

THE UNIVERSITY OF CHICAGO

A DOCTOR ON THE CLOCK:
HOURLY TIMEKEEPING AND GALEN'S SCIENTIFIC METHOD

A DISSERTATION SUBMITTED TO
THE FACULTY OF THE DIVISION OF THE HUMANITIES
IN CANDIDACY FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

DEPARTMENT OF CLASSICS: ANCIENT MEDITERRANEAN WORLD

BY

KASSANDRA JACKSON MILLER

CHICAGO, ILLINOIS

JUNE 2017

Acknowledgments

“Time is the most valuable thing a person can spend.” Theophrastus
(DL V.40.3-4)

It’s such a simple thing to spend time – even simpler to waste it. But *making* time for another person is a very different matter; it requires a tremendous amount of generosity, patience, and empathy. I cannot adequately express how grateful I am to everyone who has made time for me over the past few years. Your attention and support are priceless gifts, without which my project and I could never have made it to this stage.

I am especially grateful to the members of my committee: Christopher Faraone, Elizabeth Asmis, Jonathan Hall, and Alain Bresson. You have invested countless hours in reading, discussing, and thoughtfully critiquing my work, and I have grown so much under your guidance. Thank you for always keeping your doors open and for being such powerful advocates on my behalf.

I am also deeply indebted to the rest of my University of Chicago community, particularly within the Classics department. Kathy Fox kept me fueled and focused, and I cherish the times we spent in her office, eating candy and talking about life. Special thanks are owed to my peers-turned-lifelong-friends, Erika Jeck, Emily Wilson, Bart Van Wassenhove, Paul Vadan, Kate Agnew, Aimee Genova, Emily Forden, and Hannah Marcuson. Thank you for being my companions on this journey, and for always being prepared to celebrate, commiserate, or problem-solve with me, whenever necessary.

A project of this magnitude demands space as well as time, and I would like to thank the libraries and departments at Yale, Columbia, and ISAW that welcomed me in once I moved away from Chicago. It can be a daunting task to develop a sense of academic community within a new environment, but I quickly felt at home in New Haven and New York due to the generosity of Irene Marín, Michael Zimm, Andrew Hogan, Kyle Khellaf, Laura Wallace, Joshua Billings, Jessica Blum, Claire Catenaccio, Ridge Montes, and Dan-el Padilla Peralta. You helped turn tough transitions into wonderful adventures. I am also grateful to Greg Taubman, Chie Morita, and my fellow participants in the FORGE Writers' Retreat for encouraging me and facilitating my sprint to the finish-line.

On this journey, I have benefitted greatly from exchanges with other scholars who share my passion for timekeeping and ancient medicine. Prof. Alexander Jones was kind enough to include me in his seminar on timekeeping at ISAW, and that experience was pivotal in helping me to crystallize my thoughts into a dissertation proposal. Prof. Susan Mattern, Prof. Glen Cooper, and Dr. Paul Keyser took time out of their busy schedules to read and comment on drafts, and the Yale Interdisciplinary Working Group for the Study of Antiquity (YIWSA) offered me an arena in which to share some preliminary findings. I am likewise indebted to Profs. Robert Germany, Alexander Jones, and Barbara Sattler who have joined me in organizing both an SCS panel and an entire conference on small-scale timekeeping in the ancient world.

Finally, I would like to thank my family, those magical beings who can make any moment momentous and any place a home. Kristin Mahan, thank you for supporting me through thick and thin - and for flying all the way out to Chicago for my defense! Jessica Kwong, thank you for always being such an inspiration to me and for helping me lead an exciting and well-

examined life. Heidi Miller, Brian Miller, and Max Miller, I am so honored to be a part of your family and so grateful for the love and openness with which you've welcomed me. Mom and Dad, thank you for loving me unconditionally and for being my role models, my cheerleaders, and the best listeners on the planet.

And to my husband Jon: I am infinitely grateful for your love and empathy. You know exactly what I need and when, and you always, always make the time.

Table of Contents

LIST OF FIGURES	VII
LIST OF TABLES	IX
ABBREVIATIONS	X
ABSTRACT	XIV
INTRODUCTION: CLOCKS, GALEN, AND SCIENTIFIC METHOD	1
<i>Sundials and Water-clocks: What Are They and Where Could One Find Them?</i>	5
<i>A User of Clocks: Galen and His Biography</i>	15
<i>Project Overview</i>	20
PART 1: CLOCK CONSTRUCTION IN GALEN’S PHILOSOPHICAL WORK	24
1. CLOCK-MAKING IS GOOD TO THINK WITH: ITS ROLE IN <i>AFFECTIONS AND ERRORS</i>	25
<i>Defining the Stakes in Galen’s Affections and Errors</i>	27
<i>The Paradigm of Clock-Construction</i>	36
<i>Conclusion: Clock-Making vs. the Paradigm of the Void</i>	45
2. THE SEMIOTICS OF CLOCKS: GALEN’S ADAPTATION OF A TROPE.....	48
<i>Clocks in Architecture</i>	49
<i>Clocks and Philosophy</i>	58
<i>From Clock-as-Lifespan to Clock-as-Lifestyle</i>	69
PART 2: HOURLY TIMEKEEPING IN GALEN’S MEDICAL WORKS	72
3. FROM CRITICAL DAYS TO CRITICAL HOURS: GALENIC REFINEMENTS OF HIPPOCRATIC MODELS ...	73
<i>Galen’s Hippocratism</i>	75
<i>Galen’s On Critical Days</i>	78

<i>Temporality in Galen’s Fever Case Histories</i>	82
<i>Galen, Hippocrates, and Astronomy</i>	90
<i>Conclusion</i>	101
4. BRINGING ORDER TO DISORDERS: HOURLY TIMEKEEPING AND THE PROBLEM OF CLASSIFYING IRREGULAR PERIODIC FEVERS	103
<i>Galen’s Fever-Classification System: An Overview</i>	103
<i>Hours in Action: A Case Study</i>	107
<i>Contextualizing Galen’s Approach: What Other Doctors Were Saying</i>	111
<i>Conclusion</i>	121
5. “RIGHT TIMING” IN SICKNESS AND IN HEALTH: HOURLY TIMEKEEPING AND <i>KAIROS</i> IN GALEN’S <i>ON HYGIENE</i>	124
<i>Kairos and Galen’s Predecessors</i>	126
<i>Kairos and Febrile Disease</i>	130
<i>Kairos and Health Maintenance</i>	134
<i>Kairos and the Elderly</i>	144
<i>Conclusion</i>	149
CONCLUSION	151
APPENDIX. FULL TRANSLATION OF <i>AFF. PEC. 54,21-60,7 DB = V.80.7-89.5 K.</i>	156
BIBLIOGRAPHY	162

List of Figures

A	Gray marble conical sundial. Vatican Museum, Inv. 949. Photo Credit: Kassandra Jackson Miller.	9
B	(i) Schematic of a planar dial line net from http://www-groups.dcs.st-and.ac.uk/history/HistTopics/Sundials.html . (ii) Schematic of date and sun position from http://www.sundials.co.uk/~leicester.htm .	9
C	So-called “Anaximander Mosaic.” Image courtesy of the Rhineland Museum, Trier.	11
D	(i) Marble spherical dial from Aquileia. National Archaeological Museum of Aquileia, Inv. 844. Image from http://mw2.google.com/mw-panoramio/photos/medium/19340997.jpg . (ii) Monumental conical dial from the Theater of Dionysus, Athens. National Archaeological Museum, Athens, Inv. 3158. Image from Schaldach 2006 CD, no. 05.	11
E	(i) Schematic of hour-indicator systems from Landels 1979: 35, fig. 6. (ii) Foundations of water-clock at Oropus' Amphiareion. Photo credit: Kassandra Jackson Miller.	13
F	“Prometheus Sarcophagus,” Capitoline Museum, Inv. 638. Photo credit: Kassandra Jackson Miller.	57
G	“Portonaccio Sarcophagus,” Palazzo Massimo of Rome, Inv. 112327. Photo credit: Kassandra Jackson Miller.	58
H	Gems of Lang's Types A and D. (i) Staatliche Münzsammlung, Munich, Inv. A.197; (ii) National Archaeological Museum of Naples, Inv. 158777. Images from Lang 2012: Cat. nos. G TypA65 Pl. 21 and G TypD7 Pl. 25.	65
I	Hipparchus with globe. Bithynia, Nicaea under Commodus. Rec 293.	65

J	Detail from the “Plato’s Academy Mosaic”. Naples Archaeological Museum, Inv. 124545. Photo credit: Kassandra Jackson Miller.	67
K	Sarcophagus, Traversari Type II. Kunsthistorisches Museum, Vienna, Inv. ANSA I 171. Photo credit: Kassandra Jackson Miller.	67
L	Sarcophagus, Traversari Type III. Cloister of St. Paul Outside the Walls, Rome. Photo credit: Kassandra Jackson Miller.	68

List of Tables

1	The pattern of paroxysms patient experienced in the first five days.	123
2	The paroxysms of Galen's Tertian 1.	123

Abbreviations

Works of Galen

<i>Adv. Lyc.</i>	<i>Adversus Lycum libellus</i>
<i>Aff. pecc. dig.</i>	<i>De priorum animi cuiuslibet affectuum et peccatorum dignotione et curatione</i>
<i>De alim. fac.</i>	<i>De alimentorum facultatibus</i>
<i>De com. med. sec. loc.</i>	<i>De compositione medicamentorum secundum locos</i>
<i>De comp. med. per gen.</i>	<i>De compositione medicamentorum per genera</i>
<i>De cur. rat. per venae sect.</i>	<i>De curandi ratione per venae sectionem</i>
<i>De const. art. med.</i>	<i>De compositione medicamentorum secundum locos</i>
<i>De cris.</i>	<i>De crisis</i>
<i>De diebus decr.</i>	<i>De diebus decretoriis</i>
<i>De diff. febr.</i>	<i>De differentiis februm</i>
<i>De libr. propr.</i>	<i>De libris propriis</i>
<i>De meth. med.</i>	<i>De methodo medendi</i>
<i>De nat. fac.</i>	<i>De naturalibus facultatibus</i>
<i>De ord. libr. suor.</i>	<i>De ordine librorum suorum ad Eugenianum</i>
<i>De praen. ad Post.</i>	<i>De praenotione ad Posthumum</i>
<i>De san. tuenda</i>	<i>De sanitate tuenda</i>
<i>De sect. ad eos qui intr.</i>	<i>De sectis ad eos qui introducuntur</i>
<i>De sept. part.</i>	<i>De septimestri partu</i>
<i>De simp. med. temp. ac fac.</i>	<i>De simplicium medicamentorum ac facultatibus</i>
<i>De temper.</i>	<i>De temperamentis</i>
<i>De usu part.</i>	<i>De usu partium</i>
<i>In Hp. prog. comm</i>	<i>In Hippocratis prognosticum commentaria III</i>
<i>In Plat. Tim. comm.</i>	<i>In Platonis Timaeum commentarii</i>
<i>Thras.</i>	<i>Thrasylbulus sive utrum medicinae sit an gymnasticae hygieine</i>

Other Ancient Authors

Aen. Tact.	Aeneas Tacticus
Alc.	Alciphron
<i>Anth. Graec.</i>	<i>Anthologia Graeca</i>
Ar.	Aristophanes
<i>Ach.</i>	<i>Acharnenses</i>
<i>Ekk.</i>	<i>Ekklesiazousai</i>
Arist.	Aristotle

<i>Gen. An.</i>	<i>De generatione animalium</i>
Ath.	Athenaeus
<i>Deipn.</i>	<i>Deipnosophistae</i>
Caes.	Caesar
<i>Gall.</i>	<i>De Bella Gallica</i>
Catull.	Catullus
Cens.	Censorinus
<i>DN</i>	<i>De die natali</i>
Cic.	Cicero
<i>De nat. deor.</i>	<i>De natura deorum</i>
<i>Sen.</i>	<i>De senectute</i>
<i>Verr.</i>	<i>In Verrem</i>
Dio Cass.	Dio Cassius
Diod. Sic.	Diodorus Siculus
DL	Diogenes Laertius
Epict.	Epictetus
<i>Ab. diss.</i>	<i>Dissertationes ab Arriano digestae</i>
<i>Hist. Aug. Had.</i>	Historia Augusta: Hadrianus
Hdt.	Herodotus
Hes.	Hesiod
<i>WD</i>	<i>Opera et dies</i>
Hipp.	Hippocrates
<i>Aer.</i>	<i>De aere aquis et locis</i>
<i>Aph.</i>	<i>Aphorismi</i>
<i>De morb.</i>	<i>De morbis</i>
<i>Epid.</i>	<i>Epidemiae</i>
<i>Int.</i>	<i>De internis affectionibus</i>
<i>Nat. hom.</i>	<i>De natura hominis</i>
<i>Prisc. med.</i>	<i>De prisca medicina</i>
<i>Reg.</i>	<i>De diaeta in morbis acutis</i>
<i>Vict.</i>	<i>De victu</i>
Hor.	Horace
<i>Serm.</i>	<i>Sermones</i>
Luc.	Lucian
<i>Hipp.</i>	<i>Hippias</i>
Marcellin.	Marcellinus
<i>Puls.</i>	<i>De pulsibus</i>
Pers.	Persius
Petron.	Petronius
<i>Sat.</i>	<i>Satyricon</i>
Pl.	Plato
<i>Gorg.</i>	<i>Gorgias</i>

<i>Phaedr.</i>	<i>Phaedrus</i>
<i>Prot.</i>	<i>Protagorus</i>
<i>Rep.</i>	<i>Respublica</i>
<i>Ti.</i>	<i>Timaeus</i>
Plin.	Pliny
<i>Ep.</i>	<i>Epistulae</i>
<i>NH</i>	<i>Historia naturalis</i>
Plb.	Polybius
Philostr.	Philostratus
<i>Im.</i>	<i>Imagines</i>
Ptol.	Ptolemy
<i>Anal.</i>	<i>Analemma</i>
Sen.	Seneca
<i>Brev.</i>	<i>De brevitae vitae</i>
<i>Clem.</i>	<i>De clementia</i>
<i>Const.</i>	<i>De constantia sapientis</i>
<i>Ep.</i>	<i>Epistulae</i>
<i>Ira</i>	<i>De ira</i>
<i>Otio</i>	<i>De otio</i>
<i>Tranq.</i>	<i>De tranquillitate animi</i>
Sor.	Soranus
<i>Gyn.</i>	<i>Gynaecia</i>
Strab.	Strabo
<i>Geog.</i>	<i>Geographica</i>
Suet.	Suetonius
<i>Aug.</i>	<i>Vita Augustae</i>
<i>Tib.</i>	<i>Vita Tiberii</i>
<i>Vit.</i>	<i>Vita Vitellii</i>
Tac.	Tacitus
<i>Ann.</i>	<i>Annales</i>
<i>Hist.</i>	<i>Historiae</i>
Ulp.	Ulpian
<i>Mos. et Rom. legum coll.</i>	<i>Collatio legum Mosaicarum et Romanarum</i>
Val. Max.	Valerius Maximus
Varr.	Varro
<i>Ling.</i>	<i>De lingua Latina</i>
Verg.	Vergil
<i>Aen.</i>	<i>Aeneid</i>
Vitr.	Vitruvius
<i>De arch.</i>	<i>De architectura</i>
Xen.	Xenophon
<i>An.</i>	<i>Anabasis</i>

Reference Works and Editions

BM	British Museum, London, museum siglum.
CIL	Mommsen, T., et al., eds. <i>Corpus Inscriptionum Latinarum</i> (Berlin 1863-).
DB	De Boer, W., ed. 1937. <i>Galenī de animi cuiuslibet affectuum et peccatorum dignotione et curatione</i> . <i>Corpus Medicorum Graecorum</i> V.4.1.1. Leipzig: Teubner.
Gardner	Gardner, P. <i>The Types of Greek Coins</i> (Cambridge 1882).
I.Aeg. Thrace	Loukopoulou, L.D. et al., eds. <i>Epigraphes tēs Thrakēs tou Aigaiou: metaxy tōn potamōn Nestou kai Hevrou (nomoi Xanthēs, Rhodopēs kai Hevrou)</i> (Athens 2005).
ID	Durrbach, F., et al., eds. <i>Inscriptions de Délos, I-VII</i> (Paris 1926-1972).
IEph	Wankel, H. et al., eds. <i>Die Inschriften von Ephesos</i> , IGSK 11-17 (Bonn 1979-1984).
IG	<i>Inscriptiones Graecae</i> (Berlin 1903-).
IGUR	Moretti, L., eds. <i>Inscriptiones Graecae Urbis Romae</i> (Rome 1968-1990).
ILS	Dessau, H., ed. <i>Inscriptiones Latinae Selectae</i> (Berlin 1892-1916).
IPriene	Von Gaertringen, F.H., ed. <i>Die Inschriften von Priene</i> (Berlin 1906).
LBAT	Pinches, T.G. and J.N. Strassmaier, eds. <i>Late Babylonian Astronomical and Related Texts</i> (Providence 1955).
LSJ	Liddell-Scott-Jones Greek-English Lexicon
MDAI(A)	<i>Mitteilungen des deutschen archäologischen Instituts, Athenische Abteilung</i> . (Berlin 1876-1914, 1952-).
P. Oxy.	The Oxyrhynchus Papyri
P. Coll. Youtie	Habelt, R., ed. <i>Collectanea Papyrologica: Texts Published in Honor of H.C. Youtie</i> . Bonn 1976-.
SEG	Supplementum Epigraphicum Graecum. Vols 1-25 (Leiden 1923-1971), vols 26- (Amsterdam 1979-).
SNG von Aulock	Von Aulock, H. <i>Sylloge Nummorum Graecorum</i> (Berlin 1957-1967).
TLG	<i>Thesaurus Linguae Graecae</i> Online Database

Abstract

In the modern day, we understand time to be a fundamental scientific variable. In Greco-Roman antiquity, however, timekeeping's potential to facilitate scientific inquiry was only beginning to be explored. We have over 500 examples of sundials and water-clocks dating to as early as the 4th c. BCE, and literary and inscriptional evidence from the Imperial period suggests that, by this point, hourly timekeeping had become integrated into many aspects of society. Yet, few scholars have explored the impact that this new technology may have had on scientific investigation outside of the realm of technical astronomy. This dissertation aims to initiate such a conversation by analyzing how Galen of Pergamum, a renowned second-century physician, used sundials, water-clocks, and the unit of the hour in his medical and philosophical writings. It also contributes toward our larger understanding of horology's roles in the Greco-Roman world by offering a rare case study of how one individual engaged with the technology around him.

Two primary questions drive this dissertation. First, how, when, and why does Galen exploit clock technology in his disputes with fellow doctors and philosophers? Second, to what extent are Galen's attitudes towards horology representative for his time? Chapters One and Two address these questions within the context of Galen's *On the Affections and Errors of the Human Soul*, a treatise on epistemology and ethical psychology that, unusually, features an extended discussion of sundial and water-clock construction. Chapter One explores how Galen uses these processes to highlight the differences between his own method of scientific inquiry and the methods used by members of contemporary philosophical schools. I demonstrate that Galen associates clock-design with the positive concepts of verifiability, clarity, concord, utility, and long-term scientific progress, while associating sectarian philosophies with the opposite. Chapter

Two contextualizes Galen's attitude toward clocks by investigating the semiotic fields of sundials and water-clocks under the Roman Empire. I show that, across a range of media, sundials had become linked with the idea of the philosopher. I proceed to argue that, by incorporating clocks into his philosophical work, Galen adapts a common trope in order to promote his own scientific method as a way of life.

Chapters Three and Four focus on how Galen integrates seasonal and equinoctial hours into two of his less-studied treatises, *On Critical Days* and *Against Those Who Have Written on Types*, which deal with intermittent fevers such as malaria. The third chapter examines how Galen works references to hourly timekeeping into his defense and refinement of Hippocratic "critical day" theory. I propose that, both in his fever case histories and in his astrological explanations for critical days, Galen uses hourly timekeeping to help himself defend two claims: (a) that he is familiar with astronomy, and (b) that his own theories align closely with Hippocratic teachings. The fourth chapter explores how Galen incorporates hours into his critique of complex fever classification systems and, in so doing, manages to highlight his own empiricism and rationality, the essential components of his scientific method. In the fifth and final chapter, I relate Galen's interest in hourly timekeeping to his understanding of *kairos*, the "right moment" to engage in an action. Using *On Hygiene* as a case study, I demonstrate how Galen presents the relationship between *kairoi* and hours differently in different contexts, depending on whether the patient is sick, healthy, or simply old.

My investigation reveals that, while Galen engages closely with contemporary scholarly and representational trends, the manner and degree to which he applies hourly timekeeping to medical and philosophical controversies is unique among our limited extant sources.

Introduction: Clocks, Galen, and Scientific Method

Modern science is deeply concerned with how things change over time. Time is a common variable on our graphs, as we plot velocities and accelerations, reaction rates and diachronic growth. We have discovered that the more precisely and accurately we can measure time, the more we can learn about ourselves and our environments. To facilitate such learning, we have established international standards for time measurement based on so-called “atomic clocks,”¹ which deviate from true by less than 1×10^{-15} seconds over a given month.² Unless we are scientists or competitive cyclists, runners, or swimmers, we might pay little heed to such slivers of seconds in our everyday lives. Yet, without this kind of temporal precision, we would not have developed many of our most valued technologies, and we would know far less about the nature of our cosmos.

While these days the importance of time as a scientific variable cannot be overstated, in Greco-Roman antiquity, the role of timekeeping in scientific inquiry was still being established.³ However, beginning in the late Classical period, new tools expanded Greek and Roman timekeeping capabilities; sundials and water-clocks enabled people to measure time down to the

¹ In 1967, the International Bureau of Weights and Measures defined one second as “the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium-133 atom.” (Taylor and Thompson, eds. 2006: 113, Section 2.1.1.3). Between 1956 and 1967, the length of one second was derived mathematically from the length of the mean tropical year, and prior to that, it was derived from mechanical clocks. On the advent of atomic clocks, see Taubes 1996 and Barnett 1998: 145-160.

² Arias, dir. 2015: 6.

³ There was, of course, no category in Greek or Roman thought that would correspond directly to the modern term “science.” By using the adjective “scientific” here and in what follows, I do not mean to import an anachronism, but merely to refer to a constellation of strategies and critical frameworks designed to reveal and organize knowledge about the natural world. In so doing, I follow Keyser, who asserts, “It is no more anachronistic to employ the modern term ‘science’ than it is to use any modern term – such as ‘book’ or ‘city,’ or even ‘food’ or ‘school’ – to refer to a corresponding ancient Greek concept or practice,” provided that we remain alert to the differences (2013: 18).

hour (and, in some cases, even the half-hour).⁴ To date, we have over 500 examples of these tools, as well as a substantial body of iconographic, epigraphic, and literary evidence that attests to their increasing prevalence from the 4th c. BCE through late antiquity. Given the transformative effects that advances in timekeeping have had on modern scientific thought and practice, one would also imagine that the availability of sundials and water-clocks would have affected scientific inquiry among the ancients. Yet, while some work has been done on how ancient astronomers made use of these new technologies,⁵ virtually nothing has been written on the manner and degree to which they were adopted within other branches of investigation. In the present work, I seek to incorporate ancient medicine into the discussion by investigating the roles of clocks and hours in the writings of one Imperial-period physician, Galen of Pergamum.

Galen – who was not only a doctor, but also a philosopher, botanist, linguist, and literary critic – has become a “hot” topic in recent scholarship.⁶ The size and diversity of his corpus, as well as the significant influence of his theories on western medicine, make Galen’s work a rich and rewarding object of study. Yet, while much has been written on Galen’s contributions to modern anatomy,⁷ diagnostic procedures,⁸ and philosophical logic,⁹ there has been almost no discussion of the important role that hourly timekeeping plays in many of Galen’s treatises. Toward this end, I pose the following questions: how, when, and why does Galen exploit clock technology in his ongoing disputes with fellow doctors and philosophers? And how innovative was he in this regard? By tackling these questions, I seek to open up a meaningful dialogue between two sub-fields of ancient history that have not traditionally communicated with one

⁴ Half-hours are attested only occasionally, the earliest example being Menander Fr. 1015 (late 4th c. BCE).

⁵ E.g. Neugebauer 1975 (I): 40-2; Evans 1999: 243-53 and 2015: 1590-5.

⁶ See, for instance, Mattern’s recent biography *The Prince of Medicine: Galen in the Roman Empire* (2013).

⁷ E.g. Gross 1998; Rocca 2003.

⁸ E.g. Barton 1994.

⁹ E.g. Barnes 1991 and 1993; Hankinson 2008; Gill 2010; Singer 2014, to name but a few.

another: the history of technology, on the one hand, and the histories of medicine and philosophy on the other.

I also aim to contribute toward a broader discussion of how clocks were integrated into Greek and Roman societies. This subject, too, has received surprisingly little attention until quite recently. For example, in his frequently-cited monograph on the social history of the hour, Dohrn-Van Rossum devotes a mere twelve pages to the subject of clocks in pre-Medieval periods,¹⁰ preferring instead to focus on the much-celebrated mechanical clock.¹¹ In contrast, the study of ancient timepieces has traditionally been the preserve of historians of technology, concerned primarily with questions of their design, classification, and accuracy.¹² Such studies are of great use to classicists and social historians of the ancient world,¹³ since they allow us to better understand the prevalence and properties of ancient clocks, as well as the materials, technical knowledge, and other resources required to produce and use them. Yet social historians have exhibited little interest in clocks, despite their recent enthusiasm for discussing the political,

¹⁰ Dohrn-Van Rossum 1996. Landes (1983) and Jenzen, ed. (1989), likewise focus on clocks from the Medieval period onward.

¹¹ The Medieval invention of the mechanical clock, and the potential for hourly scheduling that it facilitated, has often been lauded as a *sine qua non* for the modern industrial age. The historian Mumford famously declared that “the clock, not the steam-engine, is the key-machine of the modern industrial age” (1934:14), and the social historian Thompson echoed this sentiment, when he contended that, “Without time-discipline, we could not have the insistent energies of industrial man” (1967: 93). For a critique of Thompson’s thesis, see Glennie and Thrift 1996 and 2009: 43-7.

¹² The *Journal for the History of Astronomy*, for instance, has published numerous articles that attempt to classify various clock types or to reconstruct their design and operation. Examples include Arnaldi and Schaldach 1997; Evans 1999; Catamo et al. 2000; Jones 2011. See also Turner 1989 in *History of Science*. The latest sundial finds are more likely to receive in-depth treatment in the *British Sundial Society Bulletin*, a non-academic publication for enthusiasts, than in journals of ancient history or classical archaeology. See, e.g. Symons 1998, Bonnin 2010b, Bonnin and Savoie 2013, Schaldach and Feustel 2013.

¹³ The major catalogues are Price 1969 (portable sundials); Buchner 1976 (more portable sundials); Gibbs 1976 (stone sundials); Schaldach 1998 (Roman sundials); Schaldach 2006 (Greek sundials); Bonnin 2015 (all extant sundials to date, including iconographic representations of dials). For studies focused on contextualizing particular sundials and water-clocks, see Rehm 1911, Scheidt 1967, Peek 1973, Lentz and Schlosser 1978, Pattenden 1981, Glaser 1982, Albani and Glessmer 1991, Fantoni 1991, Locher 1995, Arnaldi 1996, Adam 1997, Wiemer 1998, Schaldach 2004 and 2011, Schaldach and Feustel 2013. A regularly updated database of extant sundials from the Greco-Roman world can be found online at <http://bl.ocks.org/TopoiMedusa/raw/5899329>.

economic, and cultic roles of *other* timekeeping technologies (such as calendars and chronological systems).¹⁴

The few publications that do address the social roles of clocks have tended to concentrate on particular subsets of the material.¹⁵ The clepsydra of the Athenian courtroom (which is actually more of an egg-timer than a clock) has been implicated in the development of key concepts like “democracy,” “justice,” and “fairness,” and thus has received much scholarly attention.¹⁶ Interesting work has also been done on the Roman side. Wolkenhauer, for instance, devotes half of her *Sonne und Mond, Kalender und Uhr* (2011) to a discussion of clocks and hours in select Latin authors from the 3rd c. BCE through the mid 1st c. CE.¹⁷ Coming from an archaeological perspective, Bonnin has contributed a number of articles and a recent monograph

¹⁴ Feeney’s *Caesar’s Calendar* (2007) has been particularly influential, highlighting Rome’s strategic use of calendars to construct its past, establish synchronicities, and integrate its own temporal frameworks with those of foreign communities. Another significant contribution has been Rüpke’s *The Roman Calendar from Numa to Constantine* (2011), which offers a long-ranging diachronic analysis and seeks to situate Roman calendars within their institutional and societal contexts. See also Samuel 1972. Other scholars have taken a comparative approach, setting Roman calendars alongside those of other ancient cultures (esp. Mesopotamia and Egypt; see, e.g. Stern 2012) or those of more recent communities (esp. within western Europe and the United States).

Greek calendars have also been the focus of intensive study, but the sparse and ambivalent sources seem to obfuscate more than they explain. In the second half of the twentieth century, scholarship on Greek calendars consisted largely in a back-and-forth between two opposing historians: Pritchett, who believed that Greek calendars conformed to political needs first and to lunar activity second, and Meritt, who argued the reverse. See Pritchett and Neugebauer 1947; Pritchett 1947, 1957, 1963, 1999, 2001; Meritt 1961, 1964, 1969, 1974. While progress has been made in piecing together particular calendars - such as the Attic, the Corinthian, and those on the Antikythera Mechanism (on this device, see Freeth et al. 2008; Carman, Thorndike, and Evans 2012; Jones 2012a, b and 2017) – we lack information on the vast majority of Greek civic calendars and, thus, are unable to answer important questions regarding inter-*polis* coordination. Recent research has focused on other Greek strategies for reckoning or tracking time. Clarke’s *Making Time for the Past* (2011), for example, examines the chronological frameworks and temporal markers employed among Greek historians of the Classical and Hellenistic periods. Lehoux’s *Astronomy, Weather, and Calendars in the Ancient World* (2007) investigates the development and functions of Greek *parapegmata*, tools that offer weather “predictions” and/or astronomical information throughout the year (see also Hannah 2001). Schwindt has explored the motif of the “day span” in Greco-Roman drama, but does not investigate subunits of the day, such as hours (1994).

¹⁵ A notable exception is Hannah 2009.

¹⁶ Young 1939, Armstrong and Camp 1977, Allen 1996, Csapo and Miller 1998, Hannah 2013. On *clepsydrae* in the Roman courts, see Ker 2009 and Riggsby 2009.

¹⁷ With a particular focus on the windows c. 200-150 BCE and c. 50 BCE-10 CE. Her research questions include “wie diese Ordnung sprachlich konstituiert wurde, welche Metaphern sie hervorbrachte, welche Argumente man austauschte, wenn man darüber sprach, und in welchen Kontexten sie präsent war” (2). Remijsen has also contributed an article on the use of hourly timekeeping in ancient postal systems (2007).

on the social functions of sundials in the Roman Imperial west. He is especially concerned with the possible relationship between the spread of monumental clocks and Romanization,¹⁸ and with the roles of sundial iconography in funerary contexts.¹⁹ Despite these developments, however, the social history of Greco-Roman horology is a young and growing field, ripe for further exploration. This dissertation contributes to that field by providing the first detailed case study of how one individual harnessed the potentials of hourly timekeeping within his professional spheres.

I will begin by offering a brief introduction to sundials, water-clocks, and the Greek term *hora* (Gr. ὥρα), so that the reader may better appreciate the differences between ancient and modern timekeeping environments. I will then provide an overview of Galen's biography and the underlying principles of his scientific methodology, before previewing the chapters to come.

Sundials and Water-clocks: What Are They and Where Could One Find Them?

In the modern Western world, we are accustomed to thinking of an "hour" as a temporal unit of fixed length. Regardless of one's location or the season of the year, an hour will always be composed of 60 minutes of 60 seconds each, and 24 hours will invariably make up a "day." In the Greek and Roman worlds, however, equinoctial hours (i.e. hours of consistent length) enjoyed a very limited use. They are unattested before the Hellenistic period and remain the exclusive preserve of technical astronomy. In all other contexts it was the seasonal hour that prevailed, a unit produced by dividing the total amount of daylight (or nighttime) into twelve equal parts. Thus, while the seasonal hours within any given day were equal to one another, they

¹⁸ Bonnin 2010a. Cf. Étienne 1992 and Abascal 2002.

¹⁹ Bonnin 2012c and 2013. Cf. Raya Roman 1989, Traversari 1989, Turcan 1999.

were unequal to the hours on any other day, since the lengths of daylight and nighttime vary throughout the year.²⁰

Some of the earliest attestations of the Greek noun *hora* meaning “hour” appear in Herodotus (2.109.3) and certain Hippocratic texts.²¹ Prior to this time, the Greeks primarily used this term to mean “season,” though it could also designate a “right moment” or a general “time.”²² Hesiod’s Horai, for example, are four in number, not twelve, and while modern translators often call these goddesses the “Hours,” Hesiod’s Horai actually represent the seasonal subdivisions of the year (Spring, Summer, Autumn, and Winter).²³ The new definition of *hora* does not supersede the old; instead, all of these definitions continue to be used alongside one another. Clocks themselves were similarly multivalent. Like the word *hora*, these devices can represent multiple types of time at once; they mark the hour of the day, like modern clocks, but also track the time of year, like modern calendars.²⁴ Thus, they are tools for measuring both kinds of *hora*: the hour and the season.²⁵

Although sundials and water-clocks are attested in Egypt²⁶ and Babylonia²⁷ as early as the second millennium BCE, neither clocks nor the term “hour” appear in Greece or Rome until

²⁰ On seasonal hours in Greco-Roman antiquity, see e.g. Neugebauer 1975: 1069; Evans 2005: 277; Hannah 2009: 73-75. On their introduction into Babylonian timekeeping, see Rochberg-Halton 1989.

²¹ *Epid.* 4.V, 150, 17-18 and *Int.* VII, 238, 22-23. An early example of their popular (as opposed to technical) use is in Kallimachos Fr. 550 Pfeiffer. See Langhoff 1973 and Hannah 2009: 73-75.

²² See LSJ “ὥρα” and Langhoff 1973. For discussion of other terms relating to clocks and hours, see Rehm 1913 (*horologium*); Thalheim 1921 (*klepsydra*); Sontheimer 1932 (times of day); Schaldach 2006: 4; Hannah 2009: 73.

²³ Hes. *WD* 75.

²⁴ In Gibbs’ view, the design of the sundial, in particular, “gives the impression that the Greeks had embodied within it a model of solar motion” (1979: 42).

²⁵ For overviews on the history of Greek clocks and conception of the hour, see Bilfinger 1886 and 1888, Brauneiser 1944, Price 1962, Drachmann 1963, Brumbaugh 1966, Bowen and Goldstein 1987, Hannah 2008 and 2009. There is an extensive body of literature on Greek understandings of time in general. A few examples include Sorabji 1983, Aveni 2000, Darbo-Peschanski 2000.

²⁶ Our earliest attestations of “hour” units can be found in Egyptian “star tables” from the late First Intermediate Period and early Middle Kingdom (Dynasties IX-XII). On these tables, see Symons 2002b, 2007 and 2013. Painted inside coffin lids, these astral tables are composed of twelve rows and a minimum of thirty-six columns, each of which lists the names of twelve stars and covers a ten-day span. These stars, known as “decans,” performed some

the early Hellenistic period. At this time, Greeks were already employing a variety of other time-

action (presumably rising in the east, though the texts are unclear) sequentially throughout the night and, thus, were used to divide this period of darkness into twelve roughly equal portions. Although most star tables do not give this unit a specific name, a monumental one painted on the wall of the Osireion in Abydos (c. 1220 BCE) designates it *wnw.t* (“hour;” Symons 2013: 879-880).

“Hours” continue to be used throughout Egyptian history to record the lengths of days and the motions of the stars. Temple records indicate that this was the duty of the *wab*-priest from at least the New Kingdom (Shafer 1997: 15-17). We hear about hours in later New Kingdom star tables, as well as on a few preserved water-clocks and sundials from the same period. See Neugebauer and Parker 1960 (1) and Symons 2013: 880. The nobleman Amenemhet claims to have invented the water-clock (*dbh*) in the first half of the 16th c. BCE (Cenotaph of Seti I; see Frankfort 1933), though the earliest surviving example, found in the temple of Ammon at Karnak, dates to c. 1375 BCE. The exterior of this tapered outflow clock is decorated with astronomical scenes, while the interior is inscribed with twelve scales that mark the nighttime hours during each month of the year (Cotterell, Dickson, and Kamminga 1986: 36-37; Schaldach 2006: 14). Separate scales were necessary because the Egyptians, like the Greeks and Romans, used seasonal rather than equinoctial hours.

Although Egypt – during the Ptolemaic, Roman, and Imperial periods – begins to produce sundial types and adopt astronomical paradigms (like the zodiac) used in the Greco-Roman world, it is important to note that Egypt’s horological tradition differs significantly from the traditions of Greece and Rome (see Symons 1998 and 2002a). Later Egyptian L-shaped and sloped dials are unattested in Greek and Roman horologies, and it is still unclear how much overlap existed in the functions and cultural valuations of clocks within these societies. Egyptian clocks seem to have been used almost exclusively for cultic purposes – i.e. keeping track of the celestial gods and, eventually, creating horoscopes for individuals. While Greek and Roman clocks seem also to have played important roles in cult, they served many other functions, as well, within a broader range of activities and symbol systems. Thus, it would be inappropriate to speak of a simple, one-way adoption of Egyptian technology and concepts on the parts of Greece and Rome. Cultural exchange certainly occurred, but it is imperative that Greek and Roman horologies be investigated on their own terms. For more on Egyptian time-reckoning generally, see Borchardt 1920 and Clagett 1989-1999. On Egyptian water-clocks, see Pogo 1936. On specific finds see, e.g. Von Mackensen 1978, Langmann et al. 1984, and Ritner 2016.

