Using corpora to track changing thought styles: evidentiality, epistemology, and Early Modern English and German scientific discourse

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Abstract

Most research on evidentiality has focused on classifying evidential systems synchronically; meanwhile, diachronic studies on evidentiality seem to have focused on the development of specific items into evidential markers with little regard to discourse context. This paper begins to fill this gap by presenting the results of a corpus-based study of evidential markers in Early Modern scientific discourse in English and German. The Early Modern period witnessed the transition from scholastic-based models of science to more empirical models of enquiry; this study demonstrates a decrease in the use of markers of mediated information and an increase in the use of markers of direct observation and inference accompanying these sociohistorical developments.

Keywords: Evidentiality, Early Modern Period, Scientific Discourse, English, German

1 Introduction

In this contribution I shall discuss the linguistic changes that accompany profound epistemological changes in Early Modern (1500–1800) "science"[1] and scientific writing, particularly in the domain of evidentiality. The Early Modern period witnessed the gradual decline and eventual rejection of modes of enquiry based on medieval Scholasticism – a system of learning based on the study of ancient texts – in favor of more empirical methods of learning that involve personal observation and subsequent reasoning processes. It

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[1]   The use of the term *science* is admittedly problematic, as a singular field that includes disparate disciplines like chemistry, astronomy, and medicine was not conceptualized as such in Early Modern times (Shapin 1996; Park & Daston 2006). The term is adopted here for convenience to apply to the many fields affected by medieval Scholasticism and later Empiricism.

has long been acknowledged that such a significant change in scientific methodology brought about linguistic changes in scientific discourse (Siraisi 1990; Habermann 2001; Taavitsainen 2001a; French 2003; Seibicke 2003); however, very few diachronic studies of scientific discourse have focused extensively on evidentiality, the linguistic coding of a speaker's (or writer's) source of knowledge or information for an assertion. Given that changes in accepted sources of knowledge are central to the change from scholastic-based to empirical modes of enquiry, it is expected that the use of evidential markers would change as well. Specifically, since the scholastic tradition favored the use of classical authorities such as Aristotle, Hippocrates, and Galen as sources of information, whereas later empirical modes of enquiry place a premium on observation, experiment, and reasoning, it is predicted that the use of markers indicating mediated (or reported) information would decline, and this decline would be accompanied by a rise in the use of markers indicating observation and inference. An examination of the language pair English-German provides the opportunity for a broader understanding of this phenomenon than would be possible by investigating a single language; a number of diachronic corpora will be consulted for both qualitative and quantitative analyses.

The paper is structured as follows: Section 2 provides an overview of the sociohistorical context of knowledge and learning during the Early Modern period, with the domain of medicine serving to show how a specific field was shaped by the scholastic tradition. Section 3 explains how evidentiality is conceptualized in the current study. In Section 4 the methodology and the corpora used in this study are discussed. The results of the corpus searches are presented in Section 5, and a few concluding remarks are made in Section 6.

2 Science and Knowledge in Early Modern Europe

The scholastic tradition, which centred around understanding and synthesizing the writings of ancient authors such as Aristotle, Plato, Hippocrates, and Galen, began around the twelfth century and continued well into the Early Modern period – a period held to have begun ca. 1350–1400 for the German-speaking territories (von Polenz 2000, 99–102) and around 1500 for English-speaking Great Britain (Nurmi 2012, 48)[2]. These ancient *auctores*, as well as their Arabic intermediaries such as Avicenna and Averroës, were viewed as the ultimate authorities on the subjects about which they wrote, and all learning was focused on the study of their writings to determine the precise meaning of their teachings (Keil & Reinecke 1987, 221–224; Bates 1995; Crombie 1995). Granted, it was possible to make personal observations, yet all such observations would then be

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[2]   These dates are specifically in reference to linguistic epochs, i.e. *Frühneuhochdeutch* 'Early New High German' and Early Modern English.

contextualized and interpreted within the framework laid out by the *auctores* (Siraisi 1990, 170ff.). Within medicine, for example, humoral theory – initially elaborated by Hippocrates (460–370 BC), and the basis of Galen's (130–210 AD) medical model – formed the fundament of knowledge concerning the human constitution and disease (Temkin 1973; Nutton 1995, 175ff.). Humoral theory concerns how the four 'humors' believed to compose the human constitution – blood, phlegm, yellow bile, and black bile – are responsible for health and well-being: an imbalance of humors, caused by factors such as air quality, sleep deprivation, excessive or unbalanced emotions, and astronomical/astrological phenomena, led to poor health. The humors could be rebalanced through the application of various herbs (themselves possessing humoral qualities), bloodletting, emetics (substances that induce vomiting), and purgatives. Treatment would be highly individualized, as each person's humoral profile would vary depending on age, gender, season of birth, and local environmental conditions.

Such a reliance on the teachings of the learned authorities was made explicit in the writings of the time, and the reliance on these *auctores* as bases of knowledge can be seen in Examples (1) and (2):

(1) *<...>* **and Galyen saythe** *that women that haue strayte portes of kynde and narowe mothers shulde not haue ado with a man lest they conceyue and dy*. (EMEMT, 1525_SeyngeOfUrines: Anon., *Here begynneth the seynge of Uryns <...>*, 1525, f.C4r)[3]

(2) *BElangend das Chameleon/ so gehet eine gemeine Meinung von demselben im Schwange/ daß es nemlich von der Luft lebe/ und sonst keiner andern Speise bedürffe: und* **so schreiben ausdrücklich davon Solinus, Plinius, und andere/** *und mit solcher Umschreibung* **wird** *dieses Thier auch* **von dem Ovidio vorgestellet.** (GerManC, SCIE_P1_WMD_1680_Epidemica: Thomas Brown, *Pseudodoxia Epidemica*, 1680)
'Regarding the chameleon, there is a general view of the same in circulation, namely that it lives on air and does not require any other food: and thus write Solinus, Pliny, and others explicitly on this matter, and Ovid also presents this animal with a similar description.'

In (1), Galen's writings provide the basis of knowledge on which the author of this medical tract advises women of a certain physical stature not to conceive children, lest they die. In (2), the author has recourse to a number of classical authorities, and even the poet Ovid, to support his assertion of the chameleon's nutritional requirements (or

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[3]   Detailed information on the corpora used in this study is provided in Section 4.

lack thereof). In both cases, knowledge is based on information that has been mediated through the *auctores* and not on the authors' own observations or inferences.

