveal the prominence of ethical issues (see the category description). In the following, we shall discuss some differences that become evident when compared against the overall patterns. For example, the string of most important keywords for this topic pertains to medical practice, knowledge, and methods.[31] The keyword string of the second most important topic denotes people with evaluative adjectives like *good* and *bad*.[32] The topic with several words of fibre theory is third in importance.[33] Interestingly, *quacks* also

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[31] The string of the topic: nature diseases great practice knowledge man art make time method body incurable physicians reason cure proper physician human things

[32] (children people diseases drink body good time care food cold women exercise diet quantity health great constitution bad patient)

[33] (blood vessels part motion fibres parts heart circulation fluid body made arteries chyle action veins stomach small force contraction)

appears as a keyword in this category[34] with Armstrong's *Essay for abridging the study of physick* (1735) as the text most strongly associated with this topic. It grows to be a mockery of quacks with play-like dialogic elements, containing the actors *Pluto* and *Hyg*; they appear among the keywords for this reason – which also shows that this topic is in danger of overadapting to individual documents:

> (17) one of my Friends tells me, that the more **Quacks**, as he calls them, the better for the Physicians. For, says he, the Wrath of Heaven and the proper Vices of Mankind, are scarce so productive of Diseases as are these **Quacks**.
> (Armstrong, *An essay for abridging the study of physick*, 1735: 17)[35]

The term *quack* is a highly pejorative term, and some of the texts of the category contain warnings and complaints about quacks who were mostly illegal practitioners (see GENERAL TREATISES category description).

3.5.2 SPECIFIC TREATISES

The most important change in the eighteenth-century medicine is professionalization. As can be expected, it features prominently in SPECIFIC TREATISES where it comes up in several disciplinary contexts. For example, the string with the highest weight pertains to professionals with e.g. nouns denoting people and the professional titles (*dr*, *mr*) in front of the names.[36] The text that contributed most to this topic was Chapman's *A reply to Mr. Douglass's short account of the state of midwifery in London and Westminster* from 1737. The opening passage contains several of the pertinent features:

> (18) **MR.** Douglass his short Account of the State of Midwifery in London and Westminster, in which he has endeavoured to cast a Cloud of

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[34] (pluto long time good make hyg merc happy ll deity quacks happiness rest countries physick education letter honour scarce)

[35] Quackery is mentioned in other categories as well, e.g. a MIDWIFERY text from 1736 (Douglas, *A short account of the state of midwifery in London, Westminster*) has the following passage, also with a mocking tone: "If Ward's Pill, or any other quack medicine, was found by experience, to be generally of use in this, that, or t'other disease, it may be sent with proper directions, to all parts of the kingdom; so that the most distant inhabitants would have almost the same benefit of it, with those among whom Mr. Ward lived; and consequently Mr. Ward might very justly say, that (notwithstanding he would not discover what his medicine was composed of, because it would be worth so much yearly to him and his successors,) yet his country was obliged to him, for telling them where they might purchase so beneficial a remedy".

[36] (dr mr great practice time amp good make made persons physicians women account method medicines physician case men person)

> Reproach over the Characters of those that practise this noble and necessary Branch of Physick, …
> (Chapman, *A reply to Mr. Douglass's short account of the state of midwifery in London and Westminster*, 1737: 2)

The text is polemical and discusses the state of midwifery especially in the light of the new practices and men-midwives in France. Thus, it pertains to the organization of the field and is also strongly connected with professionalism:

> (19) In the same Page (the 7th.) the Plot of **Mr.** Douglass's whole Performance begins to open, when he says, that the Midwomen's want of Knowledge is more their Misfortune than their Fault, because they have not yet had such proper Opportunities of informing themselves as they ought to have. But now it must hereafter be their Fault more than their Misfortune, if they are not better qualify'd, after knowing where the Source of all Knowledge in Midwifery is to be found. This is the first Act of **Mr.** Douglass's Farce; and in the succeeding ones the Plot will unravel itself more and more, so as to be well understood by the dullest Reader, unless I am much mistaken. He asking (Pag. 8.) Whether **Physician**s don't always make a sad Out-cry, and are not alarm'd as if their Craft was in danger, when Surgeons use Pen and Ink, except in Pauper Cases, is an indecent and false Reflection on the Gentlemen of the Faculty.
> (Chapman, *A reply to Mr. Douglass's short account of the state of midwifery in London and Westminster*, 1737: 9)