²⁷ In the case of Babylonia, as in the case of Egypt, we are compelled to conclude that Greco-Roman horology did not simply involve the wholesale adoption of foreign inventions. Earlier scholars often assumed that Herodotus, in his claim that “the Greeks learned of the *polos* and the *gnomon* and the twelve divisions of the day from the Babylonians” (2.109.3), meant his readers to understand that the Greeks adopted both sundial technology and the concept of seasonal hours directly from Babylonia. Yet, more recent scholarship has called such a conclusion into question. Seasonal hours (*simanu* in Akkadian) were a late development in Babylonia (see Rochberg-Halton 1989 for discussion). The majority of astronomical cuneiform texts discuss time spans in terms of *bēru* and/or *UŠ*, instead. In this system, a full day (from one sunset to the next) was divided into 12 units of fixed, equal length, called *bēru* (1 *bēru* = two of our hours, hence its frequent translation “double hour”). Each *bēru* could be subdivided into 30 *UŠ* of four minutes each, and in fact, our 360° circle and our habit of measuring arcs and time in degrees both derive from the multiplication of 30 *UŠ* by 12 *bēru* (Neugebauer 1983: 8). Although water-clocks are known from the early 12th c. BCE, these told time according to yet another system, the four “watches” of the day or night, as expressed in *mana*, the weight of the water drained from a waterclock. On Babylonian water-clocks, see Høyrup 1997/1998; Al-Rawi and George 1991-1992; Brown, Fermor, and Walker 1999/2000; Fermor and Steele: 2000. Seasonal hours only come on the scene in the 7th c. BCE and never become common. The earliest attestations are in the Neo-Babylonian report published by Reiner and Pingree (1977: 50-55) and the Ivory Prism. The only evidence from later periods, to my knowledge, consists in a handful of Seleucid-period horoscopes (BM 33018, 35515, 38104, and 41301) and – possibly – a pair of highly fragmentary instruction manuals for the construction of sundials (LBAT 1494 and 1495 [= BM 34719 and 34067] and BM 35010). Even if these sundials indicated seasonal hours, however, it is doubtful that they would have looked anything like the *polos*, or celestial sphere, to which Herodotus refers and which is imitated in the numerous spherical, hemispherical, and conical sundials of the Greco-Roman world. The sphere did not feature in Babylonian astronomy, and their sundials seem to have been planar. Furthermore, there is insufficient evidence to determine whether Herodotus’ “twelve divisions of the day” actually referred to the number of daylight/nighttime hours or rather to the number of “double hours” into which Babylonians preferred to divide the full (i.e. 24-hour) day.

telling tools. In the Athenian law courts, perforated vessels of different sizes (the aforementioned clepsydras) were used like egg-timers to ensure that prosecutors and defendants received the exact speaking time allotted to them.²⁸ In the military sphere, Aeneas Tacticus describes soldiers using lamps lined with wax to time the night watches.²⁹ Aristophanes and other Attic comedians joke about the common practice of telling time according to one's own shadow-length.³⁰ Once sundials and water-clocks appear on the scene, these techniques persist alongside them, just as the multiple definitions of ὥρα seem comfortably to coexist.³¹

How did these tools work?³² A sundial is composed of a shadow-caster (the “gnomon”) and a designated shadow-casting surface (Figure A). The surfaces of Greek sundials are usually inscribed with a net of lines consisting in a sequence of concentric semi-ellipses (which mark the solstices and equinoxes) and a series of hour lines radiating out from the gnomon (Figure B). As the sun traces its path across the sky, one can tell the hour by the lateral movement of the gnomon's shadow across the net of lines and the time of year by the shadow's length. In order to create a sundial that would be accurate for a given location, a designer had to know the latitude of that location and the tilt of the ecliptic in degrees.³³ Happily, this also means that a modern historian can reconstruct the latitude for which a sundial was designed based on the dial's gnomon length and the value for the ecliptic commonly used in antiquity. This has allowed

²⁸ The excavations at the Athenian agora uncovered one such vessel. See Camp 1986: 111-112.

²⁹ Aen. Tact. 22.24-5. Cf. Plb. 10.44. By adjusting their lamps' capacities with different amounts of wax, the soldiers could supposedly recalibrate these timers to fit the changing seasonal hours. It is difficult to imagine how anything resembling precision was obtained by this method. Testimonies in Latin authors indicate, however, that lamps were indeed used to time night watches in the military and during work shifts in the mines. See Plin. *NH* 33.96-7 (mines) and Caes. *Gall.* 5.13.3-4 (military).

³⁰ Ex: Ar. *Ekk.* 651-2.

³¹ Our literary and epigraphic sources employ a range of terms to refer to sundials and water-clocks. Some of the more common terms include ὥρολόγιον and ὥροσκοπεῖον (Greek) and *horologium* (Latin). On the inconsistency of this terminology, see Bonnin 2010a: 185 and 2015: 73-98.

³² Overviews can be found at Mills 1996; Bonnin 2012a, 2012b.

³³ Greeks used a value of 24°, a bit higher than the actual 23.4°. Ancient technical treatments of sundial construction suggest that they were usually designed using an *analemma*, such as those offered by Vitruvius 9.7 and Ptolemy *Anal.*

modern scholars such as Gibbs, Schaldach, and Bonnin to determine that most of our extant sundials were tailored to the same geographical locations in which they were found.³⁴



Figure A: Partially-preserved conical sundial of gray marble. The horizontal lines mark the solstices and equinoxes; the vertical lines the hours. Though the gnomon has been lost, the drill holes are visible at the top. Vatican Museum, Inv. 949. Photo Credit: Kassandra Jackson Miller.

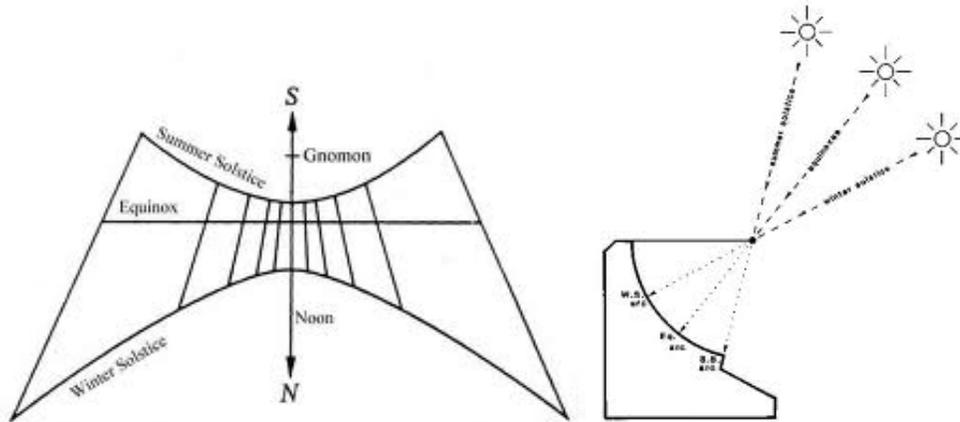


Figure B: (i) Net of hour and date lines as they would appear on a planar sundial. (ii) How the date lines relate to the position of the sun at the solstices and equinoxes.

Of the more than 500 Greco-Roman sundials that have been discovered, some are monumental and were installed in public places, while many more were sized for the home and garden. In the Imperial period, we even begin to see portable sundials, which a traveler could

³⁴ Gibbs 1976, Schaldach 2006, Bonnin 2015.

calibrate for multiple latitudes. Though the vast majority of fixed dials are marble or limestone, local tufas and other porous stones were sometimes used, and portable dials could appear in bronze or bone.³⁵ Even more diversity is apparent in their design. Spherical³⁶ and conical³⁷ dials are the most common, but we also have examples of hemispherical,³⁸ cylindrical,³⁹ vertical, and horizontal planar sundials,⁴⁰ dials with multiple faces,⁴¹ and even dials shaped like globes.⁴²

A few trends are detectable amidst all of this variety. Chronologically speaking, there is a marked decrease over time in the quality and accuracy of sundials. Concern for their calendrical (as opposed to horological) functions likewise declines. While most Hellenistic Greek clocks are finely worked and carefully calibrated, the numerous dials of Roman-period Pompeii, for example, are much cheaper and of shoddier workmanship. By Late Antiquity, many clocks are downright imprecise, and their date lines are either strictly ornamental or missing entirely. There is little correlation between chronology and style, although Bonnín has noted that the *pelecinum* dial (which is shaped like a double-headed axe) comes to dominate the iconographic representations of sundials in Late Antiquity (Figure C).⁴³ Nor are there particularly strong geographical trends with regard to style. The eastern half of the Roman Empire seems to have had a predilection for conical dials, while the west favored spherical, but variety is present everywhere (Figure D). Each of the primary production centers (including, at different times,

³⁵ On portable dials, see Price 1969, Buchner 1976, Arnaldi and Schaldach 1997.

³⁶ E.g. Gibbs 1001-1005G and Schaldach 2006, Nos. 9, 27, 34, 40.

³⁷ E.g. Gibbs 3001G-3054G and Schaldach 2006, Nos. 2-5, 10-12, 14-20, 24-26, 28-31, 35, 37, 39.

³⁸ E.g. Gibbs 1069G-1075 and Schaldach 2006, Nos. 8, 13, 32.

³⁹ E.g. Schaldach 2006, Nos. 36, 41.

⁴⁰ Vertical, e.g. Gibbs 5001-5009 and Schaldach 2006, Nos. 1, 22. Horizontal, e.g. Gibbs 4001G.

⁴¹ E.g. Gibbs 7001G, 7002G and Schaldach 2006, No. 33.

⁴² For the Prosymna globe, see Schaldach and Feustel 2013. For the Matellica globe, see Evans 2005.

⁴³ Bonnín 2013. Although Hannah does not propose a chronological sequence of sundial types, he sees formal connections between them (2009: 95).

Athens, Kos, Rhodes, Delos, Pompeii, and Aquileia) seems to have had its preferences and minor signature features, but these do not constitute formal, regional styles.



Figure C. The so-called “Anaximander Mosaic,” in which a philosopher holds a *pelecinum* sundial on his lap. Image courtesy of the Rhineland Museum, Trier.



Figure D: (i) Marble spherical dial from Aquileia (1st c. CE). National Archaeological Museum of Aquileia, Inv. 844. (ii) Monumental conical dial from the Theater of Dionysus, Athens. National Archaeological Museum, Athens, Inv. 3158.

In contrast to sundials, very few water-clocks have survived to the present day.⁴⁴ These clocks came in two basic types and a range of sizes. The earliest kind was the “outflow clock,” which operated analogously to courtroom clepsydras. An outflow clock is a vessel perforated at the bottom and fitted with a spout through which water can drain. The operator pours water into the vessel up to the fill-line and can then check the time by periodically measuring the level of the draining water against a vertical hour scale along the vessel’s side (the first hour at the top, the twelfth at the bottom).⁴⁵ This method is problematic, however, because the change in water pressure as the vessel empties can prevent the outflow rate from remaining uniform. The Greeks initially combatted this difficulty by tapering the walls of the vessel,⁴⁶ but it was not surmounted until the invention of the “inflow clock,” credited to Ctesibius in the 3rd c. BCE. In the case of inflow clocks, a float regulates the transference of water from a supply vessel into a smaller vessel with hour markings up the side (the first hour at the bottom, the twelfth at the top).⁴⁷ Ancient written sources tell us that a figure sometimes floated on the water’s surface and held a pointer up to the hour scale. Some water-clocks even sported bells, whistles, and/or mechanical clockwork to make the pronouncement of the hour a more notable experience (Figure E).⁴⁸

⁴⁴ For an overview of Greek water-clock history and technology, see Schmidt 1912, Landels 1979, Lewis 2000, Hannah 2009: 97-115. One of the earliest references to water-clocks in the textual sources appears at *Ar. Ach.* 693-4.

⁴⁵ In order to keep track of seasonal hours, these clocks needed multiple hour scales (usually one for each month of the year).

⁴⁶ To maintain hours of equal length, the vessel wall would have had to correspond to the curve given by $y = x^4$. For further discussion, see Stutzinger 2001: 12-13.

⁴⁷ Landels 1978: 193-194.

⁴⁸ Cf. *Luc. Hipp.* 8; *AP* 7. 641.

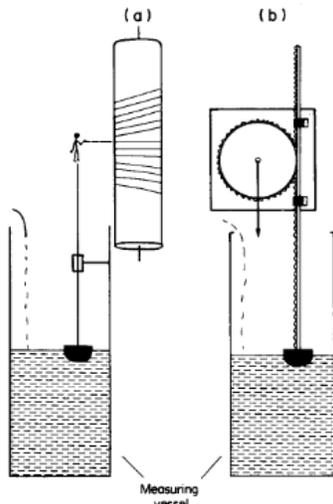


Figure E. (i) Reconstruction of two systems for indicating the hour on an inflow water-clock: (a) a float and pointer system, (b) a rack and pinion. Illustration courtesy of Landels 1979: 35, fig. 6. (ii) The foundations of a monumental water-clock at the Oropus Amphiareion. Photo credit: Kassandra Jackson Miller.

The foundations of monumental water-clocks have been uncovered at Oropus, Samos, Pergamum, Ephesus, Priene, and Athens (in the so-called Tower of the Winds and near the Rectangular Peribolos).⁴⁹ These clocks were situated in public spaces, such as an *agora* or theater, and installed in large, roofed structures, where they could operate unaffected by nightfall or inclement weather. A smaller example, exquisitely-wrought in bronze, has been associated with a temple of Borvo-Apollo in Roman Gaul, and it is likely that we possess fragments of other small water-clocks that have been mistakenly classed as regular vessels. They must have been

⁴⁹ For discussion of the nine dials on the Tower of the Winds, see Schaldach 2006: 61-83. On the Samos water-clock, installed in the agora and outfitted with a dolphin that spouted water on the hour, see Tölle 1969; Dunst and Buchner 1973. On the water-clock near the Rectangular Peribolos, see Armstrong and Camp II: 1977. On the clock in the Oropos Amphiareion, see Theodossiou et al. 2010. For the water-clock in the Pergamum agora, which emitted water through the “cornucopia of Hermes” every hour, see *IvP*. 183. For the clock embedded in a small monopteros in the Ephesian agora, see Hueber 1997: 71-3. On the water-clock in Priene’s theater, see Wiegand and Schrader 1904: 239f. and Von Gerkan 1921: 27f.

more common than our sparse material evidence suggests, because we have many written testimonies of their use - whether direct (e.g. that someone owned or used a water-clock) or indirect (e.g. the specification of an hour of the night, when sundials could not function).

The interpretation of this horological data is, however, fraught with challenges. To begin with, precise archaeological contexts are hard to come by, making it difficult – if not impossible – to reconstruct clocks’ exact locations, degrees of visibility, and potential functions. The clocks themselves tell us little, since only a small proportion bear inscriptions or non-generic decorations.⁵⁰ The epigraphic record can be of some help in explaining how clocks and hours could be used in everyday life. Inscriptions tell us, for example, that some sanctuaries received small clocks as votive offerings,⁵¹ and that sanctuaries,⁵² like town squares,⁵³ seem to have possessed larger clocks for institutional use. Clocks in baths could regulate access (e.g. opening/closing times and male vs. female bathing times),⁵⁴ while clocks in gymnasias kept the young men punctual⁵⁵ and helped responsible parties to know when they should provide oil for the athletes.⁵⁶ In order to make sense of such references, however, and to develop a fuller picture of how clocks were used and understood, it is imperative that we also consult our literary sources⁵⁷ and explore how individual authors engaged with this technology.

⁵⁰ Most sundials are plain or decorated with standard architectural motifs: rosettes, acanthus leaves, lion’s-foot bases.

⁵¹ E.g. *ID* 2087 (Delos; to Sarapis, Isis, Anubis, Harpocrates, and Hydreus); Paton-Hicks 57 (Cos; to Good Fortunes); *ASAA* 19-21 (1941-43) 99,17 (Lemnos; to the Great Gods). Unfortunately, we can only speculate as to the significance of such gifts.

⁵² *ID* 1412, 1417, 1423, 1442, 2087; *SEG* 37.527 [= *CIG* 2.1947]; *IEph* 3004; *IvP* III 103; *CIJ* 2.1351

⁵³ *ID* 1770; *BCH* 60 (1936) 336; possibly *IG* XII³ 1101, *ASAte* 1941/42:99,17, and *IK Iznik* 726 = *IK Kios* 7 (all dedications of clocks in unspecified public spaces).

⁵⁴ *SEG* 26:1044. Cf. The *Lex Metallii Vipascensis* (lines 19-23).

⁵⁵ One humorous graffito from an Ephesian gymnasium’s toilet warns the reader “On time or death (τὴν ὥραν ἢ τὸν θάνατον)!” (*IEph* 561.1). On gymnasium punctuality, see also *SEG* 27.261.

⁵⁶ For the presence of clocks in gymnasias: *ID* 1417; *MDAI(A)* 32 (1907) 257,8. On the provision of oil: *IG* V¹ 1390; *IG* X² 2 323; *IG* X² 2 326I [= *SEG* 38:680]; *IPriene* 112.

⁵⁷ The literary evidence for clocks and hours likewise clusters within particular genres. These include technical works by astronomers, engineers, and mathematicians (e.g. Posidonius, Ctesibius, Heron, Geminus, Ptolemy); erudite compendia (e.g. Pliny, Vitruvius, Athenaeus); ethnographic works (Strabo, Pausanias, Plutarch); military

A User of Clocks: Galen and His Biography

The archaeological and literary records have yielded tantalizing clues indicating that, from the Hellenistic period onward, some physicians may have used sundials and water-clocks to help them in their practice. For instance, scattered references to numbered hours appear in a variety of medical treatises, and a portable sundial was discovered along with a set of surgical instruments in a physician's tomb at Este.⁵⁸ These clues raise several questions. How common was it for physicians to consult clocks, and in what contexts might they do so? The sparseness of the evidence makes certainty impossible in the aggregate.⁵⁹ The Galenic Corpus, however, is so voluminous and contains such a comparatively large number of references to clocks and hours that it offers historians the rare opportunity to approach these questions – and more besides – on the level of one individual. So, who was Galen? And why did he take such an interest in hourly timekeeping?

As attested in the title of his work *The Best Doctor is also a Philosopher*, Galen understood himself to be not only a physician but also a philosopher, and he enjoyed extensive training in both disciplines.⁶⁰ He began studying medicine at the age of sixteen, when his father, responding to an oracular dream, found teachers for him in Pergamum.⁶¹ Galen continued his medical instruction in Smyrna, Corinth, and Alexandria before returning to Pergamum in 157 CE

narratives (e.g. Xenophon, Polybius); comedies (e.g. Attic Middle Comedians, Plautus, Alciphron); and medical treatises, such as the ones explored in this dissertation.

⁵⁸ See Chapter Three. An inscription from the healing sanctuary at Epidaurus, dated to the Imperial period, labels a series of hymns with the seasonal hour at which each is to be sung, suggesting one possible use of clocks in temple medicine. On this inscription, see Bonifas 1989.

⁵⁹ We can but speculate, for instance, that most people learned the hour aurally, via either a verbal announcement (made by a town crier or one's personal slave) or a mechanized tone (made by a bell or whistle).

⁶⁰ Galen's significance as a philosopher is attested in several later writers, such as Alexander of Aphrodisias (*In Soph. El.* 22.7), Themistion (*In phys.* 144.8f., 144.24, 149.4), Simplicius (*In phys.* 325.24, 573.19, 708.28, 718.14, 1039.13), and Philoponus (*In phys.* 576.13; *De aet. mundi* 319.7, 599.23). Alexander of Aphrodisias even places Galen on par with Plato and Aristotle (*In Top.* 549.24). For more on the perception of Galen among his near contemporaries, see Nutton 1984.

⁶¹ *De meth. med.* X.609 K and *De praen. ad Post.* XIV.608 K.

to take up the prestigious post of physician to the gladiators. He began practicing in Rome in 162 CE, where he made a name for himself by performing public surgical demonstrations on living animals and debating ferociously with rival doctors. Ultimately, Galen was so successful that he was named personal physician to the emperors Marcus Aurelius and Commodus.

Galen's philosophical instruction, so he tells us, began at his father's knee. Aelius Nicon, an architect, insisted that his son develop a solid grounding in grammar, mathematics, and morality, and Nicon's own temperance, probity, and generosity were inspirational for Galen.⁶² When he got older, Galen went on to acquaint himself with Platonism under the tutelage of Gaius and Albinus in Smyrna. He learned Stoic doctrines from a disciple of Philopater, and was introduced to the teachings of Aristotle and the Peripatetic school while studying with a student of Aspasius.⁶³ This broad exposure impressed upon Galen both the importance of philosophy in general and the particular weaknesses of each school's system of thought.

Galen felt that the professions of medicine and philosophy were closely interrelated.⁶⁴ In fact, over the course of his training, Galen became increasingly convinced that practitioners of both disciplines could learn a lot from one another's methodologies. Contemporary Sceptics, Stoics, Epicureans, Peripatetics, and Platonists, in Galen's opinion, ultimately failed in their efforts to persuade because they did not know how to subject their propositions to logical and empirical tests⁶⁵ – this in spite of the fact that Aristotle himself had invented the categorical syllogism and the Stoics had contributed the field of propositional logic.⁶⁶ On the other hand,

⁶² See, e.g. *Aff. pecc. dig.* V. 40.11-43.13 K.

⁶³ On Galen's biography, see e.g. Smith 1979: 62-72; Percy 1985; Barnes 1991: 54-5; Gourevitch 1998: 118-20; Schlange-Schöningh 2003; Hankinson 2008; Nutton 2013: 222-35.

⁶⁴ He was not the only 2nd c. CE doctor to do so. See, for example, Sextus Empiricus and Heraclitus of Rhodiapolis.

⁶⁵ Cf. *Aff. pecc. dig.* V.70.4-7 K; V.102.8-13 K.

⁶⁶ On Galen's relationship to philosophical traditions, see Barnes 1993, Tieleman 2008, Lloyd 2008. On the Hippocratic precedent for doctors denouncing the unfounded hypotheses of philosophers, see *Prisc. med.* 20. 1 = 1.620 L. Cf. the attack on Melissus in *Nat. hom.* 1.

according to Galen, the most popular medical schools of his day erred by tending to favor *either* logic *or* empiricism, each to the exclusion of the other.⁶⁷ He describes the Rationalists as relying on theoretical inference and the Empiricists as working solely on the basis of observation.⁶⁸ Then there were the Methodists, for whom Galen had nothing but contempt.⁶⁹ He presents them as rejecting both theory and observation altogether, opting instead for a slapdash, one-size-fits-all method that could be mastered in a mere six months.⁷⁰ No contemporary philosophical or medical school had, in Galen's opinion, discovered the sweet spot, that perfect marriage of rationality and empiricism, which would allow practitioners to make progress in their respective arts.⁷¹ The only member of his generation to have succeeded was, in Galen's view, himself.⁷²

For Galen, this stance was as much a competitive strategy as a conviction. He lived in a world that lacked any formal system of accreditation and, thus, every doctor was under constant pressure to demonstrate his own merit. The backing of high-profile patrons or the brand name of a particular medical sect could provide some defense against this cutthroat environment.⁷³ Nevertheless, it was typical to find several rival doctors crowded around the sickbeds of wealthy individuals, with each physician trying to persuade the patient to choose his particular course of

⁶⁷ Members of these sects would not have agreed with Galen's portrayals of them. The Empiricists, for example, did not see themselves as avoiding the use of logic.

⁶⁸ On the Empiricists, see Nutton 2013: 147-9.

⁶⁹ Although Thessalos was not the actual founder of Methodism, Galen likes to represent him as the "refounder" of the school. See Nutton 2013: 189-94.

⁷⁰ *De sect. ad eos qui intr.* I.83 K.

⁷¹ On other ancient medical sects, such as the Pneumaticists and Eclectics, see Smith 1979; Gourevitch 1998; Nutton 2013: 207-11. For references to doctors within our epigraphic sources, see Samama 2003.

⁷² Nutton describes Galen's thought-world as being dependent "on a basically Aristotelian epistemology and on a combination of data drawn from the Hippocratic Corpus and Plato and inserted into a world of Aristotelian physics" (2013: 120). For more on Galen's epistemology and positioning between these philosophical and medical camps, see Frede 1981 and Tieleman 2008.

⁷³ Galen is not shy about his successes curing such eminent philosophers as Glaucon (*Loc. Aff.* 8.361-6) and Eudemus (*Praen.* 14.605-19).

treatment.⁷⁴ Nor was the situation much different among philosophers. Aspiring students were not required to enroll exclusively in one school or another, but rather were free to hop from teacher to teacher as they pleased. If a philosopher wanted to retain pupils, it was his responsibility to persuade them that his own system was more effective and offered greater benefits than anything else on the market. Galen hoped to be a successful competitor in both the medical and the philosophical arenas, but if he was to avoid aligning himself with any school, he had some work to do. Galen needed to develop his own method – his own brand, as it were – and sell it with such confidence that his audience would feel compelled to buy.

So what was Galen’s special method? He refers to it most frequently as “demonstration” (Gr. ἀπόδειξις), or simply “the analytical theory” (Gr. θεωρία ἀναλυτική). This method seems to have been discussed most fully in Galen’s 15-book *On Demonstration* (now sadly lost), but it also appears throughout his corpus. Galen’s *apodeixis* owes much to developments in Hellenistic mathematical proofs, Aristotelian and Stoic logic, and the contemporary debates just discussed, among Rationalists, Empiricists, and Methodics.⁷⁵ The goal of the method is to “prove” the validity of a proposition using a sequence of logical inferences that are ultimately founded on universally-accepted axioms. These axioms are incontrovertible because they are empirically verifiable, that is to say, anyone can check to see that they are true.⁷⁶ Galen gives as an example of an axiom the mathematical statement “twice two is four.” All a person would have to do to check the validity of this claim is to snatch up two pebbles, group them with another two pebbles,

⁷⁴ *Diff. puls.* 8.511-14 K and *Dig. puls.* 900-16 K. For more on the competitive nature of ancient medicine, see Barras et al. 1995: vii; Hankinson 2008; Lloyd 2008; Mattern 2008: 69-97. On the agonistic aspect of Galen’s public dissections, see Gleason 2007.

⁷⁵ On Galen’s relationship to Aristotelian philosophy, see Singer 2014. On Galen and mathematics, see the introduction to Kieffer 1964. On Aristotelian conditional syllogisms and their relationship to mathematical proofs, see McKirahan 1992, Goldin 1996, Hintikka 1981, Smith 2009. On Euclidean production proofs and their analogs in Plato, see Patterson 2007 and Wolfsdorf 2008.

⁷⁶ On the importance to Galen of empirical testing, see also *De simp. med. temp. ac fac.* 11. 459-61. For discussion, see Hankinson 2008: 169.

and count up the total.⁷⁷ Galen was unwilling to give strong assent to a proposition unless it could be double-checked by observation.⁷⁸ Only in this way could a person consistently distinguish between genuine truths and falsehoods that bear a close resemblance to truth.⁷⁹

Unlike the present day, in which novelty is acclaimed, the buzzwords of Galen's time were "legacy" and "tradition."⁸⁰ Regardless of how innovative Galen's approach was, and this is controversial, Galen's most effective strategy was to present himself as the intellectual successor of the philosophers and physicians of Classical Greece. He aligns himself most closely with Hippocrates, Plato, and Aristotle, and indeed their thought pervades much of Galen's writing.⁸¹ Yet, Galen was also very much a man of his day. He was greatly influenced by Stoic notions of cosmic sympathy,⁸² and by the values, social structures, and self-presentational modes that operated in Imperial Rome.⁸³ In our investigation, we will see how Galen uses hourly

⁷⁷ Cf. *Aff. pecc. dig.* V.59.12-14 K.

⁷⁸ On "strong" vs. "weak" assent, see *Aff. pecc. dig.* V.59.4-12 K. On Galen's relationship with logical systems, see Barnes 1993 and 2003; Morison 2008a. Though Galen was once lauded by scholars such as Barnes (1991) for his invention of a third class of syllogism (the "relational"), few scholars today are impressed with Galen's contribution. Barnes himself has come to lament, "Had Galen thought of uniting categorical and hypothetical syllogistic in some fashion, he would have been the third logician of history. Instead, he discovered a bogus third species of syllogism" (2003: 24). On Galen's view that sensory input was the starting point for all physical investigation, see *De temper.* 1.588 and discussion at Hankinson 2008: 158. Galen assumes, of course, that phenomena are perceived in the same way by everyone.

⁷⁹ See *Aff. pecc. dig.* V.61.5-13, 62.8-12 K; *De const. art. med.* VI.1.245 K; *De meth. med.* XII.10.9 K and XIII.10.28 K; *De ord. libr. suor.* XIX.50-53 K; *Adv. Lycum* 22, and elsewhere. For discussion, see Barnes 1993: 35.

⁸⁰ Galen certainly did not invent axiomatic reasoning or its pairing with empiricism, nor did he claim to have done so. Nor was he original in bridging the gap between philosophy and medicine via logical reasoning. Plato himself actually praises Hippocrates for his methodology at *Phaedr.* 270c-d. For discussion, see Tieleman 2008: 52-3.

⁸¹ Galen believed that Plato and Aristotle were indebted to Hippocrates. In fact, he even asserts that Plato had studied medicine under Hippocrates. See his commentary on the *Timaeus*, *In Plat. Tim. comm.* For more on Galen's engagement with Plato, see e.g. Rocca 2006. On Galen's identification with his Greek roots, see Nutton 2013: 227. On his valorization of Greek *paideia*, see Von Staden 1997, and on the growing link between Greek *paideia*, athletic training, and the urban elite in this period more generally, see Van Nijf 2001 and Mattern 2008: 52.

⁸² See Holmes 2012 and 2015.

⁸³ The extent to which Galen was "Romanized" has been the subject of hearty scholarly debate. Scholars such as Mattern (2008) and Wilkins (2007) argue respectively that Galen viewed Rome as an essentially Greek city and that, while he regularly engaged with Latin authors, he preferred to "hold them at arm's length" (Wilkins 2007: 85). Flemming (2007), on the other hand, has drawn attention to the ways in which Galen's worldview was influenced by Roman imperial organizational structures. At *De san. tuenda.* 6.51, Galen declares that he writes "for Greeks and for those who aim to aspire to Greek pursuits even though they were born barbarians."

timekeeping to express his commitments both to the Classical and Hellenistic Greek past and to his Roman present.

Project Overview

As stated above, I have organized this dissertation around two fundamental questions. First, how, when, and why does Galen exploit clock technology for practical and rhetorical purposes in his ongoing disputes with fellow doctors and philosophers? And second, to what extent are Galen's attitudes toward clocks and hours representative for his time? To respond to these questions, I engage with a wide variety of sources, crossing the traditional disciplinary boundaries between philology, epigraphy, numismatics, archaeology, art history, and philosophy to make new connections and achieve a fresh perspective.

The first two chapters of the dissertation engage with Galen's ethical treatise *On the Affections and Errors of the Human Soul*. In Chapter One, I perform a series of close readings in order to investigate how Galen uses the language of clock-making to promote his own scientific method and, by contrast, to denigrate the methods of others. The chapter demonstrates how Galen uses the process of clock-construction specifically as a paradigm of *apodeixis* in action. At the same time, Galen presents rival philosophies as antithetical to *apodeixis*, and associates them with a lengthy list of negative qualities.

In Chapter Two, I contextualize Galen's decision to use clock-making paradigms within a philosophical treatise by comparing his portrayal of clocks with those of contemporary authors and artisans. I argue that, in giving prominence to clocks, Galen in fact adapts to his own purposes a trope that was widespread in the artistic and literary productions of his time.

Ultimately, I seek to demonstrate that, for Galen, the process of clock-making provided a model for how to live an error-free life.

In the remainder of the dissertation, my focus shifts to the roles that hourly timekeeping plays within Galen's medical treatises, especially those that address intermittent fevers. Intermittent fevers are fevers whose intensities ebb and flow according to recognizable temporal schemes, as is the case with modern strains of malaria. From the late Classical period onward, physicians competed to identify these patterns and their appropriate treatments, in order to improve their own medical predictions. Galen, of course, was not one to hang back from the fray. In Chapter Three, I examine sections of Galen's *On Critical Days* so see how Galen incorporates hourly timekeeping into his defense and refinement of Hippocratic "critical day" schemes, which were designed to help physicians anticipate turning points in febrile diseases. I argue that, in referencing hourly timekeeping, Galen seeks to support two of his favorite claims: first, that he is familiar with astronomical principles; and second, that he alone among his peers deserves to be recognized as Hippocrates' successor.

In Chapter Four, I consider the importance of hourly timekeeping to Galen's fever-classification system and his ability to "solve" – at least, in his own opinion – the problem of irregular intermittent fevers, whose periods deviate from the recognized patterns. This chapter takes as its case study a little-known treatise entitled *Against Those Who Have Written on Types*, in which Galen deconstructs the arguments of physicians whose fever-classification systems seem to him excessively complex and wholly unrealistic. I argue that Galen's use of hourly timekeeping in this context helps him to present himself as both an empirical observer and a rational logician, in other words, a peerless practitioner of *apodeixis*.

Finally, in Chapter Five, I consider how Galen's interest in hourly timekeeping relates to his understanding of "right timing" (Gr. *καίρος*). My primary case study is Galen's *On Hygiene*, a treatise in which he discusses the nature of health and strategies for maintaining it. I demonstrate how, for Galen, the window of kairic or "timely" action varies in aperture depending on whether a patient is sick, healthy, or simply aged. I also argue that the relationship between hours and *kairoi* varies in Galen's writings according to these contexts. Ultimately, I demonstrate that here too Galen's use of hours is motivated by his desire to practice good scientific method and to build upon the theories of his Classical and Hellenistic predecessors.

As a whole, my project reveals that, while Galen engages closely with contemporary scholarly and representational trends, the precise manner and degree to which he applies hourly timekeeping to medical and philosophical controversies is unparalleled in our limited extant sources. His particular interest in horology is, I argue, intimately entwined with his approach to scientific inquiry. On the one hand, Galen references specific hours in order to present himself as a careful and accurate investigator, well-versed in the latest mathematical and technological advances of his day. Yet, his interest in clock-construction and hourly timekeeping also dovetails with many of his deeper ideological commitments, such as his belief in long-term scientific progress, his dream of achieving clear communication among scientists, and his insistence that proper scientific method involves a balance between logic and empiricism. Thus, by referring to clocks and hours, Galen can advance two of his central programs: to discredit his rivals and to promote his own vision of how the process of intellectual inquiry should function.

This dissertation offers the first detailed case study of how one individual conceived of – and exploited – the social, scientific, and rhetorical potentials of hourly timekeeping. As such, it

can help us to glimpse a sliver of the lived experience of timekeeping in antiquity and to expose some of the complex ways in which an individual's understanding of time could influence his strategies for engaging with the world around him.

PART 1: Clock Construction in Galen's Philosophical Work

1. Clock-Making is Good to Think With: Its Role in *Affections and Errors*

Thus reason, after seeking by the analytical method, found a design for the water-clock (κλεψύδρα), the test of which is clear even to laymen. For the topmost line, which indicates the twelfth hour of the day, has the greatest height where the water-clock measures out the longest day, and has the shortest height where it measures out the shortest day. In between the two is the line that marks the days at the equinoxes. In between the equinoctial sections on the edge of the water-clock you will see the four days after those mentioned.... (57,10-20 DB = V.84.16-85.10 K).¹

This passage, which proceeds into a lengthy description of how to design and test a water-clock, would be very much at home in the technical writings of a Vitruvius or Ptolemy.² Yet, surprisingly, these lines were penned by Galen, in a treatise devoted not to advanced mathematics or astronomy, but to epistemology and ethical psychology. In fact, in *On the Affections and Errors of the Human Soul* (henceforth *Affections and Errors*),³ Galen elects to walk his reader through the construction of not one clock, but two: first a sundial, and then the inflow water-clock mentioned above. This provokes certain questions. Why might Galen have chosen to include passages like these in a philosophical treatise? And what, in his opinion, can clock-construction teach us about how to pursue truth and live our lives?

¹ All translations are my own.

² Both of these authors do, indeed, discuss strategies for constructing sundials and water-clocks. See Vitruvius, *De arch.* 9.1-15; Ptolemy, *Anal.*

³ Galen refers to this work at *De libr. propr.* XIX.45.10-47.11 K (= 169-171 BM), where he lists it under the heading of “Works on Ethical Philosophy (τῆς ἠθικῆς φιλοσοφίας).” My citations of *Affections and Errors* refer both to Kühn’s edition (= K) and to W. de Boer’s *Galenus de animi cuiuslibet affectuum et peccatorum dignotione et curatione (Corpus medicorum Graecorum V.4.1.1. Leipzig: Teubner, 1937): 3-68 (= DB)*. De Boer’s text derives primarily from the Medieval Florentine manuscript *Laurentianus* 74.3 fol. 149v-171r (12th or 13th century). On the challenges of the manuscript tradition for this text, see Singer (ed.) 2013: 232-6. English translations of *Affections and Errors* can be found in Riese (ed.) 1963 and Singer (ed.) 2013, and the Budé series has produced an excellent French translation and commentary (Barras et al. 1995).

Over the next two chapters, I will approach these questions from two different angles. In the present chapter, I will examine the local roles that these clock-making paradigms play within *Affections and Errors* by asking how they function to support the treatise's central claims. In the following chapter, I will contextualize Galen's decision to focus on clock construction in particular by comparing his portrayal of clocks in *Affections and Errors* with the clocks described, depicted, or produced by contemporary authors, artists, and artisans. These investigations will help us to understand what clocks signified within Galen's thought and how representative he might have been in this regard.

In order to assess the functions of the horological examples within *Affections and Errors*, we must first consider the structure of Galen's argument and identify the main claims that he hoped to defend. I will then demonstrate how Galen uses clock-making to defend those claims and, specifically, to exemplify the positive characteristics of his own method of scientific inquiry (*apodeixis*) in contrast to the unfortunate and error-riddled strategies employed by Stoics, Peripatetics, Epicureans, and other sectarian philosophers of his time. As we proceed with this study, it will be helpful to bear in mind three features of Galen and his world that were outlined in the Introduction: (1) Galen considered himself to be not only a doctor, but also a philosopher, and he was the beneficiary of extensive philosophical training across several schools; (2) in order to practice both philosophy and medicine, Galen had to work within an environment in which fierce competition and self-promotion were the norm; (3) in an effort to assert his unique success and to attract followers, Galen often took a polemical stance against those physicians and philosophers who were affiliated with contemporary schools. As we shall see, each of these characteristics is prominent within *Affections and Errors* and influences Galen's authorial decisions.

Defining the Stakes in Galen's *Affections and Errors*

The dating of *Affections and Errors* is problematic.⁴ Since the text – as we have it – makes reference to *Character Traits*, a psychological treatise that postdates the fire of 192 CE,⁵ *Affections and Errors* has been tentatively dated to the very end of the second century CE, and thus is included among Galen's later works.⁶ However, the treatise's opening sentence suggests that the text may, in fact, constitute a later writing-up of an earlier oral presentation; how much earlier, we cannot say.⁷ We do know that Galen composed this treatise for a friend who had asked him to assess Antonius the Epicurean's theories on managing the affections of the human soul.⁸

Galen's major criticism of Antonius' work is that it fails to distinguish clearly between “affections” (Gr. πάθη), which threaten the *irrational* part of the soul, and “errors” (Gr. ἀμαρτήματα), which endanger the soul's *rational* part.⁹ According to Galen's definition,¹⁰ a man who shovels half a cake into his mouth could be said to be in the grip of an “affection” or “irrational impulse” (τιν' ἄλογον ὀρμήν, 6, 26 DB = V.7.10 K), because he is yielding to a gluttonous urge. An “error,” on the other hand, derives from the creation of a “false opinion” (τὴν ψευδῆ δόξαν, 6,25 DB = V.7.9 K), and Galen seems to suggest that these come in two

⁴ It is also quite lacunose in some places (see Donini 1988 and Singer's response to Donini at Singer (ed.): 2013: 230). The passages that we will consider in this chapter are undamaged, but in thinking about the argument of the text as a whole, it is important to recall that some material may be missing.

