

## **B5 The frames and functional concepts of urine diagnostics from medieval to modern times**

### **1 General Information**

#### **1.1 Applicants:**

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#### **1.2 Topic**

The frames and functional concepts of urine diagnostics from medieval to modern times.

#### **1.3 Scientific discipline and field of work**

History of Medicine, Romance Philology, History of Science, Philosophy of Science, Comparative Linguistics, Romance Linguistics, Historical Linguistics

#### **1.4 Scheduled total duration**

Six years

#### **1.5 Application period**

Three years

## 1.6 Summary

Based on the hypothesis that it is possible to determine and visualize the structure implicit or explicit in medical texts by applying Barsalou's concept frames, the project intends to establish and standardize a method for examining shifting concept frames in the history of uroscopy and urine analysis from the 12<sup>th</sup> to the 19<sup>th</sup> century. The development of concepts, techniques, and practice will be investigated on both the lexical and the cognitive level comparatively for Latin, French, and German. The coexistence of concepts and concept shifts will be reconstructed from a synchronic and diachronic perspective. The influence of language and mechanization on the ontology of scientific paradigms in medicine will be analyzed by explicating concepts underlying texts with reference to their representation in the frame format.

## 2 State of the art, preliminary work

### 2.1 State of the art

#### 2.1.1 Scientific revolution, exact sciences and medicine

In the history of science studies on the formation of theories, their development and shifting paradigms – such as those developed by Thomas Kuhn (1922-1996) and other researchers – deal predominantly with the exact sciences like physics or chemistry.<sup>1</sup> It is evident that the conditions for thinking and working in medicine are structurally different from those in the exact sciences. For example, medicine's epistemological interest is not targeted toward the normal and the regular, but rather the abnormal, the pathological and deviations from the norm (Reckenfelderbäumer 1995). Furthermore, medicine calls for a clear distinction for the philosopher of science, since applied practical clinical work and the academic medical doctrine have to be seen separately. As a result, the identification and detection of paradigmatic regularities in medicine are more difficult than in other academic disciplines. Above all, the application of Kuhn's theory posed a number of obstacles in the past (Diemer 1977).

For one of Kuhn's precursors, the Polish bacteriologist and philosopher of science Ludwik Fleck (1896-1961), the heterogeneous character of medical work and the formation of medical theory offered a decisive advantage, specifically with regard to the development of his concepts of "thought-collectives" and "thought-styles". The philosopher Lothar Schäfer asserted that the correlation between theoretical-experimental and therapeutical-practical objectives in medicine can demonstrate the co-operative collective character of scientific research more explicitly than in physics and chemistry. This is why the physician Fleck emphasized these collective elements in scientific practice (Schäfer 1983:12). A broad reception of Fleck took place subsequent to the debates about "paradigm shifts", which

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<sup>1</sup> Several works have recently been published on Kuhn's works and concept. Cf. Marcum (2005); Nickles (2003); Dietze (2001); Fuller (2001); Bird (2000); among the older books that are still very important the one by Hoyningen-Huene (1989) deserves special consideration.

Thomas Kuhn launched. Recently the Fleck reception has been revived, focussing almost exclusively on the discourse surrounding Fleck's theory of science.<sup>2</sup> Only a few authors have resorted to Fleck's theorems for their own studies (cf. van den Belt 1997; Fangerau, Müller 2005:153-168).

### 2.1.2 Scientific revolution and language

Fleck's explications on the language of science, which are of utmost relevance for the topic at hand, have only been dealt with superficially so far. The 'circle of Vienna' (Stadler 1997) had developed a theory of science that was postulated on the possibility of the strict empirical verifiability of scientific statements. Fleck contradicts this postulate by questioning the factual terms underlying logical positivism, which assert that the empirical perception of sensations and their unambiguous transformation into sentences could represent the foundation of science (Neumann 1989:12-25). He counters that the formation of terms has its own particular history and is based upon cultural historical requirements, that the term is essentially the result of intellectual processes carried out under certain historical and social prerequisites (Neumann 1989:15). Fleck warns against approaching historical scientific works using contemporary scientific theories, because we involuntarily assume that the words denote contemporary contents. Furthermore, due to a number of influences,<sup>3</sup> terms change continually. Fleck claims that terms should certainly not be regarded as separate building blocks existing on their own, which also incite specific thoughts. Naturally, we are only able to isolate concepts *ex post* from this thought, or more specifically, from a permanent process of thought. Yet, isolated terms show a specific bias characteristic for the given thought style.

Thus, terms or conceptual contents change during the course of time in keeping with the semiotic context: A coded message is transmitted from a sender to a recipient, in order to be decoded. This concerns basic terms such as "warmth", as well as any linguistic transmission of scientific information. According to the American medical historian John Harley Warner, scientific-linguistic behaviour was only one of the parameters for the interaction between physician and patient. Consequently, he recommends examining the use of scientific language in medicine under specific cognitive settings: "Yet especially as historians pay more and more attention to medical use of the language of science, it becomes increasingly important to understand how this language was heard and interpreted by the laypeople to whom it was directed, for it was they, after all, who held the power to translate that language into cultural authority."<sup>4</sup>

Significant in medicine is the verbalization of a disease concept, the meaning of which is elusive in *two ways*. On the one hand, it does not describe a condition but a process. On the

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<sup>2</sup> Fleck's theories had been almost unknown until Kuhn referred to them in his work. Since that time the value of his theory for epistemological questions has been well-received. See for example: Schnelle (1982); Tsouyopoulos (1982:20-36); Cohen, Schnelle (1986); Dorobinski (1987); Löwy (1988:133-155); Neumann (1989:12-25); Löwy (2004); Egloff (2005).

<sup>3</sup> Changes of language are for example triggered either by non-scientific cultural effects, by politics (cf. for French Corsi 2005) or by scientific developments like the formation of (sub)-disciplines, shifting thought styles or paradigm shifts.

<sup>4</sup> Warner (1995: 172) emphasizes that different "groups" of physicians (e. g. "elite surgeons") use idiosyncratic ways of speaking, for instance as means of creating distance or to affirm of their status. Cf.: *ibid.* p. 170.

other hand, concepts of disease and the entities involved undergo considerable changes during the course of time (Höfler 1970:1184-1190). This “cognitive historicity” can also be applied to medical semiotics and diagnostics and the choice of terms in different languages.

### **2.1.3 Medical semiotics and diagnostics**

In the research literature on general semiotics, medicine is frequently referred to as one of the oldest “academic” systems of signs (Seboek 1979; Trabant 1996). Although medicine can look back on a long tradition of semiotic doctrines of interpreting signs, one which had its heyday in the 18<sup>th</sup> century, interpretive conventions became obsolete in the early 19<sup>th</sup> century. The medical semiotics used prior to the 19<sup>th</sup> century should not be regarded as a preliminary stage of the modern theory of diagnostics. Rather, it is both a comprehensive and independent conception and cannot be related to contemporary endeavors in the development of diagnostic theories (cf. Hess 2003: 21f.).

Based on humoral pathological conceptions, the Hippocratic doctrines of reading physical signs mainly served prognostic purposes. The observation of bodily functions, such as respiration, temperature, pulse, unusual sounds and odors, posture and facial expression, skin condition and excretions were central. In the Byzantine and above all in the Arabic-Islamic medieval reception of antique medicine prognostic semiotics was subtly differentiated and was eventually developed into detailed doctrines of interpreting signs. For example, urine was held to be one of the most important signifiers until the 19<sup>th</sup> century. As early as 1400 more than 20 different colors, many grades of fluidity, odors, flavor characteristics and a multitude of discernible ingredients could be classified (Eckart 1996).

Among others, Michael Martin could show that with the emergence of physical diagnostic methods (auscultation, percussion, acouphonia, spirometry, thermometry) and chemical-analytical diagnostic methods (polarimetry, colorimetry, saccharimetry etc.) 18<sup>th</sup> and early 19<sup>th</sup> century historical-philosophical semiotics lost their importance (Martin 2007). Clinical medicine followed the trends underlying mechanization and modernization. A *paradigm shift* involving a new form of semiotics took place, which was no longer semiotics in the former sense, but a “scientific” (quantitative and mechanistic) phenomenology of disease. The new measuring procedures, which were now validly reproducible, did not require a philosophical semiotic superstructure. The focus was on measured values and their visualization in charts. The practice constituting clinical diagnostics involved the systematic analysis of determinable expressions of the body (Eckart 1996). This development also affected the analysis and interpretation of a patient’s urine as a measurable, quantifiable expression of the body (cf. Büttner 2002).

### **2.1.4 Uroscopy and language**

Uroscopy, the observation and analysis of urine, is regarded as the characteristic activity of late medieval to early modern physicians, which has been documented in the arts and literature. Exceptional conditions of the urine suggested exceptional physical conditions. The “matula” (urine glass) – similar to today’s stethoscope – became the distinguishing instrument for the physician’s activity (Connor 2001; 2002). In the framework of a multidimensional quality spectrum urine developed into a “sign of disease” and a signifier of physical

conditions in academic medicine (Eckart 1996; Gazzaniga 1999; Angeletti 1999). Medical historians agree that between the 16<sup>th</sup> and 20<sup>th</sup> centuries uroscopy reached such a high degree of popularity as a medical prognostic and diagnostic method that it was also applied by various non-academic healers (Stolberg 2003:90, 101; 2007). At the same time, the term “urine prophet” (*Urinprophet*) (Grimm & Grimm 1999) served as a deprecatory term for “quacks”. As a result, since the Late Renaissance medical science had been keen on developing a conclusive nosological interpretation of a patient’s urine.

Urosopic techniques and methods were international methods, which in their respective national context were not only practiced but also enhanced, adapted and altered. In the course of the development of national scientific languages (Pörksen 1986; Habermann 2001; Keil 1997), various translations of Latin texts on uroscopy as well as translations among the vernacular languages were generated. Accordingly, a transfer of knowledge between cultures was fostered.