Next in importance comes a keyword string with more mixed words of *health* versus *disease* and *animal* versus *human*,[37] for example:

> (20) We are not therefore to be surprised, that the attempt to solve this great problem of **nature** encreased rapidly, beyond the **power** of numbering, leaving no passage untrod which afforded any hopes of leading to a solution of the mystery; hence there hardly exists another spot in the whole region of **natural** knowledge, surrounded by more intricate labyrinths, or false guides than this.
> (Blumenbach, *An essay on generation*, 1792: 4)

The third keyword string indicated Jenner's text from the very end of the century (*An inquiry into the causes and effects variolæ vaccinæ*, 1798) as the one that contributed most to it.[38] From the medical history point of view, this text introduced a theory of

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[37] (nature body diseases life disease animal effects state great natural human man health mind kind general things nervous power)

[38] (disease patient fever case great symptoms day time cases small cold matter pox state heat pain pulse smallpox effects)

the origins and an improved method of inoculation, thus contributing to professionalism. The following passage is based on observations that lead to a hypothesis about the way the disease spread:

> (21) There is a **disease** to which the Horse, from his state of domestication, is frequently subject. The Farriers have called it the Grease. It is an inflammation and swelling in the heel, from which issues matter possessing properties of a very peculiar kind, which seems capable of generating a **disease** in the Human body (after it has undergone the modification which I shall presently speak of), which bears so strong a resemblance to the **Small Pox** that I think it highly probable it may be the source of the **disease**. … not paying due attention to cleanliness, incautiosly bears his part in milking the Cows, with some particles of the infectious matter adhering to his fingers. When this is the **case**, it commonly happens that a **disease** is communicated to the cows, and from the Cows to the Dairy-maids, which spreads through the farm until the most of the cattle and domestics feel its unpleasant consequences. This **disease** has obtained the name of the Cow **Pox**. …
> (Jenner, *An inquiry into the causes and effects variolæ vaccinæ*, 1798: 2)

One of the keyword strings exhibits new knowledge of the structure of the body achieved for the first time by the novel instruments (cf. fibre theory),[39] and several topic strings are directly tied to issues discussed at different points of time in the eighteenth century, for example naval medicine and scurvy.[40] These new fields of medicine have since widened and developed, but in the eighteenth century, they were innovative new topics.

3.5.3 MEDICAL RECIPE COLLECTIONS

MEDICAL RECIPE COLLECTIONS is an exceptional category with its long history in the vernacular and genre conventions dating centuries back in time (see the category description). Recipes are also found integrated into longer treatises and thus, they occur embedded in other categories, e.g. GENERAL TREATISES, REGIMENS, and SURGICAL AND ANATOMICAL TEXTS. A more detailed investigation reveals that similarities within the topics of this category are striking, although the recipes themselves are of two principal kinds: they pertain either to households or institutions like hospitals and dispensaries. This category shows straightforward patterns with variation in the order of items, for instance. The most important topic focuses on

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[39] (blood vessels part parts body matter glands urine lungs quantity veins particles fluid fibres air arteries membrane heart motion)

[40] (de disease dr time great men scurvy amp ship sea air vid people plague infected part lib times mead)

patients and doses.[41] The text that contributed most to it is Wesley (*Primitive physick*, 1747), with sentences that contain imperative forms, measures and instructions about taking the medicine: "**Boil a handful** of Ribwort in Whey. **Drink** this warm an **hour** before the fit comes, and **lie down and sweat**." Number 2 is topic 3,[42] with instructions about preparation and application. Number 3 is topic area 2,[43] which seems to contain imperative forms of verbs, typical of instruction on how to make medicines. One of the recipe texts called *The lady's complete guide* (1788) is written by a female author, Mary Cole. Instead of imperative forms, it relies on more indirect guidance:

> (22) Elixir of vitriol is an excellent medicine in most cases of indigestion, weakness of the stomach, or want of appetite. Twenty or thirty drops of it **may be taken** twice or thrice aday, in a glass of wine or water. **It may** likewise **be mixed** with the tincture of the bark; one drachm of the former to an ounce of the latter, and two teaspoonfuls of it taken in wine or water, as above.   (Cole, *The lady's complete guide*, 1788: 514)

It is somewhat strange that there is practically no overlap with charitable notions of public health, though such ideas are also present in the texts.