⁵ Galen kept his personal “library” in the Temple of Peace. When this building burned down in 192 CE, Galen lost many of his own works. See *De comp. med. per gen.* 1.1. = XIII.362 K; *De libr. propr.* 2 = XIX.19 K and 11 = XIX.41 K. For discussion of the fire and Galen's response to it in *On Avoiding Distress*, see Tucci 2003. On the relationship between this text and *Affections and Errors*, see Singer 2013 (ed.): 38-40.

⁶ *Ibid.* 2, 34, 38-40.

⁷ 3.5-7 DB= V. 1.1-4 K: “You have asked me to write up, in the form of a commentary, my response to your question about Antonius the Epicurean's book, *On Guarding One's Affections*. Therefore, I shall indeed do so and thus make this beginning.” This would also help to explain why Galen makes no mention of the fire in *Affections and Errors*, nor references his earlier work *Avoiding Distress*, despite its relevance to the subject at hand.

⁸ On *Aff. pecc. dig.* as a work of moral instruction, or *parainesis*, see Curtis 2014: 51.

⁹ 4,2-7 DB = V.2.11-3.4 K.

¹⁰ On the complexities of the term “affections,” see Tieleman 1996: xxiv n. 42b.

flavors. An individual can err either by misidentifying which goal is most appropriate for him to pursue, or by drawing incorrect conclusions about how to attain the appropriate goal. Thus, our cake enthusiast could be said to err if he either (a) believed that gluttony was a virtue worth pursuing (hence, wrong goal, right strategy), or (b) sought to maintain good health, but concluded that devouring cake was the best way to achieve this aim (right goal, wrong strategy).¹¹ In the first half of *Affections and Errors*, Galen focuses on the different types of affections that afflict human beings, and encourages his readers to band together in order to combat these impulses. He points out that men tend to be blind to their own faults but hawk-eyed when it comes to the faults of others,¹² and thus he advocates fostering a community in which men are able to exchange criticism freely for mutual benefit.

In the second half of the treatise, Galen shifts his attention to the mistakes of judgment that can prevent human rationality from functioning correctly, and it is in this context that we find his extended discourse on clock construction. Galen's argument in this half of the treatise is two-pronged. He argues, first, that many of the beliefs which undergird the philosophical schools of his day are actually false beliefs, and thus "errors,"¹³ and second, that his own apodeictic method offers the only sure way of avoiding such errors entirely. "All the things that different [philosophical] sects do and say to contradict each other over the course of time arise on account of false judgment (κατὰ κρίσιν ψευδῆ)," Galen says. "It becomes clear that all of these are bad, and that the mistakes which pervade every sect are errors (ἁμαρτήματα), now that someone else (i.e. Galen himself) has found not only the aim but also the way of life that is in conformity with truth" (52,15-53,1 DB = V.76.11-77.4 K).

¹¹ On the problems inherent in Galen's distinction between affections and errors in this text, see Donini 1988: 66-9.

¹² 6,5-10 DB = V.6.4-7.8 K.

¹³ Galen's point is that a person cannot know whether a belief is true or false until he has tested it for himself.

To support his theses, Galen establishes a series of contrasts between his own method of scientific inquiry and the erroneous methods of other philosophers.¹⁴ Under the heading of “apodeictic arts” (i.e. arts that employ Galen’s scientific method) Galen includes “geometry, arithmetic, logic, astronomy, and architecture,” because these sciences are founded on testable axioms¹⁵ – or, as Galen likes to put it, they “bear witness to those who truly discover them (μαρτυρούσαις δὲ τοῖς ἀληθῶς εὐρηκόσιν)” (47,11-14 DB = V.68.9-14 K).¹⁶ They are, as we might say, “self-confirming.” Galen invites the reader to consider an example from geometry, which involves drawing one geometric figure around or inside another:

Take, for example, an instance where we are enjoined to draw a circle around a given square or, in the same manner, to draw a square around or inside of a given circle.... If anyone is able immediately to circumscribe each of these figures by means of the method which he has learned, then he will give evidence, by doing this very thing, that he has found the object of his search (πρὸς αὐτοῦ τοῦ πράγματος μαρτυρήσεται τὸ ζητούμενον εὐρηκῶς) (46,24-27 DB = V.66.6-67.11 K).

All one has to do in order to confirm the “validity” of an inscribed polygon is look at it and determine “whether the polygon is clearly seen (ἐναργῶς ὁρᾶται) as inscribed or circumscribed, just as the circle is seen as circumscribed or inscribed with respect to the polygon” (47,2-5 DB =

¹⁴ Such a strategy was common in philosophical protreptic. See Curtis 2014: 49.

¹⁵ For Galen, there are two kinds of self-evident truths: the empirical and the rational.

¹⁶ The alliance between the geometer and the physician is also particularly apparent at 62,13-18 DB = V. 92.16-93.4 K: “While [the philosophers] are eagerly engaging in rivalry on these matters (φιλονεικούντων μὲν αὐτῶν ἐπὶ τούτοις), rehashing the same discourses, often a geometrician will come among them, or some physicians or other men who are fond of discourse and educated in the disciplines but who don’t practice a trade anymore on account of wealth and are not enslaved to some philosophical sect (οὔτε δουλευόντων αἰρέσει τινὶ τῶν κατὰ φιλοσοφίαν).”

V.68.2-4 K).¹⁷ Likewise, if the result is mistaken, that fact will be readily apparent. By aligning his method with mathematically-based disciplines in this way, Galen claims for *apodeixis* several characteristics inherent in mathematical proofs. They are clear, visibly self-evident, easy to check, and as a result, trustworthy.

In contrast, Galen associates his rivals with the opposite characteristics. Their methods produce confusion, equivocation, blindness, and the damning corollary of these: ignorance. “What blindness in recognizing one’s own errors (τυφλότης εἰς τὴν τῶν ἰδίων ἀμαρτημάτων γνῶσιν),” Galen demands, “is greater than that of these men?” In his opinion, the only thing such men can truly be said to “see” or “know” is the fact that they are “especially dull with respect to understanding and remembering (ἑαυτοὺς ὀρῶντες ἀφυστέρους εἶς τε τὸ νοῆσαι καὶ μνημονεῦσαι) those things discovered by means of arithmetic, geometry, architecture, and astronomy” (61,11-15 DB = V.91.7-11 K).¹⁸ Elsewhere, Galen also accuses sectarian philosophers of being charlatans and producers of nonsense (διδασκάλοις ἀλαζόσι, 48,8 DB = V.70.2 K; φλυαροῦσιν, 59,24 DB = V.88.7 K), unknowing and wise solely in their own conceit (ἀνόητοι, 66,27 DB = V.101.2 K; δοξόσοφοι, 60,8-9 DB = V.89.6 K). Such practitioners make decisions hastily, even recklessly (προπετῶς), and thus pass over (μετιέναι, 63,24-5 DB = V.95.11 K), instead of catching, those important factors that allow the patient, diligent practitioners of *apodeixis* to win the day.¹⁹

Another point of contrast that Galen establishes between sectarian philosophers and followers of his apodeictic method is their relationship to a wider community of knowledge.

¹⁷ Cf. 56,14-16 DB = V.83.9-11 K, where Galen emphasizes the evidence of one’s senses (“you will perceive,” πεισθήσει). On the importance of testing propositions for oneself, rather than relying solely on someone else’s assertions, see 53,23-6 DB = V. 78.10-14 and 64,4-25 DB = 96.3-97.4 K.

¹⁸ Cf. 61,2-5 DB = V.90.11-15 K, where Galen mocks the supposedly keen vision of philosophers’ souls (τί ποτ’ οὖν εἰ οὕτως αὐτῶν ἐστιν ὀξυδερκής ἢ ψυχὴ...).

¹⁹ See 62,29-65,15 DB = V.94.1-98.8 K.

Practitioners of *apodeixis*, Galen asserts, participate in such a community, while misguided philosophers are doomed to isolation. The communal element of *apodeixis* derives in part from its universal applicability.²⁰ At 43,25-44,6 DB = V.62.13-63.4 K, for example, Galen claims that his method is useful for both doctors and philosophers alike:

The very thing that Hippocrates said about those who practice medicine seems to apply to those who practice philosophy. Hippocrates said that strong similarities cause errors and confusion even for good doctors.²¹ Inasmuch as not only average doctors but even the very best physicians get tripped up by the similarities of symptoms, it is not unlikely that errors and confusions happen even for good philosophers in matters pertaining to philosophy.

If only everyone would start employing his scientific method, Galen implies, then suddenly all people, doctors and philosophers included, would find themselves speaking the same language – not only the language of the apodeictic process itself, but also the very language of reality.²² Because *apodeixis* is founded upon truths that are verifiable, either empirically or rationally, it has the unique ability to create an interdisciplinary community of individuals who are in agreement about the nature of the world (i.e. their beliefs are based on the same self-evident

²⁰ Cf. *De cur. rat. per venae sect.* XI.256.10-18 K; *Thras.* V.810 K; *De comp. med. per gen.* XIII.605 K.

²¹ *Epid.* VI.8.26 t. V p. 352 Littré.

²² The idea of a “common language” among intellectuals was very important to Galen. In his writings, this often manifests as an obsession with defining key terms (see 41,6-11 DB = V.58.3-59.1 K; 46,7-12 DB = V.66.12-17 K). Indeed, it is Antonius’ slippery usage of important words like “error,” “passion,” and “guard” that seems to have inspired Galen to write *Affections and Errors* in the first place, in an effort to clean up the Epicurean’s semantic mess (3,8-4,7 DB = V.1.5-3.5 K). Galen’s concern with terminology and “common usage” seems to have derived, at least in part, from his efforts to catalogue the wide range of minerals and organic matter that had medicinal properties (see especially *De alim. fac.* and *De simp. med. temp. ac fac.*). He was deeply frustrated by the inconsistency in naming practices, which often left him unclear as to whether, for example, he was looking at one plant with five names or five similar plants with one name apiece. Boudon-Millot (2008) points out that physicians under the empire had to work in multilingual environments without far-reaching standards for weights, measures, or technical terminology. She suggests that Galen’s interest in precision, exactitude, and consensus stems from his frustrations navigating this polyphony. For more on Galen’s struggle with inconsistent medical terminology, see Wilkins 2007: 76-8. On his attitudes to language in general, see Hankinson 1994b and Morison 2008b.

axioms).²³ School philosophers, however, are unable to point to such axioms in order to defend their theories. Instead, these mistaken thinkers hide behind claims of “privileged knowledge” that strike Galen – and other rival philosophers – as weak and evasive.

While sectarian philosophers bicker amongst themselves,²⁴ then, the shared worldview of apodeictic scientists allows them to understand and build upon one another’s contributions to the shared pool of knowledge. Terms such as “common” (Gr. κοινός) and “to agree” (Gr. ὁμολογέω) are buzzwords for Galen, both in this text and in the rest of his oeuvre.²⁵ Towards the end of *Affections and Errors*, for instance, Galen praises an architect of his acquaintance who “uses for his demonstrations principles that are clear and with which everyone indisputably agrees (ἀναντιλέκτως ὑπὸ πάντων ὁμολογουμέναις)” (63,21-3 DB = V.98.15-99.1 K).²⁶ Philosophers whose definitions of the truth are incompatible with the communally ratified definition find themselves at odds with each other and with the unified community.²⁷

Galen highlights the isolation of these philosophers by regularly employing a syntax that places “everyone” or “all of us” in contrast with “the philosophers alone.” For instance, when two squabbling philosophers ask an architect to help them determine whether wood is heavier than water, Galen smugly reports that the architect “explained quickly and clearly, so that *all*

²³ Dewald, in her discussion of Herodotean and Thucydidean historical narrative, has demonstrated how each of these authors establishes a dialogic relationship between his own critical intelligence and that of his reader (2006: 177-82; Cf. Ibid. 2007). Galen seems to write within a similar framework, in that he not only models critical assessment for his reader but also expects his reader to exercise the same faculty.

²⁴ For quarreling philosophers, see 52,3-5 DB = V.76.1-3 K; 60,13-17 DB = V.89.12-15 K; 62,13 DB = V.92.16 K; 62,23-4 DB = V.93.10 K. Cf. *De meth. med.* X.469 K; *De libr. propr.* XIX.40.10-18 K; and elsewhere.

²⁵ According to a *TLG* lemma search, there are 1,767 instances of κοινός in Galen’s corpus, and 754 instances of ὁμολογέω.

²⁶ Cf. (among many others) *De meth. med.* X.30, 42, and 50. Many scholars have pointed out that Galen’s notion of “everyone” is not quite as universal as he would have it seem. At *De meth. med.* X.42 K, for example, he admits that, despite his desire for axioms to be universally accepted, “the discoveries and inquiries and demonstrations of the essence of the objects will depend not on what is believed by most men but on scientific assumptions.” Cf. 60,8-10 DB = V.89.6-7 K. For a discussion of this contradiction, see Barnes 1991: 78-9. For further discussion of agreement in Galen’s work, see Morison 2008a: 71.

²⁷ On philosophers’ unwillingness to convene for healthy debate, see 61,20-62,10 DB = V. 92.1-13 K.

who were present (ἅπαντας τοὺς παρόντας) understood, except for *the philosophers alone* (πλὴν μόνων τῶν φιλοσόφων)” (66,20-4 DB = V.100.11-12 K).²⁸ Galen uses this technique to great effect at the end of the treatise, where he sums up his argument thus:

So, who is more likely to know the truth? One who submits his judgments to all those philosophers who are not shams, and submits his judgments also to those who practice all the arithmetical, logistical arts that depend on reason (τοὺς ἀπὸ τῶν λογικῶν τεχνῶν ἀπασῶν ἀριθμητικούς λογιστικούς): geometers, astronomers, architects, law-makers, orators, grammarians, musicians? Or one who is judged and crowned solely by himself (τὸν ὑφ’ ἑαυτοῦ κρινόμενόν τε καὶ στεφανούμενον), yet who, if he were to subject himself to assessment by other judges, would receive no vote (μηδεμιᾶς ψήφου μεταλαμβάνεται)? (68,11-7 DB = V.103.8-14 K).

Here, Galen reiterates one of the central messages of *Affections and Errors*: namely, that membership in an intellectual community is important because it enables the productive exchange of ideas. In this case, individuals with greater expertise in rational analysis can help those with less experience by providing them with constructive criticism.²⁹ This will help the less experienced to develop their apodeictic skills until they can become experts in turn, eligible to receive the benefits that attend community members in high standing. Sectarian philosophers deliberately close their ears to the cogent arguments of peers and experts alike, and thus deprive themselves of the opportunities for moral, intellectual, and social betterment that come with

²⁸ Cf. 59,30 DB = V.88.13 K; 60,23 DB = V.90.6-7 K; 61,7 DB = 91.3 K; 62,23 DB = 93.9 K.

²⁹ Cf. 8,1-4 DB = V. 9.6-9 K and 43,3-11 DB = V. 61.5-13 K.

being part of a larger group.³⁰ Instead, their self-imposed isolation limits them to what they can learn on their own.

Galen does not restrict his definition of “community” to his contemporaries, the philosophers, geometers, and so forth who frequented imperial Rome. Galen insists, in fact, that we build upon the intellectual achievements of “our ancestors” (τοῖς πρὸ ἡμῶν, 46,2 DB = V.66.7 K), and explicitly cites authors such as Hesiod, Euclid, and Hippocrates. This suggests that Galen imagined his intellectual community to be diachronic.³¹ Only a man who “is prudent by nature and who received the education that has been esteemed by the Greeks from the beginning (τὴν παρ’ Ἑλληνικῆς ἐξ ἀρχῆς εὐδοκιμοῦσαν παιδείαν)” (51,24-52,2 DB = V.75.13-15 K) can hope to master the method that Galen advocates. With claims such as this, Galen conveys the impression that practitioners of his method are the direct inheritors of Classical Greek tradition – a weighty assertion in the time of the so-called “Second Sophistic.” Galen’s rivals, he implies, have cut themselves off from this heritage.

Galen’s notion of an intellectual community extends not only into the past but also into the future. He clearly envisions the readers of *Affections and Errors* as younger men, whose bad moral and intellectual habits have not yet ossified. Men who have long since devoted themselves to a particular school of thought, however, are past help:

Why do you think that the ignorance and pretense to wisdom of such people can easily be cured? If a man has a tumor that has grown hard over the span of three or four years, that hardness cannot be relieved (ἄλυτον ἔχει τὸν κίρρον).

³⁰ Galen says that such people are able to “be shameless” (ἀναίχλυστεῖν, 59,24-5 DB = V.88.7 K). “Shame” (αἰσχύνη) was fundamental to the Greek notion of a functioning community; it was the fear of feeling shame before fellow citizens that kept individuals from committing selfish acts which could cause harm to others and rend the social fabric.

³¹ 42,3-4 DB = V. 59.13 K (Euclid); 43,25 and 44,2 DB = 62.13 and 15 K (Hippocrates); 60,10 DB = 89.8 K (Hesiod). On Galen’s belief in the accumulation of scientific knowledge over time, see Barras et al. 1995: vii.

Similarly, what old man's soul can be relieved (ἢ δὲ τῶν τοιούτων γερόντων ψυχὴ...δύναται λυθῆναι), that has maintained the hardness of ignorance and feigned wisdom (τὸν τῆς ἀμαθείας τε καὶ δοξοσοφίας κίρρον) for thirty or forty years? (51,16-20 DB = V.75.5-9 K).

Galen exemplifies this point by pitting young men (Gr. μεράκια) whom he has trained in *apodeixis* against a group of men who have “grown old in philosophy” (γεγηρακότων ἐν φιλοσοφίᾳ, 60,15 DB = V.75.4 K). He invites these old men to try to stump the lads using sophisms that they themselves had been unable to puzzle out. Yet, to the old men's chagrin, the boys turn out to have no trouble spotting the faults in the sophistic arguments. By identifying his method so closely with the next generation, Galen represents it as the way of the future. Those poor old sectarian philosophers, on the other hand, can look forward to nothing but extinction.

Let us pause to summarize our findings thus far. In *Affections and Errors*, Galen aims to persuade his readers that his own scientific method is more successful at differentiating between truth and falsehood than any method offered by the philosophical schools of his day. To drive home his point, Galen repeatedly contrasts the positive characteristics of *apodeixis* with the negative characteristics of alternative dogmas. He associates *apodeixis* with testability, visibility, clarity, patience, universal applicability, usefulness, concord, community, and perpetuity. The dogmas of contemporary philosophical schools, on the other hand, Galen associates with the reverse: untestability, blindness, confusion, haste, limited application, uselessness, discord, isolation, and decay. We have also observed that Galen likes to draw examples of successful *apodeixis* from the realms of both theoretical and applied mathematics. Let us turn now to the most extended such example that Galen employs, namely, the account of clock construction that appears at the midpoint of this treatise. We will then contrast it with Galen's most involved

example of *erroneous* argumentation, in which philosophers argue fruitlessly about the characteristics of the circumcosmic void. This analysis should help us to gain a better understanding of the kind of work Galen is asking clock-making to do within the context of *Affections and Errors*' larger argument.

The Paradigm of Clock-Construction

It is necessary that the man who wishes to become scientific (ἐπιστημονικόν) attend to himself and train in many things successively, as I said before, which are able to bear witness to the ones who discover them (ἃ μαρτυρῆσαι δύναται τοῖς εὐρίσκουσιν αὐτά). We find such things in the theories of numbers and lines on which astronomy and architecture are based. Come; for the sake of clarity, I will give an example from architecture (<ἐξ> ἀρχιτεκτονίας...παράδειγμα) (54,14-21 DB = V.80.1-5 K).

With these words, Galen offers his readers a lens through which to view the passages that follow, which are centered around two sets of detailed, step-by-step instructions: the first for building a sundial, and the second for designing a water-clock. Most scholars have explained Galen's choice to use an "architectural" example here³² by pointing to the fact that Galen's father, Aelius Nicon,³³ was himself an architect and – as Galen stresses in the first half of *Affections and Errors* – a very influential figure within Galen's own life.³⁴ Galen may well have sought to pay

³² In Galen's time, clock-making or "gnomonics" was considered a branch of architecture. For more on this relationship, see Chapter Two.

³³ Galen does not include his father's name in any of his extant writings, but see *Suidae lexicon* 1 p. 506 Adler, s.v.: "Galen: son of Nicon, the geometer and architect (Γαληνός: υἱὸς Νίκωνος γεωμέτρου καὶ ἀρχιτέκτονος)."

³⁴ Galen establishes a sharp contrast between his father's temperance, probity, and generosity and his mother's tendency toward wild excess, spite, and parsimony: "I enjoyed the great good fortune of having a father who was particularly free from anger and extremely righteous, worthy, and benevolent. Meanwhile, my mother was very hot-tempered, to the extent that she sometimes bit her servants.... Seeing the noble actions of my father juxtaposed with the shameful affections of my mother, I came to welcome and love the former, and to avoid and despise the latter" (27,22-28,4 DB = V.40.13-41.5 K). Galen goes on to imply that Nicon's moral rectitude was grounded in his ability

homage to his father here, and perhaps to lend prestige to the art (Gr. τέχνη) of architecture by giving it pride of place among the mathematically-grounded disciplines.³⁵ Yet, these explanations do not take sufficient account of the polemics of *Affections and Errors*, or of Galen’s decision to showcase the various merits of *apodeixis* discussed above. In what follows, I will demonstrate how Galen uses these clock-construction processes to highlight several of the apodeictic features we have just explored.³⁶ We will first embark on a close, step-by-step reading of these extended passages (which are reproduced entire in the Appendix) to see how Galen develops these themes, before turning to the antithesis of Galen’s clock-making examples – i.e. the philosophers’ debate about the void – and examine the interplay between them.

At the very start of Galen’s discussion of clocks, he claims that these tools are fundamental to the creation of a civic community: “When a city is being built (πόλεωσ κτιζομένης), let the following problem be set before those who will inhabit it (τοῖς οικήσουσιν): they want to know, not by conjecture but with precision, on an everyday basis (μὴ στοχαστικῶσ ἀλλ’ ἀκριβῶσ, ἐφ’ ἐκάστης ἡμέρας), how much time has passed, and how much is left before sunset” (54,21-4 DB = V.80.7-10 K). In this example, Galen represents clocks as being constructed *while* the city is still being built (note the present participle κτιζομένης), even *before* the future citizens move in (note the future participle οικήσουσιν). Urban civilization, as Galen defines it here, requires precise timekeeping; the community cannot function without clocks.³⁷

to approach all situations rationally. Furthermore, it was specifically his schooling in “geometry, mathematics, architecture, and astronomy” (28,19-20 DB = V.42.5-6 K) that allowed Nicon to hone this skill.

³⁵ In so doing, Galen expands the mathematics curriculum that Plato outlines at *Rep.* 521e-525b. For discussion of the social status of architects in Greco-Roman antiquity, see e.g. Clarke 1963, Müller 1989, Thomas 2007. A collection of the epigraphic evidence can be found at Donderer 1996.

³⁶ Clocks are also mentioned as examples of *apodeixis* elsewhere in the Galenic corpus: *Inst.* XII.4.1-4 K; *De libr. propr.* XIX.40.10-18 K; *De cur. rat. venae sect.* XI.256.10-18 K.

³⁷ Galen may be engaging here with the trope of contrasting the highly structured, socially-oriented, and fast-paced life of the city with the leisurely, natural pace of country life. This trope was popular among Augustan-era poets and later writers. Martial’s epigram IV.8, for example, guides his reader through a “typical” day in the city: “The first

But how is it to acquire these clocks? The architects responsible for this task must – Galen insists – employ *apodeixis*. “This problem,” he says in the very next sentence, “according to the analytic method, must be referred back to the first criterion if anyone intends to solve it in accordance with the method we learned in the study of gnomonics [i.e. the art of producing and using sundials].”³⁸ For Galen, the design and construction of an operative sundial must begin from accepted axioms – such as the principles of celestial trigonometry that underlie gnomonics – and proceed according to the rules of logic. Then, in order to double-check that the clock’s hour lines have been drawn appropriately, the final product should be tested both logically (against the original axioms) and empirically (against multiple types of observable phenomena). If all of this is done correctly, the clockmaker, like any practitioner of Galen’s scientific method, can achieve a persistently high degree of precision and accuracy (cf. “ἀκριβῶς, ἐφ’ ἐκάστης ἡμέρας” above).³⁹

To demonstrate his point, Galen begins to recount, in great detail, the order of operations involved in constructing a sundial. These are as follows: (1) Learn the geometric method that will help you to translate the movement of the sun into a system of lines;⁴⁰ (2) determine the shape of the sundial body you wish to use (conical, spherical, etc.); (3) figure out how to transfer your diagram of lines onto the shape of the sundial body; (4) use logical reasoning to check your plans; (5) construct the actual sundial and find a level surface on which to mount it; and (6)

hour and the next wear out the clients making their greetings; / the third exercises the hoarse orators. / Until the fifth, Rome engages in various tasks. / The sixth gives rest to the tired; the seventh will be the end of the workday. / The eighth until the ninth is spent in the shining palastras. / The ninth demands that we throw ourselves upon heaped cushions. / The tenth is the hour for my little books, Euphemus, / when your care prepares ambrosial feasts / and noble Caesar is soothed by celestial nectar....” For discussion of the use of temporal markers within this and similar poems, see Wolkenhauer 2011: 112-114. Cf. Hor. *Serm.* 2.6 and discussion in Reckford 1997.

³⁸ On the scope and definition of ancient gnomonics, see Evans 2005.

³⁹ On the self-confirmation available in *gnomonics*, see also 47,12-21 DB = V. 68.12-69.6 K.

⁴⁰ This presumably involves acquiring (or creating one’s own) *analemma*, a 2-dimensional geometric diagram of the celestial movements. The most frequently cited *analemmata* from the ancient world include those of Vitruvius (*De arch.* 9.7) and Ptolemy (*Anal.*).

perform empirical tests to make sure that your sundial is functional.⁴¹ This process advances from logical, mathematical modeling to the creation of a testable, usable object.⁴² The method itself is both “universal and common” (καθόλου τε καὶ κοινῆς, 55,3 DB = V.81.1 K), the product of consensus within an intellectual community.

What seems to excite Galen most about the construction of sundials is the fact that it is eminently “testable.” He walks the reader through three different methods for assessing the final product’s viability. The first involves checking one’s initial and final hour lines against the actual rising and setting of the sun.⁴³ Although this is a task that could be performed by the clockmaker alone, Galen insists that other parties participate in the process: “Then, having inscribed many shapes in succession, we must give them to men for empirical testing (δοῦναι τοῖς ἀνθρώποις ἔργῳ πειραθῆναι), to see whether the aim has been achieved” (55,17-19 DB = V.81.15-82.2 K). By subjecting his work to the assessment of experts, the clockmaker can minimize the preservation and propagation of errors.⁴⁴ Galen is less explicit about the social benefits that will accrue to the clockmaker in doing this, but they must also have been compelling; in submitting his work for critical review, the clockmaker displays his commitment to truth and thereby enhances his reputation within the community.

The second test that Galen proposes for a completed sundial is one of self-consistency: have all the lines been drawn on the sundial in proportion to one another? This can easily be assessed, with the aid of the eye and a compass. Finally, Galen advocates checking the equality of the sundial’s hours against an external measure, specifically, the rate at which water fills a

⁴¹ See 55,3-13 DB = V. 81.1-11 K.

⁴² On the marriage of calculation and empirical testing in Galen, see Tieleman 2008: 5405.

⁴³ The start of the first hour should coincide with sunrise and the end of the last hour with sunset.

⁴⁴ Galen makes a similar injunction to team up with good men at 54,3-6 DB = V.79.4-7 K. For comparison, on the contribution of public critique to the maintenance of 17th century European clocks, see Sauter 2007: 698.

perforated vessel. No specialty equipment is needed, just some “clear water”⁴⁵ and a bowl with a small hole in it. The process itself is also quite basic and, Galen implies, could easily be performed by anyone.⁴⁶ When the sundial tells you that the first hour of the day has begun, set the perforated bowl in the water and allow it to fill. At the end of the first hour, mark the spot on the vessel to which the water level has risen, then dump the water out, and repeat the process for the second hour, checking to make sure that the water reaches the same level. Repeat again for each hour through the twelfth. Then, Galen insists, “Unless you are completely ignorant, you will perceive (πεισθήκη) that the sundial has been inscribed well, because what is before your eyes has indicated it (τὸ προκείμενον ἐπέδειξατο)” (56,15-7 DB = V.83.11-3 K). Galen reiterates his instructions for every single hour, in a manner that – while tedious – is also rhetorically serviceable. He stresses the ease and accessibility of the testing process and the clear visibility of its results; it is plain to the observer whether or not the water reaches the same level at the end of each hour.⁴⁷ Furthermore, in specifying each step, Galen demonstrates the thoroughness that a scientist must embrace if he is to achieve certainty.⁴⁸ Haste has no place on Galen’s road to truth.⁴⁹

⁴⁵ I.e. Free of particulates. Presumably, one also needs a larger, un-pierced vessel that can contain both the pure water and the perforated vessel.

⁴⁶ The full passage appears at 55,17-56,17 DB = V.81.15-83.13 K.

⁴⁷ Galen does not offer any suggestions for how to correct errors that do occur. Presumably, one would have to adjust one’s trigonometrical calculations and then build another sundial. It is interesting, though, that Galen glosses over the mathematical underpinnings of clock construction and chooses instead to focus on the ways in which designs can be empirically tested.

⁴⁸ Galen also stresses the importance of having a clear order of operations at *De meth. med.* X.31 K: “In order to investigate something according to the method...one must do so with some direction and order, so that something comes first in the investigation, and something second and third and fourth, and so on through the remaining sequence until you arrive at the original proposition.”

⁴⁹ Cf. 60,8-11 DB = V.89.7-9 K: “For those [who are rash in the conceit of their own wisdom] the path to the truth is neither long nor steep (οὐ μακρά...οὐδ’ ἀνάτης), as Hesiod characterized the path to excellence. Instead, it is a shortcut or, rather, it does not actually exist (σύντομος καὶ βραχεῖα, μᾶλλον δ’ οὐδ’ ὅλως ἐστίν).”

Before moving on to an equally detailed discussion of water-clock design, Galen takes a brief “historical” interlude, in which he relates the utility and versatility of *apodeixis* to the utility and versatility of subdividing the length of daylight into twelve hours:⁵⁰

It was proposed that the duration of the whole day be divided into twelve equal parts.⁵¹ They chose this number because it was the most useful (χρησιμώτατον). For it has a half, a third, a fourth, a sixth, and a twelfth, which no other number has before nor after it until you reach 24. This number they rejected as too large, and having judged twelve to be appropriate (σύμμετρον), they cut the time of the whole day into that many pieces. And because such a subdivision is so useful, the Romans and many others, having tried it out, use it when they manage their estates, dividing the whole into twelve portions. And they cut the majority of their everyday rules and measures into twelve portions, as well. If you were to ask me, I could inscribe any clock for you in accordance with my method, regardless of whether you wished to divide the whole day into twelve or into some other of the successive numbers. For you will find that the task has been accomplished, both from its consistency (συμφωνεῖν) with the measures made with the perforated vessel and from the agreement (ὁμολογεῖν) of all the lines with one another, as well as from the fact that the outermost and innermost lines mark out the limits of the day (56,17-57,9 DB = V.83.13-84.15 K).

The number twelve, Galen observes, has numerous factors (1, 2, 3, 4, 6, and 12), and has been successfully employed in a range of contexts, including not just timekeeping, but weights, measures, coinage, and estate law, as well. *Apodeixis*, Galen suggests, is just as useful and versatile as the number twelve – more so, in fact. It is more useful, because it provides the means

⁵⁰ On Galen’s attitude toward “utility” and his favoring of applied over theoretical logic, see Barnes 1993: 51.

⁵¹ Just as Galen did not name an individual person or group as the clockmaker(s) in his city-founding example, neither does Galen mention an individual inventor of the 12-hour system. Thus, we cannot say whether Galen would have agreed with Zeno and Diodorus Siculus – the only other authors known to have discussed the etiology of the hour – who attributed its invention to the Heliadae of Rhodes (Zeno Fr. 2 = Diod. Sic. V.57).

for determining whether a given number (like 12 or 24) has been accurately subdivided in the first place. And it is more versatile, because, using *apodeixis*, one can resolve any mathematical problem; one could subdivide the day not only into twelfths, but even into fifths or twenty-thirds.⁵²

Perhaps to further illustrate the versatility of *apodeixis*, Galen then launches into his second set of instructions, this time for how to inscribe the date and hour lines on a water-clock.⁵³ This procedure is rather trickier than the one for designing a sundial, since Greco-Roman society favored seasonal hours over equinoctial, and these are difficult for a water-clock to measure. The makers of water-clocks had to approximate the shift in daylight length over the course of a year by marking their vessels with twelve different sets of hour lines, one for each month.⁵⁴ Galen, however, promises to describe this finicky process in a manner that is “clear even for laymen (ἐναργῆς ἐστὶ καὶ τοῖς ἰδιώταις)” (57,11-2 DB = V.85.3 K).⁵⁵ With an apodeictic approach, he suggests, even so complex a product as a water-clock can seem easily achievable.

Galen’s discussion of the water-clock, I submit, constitutes not simply a virtuosic display of erudition. It also enables Galen to present and defend his view of scientific knowledge as

⁵² It is interesting to observe how Galen, in this passage, links hours to other metrics, including measures of distance, weight, and coinage. Many writers under the Empire, such as Columella, Pliny the Elder, Balbus, and Volusius Maecianus, display an interest in metrology and include these latter measures within its ambit. Yet, these Latin authors make no mention of calendrical and horological systems, which suggests that they did not view temporal concerns as aspects of metrology. We might wonder, then, whether Galen’s portrayal in this passage is *descriptive* – i.e. a fairly accurate reflection of contemporary understanding – or *prescriptive*, a controversial claim regarding the status of temporal measurement. On weights and measures under Marcus Aurelius, see Cuomo 2007.

⁵³ The only other extended description of water-clock construction currently extant is Vitruvius’ *De arch.* 9.5-15, in which Vitruvius provides instructions for designing both regular and “anaphoric” water-clocks.

⁵⁴ As on a water-clock discovered in the temple of Borvo Apollo. See Stützing 2001.

⁵⁵ The water-clock’s design looks like this: as we saw in this chapter’s opening passage, the uppermost line on the water-clock will indicate the twelfth hour of the day, the bottommost line the first hour of the day (with the ten intermediate lines indicating the ten intermediate hours). These hour-lines will curve to account for the varying lengths of seasonal hours throughout the year (see Introduction). Thus, the twelfth-hour line will be highest at the summer solstice and lowest at the winter solstice. To check the accuracy of a water-clock, Galen recommends comparing its reading to that of an accurate sundial (57,11-58,16 DB = V. 84.16-86.11 K).

something that accumulates over generations. In the passage that follows, Galen chastises rival philosophers for failing to appreciate this fact:

Then did you not set your heart on discovering what such a method is [i.e. for building water-clocks]? Do you not perceive the conceit of wisdom (δοξοσοφία) in yourself, you who, being uneducated (ἀμαθής) in these arguments, could find out nothing in a year or rather – one should say - in your whole life (ὅλω τῷ βίῳ)? For the theory of lines [i.e. plane geometry] was not discovered in one lifetime (βίος ἀνδρὸς ἐνός), but came about little by little (κατὰ μικρὸν). First, elementary observations were sought, and once these had been found, the men who came after added to them the most marvelous theory, which is called “analytical,” and trained themselves in it, along with those who were especially willing. And indeed, they are able to produce no handiwork of the sort which I have discussed up to this point regarding sundials and water-clocks (58,17-59,8 DB = V.86.12-87.5 K).

An individual, says Galen, starting from scratch and working alone, cannot hope to discover, even over the course of his entire lifetime, all of the mathematical theories and engineering techniques necessary to produce the kinds of clocks Galen has just described.⁵⁶ It is only by actively participating in a diachronic community of scientific thinkers that a clockmaker can hope to achieve results that equal or surpass those of his predecessors. For, with past masters as teachers, contemporary scientists are in a position to build upon their teachings and produce even greater marvels. In this way, the theory of lines⁵⁷ was built upon the analytical method,⁵⁷ upon the

⁵⁶ Galen is, of course, taking another jab at sectarian doctors and philosophers here. This entire passage may also be targeting Methodists, whose school of medical thought offered a speedy six-month training.

⁵⁷ It should be noted that Galen does not always use the term “analysis” to refer to the logical process of reducing a problem to a set of initial principles. Here, as elsewhere in his corpus, Galen seems to refer to the geometrical meaning of “analysis,” i.e. an apodeictic method of problem-solving. On the meaning of analysis within this text, see Chiaradonna 2014: 67.

analytical method was built the sundial; and upon sundial theory (gnomonics) was built the water-clock. Thus, by discussing first the sundial and then the water-clock, Galen can better illustrate for his readers the upward trajectory of scientific progress.⁵⁸ Our ancestors, Galen assures us, made brilliant discoveries, without which present society would be much the poorer. But those ancestors could not even begin to imagine the marvels that their theories have come to facilitate in the present day.

Galen concludes his discussion of clock design by explicitly contrasting the strategies that clockmakers and sectarian philosophers use to check their results:

[T]he very prospect of using it (i.e. *apodeixis*) for the greatest tasks makes it a good thing to practice, on account of its unique ability, as I said, to provide evidence of its own success - an ability that does not exist among those who make discoveries via philosophy. And because of this, it is possible for those who talk nonsense foolishly in philosophy to act shamelessly (τοῖς προπετῶς ἐν αὐτῇ φλυαροῦσιν ἔξεστιν ἀναισχυντεῖν). For, whereas the one who has badly marked a sundial or water-clock becomes plainly aware of his error by means of the fact itself, it is not the case that there is similarly clear refutation for theories in philosophy. Rather, it is possible for people to speak as they like, once they have maintained shamelessly and without logical method (ἀναισχύντως ἄνευ μεθόδου λογικῆς) that they were taught by the very matters in question (αὐτῶν τῶν πραγμάτων). Certainly, if the “facts,” taking up a voice, have indeed spoken to these men [i.e. philosophers] alone, then they are bragging with good reason (εὐλόγως ἀλαζονεύονται). But since the matters for discussion are always silent, and speak neither to us nor to these philosophers, it is clear that our reason alone will discover their nature. Therefore, let the one who can first

⁵⁸ On Galen’s understanding of scientific progress, see De Lacy 1979 and Hankinson 1994a. On the concept of progress in ancient science more generally (a controversial topic to this day), see especially Finley 1965, Edelstein 1967a, Jouanna 1999: 232-238, and Keyser 2013: 48-52.

discover what that nature is provide evidence clearly to himself about the matters at hand.... Otherwise he will no longer be trustworthy (οὐκ ἂν ἔτι πιστὸς... εἴη) in matters pertaining to unclear things (59,19-60,7 DB = V.88.2-89.5 K).