Beginning in the sixteenth century, a number of events both within and outwith the domain of "science" brought the received wisdom of scholastic learning into question. Within science, for example, a number of events occurred that undermined the words of the classical authorities: the most famous is Galileo Galilei's (1564–1642) proposal of heliocentrism, but Andreas Vesalius' (1514–1564) anatomical observations and William Harvey's (1578–1657) discovery of the nature of blood circulation had serious implications for the field of medicine (Cook 2006, 414ff.; French 1989). Thomas Syndenham (1624–1689) insisted on more empirical models of observing patients' diseases rather than relying on individual humoral profiles (Cunningham 1989), while Louise Bourgeois (1563–1636) saw the need to write a midwifery manual based on experience rather than relying on the writings of learned doctors who had no actual involvement in assisting women deliver children (Loytved & Lundgren 2013, 55–57). There was also an increased interest – spearheaded by the likes of the Swiss-born physician Paracelsus (1493–1541) – in disseminating writings in the vernacular (English, German, French, etc.) rather than in Greek or Latin, so as to enable broader access to medical and other sorts of specialized knowledge (Gottschall 1999; Newman 2006). Exploration and colonialism brought Europe into contact with heretofore unknown diseases such as syphilis – diseases never addressed in the writings of antiquity (Grafton *et al.* 1992, 161ff.). The Reformation also aided in the waning of scholastic influence, insofar as it encouraged the contesting of formerly uncontested authority. In short, the Early Modern period witnessed the erosion of scholastic authority in favor of more empirical modes of knowing.

3 Evidentiality and the Linguistic Realization of Changing Thought Styles in Science

The gradual erosion of the scholastic model of learning in favor of empirically-driven methods of investigation chiefly concerns the value given to one's source of information (vis-à-vis knowledge). It thus follows that the domain of evidentiality – the marking of a speaker/writer's source of information – is one of the key areas where these sociohistorical changes should be reflected in language usage. Although there is no shortage of work on social and interactional aspects of evidentiality in contemporary usage (Chafe 1986; Biber & Finegan 1989; Fox 2001; Bednarek 2006; Nuckolls & Michael 2012), the bulk of diachronically-oriented work on evidentiality is interested either in the evolution of specific markers and/or processes of grammaticalization and (re)lexicalization (Anderson 1986; Willett 1988; Traugott 1997; Brinton 1996, 2008; Diewald & Smirnova 2010; Timofeeva 2013; Whitt 2010, 2015). Grund's (2012, 2013) work on evidential markers in Early Modern witness depositions is one exception. There

is also some work on the history of scientific discourse – especially related to expressions of knowledge – in English and German (see, for example, Dieckmann 1998; Taavitsainen 2001b; Seibicke 2003; Schiewe 2007; Keil & Halbleib 2009; Moessner 2008, 2009a, 2009b; Hiltunen & Tyrkkö 2009, 2011; Gloning 2011; Gray *et al.* 2011). Even so, very little attention has been paid to overt expressions of knowledge sources, and those works dealing with evidentiality either restrict their focus to specific types of evidence like reported information (Gloning 2011), subsume the notion of evidentiality into broader categories such as stance (Gray *et al.* 2011), or conflate the notion of evidentiality with epistemic modality (Taavitsainen 2001b)[4]. The current investigation attempts to fill this gap in the research by focusing exclusively on sources of knowledge and how these are realized linguistically.

I adopt Boye's (2010, 2012) notion that evidentiality is a functional-conceptual category that encompasses both lexical and grammatical items scoping over propositions for which the basis of knowledge or evidential source is indicated. Hence there is no concern with the perennial discussion of evidentiality proper (as a grammatical category) vs. evidential strategies or "secondary" uses of an item being considered evidential (Aikhenvald 2004; Diewald & Smirnova 2010, 40ff.), nor with the possible differences between grammatical(ized) evidentiality and lexical(ized) evidentiality that exist in areas such as deixis (Leiss 2011). The aim here is to cast as wide a net as possible to see how writers of Early Modern scientific texts overtly signalled the evidence they had for their claims. Of key importance, however, is the delineation of the types of evidence that constitute the category of evidentiality. There is little agreement in the literature – even in terms of appropriate terminology – as to exactly how one should classify types of evidence. Willett (1988), Palmer (2001), Aikhenvald (2004), and Boye (2012) make a distinction between direct and indirect evidence (using terms such as direct vs. indirect, sensory vs. reported, firsthand vs. non-firsthand), while Anderson's (1986) more nuanced approach makes a distinction between direct evidence and observation, direct observation and subsequent inference, inference (without further elaboration), and logical expectation. Hearsay is also implicit in Anderson's analysis. The degree to which distinctions between sensory modalities are made can vary when in comes to direct evidence or perception (Aikhenvald 2004, 63; cf. Whitt 2010). Studies also vary on the degree to which forms of indirect evidence – whether concerning information reported by or mediated through others, or logical processes – are classified and sub-classified (Willett

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[4]   In the current study, the category of epistemic modality – expressing the likelihood of a proposition being true or not – is held to be notionally distinct from evidentiality – the linguistic marking of information source – and does not form part of the present investigation (see also Diewald & Smirnova 2010; Boye 2012). Although these two categories could admittedly be subsumed under broader notions of 'propositional modality' (Palmer 2001) or 'epistemic meaning' (Boye 2012), the focus here is exclusively on the linguistic realisation of writers' evidence rather than expressions of possibility and probability.

1988, 57; Aikhenvald 2004, 63–64). The key distinction for our purposes is between (1) evidence mediated through a learned or "scholastic" authority; (2) evidence mediated through a contemporary of the author or general hearsay currently in circulation; and (3) evidence arrived at through means of direct perception and inference. Consider the use of evidentials in Examples (3) through (7) below:

(3) *Althoughe (as **affirmeth** Plenie,) there be innumerable passions and diseases, whereunto the bodye of man is subiecte, and as well maye chaunce in the yonge as in the olde. Yet for mooste commonlye the tender age of chyldren is chefely vexed and greued with these diseases folowynge.* (EMEMT: 1546_Phayer_BokeOfChyldren: Thomas Phayer, *THE KEGIment* [sic] *of life, whervnto is added a treatyse of the Pestilence, with the booke of children newly corrected and enlarged,* 1546, f.S4v)

(4) *<...> weil der Geruch nicht nur ein Vorbott und Zeichen/ sonder auch eine Ursach und Nater des Geschmacks ist/ wie Helmont von den Fermentis **schreibet**.* (DTA: 1715_muralt_lustgarte, Johann von Muralt: *Eydgnössischer Lust-Garte*, 1715, 35/0067)

'<...> because smell is not just a precursor and sign, but rather a cause and extension of taste, as Helmont writes of the *fermentis*.'