The German language in written form, much like French, can be traced back to the 8<sup>th</sup> and 9<sup>th</sup> centuries (Riecke 2003; Berschin et al. 1978). As of the 12<sup>th</sup> century initial translations of religious, scientific, legal and medical texts in Latin began to appear (Schnell 2003; Keil 1963). From this time on specialized vernacular languages can be observed in different disciplines. In the 14<sup>th</sup> century medicine and surgery in particular experienced a large increase in vernacular texts. In the 14<sup>th</sup> and 15<sup>th</sup> centuries the vernacular languages were consolidated. The comprehension of the new vocabulary was also secured by applying synonyms. From the 16<sup>th</sup> to the 18<sup>th</sup> century the vernaculars considerably expanded their communicative range and finally invaded Latin strongholds, such as university medicine. Nevertheless, after a symbiotic phase the replacement of Latin by vernacular languages in printed publications also took place at that time. For example, from 1681 on book production in German prevailed over its counterpart in Latin (Hartweg, Wegera 1989). In keeping with the systematic development of the sciences in the 18<sup>th</sup> century a consolidation of the vernaculars could be observed. In the 19<sup>th</sup> century this systematic development was continued by adopting Greek-Latin neologisms (root and ending).

As far as urosopic texts are concerned, the interpretation levels and examination techniques of uroscopy became central topics of medical literature and textbooks, which had been printed as compendia in German and French since the early 16<sup>th</sup> century.<sup>5</sup>

### **2.1.5 The historiography of uroscopy, urine analysis and technology**

Several works have been published on the history of uroscopy and urine diagnostics (cf. Neumann 1894; Christoffel 1953; Wüthrich 1967; Bleker 1966; Bleker 1972; Konert 2002); thus, the field seems to be well explored. However, most of the older works adhere to a positivistic understanding of historical developments. Only very few works include aspects that have an influence on paradigm shifts, such as technological developments or processes of increasing professionalism (Voswinckel 1993; Büttner 2000; 2002; Stolberg 2007). Urosopic concepts underwent several paradigm shifts, from their integration into humoral pathology

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<sup>5</sup> English became the language of science not before the 20<sup>th</sup> century and did not play such a prominent role in the history of uroscopy of that time.

during antiquity and medieval times until the iatromechanics of the 19<sup>th</sup> century. At the same time, the development of uroscopy reflects the influence that “techniques” had on the promotion of concepts. It seems to be one of the few disciplinary fields in medicine that underwent “mechanization” from its inception, extending from early tools like the “matula” or color circles to complex apparatuses like polarimeters or colorimeters.

Critical descriptions that do justice to the complexity of the topic at the interface between medicine, natural sciences and technology and with respect to the cognitive paradigm shift or changes in styles of thought are rare. This desideratum is astonishing, since “uroscopy” in its modern shape of “urine diagnostics” is still one of the most important diagnostic tools in medicine. Whereas other routine diagnostic techniques, among them the application of stethoscopes, spirometrics, the measurement of blood pressure etc. were not developed before the 19<sup>th</sup> century, uroscopy draws upon a long tradition that harks back to antiquity. Neither works on the history of uroscopy<sup>6</sup> nor works on the history of medical technology document this aspect.<sup>7</sup> By contrast, the influence of chemistry and physics on the analysis of urine has been better explored. Good introductions to the topic have been published by Ebstein or Haber<sup>8</sup>; outstanding are Johannes Büttner’s studies, whose investigations of laboratory diagnostics also encompass the development of chemical urine analysis (Büttner 1991; 2000; 2002; 2003).

With respect to the development of clinical chemistry, there are several important reference works: an anthology, an exhibition catalogue as well as an article by Kruse-Jarres. These, however, deal primarily with the developments that occurred during the 20<sup>th</sup> century (Büttner 1982; Büttner, Habrich 1987; Kruse-Jarres 2005). Scattered references can also be found in biographical studies on the protagonists in the field (Grund 2002; Kernbauer 2002) or in textbooks on the history of chemistry. As a rule these deal only marginally with technical developments and hardly ever with the medical application of laboratory techniques originating from chemical science. This also applies to the standard work by Holmes and Levere, which investigates the technical aspects of experimental chemistry (Holmes, Levere 2000; Morris 2002), and Meinel’s works on the development of the chemical laboratory (Meinel 2000; 2003). Joel D. Howell has published a case example on the clinical development of urine analysis in two American hospitals between 1900 and 1925 (Howell 1995). So far, detailed descriptions of individual techniques or instruments are lacking (Davis, Merzbach 1994; Warner 2006).

All in all, investigation of uroscopy provides the unique opportunity of analyzing the implementation of new ideas and techniques into language as well as the interaction of language and concepts. A detailed analysis combining the cognitive and the linguistic level has not yet been carried out. Theories derived from the philosophy of science could also serve as heuristic guidelines to use the example of uroscopy for cognitive and lexical analyses.

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<sup>6</sup> In most books we only find gem cutting and endoscopy as central themes, cf. Konert (2002)

<sup>7</sup> The most detailed descriptions are given by Reiser (1978) and Keele (1963:67-73)

<sup>8</sup> Ebstein (1915); referring to the development in early-modern times: Haber (1988); as for the early 19<sup>th</sup> century also cf. Kausch (1968).

### 2.1.6 Analysis and visualization of scientific changes on a cognitive level

It has been shown that the transition from one uroscopic concept to another took place either in paradigmatic disruptions and rapid shifts or in slow adjustments (e.g. Voswinckel 1993). The application of scientific theoretical approaches to this field is only just beginning. Above all, approaches that include cognitive changes have not been pursued, since they have also received little attention in other fields pertinent to the history of science.

Besides manifold modern social constructivist approaches (Latour 1986: 1-40; 1987; 2005) – which have succeeded in explaining disruptions and shifts for the exact sciences, though rarely for medicine – only a few studies on the cognitive changes within the development of knowledge have been published. These works generally follow Kuhn's approach, who while describing paradigm shifts in his later works has pointed out incommensurabilities of knowledge on the level of concepts in various theoretical approaches ("schools", "disciplines"). Conceptual incommensurabilities call for cognitive solutions: According to Kuhn, scientists representing divergent traditions construct incompatible taxonomies; and on the basis of incompatible philosophies of life they classify the world so differently that they are unable to communicate with one another.

For the analysis of the cognitive mechanisms behind these incommensurabilities, Chen, Barker and Andersen (Chen [Xiang] 2003; Andersen, Barker, Chen 2006) have adopted a model from cognitive psychology, which attempts to explain the organization of knowledge in the form of frames (Barsalou 1992). According to the dynamic cognitive-psychological frame model that Lawrence Barsalou developed, frames are representation formats for various forms and fields of knowledge.<sup>9</sup> Frames can be established for simple everyday contexts as well as for complex systems.<sup>10</sup> However, frames are never solitary or isolated but always incorporated into frame networks. Much as they represent models and formats of knowledge, they can also be used to organize information.

Chen has been able to prove that some of the incommensurabilities between concepts in a diachronic perspective are also caused by ontological differences between object and event concepts, between spatial and temporal concepts. Blending these two levels leads to a *perception* of incommensurabilities that hides continuities (Chen [Xiang] 2003). Even more precisely, Chen and Barker describe the validity of the gradual shift of thought styles, as postulated by Fleck, by pointing out – by availing themselves of Barsalou's frame model – lines of continuity in the historical transformation of taxonomies (Chen, Barker 2000:208-223).

In contrast to the visualization of paradigm shifts by means of citation analyses, which are able to encompass greater periods of time (Chen [Chaomai] 2003), Chen and Barker have based their findings and visual representation on only very select examples. Systematic empirical testing of their hypotheses, such as Fleck has carried it out examining the historical development of the Wassermann reaction, has yet to be done. Furthermore, their study does not include different languages. It should also be emphasized that Chen and Barker have only

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<sup>9</sup> The term "frame" was invented by Marvin Minsky, who introduced it into research on artificial intelligence in his most influential study „A Framework for Representing Knowledge“ (1975). Cf. also: Minsky (1990).

<sup>10</sup> This holds true for texts of any type; cf. Holly (2001); for linguistics cf. Konerding (1993).

applied the frame method to exact sciences. Transferring the method to medicine as an empirical science and to the history of medicine has only recently been initiated by the applicants. The same is true for an analysis of the development of uroscopy with respect to linguistic development, language transfer and scientific shifts of thought style. Also the influence that translations have on this process or on scientific revolutions has not yet been examined. Specifically, the method of visualization using frames has not been applied to the areas of analysis.

To conclude, a text based study, which reconstructs texts in frames without presupposing current knowledge or structural invariants, is lacking as well as a study that examines the role of functional concepts in the development of knowledge (Löbner 1979). Our project aims at closing this gap. Applying Andersen's, Chen's and Barker's examinations and their method to uroscopy while retaining Kuhn's and Fleck's theories the hypothesis can be verified as to whether and at which points in the historical development of uroscopy scientific revolutions, shifts in thought style or even continuities occurred. Thus, our project has implications for the history of medicine, for the philosophy of science as well as for linguistics.

## **2.2 Preliminary work**

The first applicant, Heiner Fangerau, is a qualified historian of medicine whose research combines the history, theory and ethics of medicine. He has also investigated the history of medical paradigms, the history of medical ideas and medical diagnostics. His habilitation examines the development and dissemination of the biomedical paradigm under the influence of the German-American physiologist Jacques Loeb around 1900. This study includes questions of the mechanization of medicine and questions concerning paradigm shifts.

In conjunction with the second applicant Hans Geisler Heiner Fangerau has been responsible for a project funded by the DFG under the framework of the research group FOR 600. For the past two years this project has examined frames and functional concepts in uroscopy as of early modern times. Its primary focus is on how to construct frames for medical history purposes and on the functional concepts in uroscopic language.

The co-applicant Hans Geisler is a well-recognized Romanist. He has worked on the typological development of the French language and used the frame-theoretical approach for research on the history of words. Since 2005 Hans Geisler and Heiner Fangerau have developed synergies within the project, which have led to subsequent co-operations as well as grant proposals on "classification and evolution in language and the history of medicine and biology" or "representations on aging in commercials: their semiotic and historical contexts". Both applicants hold regular meetings and co-supervize all of the individual tasks stipulated by the project agenda on functional concepts and frames in uroscopy. Tasks initiated under the aegis of this undertaking serve as preparatory studies for the project being applied for.

### **2.2.1 Text corpus**

The large body of primary literature on uroscopy in French and German from the 12<sup>th</sup> to the 19<sup>th</sup> centuries has been investigated and bibliographized. During this process several problems

had to be overcome. It is nearly impossible to survey the substantial amount of literature, since bibliographies on the issue were not available. Research on older works using electronic resources proved to be ineffective. Therefore, time-consuming investigations in library catalogues, medical bibliographies and other printed resources had to be undertaken, in order to retrieve relevant authors and titles.