Philosophers, Galen remarks, claim that the secrets of the cosmos have been whispered to them alone. Unless one accepts this claim, however, it is often impossible to assess the validity of a philosopher's propositions. Unlike clockmakers, whose errors can be spotted easily by anyone, there is no agreed-upon rubric against which to measure most philosophers' commitments to the truth. And without a means of adjudication, philosophical inquiry can break down into chaos, with each philosopher saying whatever he likes to the point that all sense disappears (φλυαροῦσιν). With his trustworthiness demeaned, such a philosopher disregards – and thus no longer merits – respect (ἀναίχχυντεῖν).⁵⁹ In short, because this kind of philosopher does not pursue knowledge via the appropriate balance of logic and empiricism (i.e. *apodeixis*), he fails to earn a place within the larger community.

Conclusion: Clock-Making vs. the Paradigm of the Void

Toward the end of *Affections and Errors*, Galen further develops the contrast between clockmakers and philosophers by recounting an imaginary debate between a Stoic, an Epicurean, and a Peripatetic that highlights the speculative nature of their philosophical contributions. Galen himself acts as the adjudicator, while the philosophers argue over the nature of the void thought by many to encompass the cosmos. The first-person perspective is, of course, Galen's:

⁵⁹ At 68,8-9 DB = V.103.5-6 K, Galen describes these philosophers as “held in low esteem by all (καταγινωσκομένους), both by laymen and by other philosophers.” In several places, Galen laughs (γελάω) at the philosopher's foolishness (66,15 = V.100.3 K; 67,6 DB = 101.8-9 K).

“Each of these two philosophers,” I said, “differs in two way from the position of the Peripatetics.” I pointed to the Stoic and the Epicurean. “The Stoic says that there is no void (κενὸν) inside the world, but that there is a void outside of it. The Epicurean agrees with both of these statements, but differs from the rest in another respect. He does not concede that this is the only world, as the Stoic thinks, who shares this belief with the Peripatetics. Rather, just as he says that the void is unbounded in size, so he also says that the worlds within it are unbounded in their number. I listened to the things which the three said in their desire to advocate for their own dreams (συναγορεύειν βουλόμενοι τοῖς ἰδίοις ὀνείροις), but I think it is very clear that they possess no demonstrative argument (ἀκριβῶς δ’ οἶδα μηδένα λόγον ἀποδεικτικὸν ἔχοντας αὐτούς), only ones based on possibility and likelihood (ἐνδεχομένους τε καὶ εἰκότας) – and sometimes they don’t even have these. You will know that I am not lying if you ask each of them to provide some demonstration (τιν’ ἀπόδειξιν) for the issue at hand (67,11-68,1 DB = V.102.1-13 K).⁶⁰

These philosophers are literally fighting over nothing – an empty space that is far beyond the realm of sense perception and verification, and that has little to no bearing on human life. Their arguments, too, are insubstantial, mere “dreams” born of wishing. Galen portrays the philosophers as completely incapable of employing *apodeixis* (οἶδα μηδένα λόγον ἀποδεικτικὸν ἔχοντας). Instead, they are reduced to caricatures within Galen’s own apodeictic display, in which he attempts to demonstrate empirically that, unlike himself, these philosophers are unworthy of trust. An architect, Galen argues, one such as might construct a clock, would never even think of making claims about the void “until, after having actually gone out into the void part of the cosmos, he had tested the matter by means of experience, and had clearly observed whether each of the bodies in it remain in the same place or change position” (65,18-21

⁶⁰ The void debate is also referenced at 62,13-26 DB = V.92.16-93.12 K; 65,16-21 DB = V.98.9-14 K.

DB = V.98.11-4 K). Without real evidence to support one stance over another, the Stoic, Epicurean, and Peripatetic are doomed to quarrel interminably. The work of the architect, on the other hand, can easily be ratified by the community, thus freeing him to advance to other useful projects. For Galen, then, clock-making (a category of architecture) provides an excellent foil for the discussion of the void. While the latter emphasizes nothingness, insubstantiality, and uselessness, clock-making, on the other hand, is a rational and empirically-testable process that produces tangible objects for use within a civic community.

The dichotomy that Galen sets up here has further implications. In order for clocks to be maximally effective as foils to the void debate, Galen's audience must also have perceived them as useful, familiar tools – but did they? How representative *was* Galen's portrayal of clocks and timekeeping in the second century? We will pursue this question in the following chapter by comparing Galen's treatment of clock-making in *Affections and Errors* to the symbolic and rhetorical valences of clocks in contemporary art and literature.

2. The Semiotics of Clocks: Galen's Adaptation of a Trope

We have now seen *how* Galen uses his horological examples in *Affections and Errors* – namely, as a means of sharpening an important contrast between those who practice Galen's apodeictic method and adherents of contemporary philosophical schools. But we have not yet sufficiently examined *why* Galen elected to use horological examples in particular, instead of focusing on any other process grounded in *apodeixis*. If Galen's scientific method was as universally applicable as he claimed, then the number of potential examples at his disposal must have been myriad. The question at the heart of this chapter is: what can Galen's decision to use clock-making examples within a philosophical treatise tell us about the conceptual space that clocks occupied among Galen's contemporaries?

This chapter seeks to demonstrate that, by Galen's time, clocks – and particularly sundials – had become well-known symbols among the Roman elite, symbols that were both morally connotative and closely associated with natural and ethical philosophers. I will argue that, in *Affections and Errors*, Galen appropriates and adapts these symbols such that, for him, the process of clock construction becomes a model for the process of correct and morally upstanding decision-making. In order to get a sense of the semiotic fields of sundials and water-clocks under the Empire, it is important first to consider the development of these symbols over time, in text and in image. Then we will be able to tackle the question of how Galen, in *Affections and Errors*, adapts the symbols of the sundial and water-clock to serve his own rhetorical and philosophical purposes.

Clocks in Architecture

By placing clock-making within the domain of architecture, Galen adheres to a standard categorization that we see already in Vitruvius' *De architectura*, written a little over two centuries before *Affections and Errors*. Vitruvius, in his introductory chapter, divides the field of architecture into three sub-disciplines (*partes*): “building” (*aedificatio*),¹ “machine design” (*machinatio*), and “clock construction” (*gnomonice*) (I.3.1). Later in the same book, Vitruvius explains how one can use a sundial to correctly orient a wind rose, i.e. a compass that helped the user to identify the cardinal direction from which the wind was blowing.² Furthermore, the entirety of Book IX is devoted to the history, classification, and design of both sundials and water-clocks.³ Although Galen does not explicitly cite Vitruvius as one of his sources in *Affections and Errors*, the Vitruvian definition of architecture seems to have been alive and well during Galen's time.⁴

Although very few technical architectural treatises have been preserved to the present day, intellectual elites under the Roman Empire interacted frequently with architectural forms, both real and ideal. They did not simply appreciate these forms as passive viewers, but responded to them actively through literature, oratorical performance, and visual art. By Galen's period, some of the most common modes of literary engagement with architecture included: lists of monuments, such as the “Seven Wonders of the World;”⁵ travel accounts, like Pausanias'

¹ Vitruvius further divides this category into “public-defensive,” “public-religious,” “public-utilitarian,” and “private.”

² *De arch.* I.6. This may help us to understand the presence of wind roses on several extant sundials, e.g. Gibbs 1976: 330, pl. 53 and 352, pl. 55.

³ On the origin of sundials, see also Varr. *Ling.* VI.4; Plin. *NH* VII.212-215; Cens. *D.N.* XXIII.

⁴ See Thomas 2007: 229.

⁵ E.g. the papyrus from Ptolemaic Egypt discussed at Diels 1904: 1-16.

Description of Greece; ekphrastic poetry,⁶ and epideictic oratory,⁷ wherein rhetors delivered speeches designed to complement or compete with the artistry of well-known civic structures (including, often, the very buildings in which the speeches were being performed). A certain vocabulary of praise was shared across these genres; buildings were lauded for their symmetry, harmony, beauty, and fitness for their functions. Vitruvius proposes the following criteria for judging architecture, and the terms he employs recur frequently in the architectural encomia of later periods:

These things [i.e. buildings, machines, and clocks] ought to be made in a way that takes account of their durability, utility, and beauty (*ut habeatur ratio firmitatis utilitatis venustatis*). Durability will have been secured when their foundations have been pressed down into solid ground and when the materials, whatever they may be, have been selected carefully and without greed. Utility will have been achieved when the arrangement (*dispositio*) of the rooms is free of faults, without impeding use, and the distribution (*distributio*) of each type of building is suitable and appropriate for its exposure (*ad regiones sui cuiusque generis apta est commoda distributio*). Beauty will truly have been acquired when the appearance (*species*) of the work is pleasing and elegant and the proportion (*commensus*) of its parts has been determined through the proper principles of symmetry (*cum fuerit operis species grata et elegans membrorumque commensus iustas habeat symmetriarum ratiocinationes*) (I.3.2, 13.3-11 Krohn).⁸

⁶ E.g. Verg. *Aen.* I.418-493, VI.20-30; Catull. 64; Philostr. *Im.* For ancient descriptions of the genre of ekphrasis, see the various *Progymnasmata*. For modern discussions, see especially Elsner 1996 (ed.) and 2007; Webb 2009.

⁷ E.g. Luc. *Hipp.*, in which the artistry of Lucian's rhetoric vies with the imagined artistry of the baths commissioned by Hippias. Lucian also incorporates clocks into his description, presenting them as useful embellishments: "Besides [the baths'] adornment with other subtleties, furnished with two bathrooms and many means of egress, you will see two clocks, one that works by means of water and a bell, and another which operates by tracking the path of the sun (ὥρῶν δὲ διττὰς δηλώσεις, τὴν μὲν δι' ὕδατος καὶ μυκῆματος, τὴν δὲ δι' ἡλίου ἐπιδεικνύμενον)" (8). For a discussion of this text as a commentary on the character of Hippias, see Thomas 2007: 228.

⁸ It is interesting that Galen uses some but not all of these terms of praise to describe the clocks in *Affections and Errors*. He focuses on the clocks' utility without discussing their durability or beauty.

The scope of these architectural virtues extended far beyond the realm of the aesthetic. Terms such as “symmetry” and “harmony” also had important moral connotations, which made architecture a potent vehicle for metaphor and allegory.⁹ Certain types were particularly popular in Galen’s time. Houses and cities could represent the order and durability of the cosmos,¹⁰ and many buildings, in turn, were designed to imitate the structure of the heavens or even to respond to the motions of celestial bodies.¹¹ Similar claims were made about the design of clocks. We have, for example, two ekphrastic poems by the early 2nd-century CE lyric poet Mesomedes which meditate on the connection between the artistry of a particular clock and the artistry of the heavenly movements that the clock portrays. Here are selected lines from one of the two poems:

Another to the clock (ἄλλο εἰς ὠρολόγιον):

Who produced, by the art of bronze-forging,
the course of the blessed ones in order to measure the day?
Who arranged the course of the stars in a circle,
an all-bronze likeness of the cosmos (εἰκόνα κόσμου),
having divided the matrix of the well-running lines,
having designated the pure road among the paths,
the number of the [zodiac] animals, three times four?

...

After the boundless battle of heaven,
a bronze delight rang out (μυκήσατο χάλκεος ἀδονά),

⁹ For an extended discussion on the relationship between architecture and morality, see Thomas 2007 and associated bibliography.

¹⁰ For a list of such passages within Stoic writings, see Wendland 1892: 10, n. 27.

¹¹ E.g. the Pantheon at Rome. For discussion of the ways in which this structure interacted with the movement of the sun, see Hannah 2009: 147-155.

making clear to mortals the measure of the day (Fr. 8 Heitsch).¹²

Mesomedes is probably describing an anaphoric water-clock,¹³ as we know that these were often outfitted with rotating models of the celestial bodies and a bell or whistle to announce the hour. This ekphrastic poem simultaneously presents the clock as a technical marvel and as a jumping-off point for contemplating the cosmic order, thus combining two approaches to architectural features that recur in the literary sources.

Buildings were also frequently used as allegories for divine or imperial power, its awe-inspiring immensity and eternal perpetuation.¹⁴ Most relevant to our present concerns, however, was the habit of comparing architectural features to parts of the human body. Allegories of this kind depended on multiple levels of resemblance, one of which was purely physical. Building façades, for example, were called “faces” (Ltn. *facies* or Gr. πρόσωπον) and walls “eyebrows” (Gr. ὄφρῦς).¹⁵ Greek authors sometimes exploited the homophony between a metope (Gr. μετώπη), a rectangular element in Doric friezes, and a *metopon* (Gr. μέτωπον), the human “brow.”¹⁶ In Vitruvius’ description of the columnar orders, he asserts that the Doric and Ionic styles acquired their “proportion, strength, and beauty (*proportionem et firmitatem et venustatem*) from the human figure...the former being of a masculine character, without

¹² Cf. Fr. 7, entitled “To the clock (εἰς ὠρολόγιον).”

¹³ Vitruvius describes such a clock at *De arch.* IX.8-15.

¹⁴ To what extent such messages were descriptive vs. prescriptive has been much debated. Gibbon famously saw them as trustworthy indicators of the prosperity of the empire (Vol. 1: 78), while scholars have more recently begun to emphasize the rhetorical power of such messages to actively shape the empire’s image and boost citizen morale. See Thomas 2007 for discussion. A similar rhetorical program can be seen on coin legends, especially under the Antonines. For treatment of the numismatic evidence, see Williams and Meadows 2001; Zaccaria Ruggiu 2006: 27-29.

¹⁵ E.g. *SEG* 2.545 (Mylasa).

¹⁶ On the use of facial terminology to describe building facades in general, see Orlandos and Tavlos 1986: 224. For the application of the terms “head” and “arms” to an aqueduct, see e.g. *CIL* 9.3018 = *ILS* 5761. Greeks also compared elements of their natural environment to human body parts, such as breasts, arms, and heads. See Finzenhagen 1939: 74.

ornament (*unam virili sine ornatu nuda specie*), and the latter being of a character which resembles the delicacy, ornament, and proportion of a female (*alteram muliebri subtilitate et ornatu symmetriaque sunt mutuati*)” (IV.1.6-7, 77.22-78.7 K).¹⁷ Sundials were also incorporated into this kind of rhetoric, as analogs for the human face or head.¹⁸ An epigram attributed to Trajan, for instance, exploits this analogy to humorous effect: “If you raise your nose to the sun and open up wide / you will mark off the hours for all who pass by” (*Anth. Graec.* XI.418 Beckby).¹⁹

Under the Empire, buildings and individual architectural elements were also often said to reflect the moral dispositions of their owners. Plato may have been influential in this trope’s development since, in the *Timaeus*, he uses architectural terms to situate the human soul within the body and to describe the functions of each ensouled organ.²⁰ Plato explains, for example, that “the mortal part of the soul (τὸ τῆς ψυχῆς θνητὸν γένος)” (69e4 Burnet) resides in the cavity of the thorax, which is divided into two sections “in the way that women’s and men’s apartments are divided within houses (διορίζοντες οἶον γυναικῶν, τὴν δὲ ἀνδρῶν χωρὶς οἴκησιον)” (69e6-70a Burnet). A few lines later, Plato likens the human head to an acropolis and the heart to a guardroom (τὴν δορυφορικὴν οἴκησιον, 70a2-b3 Burnet).

¹⁷ Vitruvius goes on to describe how the Corinthian order is meant to evoke the grace of a young virgin (IV.1.8). Cf. Cicero’s comment that the city of Himera had the “form of a woman” (*Verr.* 2.2.87).

¹⁸ This practice likely derived from the fact that many sundials were mounted on pillars and had a spherical or conical shape, causing them to look like heads perched atop torsos. It may also have resulted from the fact that, prior to the advent of sundials and water-clocks, ancient Greeks and Romans often used their own bodies to measure time. This practice could take many forms and persisted alongside the use of sundials and water-clocks. In Aristophanic comedy, for example, characters often specify the time of day in terms of “feet,” i.e. the length of one’s shadow at that point in the day (*Ekk.* 651-2. Cf. *Ath. Deipn.* 1.8b-c, 6.243a). On this practice, see Hannah 2009: 75. According to another trope—attested in both Plautus (preserved at *Gel.* 3.3.5) and Alciphron (*Ep.* 3.1)—a social parasite complains that life was much better when mealtimes were determined by one’s belly instead of by a clock. For an analysis of this trope, see Gratwick 1979; Wolkenhauer 2011: 126-137.

¹⁹ Cf. Cratinus’ joke comparing the bulging shape of the Odeion to the shape of Pericles’ head (Kassel-Austin Fr. 74). In contrast to sundials, I have found no evidence of water-clocks being used as analogs for the human form.

²⁰ *Pl. Ti.* 69c-72b; cf. *Sen. Ep.* 82.5.

One of the more extended explorations of the moral similarities between men and buildings appears in Plautus' fragmentary comedy *Mostellaria* or "The Haunted House."²¹ The character of Philolaches – a youth who, during the frequent absences of his father Theuropides, has become "corrupted" by the pleasures of city life – delivers a lengthy monologue in support of the claim that "a man is similar to a new house when he is born (*novarum aedium esse arbitror similem ego hominem / quando natus est*)" (1.2.8-9 Ulonka). Philolaches develops this theme over 74 lines, comparing a child's parents to those who construct a house, the child's education to a building's foundations, and the misfortunes that can lead a person into vice and destitution to the storms and floods which cause buildings to decay.

This attitude leads to a broader trend of seeing certain private buildings and architectural features as extensions of their owners.²² By Galen's time, one also encounters instances where individuals are identified specifically with their sundials. This happens especially within the context of omens and portents. Valerius Maximus, writing in the mid-1st c. CE, offers an example. In his *Memorable Deeds and Sayings*, Valerius describes how Cicero's death was presaged when a raven collided with Cicero's sundial and knocked the gnomon out of true:

The imminent death of Cicero was predicted by an *auspicium*: for when he was in the villa at Caletana, a raven in his sight knocked out of place the iron gnomon by which the hours were distinguished, and headed straight for him. It held the end of Cicero's toga continuously in its beak until the assassins came to kill him (1.4.6 Briscoe).

²¹ XI.2.35-65. On this passage, see Leach 1969, Perutelli 2000, Fontaine 2014.

²² See Bodel 1997: 5 and Thomas 2007: 81. Not unlike today, Romans under the Empire were taken with the idea of visiting the houses of historical celebrities, such as Pindar and Simonides, thinking in this way to become more intimately acquainted with them. See Paus. 9.25.3 (Pindar) and Strabo 17.1.29 (Plato and Eudoxus). For discussion of the houses of Pindar and Simonides, see Slater 1971a and b, respectively.

In order for this portent to make sense, we must infer the existence of a symbolic link between this particular sundial and its owner, Cicero.²³ A similar principle underlies Artemidorus' explanation of sundial symbolism in dreams. "The clock (ὥρολόγιον)," he says, "signifies deeds, undertakings, movements, and enterprises. For all actions men take they perform with an eye toward the hours. Hence, a ὥρολόγιον that has collapsed or ceased to function would be bad, even fatal (ὄθεν συμπύπτον ἢ κατεασσόμενον πονηρὸν ἂν εἴη καὶ ὀλέθριον), especially to those who are ill" (*Oneir.* 3.66 Reichardt).²⁴ The structural integrity of a given dream-clock, Artemidorus implies, is indicative of the dreamer's own structural integrity. Should a clock cease to function, as Cicero's does when the raven knocks its gnomon askew, then the owner (or dreamer) of the clock will be unable to go about his or her business²⁵ – even, in some cases, the business of staying alive.²⁶

This development in the connotative significance of clocks is related to another: the connection between hourly timekeeping and the increasingly popular practice of astrology.

²³ Davis also reads into this scene a pun on the word ζῆθι, which is both the Greek imperative "Live!" and the sequence of letters *qua* numbers that mark the seventh through tenth hours (1956: 70). However, as very few extant sundials from this period have labeled hour-lines, Davis' interpretation is speculative, at best.

²⁴ Artemidorus does not make a clear distinction here between sundials and water-clocks, but uses the general term ὥρολόγιον which can refer to either.

²⁵ It is possible that etymological puns also facilitated the development of such clock symbolism. A common Latin term for a sundial's pointer, as we saw in the passage from Maximus, was *motum*. This term derives from the verb *moveo*, meaning "to move, to undertake." Although the *Oneirocritica* was written in Greek, Artemidorus was a citizen of the High Roman Empire and surely familiar with the Latin term; perhaps the etymological root of *motum* influenced his assessment of the clock as something that "signifies deeds, undertakings, movements, and enterprises." The Greek term for a sundial's pointer also lends itself to punning, since γνώμων derives from the verb γινώσκω and translates literally to "one who knows." As the seat of knowing and rationality was understood by many (including Galen) to be the human brain, this etymology may have served to reinforce the relationship between the functioning of a sundial's pointer and a person's capacity for rational thought while alive. It is impossible to say which came first – the terminology or the symbolic connotations of sundials – but it is likely that the availability of these puns helped to propagate such symbolic readings of clocks.

²⁶ It is possible that the depictions of sundials in funerary art served a prescriptive purpose in this regard. In addition to potentially signifying the lifespan of the deceased and evoking the idea of eternity as the sum of all hours, the inclusion of erect, unbroken sundials on sarcophagi and *stelai* might have been intended to persuade the gods to "resurrect" the deceased and grant him or her a "life" in the beyond.

Despite periods of virulent imperial opposition,²⁷ astrology flourished under the Roman Empire.²⁸ Augustus himself was said to have published his horoscope,²⁹ and was responsible for constructing a colossal gnomon and meridian line in the center of Rome.³⁰ Furthermore, by Galen's time it was not unusual to see funerary *stelai* that recorded the deceased's lifespans, often down to the hour.³¹ Knowledge of the exact hour at which a person was born and the exact hour at which he or she died was considered important for this kind of astrology. It is no coincidence that the very word *horoscope*, in fact, means "hour-watcher."

Presumably because sundials and water-clocks were the only instruments that could provide temporal measurements down to the hour, iconographic representations of clocks – specifically, sundials – began to crop up in scenes with astrological significance.³² A common motif on sarcophagi of the 2nd and 3rd centuries CE involves the three Fates determining a person's horoscope, with Atropos pointing out the hour on a sundial, Lachesis spinning out the appropriate length of thread, and Klotho making the cut.³³ In a handful of cases, the Fates are part of a larger mythological scene in which Prometheus molds the human bodies to which the

²⁷ Astrologers were expelled from Rome on at least eight occasions between 139 BCE and 139 CE. See e.g. Val. Max. I.3.3; Dio Cass. IL.43.5, LVI.25.5, LVII.15.8, LXIV.1.4, LXV.9.2; Tac. *Ann.* II.32, *Hist.* II.62; Suet. *Tib.* 36; Suet. *Vit.* 14.4; Ulp. *Mos. et Rom. legum coll.* XV.2. For discussion, see Cramer 1954: 232-248 and Ripat 2011.

²⁸ On the status and roles of astrology under the empire, see especially Barton 1994. Lehoux provides an insightful discussion of the nature of ancient astrological prediction (2009: 155-75).

²⁹ Suet. *Aug.* 94.12. For discussion, see Barton 1994. On the use of astrology in Roman imperial rhetoric, see Cramer 1954; Barton 1995; Oestmann et al. (eds.) 2005: 1-94.

³⁰ The debate over how to interpret the time-telling capabilities of the *horologium Augusti*, as well as its relationship with Augustus' other monuments, has been raging for decades. See Buchner 1982, Schütz 1990, Simpson 1992, Heslin 2007, Lowrie 2009, Hannah 2011, Haselberger 2011, and Baiocchi et al. 2016.

³¹ E.g. *I Eph* 2268, 1636.6-17; *SEG* 9:877, 18: 402; *IG XIV* 2308; *IGUR* II 389, 436, 703, 727, 799, 890, 903, 993, 1004, 1023, 1028, 1084, 1090, 1355. This practice may be analogous to the later 19th-century trope of a man's clock stopping at the moment of his death, an idea encapsulated in the popular song "My Grandfather's Clock," by Henry Clay Work. The chorus of the song goes, "Ninety years without slumbering / (tick, tock, tick, tock), / His life's seconds numbering, / (tick, tock, tick, tock), / It stopped short – never to go again – / When the old man died."

³² We have yet to identify a single iconographic representation of a water-clock, despite the fact that this is the only tool capable of marking the hour of a nighttime birth or death. This may have something to do with the fact that, unlike sundials, water-clocks did not bear much resemblance to the human form.

³³ Persius describes a similar scene at V.45-51. For a survey of the role of sundials in funerary art, see Bonnin 2013. On the iconography of Roman sarcophagi, see Turcan 1999.

horoscopes will be assigned (Figure F).³⁴ The three Fates together, or simply Atropos alone with her sundial, are also a frequent presence on the sarcophagi of young children – perhaps emphasizing the brevity of the span allotted them – and on sarcophagi that depict scenes from daily life. The lid of the “Portonaccio Sarcophagus,” for example, dated to c. 190-200 CE and currently in the Palazzo Massimo of Rome, captures a series of moments from a deceased general’s life, proceeding from his birth on the far left, supervised by Atropos with her sundial, to the erection of a military trophy on the far right (Figure G).³⁵



Figure F. “Prometheus sarcophagus,” Capitoline Museum, Inv. 638. Photo credit: Kassandra Jackson Miller.

³⁴ E.g. the Prometheus sarcophagus at the Museo Pio Clementino at the Vatican and one at the Capitoline Museum. For images of the former, see Robert 1919: 440-441, no. 354, pl. 116, and for discussion, see Turcan 1968. For images of the latter, see Koch and Sichtermann 1982: 183, no.41, fig. 215 and Robert 1919: 441-444, no. 355, pl. 117.

³⁵ We also have evidence to suggest that sundials were sometimes mounted atop funerary stelai to encourage passers-by to pause at the grave monument in order to check the time and, while doing so, invoke the memory of the deceased. See, e.g. Petron. *Sat.* 71; a lamp in the Kunsthistorische Museum of Vienna’s Ephesus Museum, discussed by Veyne (1985); and two funerary *stelai*, those of Izmit and Odessos. For the former *stela*, see Firatli 1971, pl. 17 and 22 and Şahin 1973: 44, no. 19, pl. 5. For the latter, see Tonchéva 1969: 17, figs. 15 and 39, no. 16.



Figure G. “Portonaccio Sarcophagus,” Palazzo Massimo of Rome, Inv. 112327. Photo credit: Kassandra Jackson Miller.

Clocks, in the contexts we have explored thus far, could have a variety of connotations. They could represent a single moment – the hour of birth or death, specifically – or they could stand for the length of time between the two: a person’s entire lifespan. Analogously, clocks could signify the brevity of human life, which lasts but a metaphoric hour, or conversely, the sum of all hours in existence, i.e. eternity.³⁶ Iconography is, by nature, polyvalent, so it would be difficult, if not impossible, to attempt to pin down which precise interpretations were being evoked on the sarcophagi and funerary *stelai* mentioned above.³⁷ However, we are fortunate enough to have a smattering of literary sources that utilize this symbolism and offer glimpses of how certain individuals chose to read it.

Clocks and Philosophy

³⁶ The concept of eternity was often personified by the figure Aion, a popular theme in Roman art. On the development of *aion* as a temporal concept, see Lackeit 1916; Zuntz 1989, 1991, 1992; Parrish 1993; Zaccaria Ruggiu 1998 and 2006.

³⁷ It is similarly difficult to clearly distinguish the semiotic fields of sundials and water-clocks from one another. To my knowledge, water-clocks are not represented iconographically on any extant artifact, and their use as literary symbols is rare. Yet, within these literary sources (such as Mesomedes’ poem, the ambiguous reference in Artemidorus’ dream book, and the *Epistles* of Seneca which we will examine below), water-clocks take on a range of meanings, representing the cosmos, a human being, and a human’s lifespan, respectively.

Interestingly enough, the most explicit of these discussions appear in the writings of two Stoic philosophers, Seneca (c.4 BCE-65 CE) and Epictetus (c.55-135 CE). An investigation of these passages will allow us to see how these two philosophers employed clocks and hours as metaphors, and thus to better appreciate how Galen's treatment of clocks in *Affections and Errors* compares with those available to his imagined interlocutors.

In the *Epistles to Lucilius*, Seneca often employs metaphors to help his readers grasp the fundamentals of Stoic philosophy.³⁸ Such metaphors are drawn from diverse social spheres – law, finance, medicine, daily life – and serve to render familiar and concrete concepts that might otherwise appear foreign and abstract. One of these challenging concepts is the notion of “time.” As Armisen-Marchetti has persuasively argued, a theme throughout the *Epistles* is the presentation of time as a tangible good with inherent value, which one should not squander lightly.³⁹ This serves one of Seneca's central paraenetic aims: to encourage Lucilius, and each future reader, to take ownership of the time allotted him upon this earth, for it is a finite and irreplaceable resource.⁴⁰

Seneca often employs water metaphors to make the flow of time vivid to his reader's eyes. Most commonly, he presents time as a river that is turbulent and panic-inducing for those who have not mastered the Stoic precepts, but placid and pleasant for the lucky few who have.⁴¹

³⁸ On Senecan metaphors, see esp. Armisen-Marchetti 1989 and 1995; Lotito 2001: 144-165; Wilson 2008; Bartsch and Wray 2009.

³⁹ Armisen-Marchetti 1995, esp. 549-553. See, e.g., Sen. *Brev.* 8.1-4.

⁴⁰ On achieving mastery over time, see, e.g., Sen. *Brev.* 15.5: “Therefore life permits much more to the wise man. The boundary that shuts out others does not do the same to him. He alone is released from the laws of mankind. All the centuries serve him as if he were a god (*omnia illi saecula ut deo serviunt*). What of the time that has passed? This he has grasped with his memory. What of the present? This he utilizes. What of the future? This he has anticipated.” Cf. *Brev.* 7.5; *Otio* 4 and 5.

⁴¹ E.g. *Clem.* II.6.1; *Ira* II.20.3; *Ep.* 68.13, 99.27; *Const.* 8.2; *Tranq.* 2.4. Armisen-Marchetti 1989 has collected Seneca's water metaphors at p.108 (including the reference to the water-clock), and his river metaphors, specifically, at pp. 121-122.

In *Epistle* 24, however, Seneca includes a telling variation on this theme; he compares a human lifespan to the water draining from a water-clock.

Just as it is not the final drop that empties the water-clock, but whatever has flowed out before (*quemadmodum clepsydram non extremum stillicidium exhaurit, sed quicquid ante defluxit*), so the final hour in which we cease to exist is not the only one to cause death; it is simply the only one to complete it. At that time, we arrive at death, but we have long been coming to it (*Ep.* 24.20 Hense).⁴²

Seneca's particular concern in this letter is to assuage Lucilius' fear of death. He does so by emphasizing the fact that we have all been dying steadily since the moment of our birth. In light of this, we should not consider our inevitable demise to be an aberration, an unnatural snatching-away of existence, but simply the final step in a continual, life-long process of passing away. The water-clock is an apt metaphor for a human lifetime viewed in this way, for the dropwise reduction in its water level neatly parallels the incremental shortening of a person's remaining lifetime as the moments pass by.

This metaphor is also consistent with Seneca's goal of reifying time. Seneca depicts each moment as a concrete entity (a water droplet) with a measurable value (a fraction of an hour). These fractions of hours are all the more valuable because, here, a single draining of a water-clock (i.e. one day) represents the length of an entire human life. When one views the day as a microcosm of human existence, there really is no time to spare! Seneca explores this conception of time in even greater detail in his twelfth *Epistle*:

⁴² Cf. *Ep.* 120.17-18, which makes the same argument without using the metaphor of a water-clock. See also *Ep.* 1.2-3.

A whole lifetime is made up of parts and has larger circles enclosing smaller ones.... For the longest span of time has that which you would find in a single day, namely light and darkness, and a day continually produces more of those changes; it is no different when the day is shorter or again when the day is longer. Therefore, every day ought to be regulated as if it contained the whole temporal series, and both consumed and filled out a life (*Ep.*12.6-7 Hense).⁴³

Seneca goes on to tell the story of one Pacuvius, who was accustomed to holding a burial sacrifice for himself every evening, complete with wine and feasting. Then, when the party was over, he would have himself “carried out” (*ferebatur*) from the dining hall to his bed chamber, while his eunuchs sang, “He has lived! He has lived! (βεβίωται, βεβίωται)” (12.8 Hense).

While Seneca hastens to express his disapproval of Pacuvius’ behavior, he encourages his readers to adopt a similar attitude mentally: “Let us go to sleep happy and cheerful, and let us say: I have lived and that which Fortune assigned me I have completed” (12.9 Hense).⁴⁴

Petronius, too, exploits the funerary connotations of sundials when he introduces the character of Trimalchio as “a very well-to-do man, who has a clock in his *triclinium* along with a uniformed

⁴³ C.f. *Brev.* 7.9; *Ep.* 61.1 and 101.10.

⁴⁴ A similar scene occurs in Petronius’ *Satyricon*, wherein the extravagant host Trimalchio, after delivering what amounts to a eulogy for himself, demands the following of his slave Stichus: “Bring me the funeral garb in which I intend to be carried out. And some ointment, and a mouthful from that jar which must be poured over my bones” (77). This pageantry is but the climax of a dinner party that is regularly punctuated with reminders of the diners’ mortality. After pouring the wine, for example, Trimalchio calls for a little silver skeleton to be brought to him and, while playing with it, declares in verse: “Woe to us poor mortals! All that poor man is amounts to nothing. So shall we all be, after the underworld snatches us away. Let us live, then, while things go well for us” (34; cf. 72). It is interesting to note that, whereas the narrator judges the mock funeral to be “utterly sickening (*ad summam nauseam*)” (34), he says that Trimalchio’s performance with the skeleton was met with praise (*laudationem*, 35). That it was, in fact, appropriate to contemplate death at a dinner party in this way is suggested by the number of skeletons that appear in banqueting scenes on Roman period sarcophagi and gemstones (e.g. the sarcophagus of Polybius from Heraclion [see Alexiou 1968] and the gem at Furtwängler 1900, pl. 46, 26; see Bonnín 2013: 486-7 for discussion). On the theme of the skeleton in funerary art more generally, see Dunbabin 1986. It is especially interesting, for our purposes, that sundials also participate in this symbol system, appearing alongside skeletons in the examples listed above.

trumpeter, in order that he might know from them how much of his life he has lost” (26 Breitenstein). This way of reading a clock is analogous to Seneca’s metaphor of the water-clock.

Although clocks do not reappear elsewhere in the *Epistles*, the unit which they alone can measure, the hour, pops up in a variety of contexts, usually to indicate the brevity of a time span or the suddenness of an event. In *Epistle 91*, for example, during a discussion of Fate’s fickleness, Seneca exclaims that the day is too large a unit for measuring the speed at which one’s fortunes can go belly-up: “Whatever one has built over a long stretch of time, with many labors and through the indulgence of the gods, a single day scatters and dissipates. In fact, he who said ‘a day’ granted a long delay to evils that are, in fact, rapid. An hour, a moment of time (*hora momentumque temporis*), suffices for overturning empires” (*Ep.* 91.6 Hense).⁴⁵

It is with this connotation that we see the hour appear in Epictetus’ second *Discourse*, as transcribed by his pupil Arrian. In this text, Epictetus underlines the importance of distinguishing between the factors in life that are under the control of one’s internal volition (προαίρεσις) and those things that fall outside of its purview (τὰ ἔξω, 2.5.4 Schenkl). By concerning oneself solely with the former and cultivating indifference toward the latter, so Epictetus argues, one can lead a happy life. To model how one might go about identifying the elements that are and are not under one’s control, Epictetus first offers the example of a sea voyage:

What can I do? Pick the captain, the ships, the day, the opportune moment. But then – a storm has come upon us! Still, what does it matter to me? My part has been fulfilled. The plan of action belongs to someone else, to the captain. But the ship is in fact sinking! What can I do? I do the only thing that I am able: I drown

⁴⁵ Cf. *Tranq.* 11.9: “But a fraction of an hour exists between being on the throne and at another’s knees.”

unafraid, having neither cried out nor called upon God, but knowing that that which has come into being must also perish (2.5.10-12 Schenkl).

Epictetus anticipates the objection, however, that it is difficult to face the prospect of drowning with calm indifference. To mitigate the terror that such a violent death might instill, Epictetus, like Seneca, uses a horological metaphor to stress the fact that, one way or another, we all die in the end:

For I am not an ever-lasting creature, but a man, a part of all things as the hour is a part of the day (οὐ γάρ εἰμι αἰών, ἀλλ' ἄνθρωπος, μέρος τῶν πάντων ὡς ὥρα ἡμέρας). I must be present like the hour and pass like the hour (ἐνστῆναί με δεῖ ὡς τὴν ὥραν καὶ παρελθεῖν ὡς ὥραν). What difference does it make to me, then, how I pass, whether I do so by drowning or falling ill with fever? For I must pass in some such way (2.5.13-14 Schenkl).

Rather than establish the whole day as a microcosm of human life, as Seneca does, Epictetus increases the magnification by an additional step, seeing a metaphor for human life within a fraction of a day, a single hour.⁴⁶ He builds on this metaphor to establish an analogic relationship: just as an hour (ὥρα) is the smallest measurable fragment of eternity (αἰών), so is a man the smallest measurable fragment of the all-pervasive Stoic god.⁴⁷ Thus we see that, by the time Galen began to write *Affections and Errors*, a treatise intended to critique Stoicism and other sectarian philosophies, two eminent Stoics had already used horological metaphors to explain important aspects of their worldviews.

⁴⁶ Lucretius, too, contrasts the “single hour (*unius horae*)” that a person spends on this earth with the “eternal time (*temporis aeterni*)” that awaits him or her after death (III.1071-1074).

⁴⁷ For Epictetus’ characterization of humans as part of the divine whole, see *Ab. diss.* 1.12.26; 2.10.3; 2.8.10-11; 4.7.6-7. For discussion, see Long 2002: 233-4. Cf. Aur. 2.4.1.

However, by Galen's day, the connection between philosophers and the symbol of the clock was not limited to the textual realm; it had also entered into iconography. As early as the 1st c. BCE, we begin to see in the archaeological record engraved gemstones that play with the motif of a philosopher sitting near a sundial. Lang has developed a typology for these images (Figure H).⁴⁸ "Type A" features a philosopher who is seated before a sundial and reading from a scroll.⁴⁹ In "Type B" the philosopher sits with his chin in his hand.⁵⁰ "Type C" features a seated philosopher gesturing in an argumentative manner toward the sundial in front of him,⁵¹ whereas the philosopher in "Type D" maintains this same posture while holding a pointer.⁵² Finally, in "Type E," we see a philosopher who is seated before a sundial and scribbling away on a scroll.⁵³ The trope of the philosopher and sundial on gems is analogous to certain numismatic motifs, in which the thinker appears seated before a *sphaera* (Figure I).⁵⁴ Interestingly, though, I have been unable to find even a single coin on which the *sphaera* has been replaced with a sundial.

⁴⁸ Lang 2012: 80-109.