(5) *Ich weiß nicht, wie diese Stricke gemacht waren, denn, wenn ich Darmsaiten und Bindfaden von Hanf naß gemacht habe, so **sahe** ich, daß sie sich aufdreheten, daß sie aufschwollen, und daß ich sie, ohne große Stårke anzuwenden, betråchtlich in die Långe ziehen konnte <...>* (GerManC: SCIE_P3_WOD_1744_Hygrometrie, Johannes Heinrich Lambert, *Hygrometrie oder Abhandlung von den Hygrometern*, 1744)

'I do not know how these cords were made, for when I made gut strings and twine of hemp wet, I thus saw that they coiled themselves up, that they swelled up, and that I was able to lengthen them substantially without using a great deal of strength.'

(6) *That which **seems** at once to fulfil most of these intentions, is taking of Tobacco in a Pipe; the Smoke of this secures those parts which lye openest, and at once intercepts the Contagion from the Brain, Lungs, and Stomach: Nay more than this, it stirs the Blood and Spirits all the Body over, and makes them shake off any poysonous Matter that adher'd to them <...>* (EMEMT: 1691_Willis_PlainAndEasieMethod, Thomas Willis, *A Plain and Easie Method FOR Preserving [by God's Blessing] those that are WELL from the Infection of the PLAGUE*, 1691, pp. 20–21)

(7) *<...> and so it is with several others, I **suppose**, according to their several Constitutions.* (ARCHER: 1721desa_s3b, John Theophilus Desaguliers *et al.*, essays in *Philosophical Transactions* 31, 1721)

In (3), Phayer has recourse to the words of Pliny the Elder (23–79) to add weight to his claims on how children can be especially vulnerable to certain diseases, whereas in (4), von Muralt points to the Early Modern iatrochemist Jan-Baptist van Helmont (1580–1644) as a reliable source of information concerning the nature of olfactory and gustatory perception. That is, a classical author is cited as evidence in the former and an Early Modern authority is referenced in the latter. Direct perception serves as the basis of Lambert's knowledge of hemp ropes in (5), while direct observation and subsequent inference inform Willis' belief that tobacco can shield one from the plague in (6). Finally, in (7), the verb *suppose* indicates an inference on the part of Desaguliers (but without explicit recourse to the perceptual/experiential basis of such deduction, as is indicated in (6) by *seem*). The crucial distinction here is between evidential uses such as (3), in which the scholastic tradition is upheld through the citation of a learned author, and cases like (4), where more contemporary authorities like van Helmont are cited, or in the case of (5) through (7), where the writers' own perceptions and reasoning processes serve as evidence for the expressed proposition(s). Accordingly in what follows, a three-way distinction will be made between (1) information mediated (or reported) by classical or learned authorities in the tradition of Scholasticism (Mediated Scholastic Information, or MS); (2) information mediated by a more modern author or mere hearsay (Mediated Non-Scholastic Information, or M); and (3) evidence deriving from processes of direct perception and logical reasoning (Direct Observation and Inference, or DI)[5].

4 Data and Methodology

A number of diachronic English- and German-language corpora were consulted to track the possible changes in the use of evidential markers in scientific discourse throughout the Early Modern period. For English, the Corpus of Early Modern English Medical Texts (EMEMT) was consulted for the sixteenth and seventeenth centuries (Taavitsainen & Pahta 2010). This corpus contains a number of genres of medical writing: general treatises and textbooks; treatises on specific topics such as the plague, midwifery, therapeutic substances, etc.; surgical treatises, regimens and health guides; recipes and *materia medica*; and early issues of the *Philosophical Transactions* from the Royal Society (from 1665 to 1694). The regimens and health guides, as well as the recipe collections, are excluded from the current study because of their regimented and formulaic structure with little if any mention of knowledge sources (Marttila 2010; Suhr 2010); the sub-corpus of the *Philosophical Transactions* is also excluded, as it covers

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5   It must be conceded that there are items such as *certain(ly)* / *gewiss* that appear to simultaneously indicate inference and a strong epistemic commitment on the part of the speaker/writer (cf. Mortelmans 2000; Palmer 2001, 24ff.). Only items such as *certain(ly)* and *sure(ly)* indicating absolute certainy (rather than shades of possibility or probability) are considered evidentials in the present study so as to avoid conflating the notions of evidentiality and epistemic modality.

only a very small time frame of the period under investigation and does not lend itself to lengthy diachronic or comparative analysis (although see Moessner 2008, 2009a, 2009b and Gray *et al.* 2011 for analyses of the language of these publications). Individual text samples are roughly 10,000 words in length, and texts consisting of under 10,000 words are included in their entirety. The total word count for the examined sub-corpora of EMEMT (general treatises, treatises on specific topics, surgical treatises) is 1,090,078. For the eighteenth century, the science and medical subsections of the ARCHER (A Representative Corpus of Historical English Registers) Corpus were consulted (Biber *et al.* 1993; Yáñez-Bouza 2011). The combined word count of these two sub-sections for the period 1700 to 1800 is 128,696 (individual text extracts consisting of 2,000 words or less).

For German, the Bonn Corpus of Early New High German was consulted for the periods 1350 through 1699 (Lenders & Wegera 1982; cf. Wegera 2013); however, only four texts in this corpus – from the fourteenth century (specific date unavailable); 1485; 1497; and 1582, totalling 51,369 words – could be considered scientific texts. These samples ranged from roughly 6,000 words to over 18,000 words in length. In addition, a selection of 10,000 word samples from various scientific texts of the seventeenth and eighteenth centuries was extracted from the German Text Archive (*Deutsches Textarchiv*, or DTA) (Geyken & Gloning 2015); the total size of the DTA sample is 162,603 words (see Appendix 1 for information on texts from the Bonn and DTA corpora). Finally, the science sub-section of the German Manchester Corpus (GerManC), which contains forty-five 2,000 word samples (90,000 word total) of German-language scientific writing from 1650 to 1800, was consulted (Scheible *et al.* 2012). Tables 1 and 2 provide an overview of the corpora and sample sizes used in this study:

As can be seen from Tables 1 and 2, the English corpora allow for a systematic investigation on texts dating back to 1500, whereas the German-language corpora only allow for a study dating back to 1650 (although the results of pre-1650 data will be

Period	Number of Samples	Total Word Count	Source Corpora
1500–1549	10	89,869	EMEMT
1550–1599	28	276,417	EMEMT
1600–1649	29	288,691	EMEMT
1650–1700	50	435,101	EMEMT
1700–1749	24	42,878	ARCHER
1750–1799	49	85,818	ARCHER
TOTAL	190	1,218,774	EMEMT + ARCHER

Table 1. English corpora and sample sizes

Period	Number of Samples	Total Word Count	Source Corpora
pre-1600	4	51,369	Bonn
1600–1649	4	40,259	DTA
1650–1700	19 (4 DTA + 15 GerManC)	69,999	DTA; GerManC
1700–1750	19 (4 DTA + 15 GerManC)	70,545	DTA; GerManC
1750–1799	19 (4 DTA + 15 GerManC)	71,800	DTA; GerManC
TOTAL	65	303,972	Bonn + DTA + GerManC

Table 2. German corpora and sample sizes

presented as well) [6]. In accordance with several corpus structures (ARCHER, Bonn, GerManC), all texts are grouped into discrete fifty-year categories (e.g. 1500–1549, 1650–1699, etc.) to trace diachronic continuities and developments. Given the disparate size of text extracts and overall sample sizes among the corpora, all frequencies are normalized to rate per 10,000 words. Where enough samples (more than five) exist for a given 50-year period, statistical testing using analysis of variance (ANOVA) was carried out to find statistically significant differences (where $p < .05$) in frequencies between the periods (Johnson 2008, 104ff.; Eddington 2015, 65ff.). Where a number of post-hoc tests (Levene's, Kruskal-Wallis, Shapiro-Wilk) determined that the assumption of homogeneity was not met, the Mann-Whitney U-test was used instead (Zimmerman & Zumbo 1990; cf. Boggel 2008, 112–113).

A combination of "top-down" and "bottom-up" analyses (Pahta & Taavitsainen 2010: 563) was employed in the corpus searches to find as many evidential items as possible. In a "top-down" corpus search, the results of previous research informs a pre-determined set of items to be searched for. Here, previous work on *seem* and *scheinen* (Aijmer 2009; Diewald & Smirnova 2010; Whitt 2015), perception verbs (Whitt 2010; Whitt 2017), and various adverbs (Biber & Finegan 1989; Downing 2001) provides useful guides as to which items serve evidential functions. On the other hand, recent "bottom-up" analyses of evidentiality (Bednarek 2006; Gloning 2011; Grund 2012, 2013; Whitt 2016) demonstrate that examining data without preconceptions of what items are or are

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[6]   It is acknowledged that there may be some overlap at certain period boundaries in the corpora: in English at 1700, for example, due to the presence of texts from 1700 in both EMEMT and ARCHER, and the fifty-year demarcations of the GerManC Corpus provide similar potential for overlap (although in practice this meant only a single text published in 1700 placed in the 1650–1700 rather than the 1700–1750 group).

not used evidentially can yield a wide array of evidential items that might be missed in a more restricted top-down approach. A close reading of a portion of the corpus (or corpora) is used to identify relevant items to be searched for in the bottom-up analysis. To this end, a 2,000 word sample from each fifty-year period covered by the corpora was read closely and all evidential items were identified. This not only yielded a number of individual types, but also several recurring syntactic patterns, such as complement clauses beginning with *that* or *dass* (as seen in (1) and (5)) or parentheticals beginning with items such as *wie* and *as* (see (3) and (4) for examples). A search for these frequently occurring grammatical items yielded further results (at times unwieldly) that resulted in further tokens being classified as having evidential functions. All searches were done using the WordSmith 6 concordancer programme (Scott 2012). Spelling variation posed a potential problem to such automated searches, but in the case of English, the EMEMT contains normalized versions of the texts (Lehto *et al.* 2010), while the Lancaster Corpus Query Processor (CQP: https://cqpweb.lancs.ac.uk/) allows one to search for lemmas in ARCHER and thus bypass any potential spelling variants. Finally, the use of the wildcard <*> in WordSmith (e.g. using *sch** to search for all cases of *scheinen*) allowed spelling variants to be detected alongside the items spelled as they would be in the modern standard varieties. All examples are provided in the original spelling here.

It must be stressed that most, if not all, items found with evidential functions can also have non-evidential functions. For example, consider the use of *say* in (8) and *sehen* 'see' in (9):

(8)   *So that by this maner and order of dressing aforesaid, which was continued till the extremitie of his paines, and burning heat was well qualified, I* **say** *within the space of sixteene daies, he was made whole by these cooling remedies <...>* (EMET: 1596_Clowes_BookeOfObseruations, William Clowes, *A PROFITABLE AND NECESSARIE Booke of Obseruations, for all those that are burned with the flame of Gun powder*, 1596, p. 5)

(9)   *Dann vnser Wandel ist im Himmel:* **Siehet** *was droben ist/ vnnd nicht was auff Erden ist.* (DTA: 1618_weigel_gnothi, Valentin Weigel, *Gnothi seauton. Nosce te ipsum. Erkenne dich selber O Mensch*, 1618, 99/106)
       'For our change will be in heaven: Look to what is above and not what is on Earth.'

In (8), Clowes uses the speech-act verb *say* to emphasize the claim he himself is making; he is not pointing to some third party as his source of information. In (9), Weigel beseeches his readers to keep their "eyes" on heavenly virtues rather than on worldly desires; he is not indicating direct perceptual evidence for his claim. Such uses do not feature in the discussion below; all that is of concern here is the evidential function of the items in question. On the other hand, certain low-frequency items – such as *have* or

add – may not appear capable of serving an evidential function at first glance, but such use was discovered (see Appendix 2 for English and Appendix 3 for German):

(10) *The carrying of Mr. Silk from his Companion, Mr. Marshall, in the Fens, on his Horse back in the Air diverse miles, till he lighted into Sr. Oliver Cromwels Yard, leaping over one wall, and then another, leaving here a Glove, and there another, and elsewhere his Hat, could be no Delusion. I* **had** *it from a sober Gentleman, who took it from their mouths. Doubtless some Witch did it.* (EMEMT: 1665_ Drage_Daimonomageia, William Drage, *DAIMONOMAGEIA A Small TREATISE OF Sicknesses and Diseases FROM Witchcraft, AND Supernatural Causes,* 1665, p. 9)

(11) *Now seeing by reason of the face a man is called beautifull or ugly, who can deny that they deserve the care of the Physitian, and Chirurgian? He* **addeth** *that a Tumor is a disease most commonly compounded; if he had said ever compounded, he had spoken a truth: for in every one of these Tumors there is a Tumor conspicuous or latent; or a solution of unity either sensible or imaginary.* (EMEMT: 1650_ Read_WorkesOfThatFamousPhysitian, Alexander Read, *THE WORKES OF THAT FAMOUS PHYSITIAN Dʳ. Alexander Read, Doctor of Physick, and one of the Fellows of Physitians-Colledge, London,* 1650, p. 14)

In these cases, the markers are indicating that the author has received his information from someone else: a 'sober Gentleman' in (10) and the sixteenth-century Italian physician Girolamo Mercuriale in (11).