3.5.4   REGIMENS

Among health guides and regimen texts, the keyword string for this topic pertains, as can be expected, to general health advice and nutrition. The text that contributed most is Cheyne's *An essay of health and long life* from 1724 (discussed in detail in Chapter 6 in this volume). Next comes a string with very similar items but in a different order, and with a somewhat different focus. Trusler's *An easy way to prolong life, by a little attention to our manner of living* (1780) is indicated as its most significant text. Most of its health instructions are formulated as warnings or cautions against excessive habits and given in prescriptive sentences, e.g.:

> (23) Cautions to be observed in the use of drinking.
>   THE necessity and use of drink is to preserve natural moisture, and to make good a mixture and distribution of meat, that it may digest the

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[41] (water patient great dose stomach frequently proper drops quantity good cases blood grains body time times likewise complaints medicine)

[42] (water half morning drink ounce pint powder cold till apply warm day hours juice white mix leaves boil, spoonful)

[43] (half ounce ounces drams syrup dram make dose powder mix boil sugar quantity liquor heat white tincture root made)

better. For these reasons **it should be moderately taken** at meals. Sundry little draughts are more wholesome than two or three large ones. Large draughts at meals makes the food fluctuate in the **stomach**. This with its weakening and relaxing the coats of the **stomach**, destroys **digestion**. Great draughts also lessen the natural heat of the **stomach**, drives the food down too hastily, and corrups the whole body with too **great** moisture and crudity.
(Trusler, *An easy way to prolong life, by a little attention to our manner of living*, 1780: 24)

3.5.5 SURGICAL AND ANATOMICAL TEXTS

This category has direct continuation from the late medieval period to the early modern times and to the eighteenth century. The most important string is topic number 6[44] with Bell's *A system of surgery* (1783) as the most important contribution. Second comes topic 4,[45] with Blane's *A lecture on muscular motion* (1788) and topic 9[46] with Gooch's *Cases and practical remarks in surgery* (1758) with a series of case studies. The innovations of the category seem to pertain to new equipment made of steel designed to provide aid to deformed bodies (see Withey 2016).

3.5.6 PUBLIC HEALTH

This category is brand new and should therefore receive more attention than the previous ones. The most weighty topic string number 1[47] contains several adjectives as well as some central nouns denoting medical professions. The most important contribution was by Aikin's *Thoughts on hospitals* from 1771:

(24) It is well known to the world, and with a conscious pride I repeat it, that no profession or set of men have shown themselves so ready to offer their assistance to the poor, or so disinterested in promoting improvements in their art for the benefit of mankind, as the medical faculty. Their voluntary unpaid attendance on the numerous sick at **Hospitals**, their readiness to give advice to the poor at home, amply prove the former; their spirited patronage of inoculation, with every other means of prevention against **diseases**, their union into societies for

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[44] (parts blood arteries ligature made part artery vessels manner great wound degree considerable means time divided vessel needle found)
[45] (parts inflammation part natural state nature action motion pain body nerves muscular vessels matter contraction muscles sensation life case)
[46] (years wound patient days case great bone found time part mr matter symptoms perfectly surgeon operation appeared day beginning)
[47] (great good general surgeons number means time hospitals persons cases public disease present case place practice part proper degree)

> the free communication of knowledge and improvement, sufficiently declare the latter …
>
> (Aikin, *Thoughts on hospitals*, 1771: 8)

Next comes the string of topic 2[48] with Guybon's *An essay concerning the growth of empiricism; or the encouragement of quacks* (1712). The string is different as it contains nouns denoting various professionals in the field. The third in importance is topic 5.[49] This topic is philanthropic in nature, calling for *support* for the *poor* and a *humane society*. An eloquent "address" to the Royal Humane Society (1790) is clearly at its core:

> (25) … This awful solemnity of **humanity**—this noble representation of charity triumphing over **death** and the grave, over misfortune and despair, has at each succeeding meeting been attended with additional circumstances of exultation and gratitude, in proportion as the influence of the **Society** has extended, and its success increased.
>
> (*Royal Humane Society, instituted in 1774*, 1790: 3)

Of the other strings, some bring new fields of medicine into the discussion, e.g. topic 8[50] contains words connected with new areas of military and naval medicine. The pertinent text extract comes from Pringle (*Observations on the diseases of the army*, 1752). This is noteworthy for the overall lines of the century. The text shows very clearly the extending world of the British Empire.