The literature found was categorized thematically and conceptually. Adopting Ludwik Fleck's theories on different categories of medical and scientific literature we developed a model to classify the material according to its character and the intentions of the authors (Martin, Fangerau 2006a). According to Fleck the different social strata within scientific thought-collectives employ different means of communication. Whereas esoteric specialist-knowledge is communicated through scientific journals and the knowledge of general specialists is documented in scientific textbooks, information for laymen is generally found in popular books.

In order to manage the large amounts of analyzable material, we decided to include works representing contemporary "state of the art"-uroscopy in our text corpus. Journal articles were excluded. Only texts reflecting canonized knowledge in the form of textbooks and handbooks for medical specialists and general practitioners were included. Popular treatises were incorporated when they demarcated the borderline between academic medicine and the medical penumbra in urine analysis (e.g. Brockliss, Jones 1997).

Although some of the texts are only available through international libraries, we contacted the historical archive of the German society for urology (Deutsche Gesellschaft für Urologie), which will allow us to access to their archival holdings of rare books. The material in French and German had to be verified for compatibility, since the book titles alone did not provide adequate data. Thus, we were able to collect a significant corpus of French and German texts to meet our project's purposes (see chapter "methods", "Text Corpus"). Furthermore, a first selection of Latin texts for the proposed project has been added.

### **2.2.2 Frames and texts**

First frames for texts have been constructed and the frame model has been successfully applied to exemplify major paradigm shifts in uroscopy. A paper was given at the Fachkongress der "Deutschen Gesellschaft für Urologie" (Martin, Fangerau 2006) and a respective manuscript was published in the most important German journal on urology "Der Urologe" (Martin, Fangerau 2006b). Similarly, our approach to applying frame analyses to comparative studies on French and German texts has been introduced to an international audience of linguists (Martin, Zaun 2007) as well as to an interdisciplinary audience of philosophers and historians of science, neuroscientists and cognitive psychologists (Fangerau, Geisler, Martin, Zaun 2007).

A method for a standardized frame analysis of textual sources has also been tested. Questions arising on the level of frames include the visualisation of events, structural invariants, constraints etc. The translation of color terms into French and German or the development of verbs into functional concepts has also been considered on the lexical level (Zaun in press). An interdisciplinary workshop entitled "The scientification of medical observation – verbal mediation of science" was organized and conducted on 2 March 2007 in Düsseldorf. The proceedings are being prepared for publication.

### 2.2.3 Mechanisation and frames – preparatory study

We studied the influence of new technologies on the development of urine analysis and presented our results to an audience of specialists (Martin, Fangerau 2007; Martin 2007). As we intend to examine the influence of mechanization processes on the lexical level and on the structural level of frames the preparatory study that follows below serves as an excellent example of how conceptual shifts cause lexical as well as conceptual changes. We will briefly display conceptual shifts in relation to diabetes and their representations on the lexical level:

#### *Preparatory study on conceptual shifts in connection with diabetes*

Since antiquity medical semiotics had been based on signs solely accessible to the physician's sensory perception. In the 19<sup>th</sup> century the spectrum of signs was extended by using new techniques and instruments as well as chemical analytical procedures. Transferring technoscientific methods to the medical area led to a paradigm shift: *qualitative* signs, which had been adequate for "humoral pathology" or the "doctrine of qualities" (Qualitätenlehre), were by no means sufficient for epistemological investigations based on *quantifiable* data. Traditionally oriented physicians showed a lack of understanding or even disapproval for the new "iatrotechnic" methods. Only very slowly were they willing and able to adjust to a *semiotic turn*, i.e. the increasing replacement of linguistic signs by abstract signs.

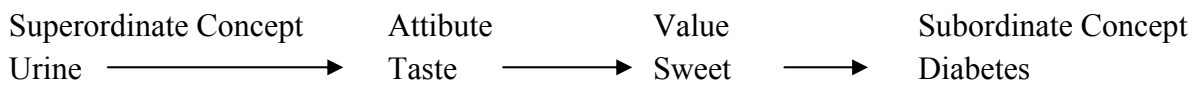
Figures 1 and 2 represent this conceptual shift schematically and an exemplary urine frame. Frames are hierarchical structures which can embody multi-level hierarchies. For our purposes we consider "urine" to be the superordinate concept, which has to be extracted from texts and represented in the frame format. However, "urine" itself is a subordinate concept of the full semiotic, prognostic or diagnostic frame related to the patient (the relation of super- and subordinate concepts in scientific conceptual structures has been described by Andersen, Baker and Chen 2006).

Specific attribute-value sets of the urine-frame highlighted by constraints signify a subordinate concept of the urine-frame, which is initially nothing more than a multi-attribute-value constellation. If this constellation, which is caused by constraints, is given a specific name, it can – as a subordinate concept – have take on the character of a diagnostic finder, a disease, a prognosis or a diagnosis. It can also be simply described as a constellation of attributes and values. In this case, structural invariants determine its character as a diagnosis, a disease etc. In the following and for the purposes of our project we will focus on the change of attribute-value constraints and hierarchy violations to evaluate concept changes in the results and interpretations of urine analyses.

Figure 1: Schematic display of the concepts “humoral pathology” and “iatrotechnics”. Example for urine-frames using these concepts as structural invariants.

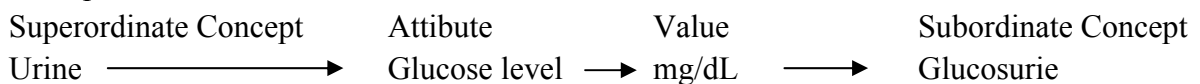
Concept	cause of disease	Methods	Uroscopy
Humoral pathology	Condition of body fluids	Holistic	steady state
		Subjective	Physician
		physical sensations	see, taste, feel...
		qualitative signs	adjectives: sweet, yellow etc.
		Status – Prognostics	Dyskrasie

Example:



Concept	cause of disease	Methods	Uroscopy
Iatrotechnics	physico-chemical processes	Localistic	kidney, bladder, urinary tract
		Objective	Physician, techniques
		Measuring	Polarimeter, Saccarimeter...
		quantitative data	Numbers, curves
		Values (>15mg/dL)	Status – Diagnostics

Example:



Originally, an adjective was used when examining urine for its “sugar” content; in the 17<sup>th</sup> century Thomas Willis described its taste as “sweet”. In 1776 Matthew Dobson succeeded in chemically detecting sugar in urine on the qualitative level: either it was present (positive) or absent (negative). An initial semi-quantitative test (“more” or “less”) was developed in 1858. Subsequently, polarimeters as mechanistic measuring instruments for quantitative analyses of sugar became available. Thus, the beginning of the historical process was marked by the sensory impression “sweet taste”, which was replaced by instigating chemical reactions, such that the change in color of the test solution indicated the existence of a sugar substance in urine. At the end of the process exact measuring methods have been instituted. Finally, the polarisability of light was used in analytical chemistry to measure the concentration of solutions with optically active substances. Saccharimetry is a method for determining sugar concentration. Sugars are optically active compounds, because they contain asymmetrical carbon atoms. Concentrations are determined by by measuring the specific torsion angle in polarimeters and are expressed numerically (e.g. g/litre).

Table 1: Schematic overview *diabetes mellitus* – conceptual and technical influences on the diagnosis (see text above)

Concept	Period / Author	Pathophysiology	Signs, Production of signs
Humoral pathology	Antiquity / Galen	Fluids not “cooked” Body as a pass “Harnruhr”	Color, Consistency
Iatrochemistry	16 <sup>th</sup> century / Paracelsus	“Vitiated” blood caused by salts and sulphur	Distillation
Humoral pathology / Iatrochemistry	17 <sup>th</sup> century / Willis	Harnruhr / precipitation of salt and sulphur in the blood	Taste
Iatrochemistry / Clinical Chemistry	18 <sup>th</sup> century / Dobson	Chemical verification of “sugar” in urine and blood serum	Evaporation / qualitative result
Clinical Chemistry	19 <sup>th</sup> century, 1 <sup>st</sup> half / Berzelius / Heller ...	Chemical analysis of urine	Verifications, tests / quantitative results
Clinical Chemistry	19 <sup>th</sup> century, 2 <sup>nd</sup> half / Bouchardat / Schönlein ...	Chemical-technical analysis of urine	Polarimetry etc. / quantitative results

The transition from sensory impressions in medical investigations to processes based on scientifically produced physical data took place incrementally. Characteristic is thus the coexistence of contrasting paradigms for extensive periods of time. This phenomenon is not unusual for medicine, where paradigms and concepts that change in the course of time compete against one another or ignore each other. Decisive for the acceptance of certain views or procedures are parameters like usefulness, effectiveness, ability to solve problems as well as issues involving the educational system, health care system or power structures.

The frame theory, which has only been applied within the exact sciences, will be transferred to the area of medicine, in order to record these processes. Accordingly, the project proposes to examine different representations of frames as well.

### 3 Goals and work schedule

#### 3.1 Goals

Frames as an organisational format and a visualization of knowledge conceptualisation are to be applied, in order to trace shifts in style of thought and paradigm shifts in the field of medicine on the linguistic level. Questions regarding concept changes on the level of constraints as well as on the level of attributes and values are to be explored. On the one hand, changes and developments in diagnostic and prognostic concepts can be determined on the

level of constraints; on the other hand, introducing new technologies necessarily leads to modifications on the level of attributes and values. Changes of attributes and values, however, do not always result in changes of the whole superordinate concept. This has to be relinquished when these changes affect hierarchical principles of frames (see “Methoden”, “Examination of the incommensurabilities in collocated frames”, p. 18). The following hypothesis has been proposed: concept shifting is initially accompanied by attempts at harmonisation (Fleck 1980: 40-53). The questions to be addressed are whether new terms and values become integrated into existing frames when the structure of attributes and values becomes more complex or whether foundational constraints are gradually or immediately dissolved.