5 Results

In total, the corpus search found 137 individual lexemes in English serving an evidential function (see Appendix 2) and 83 such lexemes in German (see Appendix 3). There were a total of 3,689 evidential tokens in EMEMT and ARCHER and 791 evidential tokens in the German corpora[7]. This is quite a sizeable difference, but as Tables 1 and 2 show, far more data was available for English than for German (1,218,744 vs. 303,972 words, respectively). In both languages, a single item accounted for a large portion of the total count of evidentials: in English, the verb *say* accounted for 1,139 (or 30.88%) of evidentials used, while in German, *sprechen* 'to speak' accounted for 376 (or 47.53%) of evidentials. Many items were used only a handful of times, some only once, as is the case in examples (10) and (11).

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7   This figure is roughly in proportion with the size difference between the English- and German-language corpora. That is, the English sample is 4.01 times larger than the German sample, and there are 4.67 times more evidential tokens in the former than in the latter.

The normalized aggregate frequencies of the different types of evidentials – information from a learned authority in the tradition of Scholasticism, information mediated through a contemporary of the author or through hearsay, or information acquired via direct observation and/or logical processes of inference – used in English- and German-language scientific writing are presented in Figures 1 and 2:

Evidentials in English-Language Corpora

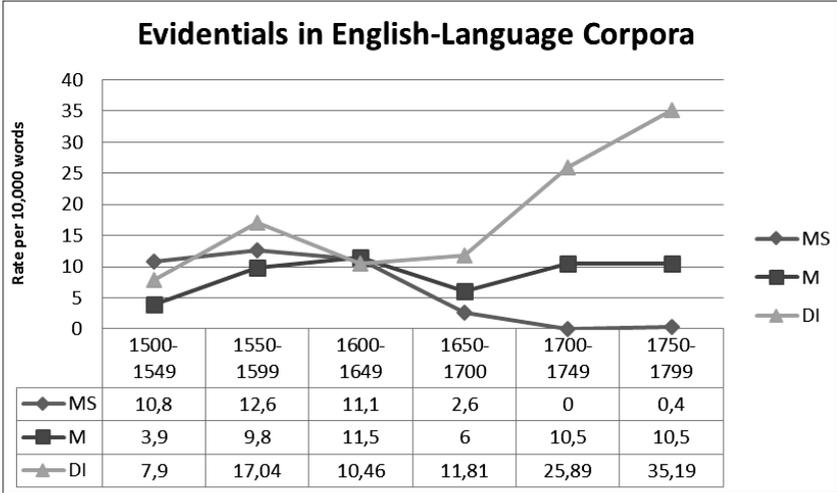|	1500-1549	1550-1599	1600-1649	1650-1700	1700-1749	1750-1799
MS	10,8	12,6	11,1	2,6	0	0,4
M	3,9	9,8	11,5	6	10,5	10,5
DI	7,9	17,04	10,46	11,81	25,89	35,19

Figure 1. Normalized frequencies (per 10,000 words) of evidential markers in the English-language corpora. Key: Mediated Scholastic Information (MS), Mediated Non-Scholastic Information (M), Direct Observation and Inference (DI)

Evidentials in German-Language Corpora

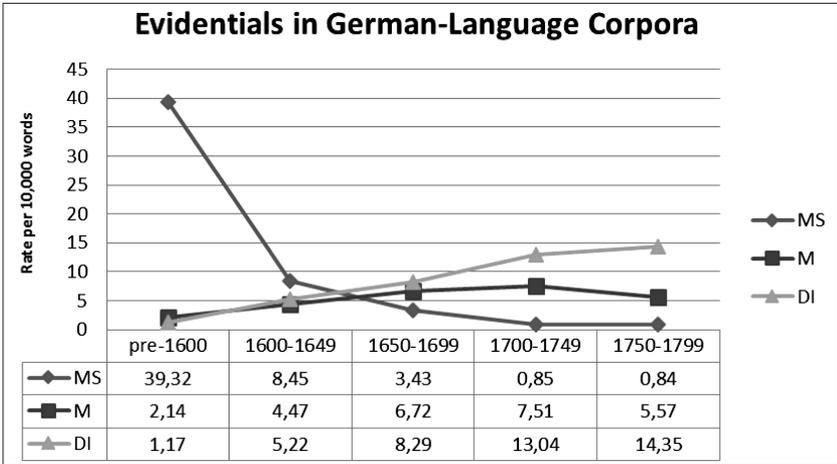|	pre-1600	1600-1649	1650-1699	1700-1749	1750-1799
MS	39,32	8,45	3,43	0,85	0,84
M	2,14	4,47	6,72	7,51	5,57
DI	1,17	5,22	8,29	13,04	14,35

Figure 2. Normalized frequencies (per 10,000 words) of evidential markers in the German-language corpora. Key: Mediated Scholastic Information (MS), Mediated Non-Scholastic Information (M), Direct Observation and Inference (DI)