⁴⁹ Cf. *Abdruck der Imprime Gemmarie dell'Istituto IV*, 81 (1837); Landesmuseum Mainz. Inv. R 6036; Bibliothèque Nationale of Paris, Cabinet des Médailles, collection of Slg. Duc de Luynes, No. 127; the Römisch-Germanisches Museum of Cologne. Inv. 8827; the Rheinisches Landesmuseum of Bonn. Old inv. G139. Inv. U1816; the Staatliche Münzsammlung of Munich. Inv. A.197.

⁵⁰ Cf. the Antikensammlung, Staatliche Museen of Berlin. Inv. FG 4523.

⁵¹ Cf. University of Pennsylvania Museum. Inv. 29-128-1149.

⁵² Cf. Staatliche Museen of Berlin, Antikensammlung, Altes Museum. Inv. FG 4520, FG 1262; Museo Archeologico Nazionale di Napoli. Inv. 158777; Kunsthistorisches Museum of Vienna. Inv. XIB538; Museo Archeologico Nazionale of Aquileia. Inv. 48593; Archäologisches Institut of Göttingen, Georg-August-Universität. Inv. G443; Museum August Kestner in Hannover. Inv. K1033.

⁵³ Cf. Geldmuseum of Utrecht. Inv. RRC 2075.

⁵⁴ E.g. SNG von Aulock 733 (Valerian II; Nikaia, Bithynia; depicting Hipparchos) and Gardner, Period IX, Nos. 15 and 16 (Trajan Decius and Commodus; Samos; depicting Pythagoras).



Figure H. Gems of Lang’s Types A and D, respectively. (i) Staatliche Münzsammlung, Munich, Inv. A.197; (ii) National Archaeological Museum of Naples, Inv. 158777. Images from Lang 2012: Nos. G TypA65 (Pl. 21) and G TypD7 (Pl. 25).



Figure I. Hipparchus with globe. Bithynia, Nicaea, under Commodus. Rec. No. 293.

By the Imperial period, related motifs begin to appear on the mosaics and sarcophagi of the elite.⁵⁵ In some cases, the sundial is linked to particular philosophers. The famous “Anaximander Mosaic” (3rd c. CE) depicts a philosopher holding a multi-faced sundial on his lap, and may represent Anaximander’s supposed invention of the gnomon (although this

⁵⁵ Though a few examples are known from earlier. The funerary stele of Theodotos, for example, now at the Istanbul Archaeological Museum, has been dated to the 2nd c. BCE (Gibbs No. 1051G).

identification is controversial) (Figure C).⁵⁶ A mosaic from the villa of T. Siminius Stephanus in Pompeii (mid 1st c. BCE/ CE) has been said to represent Plato’s Academy, featuring seven philosophers gathered in discussion around a globe, with a sundial perched on a column behind them (Figure J).⁵⁷ On many imperial sarcophagi, however, the trappings of the philosopher – including the sundial – are transferred to the deceased. Traversari has grouped these scenes into three general types.⁵⁸ In Type I scenes, the Muses gather round the deceased,⁵⁹ who is presented as a poet or philosopher, while a sundial stands mounted on a column in the background.⁶⁰ Type II scenes build upon the gem motifs, showing the deceased standing or seated upon a curule chair, facing a sundial and holding a *volumen* in his hands (Figure K).⁶¹ Type III scenes portray a philosophical lesson or discussion. The deceased is seated at the center, often sporting a long beard and *pallium* and holding a *volumen*. As in Type I scenes, the sundial stands watch in the background (Figure L).⁶²

⁵⁶ The mosaic has been dated on stylistic grounds to the 3rd century CE and is currently in the Rhineland Museum, Trier. The tradition that Anaximander was the first to set a *gnomon* on a shadow-casting surface is preserved at D.L. 2.1. However, the identification of the figure in the Trier mosaic is based solely on the fact that he is holding a sundial. Traversari has argued that the figure should rather be identified as Patrocles, the inventor – so Vitruvius tells us – of the very double-winged *pelecinum* dial that rests on the figure’s lap (1991: 69).

⁵⁷ For discussion of this mosaic, see Gaiser 1980. On temporal themes in Roman mosaics, see Kondoleon 1999.

⁵⁸ Traversari 1991: 66-67. This classification has also been adopted by Bonnin 2013: 482-3. The designation of “Type Number” is my own. Extensive bibliography on these sarcophagi can be found at Traversari 1991: 71-73. For further discussion of the “philosopher” as a motif on imperial-period sarcophagi, see Ewald 1999.

⁵⁹ cf. A sundial dedicated to the “Nine Muses” (Gibbs No. 1004 = *I.Aeg. Thrace* 436).

⁶⁰ Sarcophagi of Type I are preserved in the crypt of the Duomo of Palermo (Wegner 1966: 33f., no. 68, pls. 66, 138a-b); the Castello di Agliè, Piemonte (Wegner p. 9, no. 2, pls. 35, 45b, 47a, 49a); the Villa de Medici at Rome (Wegner p. 82, no. 215, pls. 27a, 29, 30, 43a); the Museo Maffeiano of Verona (Wegner p. 87, no. 227, pl. 127b); the William Randolph Hearst Estate in San Simeon, CA (Wegner p. 83s, no. 219, pl. 31a); the Santa Maria del Priorato in Rome (Wegner p. 71f., no. 183, pls. 36a, 44b, 46a, 47b, 49b); the Cortile del Belvedere in the Vatican Museum (Wegner p. 56f., no. 137, pl. 37b); and the cathedral of Murcia in Spain (Wegner p. 28f., no. 57, pls. 104a, 107c).

⁶¹ See the “Sarcophagus of the Muses” in the Kunsthistorisches Museum of Vienna. Other sarcophagi of Type II are preserved at the Museo Profano Lateranense (“Sarcophagus of Plotinus,” Wegner p. 47, no. 116, pls. 64b, 70, 71; a second sarcophagus, Grabar 1967: 140, fig. 144); the museum of the Villa Torlonia in Rome (Wegner p. 53ff., no. 133, pls. 60, 61, 62, 64a, 73a); in the cathedral of Cagliari (Koch and Sichtermann 1982: 205); and in the National Museum at Naples (Himmelmann-Wildschutz 1973: 5, pl. 3).

⁶² Type III sarcophagi can be found at The National Museum in Rome (two sarcophagi; see Marrou 1938: 64ff., no. 54, fig. 9 and p. 97ff., no. 98, fig. 13); the museum of the Castello Sforzesco in Milan (Wegner p. 25f., no. 47, pl. 111b); the catacombs of San Callisto in Rome, inside the Tricora Orientale (two fragments; Wegner p. 42, nos. 89

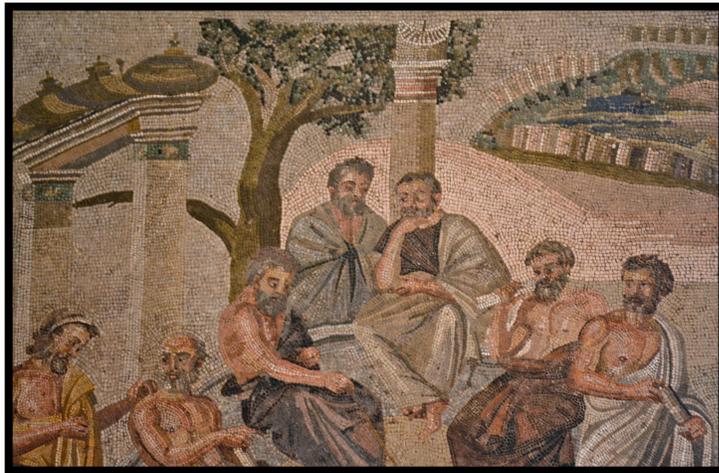


Figure J. Detail from the “Plato’s Academy Mosaic.” Naples Archaeological Museum, Inv. 124545. Photo credit: Kassandra Jackson Miller.

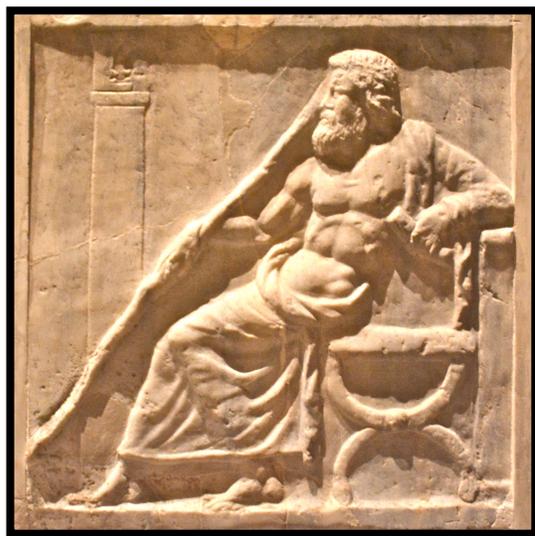


Figure K. Traversari Type II. Kunsthistorisches Museum, Vienna, Inv. ANSA I 171. Photo credit: Kassandra Jackson Miller.

and 91, pl. 80a); the catacombs of Praettestato (Wegner p. 44, no. 105, pl. 80b); The Museo Terme at Rome (Wegner p. 52, no. 129, pl. 119a, 124a); and the cloister of San Paolo (extramural) in Rome (Wegner p. 73, no. 187, pls. 107d, 119c).

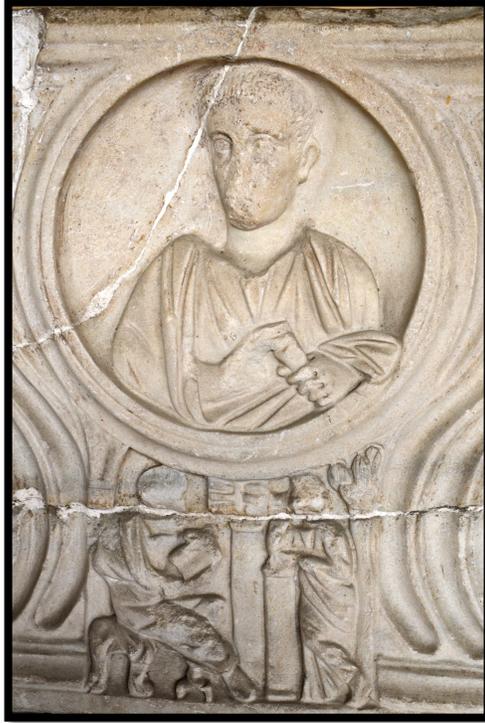


Figure L. Traversari Type III. Cloister of St. Paul Outside the Walls, Rome. Photo credit: Kassandra Jackson Miller.

What exactly the clock was meant to signify in this context is a matter of much debate, and there is probably no single answer. Perhaps the sundial is a celebration of human ingenuity and the engineering feats one can attain with a good education.⁶³ Alternatively, it might be a reference to the fact that philosophers often wrestled with the concept of time and the associated issues of birth, death, and change.⁶⁴ Or perhaps the clock serves, in these cases, as a symbol of the kind of immortality available to those who live in accordance with philosophical teachings.⁶⁵ It is clear, however that by Galen's time the clock – and particularly the sundial – was often interpreted as the attribute of a thinker. In light of this awareness, Galen's decision to use clock-

⁶³ Cf. Wolkenhauer 2011: 333, in the context of her discussion of Cic. *De nat. deor.* 2.87-8. Here Cicero praises the *sphaera* and the *horologion* as pinnacles of human *ratio*.

⁶⁴ Cf. Marrou 1938: 30; Cumont 1942: 336; Bonnin 2013: 482-3.

⁶⁵ Cf. Marrou 1938: 288; Traversari 1991: 70-1.

making as the paradigmatic embodiment of his own analytic method seems far from innocent. Rather, I suggest that he is laying claim to a recognizably philosophical image and, by changing its allegiance, asserting that his method is in fact *more* philosophically valid than the dogmas of contemporary schools.

From Clock-as-Lifespan to Clock-as-Lifestyle

Our investigation thus far has revealed that writers and craftsmen of Galen's time used the symbol of the clock to represent a whole constellation of ideas that cluster around two basic comparisons: between clock and body, and clock and lifespan. Such metaphors were clearly available to Galen as well, and yet, in his philosophical treatise *Affections and Errors*, he elects to approach this familiar symbol from a new angle. Instead of focusing on the clock itself, as a metaphor for the human body or lifespan, Galen decides to focus on the *process* of clock-making in order, I submit, to illustrate his ideal human *lifestyle*.

Although Galen, in *Affections and Errors*, briefly addresses himself to the "body" (Gr. σῶμα) of the clock as a whole,⁶⁶ he is clearly less concerned with the sculpting of these bodies than with the ways in which the hour and date lines are marked upon their surfaces (Gr. ἡ καταγραφή). As we saw in the previous chapter, Galen spends pages walking his reader through the basic processes of inscribing lines on sundials and water-clocks and then checking them for accuracy. For Galen, the precise inscription of hour and date lines, achieved through *apodeixis*, is what makes a clock a clock. This inscription process allows one to transform simple shadows and water tanks into tools that transmit useful information (i.e. the hour and, in most cases, the time of year).

⁶⁶ See 55,5-17 DB = V.81.3-15 K.

Yet, *Affections and Errors* is not a technical manual along the lines of Vitruvius' *De architectura*. A reader who should try to construct an actual sundial or water-clock solely on the basis of Galen's instructions would find himself at a total loss. *Affections and Errors* does not provide an *analemma* for drawing the lines on a sundial, nor does it include any diagrams, equations, or explanations of geometric principles. Despite its emphasis on the practical application of *apodeixis*, *Affections and Errors* is fundamentally a philosophical work, and Galen, like Seneca and Epictetus before him, is using horology to make a claim about how best to live one's life.⁶⁷ Yet, his concern is not with the span of that life or with the body that contains it. Instead, Galen uses the process of clock-making to represent a method of inquiry (based on logical reasoning and empirical verification) that humans should employ when making decisions about what to believe and how to act. Galen does not expect the readers of *Affections and Errors* to go out and build a clock; he wants them to use the process of clock-making both as a blueprint for evaluating the truth of philosophical claims and, by extension, as a model for developing a habit of rational thinking within their own daily lives. "I have discovered," Galen tells us about his apodeictic method, "not only the goal but also the way of life that conforms to the truth" (52,19-53,1 DB = V.77.3-4 K).⁶⁸

One could also argue that *Affections and Errors* participates in the broader trend, discussed above, of using clocks to represent either the brevity of life on earth or the eternity of life hereafter. At 59,3-8 DB = V.86.15-87.5 K, a passage that we examined in the previous

⁶⁷ Though Galen is surprisingly cagey about what the ultimate *goal* of life might be. See Donini 1988 and Singer (ed.) 2013: 230.

⁶⁸ Galen expresses this sentiment elsewhere in his corpus, e.g.: "And, as all matters of enquiry require two tools, reasoning and experience (λόγον και πείραν), for any discovery in all the arts, and not less in our whole life (ἐν ἀπάσαις ταῖς τέχναις, οὐχ ἥκιστα τε καθ' ἕλον τὸν βίου), I consider it necessary to seek for discovery of the facts before us by using reasoning alone or experience alone, or both together" (*De cur. rat. ven. sect. 3* = XI.255 K; cf. *De meth. med.* IV.4 = X.272 K). On the interrelation of βίος and μέθοδος in the Galenic corpus, see Boudon-Millot 2009.

chapter, Galen situates developments in clock technology within the context of continuous scientific progress. Though each individual clock is the product of a particular human architect or team, Galen points out that the theoretical framework on which the act of clock-making relies has been built up over many generations and continues to mature. In this passage, Galen mocks the hubris of sectarian philosophers who think they can squeeze many lifetimes' worth of study, experimentation,⁶⁹ and reasoning into their single, lonely lifespans. Rather than engage in such navel-gazing, Galen advocates recognizing and embracing one's small part in the "eternal" progress of scientific thought. In short, it is the process of scientific reasoning (i.e. *apodeixis*) that achieves a kind of immortality, not necessarily the individual human. But by utilizing logic and empirical demonstration, the individual can participate in that kind of immortality, and be assured that he is leading a life of truth and virtue.

⁶⁹ On the degree to which experimentation can be said to have taken place in Greco-Roman antiquity, see Von Staden 1975 and Lloyd 1979.

PART 2: Hourly Timekeeping in Galen's Medical Works

3. From Critical Days to Critical Hours: Galenic Refinements of Hippocratic Models

In the preceding discussion of *Affections and Errors*, we saw how, in Galen's view, the process of clock-construction exemplifies ideal scientific methodology and serves as a model for unerring truth-assessment and decision-making. At the same time, however, we saw that Galen describes clocks as tools that are not only good to think with representationally, but are also “useful” (Gr. *χρήσιμος*), on a practical level, for obtaining temporal measurements.¹ This leads one to wonder just how an Imperial-period physician like Galen might have incorporated hourly timekeeping into his day-to-day medical practice. This question is at the core of the present and succeeding chapters.

To the modern investigator, this question poses a methodological challenge. On the one hand, as we saw in the Introduction, archaeological, inscriptional, and textual evidence indicates that, in many communities under the Empire, both sundials and water-clocks were available in monumental, domestic, and sometimes portable formats. Thus, it would seem reasonable to assume that the physicians in such communities had access to clocks – whether they were personal (the physicians' own or their patients') or publically available in bathhouses or town squares. Yet, it is difficult to pinpoint within our textual and archaeological sources any *direct* evidence of doctors using these clocks in the sickroom. For example, a portable sundial discovered in a physician's tomb at Este suggests that the doctor had wanted to be able to keep time on the go.² However, it is impossible to determine whether this physician actually employed

¹ Cf. *χρησιμώτατον* at 56,19 DB = V.83.15 K.

² The tomb was identified as that of a physician due to the medical instruments included among the grave goods. “These grave goods comprised surgical and chemical instruments, glass cups, ornaments, a spoon and a little amber

the sundial during his medical rounds, or whether he simply used it to manage his personal schedule. It is also possible that the sundial was placed in the grave by a friend or relative, in which case the physician may never have used it at all.³

In the face of such interpretative challenges, one must rely on *indirect* evidence of clock use among physicians, and for this the Galenic corpus stands out as a rich source. While Galen never explicitly says that he has consulted a sundial or water-clock during a patient-visitation, he will often state that a medical event occurred at a particular numbered hour of the day or night, or that it lasted for a specific number of hours. The distribution of these references is far from uniform.⁴ The majority appears in his discussions of cyclical phenomena, especially the oscillations between attack (“paroxysm”) and remission that characterize periodic fevers. In Chapters Three and Four, I investigate many of these references in an effort to discover (a) why Galen chose to adopt hourly frameworks within particular medical contexts, and (b) how his use of hourly timekeeping allowed Galen to support certain claims about himself. We will see that

statue, in addition to a small sundial that was particularly well preserved” (Arnaldi and Schaldach 1997: 109). The dial is on display at the Museum of Este, near Padua, Italy, and has been dated to the first century CE.

³ The imperial-period physician Marcellinus provides evidence that is similarly equivocal. In his work *On the Pulse*, Marcellinus recounts how the renowned Hellenistic physician Herophilus was in the habit of using a small *clepsydra* to measure his patients’ pulse rates (*Puls.* 260-7). However, *clepsydrae* do not keep continuous time throughout the day. Thus, while Marcellinus’ account tells us something about Herophilus’ interest in “egg-timer timing,” it sheds no light on the question of how doctors made use of *continuous* timekeeping mechanisms. On the distinction between *clepsydrae* and water-clocks, see Bonnin 2015: 88-98. For more on Marcellinus’ understanding of the pulse, see Schöne 1907. On Herophilus, see Von Staden 1989.

⁴ Galen seems to have had clear ideas about which medical challenges could and could not be mitigated with the aid of a sundial or water-clock. It is noteworthy, for example, that in all of Galen’s voluminous and detailed discussions of pulse theory, the term ὥρα as “hour” appears in a mere handful of places, usually in contexts unrelated to practical bedside applications. In *On Diagnosing Pulses*, for instance, Galen uses hours to illustrate the basic concept of a “rate” (e.g. VIII.830.6-10 K). Nowhere, however, does Galen recommend using a clock to time the actual pulse rate of a patient, in the manner of Herophilus. Nor does Galen recommend that doctors check their patients’ pulses regularly at particular times of day – “at the third hour,” for instance, or “two hours after eating.” In *On the Rationale for Healing by Means of Blood-Letting*, Galen does use hours to structure a brief narrative of treatment: “[H]e came at the fifth hour, and I performed the first letting of blood straight away (three liters), then once more at the ninth hour. On these I left coverings until the next day; having mixed one of the soft eye salves with wine, as we were accustomed to do in such cases.... This was done first at dawn, then at the fourth hour, then at the ninth” (XI.300.11-18 K). However, nothing of the sort appears in Galen’s treatises on pulse theory. For discussion of some of the rhetorical strategies that Galen *does* employ in his treatises on pulse theory, see Barton 1994: 134-173.

Galen often calls upon hourly timekeeping both in the interest of advancing controversial medical debates and in order to demonstrate that he himself rigorously adheres to his own manner of scientific method (*apodeixis*).

The present chapter will focus on Galen's *On Critical Days*, in which he seeks to assess and justify Hippocratic "critical day" schemes – that is, schemes for anticipating important moments of change in the course of febrile diseases. This text, I argue, highlights how Galen uses the concept of hourly timekeeping to defend Hippocratic doctrine, while simultaneously bringing it into greater harmony with Imperial-period ideas and technologies. I suggest that this strategy permits Galen to support his oft-repeated claim to be the true intellectual successor of Hippocrates, while enabling him to showcase his appreciation for and familiarity with aspects of astronomy.

Galen's Hippocratism

Galen makes no secret of his admiration for and reliance upon Hippocratic teachings, and many modern scholars have investigated the techniques, biases, and agendas with which Galen approached Hippocratic exegesis.⁵ I will therefore not linger on the nature of Galen's Hippocratism, but will make some brief comments to orient the reader before we embark on our analysis of *On Critical Days*.

Nowadays, one often hears Hippocrates lauded as the "Father of Medicine." In Galen's day, however, there were multiple contenders for this title, and to whom it was awarded depended largely on the medical sect of the physician doing the speaking. The Methodists,⁶ for

⁵ A partial list includes Smith 1979, Manuli 1983, Nutton 1992, Manetti and Roselli 1994, Manetti 2003, Holmes 2012.

⁶ The extant writings of Methodist physicians have been collected by Tecusan (2007).

example, who were so loathed by Galen, called upon the authority of Thessalus of Tralles, while the Pneumaticists followed in the footsteps of Agathinus and Athenaeus.⁷ Smith, in his account of the development of “Hippocratism,” has cogently argued that the campaign for Hippocrates as the Father of Medicine was first initiated by the Empiricists of the Hellenistic period.⁸ Empiricist doctors were at pains to differentiate their medical ideology from that of the early Rationalists. Hippocrates was an excellent candidate for their sect’s figurehead, because so many Hippocratic texts emphasize observation and engage in detailed descriptions of the symptoms and environmental conditions associated with particular illnesses. By Galen’s time, Hippocratic exegesis had also become a favored past-time among physicians like Marinus, Quintus, and Numesianus, whose affiliations are uncertain,⁹ but whose views on physiology, pharmacology, and clinical medicine likely had a profound effect upon Galen.¹⁰

Determining what the great Hippocrates actually said or intended, however, was – and still proves to be – something of a challenge. From the perspective of modern scholarship, “Hippocrates” is more of a legendary persona than a historical personage. We know very little about “Hippocrates” the man;¹¹ we do know, however, that the “Hippocratic Corpus” as we have it today was not composed by a single author, but is rather a collection of texts by a variety of

⁷ On the distinctions between ancient medical sects and on their most prominent adherents, see e.g. Smith 1979: 198-215 (specifically on the rivalry between Empiricist and Dogmatic sects), Gourevitch 1998, Nutton 1992 and 2013.

⁸ Smith 1979: 177-210. Smith cites the 1st c. CE author Celsus as our earliest coherent source for the conflict between the Empiricists and the Rationalists, but notes that Celsus’ account is influenced by the earlier writings of Aesclepiades (1st c. BCE).

⁹ Gourevitch calls theirs an “unnamed sect” (1998: 118). On Marinus and Quintus, see Keyser and Irby-Massie (eds.) 2008: 532 and 717, respectively.

¹⁰ While in Pergamum, Galen studied under Satyrus, a pupil of Quintus, and attended lectures by Pelops, a pupil of Numesianus. On Galen’s medical education, see e.g. Nutton 1993, Smith 1979: 64-72, Gourevitch 1998: 120. On Pelops and Satyrus, see Keyser and Irby-Massie (eds.) 2008: 634 and 728, respectively.

¹¹ Plato, for instance, mentions that Hippocrates charged money for his medical services (*Prot.* 311b-c).

contributors.¹² These men wrote from different geographical locations and at different times within the late Classical and early Hellenistic periods. Even the theories of medicine that are articulated or implied within the Hippocratic texts differ from one another to varying degrees.¹³ These inconsistencies were not lost upon readers from the late Hellenistic and Imperial periods and, from then on, there has been a culture of debate surrounding the proper attribution of particular Hippocratic treatises. In antiquity, however, it was assumed that there was a core of “genuine” texts composed by Hippocrates himself. More problematic texts were often attributed to one of Hippocrates’ sons or grandsons (presumed to be writing from the great man’s notes) or were rejected as spurious. Which works constituted the Hippocratic “canon” depended on the individual commentator; there was no strict consensus.

As scholars of recent decades have begun to point out,¹⁴ the inconsistencies, ambiguities, and generalities within the Hippocratic writings left later commentators plenty of room to exercise interpretative license. Galen himself regularly seized the opportunity to reinterpret Hippocratic doctrines in light of his own ideologies. One strategy that Galen frequently employed was to explain what Hippocrates had “really meant” by a particular word or phrase, using thick descriptions to expand upon pithy Hippocratic statements and thereby to refashion the great man’s message.¹⁵ At other times, Galen would “read back” into Hippocratic works concepts and terms that were not there to begin with, either because they were anachronistic or

¹² For an overview of the Hippocratic corpus and how Hippocratic medicine related to contemporary intellectual trends, see e.g. Jouanna 1999.

¹³ For a detailed discussion of the medical theories present within the Hippocratic Corpus, see Langholf 1990.

¹⁴ See, e.g. Smith 1979: 175-176; Lloyd 1988; Von Staden 2002: 114-116; Yeo 2005; Flemming 2007: 343-346; Van der Eijk 2012: 33-34.

¹⁵ For discussion of this phenomenon, see e.g. Manuli 1983 and Asper 2013. Manuli calls this practice “l’integrazione del significato” (472).

simply because they did not pique the Hippocratic authors' interest.¹⁶ This revisionist technique allowed Galen to claim for his own theories the full weight of Hippocratic tradition and authority. In what follows, we will consider how Galen employs such tactics in *On Critical Days* to introduce the concept of hourly timekeeping into essentially Hippocratic frameworks.

Galen's *On Critical Days*

Despite the recent upsurge in Galenic studies, *On Critical Days* has not been the beneficiary of much scholarly attention. This is due perhaps in part to the dearth of critical editions and translations. The most recent Greek edition is that published by C.G. Kühn in 1825.¹⁷ In 2011, Glen Cooper published a much-needed critical edition, English translation, and commentary of the Arabic translation that Hunayn Ibn Ishaq penned in the 9th c. CE.¹⁸ Cooper has promised that a new edition of the Greek text will follow, but at the time of writing, this work had not yet been completed. Thus, while *On Critical Days* certainly merits additional study, it should also be approached with a measure of exegetical caution.

In *On Critical Days*, Galen seeks to test out a set of theories, advanced by Hippocratic writers, for anticipating when the course of a febrile illness might change. Central to these theories is the concept of a “crisis” (Gr. κρίσις), a decisive moment at which a fever either

¹⁶ Holmes (2012), for example, has argued that Galen adapted the Stoic concept of “sympathy” (Gr. συμπάθεια) for incorporation into his own theory about the interconnectivity of anatomical systems. In his liberal commentary on *Epidemics* II, Galen manages to read the concept back into the Hippocratic text, despite the fact that the term συμπάθεια does not appear there. Manetti (2003) has observed that Galen also reads certain stylistic qualities back into the Hippocratic Corpus. By being selective about which texts and passages he cites, Galen could claim that Hippocrates' style was clear, concise, and properly Greek, and thus should act as a model to the loquacious, long-winded physicians of Galen's day. For further discussion of Galen's views on language usage, see Manetti and Roselli 1994; Von Staden 2002; Manetti 2009.

¹⁷ C.G. Kühn, *Claudii Galeni opera omnia*, vol. 9. Leipzig: Knobloch, 1825 (repr. Hildesheim: Olms, 1965): 769-941.

¹⁸ Cooper 2011c. For a critique of this edition, see Langermann 2012. On the later Alexandrian summaries of Galen's *On Critical Days*, see Bos and Langermann (eds.): 2015.

dissipates or begins a transition into a new phase (including, but not limited to, death).¹⁹ Some Hippocratic writers had come to recognize through their own bedside experiences that, in illnesses lasting longer than a single day, such turning points tended to recur after certain numbers of days. The Hippocratic doctors were concerned to map out these intervals and to come up with a scheme that would allow them to anticipate and prepare for crises in the future. To prognosticate accurately about the outcome of an illness was vitally important for the ancient physician, because patient deaths – whether preventable or not – could damage his reputation and ability to attract new clients.²⁰

The Hippocratic authors of the *Epidemics* display a particular interest in constructing “critical day” theories. The *Epidemics* is a collection of useful aphorisms, individual case histories, and “constitutions” (Gr. καταστάσεις), i.e. detailed accounts of the seasonal disease patterns produced in different geographic locations.²¹ The dating and authorship of each of the *Epidemics’* seven books has been controversial since antiquity.²² There have been tendencies,

¹⁹ Galen often indicates a febrile crisis by using the term *kairos* (Gr. καιρός), which includes within its range of meanings the notions of “right time” and “critical or decisive time.” For further discussion, see Chapter Five. On the semantic field of the term *kairos*, see Sipiora and Baumlin (eds.): 2002.

²⁰ The Hippocratic author of *Prognostic* summarizes this state of affairs in the following manner: “It seems to me to be an excellent thing that the physician practice prognosis. For if he should prognosticate and foretell, in the presence of patients, things present, things past, and what will be in the future, and if he explains however many things the patients have neglected, he would be more trusted to know the circumstances of those who are sick, with the result that men will dare to entrust themselves to this physician....[A]nd by knowing and declaring in advance who will die and who will be saved, he can be blameless (ἀναίτιος)” (1, 2.110 L). Galen, likewise, declares in *Against Those Who Have Written on Types* that “nothing is so useful – and especially in the case of fevers – as the prognosis of the beginnings of the paroxysms yet to come. If someone is able straightaway, from the beginning, to accomplish this by means of a technical estimate (στοχασμῶι τεχνικῶι), he will benefit the patient very greatly throughout his illness” (VII.479.16-480.2 K).

²¹ My citations of refer to the following editions. *Epidemics* Books I and III: Littré II,598f. and III,24f.; Kühlewein, H. *Hipp. Opera omnia* I (Libri I, III). Books II, IV, and VI: Littré V,72f., 144f., and 266f.. Books V and VII: Littré V,204f. and 364f.; Jouanna, J. *Hippocrate: Tome IV 3: Epidémies V et VII*. Paris 2000.

²² Among the earliest attested Hippocratic commentators are Bacchius, Heraclides, and Zeuxis, all of whom wrote in the 3rd c. BCE. Our earliest extant Hippocratic commentary was penned by Apollonius of Citium. Dioscorides (1st c. CE) was the first to produce critical editions of Hippocratic texts and to reject certain passages and works as spurious. His list of “genuine” Hippocratic texts included the surgical treatises as well as *Aphorisms*, *Prognostic*, *Regimen in Acute Diseases*, *Airs Waters Places*, and *Epidemics* I and III. Artemidorus of Capiton was the next to take up the torch of Hippocratic literary criticism. On these developments, see Smith 1979: 235-239.

however, in ancient as well as modern scholarship, to group certain of these books together chronologically according to the following scheme: (a) Books I and III, which are dated to c. 410 BCE²³ and have a more polished, coherent form;²⁴ (b) Books II, IV, and VI, which have been dated to between 427/6 and 373/2 BCE, and are less polished and consistent in their style; and finally, (c) Books V and VII which, already in antiquity, were considered by many to be post-Hippocratic additions to the Corpus.²⁵ In short, the *Epidemics* was probably pieced together out of a variety of sources, whose authors were located primarily in Northern Greece and wrote, by-and-large, during the late 5th and early 4th centuries BCE.²⁶

Different configurations of critical days appear throughout the Hippocratic Corpus. The author of *Epidemics* I, for instance, explains:

The fevers that have their paroxysms on even days have their crises on even days. Those that have their paroxysms on odd days have their crises on odd days. Among those that have their crises on even days, the period is the 1st, 4th, 6th, 8th, 10th, 14th, 20th, 30th, 40th, 60th, 80th, and 120th [day]. Among those that have their crises on odd days, the period is the 1st, 3rd, 5th, 7th, 9th, 11th, 17th, 21st, 27th, and 31st [day]. One must know that if a crisis should occur otherwise, outside of the days listed, it indicates that there will be a relapse, and it could even become fatal (I.12, 2.678-82 L = I:201.18-202.5 Kühlewein).

²³ Based on corroborating inscriptions discovered at Thasos (Langholf 1990: 77).

²⁴ In fact, some scholars now consider them to be two halves of a single work produced by a single author. See, e.g. Álvarez Millán 1999: 22. Wee, however, cautions against conflating the two, noting in particular that “variables of geography, time, and patient were defined and prioritised differently in Books 1 and 3” (2015: 145).

²⁵ These constitute two separate collections of case histories, although parallel versions of certain case histories appear in both. The extreme heterogeneity of *Epidemics* VII, along with the dramatic style of its story-telling, suggests that it was constructed from a wide variety of sources and edited to enhance its narrative effect. For more on the generic style of these two books, see Smith 1981.

²⁶ On the history, dating, and style of the *Epidemics*, see Deichgräber 1933; Langholf 1990: 77-242; Smith 1979: 237 and 1981; Álvarez Millán 1999: 21-27.

Yet another sequence of critical days is outlined at *Aphorisms* IV.36: “Sweats, in febrile diseases, are favorable if they set in on the 3rd, 5th, 7th, 9th, 11th, 14th, 17th, 21st, 27th, and 34th day, for these sweats prove a crisis to the disease” (4.514-6 L = p.144 Jones).²⁷

By Galen’s time, it seems that the utility of such schemes was open to debate. In *On Critical Days*, Galen informs us that there are those among his contemporaries who “seek what is indicated by the term *crisis* (τὸ σημαϊνόμενον ὑπὸ τοῦ τῆς κρίσεως ὀνόματος) and whether such a thing is even possible” (IX.772.11-13 K). Galen aims to resolve this controversy by means of his own scientific method, which we have seen to be a combination of empiricism and logical reasoning. In the first two books of *On Critical Days*, he proceeds to test the Hippocratic systems against the rubric of his own experiences and the observational data aggregated in the *Epidemics* itself.²⁸ Then, in the third book, Galen reasons through the theoretical underpinnings of such predictive schemes. “Since everything to do with the medical art is discovered and tested sometimes through experience, sometimes through reasoning, and sometimes through the two together,” Galen explains, “one must therefore attempt, by means of both tools, to refute what is erroneous and to commend and accept what is correct” (IX.841.9-842.4 K). In this chapter, we will concern ourselves with two aspects of Galen’s approach: (a) the temporal structure of his fever case histories and (b) the links that he forges between medical and astronomical periodicities.

²⁷ For other critical day lists within the Hippocratic Corpus and discussion, see Langholf 1990: 78-127. For overviews of critical day theory, see also Lloyd 1979: 154-168 and Cooper 2011c: 127-128.

²⁸ Cooper has written extensively on Galen’s methodology in *On Critical Days*. See especially Cooper 2004, 2011b, and 2011c.

Temporality in Galen's Fever Case Histories

Interestingly, recent scholarship on Galen's patient case histories has emphasized the many ways in which they tend to depart from Hippocratic models. Álvarez Millán, for example, has asserted that, when it came to clinical narratives, "Galen did not follow the Hippocratic pattern." In the same vein, Lloyd's contribution to the volume *Galen and the World of Knowledge* is titled "Galen's Un-Hippocratic Case Histories."²⁹ These scholars' arguments are based primarily on Galen's work *On Prognosis*, in which the majority of his case histories are compiled. Yet, medical historians have often overlooked the various case histories embedded within Galen's fever treatises, such as *On Crises*, *On Critical Days*, and *On the Differences Among Fevers*.³⁰ While references to hours do not appear in the case histories collected in *On Prognosis*, we will see that hourly timekeeping is an important structuring device in Galen's fever narratives. I hope to demonstrate here that the latter actually bear a close resemblance to the case histories included within the *Epidemics* (especially Books I and III),³¹ but that Galen's narratives introduce greater temporal precision.

As Langholf has pointed out, critical day schemes serve as the dominant organizing principle in the case histories of *Epidemics* I and III. Some of these case histories are laconic and

²⁹ Álvarez Millán 1999: 32; Lloyd 2009. For an overview of how this genre of medical writing develops over time and across cultures, see Pomata 2014.

³⁰ E.g. *De cris.* IX.680.13-683.2 K; *De diebus. depr.* IX.800.1-802.6 K; *De diff. febr.* VII.351.15-354.13, 355.12-357.17, and 359.9-363.3K.

³¹ These are the only books of the *Epidemics* that Galen consistently attributes to Hippocrates himself. Elsewhere, Galen argues that Books II, IV, and VI were composed by Hippocrates' son Thessalus and that Books V and VII are spurious. This appears in Hunayn Ibn Ishaq's Arabic translation of Galen's commentary on the *Epidemics*: Escorial, MS. 805, fol. 1v (according to Western pagination). For discussion, see Lloyd 2009: 116.

offer no additional temporal markers beyond the potentially critical days. Case 10 of *Epidemics* III.1, for example, proceeds as follows (with day-references marked in bold):

A woman from among those around Pantimides, just out of childbirth, was seized **on the first [day]** by fever. Tongue very dry. Thirsty. Nauseous. Sleepless. Disturbed bowels, with slender, frequent, undigested [stools]. **On the second [day]**, much shivering. Acute fever. Much discharge from the bowels. Didn't sleep. **On the third [day]**, sufferings were greater. **On the fourth [day]**, she was delirious. **On the seventh [day]**, she died. Bowels moist throughout, with frequent, slender, undigested stools. Urine small, thin. Causic fever (III 1, 3.60 L = I:222.6-13 Kühlewein).

We can see here both how the patient's symptoms are grouped according to the day on which they became manifest and how the author has been selective about which days to include in his account. Less clear is what we ought to make of the absence of Days Five and Six. Do they go unmentioned simply because no important changes actually occurred on those days? Or rather, because this physician did not view the fifth and sixth days of such an illness as critical, and thus may not have bothered to observe the patient between the fourth and seventh days? This yields a follow-up question: are we to imagine that practice preceded theory in the development of critical day systems, or theory practice? While certainty is beyond our reach, many have come to agree with Langholf in supposing that, while critical day theories may have found their *inspiration* in actual experience (and perhaps continued to be honed in order to bring them into closer alignment with observed phenomena),³² it is likely that many physicians chose simply to place their trust in a particular critical day system, and only checked in on patients at times that

³² Langholf 1990: 115.

the system anticipated would be decisive. For the physician, such a practice may have served as a method of self-advertising, because patients were bound to be impressed by doctors who tended to show up “gloves on,” as it were, at precisely the right moment.