The project will pursue three closely interwoven queries, all of which hinge on the superordinate problem of the applicability of the theory of frames to the development of concepts in medicine.

a) The question has been raised as to what extent technical achievements and innovations influence changes within frames and how these are represented on the linguistic level. Central to the investigation is how alterations in frames exert influence on frame structures, leading to the violation of regularities in conceptual frames and a possible change in concept. The transition from qualitative to quantitative methods, for example, has serious effects on theory and practice, techniques and methodology, as well as the semantics used within the discipline. The influence of mechanization on urine analysis can be found on lexical levels (meaning of words, internal structuring of the vocabulary) as well as on sentence structures, textual semantics or areas of discourse. Furthermore, technical terms (aerometer, polarimeter, saccharometer) emerge, which reflect new measuring procedures and value categories (specific weight: p/ml; blood sugar: mg/dL). Adjectival terms are increasingly replaced by numerical values. Subjective descriptions of phenomena (“Gewölk”, “Körnchen”, “Flockige Materie” as “substances in the urine”) are replaced by exact nomenclatures or neologisms (“urophein”, “uroxanthin”, “phosphates”). Previously unknown components are made “visible” by applying technical or chemical procedures. As a result, the arsenal of “signs” is enlarged. Finally, with the “birth of the clinic” in the 19<sup>th</sup> century, laboratory and practical patient care converge. In the search for objective symptoms, chemical-analytical, physical-technical and microscopic methods come to the fore. The phenomena and signs observed become symptoms marked by increasing levels of exactness. For example, a sweet taste of urine in older texts, becomes a precisely defined “glycosuria”, because per definitionem “glycosuria” leading towards diabetes mellitus is diagnosed if the concentration of glucose in urine is higher than 15 mg/dL (see chapter “Preliminary work”, “Mechanisation and frames – preparatory study”, p. 10).

b) Furthermore, questions arise concerning the influence that the translations of specific terms have on concept structures. Do frames and the constraints between values and attributes represented in them, which mostly characterize prognoses or diagnoses, undergo a change which is triggered on the linguistic level? With respect to the proposed project this question will be examined for the translation process from Latin into the German and French vernaculars as well as for translations between German and French.

The two corpus languages German and French are relevant for the selected period of time (1100-1900). This is evident in the overlap of publications in both languages. On the one

hand, translations were made from the traditional scientific language Latin into French and German. On the other hand and in direct contradiction to Klare (1998), an inner-vernacular cultural transfer took place between French and German: The *Miroir des Urines* by Davach de la Rivière was reprinted five times in its original language (1700, s.a., 1722, 1752, 1763). It was translated into German in 1744 and published as the *Wohlgegründeter Urinspiegel*. The second edition in German appeared in print after the last French edition (1777). More than one and a half centuries later Nicolas Philibert Adelon's *Dictionnaire de Médecine* (1821-1824) served as a model for Ludwig Meissner's *Encyclopädie der medicinischen Wissenschaften* (1828-1830).<sup>11</sup> Inversely, the standard work by Neubauer and Vogel (1853) was also translated into French several times.

In France and Germany pioneering discoveries in the field of uroscopy took place during the period under scrutiny. For example, urea ( $\text{CH}_4\text{N}_2\text{O}$ ) as a substance was discovered by Hilaire Rouelle in 1773 in France and artificially synthesized for the first time by Friedrich Wöhler in 1828 in Germany. Consequently, the corresponding publications were in French and German. Also the first modern analyses of human urine were carried out by the French chemists Louis-Nicolas Vauquelin and Antoine François de Fourcroy.<sup>12</sup>

c) Moreover, questions concerning the extent to which texts on uroscopy and urine analysis published at the same time show one or several urine concepts have to be posed. Can one paradigm for the analysis of urine by frames be extracted from one and the same text or do individual texts or texts published simultaneously evidence a variety of paradigms? Given the co-existence of a standard approach to academic medicine and pluralistic medical practices well into the 19<sup>th</sup> century this question is relevant for determining the sequence of concept change. Of central interest is how long it takes for an academic concept to be incorporated into practical medicine and to what extent the practical data conceptualized in frames equals or differs from academic facts.

The social historiography of medicine has documented that various healers with divergent concepts competed against one other in the health care market during the period between the 16<sup>th</sup> and 18<sup>th</sup> centuries, (Mc Cray Beier 1987; Pelling 1985; Pelling 1986; Porter, Porter 1988; Ramsey 1988; Stolberg 2003). Besides orthodox approaches supported by academic medicine, which followed the dogma of humoral pathology, there was room for healers from other schools (the medical penumbra). They worked as barbers, salespersons or as healers. Wealthy patients used this competitive situation to purchase therapies in accordance with their notions of health and disease. This meant that physicians needed both professional and commercial skills, since they had to market frequently unpleasant therapies, which involved cupping, blood-letting and clysterizing. Non-academic physicians, on the other hand, had to compensate their lack of academic honors by travelling around and advertising unorthodox methods. All these groups of healers used uroscopy and urine analysis, a circumstance which elicits questions concerning comparative analyses of concept frames and the inner-textual coexistence of competing concepts.

Furthermore, it should be observed as to whether different paradigms were integrated

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<sup>11</sup> Cf. also the standard work by Becquerel in French 1841 and in German 1842.

<sup>12</sup> An account of the most important persons for the development of urine diagnostics can be found in Büttner (1991:8-10)

into frame concepts by one and the same author with full acknowledgment of the multiplicity of paradigms. For example, Lazare Meyssonier's French translation of Hippocrates' aphorisms (1668) is based on three paradigms. The author uses the discovery of blood circulation (paradigm 1) by William Harvey in 1628 as an impetus to re-translate a historic text, the ancient Hippocrates aphorisms (paradigm 2). However, he explains them from humoral pathological background, which excludes blood circulation (paradigm 3). The problem of how and in which form authors or translators reflected the competing paradigms that their texts were based on needs to be addressed.<sup>13</sup>

### 3.2 Methods and work schedule

The superordinate goal of the project is the utilization of the cognitive frame concept for medicine as an applied, empirical, and non-exact science. Concepts on uroscopy and urine analysis deduced from medical texts are to be transferred into frames. Concept-frames extracted from texts on urine analysis, which were published in Latin, German and French (from the first uroscopic texts in the vernacular languages until the 19<sup>th</sup> century) are to be analyzed by diachronic comparison. Consequently, four points can be listed, interpreted and made available for further examination:

- 1) concept changes similar to paradigm shifts,
- 2) shift of emphasis in frames leading to concept changes,
- 3) dissolution of constraints resulting from the integration of new values and attributes in frames and
- 4) the increase and disappearance of variables in frames.

The emphasis has been placed on three aspects in the development of uroscopy, all of which have not been investigated at any great length and which will be a central focus of the project being applied for.

- a) On the one hand, the goal is to examine the influence of mechanization on concept changes, constraint dissolutions and shifts in frames. The expectation is to show how technical innovations lead to linguistic changes, which themselves contribute to the dissolution of thought structures inherent to the concept frames
- b) On the other hand, the project aims to reveal vernacular influences and the effects of translations on the alterations to the concept frames. It will be demonstrated how the language shift from Latin to German and French led to a change of concept frame structures in the field of uroscopy. Latin, German and French texts will be compared and contrasted with each other synchronically and diachronically. The attributes and values represented in uroscopy frames are to be examined with the consideration of how translations contributed to establishing new forms of knowledge and dissolving old truths.
- c) Finally, synchronic comparison will be used to analyze whether incommensurable concepts on uroscopy can be found in one and the same text or in different texts. The status of academic knowledge on uroscopy in concept frames is compared to practical applied

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<sup>13</sup> If they are reflected e. g. in para-texts like introductions or commentaries or not at all.

knowledge or clinical knowledge in the period under investigation. Concept frames extracted from Latin, German and French uroscopical texts intended either for scientists or practising physicians will be examined with regard to the variety of paradigms or “paradigm monocultures” they contain.

Beyond the goals described above a collection of sample frames will be outlined within the framework of this project, which can be used for analyses and applications by the other projects of the Forschergruppe. This concerns projects A1, A2, A4, A5, B1, B3, B6, S2, S5 (see 5.2 “Cooperation with other projects”)

### **3.2.1 Methods**

The methods presented in the following represent an attempt to expand previous approaches to the examination of knowledge shifts in medicine on the basis of procedures used in the cognitive sciences. Specific instruments enable the exact determination and analysis of correspondences, shifts and differences in the structures of medical disciplines or individual terms.

Although we might be familiar with the paradigm shifts defined by Thomas Kuhn and the shifts in thought style attributed to Ludwik Fleck, at least from a perspective that delineates shifts from a previous to a subsequent condition, the process of shifting itself has not been comprehended yet. This is certainly true for the semantic level. Kuhn argues that paradigm shifts frequently go unnoticed, especially since the vocabulary used by the new paradigm often resembles that found in the old. For similar reasons, Fleck was also of the opinion that his shifts in thought style take place silently and clandestinely. As a differentiated repertoire for analysis frames could disclose the invisible shifts on a linguistic-functional, cognitive-scientific level and help dissolve the “linguistic incompatibility” of medical epochs and conceptions. A four-step integrated procedure is planned.

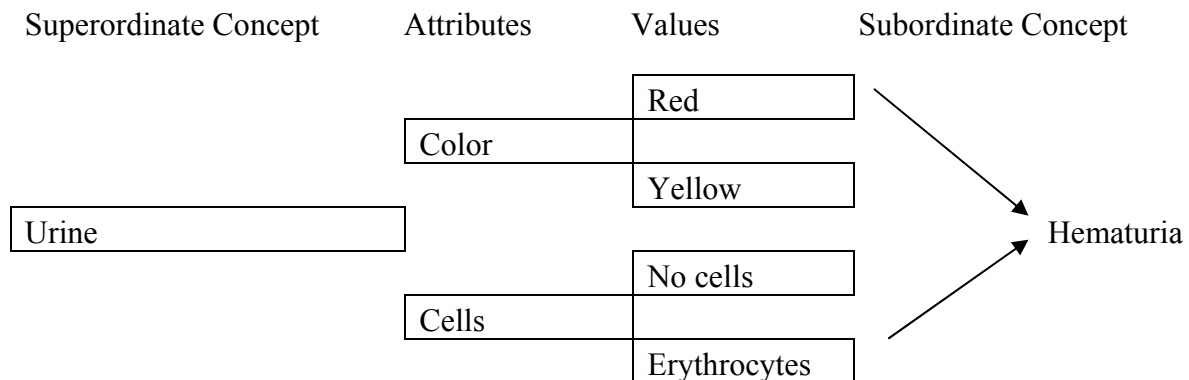
#### **1. Transfer of concepts into frames**

Frames are standardized and structured segments of collective knowledge, which result inductively from the intersection of similar discrete experiences. They are the format of any kind of conceptualization in our cognitive system. Our brain works with mental representations of individual objects or of categories involving objects, sensations, actions, perceptions etc. These representations evidence the same structure as frames. At the same time, frames represent knowledge on all levels of abstraction, so that scientific analysis models or frames larger linguistic units (texts, discourses etc.) as well as minimal shifts on the semiotic level. According to Fillmore frames have a double function (cf. Fillmore 1976:20-31). On the one hand, they serve as analytical instruments for determining meanings. On the other hand, they also have the status of cognitive concepts, which function as a format for presenting and organising knowledge in the processes underlying language comprehension.