Both languages display the predicted decline over time in the reliance on information mediated through learned authorities, and by the end of the eighteenth century, markers indicating direct perception and inference are the most frequently used types of evidential markers in both English and German scientific discourse. These markers display a steady rise in frequency in the German-language corpora, although in the English-language corpora, they rise but then decline again in EMEMT up to 1700, and then their comparative frequency in the ARCHER corpus suggests a seemingly substantial increase in frequency. Markers of non-scholastic mediated information (M) show an overall rise in frequency in both languages, but this is not a steady, progressive rise in either case. When subjected to statistical testing, the corpora reveal some statistically significant changes. In English, the decline in the use of markers referring to learned authorities (MS) through the seventeenth century (from 1600–1649 to 1650–1699) was found to be highly significant[8], as was the following decline in the first-half of the eighteenth century (from 1650–1699 to 1700–1749)[9]. There is also a highly significant difference between the use of such markers at the beginning of the sixteenth century and at the end of the eighteenth century (between 1500–1549 and 1750–1799)[10], so the general decline in the reliance on the *auctores* as sources of knowledge that occurred during this period is clearly manifested in language use as well. Regarding markers that point to direct observation and inference as evidence (DI), a significant increase is attested from the end of the seventeenth century to the beginning of the eighteenth century (1650–1699 to 1700–1749)[11]. The difference in use between the first-half of the sixteenth century and the latter-half of the eighteenth century (1500–1549 and 1750–1799) is significant as well[12]. Here too, the rise of empirical trends in science witnessed during the Early Modern period has a clear linguistic realization in the realm of evidentiality. As for information mediated by contemporaries (M), a few significant changes took place through the Early Modern period: an increase in the use of such markers during the sixteenth century (1500–1549 to 1550–1599)[13], a subsequent decline in use during the seventeenth century (1600–1649 to 1650–1699)[14], and then a following increase at the beginning of the eighteenth century (1650–1699 to 1700–1749)[15]. However, there is no significant difference between the use of such markers at the beginning and end of

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8   Mann-Whitney: $U = 313.50$; $n = 29$ (1600–1649), 50 (1650–1699); $p < .001$.
9   Mann-Whitney: $U = 216$; $n = 50$ (1650–1699), 24 (1700–1749); $p < .001$.
10   Mann-Whitney: $U = 32$; $n = 10$ (1500–1549), 49 (1750–1799); $p < .001$.
11   Mann-Whitney: $U = 356.5$; $n = 50$ (1650–1699), 24 (1700–1749); $p = 0.005$.
12   Mann-Whitney: $U = 49.5$; $n = 10$ (1500–1549), 49 (1750–1799); $p < .001$.
13   Mann-Whitney: $U = 77.5$; $n = 10$ (1500–1549), 29 (1550–1599); $p = 0.037$.
14   Mann-Whitney: $U = 442$; $n = 29$ (1600–1649), 50 (1650–1699); $p = 0.004$.
15   Mann-Whitney: $U = 428$; $n = 50$ (1650–1699), 24 (1700–1749); $p = 0.047$.

the periods under investigation (that is, between 1500–1549 and 1750–1799)[16]. These markers did not change as predicted: they attest neither a steady decline as MS markers do, nor a steady rise as DI markers show. Nevertheless, their frequency generally increases throughout the period, demonstrating an increasing recourse to on-going discussions within the scientific community and a decreasing concern with the writings of antiquity. Although the German data demonstrate the same general trends as the English data, none of the changes were found to be statistically significant, which is likely due to smaller sample sizes and less data being available[17].

Another way to look at the data is to see what proportion of evidential markers in a given period are indicative of one type of evidence or another. That is, of all the evidential markers used, what proportion of them indicates reference to a learned authority (MS), a contemporary of the author or mere hearsay (M), or direct observation and logical processes (DI)? These proportions can be seen in Figures 3 and 4:

Proportion of Evidence Types in English-Language Corpora

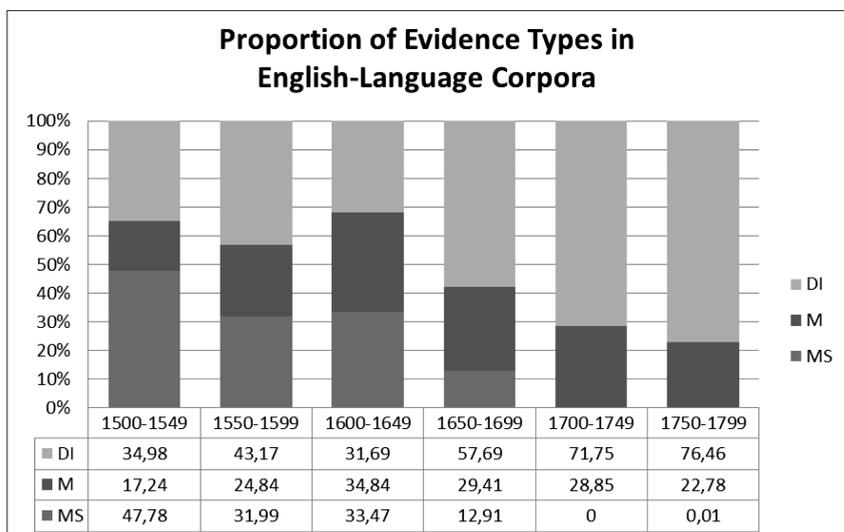|	1500-1549	1550-1599	1600-1649	1650-1699	1700-1749	1750-1799
DI	34,98	43,17	31,69	57,69	71,75	76,46
M	17,24	24,84	34,84	29,41	28,85	22,78
MS	47,78	31,99	33,47	12,91	0	0,01

Figure 3. Proportion of different types of evidence in the English-language corpora. Key: Mediated Scholastic Information (MS), Mediated Non-Scholastic Information (M), Direct Observation and Inference (DI)

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16   Mann-Whitney: $U = 183$; $n = 10$ (1500–1549), 49 (1750–1799); $p = 0.205$.
17   For a critical discussion of the notion of 'bad data' and the use of quantitative analysis on historical corpora, see Durrell (2015) vis-à-vis Labov (1992).
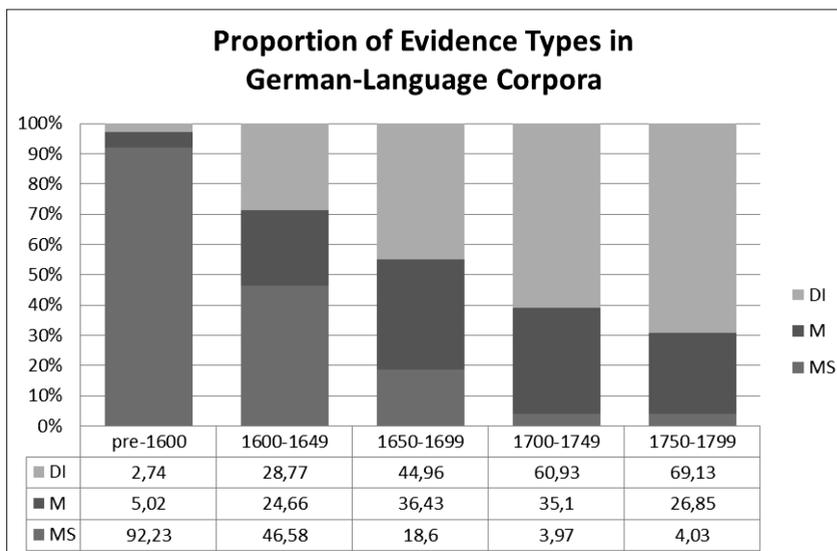
Figure 4. Proportion of different types of evidence in the German-language corpora. Key: Mediated Scholastic Information (MS), Mediated Non-Scholastic Information (M), Direct Observation and Inference (DI)