Yet, while critical days create the main framework within *Epidemics* I and III, many case histories also take an interest in the timing of symptoms *within* the day – what I will refer to as “intra-day” timing. Case 3 from *Epidemics* III.17 offers a representative example. In addition to putting the references to day-units in bold, I have italicized the intra-day time markers and references to temporal durations.

In Thasos, Pythion, who was living above the Temple of Heracles, was seized, on account of his labors and fatigue and careless daily regimen, by a powerful shiver and an acute fever....**On the second [day]**, *around the middle of the day*, an extreme chill, especially in the regions around the hands and head. Speechless, voiceless, short of breath *for a long time*. He heated up again. Thirst. Had a quiet *night*. Sweated a little around the head. **On the third [day]**, had a quiet *day*. *Late, around sunset*, he became a little chilled....**On the ninth [day]**, lethargic. Nauseous when he got up. Not very thirsty. *Around sunset*, he felt ill, became incoherent. Bad *night*. **On the tenth [day]**, voiceless *in the morning*. Very chilled. Acute fever. Much sweat. He died. The sufferings of this man were **on the even days** (III 17, 3.113-6 L = I:235.7-236.10 Kühlewein).

Although this doctor concludes by identifying a critical pattern in the patient’s illness (i.e. suffering increased on the even days), he is deeply interested in charting the *whole* temporal progression of the disease. He records his patient’s condition not only on the critical even days, but on *all* of the days between the onset of the sickness and the patient’s death. Furthermore, this doctor wants to explore the variations in the patient’s condition *within* each given day. Thus, he

is much more meticulous in his timekeeping than the author of Case 10. Here, the physician's intra-day time descriptors are approximate and cued primarily by the position of the sun (e.g. "at sunset," "toward day"). He occasionally alludes to the durations of symptoms, but does not record them with any specificity (e.g. "for a long time," "after a time"). Hours make no appearance in this account, nor do we see any intra-day time markers that are derived from social, rather than celestial, cycles.

By the time we get to the "later" books of the *Epidemics*, however, the situation has changed. On the one hand, we begin to see some socially-based time markers, derived primarily from the cycles of activity in the agora. Case 92 in *Epidemics* VII, for instance, describes sweats that come "on the third [day], when the agora fills (τρίτη δὲ, ἀγορῆς πληθούσης)" (VII 92, 5.448 L = 104.9-10 Jouanna),³³ and Case 62 in *Epidemics* V informs us that the patient "died before the opening of the agora, coincident with daybreak (ἔθανε πρὶν ἀγορῆν λυθῆναι, ἅμ' ἡμέρη πληγείς)" (V 62, 5.242 L = 28.8-9 Jouanna). *Epidemics* IV may even contain an isolated reference to a numbered hour: "He felt the same amount of pain later in the third hour" (IV 12, 5.150 L).³⁴ Yet, as Álvarez Millán has pointed out, the authors of these later case histories seem less committed to strict critical day schemes – not to mention hourly ones – and increasingly, their interest in temporal patterns is eclipsed by an interest in self-advertising and dramatic narrative.³⁵

³³ Cf. *Epid.* V.88.3 and VII.25.20-21. The Liddell-Scott Jones lexicon lists comparanda from other well-known literary sources, including Herodotus (2.173, 4.181, 7.223), Xenophon (*Mem.* 1.1.10; *An.* 1.8.1 and 2.1.7), and Plato (*Gorg.* 469d).

³⁴ τρίτην mss. and edd.; αὐτήν Smith. One other reference to numbered hours appears in the Hippocratic Corpus, at *Int.* 27, 7.238 L: "And if he vomits up some bile or phlegm, it is necessary to do [the procedure] again in four hours, for it will help." For discussion of the fever theory implied in *Epidemics* V and VII, see Smith 1981.

³⁵ Álvarez Millán 1999: 24-27. Some later physicians abandoned critical day theories all together. One such was Asclepiades, whom later Methodics claimed to be the founder of their school (Smith 1979: 228). Percy makes the interesting observation, however, that when Aelius Aristides contrasts divine and human medicine at *Sacred Tales* 61-68, he presents the god Asclepius' medicine as "perplexing, fey, and ambiguous" while the medicine of the

There are many ways in which Galen's fever case histories can be said to imitate the temporal patterns and principles found in *Epidemics* I and III. A representative case history occurs in the first book of *On Critical Days*. In this instance, Galen presents a clinical narrative that he marks as hypothetical, but which he recounts with such specificity that a reader might be inclined to assume that Galen had experienced one or more similar cases in real life. He begins in the following manner:

Let some such patient be set before us, as an example for the clarity of our teaching, a patient who began to experience fever acutely in the tenth hour of the day.... We ourselves, during the second day, closely observed whether the paroxysm made a beginning in it that was perceptible and clear, or whether instead it made the other kind of beginning. Then [we did] likewise, during the third day, in order that we might know whether the paroxysms occurred every day and, still more than this, whether the paroxysms were more robust on the odd or even days (IX.800.1-9 K).

It is clear that Galen's narrative will be structured according to a critical day format. But in specifying the precise hour at which this hypothetical fever comes on, Galen signals that his temporal framework will deviate somewhat from the Hippocratic. As the case history progresses, it maintains this extra level of temporal precision:

[L]et the paroxysms come every third day. And let there be a paroxysm in the eleventh hour of the day, and another on the fifth day in the first hour of the night, and another on the seventh day in the third hour of the night. For let us assume

human doctors is "chronological, rational, [and] particularized" (1992: 606-609). That said, Aristides does not use hours in this passage.

that the paroxysm always comes two hours later, with the result that there will be a paroxysm on the ninth day during the fifth hour of the night, as well as on the eleventh day during the seventh hour....” (IX.800.11-16 K).

Galen’s temporal map of this imagined illness is plainly at a higher resolution than those of the Hippocratic writers. Galen organizes his account according to a scheme that indicates not only the critical *days* upon which a paroxysm occurred, but also what one might call the “critical *hour*” within each day. He asserts that, ideally, such precision will help the physician “to be able to say at times, with certainty, not only the day but also *the very hour* (τὴν ὥραν αὐτὴν) in which one of his patients will experience a crisis – or must die” (IX.831.7-9 K, emphasis added).

Unfortunately, due to the extreme dearth of extant medical writings by Galen’s contemporaries, it is difficult to say how unique Galen was in giving pride of place to hourly schemes within his clinical narratives.³⁶ The best available source for comparison is a collection of case histories, preserved only in Arabic, that claims to reproduce faithfully texts written by “Rufus of Ephesus and other ancient and recent doctors.”³⁷ Ullmann, who edited the compilation and provided a German translation, has argued on the basis of syntax, diction, and the case histories’ internal references to one another that the Arabic texts not only mask authentic Greek originals, but also can be attributed, as a collection, to Rufus or to members of his school.³⁸ Ullmann’s second claim has since been contested,³⁹ but the former is still accepted widely. Thus, with due caution, let us examine a few case histories from this collection to see how their

³⁶ We have reason to believe that the Pneumaticists made extensive use of hours in constructing their own fever theories, but since none of their writings have been preserved, we do not know whether they also wrote case histories and employed a “critical hour” framework in the process. Galen’s relationship to these Pneumatic fever theories will be discussed further in Chapter Four.

³⁷ The manuscript, housed at the Bodleian Library, Oxford, is MS. Hunt. 461, fols. 38b-50a.

³⁸ Ullmann 1978: 16.

³⁹ See, e.g., Mattern 2008: 33. Álvarez Millán, however, accepts both parts of the claim (1999).

temporal structures compare with those we have already seen in Galen's *On Critical Days* and in the Hippocratic *Epidemics*.

Of the 21 case histories included in this compilation,⁴⁰ only one treats fever as its central theme. Case 5, addressing a "Quartan Fever with Melancholic Symptoms," reads:

Another man lay for a long time with quartan fever. He was thereby an ascetic; he killed his desires and fasted for a long time. Impairment overtook his thoughts, and he developed bad ideas with regard to himself. When I saw the sign of coction in his urine, and when an evacuation of black bile came out of him, I could hope that he would get better, since the cooked humor had come out. However, that was not at the beginning, but he mangled the coction, until he was [...] Then I made his body moist and reestablished his vigor. Then he recovered without having had a noteworthy evacuation. I have cured many patients of this disease by bringing their temperament into balance, without evacuation.⁴¹

There are no time markers in this passage whatsoever, not even a consideration of critical days. This physician is concerned less with the temporal cycles of the quartan fever than with the patient's dietary regimen and humoral balance. The majority of the other case histories in the collection share this focus, though some reveal slightly more interest in the timing of a patient's symptoms.⁴²

As in the *Epidemics*, the most common temporal indicators in these case histories are approximate and pegged to solar rhythms. Case 1, for instance, describes a patient who "experienced a fever in the evening and melancholia the next morning, in which, however, he did

⁴⁰ Ullmann suggests that the extant group is only the beginning of a more extensive compilation (1978: 16).

⁴¹ Author's English translation of Ullmann's German translation of the Arabic translation of the (lost) Greek.

⁴² For further discussion of Rufus' case histories, see Swain 2008. On Rufus' approach to medicine generally, see Thomssen 1994.

not persist for long” (12). References to numbered hours do occur, but they are rare and diffuse. I have counted only seven, extracted from four different case histories.⁴³ Only in Case 21, an account of angina, are hours used as an organizing principle, and this only for the brief section of the case history in which the physician records the frequency with which he lets the patient’s blood (10-12). In this instance, hours are used to describe the behavior patterns of the physician, not of the disease.⁴⁴

If these Arabic case histories are indeed translations of Greek originals composed under the Empire (whether or not they should be attributed to Rufus himself), they illustrate that, around Galen’s time, case histories could take many forms. They need not have been organized according to a system of critical days – or hours – nor must they exhibit any particular interest in the temporal patterns of diseases at all. Thus, in imitating the temporal structures of early Hippocratic case histories, but adapting them to emphasize the role of what I am calling critical hours, it becomes clear that Galen made a deliberate choice, one that was available to his contemporaries but not (or at least, not always) adopted. I suggest that Galen’s decision was based, at least partially, on a desire to support his frequent claim that he himself was the only later physician to merit the title of Hippocrates’ intellectual descendent. By recalling the systems of critical days that pervade *Epidemics* I and III, Galen establishes continuity between those systems and his own temporal framework for analyzing fevers, complete with its emphasis on

⁴³ Cases 14.9, 15.9, 18.6, and 21.7 and 10-12.

⁴⁴ This relative disinterest in the temporal cycles of disease seems to persist into the Islamic period. Álvarez Millán, for example, has shown that the case histories of the 10th century physician Abū Bakr Muhammad ibn Zakariyā al-Rāzi (which were collected posthumously by his students in two volumes: the *Kitāb al-Tajārib* and the *Kitāb al-Hāwī*) are not structured according to any critical temporal system (1999: 33-42). Álvarez Millán has also demonstrated that the case histories of Avicenna (Ibn Sīnā), whose *Canon of Medicine* (*al-Qānūn fī l-ṭibb*) was considered an essential medical textbook through the 18th century, do not seem to have been based on personal experience and hardly employ temporal markers at all (2010: 209-213). It seems that the models most commonly used by Islamic writers of case histories were Rufus’ collection (discussed above), the Hippocratic *Epidemics*, and Galen’s *On Prognosis* (as opposed to his fever case histories).

critical hours. Galen manages to present himself as an “updater” of Hippocratic tradition by adjusting the critical days concept to allow for developments in timekeeping that had occurred between the Classical and Imperial periods.⁴⁵

But why else might Galen have taken such an interest in the temporal cycles of fevers? Let us turn to the third book of *On Critical Days*, where Galen transitions from his more “empirical” discussion of how and when febrile crises manifest in the sickroom to a more “rational” meditation on how the cycles of human biology relate to the cycles of the heavenly spheres. In what follows, I will propose that Galen’s interest in such cycles was motivated not only by his desire to imitate Hippocrates, but also by the great esteem in which he held certain forms of astronomy.

Galen, Hippocrates, and Astronomy

At many points within his corpus, Galen praises those arts (Gr. τέχναι) that lend themselves to *apodeixis*. In *On Errors*, his list includes arithmetic, formal logic, architecture, music, oratory, law-making, linguistics, and especially geometry and astronomy. In *On Good and Bad Humors*, Galen traces his appreciation for these arts back to his own father, Aelius Nicon, a man who we know loomed large in Galen’s intellectual development. Nicon, Galen boasts, “reached the highest point of geometry, architecture, calculation, and astronomy, and was admired by all those who knew him for his justice, usefulness, prudence, like no one among the philosophers” (VI.755.11-15 K). Night and day, Nicon would drill his son in these same

⁴⁵ Tieleman observes, “Galen’s independence of mind is of a backward-looking kind. He tends to stress his independence from his contemporaries, while representing himself as conversing directly with the classical authors. That is to say, he intimates that his readings are not mediated by the exegetical and scholastic traditions. And of course he understands the great past thinkers much better than their self-styled followers do” (1996: xxii). Tieleman goes on to discuss how Galen updates Hippocratic anatomy and physiology to account for Hellenistic developments and his own discoveries (xxix). See also Dillon 1977:289 and Mansfeld 1991: 137 n.78.

disciplines, until Galen's own learning surpassed that of his former classmates (VI.756.2-3 K). Thus, from an early age, Galen began to acquaint himself with the fundamentals of astronomy and learned to associate it with the concepts of utility, moral rectitude, and true erudition.⁴⁶

In his medical writings, Galen often asserts that astronomical knowledge is not simply useful in a general sense, but is actually a critical component of medicine in particular. This view he traces directly back to Hippocrates. In *The Best Doctor is also a Philosopher*, for example, Galen criticizes other physicians who are wont to praise and assimilate themselves to Hippocrates and yet, at the same time, are unwilling to take the renowned physician's advice about integrating geometry and astronomy into one's medical studies. "For [Hippocrates]," Galen tells us, "says that astronomy contributes no small part to medicine, and it is clear that geometry is antecedent to this. Yet they themselves (i.e. other doctors) not only take no part in these things but even censure those who do" (1.7-11 Mueller = I.53.5-54.2 K). Galen, on the other hand, is eager to avoid this mistake. He has chosen to heed Hippocrates' advice and to follow the great man in his interdisciplinary scientific pursuits. "For if," as Galen cautions in *On the Method of Curing Diseases*, "those who expect to become doctors have need of neither astronomy nor... any other among the noble disciplines... it will soon be permitted to everyone to become a doctor easily" (X.5.3-9 K). Galen claims to have learned from Hippocrates that what distinguishes a true doctor from a lay-healer is not only the doctor's cache of medical experience, but also his theoretical grounding in apodeictic arts like astronomy.

⁴⁶ Cooper has argued persuasively, however, that Galen likely received only elementary instruction in this field: "Basic knowledge of astronomy was a part of Galen's unusually broad education, however, there is no indication from the *Critical Days* or anywhere else that Galen had more than a general knowledge of the subject" (2011c: 62). Lloyd has made a similar observation about Galen's engagement with mathematics: "Galen's admiration for 'mathematical method' is evident in one text after another... Yet in practice many of these are quite elementary – and need to be excused with the argument that many of his readers are ignorant of mathematics and doctors in particular detest it" (2006: 127). For an overview of Galen's education in the exact sciences, see Elliott 2005: 51-9. On how Galen's knowledge of astronomy manifests in the Arabic version of his commentary on *Airs, Waters, Places*, see Strohmaier 1993 and 1997.

In Book III of *On Critical Days*, Galen draws upon his mathematical and astronomical knowledge in an attempt to explain the theoretical basis of critical day models. At the beginning of the book, Galen takes a moment to review some of the principles he has gleaned from the “empirical” testing he carried out in Books I and II:

Experience clearly bears witness to the fact that the crisis does not occur on all days to the same degree. And it attests that the weekly periods have the strongest power, and after that the periods of four days, while some [crises] fall outside of these periods. Moreover, experience attests that some of these periods are distinct and some are joined (i.e. overlapping) (IX.900.6-901.4 K).

Having compared the Hippocratic critical day systems both to his own bedside experiences and to the data collected in the *Epidemics* itself, Galen is now confident that he has identified the basic temporal patterns that underlie febrile crises. There is, he concludes, a hierarchy of relevant periodicities: the primary cycle is one week, the secondary four days; and it is even possible for less-decisive crises to occur on days that do not belong to either the primary or the secondary cycles.

Galen’s data, however, present him with some problems. First, he would like the primary cycle to be divisible into secondary-cycle units, but the number of days in a week, seven, is not neatly divisible by four. In Book II, Galen sidesteps this problem by recourse to creative numbering.⁴⁷ If one divides the 7-day week in half, he points out, the midpoint of the week will fall on the fourth day. If you then count this day twice – both as the last day of the first four-day period and as the first day of the second four-day period – you will wind up with a seven-day

⁴⁷ For discussion of this strategy, see Cooper 2004: 48-9 and 2011c: 448.

primary period that is indeed divisible into two four-day periods.⁴⁸ Galen adopts a similar strategy to resolve a second conundrum; his empirical testing has indicated that the clearest and most decisive crises occur on the seventh, fourteenth, and *twentieth* day – not on the seventh, fourteenth, and twenty-first.⁴⁹ This is all right, Galen explains, because the second and third weeks can be said to “overlap,” so that one day is shared between them.⁵⁰ Greeks were familiar with the practice of inclusive counting, and this may have made Galen’s argument seem rhetorically plausible to his readers, though it is clearly mathematically unsound.

In Book III, however, Galen offers a different explanation for critical day patterns, one that appeals to astronomical principles. He may have been motivated to alter his approach in response to a change in intended audience. Galen tells us that Books I and II were written for medical students, whose astronomical knowledge could perhaps not be assumed.⁵¹ He composed Book III, on the other hand, for a small group of professional colleagues keen to receive a technical account of why the critical days are the way they are.⁵² To this group, Galen explains that the critical days result from the changing position of the moon and the waxing and waning of its influence over earthly matters during the course of a month. Cooper and others have laid out the structure of Galen’s argument and analyzed its fine points.⁵³ Our concern here will be the particular struts of that argument that rely on the use of hours.

Galen notes that “Hippocrates” was aware of the fact that months and years cannot be neatly divided into whole days. In support of this,⁵⁴ he cites a passage from the *Prognostic* in which the Hippocratic author asserts that “the year and the months cannot, by nature, be

⁴⁸ IX.845.16-846.5 K.

⁴⁹ On the significance of the twentieth day, see e.g. IX.851.11-853.6 K.

⁵⁰ IX.850.16-851.11 K.

⁵¹ IX.789.17-790.10 K.

⁵² IX.934.1-9 K. See also Cooper 2011c: 61.

⁵³ See especially Cooper 2011c: 61-76 and Langermann’s 2012 critique.

⁵⁴ IX.928.16-929.3 K.

numbered in whole days” (20, 2.170 L = 58.9-59.2 Jouanna).⁵⁵ Galen supplements this quotation by turning to the Hellenistic astronomer Hipparchus, who demonstrated that “the length of the month is not thirty complete days, but is less by about half a day” (IX.907.14-16 K). Galen proceeds to use this refined month-length to calculate the true length of a week.⁵⁶ He expresses this figure using even greater temporal precision, speaking in multiple fractions of a day:

If you should cut this [i.e. the length of the month] into fourths, you will find that the precise time [of a week] is less than seven days, not only by one-sixth of a day, but by still more. For let us take the fourth part of 26 [days] plus a half and a third and a twelfth [of a day]. The time of this will be six days and a half and a fifth, and beyond this even smaller parts will be added, which specifically are, first, one sixtieth and one hundred-twentieth, and second, one two-hundred-fortieth [of a day].... (IX.932.13-933.1 K).⁵⁷

Elsewhere in his corpus, Galen instead chooses to translate these day-fractions into hours and fractions of hours. The relevant passage occurs in *On Seven-Month Children*, which Galen composed in response to the Hippocratic texts *On the Seven-Month Child* and *On the Eight-Month Child*.⁵⁸ It has come down to us both in a fragmentary Greek version and in a complete

⁵⁵ On fever theories in the Hippocratic Corpus, see Sticker (1928-1930).

⁵⁶ On Galen’s calculations here and on his process for defining a “medical week” and “medical month,” see Garofolo 2003: 52-3 and Cooper 2004: 53-5, 2011a: 129, 2011c: 75.

⁵⁷ The ancient Greeks and Romans, like the Egyptians, expressed the remainder of a quotient as the sum of a series of so-called “unit fractions,” which had the number one as numerator. On fractions in ancient Greece and Egypt, see Knorr 1982 and Maher and Makowski 2001.

⁵⁸ The relationship between these two texts is highly controversial. *On the Eight-Month Child* appears in a different sequence in manuscripts M and V. As Potter, the editor and translator of the Loeb Classical Library edition, explains, “V presents the whole of chs. 10-13 and 1-9 in succession under the title *Eight Months’ Child*, and then another short spurious text under the title *Seven Months’ Child*.... To avoid the unnecessary confusion a departure from Littré’s chapter numbering would entail, I have kept his and M’s order of the text, but adopted Joly’s and V’s title *Eight Months’ Child* for the whole work” (73-4).

Arabic translation produced by Hunayn Ibn Ishaq.⁵⁹ In this text, Galen participates in a lively medical debate, ongoing since the time of Hippocrates, over the appropriate length of human fetal gestation.⁶⁰ Galen observes that at the heart of this debate lies a dispute over the precise definition of a month. He therefore sets himself the task of explaining to his readers how trained astronomers measure this unit. Preserved among the Greek fragments of *On Seven-Month Children* is the following passage:

Hipparchus demonstrated that, of a whole day, one thirtieth and one twentieth and one 27,000th are added, and another small fraction again in addition to this, which it is superfluous to mention at present.⁶¹ For the point is that [the month] has the aforementioned definition, according to the second book of the *Epidemics*.... [Galen quotes the Hippocratic *On the Eight-Month Child*]: “The seven-monthers,” [Hippocrates] says, “are born after 182 days and an additional fraction.” With regard to seven-month infants or children, he means that the portion added to the 182 days is 15 hours, with, as I said before, some small fraction which is close to one 24th of an hour. It is clear that we are talking about equinoctial hours in all these cases, a 24-hour span of which is called the “night-and-day” (Gr. νυχθήμερον) by astronomers because all of the hours are equal - but since there is the slightest deviation, some think that this is not completely the case. For equinoctial hours are a mean, with respect to their length, between the longest and the shortest hours in each location. Thus, consider that I have stated the length of the [average] month, even though the months themselves are unequal [in length] (19-40 Schöne).

⁵⁹ The incomplete Greek text is based on the Greek codex Laurentianus LXXIV 3 (L), fol. 104r-105v and Laurentianus Gr. LXXIV 2 (I). The complete Arabic translation appears in Codex 3725 of the Library of the Aya Sofia in Istanbul (fol. 127b-134b). See Walzer 1935.

⁶⁰ Mention of this debate also occurs at e.g. Plin. *NH* 4.7 and Gel. III. 10 and 16.

⁶¹ For an explanation of this calculation and its relationship to Hipparchus' data, see Neugebauer 1983.

In this passage, as in *On Critical Days*, Galen clearly seeks to dazzle his reader with his scientific knowledge and temporal precision. Here, in fact, Galen goes even further than in *On Critical Days*, as he not only name-drops Hipparchus⁶² and uses a very precise figure for the length of an average month, but he also lets the reader know that he is familiar with the difference between the seasonal hours used in everyday life and the equinoctial hours employed in technical astronomy. But even more interesting for our purposes is how, later in the text, Galen goes on to explain the different month-lengths cited in various Hippocratic texts.

Galen assures the reader that the great Hippocrates was, like himself, familiar with Hipparchus' work⁶³ and aware that years and months could not be measured in whole twenty-four-hour periods; Galen even cites the same passage from *Prognostic* that he quotes in *On Critical Days*.⁶⁴ Yet, nowhere in the Hippocratic texts does an author translate this fraction of a day into a number of hours. Rather, it is Galen who specifies that such a fraction comes to 15 hours and one 24th. Galen explicitly reads this figure into the subtext of *On the Eight-Month Child* when he asserts, "he (i.e. Hippocrates) means that the portion added to the 182 days is 15 hours..." (emphasis added). Galen thereby attributes to the Hippocratic author the same interest in temporal precision that he himself shares, despite the fact that the word *hora*, in the sense of "hour", only appears in the Hippocratic corpus on a handful of occasions.⁶⁵ This indicates that, while at least some of the Hippocratic writers had exposure to hourly timekeeping, they elected not to use hours in their calculations (or, as we have seen, in structuring their case histories). This contribution is wholly Galen's.

⁶² Whose name, according to a search of the *TLG* database, occurs six other times in the Galenic corpus: *De diebus decr.* IX.907.16; *In Hp. epid. I comm.* XVIIa.23.13 K; *In Hp. prog. comm.* XVIIIb.240.12 K; *De meth. med.* X.12.10; *De com. med. sec. loc.* XIII.353.14; *De sept. part.* 19; *De usu part.* IV.359.12 K.

⁶³ Though Hipparchus' name does not appear in our extant Hippocratic works.

⁶⁴ 114-124, p. 347 Walzer.

⁶⁵ *Epid.* IV 12, 5.150 L and *Int.* 27, 7.238 L.

Returning to Book III of *On Critical Days*, we find another passage where hourly timekeeping, though not mentioned explicitly, is fundamental to Galen's argument. In this instance, Galen is attempting to justify the connection between lunar and critical day periods by recourse to a superficial and rather muddled understanding of catarchic astrology,⁶⁶ i.e. the kind of astrology that allows one to determine whether an event or undertaking will be auspicious or not:

One must recall the discovery of the Egyptian astronomers which we, in our thorough observations, found always to be most true: that the moon, by its nature, makes clear what the days will be like, not only for the sick, but also for the healthy. For if [the moon] should be positioned in relation to the well-disposed planets..., it will cause the days to be good. But if it is positioned in relation to the ill-disposed planets, it causes them to be grievous.... You can thoroughly observe, if you wish, that this stands in agreement with what the astronomers say (IX.911.14-913.10 K).

According to the principles of catarchic astrology, the character of a given event (i.e. whether it is auspicious or not) depends upon the positional relationship between the moon and the planets at the time of its inception.⁶⁷ If the moon was in an astrologically significant position with respect to a benefic planet, the undertaking will prove auspicious; if it was so with respect to a

⁶⁶ See Cooper 2011c: 69. Elsewhere, Cooper draws a distinction between "natural" astrology (the notion that, for instance, celestial bodies influence the weather or other environmental conditions) and "judicial" astrology (which includes the reading of star charts and the casting of horoscopes). He proceeds to argue that, "while Galen's medicine is consistent with natural astrology, it is not so with judicial astrology, and his attempt to present his theory of the critical days in Book III of the *Critical Days* in terms of judicial astrology is a practical failure, if a rhetorical success" (2011a: 124).

⁶⁷ I am indebted to Alexander Jones and Glen Cooper (pers. comm.) for the following discussion.

malefic planet, it will be inauspicious.⁶⁸ These positional relationships, however, depend upon the celestial bodies in question being in certain locations *at certain times*. Thus, the more precisely an astrologer could determine when a star or planet would move where, the more accurately he could pinpoint syzygies and thereby make his predictions⁶⁹.

The technology for tracking and modeling celestial cycles improved dramatically between Hippocrates' day and Galen's. The late Classical and early Hellenistic periods, when the Hippocratic writers were active, constituted an important transitional time for Greek astronomy. It was already recognized in the Archaic period that close observation of celestial movements could enable one to make predictions about related, personally-relevant phenomena. Farmers and merchants were better off if they could anticipate the likelihood of rain, high winds, etc., and if they knew when the period of daylight would be longer or shorter. Since both the weather and the length of daylight correlate with the time of year, farmers and merchants discovered that they could get a handle on these factors by pegging their own enterprises to recurring celestial events. The poet Hesiod offers our earliest literary testimony. In *Works and Days*, he provides his lay-about brother Perses with something like a Farmer's Almanac, in which he recommends, for instance, that Perses gather the grapes from his vines "whenever Orion and Sirius reach mid-heaven and rosy-fingered Dawn sees Arcturus" (609-610).

By the end of the Classical period, however, new technologies and new data enabled Greeks to develop predictive models of greater complexity. One such tool was the *parapegma*

⁶⁸ As Cooper points out, Galen is remarkably vague here, and he neglects to discuss several important astrological features, such as the Ascendant (2011c: 69-71).

⁶⁹ I use the term "syzygy" here in the astrological sense of "alignment," not in the modern astronomical sense of three celestial bodies that appear in a line.

(from Gr. παραπήγνυμι, ‘to fix beside’),⁷⁰ which coordinated the risings and settings of fixed stars with weather predictions for given dates.⁷¹ Another was the practice of astronomical table-making.⁷² Babylonian priests, eager to predict the occurrences of celestial omens such as lunar and solar eclipses, had maintained meticulous records of astral, planetary, and lunar positions with which they could calculate impending syzygies. At some point during the Hellenistic period,⁷³ these tables made it into the hands of Greek astronomers, providing them with plentiful raw data and with models⁷⁴ for how to organize their own records and observations in the future.⁷⁵

As sundials and water-clocks become more widely available over the Hellenistic and Imperial periods, a variety of tables begin to appear in the papyrological record that record the

⁷⁰ *Parapegmata* came in a variety of forms, both literary and inscriptional. Inscriptional varieties use a hole-and-peg system to keep track of the date, and it is from this practice of “fixing” the peg in each successive hole that the term *parapegma* derives. For an in-depth history of Greek and Roman *parapegmata*, see Lehoux 2007. See also Lehoux 2005 and Hannah 2009: 53-54.

⁷¹ Though not all extant *parapegmata* are equally concerned with weather prediction. Lehoux notes that the Greek *parapegmata* of the Hellenistic period show a greater interest in astrometeorology than do the Latin *parapegmata* of the Roman period (2007: 14; 24).

⁷² On the history of mathematical table-making, see Campbell-Kelly (ed.): 2003.

⁷³ We do not know precisely when or how this Babylonian data was transmitted to the Greek world, but we do know that Hipparchus, who was active in the 2nd c. BCE, had access to Babylonian lunar eclipse reports that ranged from the mid-8th c. BCE to at least the early 4th c. BCE (see Neugebauer 1975: 309 and 590; Jones 1991: 443). Toomer (1985) suggests that Hipparchus himself was instrumental in copying sections from the Babylonian archives and conveying them to Alexandria. Hipparchus’ own lunar system borrows heavily from Babylonian System B lunar theory, and he was but one of many Greek astronomers and astrologers who, in the coming centuries, would be inspired by Babylonian table-making and adapt Babylonian predictive systems to his own purposes (Jones 1991: 442-3). On the Greek adaptation of Babylonian astronomy, see also Neugebauer 1969: 145-90 and Jones 1996.

⁷⁴ Lehoux has pointed out that the producers of *parapegmata* often preferred to collate data from preexisting models rather than make new observations of their own. Thus, their predictions tended to be grounded in “texts, tables, and instruments: pegs, not stars” (Lehoux: 2007: 69). The Babylonian system was also based primarily on mathematics, not observation (see Neugebauer 1975: 363-8).

⁷⁵ These developments in astronomical data organization also contributed toward the invention of more complex predictive devices, like the so-called Antikythera Mechanism, which has been salvaged from an ancient shipwreck off the coast of Antikythera and dated to c. 100 BCE. The Antikythera Mechanism (National Archaeological Museum of Athens, Inv. 15087) is a geared, computational device that allows the user to input a date and determine where that date falls within a number of calendrical cycles (both astronomical and political) and the positions of the celestial bodies at that time. On the mechanism and its functions, see, e.g. Freeth et al. 2008, Carman et al. 2012, and Lin and Yan 2016, as well as Jones 2012a/b and 2017.

hour of a celestial event's occurrence alongside numerous other factors.⁷⁶ Ephemerides, for example, list the daily positions of certain celestial bodies, and often include the hour of zodiac sign-entry as well as the longitude and time of particular syzygies.⁷⁷ Sign-almanacs from the 3rd c. CE onward also tend to include a column for the seasonal hour of sign-entry.⁷⁸ Thus, by Galen's day, astronomers were in the habit of recording the exact hours at which periodic events occurred, and then using that observational data (whether their own or someone else's) to build mathematical models which would help them to extrapolate about the timing of those events in the future. In turn, catarchic and horoscopic astrologers, whose trades became wildly popular under the Roman Empire, often attempted to impress their clients by drawing upon the latest developments in astronomical table-making, time-keeping, and celestial trigonometry.⁷⁹

In our *On Critical Days* passage, we see Galen appeal to these developments in order to provide a more nuanced explanation of why Hippocratic critical day theory works. Since these astronomical and astrological trends, in full force during Galen's time, were only just beginning to take off during the period of the Hippocratic writers, it seems likely that these writers did not share the same degree of exposure to or interest in this mode of interpretation. Many of the

⁷⁶ See especially Jones 1999 and 2009.

⁷⁷ Some *ephemerides* were used for catarchic astrology (e.g. Jones 1999 no. 4180), as evidenced by the fact that they include evaluations of each day as "good" or "bad" for certain kinds of endeavors. Our extant *ephemerides* date from the 1st c. BCE to the late 5th c. CE. The most extensive collection and commentary to date can be found in Jones 1999.

⁷⁸ E.g. Jones 1999 nos. 4192 and 4194-4196a.

⁷⁹ For collections of Greek and Roman horoscopes, see e.g. Vettius Valens, Ptolemy's *Tetrabiblos*, and the astronomical papyri collected in Neugebauer and Van Hoesen 1959 (repr. 1987) and Jones 1999: 371-450. On Babylonian horoscopes, see Rochberg 1998. A standard Hellenistic or Imperial-period horoscope was pithy and could contain the following information: a brief opening formula, such as ἀγαθὴ τύχη ("good fortune"); the name of the "native" (i.e. the person receiving the horoscope); the year, date, and seasonal hour of the native's birth; the longitudes of the sun, moon, planets, and ascendant at that time; and a short closing formula, such as διευτύχει ("good luck"). Deluxe horoscopes were more florid in their prose and provided more detailed data, such as the astrological houses and terms in which certain planetary bodies were located. Horoscopic astrologers adapted models originally designed for predicting celestial motion and claimed that, from these patterns, they could make further predictions about the personalities and accomplishments of individual "natives." For discussion of horoscope genres, see Jones 1999: 47. On the data-processing and marketing strategies of ancient astrologers, see Barton 1994: 27-94. On the tools of the trade, see Evans 2004.

Hippocratic works do, indeed, display an appreciation for astronomy.⁸⁰ The *Epidemics*, for example, contains many references to seasonal astronomical events, such as equinoxes, solstices, and the rising and setting of stars and constellations.⁸¹ The author(s) of *Epidemics* I and III, whose case histories we examined above, could even be said to map the progression of diseases over time for predictive purposes in a manner analogous to the astronomer tracking the movements of celestial bodies. Galen, however, seems to read back into these texts a capacity for and familiarity with hourly timekeeping and its astronomical and astrological applications which was simply not appropriate for the late Classical and early Hellenistic eras. In so doing, Galen appears once again to present himself as both a follower and a refiner of Hippocratic doctrine.

Conclusion

Through an examination of passages drawn from *On Critical Days*, this chapter sought to demonstrate how Galen uses references to hourly timekeeping in order to update Hippocratic models for a contemporary audience. We first saw how Galen introduces greater temporal precision into clinical narratives that are otherwise modeled on Hippocratic critical day structures. We then turned to Galen's account of the theory behind critical days, and saw that the astronomical and astrological arguments he musters imply the use of hourly timekeeping technology. Engaging with hourly timekeeping in these ways enabled Galen not only to weigh in on a controversial debate surrounding the utility of critical day systems, but also to bolster two claims that he makes repeatedly throughout his corpus: that he is familiar with astronomical

⁸⁰ See, e.g., Hipp. *Aer.* 2, 2.14 L; *Vict.* 1.2, 4.470 L. On the ways in which the Hippocratic texts engage with meteorological medicine, see Liewert 2015.

⁸¹ *Airs Waters Places* and *On Nourishment* also contain such references. For discussion, see Phillips 1983.

principles, and that he is the only physician among his contemporaries who is worthy of being considered Hippocrates' successor.

4. Bringing Order to Disorders: Hourly Timekeeping and the Problem of Classifying Irregular Periodic Fevers

In the previous chapter, we saw how Galen brought increased temporal precision to bear on a current controversy over the nature and utility of Hippocratic critical day schemes. We also began to appreciate how hourly timekeeping might appeal to a physician interested in practicing Galenic *apodeixis*, that is, in eliminating errors by testing claims against experiential data and logical reasoning. I will develop these ideas even further in the present chapter, as we explore how Galen uses hourly timekeeping to contribute to (and, in his opinion, resolve) another active medical debate, this time over the best means of classifying irregular periodic fevers.

I will first examine Galen's own fever typology and the mechanisms he includes for handling irregular fevers. I will then turn to the little-studied *Against Those Who Have Written on Types* (*Adversus eos qui de typis scripserunt*), a polemic directed against physicians whose fever-classification systems Galen found unwieldy and impractical.¹ This chapter argues that Galen's appeals to hourly timekeeping within this text and elsewhere help him to present himself as both an astute observer and a logical, systematic thinker – in short, as an impeccable practitioner of *apodeixis*.

Galen's Fever-Classification System: An Overview

In order to appreciate the nuances of Galen's strategy for explicating irregular intermittent fevers, it is important to familiarize ourselves with the principles of Galen's own typology, which he develops most extensively in the treatises *On Crises*, *On Types*, and *On the*

¹ The sole Greek edition is that of C.G. Kühn, *Claudii Galeni opera omnia*, vol. 7. Leipzig: Knobloch, 1824 (repr. Hildesheim: Olms, 1965): 475-512.

Differences Among Fevers. As his classification system has already been treated by many scholars,² and as our present interest in this system runs more toward the cultural than the technical, I will simply outline it in brief.

For Galen, the ultimate source of any fever was the excessive stoking of one's internal, life-giving fire.³ This stoking could come about in one of three general ways.⁴ High atmospheric temperatures could overheat the *pneuma* (Gr. πνεῦμα) that pervades the blood, thus yielding fevers that Galen termed "ephemeral" (Gr. ἐφήμεροι). Alternatively, severe dryness or withering in a particular body part could bring on "constitutional" fevers (Gr. ἐκτικοί).⁵ Finally, and most pertinently for our concerns, certain humors could become clogged in the arteries and start to ferment, thereby causing "septic" fevers (Gr. σηπόμενοι).⁶

Different putrid humors yielded septic fevers with different characteristics. As we recall from the Introduction, Galen associated each of the four humors (Gr. χυμοί: yellow bile, black bile, phlegm, and blood) with two of four "qualities" (Gr. ποιότητες: hot, cold, moist, dry). Yellow bile was hot and dry, blood hot and moist, black bile cold and dry, and phlegm cold and

² See e.g. Bynum and V. Nutton (eds.): 1981; Wittern 1989: 3-22; Yeo 2005: 433-43.