To the extent that cognitive frames categorize data collected by sensory repetition into a cognitively constructed context, it is also possible to transfer textual representations of these data into frames and visualize them. Frames consist of structured attribute-value sets. The structure of attributes and values is determined by an underlying “thought style”, by so called “structural invariants”. Set against the background of these invariants, connections between the attributes and values are called “constraints”.

An oversimplified frame for urine for example could consist of the attributes “color” and “cells” and of the values “yellow”, “red”, “no cells”, “erythrocytes”.

Figure 2: Urine-frame



The diagnosis derived from a certain status of urine is called “Hematurie”, if the color of the urine – “red” – can be linked to the occurrence of “erythrocytes”. If this constellation characterizes the diagnostic concept, then the respective attributes and values are linked by constraints.

- Links can be temporal, diagnostic, prognostic, causal etc. The differentiation of possible relations is part of the project.
- Attributes reflect the state of diagnostic technology. Their values reflect their character as qualitative or quantitative urine attributes.
- Diagnostic results are reflected in constraints.
- Paradigm shifts are highlighted most prominently on the level of constraints.

The project entails transferring the uroscopical concepts dealt with in the texts into frames in an operationalized fashion. Each word (“filler”) – whether occurring in sentences or in texts – evokes a frame, and each of these frames is equipped with standard information (“default-values”), which builds other frames as well. Consequently, each frame system can be analyzed according to at least two dimensions: in a horizontal direction, which interlaces frames along the syntagmatic organisation of linguistic units, and in a vertical direction, which observes frames in their paradigmatic network with superordinate and subordinate frames (cf. Ziem 2005)

The conceptual knowledge underlying the respective discourse context – called “structural invariants” in Barslou’s terminology (see above) – belongs to the highest level of abstraction. In uroscopy medical concepts such as iatromechanics, iatrochemistry, vitalism and many others can be included, which can be portrayed in their respective concept frames. These superordinate frames determine the structure and content of the linguistic units to be examined. They are missing in the graphic representation, however, and have to be imagined, because only one frame within a complex frame network can be displayed. Consequently, frames represent a concept’s potential for contextualization possibilities in communication vectors (Ziem 2005:6). These structural invariants have been integrated into the presentation using classical heuristic methods derived from the history of science and under the direction of the project members most versed in medical history.

Blanks in respective concepts (“slots”) can be filled with different elements of

knowledge. When dealing with attributes typically used in this context, one refers to “default values”. Their essential characteristic consists in belonging to the collectively shared knowledge of a specific community at a certain time and place. This may refer to a linguistic community, a social group or a scientific collective. On the other hand, deviations from the corresponding thought style can be identified when contents other than generally expected attributes are determined.

Project staff members extract uroscopical frames from texts according to logical steps, oriented toward traditional categorisation procedures of phenomena on the basis of dichotomous, trichotomous or polytomous structures. The frames established will undergo a process of revision by the entire research staff. Formatted and expanded in conjunction with projects A1 and A2, the frames are expected to form the basis for a thesaurus of concepts.

**2. Examination of the incommensurabilities in collocated frames**

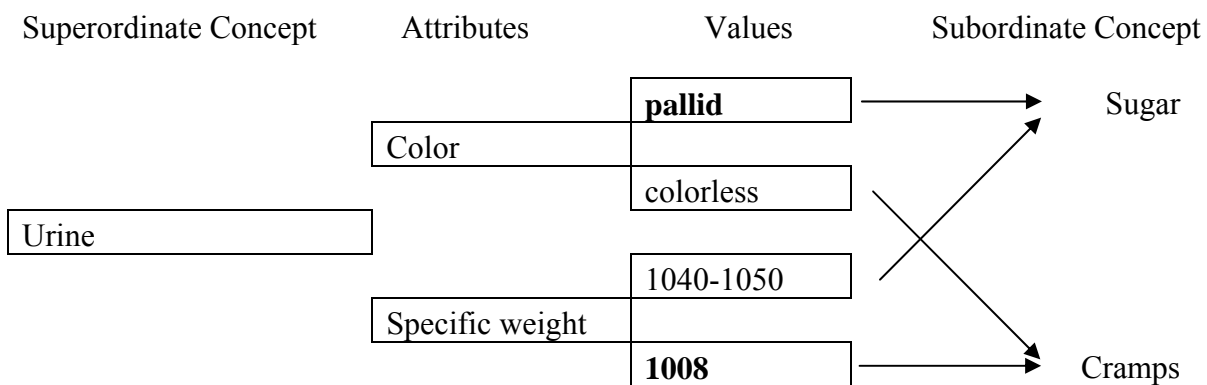
The concept frames will be compared and contrasted with each other. First, those frames that are chronologically collocated have to be checked for incidences of conceptual changes.

According to Andersen, Barker and Chen (2006), and in adherence to Kuhn, three principles determine the consistency of concept frames and their constraints:

1. The principle of “no-overlap”, which stipulates that “the division in a kind hierarchy is exclusive: no concepts in a contrast set formed by division of a superordinate are allowed to overlap“ (p. 67).
2. The “exhaustion principle”, according to which “a division of a superordinate concept never leaves any residual instances: that is, the extension of all concepts in a contrast set together exhaust the extension of their superordinate” (p. 68).
3. The “inclusion principle”, which specifies that “all instances of a subordinate concept are also instances of the superordinate concept.” (p. 68).

Infringements of these hierarchical principles, as might occur by introducing new attributes, are regarded as anomalies that must be resolved (Figure 3). Resolving anomalies leads to a conceptual shift. Andersen, Barker and Chen have already detected two solutions: a) a change of value constraints and b) the addition of new “subordinate” concepts. Additional solution strategies will have to be distinguished for uroscopical frames.

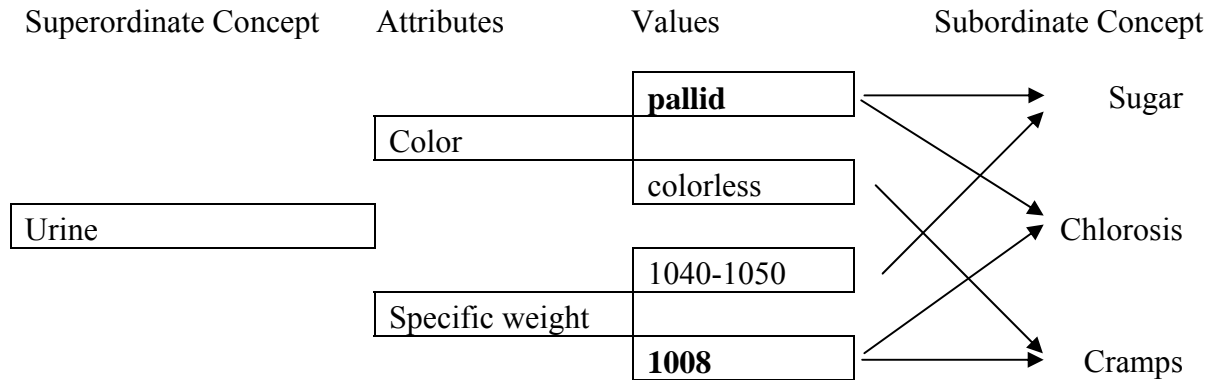
Figure 3: Example of the violation of the hierarchical principles shown in the frame representation of urine as posited by Fränkel and Ravoth (1850).



Urine that is pallid and has a specific weight of 1008 violates the “no overlap”-principle as well as the exhaustion-principle. The pattern of values activated does not correspond to a single subordinate concept but to a mismatch of the contrasting categories (see a similar

example for water birds in Andersen et al. 2006, p. 71). This anomaly can be resolved by integrating a new subordinate concept, namely “chlorosis” (figure 4).

Figure 4: Resolution of the violation of the hierarchical principles by extending the subordinate concepts as in Fränkel and Ravoth (1850).



### 3. Translation and conceptual change

The influence of translations on conceptual changes will be checked during the project. For this purpose, terms must be systematically recorded, which were translated from Latin into French or German. Their function and valency in frames as well as their development must be tracked diachronically. According to this principle a thesaurus of terms will be established, which includes the concept connoted by the term translated. On the basis of this thesaurus, the question can be answered as to how pivotal concepts of urine are lexicalized and translated into different languages (e.g. color, substance, consistency etc.)