> (26) The epidemic of the hot **season**, and great endemic of this and other marshy countries, is a **fever** of an intermitting nature, commonly of a tertian shape, but of a bad kind; which, in the damper places and worst **seasons**, appears in the form of a double tertian, remittent, continued putrid, or even an ardent **fever** …
> In Zealand, where the air is worst, it is called the gall-sickness; and, indeed, both the surcharge and depravation of the bile is so remarkable, wherever these **fevers** prevail, that the immediate cause has been usually referred to the corruption of that humour …
>
> (Pringle, *Observations on the diseases of the army*, 1752: 8)

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[48] (physicians medicines physician apothecaries physick apothecary knowledge art practice man tho make patient nature diseases remedies tis men natural)

[49] (life society state death health humane dead human poor body lives mr sickness restored families humanity man institution support)

[50] (fever men sick season army time summer cold fevers troops winter air weather health ill part continued rest hospital)

4   Discussion

4.1   What we set out to do in this chapter

Our point of departure in this article has been medical historians' expertise and familiarity with eighteenth-century medical texts. In the second part we conducted a digital humanities quantitative assessment that utilizes data-driven methods. In this section, we shall compare the approaches to verify to what extent the results achieved by different methodologies agree, what aspects our triangulation confirms and what was not so conspicuous, and how far the different approaches yield agreement or disagreement. After the comparisons, we shall return to our aims and evaluate the methods.

4.2 The approaches, our findings, and the underlying reality

Both approaches take a selection of texts as their point of departure. The medical historians start from their own personal selection of eighteenth-century English texts which they interrogate with the help of various interpretative frameworks. These text selections may aim at representativeness of a time and place but will not usually claim to be exhaustive, but instead offer a sampling of the relevant material. The quantitative approach must also select texts but on a rather different basis: the digital corpora employed here aim at representative accounts of what appeared in print in various defined categories of text. Distributional methods applying Topic Modeling and Kernel Density Estimation require a large amount of data and are fully dependent on the quality of the corpora. In this respect, we can stand on firm ground, as our databases have been carefully compiled to be as representative as possible (see Chapter 1 in this volume). A very useful feature of the programs is that they indicate which documents are central to the topics. We have made use of this feature, selected illustrative examples from these texts, and interpreted the results with qualitative text analyses in a sociohistorical frame, paying attention to patterns of linguistic use to achieve a linguistic-stylistic overview. Thus, this article counts as a methodological test in three disciplines: medical history, digital humanities/computer science, and linguistics/computer-aided discourse analysis.

The choice of our corpus categories was made in such a way as to enable exploration of both continuities and innovations, as LMEMT deliberately engages with the choices already made for EMEMT. And further, the main issue here is how well we can map the results to the "reality" of medical history as it has been established in the previous literature. Yet, it is somewhat problematic to talk about reality as revealed in medical history as it might involve talking about things like rates of mortality and morbidity, population replacement, institutions (like universities and hospitals), legal frameworks, economic factors in the health market, and other relevant facts, where the point might be instead to identify developments which "lie behind" the language employed in medical discourses of the period. Some interesting suggestions as to connections between textual phenomena revealed by quantitative analysis and the creation of new institutions, or, for example, the impact of exploration of new countries, can be interpreted and subsumed under increasing professionalization, but this kind of reality perhaps comes out best in the category descriptions in this book, e.g. in new *materia medica* and the advent of a whole new category of institutional writings. The chapters by medical historians, David Gentilcore and Alun Withey, illuminate another trend with the focus on eighteenth-century medical discourses rather than on factors lying behind these texts, and they complement the picture in an excellent way. Perhaps we should talk about thought styles here as it seems a more suitable term for the area where we can map the results of the medical history approach to linguistics and discourse analysis. But a pertinent question remains: is it possible to find concrete textual evidence for the changes in medical writing, relate them to the underlying thought styles and pinpoint the changes with more accuracy than before?[51]