³ As Wittern notes (1989: 4), Galen is inconsistent in his details. In *On the Differences Among Fevers*, he claims that fevers should be categorized among "unnatural" (ἄλλοτρία, οὐκ ἔμφυτον) or "external" fires (ἔξωθεν) (e.g. at VII.374.15-18 K), but in his commentary on the Hippocratic *Aphorisms*, he defines fevers as transformations of the inherent fire within living creatures (e.g. at XVII B 414 and 426 K).

⁴ See *De diff. febr.* VII.312-336 K. As we recall from the Introduction, an important tenet of Galen's medical theory was that each person had flowing within his or her veins a different mixture of the four χυμοί or "humors" (*De nat. fac.* II.129.3-131.6 K). The relative amounts of these humors vary from person to person, such that different humors dominate in different individuals.

⁵ Galen describes these alternatively as "wasting" fevers (μαρασμώδεις), in which the body is broken down and consumed "just like the wick of a candle, whenever it has been mostly burnt (οἷόν περ ἢ θρυαλλίς ἐν τοῖς λύχνοις, ἐπειδὴν ἐπὶ πλεῖστον ἐκκαυθῆι)" (*De diff. febr.* VII.313.15-314.12 K).

⁶ As Lonie observes, "The basic feature of [Galen's] explanation was that the temporal discontinuity of the fever is correlated with a spatial discontinuity of the humors in the body. Both the fits of shivering and the period of the onsets were accounted for by *quanta* of putrid humors moving from one part of the body to another. These *quanta* accumulated, putrefied, and were expelled in periods of time which differed according to the quantity and quality of the particular humor" (1981: 19-44). Lonie goes on to note that sixteenth-century writers found this component of Galen's fever theory to be unpersuasive.

moist.⁷ Thus, in Galen’s view, a fever due, for example, to an excess of yellow bile, would cause the patient to be overly hot and dry. To alleviate this condition, a Galen would forbid the patient from having contact with substances that were likewise warming or drying, and instead subject the patient to materials with the opposite qualities (i.e. things that were cold and moist).⁸ For Galen, it was important that a doctor know which humor was to blame for a given fever, not only so that he could predict the course of the illness, but also so that he could design a treatment plan for the patient that was tailored to that humor.

Another important aspect of septic fevers was their temporality. Galen divided septic fevers into two broad categories: those that were “continuous” (Gr. συνεχεῖς) and those that were “intermittent” (Gr. διαλείποντες). Intermittent fevers went through cycles of paroxysm and remission, and the lengths of these periods depended upon the type of humor that had been corrupted. Phlegm, for instance, if fermented, produced a fever that underwent a full cycle of paroxysm and remission every 24 hours, and was therefore called a “quotidian” fever (Gr. ἀφημερινός). Fermented yellow bile caused a fever with a 48-hour cycle, which was called a “tertian” (Gr. τριταῖος) because it arrived every third day, inclusive of the day from which the counting began. Septic black bile produced a fever with a 72-hour cycle, called a “quartan” (Gr. τεταρταῖος).⁹

Quotidian, tertian, and quartan were, for Galen, the three simple fever types (τύποι ἀπλοῖ).¹⁰ To account for so-called “irregular” fevers, which deviated from these types, Galen also incorporated into his system mechanisms for combining and adjusting the three primary

⁷ *De nat. fac.* II.129.3-131.6 K.

⁸ *De meth. med.* X.590.4-11 K.

⁹ These terms – and the recognition of 1-day, 2-day, and 3-day fever periods – did not originate with Galen. We see them already in the Hippocratic works of the late Classical period.

¹⁰ Galen did not believe that the fourth humor, blood, could ferment in this way. As noted above, he considered fevers that originated in the blood to be “ephemeral” (See *De diff. febr.* VII.374-377 K).

types to produce a wider range of periodicities. He made a distinction between fevers whose paroxysms arrived at precisely the same hour every day (τύποι ἐστῶτες or “stationary types”) and those whose paroxysms tended to arrive two to three hours early or late (τύποι κινούμενοι or “moving types”).¹¹ This allowed Galen to include under the heading of a “moving quotidian,” for instance, fevers with a wide range of paroxysmal cycles, extending from roughly 21 to 27 hours. Galen also dealt with irregular fevers by suggesting that the three simple fever types could synthesize to produce compound fevers (Gr. τύποι σύνθετοι). Such compounds could themselves be of two types. “Homogeneous” ones were composed of multiple fevers of the same simple type (such as three tertians or two quartans), whereas “heterogeneous” compounds were formed by a mixture of different simple types (such as one tertian and one quartan).¹²

Galen’s classification system proved so attractive to later physicians that it became the foundation of fever theory first in the Medieval Arabic world and then in the European West, up through the 15th century. During that time, Galen’s writings were widely considered to be one of the two main pillars of ancient medical wisdom, the other being the *Canon of Medicine* (*al-Qānūn fi l-ṭibb*) of the Arabic philosopher Ibn-Sīnā or Avicenna (980-1037 CE). Galen’s reputation was shaken in the 16th and 17th centuries, initially under the pressure of attacks launched by the mystic Paracelsus and his followers, but ultimately also due to scientific discoveries, such as those made by Vesalius and Harvey, which disproved central elements of

¹¹ *De diff. febr.* VII. 351 K.

¹² Galen also speaks often of the “semitertian” fever, though he does not classify it among the simple types. For Galen, a semitertian was the deadly product of a continuous quotidian fever and a tertian, and he distinguishes between multiple kinds (*De diff. febr.* VII. 358.6-359.9 K). Another Imperial-period physician, Celsus, describes the semitertian as a tertian that never undergoes complete remission and whose paroxysms last roughly 36 hours (III.3.2).

Galen's medical theories.¹³ Yet, vestiges of Galen's fever classification system remain embedded in modern medical terminology. To this day, fevers are still categorized as "continuous" or "intermittent," and among the intermittent fever types we still recognize the "quotidian," the "tertian," and the "quartan." These are now used primarily to identify different strains of malaria.¹⁴

Hours in Action: A Case Study

In order to see Galen's classification system in action, let us consider an extended passage from *On Crises*. Galen's ultimate aim in this passage is to demystify a seemingly irregular fever by interpreting it as a mixture of three tertians. We will see how Galen deploys hourly timekeeping to illustrate the temporal patterns underlying the illness in question and to promote the image of himself as an exemplary scientist. I quote the passage nearly in full so that the reader can better appreciate the overall shape of Galen's argument and the temporal landscape that he depicts.

And yet frequently [fevers] have a clear mathematical proportion (ἀναλογία), just like in the case of the young man who began to have a fever in autumn, on the first day and around the fifth hour together with short shivering spells.... To me, who examined the whole form of the fever, it seemed to be a combination of three tertians.... [This fact] appeared clear to me immediately upon the second day. The first [tertian] was recognized to have also had an early paroxysm on the third

¹³ Vesalius' *Fabrica* (1543), for example, demonstrated that Galen's was not the last word on human anatomy, while Harvey's work on the circulatory system (1628) revealed that Galen had been wrong in his interpretations of veins and arteries. On the reception of Galenic medicine from the Renaissance onward, see Temkin 1973; Smith 1979: 1-44; Bates 1981: 45-70; Lonie 1981; Yeo 2005: 435; Nutton 2008: 355-90.

¹⁴ On the modern medical definitions and treatments of malaria, see e.g. Pampana 1963 and the Center for Disease Control's entry for "malaria." On the role that malaria may have played in the ancient world, see Jones 1907 and 1909; De Zulueta 1973: 1-15; Grmek 1989; Burke 1996; Scheidel 2001: 76-89; Sallares 2002; Van der Eijk 2014.

[day], for the paroxysm came on in the second hour - not the fifth as on the first [day] - and conveyed all the signs of the tertian period more clearly than on the first day. From there, keeping an eye on everything, we found that the paroxysms were coming on two or three hours early, with the result that the mathematical proportion corresponding with the first with regard to its period came into being on the fifth day during sunrise, then much more rapidly on the seventh day, like around the ninth hour of the night. Then the next one according to this mathematical proportion [arose] in the seventh hour of the night. The next one in succession arose in the fourth hour, and thence again the next one at the fourth hour, and the one after this during the fifth hour, and then again during the sixth. Then the tenth paroxysm from the beginning came about during the eighth hour. Analogously to this one, the other two after the seventh period not only did not come early but they also arrived late, which thing is very clear to all, even to those who think that [this fever] is a semitertian, although they are very much mistaken (IX.680.13-683.2 K).

In the opening of this passage, Galen makes it clear that he is participating in an ongoing terminological debate over how to define atypical fevers. Other doctors, he claims, find themselves entirely nonplussed by fever periods that do not fit their standard simple types. Galen, on the other hand, asserts that he knows better and can even support his diagnosis by offering physical and temporal evidence for his interpretation. By indicating, in the subsequent case history, the exact days *and hours* at which the patient experienced paroxysms, Galen attempts to demonstrate that, in spite of the apparent irregularity of these paroxysms, an underlying pattern is still discernible. He claims that this pattern can actually be explained as the result of three tertian fevers with different start-dates, whose paroxysmal periods overlap (see Table 1). Galen explicates the unusual periods of these tertians (see Table 2) by calling upon his distinction between fixed and moving fever types. These tertians, he argues, are moving, and thus one

should expect each paroxysm to arrive two to three hours later or earlier than the one that preceded it.¹⁵ Characteristically for Galen, the resulting argument seems designed to strike the reader as both straightforward and mathematically complex at the same time.¹⁶

Galen's decision to use hours as a structuring tool in this clinical narrative permits him to accomplish a number of things. First, it gives him a way to describe the behavior of an intermittent fever that is more precise and information-rich than the terminology commonly employed during his day. Galen makes this claim explicitly in another of his fever treatises, *On the Differences Among Fevers*, in the midst of a discussion about how best to refer to tertians of varying paroxysmal lengths. Galen describes how other physicians often resort to vague adjectival modifiers to differentiate between tertians whose paroxysmal periods are exactly 24 hours and those that are longer by various degrees. They call the former sort of tertian "strict" or "simply lengthened" (ἀπλῶς μεμηκυσμένον), and divide the latter category into the "sufficiently lengthened" (μεμηκυσμένον ἰκανῶς), the "very lengthened" (ἐπιπλέον μεμηκυσμένον), and the "most lengthened of all" (ἐπιπλεῖστον [μεμηκυσμένον]).¹⁷ Galen observes that such labels are relative terms, at best, and do not necessarily aid a doctor in predicting a fever's specific behavior. He then states that he himself will employ a different method: "But if I wish to explain to someone else what sort of fever a patient has, it will be more precisely clear if I mention the length of the paroxysm and of the interval (i.e. remission phase) (ἀκριβέστερον δηλώσει τό τε τοῦ παροξυσμοῦ καί τό τοῦ διαλείμματος εἰπὼν μήκος) than if I attempt to indicate it clearly and definitely with a term (ὄνομα) that amounts to the same thing" (VII.373.3-7 K). In the

¹⁵ Galen seems untroubled by the nine-hour jump in the timing of the paroxysms on Day 9 and Day 11.

¹⁶ Barton has observed that, "despite [Galen's] idealization of the autodidactic doctor and his implication that anyone who follows his example can enjoy similar fame and success, he appears to relish the mastery of such knowledge more than he does attempting any real communication of it" (1994: 137).

¹⁷ VII.372.1-10 K.

example that Galen offers, he states the durations of both the paroxysm and the succeeding period of abatement specifically in hours.¹⁸

Galen is concerned that disputes over fever terminology can lead to the propagation of harmful errors, both among students building up the foundations of their medical knowledge and among actual physicians attempting to treat patients. At this point in *On the Differences Among Fevers*, Galen essentially asks: if one physician cannot understand what another physician means by “tertian fever,” then what good is that term? And how is medical progress ever to be achieved, if physicians cannot even agree on such fundamentals as the technical language of their art? We know from Chapters One and Two that Galen avidly promoted the development of a universal “scientific language” which would allow practitioners to communicate with one another without any loss or garbling of information.¹⁹ In the realm of fever typology, he seems to see the temporal unit of the hour as offering physicians a method for characterizing fevers precisely, without resorting to approximate or controversial terms.²⁰

Secondly, by using hours in the case history from *On Crises* quoted above, Galen is able to produce a temporal map of these fevers that is so detailed, it reinforces the impression that Galen acquired his temporal data points through genuine autopsy. We are tempted to picture Galen himself seated at a patient’s bedside, with a chart in his hands and his eye - as it were - on the clock. He enhances this image later in the passage, with additional references to his own

¹⁸ “Let us assume that this particular man experiences fever for fifteen hours and becomes fever-free for thirty-three, and that this state of affairs persists for him in the successive days according to this progression” (VII.372.14-16 K).

¹⁹ On Galen’s desire for a universal scientific language, see also Von Staden 2002: 109-40.

²⁰ Galen does warn his readers that fever periodicities are not always sufficient, on their own, for producing accurate diagnoses and prognoses. A good doctor must consider the whole picture: the quality of the patient’s internal heat; the presence or absence of other symptoms, such as shivering or inflammation; the characteristics of the pulse, urine, and stool. We see this in our *On Crises* passage, for example, when Galen observes that the patient’s pulse, temperature, shivering, and sweating all corroborate the conclusion that Galen had tentatively drawn from the fever’s paroxysmal periods – namely, that he is faced with a triple tertian. Yet, among these diagnostic features, Galen seems to give pride of place to fever periodicity, as measured specifically in hours.

personal experience: e.g., “to me, who examined the whole form of the fever...”²¹ or “from there, keeping an eye on everything...”²² Thus, Galen presents himself as a physician who grounds his theories in empirical research.²³ Meanwhile, by mapping out the progress of the triple tertian in a schematic way, Galen suggests to his readers that he has subjected his empirical data to systematic analysis. This exercise has allowed Galen to demonstrate that a coherent, logical framework underlies even the most erratic fever periods. Such a framework promises to enable doctors to identify and make predictions about any kind of febrile behavior. The balance between logic and empiricism that Galen displays here is, of course, the hallmark of his scientific method, or *apodeixis*, a system which allowed Galen to walk the line between Rationalist and Empiricist approaches to medicine. Thus, by using hours to structure his clinical narrative in this context, Galen could bolster his pet claim to be a meticulous practitioner of *apodeixis*.²⁴

Contextualizing Galen’s Approach: What Other Doctors Were Saying

Galen seems to have been neither the first nor the only physician to propose a theory of compound fevers to explain irregularities in paroxysmal periods. Nor, as we shall see, was he alone among his contemporaries in expressing fever periodicities in terms of hours. Galen stands out (amidst our limited extant material) in two ways: first, in specifying the length of each paroxysm and abatement in terms of hours; and second, in distinguishing between “stationary” and “moving” paroxysms, a practice that allowed him to integrate precise and allegedly

²¹ IX.681.8 K.

²² IX.682.7 K.

²³ Cf. (as one comparandum among many) *De diebus decr.* IX.772.9-13 K, where Galen accuses “some doctors (ἔνιοι τῶν ἰατρῶν)” of weighing in on medical discussions despite never actually having attended (οὐδὲ παραγεγονέναι...οὐδεπώποτε) those who suffered from the illness at issue.

²⁴ Cf., for example, *De diff. febr.* 370.3-6: “I have tried, as best I can, to express every fever type accurately, finding out the useful differences among them through both experience and logic (δι’ ἐμπειρίας ἅμα καὶ λόγου) over a long period of time.”

observational measurements into a simpler, more practical classification system.²⁵ While few fever treatises have come down to us from among Galen's near-contemporaries themselves,²⁶ Galen alludes to the existence of such treatises in his work *Against Those Who Have Written on Types* (henceforth, *Adversus typos*).

In this polemical text, Galen criticizes a group of physicians who adopted, in his opinion, an overly-complicated and thoroughly unrealistic scheme for classifying fevers. Though he does not mention the affiliation of these doctors, it is possible that Galen means to target members of the Pneumatic sect.²⁷ This sect earned its name from its members' belief that the *pneuma* was the fundamental principle of life. The health of the *pneuma* could supposedly be determined by analyzing a person's pulse. We know from Galen that Pneumatic physicians developed elaborate systems for classifying pulses, often incorporating charts alongside comprehensive descriptions.²⁸ As we shall see, Galen's imagined interlocutors in *Adversus typos* seem to adopt similar strategies with regard to periodic fever classification. It is also noteworthy that the two physicians Galen names within this text, Agathinus and Philistion, may be connected to the Pneumatic school. Agathinus was widely considered to be the official founder of the sect, and its central tenets can be found in Philistion (if Galen intends here a reference to Philistion of

²⁵ Celsus mentions that some paroxysms "recur at the same time the next day (*tempore eodem postridie*), while others recur either later or sooner (*vel serius vel celerius*)" (III.3.4). It seems, however, that he is simply making a general observation, not identifying discrete categories analogous to Galen's "stationary" and "moving" types.

²⁶ The Pneumaticist Aretaeus of Cappadocia (c. 150-190 CE) wrote a treatise on fevers, fragments of which are preserved in Ps-Alexander of Aphrodisias' work *On Fevers* (16.1, 24.5, 30.1 Tassinari). While Aretaeus mentions fevers in a handful of places in his extant works, *On Causes and Signs of Acute and Chronic Diseases* and *On Therapy of Acute and Chronic Diseases*, he does not discuss their periodicities (see e.g. *De caus. sign. acut. morb.* I.4). The fever treatise by Ps-Alexander of Aphrodisias (150-200 CE) shares neither Galen's interest in fever temporality, nor his humoral view of anatomy and pathology. See Keyser and Irby-Massie (eds.) 2008: 55-56 (Ps-Alexander) and 129-130 (Aretaeus).

²⁷ On this sect, see e.g. Gourevitch 1998: 115-7; Nutton 2008: 207-10.

²⁸ See Smith 1979: 100.

Locri).²⁹ Galen was also under constant pressure to distinguish his own systems from those of the Pneumatics in order to preserve his reputation as one “above” sectarian affiliation.³⁰ Given these factors, it is plausible that certain Pneumatics, at least, were among the intended audience of *Adversus typos*. However, as the term “Pneumaticist” may not encompass the full set of Galen’s intended victims, I will follow Galen himself in leaving this group unnamed.

In *Adversus typos*, Galen charges this group of physicians with committing a number of medical crimes: (1) incorrectly identifying fever types, thereby creating classificatory confusion; (2) producing tardy and unhelpful diagnoses; and, in general, (3) prognosticating more like seers (Gr. μάντις) than like doctors – which, for Galen, means doing so without adhering to the proper scientific method. In criticizing such behavior, Galen also creates - and seizes - the opportunity to present himself in contrasting terms. Galen, he would have us believe, (1) utilizes a precise classificatory system, that is simultaneously nuanced and easy to use; (2) regularly produces rapid and accurate diagnoses, due to his great familiarity with fevers; and (3) obtains his prognoses via true *apodeixis*. We will examine each of these claims more closely to see how Galen uses hourly timekeeping in their support.

In his other fever treatises, Galen often accuses doctors of creating classificatory confusion by being insufficiently precise. Toward the beginning of *On the Differences Among Fevers*, for example, Galen complains that most doctors fail “to distinguish the useless [fever categories] from the useful,” sometimes omitting important types or adding superfluous ones.³¹ In *Adversus typos*, Galen focuses his attack on doctors who allow for too many categories. They do not limit themselves to the three simple fever types recognized by Galen (the quotidian, the

²⁹ See, e.g., *Londiniensis Medicus* 20.24-50 (Jones, 1947, p.80). For commentary, see Longrigg 1998: 80. On Agathinus and Philistion, see Keyser and Irby-Massie (eds.) 2008: 42-43 and 649-650, respectively.

³⁰ On Galen’s relationship to the Pneumaticist School, see Smith 1979: 99, 230-3.

³¹ VII.274.1-8 K.

tertian, and the quartan),³² and they adhere too strictly to the notion that all fever types must be “defined in complete days and nights (ὅλοκλήροις ἡμέραις τε καὶ νυξὶ περιγράφηται),”³³ an idea that – as we discovered in the last chapter – flies in the face of what Galen has learned from Hipparchus and from his reading of Hippocrates’ *Prognostic*. These misguided physicians must resort to convoluted and, in Galen’s view, utterly impractical calculations in order to account for fevers whose periods deviate from the simple types by just a few hours. Galen condemns these men as ones who “after wasting their own and their students’ time, whenever they come to patients’ bedsides, are worse than any layman.”³⁴ For a layman, Galen insists, would not be confused by a quotidian fever whose paroxysms arrived two hours earlier than expected; despite this slight temporal variation, that laymen would still have “the impression (φαντασία) of the period called ‘daily.’” The offending doctors, however, assume that each manifestation of what Galen would classify as a simple moving quotidian must actually constitute a complex compound:

Those who are slaves (δουλεύοντες) to the aforementioned hypotheses ... would say that [the fever’s] period is 22 hours, and they would think that the whole type is not simple, but some sort of compound. Then, having investigated sufficiently and calculated on their own - some on their fingers, some even drawing a diagram in a book - they would say that such a fever type is twelve “dodecan” fevers (δωδεκαταίους, i.e. fevers whose paroxysms arrive on the twelfth day, and whose periods thus last eleven days). When the hearers laugh at this, they become irritated (VII.477.6-12 K).

³² Cf. VII.489.4-8K: “These men do not call every period a ‘type,’ but whatever period is composed of complete days and nights, and they want there to be a type for each particular quantity of days. And [they want these types to include] not 20 or 30 days alone, but also the periods outside of these that extend beyond their types.”

³³ VII.476.12-13 K.

³⁴ VII.476.14-16 K.

In what follows, we will walk through one of the mechanisms that such doctors used to obtain these diagnoses. For the time being, what matters is that, in Galen's view, these doctors misidentify a moving quotidian, with a period of *approximately* 24 hours, as a different illness with a strict 22-hour period. To explain the strangeness of such a period, the doctors must resort to a rather absurd combination of twelve so-called "dodecans."

Despite the abuse that Galen heaps upon his rivals, he seems to enjoy playing with their mathematical methods. Rather than simply dismiss them out of hand, as too silly to warrant consideration, Galen instead devotes the greater part of *Adversus typos* to explaining and testing out some of their theories – before subjecting them to crippling refutations. In order to elucidate the mathematical operations that underpin these doctors' diagnostic systems, Galen begins by laying out a table of his own, which he advises any interested readers either to commit to memory or to copy out onto a notecard for easy consultation during the discussion that follows.³⁵ In the left-hand column of the table, Galen lists the different fever types recognized by these doctors, which are not limited to quotidians, tertians, and quartans, but go all the way up, day by day, to "quinguagintans," fevers whose paroxysms occur every 50th day. In the right-hand column, Galen gives the period of each of these fever types, listed not in units of whole days but in the equivalent number of (presumably equinoctial) hours. Thus, the number 48 appears next to the type labeled "tertian," the number 120 next to "sextan," and the number 936 next to "quadragintan." Galen invites us to employ these figures in the following mathematical formula:³⁶

³⁵ VII.490.1-493.3 K.

³⁶ The letters for each variable were assigned by the author, not by Galen himself.

$$P/p = N$$

In this equation, P = the period, in hours, of a fever type listed on the table; p = the period, in hours, of an observed fever; and N = the number of fevers (of the type corresponding to period P) that have combined to create the compound. Galen explicates this formula using the following example:

Let it be the case that someone suffers a paroxysm for six hours and experiences abatement for two hours, with the result that the whole period of hours is eight. In accordance with this hypothesis, consider what fraction of 24 is 8. Then, having discovered that it is one third, you will say that the number of quotidian fevers which have combined is three. Quotidians, because eight is a fraction of the number 24; three, because that fraction is one third (VII.493.4-494.4 K).

If we plug these figures into the equation, we get: 24 hours / 8 hours = 3 fevers (each of length 24 hours). An observed paroxysmal period of 16 hours, Galen continues, would indicate a combination of three tertians, because 48 hours / 16 hours = 3 fevers (each of length 48 hours).

Since, however, the only given in any particular diagnostic situation is p , how, Galen asks, should one decide which values to assign to P and N ? In order to ensure that both of these are whole numbers, Galen ultimately advises using the Rule of the Greatest Common Denominator expressed by Euclid in chapter 7 of his *Elements*.³⁷ Galen offers, as one of several examples, the case of a fever with an observed 15-hour period. He recommends first finding the lowest denominator common to both 15 and 24 (the number of hours in a day); this number is 3, which goes into 15 five times and into 24 eight times. “If you cross-multiply that five by 24 and that

³⁷ VII.511.10 K.

eight by 15, you will discover that the same number is produced, namely 120 hours, which is clearly 5 days.”³⁸ Thus, you are plainly dealing with eight “sextan” fevers, whose paroxysms arrive every sixth day (i.e. after a span of five days). Galen spends several pages manipulating numbers to further illustrate these calculations, before he abruptly concludes the treatise, declaring that “it would be better to despise these things all together, recalling the pronouncement of Pythian Apollo that it is best not to waste time.”³⁹

Galen seems to relish the opportunity to impress his readers with this virtuosic display of mathematics.⁴⁰ Yet, Galen does not hesitate to point out the significant problems with this fever classification system, in his signature vitriolic style.⁴¹ To begin with, he notes that this diagnostic method does not yield one decisive diagnosis for each observed period. There are instead many numbers of which a given p can be a factor. “Which is the more appropriate choice,” Galen asks, “between 18 decans or 20 dodecans [i.e. fevers whose paroxysmal cycles end on the tenth and twelfth days, respectively] ... or one of the periods that come after?”⁴² In other words, how ought one to decide among these equally absurd options? Such a question, Galen points out,⁴³ matters on the practical level because, at least according to his own theory of pathology, each fever type is produced by a different humor or combination of humors, and therefore demands a different regimen of treatment. In Galen’s opinion, classification systems that are unable to help a doctor

³⁸ VII.511.16-512.2 K.

³⁹ VII.512.14-16 K.

⁴⁰ Though it should be noted that Galen does not consistently use the formula that he himself lays out. For instance, shortly after introducing the formula, Galen says, “Since, whenever the paroxysmal period is twelve, it can be two quotidians but it can also be four tertians, and – still further – six quartans, eight quintans, ten sextans, twelve septans, fourteen octans, sixteen nonans, and eighteen decans” (VII.497.14-498.1 K). This sequence has its own mathematical logic: as P increases by one day, N increases by two. Galen does not offer an explanation of this system.

⁴¹ VII.497.10-13 K: “[I]t suffices to proceed in the useless art of these things up to such a point, in order that we might be able to demonstrate, through a short summary, each of the errors that follow....”

⁴² VII.498.4-6 K.

⁴³ VII.485.19-488.16 K.

determine how best to treat his patient are nothing more than “exercises for young men, similar to the riddles that are posed around the dinner table.”⁴⁴ In short, they are utterly useless. Elsewhere in his corpus, Galen recommends that physicians pay attention not simply to the periodicity of the paroxysms, but rather to a whole suite of critical signs, including the quality of the patient’s urine, the speed of his pulse, the consistency of his stool, and other such indicators.⁴⁵ In *Adversus typos*, Galen seems to suggest that a similar practice would help the physician to adjudicate in cases where multiple fever configurations are viable based on periodicity alone.

Galen’s second damning criticism of this system is that, if one allows *homogeneous* compounds of fever types that extend beyond the quartan all the way up to the “quinquagintan” [i.e. fevers whose periods conclude on the 50th day], then one must also be prepared to consider all the *heterogeneous* compounds that could be formed from those types. After pointing out that numerous heterogeneous combinations are available even to physicians who limit themselves to mixing quotidians, tertians, and quartans, Galen exclaims:

If you then combine every complex of the quintan with that of the sextan, you will know, I think, what the quantity will be. And if you also mix with them the septan or octan or one of the ones that come after, and make other compounds, first out of the four types thus combined with one another, then out of five types, and then again out of more, I think that you will appreciate how great a number of

⁴⁴ VII.487.12-13 K.

⁴⁵ Galen lists some of these critical signs in *On Sects for Beginners*, where he marvels at physicians who “did not ever look at the sweats, the urine, the vomit, or the excrement beyond what is natural, though these evacuations are useful in diseases. And strangest of all, [I marvel] if they never observed the critical bleeding of the nose” (I.94.6-10 K). Further discussion of these signs can be found in, e.g., *Method of Medicine*. Galen discusses the importance of the pulse for diagnosis and prognosis in numerous treatises, such as *On the Pulse for Beginners*, *On the Differences of Pulses*, *On the Knowledge of the Pulse*, *On the Use of the Pulse*, *On the Causes of the Pulse*, and *On Prediction from the Pulse*.

combinations there will be – and how many books you will need in order to teach about them (VII.505.8-15 K).

As someone who generally supports integrating mathematics into the art of medicine, Galen can appreciate these physicians' desire to create a fever classification system that is mathematically grounded. The problem, in his opinion, is that they get it wrong; they are too interested in complexity and false “precision,” and they fail to subject their results to the logical and empirical tests which would alert them to their methods' impracticality.⁴⁶

For Galen, this method can result in the following errors. First, since it does not impose any limit on how long a paroxysmal cycle can be, physicians may find themselves waiting indefinitely to see whether another paroxysm is forthcoming or whether they can, in fact, declare a patient cured. As Galen puts it, “it is impossible for those who extend their periods into a great number of days to make a prognosis about the paroxysm that will come.”⁴⁷ Second, this method allows for fever types that defy experiential wisdom. Galen, for instance, describes an imaginary debate between himself and a rival physician over how to characterize a fever whose paroxysms last five hours and whose periods of abatement last two hours (yielding a total cycle of seven hours). “I would reply straight away,” Galen tell us, “that this is not even possible (μηδ' οἶόν τε γενέσθαι τοῦτο). For paroxysms that are of such short duration produce abatements that are long, and on the whole, they result in a fever-free state (ἀπυρεξίαν).”⁴⁸ He then presents his interlocutor as being indifferent to the question of “whether a hypothesis is possible or impossible,” and thus as someone who is happy to entertain fantastical interpretations solely “for

⁴⁶ Galen describes such physicians as “those who practice the [medical] art with illogical method (τοῖς ἀλόγῳ τριβῆι μεταχειριζομένοις τὴν τέχνην)” (VII.478.3 K).

⁴⁷ VII.480.18-481.1 K.

⁴⁸ VII.479.2-5 K.

the sake of exercise (γυμνασίας δ' ἔνεκα).⁴⁹ Finally, this method is further flawed because, as we have just seen, it does not offer clear strategies for distinguishing between several different fever combinations that, mathematically, could all yield the same paroxysmal period.

Galen, of course, would have his readers believe that he himself is exempt from such criticisms. Not only has he succeeded in identifying the errors that these other doctors have built into their system, but Galen has also proposed a different system which, despite its own complications and defects (characteristically unacknowledged by Galen), he presents as cleaner and more effective. We recall that Galen recognizes only three simple fever types, each of which is assigned to its own humor and associated method of treatment. These can combine to explain irregular patterns, but Galen's system avoids excessive complexity (at least in terms of the types and numbers of fevers that can combine) by allowing the paroxysmal times of some fevers (those he classifies as "moving") to deviate by a handful of hours.

Furthermore, Galen suggests that, unlike the doctors he is critiquing, he himself knows how to test medical theories using the proper blend of logic and empiricism. Galen's favorite term for this approach, *apodeixis*, appears only once in this treatise, but it carries much significance; Galen describes the entire exercise that he has performed in writing *Adversus typos* as an instance of *apodeixis*.⁵⁰ At the end of the text, Galen brings his argument to a close by saying, "So now you have this demonstration (ἀπόδειξις) of their method, despite my not having wanted to teach you useless things."⁵¹ Here, *apodeixis* does not refer to a formal logical proof, but to the rigorous testing and refutation of the other doctors' hypotheses that constitutes the bulk of *Adversus typos*. Galen's apodeictic strategy in this treatise is: first, to identify the premises

⁴⁹ VII.479.7-9 K.

⁵⁰ The related term ἐνδείκνυμι, "to point out, to prove," makes several appearances, at VII.479.13, 498.18, 499.2, 505.16 K.

⁵¹ VII.512.12-14 K.

upon which these rival doctrines are constructed and pursue them to their logical conclusions; second, to assess the viability of these conclusions by comparing them against his personal experiences of what works in the sick room. In doing so, Galen seeks to display his own logical aptitude and commitment to empiricism, while also demonstrating his familiarity with table-making and manipulating mathematical formulae, just like the physicians he is criticizing. Ultimately, the results of these rival diagnostic methods speak for themselves: Galen (so he claims) is able to identify fevers quickly and offer patients accurate prognoses; the other doctors, in contrast, must wait for long periods of time before they can even feel confident offering a diagnosis, much less a prognosis, and their conclusions are usually wrong.

Conclusion

This chapter explored how Galen uses hour-units to participate in an ongoing medical debate over how to classify irregular periodic fevers and how, in the process, he could portray himself as a faultless practitioner of *apodeixis*. We saw that, for Galen, numbered hours seem to offer physicians a lexicon for describing periodic fevers that is both more quantitative and therefore more broadly comprehensible than the language typically employed. Because Galen (allegedly) was willing to chart the exact hours at which a fever's paroxysms arrived, he was also able to distinguish between stationary and moving fevers, a distinction that he considered useful for making sense of seemingly irregular fevers. Furthermore, by incorporating systematic hourly timekeeping into his fever theory, Galen could demonstrate to his readers that he – in contrast to his overly cerebral and performative contemporaries – was (a) meticulous about recording and organizing observational data in accordance with specific temporal schemes; (b) adept at

interpreting this data with the aid of logical reasoning and mathematical formulae; and (c) capable, thanks to his scientific method, of catching and correcting any potential errors.

Tables

Hour	Day 1	Day 2	Day 3	Day 4	Day 5
4				(Tertian 2)	
5					
6					
7		Tertian 2			
8					
9					(Tertian 3)
10			Tertian 3		
11					
12					Tertian 1
1					
2			Tertian 1		
3					
4					
5	Tertian 1				

Table 1. The pattern of paroxysms experienced by the patient within the first five days of his illness, and Galen’s attribution of them to particular tertians. Shaded boxes indicate seasonal hours of the night, unshaded boxes seasonal hours of the day.

Hour	Day 1	Day 3	Day 5	Day 7	Day 9	Day 11	Day 13	Day 15	Day 17	Day 19
6										
7					x					
8										
9				x						
10										
11										
12			x							
1										
2		x								
3										
4						x	x			
5	x							x		
6									x	
7										
8										x

Table 2. The paroxysms of what Galen identifies as Tertian 1. In this table, the days advance in units of two because the paroxysmal period of a tertian is approximately two days.

5. “Right Timing” in Sickness and in Health: Hourly Timekeeping and *Kairos* in Galen’s *On Hygiene*

Our investigation into Galen’s fever literature revealed how Galen used hourly timekeeping to track paroxysmal cycles and build predictive, mathematical models of fever behavior. Galen’s ultimate goal in designing these models was to anticipate the time and outcome of a crisis, a decisive moment at which a patient’s illness would transition to a new phase. The febrile crisis is a specific instance of a much broader concept, which the Greeks called *kairos* (Gr. *καῖρός*). The semantic field of this term is extensive, but its most fundamental definitions include “right time,” “critical time,” and “opportunity.”¹

This concept was significant for Galen, as both a physician and an educator. In his medical literature, Galen often discusses the question of “right timing:” when is the “right time” for a doctor to administer a particular treatment?² When is the “opportune moment” to present a particular medical concept to his readers?³ According to a lemma search of the *Thesaurus Linguae Graecae* database, the closely-related words *kairos* and *eukairos* (“particularly opportune moment”, Gr. *εὐκαῖρος*) appear a total of 1,248 times within the Galenic corpus, while their antonym *akairos* (Gr. *ἄκαῖρος*) appears 65 times. In this chapter, I will explore how Galen’s interest in identifying kairic moments intersects with his interest in hourly timekeeping. I focus specifically on how this dynamic plays out in his treatise *On Hygiene* (*De sanitate tuenda*

¹ As Sipiōra notes, while *kairos* fundamentally means “timing” or “right time,” its use extends to include concepts like “symmetry, propriety, occasion, due measure, fitness, tact, decorum, convenience, proportion, fruit, profit, and wise moderation” (2002: 1). For a full bibliography on the concept (up to 2002), see Zhelezcheva and Baumlin 2002: 237-245.

² E.g. “It is necessary for the one who pursues the hygienic art to understand the properties of all the hygienic materials. The deft use of these things results from that. And the deft use of these things, in turn, arises if we should discover the right time (*καῖρόν*) and amount of each” (37,6-9 Koch = VI.80.8-11 K).

³ E.g. “Now is the right moment to transition to the [subject of] the anomalous constitutions of bodies...” (184,19-20 Koch = VI.419.14-420.1 K).

vi), a text concerned less with the healing of sick bodies than with the maintenance of healthy ones.⁴ As such, this treatise provides an instructive contrast to the texts we examined in the previous two chapters, which showcased how Galen employs hourly timekeeping in the context of curing febrile diseases. I will begin by reviewing some of the ways in which Galen’s intellectual role models understood the concept of *kairos* (particularly in relation to medicine), and proceed to identify ways in which Galen’s understanding aligns with and differs from those of his predecessors. We will then briefly revisit one of Galen’s fever texts, *On Crises*, in order to see, for the sake of comparison, how Galen defines *kairos* in the context of illness. Finally, we will turn to *On Hygiene* to explore how Galen’s understanding of *kairos* – and its relationship to hourly timekeeping – changes when he is discussing healthy individuals, and shifts again when he considers the elderly, a group that Galen understood to occupy a precarious position between sickness and health.

I will demonstrate that Galen consistently employs hourly timekeeping in order to answer the question, “What is the *right moment* for this specific patient, illness, or physician to engage in a particular behavior?” But I will further argue that Galen envisions the specific relationship between hours and *kairoi* to be different depending on the context. In *On Crises*, hours act as indices that are *predictive* of febrile *kairoi*; in *On Hygiene*, on the other hand, they can also be variables that *influence* *kairoi*. Furthermore, we will see how, for Galen, the kairic window of opportunity differs in size depending on whether a patient is sick, healthy, or aged, and how the pursuit of this “right moment” requires Galen’s scientific method.

⁴ All references to *On Hygiene* will refer to the editions of Kühn and Koch: Kühn VI.1-452 and Koch, K. (1923) *Galen de sanitate tuenda libri vi* [*Corpus medicorum Graecorum* 5.4.2.] Leipzig: 3-198.