One of the most striking examples of urine concept formation and reformation involves the denomination of the “undissolved components/ingredients of urine”. Hippocrates designated these ingredients as το παρυφιστάμενον, which represents a verbal noun derived from the neutral form of the Greek medial present participle παρυφιστάμενον, an inflected form of the verb παρυφίστημι ‘to come to stand below additionally’ (a composition of παρά ‘at, with, in addition’ + υφίσταμαι ‘below, beneath’ + ἵσταναι ‘to stand’).<sup>14</sup> In the famous *Liber de urinis*, a Latin translation of the Greek Περί ουρῶν βιβλίον ascribed to Galen, these urine ingredients were translated as *contentum* or *sedimentum*. Unable to render the Greek verbal noun both Latin formations reconceptualize the process of ‘urine settlement’ by profiling different aspects of the process: the verbal noun *contentum* is a perfect participle verbalizing the stative aspect of ‘what is contained in, sticks together in (urine)’ and is related to *contineo* ‘to stick together’ (going back to *con + teneo* ‘to hold together’). The neuter verbal abstract noun *sedimentum* is derived from *sedeo* ‘to sit’ and specifies the ‘settling down’ of urinal components. Greek uroscopic texts also exhibit the resultative verbal noun υφίστασις ‘the settling’ (going back to ‘what is standing below’ also derived from υφίσταμαι ‘to stand below’). The first French uroscopic texts either resort to integrated Greek or Latin loans like *hypostase*, *sediment* with an additional online translation (*ce qui est contenu au fond de l’urinal, choses contenue*) or to forged loan translations like *residence* (Corbechon 1372),

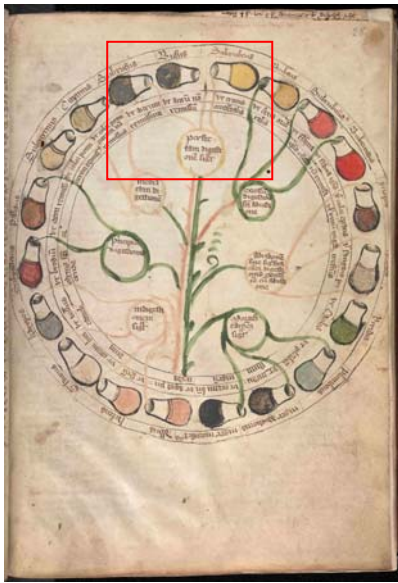
<sup>14</sup> See also the use of *parhyphistamenon* ‘the substance that settled down in our mind as coexistent with the idea’) by Stoic semanticists (Botti 2002: 208).

*siege* (Anonyme, 15<sup>th</sup> c.) or *dépôt* (Littré, 1840). Middle French *residence* is a loan from Medieval Latin *residentia* ‘remainder, residu’ which appears in alchemistic texts to designate the remnants of combustion (referring to Latin *resideo* ‘to be left, to remain’ from *re* + *sideo* ‘to remain seated’).

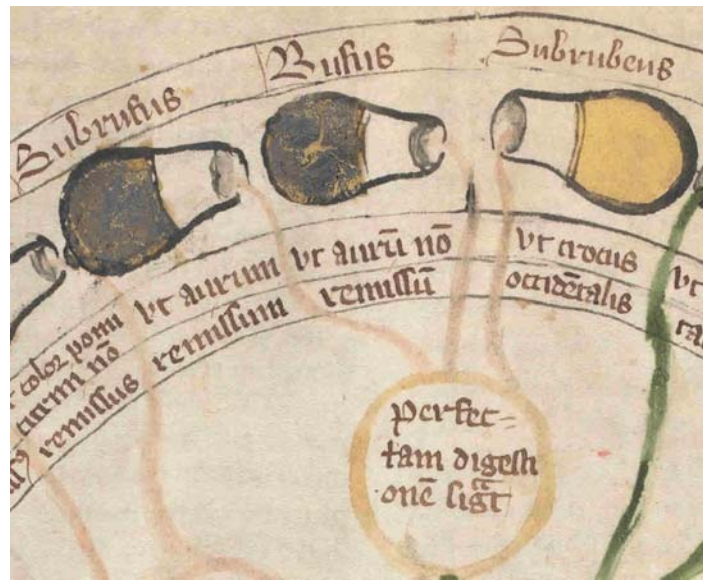
Middle French *siege* ‘seat’ goes back to a supposed Vulgar Latin noun *\*sedica* derived from Latin *sedeo* ‘to sit’. Later the concept is differentiated into *sediment*, *subsidence* and *suspension* (Colin 1558), indicating a shift to different types of ‘sediments’ that are ‘hanging’ or ‘sitting’ and thus indicative of a paradigm shift. With the help of similar inquiries we will be able to answer the question as to which translation conveys synonyms and which stands for new concepts. Similar analyses need to be performed for the development of other central terms. These conceptual analyses include the historical background of the text and exceed etymological questions because they help determine the role key terms have within frames, their development over time and the changes realized via translations.

As far as the investigation on the influence of translations on conceptual change is concerned, the analysis of uroscopy in frames offers a unique opportunity. We can find data about urine colors not only in treatises on urine but also – in a condensed manner – in so called “urine colour charts” or “urine wheels”. Since these charts organize knowledge they also share some of the characteristics that Barsalou’s frames have. They display urine colors and constraints linking these colors to a specific diagnosis (figure 5). In order to make use of this source in our study the textual corpus has been enlarged to include a corpus of manuscripts, incunabula and printings. So far more than forty urine color charts from the 13<sup>th</sup> to the 17<sup>th</sup> century could be identified in various European and US-American libraries. They will be analyzed by means of iconography and on structural and lexical levels. Paradigm shifts can be detected on the structural level by comparing the status of the *coctio* given in these illustrations.

Figure 5: Urine wheel, colors and constraints



MS Leipzig 1177, fol. 28r



detail: Perfectam digestionem significant

In the manuscript displayed in figure 5 three colors indicate a patient's ideal state of health (perfectam digestionem: subrufus, rufus, subrubeus), while in another manuscript (Bibliothèque nationale de France, Ms lat. 11229, fol. 19v) only the first set subrufus and rufus do. Thus, a practitioner with the Leipzig manuscript at hand, who considers a patient's urine to be "reddish like western crocus", would not intervene at all, since this indicates perfect health, whereas the Paris manuscript suggests an excessive warmth (cooking) of the bodily fluids, indicating that cooling treatments should be applied.

On the lexical level, the color terms used to describe urine reflect the evolution of a specialized medical language in the vernacular. Individual translations handle the problem of translation differently. For example, the translator of a French version (Ms Brussels 5876, fol. 154v) decided not to render the Latin *rubicundus* ('intensely red') indicated in the loan word *rubicond*, choosing the color term *vermeil* instead. Similarly, he decides not to distinguish between the three shades of white in the Latin text (*albus*, *lacteus*, *glaucus*), but reduces the information by designating all three of them as *blanche*. The translator of a Gaelic urine wheel did not even bother to translate the colors; he maintains the Latin terms throughout. Apparently, Gaelic had not yet developed its medical terms in this sub-discipline.

Our aim is to accumulate a database which allows urine wheels to be compared and contrasted with respect to structure and language. Furthermore, as a public outreach activity an exhibition consisting of urine color charts and the details of our findings is planned.

#### 4. Genealogy of the texts in order to differentiate between collectives of thought and thought style, selection of the corpus to be examined

Concepts are discussed and passed on within communication communities. The paradigm constituting a specialized communication community (thought collective) is imparted by social factors (education, textbooks, handbooks, "canonized knowledge") and facilitated by institutions (university institutes, laboratories). Special fields are launched by contacts between scientists, until a communication network has been formed. The process of

differentiating science into these networks involves “translating” produced knowledge. As differentiation progresses the research objects become more abstract; scientific terminologies become progressively more specialized and efforts to impart and transmit data to the general public intensify. Popularization not only takes place externally but also internally, either among disciplines or schools or as an essential part of any form of scientific communication, explanation and simplification.

Hence, the genealogy of the texts has to be scrutinized. The relationships between writers and addressees are important and the semiotic context of the texts requires reconstruction. For example, questions concerning urine diagnostics are presented differently in a popular guide “for the educated layperson” than in a scientific standard work. By token, an academic handbook employs more specific terms than a handbook for practicing healers.<sup>15</sup> At the same time, the corpus examined should be as diverse as possible and not restricted to texts representing the academic view of uroscopy or to texts published for the professional medical community. While our corpus excludes the paramedical penumbra, it does include exemplary works of practicing healers as well as guides for laypersons.

### 3.2.2 Work packages and work programme

The work programme will encompass eight interlinked and overlapping workpackages.

- Workpackage 1: Re-examination and verification of preliminarily selected Latin texts
- Workpackage 2: Transcribing the information on urine and uroscopy from the text corpus into frames
- Workpackage 3: Analysing paradigm shifts on different levels
- Workpackage 4: Investigating the influence of mechanization/ mechanization on frame-structures and paradigm shifts
- Workpackage 5: Investigating the influence of translations and vernacular peculiarities on frame-structures and paradigm shifts
- Workpackage 6: Investigating the co-existence of multiple paradigms in urine-frames.
- Workpackage 7: Cooperation within the planned FFF
- Workpackage 8: Publication

Workpackage 1: Re-examination and verification of preliminarily selected Latin texts

The existing text corpus (first funding period) covers French and German works on uroscopy from the 12<sup>th</sup> to the 19<sup>th</sup> century. In a preparatory step this corpus was extended to cover Latin works as well. The eight Latin works selected have to be confirmed with the support of bibliographies and library catalogs. The titles chosen have to be ordered from international libraries, inspected and cataloged for possible integration into the material for the project. This represents a time-consuming task, because not all of the books are available through interlibrary loan. Some have to be inspected at local venues. Verifying the text corpus and

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<sup>15</sup> Baldamus (1979: 213-233) is of the opinion that an adequate translation of specialized technical knowledge into the language of laypeople is impossible, because the vocabulary of exoteric disciplines becomes the more imprecise the more precise the esoteric vocabulary is.

categorising the works will take two part-time researchers approximately 30 person days.<sup>16</sup> The researchers will be supported by two student research assistants, whose duties include assembling, copying and cataloging the text corpus.

**Workpackage 2: Transcribing the information on urine and uroscopy from the text corpus into frames**

The transcription of the textual information on urine and urine analysis from the text corpus into frames is the most difficult task. It is impossible to transcribe the full corpus within the three years that have been set aside for the project. Therefore, a selection of the works has been determined according to a) key authors, b) relevance, c) paradigmatic works (academic vs. non-academic literature), d) publication dates (the intention is to cover one generation of physicians, e.g. ca. 25 years). An analysis of the full corpus may be prospected. Twelve German works, twelve French works and eight Latin works need to be transcribed into the frame format. Although incomplete, texts frames have already been established for parts of the German and French sources. Based on this preparatory work ca. five person days will be needed to extract the additional frames per title. Additional time should be spent on reviewing and verifying the transcriptions. All in all, 180 person days are reserved for the frame extraction, for which two student research assistants will support the researchers in collecting data and preparing visualizations of the frames.

**Workpackage 3: Analysing paradigm shifts on different levels**

During the frame-extraction process paradigm shifts and shifts in thought styles from one text to the other will be analyzed and documented. Possible violations of hierarchical principles will be investigated and recorded. A database will be created to structure and collate shifts. Since this workpackage is an ongoing process it will take place during the entire duration of the project. 90 person days will be needed to perform the tasks outlined. Two student research assistants will update the database.