Our initial comparison in this chapter focused on the differences between early modern and late modern medical writing in order to detect the most important changes and place them in their medical contexts. Our assumptions proved correct, as we found both direct and indirect evidence for almost all changes discussed in medical history (see Section 2 above). In particular, we expected the programs to

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[51] This takes us back to the beginnings of the project "Scientific thought styles". In our inaugural article, we wrote: "…to discuss features of English medical writing in relation to changing 'thought styles' of science and relate these changes to the various levels of audience. Our aim is to see whether the changing trends of philosophy underlying science are reflected in the discourse structure; and if they are, how they are reflected, and how they affect the language and style of writing" (Taavitsainen and Pahta 1995: 519).

identify emerging topics that would show a long diachronic continuum. Changes in the field can be detected by comparing topics of rising or diminishing importance in different periods. Even the reconceptualized notions of melancholy as over-refined nerves and iatromechanical nervous disorders came up in terms like *nerve* and *nervous* in some topic strings (see above).

The Kernel Density Estimates program detects similar words, but the interpretation of the results poses a demanding task for the data analyst, and familiarity with the texts is a prerequisite for successful interpretations. A criticism of word-based approaches has been that they only detect differences at the word level, but this can be addressed in several ways. Topic Modeling goes beyond grouping words that appear close to one another and it employs an adaptable method of building concepts, based on the words, but it also takes the semantic unity of the document into account. The ranked lists of words enable more systematic insights, and minimize the risk of oversights.

4.3   Paradigm changes and emerging thought styles in LMEMT

In this section, we shall list some of the most important new topic areas that were revealed by our computerized methods. Some fundamentally new principles had already become well established in the latter half of the seventeenth century with the Royal Society (1662–). New requirements were posed to science, and the principles of replicability, objectivity, and credibility were accepted as the goals of the new science with its Matter-of-Fact principle (see above). The innovations of the period include the material side in the form of new instruments, e.g. the air pump, and the microscope, which opened up new visions and made novel observations possible in medicine and in biology on microlevel phenomena that were not visible to the plain eye. One of the accompanying changes concerns the attitude to the human body: it came to be seen in a new light as a mechanical system in its own right. Technological innovations also contributed to the changing body image and made altering the body shape and personal appearance possible, as the attitudes changed in the mid-century with the waning of the moral outlook that argued that one should not interfere with

God's work (Withey 2016: 1–2).[52]

New institutions and organizations can be connected with rising professionalization (see also Broman 2003). The incentives for founding them came mostly from philanthropy, which rose to be a prominent trend in the latter half of the eighteenth century. Public health and welfare issues concerning hygiene and sanitation had started to attract attention already earlier especially as the poor conditions of e.g. waterways needed repairing, and repeated epidemics pointed to the need for sanitation. The same motivation, public good, was the leading force behind the initiatives to establish charitable institutions and provide medical care for the poor. The trend can be noticed both in local initiatives and on the national level in rising patriotism as more pride was being taken in British medical and welfare institutions as an index of national greatness.

A trend that has to do with the new professionalism finds expression in the latter half of the century and coincided with the expansion of the British Empire after the Seven Years' War (1756–1763).[53] The explorers to the unknown parts of the world faced health hazards and the new conditions had to be dealt with as the new parts of the world were now connected to the old. The new circumstances gave an incentive for improvements in the army and the navy, including medical concerns within them, e.g. new therapeutic measures were detected for scurvy. The situation in the latter half of the century has also been described as a "proliferation of systems" (see above, Cunningham and French 1990: 1–3; Ishizuka 2012: 563–564). This refers to the competition between explanatory medical systems in the later eighteenth century (i.e. mechanist, Brunonian, fibre-based, nervous, humoralist), no one of which held sway. We take this statement to refer to the multi-layered medical market and the unstructured nature of medical care available to the population at large. This competition reflected the character of a medical marketplace in which many different kinds of medical practitioners flourished, and that there was no control of this marketplace by the state, only the limited (and largely ineffectual) intervention of corporations like the College of Physicians or Society of Apothecaries. The practices