In both languages, the trend is clear: of all the evidential markers used in both corpora, the proportion of these dedicated to referring to information mediated by the *auctores* decreases steadily through the centuries. This is most starkly seen in the German data, although the abundance of such markers in the pre-1600 texts is admittedly due to the myriad references to classical authors in one text, the *Hortus Sanitatis* (1485), a compendium of herbs and herbal remedies. At the same time, the proportion of times authors point to their own observations and reasoning processes increases as drastically as references to learned authorities decreases: from 34.98% to 76.46% in English and from 2.74% to 69.13% in German. Regarding authors pointing to their contemporaries or hearsay as their source(s) of knowledge, there is a general proportional increase as well, although this is not as steady or drastic as for markers referring to observation and inference.

The waning influence of scholastic models of learning and knowledge transfer can also be seen in a qualitative analysis of some of the later uses of references to learned authorities. That is, the discourse context in which references to the *auctores* occurs is one of disagreement and criticism, rather than of acceptance (Gloning 2011, 322–326; Whitt 2016). This is also clear in the present data set, as seen in (12) and (13):

(12) *But this Rule is too general to be put in practice: 'tis true, as he **says**, that fat people, whose veins are generally small, and consequently cannot contain much blood, if they be drain'd of an indifferent quautity, will feel the inconveniences of the want of blood, or of a dispirited blood, very soon and fatally, by cachectical diseases and a Dropsie: Yet it is no less certain, that melancholy splenetick men, or women that are troubled with vapours, whose vessels are generally wide, and actually contain a great deal of blood, and by this Rule can spare the most; yet they, for the most part, can never bear so large a bleeding, even as those fat people we just now spoke of, and very seldom can endure the loss of ten or twelve ounces of blood without a sinking in their heart (as they call it) dimness of sight, or as it is expressively called by the French, une Defaillance des esprits; so that their overmuch comes sooner than that of the fat people themselves, which plainly contradicts this Rule.* (EMEMT: 1697_Cockburn_ContinuationOfTheAccountOfDistempers, William Cockburn, *A CONTINUATION Of the Account of The Nature, Causes, Symptoms and Cure OF THE DISTEMPERS That are incident to Seafaring People*, 1697, pp. 15–16)

(13) *Seneca **sagt** an einem Orte, den ich jetzt nicht finden kann: Fata non servant ordinem inter senes & juvenes. Dieses ist aber ein ganz falscher Satz, der hier seine Widerlegung finden wird, indem sowol Jünglinge als Alte nach Regeln der Ordnung sterben.* (GerManC: SCIE_P3_NoD_1761_Menschlich, Johann Peter Süßmilch, *Die göttliche Ordnung in den Veränderungen des menschlichen Geschlechts, aus der Geburt, dem Tode und der Fortpflanzung desselben*, 1761) 'Seneca says somewhere (that I cannot currently find): *Fata non servant ordinem inter senes & juvenes* [Fate does not sustain rank between elders and youth]. This is a completely untrue sentence which will be rebutted here, whereby both the young and the old die according to the rule.'

In contrast to the cases in (1) through (3), where learned authors are cited as definitive authorities on the topics under discussion, (12) and (13) demonstrate a more critical approach towards these authors. In (12), the physician William Cockburn takes critical stance on Hippocrates' advice concerning bloodletting (*'tis true . . . yet*), while in (13), Johann Süßmilch – an eighteenth-century demographer – openly disagrees with the sayings of Seneca (*Dieses ist aber ein ganz falscher Satz*). So even where the quantitative data reveal a decrease in the reference to learned authors, they do not show the changing discursive contexts that accompanied these changes. That is, the abandonment of the scholastic model was likely more drastic than the data in the figures show. Unfortunately space limitations (and the sheer amount of data in the corpora) preclude a thorough qualitative analysis, but the cases highlighted by (12) and (13) demonstrate the value of combining quantitative with qualitative analysis.

6 Concluding Remarks

This investigation has shown how the significant epistemological shift in Early Modern science from scholastic-based models of learning and enquiry to more empirical modes of investigation has a definitive linguistic realization in the domain of evidentiality. A combination of top-down and bottom-up corpus analysis has supported the hypothesis that a decline in the use of evidential markers signalling the words of the *auctores* would be complemented by an increasing number of evidentials indicating direct observation and logical processes. This holds for both English and, apparently, German (although the latter did not yield any statistically significant results relating to frequency changes, most likely due to less data being available). Of course, there are a number of desiderata resulting from this study. For one, an examination of the use of evidential markers in different writer-reader relationships would be interesting: some texts in the corpora are written for an audience of medical professionals, while others are geared towards a more general readership. Whether the discursive use of evidential markers differs across such texts is something that remains to be seen, that is, is the discourse surrounding the evidence, and the way in which this evidence is presented, different in varying author-audience relationships (as was seen in examples (1) through (3) vs. (12) and (13))? Some texts in the corpora are not original English- or German-language compositions, but rather translations from other languages; how the use of evidential markers in the source languages did or did not influence the choice of evidential markers in the translations versus original texts is a matter worthy of further investigation. Indeed, the study of language use and change within the history of science is a field full of possibilities and opportunities for new discoveries.

Appendix 1

Texts from the Bonn Corpus of Early New High German (*Bonner Frühneuhoch-deutschkorpus*) used in this study (in chronological order):

St. Gallen, Konrad von. *Naturlehre Mainau*. Late 1300s. (Blatt 293 recto A – Blatt 303 recto B), 6,036 words.