**Workpackage 4: Investigating the influence of mechanization/ mechanization on frame-structures and paradigm shifts**

On the basis outlined in workpackage 2 and 3 the influence of mechanization processes on frame structures and paradigm shifts will be investigated. This is an ongoing process for the duration of the project. However, special emphasis will be placed on this workpackage in the the first three years. The workpackage is closely linked to workpackage 5, since translation processes affecting terms signifying mechanization need to be observed. A workshop on “Technical Inventions and the Lexicon” will be held pursuant to the second year. A publication on the results of this workshop is planned (see WP 8). Ca. 90 person days are needed. Two student research assistants will support the logistics of the workshop and the preparation of the proceedings

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<sup>16</sup> Work one person can do on one day. The project intends to have two half-time employed researchers. Each of them is supposed to work 110 days a year (on the basis of 220 assumed working days per year for a full time researcher). All in all manpower of 660 person days (110 \* 3 years \* 2 researchers employed half-time) should be available.

Workpackage 5: Investigating the influence of translations and vernacular peculiarities on frame-structures and paradigm shifts

The influence of translations and vernacular peculiarities on frame-structures and paradigm shifts will be studied on the basis of data gathered in workpackage 2 and 3 and linked with workpackage 4. This workpackage will be performed from the outset of the project until its final phase. A thesaurus of terms will be set up, which includes the concept connoted to the term that has been translated. The thesaurus will be applied to the question as to how pivotal concepts of urine are lexicalized and translated into different languages. As a public outreach activity this workpackage includes an exhibition on “urine colour charts”, placing emphasis on the translation of colors into the vernacular and on the role these translations play for constraints, values and attributes in frames. The exhibition is planned for the second year of the project, for which 90 person days are needed. student research assistants will support the data entry for the thesaurus and the logistical preparation of the exhibition.

Workpackage 6: Investigating the co-existence of multiple paradigms in urine-frames

On the basis of workpackage 2 and 3 this workpackage concentrates on the determination of the co-existence multiple paradigms in urine-frames. After the genealogy of the texts to be investigated has been clarified, texts that are closely linked to each other will be checked for multiple coexisting paradigms. Academic and non-academic texts published in the same period will be compared and verified for underlying paradigms or possible violations of frame hierarchies due to the incidence of multiple paradigms in one text. 60 person days are needed.

Workpackage 7: Cooperation within the planned FFF

This workpackage serves the purpose of fostering co-operation with the other members of the proposed FFF. Since the project is interlinked with several other projects and these projects rely on reciprocal results, emphasis should be put on regular meetings and data exchange. 60 person days (ca. 1/2 days per week) have been allotted for this task, a student research assistants is needed to prepare files and materials for meeting purposes.

Workpackage 8: Publication

A final comprehensive publication outlining the results of the first and the second funding period of the project within the FFF-Forschergruppe will be prepared. In addition, a systematic survey of frames and their use in the sciences (“Conceptual structures in science: frames as a model”) which has already been prepared in close cooperation with project B1 (edited by Wiebke Petersen and Heiner Fangerau) will be completed. The proceedings of the workshop organized under the aegis of WP 4 (“Technical Inventions and the Lexicon”) will be published.

A graphical representation of the workpackage agendas is provided in figure 6.

Figure 6: Schematic overview of the time needed per workpackage.

Months	
1	<p>WP1: Extension of the corpus (30 person days) <b>Deliverable: Latin corpus</b></p>
6	<p>WP2: Transcription of texts into the frame format</p>
12	<p>WP4: Influence of mechanization on frame-structures and paradigm shifts (90 person days)</p> <p>WP5: Influence of translations on frame-structures and paradigm shifts (90 person days)</p> <p>WP3: Analysis of paradigm shifts on different levels (90 person days)</p> <p>12 German 12 French 8 Latin texts</p> <p>(5 person days per text = 180 person days)</p>
18	<p><b>Deliverables: recording of mechanization effects on frames, workshop after year 2</b></p> <p><b>Deliverables: database, thesaurus, exhibition after year 2</b></p> <p><b>Deliverables: text based frames for the respective texts, database</b></p> <p><b>Deliverables: analysis and recording of violations of the hierarchical structure of frames, database</b></p>
24	<p>WP6: Co-existence of multiple paradigms in urine-frames (60 person days)</p> <p><b>Deliverables: analysis, recording and documentation of co-existing paradigms</b></p>
30	<p>WP7: Co-operation (60 person days)</p> <p><b>Deliverable: Synergy for the FFF</b></p>
36	<p>WP8: Publication (60 person days) <b>Deliverables: 3 monographs (1 general, 1 focussing on the language of uroscopy in the history of medicine, 1 proceedings of workshop WP4)</b></p>

## Text Corpus

In the 16<sup>th</sup> and 17<sup>th</sup> centuries, the production of vernacular treatises on urine was initiated separately from individual medieval texts. Initially, translations from Latin (*Hortus Sanitatis*, *Regimen Sanitatis*) and Greek (*aphorisms*) were produced. In the Renaissance the first French treatise on urine was compiled by Sébastien Colin in 1558, the last by Davach de la Rivière in 1700. The oldest German treatise stems from the 12<sup>th</sup> century (*Breslauer Codex*). It was followed intermittently by short German treatises. The first independent publications on urine analysis were published during the 16<sup>th</sup> and 17<sup>th</sup> century. Most of them can be characterized as compilations or translations of Latin texts, but some of them advanced independent concepts (e.g. iatrochemic-alechemistic Thurneysser). The German literature of the 18<sup>th</sup> century mirrors the discussions about the value of uroscopy and the claims put forward by academic doctors in the vernacular language that non-academic healer's use of uroscopy was tantamount to quackery. During the 19<sup>th</sup> century and independently of Latin predecessors the new paradigm of "scientific urine analysis" was advanced in German. The result is a corpus of French, Latin and German-language texts on urology, which commences in the 12<sup>th</sup> century with the emergence of first vernacular uroscopic texts and ends at the beginning of the 20<sup>th</sup> century (table 2).

Inclusion and selection criteria for the works to be analyzed in the proposed study include:

- central texts on uroscopy or texts with important chapters on uroscopy documenting existing academic (university based) paradigms from the 12<sup>th</sup> until the end of the 19<sup>th</sup> century
- texts that represent canonized knowledge (no dissertations or other research literature, see Martin, Fangerau 2006)
- texts existing for the same period were prioritized according to specific criteria: translations from Latin into German and French
- texts criticizing or ridiculing uroscopy were excluded on the assumption that these texts document aspects of the uroscopic practice of its time and are marked by a special intention
- unprinted manuscripts were only included if a historically edited version is available
- texts published parallelly were included if we hypothesized that multiple paradigms existed in one period.

The resulting corpus consists of the following groups:

- French and German translations of Latin treatises on urine (e.g. *kurzer Harntraktat*)
- relevant chapters of French and German translations from complete works in Latin (e.g. *De proprietatibus rerum*)
- several French and German translations from Greek and Latin of Hippocrates' aphorisms, the first and most important text on classical approaches to uroscopy
- French and German compilations of Latin publications
- translations from French into German
- French and German treatises on urine
- independent works in French and German for lay-people
- independent academic works in French and German

Table 2: Texts to be included in the study, a selection of the most important works on uroscopy published in German, French and Latin from the 12<sup>th</sup> to the 20<sup>th</sup> century (the Latin corpus is not exhaustive)

<i>German</i>	<i>French</i>	<i>Latin</i>
		9./10. Jh. <b>Isaac Judaeus:</b> De urinis, in: Omnia opera ysaac in hoc volumini contenta: cum quibusdam alijs opusculis: [...] Liber de vrinis cum commento eiusdem [...], Lugdunum: Trot, 1515
12. Jhd. Breslauer Codex Salenitatis Liber de urinis / Kurzer Harntraktat		12. Jh. „Der kurze Harntraktat des Codex Salernitanus“, ed. Gundolf Keil, in: Keil 1969: 20-29.
		13. Jh. <b>Bernardus Gordonius:</b> De urinis, Lugduni: apud Gulielmum Rouillium, 1550.
		1253 <b>Bartholomaei Anglici</b> de genuinis rerum coelestium, terrestrium et inferarum proprietatibus, libri XVIII ...: cui accessit liber XIX de variarum rerum accidentibus, Frankfurt a.M. : Minerva 1964, Unveränd. Nachdr. der Ausg. Richter, Francofurti, 1601.
	15. Jhd. Le signiffiance de totes orines (Übersetzung des anonymen „kurzen Harntraktats“); Ms Brüssel 5874-5877, fol. 154v-155v	1491 Ortus sanitatis. De herbis et plantis. De animalibus & reptilibus. De avibus et volatilibus. De piscibus & natatilibus. De lapidibus & in terre venis nasce(n)tibus. De urinis et ea(ue) speciebus. Tabula medicinalis cum directorio generali per omnes tractatus, Mainz, Jacob Meydenbach, 23. Juni 1491
1526-44 <b>Harntraktate</b> , in: Ludwig V. von der Pfalz: ‘Buch der Medizin’, zehnter Band; Heidelberg Cod. Pal. germ. 269 (Bartholomäus Anglicus); Cod. Pal. germ. 270 (diverse Harntraktate)	ca. 1500 Jardin de santé: herbes, arbres et choses qui de iceuly coqueurent et conviennet alusage de medecine. Translaté de latin par <b>Jehan Cuba</b> en françois, Edition de Paris par Antoine Verard, 1500.	
1543 <b>Cordus</b> , Euricius: De vrinis, das ist, vo[n] rechter besichtigung des harns, vnd jhrem mißbrauch / etwan durch D. E. Cordum Medicum gesetzt. Ytzt vbersehen, vnd in truck verfertiget. Durch J. Dryandrum genent Eychman medicum Marpurgen[sem], Frankfurt 1543		1555 <b>Vassès</b> , Jean: Enchiridion rei medicae triplicis : illius primum quae signa ex pulsibus & urinis diiudicat; deinde therapeuticae de omni morborum genere curando singillatim; tertio diaeteticae vel de ratione victus, praesertim in febribus ..., Tiguri 1555
1571 <b>Thurneysser</b> zum Thurn, Leonhardt: Prokatalēpsis/ Oder Praeoccupatio./ Durch zwölf verschiedenlicher Tractaten/ gemachter <i>Harn Proben</i> / Durch Leonhart Thurneisser zum Thurn erfunden/ vn[d] gemeinem/ nutz zu gutem an tag geben, Frankfurt/Oder 1571		