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[52] New instruments for this purpose came onto the market with the steel industry in the latter half of the century (Withey 2016).
[53] The Seven Years' War (1756–1763) was a major European conflict but it also involved overseas colonial struggles between Great Britain and France over North America and India.

of lay people seeking advice on health care were different from the elite classes, and the issue received a great deal of attention in the contemporary professional literature. Medical services at the lower end of society have been framed in terms of the pejorative category of quackery by their more orthodox and privileged competitors but, stripped of the dismissive language, what was being described was the direct sale of medical services and commodities, above all nostrums advertised by product names (Daffy's Elixir, etc.) by which quacks made their profits (see Porter 1993: 40).

4.4   Thought styles of diminishing importance in LMEMT

Our timespan stretches over three hundred years, with the focus on the eighteenth century. A fundamental change in the worldview had already taken place in the transfer period from the late medieval to the early modern, when the all-encompassing hierarchical system with religion, inherited from the earlier medieval times, was played down and replaced by a more secular outlook. Secularization presumably involved a steadily decreasing role for heaven and its denizens and increased scope for human healing agency and a demystified nature.[54]

The change was gradual and went on for centuries so that we still encounter some remnants of the old system lingering on in the eighteenth century and even later. But when and how the change took place is a problematic issue that has been discussed in terms of disenchantment or how the role of superstition and magic diminished in people's lives.[55] Changes in thought styles are a complicated issue, and medical matters are of concern to the population at large, even the illiterate possessed some knowledge of health and sickness, handed down by word of mouth and practices based on long-standing traditions.

A different line of research assesses how vernacular literacy spread more widely in

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[54] The earlier system saw the world as a set of beliefs about the way in which divinely created nature and providential history defined expectations about what medicine could achieve in a reflection of the Christian hierarchy: heaven (God, angels, the Virgin Mary and Saints) is above human agents (priests and healers), and nature (bodily systems and *materia medica*), contra-nature (disease) and non-naturals (food, drink, etc., subject to human control).

[55] The disenchantment model was originally launched by Max Weber, who states that the abandonment of magic made the upsurge of technology possible, and not the other way round. The model served as the theme in Keith Thomas's seminal book *Religion and the Decline of Magic* (1971, see page 786 for Weber). It has received more attention recently (see below), e.g. a discussion of the processes of disenchantment and secularization in the Western world and beyond can be found in Bilgrami (2016).

society and more people received some kind of basic education. The issues are further complicated by vernacularization processes as researchers from earlier periods have provided some telling arguments against simply identifying the vernacularization of medicine with dissemination of elite knowledge from the universities.[56] Our previous research has shown that changes in written medical texts, and the establishment of new genre conventions, take place in learned writing and spread slowly to texts produced for people of lower levels of education. This process is, however, far from straightforward as meanings and functions change and become renegotiated in new contexts (see Taavitsainen 2009, 2017, and 2018). Increasing literacy rates facilitated dissemination of knowledge across wider layers of society and to larger parts of the population, presumably decreasing reliance on orally transmitted knowledge, and for example the new media of newspapers also contributed by spreading medical news, thus diminishing the role of rumours and received wisdom in people's lives (Taavitsainen 2015). It is obvious that we cannot simply assume a narrative of progressive disenchantment, but more accurate evidence of its course is lacking as extant linguistic data is scarce for the lower levels of society.

Our corpus catches the top levels of society, and some texts are targeted at semiliterate audiences, though on the whole, such texts are scarce and may not render enough evidence to reveal the patterns of dissemination to the semiliterate and beyond. The old traditions deriving from earlier times were still valid although the evidence is more scattered and, on the whole, the more "popular" writings in the eighteenth century are still largely uncharted (see Section 2.4 above), and the lowest levels remain without documentation of textual evidence. In addition, there has been disagreement about the timing of these fundamental changes in the worldview.[57] There is a grey area that needs further philological research in the archives.

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[56] Demaitre (1998) gives first-hand evidence of translation strategies and metacomments with more complex motivations for an intermediate audience and Holbrook (1998) analyses an interplay of textual and visual components in a vernacular version of the printed *De proprietatibus rerum* that gives admission to a wider circle of readers to learned culture.