Cube, Johann Wonnecke von. *Hortus Sanitatis*. Mainz, 1485. (Kapitel 76 – Kapitel 123), 15,176 words

Brunschwig, Hieronymus. *Chirurgie*. Straßburg, 1497. (Blatt 13 verso A – Blatt 35 recto B), 18,481 words

Rauwolf, Leonhart. *Aigentliche Beschreibung der Raiß*. Lauingen, 1582. (S. 1–45)

TOTAL: 51,369 words

Texts from the German Text Archive (*Deutsches Textarchiv*) used in this study (in chronological order):

1600–1649

Valentinus, Basilius. *Von den Natürlichen vnnd vbernatürlichen Dingen*. Leipzig, 1603. ([1]0014 – 63/0076), 10,080 words

Weigel, Valentin. *Gnothi seauton. Nosce te ipsum. Erkenne dich selber O Mensch*. Neustadt, 1618. (73/0080 – 111/0118), 10,115 words

Crüger, Peter. *Cupediæ Astrosophicæ*. Breslau, 1631. (0055 – 0079), 9,795 words

Glauber, Johann Rudolf. *Furni Philosophici*. Vol. 5. Amsterdam, 1649. (1/0005 – 45/0049), 10,269 words.

TOTAL: 40,259 words

1650–1700

Czepko, Daniel von. *Sieben-Gestirne Königlicher Busse*. Brieg, 1671. (entire text) 6,299 words

Purmann, Matthäus Gottfried. *Der rechte und wahrhafftige Feldscher*. Halberstadt, 1680. (169/0209 – 240/0280), 10,862 words

Pinter von der Au, Johann Christoph. *Neuer, vollkommener, verbesserter und ergänzter Pferd-Schatz*. Frankfurt (Main), 1688. (0005 – 14/0020), 12,009 words

Siegemund, Justine. *Königliche Preußische und Chur-Brandenburgische Hof-Wehe-Mutter*. Cölln (Spree), 1690. (05/0052 – 38/0103), 10,829 words

TOTAL: 39,999 words

1700–1750

Böhme, Michael. *Kurtze doch bewährte Vieh-Artzney*. [s. l.], 1712. (entire text), 10,052 words

Muralt, Johann von. *Eydgnössischer Lust-Garte*. Zürich, 1715. (33/0065 – 89/0121), 10,053 words

Seip, Johann Philipp. *Neue Beschreibung der Pyrmontischen Gesund-Brunnen*. Hannover, 1717. (0269/249 – 0320/300), 10,197 words

Unzer, Johann August. *Gedanken vom Einfluß der Seele in ihren Körper*. Halle (Saale), 1746. (0031/1 – 0077/47), 10,243 words

TOTAL: 40,545 words

1750–1799

Kant, Immanuel. *Allgemeine Naturgeschichte und Theorie des Himmels*. Königsberg u. a., 1755. (0221/153 – 100[200]/0268), 10,534 words

Naumann, Bernhard. *Der aufrichtige Leipziger Roßarzt*. 1780. (11/0013 – 62/0064), 10,546 words

Gleditsch, Johann Gottlieb. *Vermischte botanische Abhandlungen*. Vol. 1. Berlin, 1789. (60/0072 – 110/0122), 10,316 words

Gall, Franz Joseph. *Philosophisch-medizinische Untersuchungen über Natur und Kunst im kranken und gesunden Zustand des Menschen*. Wien, 1791. (0018 – 48/0067), 10,404 words

TOTAL: 41,800 words

GRAND TOTAL: 162,603 words

Appendix 2

Below is a list of the 137 lexemes that were used in evidential constructions in the English-language corpora (individual counts are not included).

according	demonstration	persuade
account	deny	phrase
acknowledge	describe	plain
add	discover	preceive
admonish	divide	presume
advice	do	propose
advise	dream	prove
affirm	evidence	quote
agree	evident	read
allege	evidently	reason
answer	experience	receive
apparent	expound	recite
apparently	express	recollect
appear	find	record
appoint	follow	relate
apprehend	foresee	remark
as	gather	report
assert	give	represent
assertion	have	say
assure	hear	see
avouch	hearsay	seem
avow	hold	show
be	imagine	sign
betoken	imply	signification
bid	infer	signify
by	inference	speak
certain	inform	state
certainly	insinuate	suppose
certainty	insist	supposed
clear	interpret	supposition
command	inveigh	sure
communicate	judge	surely
complain	learn	suspect
conceive	maintain	take
conclude	make	teach
confess	manifest	tell

confident	mean	testify
confirm	mention	think
conjecture	note	token
consider	observable	understand
convince	observation	verify
counsel	observe	will
cry	obvious	wit
declare	occur	witness
decree	opinion	write
demonstrate	perceive	

Appendix 3

Below is a list of the 83 lexemes that were used in evidential constructions in the German-language corpora (individual counts are not included).

abnehmen	halten
andeuten	handeln
anführen	hinsetzen
Anmerkung	hören
Antwort	klar
Anzeichung	lauten
anzeigen	lehren
aus	lesen
ausdrucken	meinen
bedeuten	Meinung
befinden	melden
behaupten	mercken
bekennen	offenbar
bemerken	offenbaren
berichten	reden
bescheinen	Sage
beschreiben	sagen
Beschreibung	scheinen
bestätigen	schließen
Bestätigung	schreiben
Beweis	sehen
beweisen	setzen
bezeugen	sollen
dafürhalten	sprechen
deutlich	teilen

einleuchtend	überzeugen
einsehen	vermeinen
erachten	Vernunft
erfahren	verzeichnen
Erfahrung	wahren
erhellen	wahrnehmen
erkennen	wollen
erscheinen	Zeichen
ersehen	zeigen
erwehnen	zeugen
erweisen	zugestehen
erzählen	Zweifel
finden	
folgen	
Folgerung	
fühlen	
führen	
gedenken	
geweißsagen	
gewiss	
glaublich	

Data Sources

ARCHER	*A Representative Corpus of Historical English Registers*. Available via the Lancaster Corpus Query Processor (CQP): https://cqpweb.lancs.ac.uk/
Bonn	*The Bonn Corpus of Early New High German*. Available at: https://korpora.zim.uni-duisburg-essen.de/Fnhd/
DTA	*Deutsches Textarchiv*. Available at: http://www.deutschestextarchiv.de/
EMEMT	*The Corpus of Early Modern English Medical Texts*. Available on CD in Taavitsainen & Pahta 2010.
GerManC	*The German Manchester Corpus*. Durrell, M., P. Bennett, S. Scheible, R. J. Whitt, A. Ensslin. 2012. Available at: http://ota.ox.ac.uk/desc/2544

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