<b>German</b>	<b>French</b>	<b>Latin</b>
1610 <b>Apollinaris, Q.:</b> Urin Büchlin. Darinnen einem jeden ... Menschen, zu seiner Gesundheit, ein ... nötiger Unterricht mitgetheilet wird, was er sich auff das Wasser oder Urin zuverlassen, ... Item ein ... Bericht, wie man die Kranckheiten an seinem Leibe gewiß erkunden sol: Theodorus 1610		
		1670 <b>Willis, Thomas:</b> Dissertatio de urinis, Trajectum ad Rhenum: 1670.
	1683 <b>Willis, Thomas:</b> Dissertation sur les urines, Tirée des Ouvrages de Willis tres-celebre Medecin d'Angleterre, Nouvellement mise en François, Par ***, A Paris chez Laurent d'Houry 1683.	1683 <b>Bellini, L.:</b> De urinis et pulsibus, de missione sanguinis, de febris, de morbis capitis, et pectoris. Ed. quarta prioribus correctior, Bologna 1683.
1703 <b>May, Theodor:</b> Urin-Büchlein, darinnen einem jeden frommen Menschen zu seiner Gesundheit ein fruchtbarer und nöthiger Unterricht mitgetheilt wird, was er sich auf das Wasser oder Urin zu verlassen und wie dasselbe zu besehen sey, Hamburg 1703	1700 <b>Davach de la Rivière, Jean:</b> Le miroir des urines: Par lesquelles on voit et connoit les differens temperamens, les humeurs dominantes, les sieges & les causes des maladies d'un chacun ... 2 ed., rev. & corr. ... & augm. ... 1700, s.a., 1722, 1752, 1763.	
1744 <b>Davach de la Riviere, Jean:</b> Herrn Davach de la Riviere, ... Wohlgegründeter Urinspiegel : worinnen nach Erfahrung der berühmtesten ... Aerzten die verschiedenen Temperamente, vordringende Feuchtigkeiten des Geblüts, und Ursprung der Krankheiten zu ersehen / Davach de la Rivière. Aus dem Französischen übersetzt von Johann Gottfried Essich, Augsburg: Rieger 1777 (erste Ausgabe: Stadt am Hof: Gastel 1744)	1765 <b>Jaucourt, Louis de:</b> „Urine“, in: Diderot, Denis/ d'Alembert, Jean Baptiste le Rond : <i>Encyclopédie, ou Dictionnaire raisonné des sciences, des arts et des métiers</i> , Geneve, Paris, Neufchastel: Chez Briasson, vol. 17, 497-513.	
	1773 <b>Rouelle, Hilaire-Marin:</b> Observations sur l'urine humaine et sur celle de vache et de cheval (Journ. de méd. nov 1773).	
1793 <b>Kortum, Carl Arnold:</b> Vom Urin als einem Zeichen in Krankheiten und von den Kunstgriffen der Harnärzte, wenn sie daraus die Krankheiten sagen, Duisburg 1793	1799 <b>Fourcroy, Antoine/Vauquelin, Louis:</b> Premier mémoire pour servir à l'histoire naturelle, chimique et médicale, de l'urine humaine. Ann Chimie 31:48–71, 1799	
1815 <b>Loew, Joseph:</b> Ueber den Urin als diagnostisches und prognostisches Zeichen in physiologischer und pathologischer Hinsicht, Landshut 1815	1828 <b>Andral fils:</b> „Urine“, in: Adelon, Nicolas Philibert: Dictionnaire de Médecine, Paris: Béchet, Band 21, 1821-1828, S. 75-85.	

<b>German</b>	<b>French</b>	<b>Latin</b>
1842 <b>Becquerel</b> , Alfred: Der Urin im gesunden und krankhaften Zustande chemisch- physikalisch und semiotisch-diagnostisch betrachtet : nebst einer Abhandlung über die Bright'sche Krankheit / Deutsch bearbeitet von Carl Neubert, Leipzig 1842 (best., Münster)	1841 <b>Becquerel</b> , Alfred: Séméiotique des urines, ou traité des altérations de l'urine dans les maladies: suivi d'un traité de la maladie de Bright, Paris 1841.	
1850 <b>Fränckel</b> , Albert <b>Ravoth</b> , Friedrich: Uroscopie oder vereinfachtes Verfahren, den Harn in Krankheiten chemisch und mikroskopisch zu untersuchen und semiotisch zu deuten. Nebst Angaben des erforderlichen, leicht zu beschaffenden Apparats, Berlin 1850		
1863 (1853) <b>Neubauer</b> , Carl <b>Vogel</b> , Julius: Anleitung zur qualitativen und quantitativen Analyse des Harns sowie zur Beurtheilung der Veränderungen dieses Secrets ; mit besonderer Rücksichte auf die Zwecke des praktischen Arztes, 4. verm. u. verb. Aufl., Wiesbaden 1863 ( <i>Erstauflage 1853</i> )	1877 <b>Neubauer</b> , Carl/ <b>Vogel</b> , Julius: De l'urine et des sédiments urinaires: propriétés et caractères chimiques et microscopiques des éléments normaux et anormaux de l'urine ..., précédé d'une introduction par R. Fresenius 2e éd. française / traduite sur la 7e éd allemande et annotée par L. Gautier, Paris: Savy.	
1883 <b>Buchwald</b> , Alfred: Uroscopie. Zum Gebrauch für Ärzte, Stuttgart 1883	1885 <b>Danlos</b> , Henri: „Urine“, in: Anger, Benjamin (Hrsg.): Nouveau Dictionnaire de Médecine et de Chirurgie pratiques, Band 37, 1865-1886, S. 311-550.	
1896 <b>Eulenburg</b> , Albert: Real-Enzyklopädie der gesamten Heilkunde. Medicinisch-chirurgisches Handwörterbuch für practische Aerzte, 3., gänzlich umgearbeitete Auflage, Bd. IX, Wien und Leipzig 1896, Art. „Harn, Harnuntersuchung“, S. 528-552.	1898 <b>Viellard</b> , Camille: L'urine humaine: urines normales, urines abnormales urines pathologiques, préface d'Armand Gautier 2e éd., revue et mise au courant des travaux les plus récents, Paris: Société d'éditions scientifiques.	

## Publications by the research group

### Refereed Publications

- Martin, Michael; Fangerau, Heiner (accepted): Listening to the heart's power: The introduction of technology into medical diagnostics. *ICOHTEC Journal*.
- Fangerau, Heiner; Mueller, Irmgard (2007): Scientific exchange: Jacques Loeb (1859-1924) and Emil Godlewski (1875-1944) as representatives of a transatlantic developmental biology. *Studies in History and Philosophy of Biological And Biomedical Sciences*. 608-617.
- Lindenberg, Robert; Fangerau, Heiner; Seitz, Robert (2007): 'Broca's area' as a collective term?. *Brain and Language* 102. 22-29.
- Martin, Michael (2007): Basilisken der Medizintechnik. Zur schwierigen Durchsetzung technischer Verfahren in der medizinischen Diagnostik vor 1900. *Technikgeschichte* 74.1-24
- Martin, Michael; Fangerau, Heiner (2006): Historische Umbrüche in der Harndiagnostik und ihre Visualisierung in "Frames". *Der Urologe* 45.742-748.

### Refereed publications on scientific congresses

- Martin, Michael; Fangerau, Heiner (2007): Listening to the heart's power: Designing blood pressure measurement (Section: Designing the Body: Technology and Medicine), on: ICOHTEC – International Committee for the History of Technology, International Symposium 2007, Copenhagen, Denmark, 14 – 18 August 2007.
- Martin, Michael; Zaun, Stefanie (2007): Uroscopic texts in the French and German Vernacular: Paradigm Shifts and the Evolution of the Medical Lexicon, on: Symposium on the Languages of Science in the Time of Linnaeus, 7 – 9 June 2007, Uppsala, Sweden.
- Martin, Michael (2007): Basiliken der Medizintechnik. Zur schwierigen Durchsetzung technischer Verfahren in der medizinischen Diagnostik vor 1900, on: Medizintechnik – mehr als Apparatedizin. Jahrestagung des Vereins Deutscher Ingenieure, Düsseldorf, 22 – 23 February 2007.
- Martin, Michael; Fangerau, Heiner (2006): Vom „Pissprophet“ zum Arzt im Labor: Die Entwicklung der Harnschau in „Frames“, on: 58. Kongress der Deutschen gesellschaft für Urologie, Hamburg, 20 – 23 September 2006.
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- Fangerau, Heiner; Müller, Irmgard: „Der Biologe Jacques Loeb (1859-1924) in der Zoologischen Forschungsstation Anton Dohrn (1840-1909) in Neapel: ein Beispiel für Ludwik Flecks (1896-1961) Theorie vom Denkkollektiv?“, *Verhandlungen zur Geschichte und Theorie der Biologie* 11. 153-168

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- Fangerau, Heiner; Geisler, Hans; Martin, Michael; Zaun, Stefanie (2007): Concept Frames in Action – An example from the History of Medicine. International Conferences FOR 600 Concept Types and Frames in Language, Cognition and Science, Düsseldorf 20 - 22. August 2007

### Non-refereed publications in anthologies

- Martin, Michael; Fangerau, Heiner (2006): Die Bedeutung unterschiedlicher Textsorten für die Repräsentation von Denkstil-Verschiebungen, in: Jörg Vögele, Heiner Fangerau, Thorsten Noack (Hg.): *Geschichte der Medizin – Geschichte in der Medizin: Forschungsthemen und Perspektiven*, Münster. 141-148
- Zaun, Stefanie (in press): Konzept- und Sprachentwicklung in französischen uroskopischen Fachtexten des Mittelalters und der frühen Neuzeit, in: Lidia Becker (ed.): *Aktualität des Mittelalters und der Renaissance in der Romanistik (proceedings of the network „Mittelalter und Renaissance in der Romania“ in Trier, 13 – 15 October .2006)*, München: Meidenbauer.

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### **3.3 Experiments involving humans or human materials**

yes  no

### **3.4 Experiments with animals**

yes  no

### **3.5 Experiments with recombinant DNA**

yes  no