[57] The timing has proved problematic. Bailey (2013) argues for an earlier date and states that the process of the disenchantment of the world came into full vigour with the Reformation and continued into the eighteenth century. He states "[w]hether or not we have ever been modern, and whether or not we are now—in the West", we are now "only partially—disenchanted … " (Bailey 2013: 251; see also Bailey 2006).

5. Conclusions

At the beginning we hypothesized that our methods of Topic Modeling and Kernel Density Estimation should be able to confirm some of the most conspicuous trends, but we also assumed it likely that not all trends mentioned in the earlier literature could be confirmed. And further, we hypothesized that the methods would bring up some new aspects that had gone unnoticed before.

In Section 2, we discussed the Galenic doctrine of humoralism that had dominated in the EMEMT period, but we assumed that it should also be present to some extent in LMEMT. The dominant characteristic of humoralism is mirrored by the fact that *humours* appears closer to *ememt* in Figure 1 (textplot map) than any other keyword in the conceptual map derived from Kernel Density Estimation (see Section 3.1), and by the fact that the topic referring to humours (topic 2; Section 3.3) is one of the most strongly overrepresented topics in EMEMT, as 20% of the texts refer to it. According to the topic model, 3% of the texts in LMEMT still refer to this topic, so our assumption was confirmed. The change from logocentric scholasticism to observation is equally obvious in our results. The keywords *method*, *observed*, and *effects* appear close to *lmemt* in the conceptual textplot map (Section 3.1). The scholastic topic (0) in Section 3.3 is the most prominent in EMEMT; in contrast, the empirical science topic (5) is the second in order in LMEMT. The new instruments, such as microscopes, leave less direct traces in our results but were, nevertheless, influential. On the one hand, new instruments helped to achieve many of the observations that dominate the LMEMT texts. On the other hand, SPECIFIC TREATISES reveals topics showing new knowledge of the structure of the body achieved for the first time by these means. For example, the fibre theory was based on these observations and it features strongly in LMEMT texts.

The most important topic in SPECIFIC TREATISES (Section 3.4.2) refers to the professional titles *Dr.* and *Mr.* as one of the many indications of the professionalization of the field. Topic 1 in Section 3.3 refers to professionalized medical methods and is both the most overrepresented one in LEMEMT and also its strongest in weight. The professionalization of medicine is the result that stands out most strongly in quantitative terms. It came out clearly beyond our expectations, and our results indicate that professionalization has perhaps been somewhat

underestimated in the earlier literature and deserves further discussion. Running a topic model over GENERAL TREATISES (Section 3.4.1) also revealed a discussion of quackery in tune with Porter's coinage of the eighteenth century as "the Golden Age of Quackery", which represents another facet of the period. The topics of philanthropy and public health are closely linked to professionalism. Looking at PUBLIC HEALTH in more detail (Section 3.4.6) brings up keywords such as *poor*, *humane*, *humanity*, and *society*. These were novel ideas in the medical history with concrete outcomes in the establishment of new institutions like hospitals and the foundling children's home. The topics of *childbirth* and the *four elements* remain important in both periods, but a look at the representative texts (Section 3.3) reveals a fundamental change within the topic, towards professionalism in the case of childbirth, and the change from alchemy to chemistry in the case of the four elements. Both of these discoveries went beyond our expectations and show the power of the method. The change from a religious system to a more vernacular one is also evident in our results. *God*, *good*, and *evil* appear close to *ememt* in the conceptual map (Section 3.1), and the topic of religion (topic 8 in Section 3.3) has stronger weight in EMEMT; the scarceness of data at the bottom end of the scale, however, restricts a full-scale assessment.

The visual representations in Figures 1 and 2 show changes in thought styles within three hundred years: some of them take place earlier, some later. The methods that we employed are able to indicate a more precise timeline, and the timing of the changes is the area where our method adds accuracy to our knowledge. A further desideratum of the timing processes of disenchantment and the dissemination of knowledge to various layers of writing remain to be pursued in more detail in the future. We are, however, convinced that linguistic/computational methods applied to comprehensive multilayered data with their different sociohistorical contexts can help in drawing a more detailed picture of the processes of change in eighteenth-century medical texts. This interdisciplinary study provides a step towards this ambitious goal.