***Kairos* and Galen's Predecessors**

By the Hellenistic period, writers across a variety of genres were praising *kairos* as an essential virtue. Among these authors were some of Galen's favorites, including Plato, Aristotle, and of course, Hippocrates. Over the course of this chapter, I will argue that, while Galen's understanding of *kairos* closely resembles those of his intellectual heroes, it also differs in a few significant ways. In order to best appreciate both these similarities and these differences, let us first identify some of the essential features of Classical and Hellenistic *kairos*, as presented by these authors. We will then discuss how Galen interprets this concept first in the context of febrile illness and then in the contexts of good health and old age.

Kairos appears in the famous opening line of *Aphorisms*, where the Hippocratic author opines, "Life is short. The art [i.e. of medicine] is long. Opportunity is sharp (ὁ δὲ καιρὸς ὀξύς)" (I.1.1-2 IV,458 L).⁵ The idea that a kairic moment is "sharper than any edge"⁶ led many ancient writers to contrast *kairos* with another temporal concept, *chronos* (Gr. χρόνος). This term differs from *kairos* in two primary ways. First, whereas *kairos* indicates a moment with no temporal duration, *chronos* indicates an interval of time, whether definite (e.g. "for a time of six months") or indefinite (e.g. "for a time"). Second, whereas the term *kairos* is morally charged, in that a kairic moment calls for decisive action, *chronos* carries no moral freight. The Hippocratic author of *Precepts* describes the relationship between these two terms in the following manner, "Chronos is that within which *kairos* exists; *kairos* is that in which there is not much *chronos*

⁵ Cf. *De morb.* I.5 VI,146 L.

⁶ The Hellenistic poet Posidippus composed an epigram in which a casual passerby has a dialogue with a statue of the divinely personified Kairos. In response to the passerby's query as to why Kairos carries a razor in his right hand, Kairos declares, "As an example to men that I am sharper (ὀξύτερος) than any edge!" (*Ep.* XVI.275.5-6 Beckby).

(χρόνος ἐστὶν ἐν ᾧ καιρὸς, καὶ καιρὸς ἐν ᾧ χρόνος οὐ πολὺς)” (I.1.1-2 IX,250 L).⁷ Fleeting kairic moments punctuate the neutral timeline of *chronos*; they take place in time, but scarcely take up time.

How ought one to identify such a *kairos* and determine how best to act at that decisive moment? Plato – inspired, no doubt, by figures such as Gorgias and perhaps even Pythagoras himself⁸ – explains in his *Phaedrus* how a student might begin to answer these questions within the domain of rhetoric.⁹ Plato points out that different people have different kinds of souls (Gr. ψυχαί), and that this variation will lead one man to be more easily persuaded by one style of oration, another by another (271d). The would-be orator must first learn “how many forms the soul has (ψυχῆ ὅσα εἶδη ἔχει),” so that he may develop a theoretical basis for classifying the souls he will encounter. But theory alone will not suffice:

Once he [i.e. the student] has understood these things sufficiently, afterward he must see that they are so in actual affairs and events, and he must be able to verify them acutely by means of his senses (ὀξέως τῆ αἰσθήσει). Otherwise, the majority of the relevant theory he heard back then will be no good to him. But whenever he can say sufficiently which sort of man is persuaded by which sorts of things, and is able to indicate to himself, perceiving fully and attended by others, that *this* is the man, and *this* is the nature...to which he must apply *these* sorts of arguments in *this* way in order to achieve persuasion for *these* purposes – for the man who grasps all of these things in addition to the right moments (καιρούς) for speaking and for being silent, for the man who distinguishes the best occasion

⁷ On the role of *kairos* in the Hippocratic corpus, see Eskin 2002.

⁸ The “Pythagorean” references to *kairos* come from the *Carmen aureum* (27-39), which some scholars (e.g. Thom 2001) argue should be dated to the Hellenistic rather than the Imperial period. On *kairos* in the writings of Gorgias and Pythagoras, see Kucharski 1963, Poulakos 2002, and Rostagni 2002.

⁹ For further discussion of how *kairos* is used in this passage, see Smith 2002: 52-3. On *kairos* in Plato’s writings, see Levi 1923. On the history of *kairos* in classical and later rhetoric, see Baumlin 1984, Enos 1995, and Sipiora and Baumlin (eds.) 2002. On its usefulness in modern scientific rhetoric, see Miller 1992.

(τὴν εὐκαιρίαν) and worst occasion (ἀκαιρίαν) for using brachylogies, piteous appeals, and hyperbole...only for this man is the art [of speaking] well and completely perfected (271d-272b).

We observe that for Plato, as for Hippocrates, *kairos* is a moment that is “sharply (ὀξέως)” perceived by the senses; it occupies little to no *chronos*. Furthermore, Plato’s *kairos* is utterly contingent. Plato’s repeated use of the deictic pronoun “this/those” (Gr. οὗτος, etc.) hammers home his point that the “right moment” to use a particular rhetorical strategy depends upon a variety of factors: to whom is the orator speaking? What kinds of souls or characters do his listeners have? What is the ultimate goal of his persuasion? Which rhetorical forms has he been taught, and which are likely to be of the greatest use in the present context? In order to answer this barrage of questions, the orator must synthesize his theoretical knowledge with both his prior personal experiences and his current, real-time observations. Thus, for Plato, these decisive, kairic moments are dynamic and require a process not unlike Galen’s scientific method.¹⁰ We will discuss this observation further below.

Aristotle, in his *Nicomachean Ethics*, echoes Plato’s sentiments, but goes on to provide two examples of arts other than rhetoric that are especially dependent upon *kairoi*: navigation and medicine. Aristotle’s treatment of medical *kairos* takes place in the midst of a larger discussion about how general ethical systems should not be overly rigid because so many ethical decisions are predicated on situational circumstances. “Matters pertaining to conduct and expediency,” Aristotle asserts, “are in no way fixed, just like matters pertaining to health (τὰ ὑγιαινά). If such is the case for the general theory [of ethics], still more is precision lacking in the theory of specific cases, for this falls under no established art or set of rules. Rather, the

¹⁰ On the differences between Plato’s and Galen’s approaches to scientific investigation, see Cooper 2011a: 161-3.

people who perform actions must always consider for themselves those things that are opportune (τὰ πρὸς τὸν καιρὸν), just as is the case in both the medical and the navigational arts (ἐπὶ τῆς ἰατρικῆς ἔχει καὶ τῆς κυβερνητικῆς)” (1104a Bekker). Aristotle sees the sickroom as a paradigmatic example of a domain in which contingency is king.¹¹ The physician must know the principles of his art, of course, but he must also recognize that, when it comes to human health, many variables are in play. He must therefore pay close attention to the circumstances of each individual case, if he is going to correctly identify and respond to kairic moments, and thereby excel at his craft.

Galen’s beloved “Hippocrates” also emphasizes the importance of *kairos* for medicine. Directly after specifying the relationship between *kairos* and *chronos*, as we saw above, the Hippocratic author of *Precepts* goes on to add, “Healing happens in *chronos* when it is also in *kairos* (ἄκεσις χρόνω, ἔστι δὲ ἡνίκα καὶ καιρῷ)” (I.1.3 IX.250 L). The Hippocratic writings stress the importance of tailoring medical treatments to suit the specific characteristics and environmental conditions of particular patients.¹² They take a wide variety of factors into consideration: the patient’s age, physical constitution, and daily habits; the climate to which he is accustomed and the current season of the year.¹³ The Hippocratic authors recognized that all of

¹¹ On *kairos* in Aristotelian rhetoric, see Kinneavy and Eskin 2000.

¹² Craik outlines some of the “profound perceptions” regarding health, disease, and diet that are put forward in the Hippocratic writings: namely, “that different individuals have different needs; that the same individual has different needs at different ages and in different seasons; that to understand the patient in illness it is useful to understand the patient in health; that what we eat affects how we function; that some illnesses affect all inhabitants of a region while others are peculiar to individuals in it; that environment cannot be disregarded as a factor in human well-being. These perceptions are in line with such modern catch-phrases as social geography, environmental health, and preventive medicine, and they are at the root of the homeopathic principles formulated under their influence in the nineteenth century” (1995: 398).

¹³ See, for example, the “constitutions” and case histories in the *Epidemics*.

these could affect the ways in which health or disease manifest in individuals, and could similarly influence the kairic timing of that individual's treatments.¹⁴

So to review, we have seen how in the writings of Galen's favorite authors – Plato, Aristotle, Hippocrates – the concept of *kairos* often has the following features. It is both “sharp” (or “momentary”) and morally charged, in contrast to *chronos* which is neither. To identify a *kairos*, one must assess the circumstances of the specific situation, a process which involves a combination of theory, experience, and improvisation. Furthermore, by the Hellenistic period, the concept of *kairos* was already seen as important particularly for arts like rhetoric, navigation, and medicine.¹⁵ In what follows, we will see that Galen's understanding of *kairos* often cleaves closely to those of his predecessors. However, we will also discover that he parts ways with them in certain respects. First, he incorporates hourly timekeeping into the discussion, which his predecessors did not.¹⁶ Second, he distinguishes between different kinds of *kairoi* for the sick, the healthy, and the aged.

***Kairos* and Febrile Disease**

Let us now return to a text we discussed in the previous chapter, the fever treatise *On Crises*, in order to understand how Galen defines a *kairos* within a febrile context. On the first page of this text, Galen tells us that every febrile illness can be divided into four “parts” (Gr. μόρια): the “beginning” (ἀρχή), the “increase” or “growth” period (αὔξησις), the “prime” or

¹⁴ On *kairos* in the Hippocratic Corpus, see Eskin 2002.

¹⁵ Cooper (2011a) highlights how the methodologies of such sciences – particularly medicine – differ from the ultra-rational approaches characteristic of ancient astronomy.

¹⁶ The Hippocratic author of *On Diseases* does recognize that some treatments are best administered during a particular part of the day (i.e. morning, evening, night), but he does not translate these times into hours (I.5 VI.148-50 L).

“acme” (ἀκμή), and the “past-prime” or “abatement” phase (παρακμή).¹⁷ These correspond to terms that Galen often uses to denote the stages of a human or animal life,¹⁸ which suggests that Galen viewed the disease process as having a microcosmic “life” of its own. He goes on to say that “some men call these parts the ‘*kairoi* of the disease as a whole’ (καιρούς ὅλου τοῦ νοσήματος); for this same reason, they also call them the ‘general *kairoi*’ (καθόλου καιρούς), in order that they might be differentiated clearly from the ‘specific *kairoi*’ (τῶν κατὰ μέρος), where the paroxysms vary” (IX.551.5-9 K). In other words, Galen is saying (a) that all fevers pass through these four general phases (though, as he later points out, the precise timing and character of each differs from one fever to another);¹⁹ and (b) that each paroxysm goes through its own set of four phases, making it something of a microcosm of the disease as a whole. By referring specifically to the *kairoi* of these phases, the physicians (and Galen, too, as he adopts their practice) direct the reader’s attention to the moment of transition between one stage in a patient’s illness and the one that follows, a decisive moment that will both reveal the disease’s next move and suggest to the doctor how he should adjust his treatment plan going forward.

Physicians of Galen’s time seem to have quarreled over where to set the kairic boundaries of these stages for any given illness. “Some,” Galen says, “ask whether the paroxysms come early or late; others look at their length, others consider their magnitude (which they call the ‘severity’), and some examine these things along with the abatements... Scarcely anyone can thus make an accurate guess as to the designated *kairos* (τοῦ καθεστῶτος καιροῦ)....” (IX.552.1-7 K). The doctors to whom Galen refers here clearly detect a link between the temporal patterns of

¹⁷ IX.551.1-2 K.

¹⁸ For ἀξίησις, see e.g. VI.5.9, 386.10 K. For ἀκμή, VI.346.8, 386.12, 387.2 K. For παρακμή, VI.387.3 and 12, 397.12 K.

¹⁹ IX.551.9-12 K.

an illness and the timing of a kairic phase-change. There was no consensus, however, as to which indicators were more reliable or how the data from multiple indicators should be synthesized.

Galen, as we saw in the preceding chapters, presents himself as the only physician capable of resolving this thorny problem. He advocates comparing a series of two or more paroxysms with regard not only to their length, duration, magnitude, and intervals, but also to their attendant symptoms and the characteristics of certain indicator substances, like urine, sweat, and stool.²⁰ He then offers these rules of thumb for determining whether a febrile illness is currently in the *kairos* of “growth” or “abatement,” or whether it has actually reached its “acme:”

For let the paroxysm arrive earlier than the customary hour (τῆς συνήθους ὥρας), and let it be longer, more violent, of worse character, and accompanied by many bad symptoms. And let the time of the abatement be short and not precisely easy to bear, nor free of all the symptoms of the paroxysm.... Then, in another case, let everything be opposite to this, with the onset later, the length and magnitude of the paroxysm shortened, the bad character mitigated, and the attendant symptoms fewer and simpler or not entirely visible. And let the interval or abatement that follows be easy to bear and long, and let it completely dispel the paroxysmal symptoms. These last, in particular, are the clearest indicators (γνωρίσματα) of abatement (παράκμη), just as the ones mentioned first are the clearest indicators of growth (αὔξησις). Whenever the features of both paroxysms are particularly equal, it is clear that the disease is at its acme (ἀκμή)” (IX.554.13-555.13 K).²¹

Here, Galen explicitly identifies the temporal aspects of paroxysms and their abatements as “indicators” (γνωρίσματα) of the fever’s most recent *kairos* (in this case, its moment of

²⁰ See, e.g. IX.562.6-563.3 K, where Galen attributes this insight to Hippocrates.

²¹ Galen recognizes that identifying the precise temporal boundaries of these phases is not always so simple. Sometimes the physician is forced to assume that the moment of transition has occurred somewhere between two paroxysms and thus was not directly observable. See IX.557.2-562.6 K.

transition into the stage of “growth,” “acme,” or “past-prime”).²² He goes on, as we saw in the previous chapter, to offer case histories in which these temporal factors are specified in seasonal hours.²³ For example, in his case history of a woman suffering from what he deems to be a semitertian fever combined with a tertian, Galen meticulously chronicles the pathological events that lead up to the kairic “acme” of each fever:

Recently, a little woman (γύναιον) had a shivering paroxysm on the even days that was precisely semitertian. And on the odd days, from dawn, she had one much smaller than the one that came before, so that the semitertian seemed to have stronger paroxysms on the alternate days, which indeed is customary in a semitertian. And around the *eighth hour of the day*, another paroxysm came on with powerful shivering, bearing precisely all the indicators of a tertian fever. This one broke during *some hours of the third night*, with sweat and vomiting of bile, and extended into the *second hour of the even [day]*. Indeed, after it had approached a fever-free state, the shivering fever that had an anomalous paroxysm came on again, namely the one which we said arose on even days. Then, withdrawing and attacking again malignantly throughout the whole day, [the fever] only just culminated in acme when the sun went down. It began to abate during *some hours of the fourth night*, and then from dawn again a not very anomalous increase to the ample remnants lasted until the *eighth hour*. Then, when this fever seemed clearly to reach its acme, another paroxysm succeeded it, strictly tertian. We diagnosed this fever right away on the second day as being

²² Galen credits Hippocrates with these ideas, citing especially his advice at *Aph.* 1.12.1-9, which Galen quotes as follows: “As for the paroxysms and constitutions, the diseases themselves and the seasons of the year, as well as the relations of the periods to each other, will make clear whether it is every day or throughout the day or happens over a longer period of time. This is so also with respect to the phenomena, such as in pleuritic cases, whether the saliva appears right away with a short beginning, or whether it appears later with a lengthened one. And urine and stool and sweat, doubtful and certain, short and long – the things that appear elucidate the diseases” (IX.562.11-18 K). Here again, as in Chapter Two, we see Galen build upon the pithy dicta of his predecessor to support his own theories.

²³ Galen says that hourly timekeeping is especially useful for anticipating when two paroxysms are going to overlap and thereby confuse the physician’s reading of the symptoms (IX.674.14-675.9 K).

from an interweaving of a tertian and a semitertian, and the third day confirmed the diagnosis much more trustworthily. We expected the next period, the one belonging to the tertian, to stop quickly while the other was protracted, and so it was (IX.675.16-677.4 K).

In *On Crises*, as in the other fever literature we have examined,²⁴ Galen uses hours to *describe* and *classify* febrile diseases with the goal of anticipating their future behaviors. This, as we are about to see, is not the case in *On Hygiene*.

***Kairos* and Health Maintenance**

On Hygiene is a six-volume work, dated to approximately 180 CE,²⁵ that investigates the condition of “health” (Gr. υγίεια) and how an individual might maintain it throughout his or her life.²⁶ Galen’s stated motivation for writing this treatise is to refute the “majority (οί πλείους)” of doctors and trainers, who write about personal hygiene “as if they were talking about a single man” (135,13-4 Koch = VI.306.5-6 K).²⁷ Galen charges these writers with assuming that all human bodies are the same, and that therefore a single health regimen is best for everyone. Galen challenges this position by demonstrating, over the course of the text, that health is actually relative and contingent, rather than universal and fixed.²⁸ Health is relative, because human bodies differ from one another with respect to their age, build, and what we might call their

²⁴ See Chapters Three and Four.

²⁵ On the dating of this treatise, see Koch’s introduction to the *CMG* edition (p. 7) and Wilkins 2015: 415.

²⁶ On the concept of regimen or *diata* in Galen’s writings, see Capriglione 2000, and within *On Hygiene* specifically, see Wöhrle 1990, Grimaudo 2008, and Wilkins 2015. On diet and dietetics in Greco-Roman antiquity, see e.g. Edelstein 1967b, Smith 1980, Lain-Entralgo 1987, Craik 1995, Schwartz 1995, Bartoš 2009. For an overview of the concept of health and the cult delivered to the goddess Hygieia in antiquity, see King (ed.): 2005.

²⁷ His intended audience seems to be educated elites, who are not themselves medical specialists, but have enough leisure and training in logical methods to be able to apply Galen’s dietetic principles to their own lives (197,2-17 Koch = VI.449.5-450.4 K). For further discussion of Galen’s audience in this text, see Wilkins 2015: 416.

²⁸ See 73,1-21 Koch = VI.164.1-165.13 K, where Galen provides an overview of the structure and argument of *On Hygiene*.

biochemical makeup or constitution, which for Galen meant their particular mixture of the four humors and qualities (phlegm, yellow bile, black bile, and blood; cold, hot, dry, and moist). Health will manifest differently in, for example, an athletic and phlegmatic twenty-year-old than in a frail and bilious sixty-year-old. To further elucidate this concept, Galen offers the following metaphor: “For just as the whiteness in snow does not differ from the whiteness in milk in being white, but rather in being more or less white, so in the same way the health in Achilles, for instance, does not differ from the health in Thersites in being health – that is the same. But they [i.e. the two healths] differ in another way, in the degree of more or less” (9,30-5 Koch = VI.16.15-17.5 K).²⁹ Achilles, in this example, has “more” of health than Thersites to the extent that his body can perform better; he is stronger, faster, and more dexterous with a blade. But even though Thersites’ version of health may pale in comparison to Achilles’, this does not mean that Thersites is unhealthy. His body is simply different from that of Achilles, and therefore has different capacities and characteristics when healthy.

For Galen, then, health is not monomorphic; it takes a different form in each body. However, it is clear that people often fail to achieve their personal version of best health, whether compelled by external forces, such as overwork or foul weather, or by internal forces, such as laziness or gluttony.³⁰ Thus, Galen insists that a person’s health is not only relative, but also contingent upon his or her environment, mental state, and behavioral patterns. At the beginning of Book II, he puts it this way:

Just as the diversity of bodies themselves has been shown to be very great (παμπόλλη), in the same way, the forms of the lives we live are also very great.

²⁹ Cf. 11,33-6 Koch = VI. 22.3-6; 73,1-21 Koch = VI.164.1-165.13 K; 164,15-23 Koch = VI.372.6-14 K.

³⁰ See, e.g., 6,31-7,9 Koch = VI.9.14-10.10; 177,29-178,6 Koch = VI.404.2-12 K.

Thus it is impossible to recommend the best treatment of the body for every given life, but it is possible to recommend what is best for each particular life, since the absolute best is not achievable in all lives. For many men have a life involved in the circumstances of their business and must necessarily be harmed by the things they do; it is impossible for them to avoid this. Some fall into such lives through poverty, others through slavery.... But the man who is completely free, both by fortune and by choice, him it is possible to instruct as to how he may be most healthy and least sick, and age in the best manner (38,9-26 Koch = VI.82.1-83.3 K).

Galen points out that, in order for a person to maintain maximum health, he must devote virtually all of his time and energy to the care of his own body.³¹ Since few people, in reality, have the leisure and inclination to do this, it is important that a physician, when recommending a day-to-day personal care regimen, take a patient's lifestyle-constraints into consideration, along with other circumstantial factors.

The concept of *kairos* plays an important role in Galen's argument because he keeps returning to the following question: given a particular patient's body and circumstances, what is the "right moment" for him to perform a certain activity, like exercising, eating dinner, or taking a bath? Time and again, Galen emphasizes the contingency of these individual *kairoi*. In Book I, for example, Galen addresses the appropriate time (*kairos*) to bathe or rub down a healthy baby. He recommends waiting until after the infant has awoken from a prolonged sleep, because at that time there is likely to be little or no food in the baby's stomach which could be disturbed by the rubbing or bathing motions. Galen then cautions against doing "what some nurses do," namely "designating one particular time of day (ἕνα τινὰ χρόνον ἀφορίσασθαι τῆς ἡμέρας)" for bathing

³¹ "Hippocrates" and Soranus also express this idea: see Hipp. *Reg.* 3.68 and Sor. *Gyn.* 2.24.

or rubbing, or simply performing these tasks “whenever they have leisure (ὅταν αὐταὶ
εὐχολάωσι)” (23,24-6 Koch = VI.49.5-6 K). Instead, Galen says, “the right moment designated
by us (ὁ γὰρ ὑφ’ ἡμῶν ἀφοριζόμενος καιρὸς) occurs sometimes at one time of day or night
(χρόνον ἦτοι τῆς ἡμέρας ἢ τῆς νυκτός), sometimes at another” (23,27-9 Koch = VI.49.7-9 K).
Galen draws a distinction between *kairos* and *chronos* here that is similar to the one we saw
above, in the opening line of the Hippocratic *Precepts*. Galen agrees that, when the bathing or
rubbing takes place, it will necessarily do so at a *chronos*, a particular interval of time within the
day or night. But in order for that action to be most effective, and least harmful to the child, it
must also take place at a *kairos*, or opportune moment, that is dependent on additional factors,
such as the amount of food in the baby’s belly and – as an index of this – how recently the baby
has slept.

In *On Hygiene*, Galen connects hours to the concept of *kairos* in two general ways: in
order (a) to identify one of the factors upon which a *kairos* is contingent, and (b) to define the
specific *chronos* (hour or interval) that turns out to be the *kairos* in a given instance. Let us
consider some examples of the former before turning to the latter. According to Galen, one of the
additional factors that can influence a *kairos* is the length of daylight a patient experiences, as
measured in equinoctial hours. As we recall from the Introduction, Greeks and Romans under the
Empire typically marked off their days according to seasonal hours, which were derived by
dividing the period from sunrise to sunset (or sunset to sunrise) into twelve equal parts whose
lengths varied throughout the year. Hours of consistent length, like the ones we use today, were
employed primarily by astronomers and, for the most part, were not integrated into other cultural
contexts. There was, however, one exception. By the mid-fourth century BCE, Greek scientists
had discovered that one could map the world by dividing it up into latitudes, which the Greeks

called *climata* (Gr. κλίματα).³² A city's latitude was expressed as a ratio of the lengths of its longest and shortest days, lengths which differ more dramatically as one moves north or south of the equator due to the curvature of the earth. To give these lengths in seasonal hours would be meaningless, as every day in every location is twelve seasonal hours long; equinoctial hours had to be used instead. By the Imperial period, knowledge of *climata* and the daylight lengths associated with them had spread beyond the bounds of technical astronomy, and we see latitudes (with their ratios expressed in equinoctial hours) popping up not only in writers like Ptolemy and Cleomedes, but also in writers like Strabo and Pliny.³³ Excavations have even turned up several portable sundials that users could adjust to different latitudes.³⁴

On Hygiene makes it clear that Galen had been exposed to these ideas, whether through his studies of basic astronomy³⁵ or simply through cultural osmosis, and that he found them applicable to his medical practice. In this treatise, Galen points out that, because the length of daylight varies seasonally and geographically, inhabitants of different regions will have different quantities of time available for personal care. Any “hygienist” worth his salt should therefore take special note of the location in which a given patient lives and thus of the amount of time that he or she will realistically have for bathing, exercising, etc. between the end of the workday (at sunset) and bedtime. As an example, Galen asks us to imagine an enslaved rower, in excellent

³² Our earliest references to the term are found in Hypsicles' *Anaphoricus* (p. 36 De Falco-Krause-Neugebauer) and Hipparchus' *Commentary on Aratus*, where it is embedded within a quotation from Eudoxus (1,2,22 Manitius p. 23 = F 68 Lasserre; 1,3,9–10 Manitius p. 28 = F 67 Lasserre). For discussion, see Neugebauer 1975: 34-44; Nicolet 1991: 59; Shcheglov 2003-2007: 2. Some of the foundational works on ancient *climata* include Honigmann 1929, Diller 1934, and Dicks 1955.

³³ See, e.g. Strabo *Geogr.* II.5.14, 36, 38-42; Plin. *NH* II.77.

³⁴ Such sundials look rather like makeup compacts. They can open and shut on a hinge and carry inside them a series of discs engraved with different networks of hour- and date-lines. Each disc corresponded to a specific latitude, and could be swapped out in exchange for other discs as one moved from place to place. For catalogues of portable sundials, see De Solla Price 1969 and Wright 2000.

³⁵ On the likely sources of Galen's astronomical knowledge, see Cooper's commentary to *On Critical Days* (2011b: 62-3).

physical condition, whose master releases him from duty at the end of each day. Galen then asserts that, if one is to determine how much time the rower has to complete his evening healthcare regimen, one must define the phrase “end of day (τὰ πέρατα τῆς ἡμέρας)” much more precisely:

If I should say that he [i.e. the slave] first departs for the care of his body when the sun sets, if I do not then add what sort of day I am talking about – whether one around the summer or winter solstice, or at one of the equinoxes, or during one of the other times in between those mentioned – it will be impossible to provide beneficial instructions [for his personal care]. In the city of the Romans, the longest days and nights are a little longer than fifteen equinoctial hours (ὥρων ἰσημερινῶν), just as, again, the shortest are fewer than nine. In the great city of Alexandria, however, the longest [days and nights] are fourteen hours, and the shortest are ten. If [a rower] is absent from the ship’s crew during the shortest days and longest nights, then when the sun sets, he can be rubbed down and bathed at leisure and go to bed at a suitable time (συμμέτρως), whereas the [rower] who is gone during the longest days is not able to do any of these things suitably (178,15-28 Koch = VI.405.6-406.2 K).³⁶

Galen sees the length of daylight (as measured in equinoctial hours, according to both the time of year and geographical location) as a factor that can influence one’s *kairoi* for bathing, massage, and other activities. Galen encourages his fellow physicians to recognize that, while it might ultimately be healthier for a patient to pay a leisurely visit to the bathhouse every evening of the

³⁶ Boudon-Millot cites this passage as an example of how difficult it was for an Imperial-period doctor to “fixer des repères temporels stables et fiables dont dépendront l’exactitude et la juste observance de ses prescriptions” (2008: 77).

year, there will be places and seasons in which this is simply not possible.³⁷ In response to such constraints, the effective physician will adjust his own assessment of the “right time” for a given patient to perform this activity.

This passage highlights one way in which the growing awareness of clocks and hours (both seasonal and equinoctial) influenced the development of medical theory under the Empire. The Hippocratic authors were revolutionary, at least among our extant sources, in taking account of environmental and seasonal conditions when treating patients.³⁸ But the world in which many of them lived and wrote had not yet been divided into *climata*, and geographical locations were not yet being translated regularly into daylight lengths.³⁹ Once again, as in the fever case histories we examined in Chapter Three, Galen builds upon an originally Hippocratic premise so as to take into account the ideas and technologies of his own time.

Let us now direct our attention to the other way in which Galen connects hourly timekeeping to the idea of *kairos*, namely in order to define that *kairos* within a given situation. In *On Hygiene*, Galen devotes a good deal of space to the question of the temporal relationship between eating and bathing: which activity should take place first, and what interval of time should separate them?⁴⁰ After setting forth some general principles, such as the dangers of exercising on a full stomach, Galen offers up his own practice as an illustrative example:

³⁷ Inscriptions from Crete (*SEG* 26: 1044) and Portugal (*Lex Metallii Vipascensis* 19-23) suggest that bathhouses could have specific opening and closing times, as well as designated periods for male or female bathing. See Ducrey and Van Effenterre 1973. Hadrian also decreed separate bathing times for the sick and the healthy at Rome (*Hist. Aug. Had.* 22.7: *ante octavam horam in publice neminem nisi aegrum lavari passus est*). Such rules would also have restricted the times at which a person could choose to bathe. On Roman bathing habits, see Yegül 2010.

³⁸ The Hippocratic *Regimen in Health*, for example, recommends different sorts of daily regimens according to the season and the patient’s body type and humoral balance.

³⁹ Strohmaier observes, “Hippocrate croyait encore que la terre était un disque plat et que le soleil se mouvait au-dessus d’elle en une courbe relativement basse. Galien sait que la terre est seulement ‘un point’ au milieu des sphères célestes...Pour Galien, comme pour Ptolémée et pour Aristote, la terre est une sphère et les grandes différences météorologiques dépendent du fait que les zones ou les ceintures déterminées par une certaine latitude géographique sont plus ou moins inclinées par rapport aux rayons du soleil” (1997: 211).

⁴⁰ See, e.g., 40,33-41,12 Koch = VI.88.2-89.2 K; 162,32-163,7 Koch = VI.369.3-13 K.

For since, as I said, for some people it is better to eat before bathing, I ought to speak about the hour (τῆς ὥρας) at which they should do this, and about the quantity and quality of what should be administered to them. Thus I will not hesitate to say what I myself am accustomed to do on a day in which I decide to bathe later on account of either examining patients or attending to some civic matter. Let us consider a day, on which this happens, of thirteen equinoctial hours (τῶν ἰσημερινῶν ὥρῶν), and let us anticipate that the care of the body will take place around the tenth hour. According to this assumption, it seems to me that around the fourth hour the simplest meal should be taken... But let the amount of food be only so much that it can be digested in the stomach by the tenth hour. For, if [patients] should wish to exercise, in this way they would exercise least harmfully (181,13-29 Koch = VI.411.13-412.15 K).

Note the care that Galen takes here to specify the length of daylight available to him on this particular day (i.e. thirteen equinoctial hours). On a day of such a length, Galen tells us, he is often in the habit of exercising around the tenth seasonal hour. From these two temporal “givens,” the length of daylight and his anticipated hour of exercise, Galen then calculates the *chronos* that is the *kairos* for his mid-day meal: i.e. around the fourth hour of the day. Galen selects this hour as the right moment to lunch because it leaves a six-hour window of time between his meal and his training session, which will allow him plenty of time to digest before subjecting his body to vigorous motion.

This passage showcases how Galen use hours as both contributing factors and definitions of *kairos*. The length of daylight, in equinoctial hours, is a variable that helps to determine the right time - defined as a specific seasonal hour - at which Galen will go to the gymnasium. The time of this gym appointment, in turn, becomes a factor in determining the kairic seasonal hour

for his meal. For Galen, then, the process of designing a person's daily health regimen involves, first, establishing a set of assumptions (based on body type, environmental conditions, personal preferences, etc.), and then reasoning from those assumptions in order to create a coherent system; in other words, Galen uses logic to move from axioms to recommended actions. Now, at this point in our investigations, whenever we see logical reasoning emphasized in a Galenic text, we should be on the alert for references to experience, as well, since we have learned that logic and experience are the foundational principles of Galen's scientific method. And sure enough, Galen's system for constructing hygienic regimens does indeed rely on experience, and hours play a role in this part of the process, as well.

To see how Galen interweaves logic and experience in order to solve a hygienic problem, let us turn to his discussion of massage. In this discussion, Galen first stresses the importance of fixing one's variables: "Up to this point, only two things have been defined: the condition of the patient's body and his age. But it has not been additionally determined in which part of the world he was raised, nor the time at which he intends to exercise currently, nor what season of the year it is or what hour of the day (τοῦ ἔτους ὥραν ἢ καὶ τῆς ἡμέρας). And yet the measure of massage varies according to all of these things" (56,12-16 Koch = VI.125.12-16 K). Galen then describes what kind of massage might be appropriate for an ideal young man (i.e. one in unrealistically perfect health) who trains at the gym under ideal conditions. He lays out those conditions in the following manner, beginning with the ideal geographical location:

Of our very own country... the most central part is the most temperate, such as is the case in the fatherland of Hippocrates. For this region is temperate both in winter and in summer, and still more so in the spring and autumn. Thus, let us assign such a country to our exemplary patient's body, and let us assume

additionally that the season of the year in this case is the very middle of spring (i.e. the equinox). And within that day, on which he is going to be first trained by us, let it be as close to noon as possible (ὥς οἶόν τε τὸ μεσάτατον), in order that the physical power of the patient's constitution might in no way be changed by the environment. According to the same reasoning, it is best that the building in which he is going to train be neither warmer nor colder than the general air of the whole city on that day (56,32-57,7 Koch = VI.127.2-13 K).

This is Galen's best-case scenario: a perfect physical specimen comes for his massage after training in a temperate environment that will neither chill his muscles nor overheat him. But, as we have seen, Galen recognizes that such bodies and days come around but rarely. How, then, is a masseur to determine what kind of massage is most appropriate for various clients at different times of year? The key, Galen asserts, is not only to reason logically from physical and circumstantial givens, but also to check and refine one's system by recourse to experience:

How great the quantity of massage should be cannot be clarified [simply] by logic (λόγῳ), but the knowledgeable person who is beginning to massage such people [in this case, teenage boys], must not use a precise conjecture (ἀκριβεῖς στοχασμῶ) on the first day, but in the following days, gaining some experience (ἐμπειρίαν) of that body's nature, should make the rule ever more precise (ἀεὶ καὶ μᾶλλον ἐξακριβοῦν). And moreover, with regard to training, on the first day it is not possible to be precise about the amount, but in the days after this it becomes entirely possible (57,28-58,2 Koch = VI.129.4-11 K).⁴¹

This "precise conjecture" to which Galen refers, about when and how to massage, is ultimately the product of reasoning, but when a masseur or trainer is first getting to know his client, he does

⁴¹ Cf. 83,27-34 Koch = VI.189.2-9 K.

not yet have all of the information necessary for establishing his axioms. As a result, it is important, especially in the early days, that he closely observe his client to see what works and what does not, and to parse his client's physical constitution (in particular, the mixture of his humors). Only by pairing logic and empiricism in this way can a practitioner hope to minimize errors and learn how to correct those that do occur.⁴² Thus in *On Hygiene*, as in the other texts we have examined, Galen's interest in hours is informed by his approach to scientific inquiry, or *apodeixis*.⁴³

Kairos and the Elderly

Up to this point, we have explored how Galen uses hours to determine and describe specific *kairoi* both for diseased patients and for the predominantly healthy. I would like to conclude our discussion by examining an intermediate case, that of the elderly. In Galen's opinion, gerontology, the topic of *On Hygiene*'s fifth book, is an especially tricky subject.⁴⁴ He tells us that there is some debate over whether old age, though a universal life stage, should actually be considered something of a disease.⁴⁵ He compares old people to patients convalescing from illness, noting that individuals in both groups occupy a liminal position between disease and health:

⁴² Galen states this most explicitly at 139,4-9 Koch = VI.314.11-16 K; 164,25-30 Koch = VI.373.2-7 K.

⁴³ The noun occurs eleven times in this work, and the related verb ἀποδείκνυμι seventeen times.

⁴⁴ On the health regimens of the elderly in antiquity, see Orth 1963 and Cockayne 2003: 34-56.

⁴⁵ Aristotle takes this position at *Gen. An.* 5.784b32-34, as does Seneca at *Ep.* 108.28-9 (in which he also cites Vergil's *Aen.* 6.275). On the ancient debate over how to characterize old age, see Cockayne 2003: 34-56 (on aging in Galen's *On Hygiene*, see specifically pp. 41-44). Galen also mentions a physician, Philippus of Egypt (100-170 CE), who contributed two volumes to this debate: one on the best regimen for maintaining youth and another, titled *Amazing Agelessness*, which argues that one must begin such a regimen in infancy in order for it to work (Keyser and Irby-Massie (eds.) 2008: 646).

Both of these dispositions [i.e. the elderly and the convalescent] seem not to be in accordance with strict health, but rather they seem to be in the middle between sickness and health (μέσαι τινές εἶναι νόσου τε καὶ ὑγείας)... Therefore, whether one ought to call old age a “disease,” or a “diseased disposition,” or a “disposition in between health and disease,” or “health in accordance with one’s state”... still, one must understand the condition (κατάστασιν) of old bodies, because they can slide into disease due to minor causes, in a manner similar to those convalescing from illness (τοῖς ἀναλαμβάνουσιν ἐκ νόσου) (142,23-31 Koch = VI.330.7-331.2 K).

The bodies of elderly people are in a precarious position. As their bones become more brittle and their internal systems start to break down, it becomes easier and easier for small shifts in their habits and environments to have an outsized negative impact on their health.

Galen observes that the bodies of younger people, in contrast, can handle even substantial changes to their circumstances without suffering many ill effects.⁴⁶ It may be in part for this reason that in the four preceding books of *On Hygiene* – in which Galen discusses the life stages of infancy, childhood, adolescence, and maturity – he never offers a detailed case history that exemplifies how an individual structures (or should structure) his day. The closest Galen comes, in fact, is in the passage we examined above, wherein Galen shares the times at which he is often (though not always) accustomed to take lunch and visit the gymnasium (181,13-29 Koch = VI.411.13-412.15 K). The absence of extended case histories seems to suit Galen’s emphasis, in these earlier books, on the seasonal and environmental contingency of personal care regimens.

The regimen of a teenager living in Alexandria must necessarily be different from that of a fully-

⁴⁶ Cf. 143,10-16 Koch = VI.331.11-332.2 K: “For those who are habitually healthy, not even powerful causes change their bodies. But for the elderly, the smallest things produce the greatest disruption. This holds true also with regard to the quantity and quality of food. For in these matters, too, if old men deviate a little bit from what is proper, they are harmed in no small degree, although young men are harmed little by the greatest deviations.”

grown man living in Rome, and the regimen of that man must itself be different in summer than it is in winter. Thus, why waste ink on detailed case histories that could only rarely be applicable as models?

Galen points out, however, that the frequent regimen adjustments appropriate for the young would be downright dangerous if adopted by the old. Galen proposes that an elderly person should try to adhere to a single, constant regimen throughout the year. He then provides not one, but two detailed examples of personal care regimens that proved successful for different geriatric patients. I reproduce one of these nearly in full, so that the reader can appreciate the degree of Galen's temporal specificity. The patient in question is one Antiochus, a fellow physician who managed to keep himself in relatively fine fettle past the age of eighty. He accomplished this in the following manner:

[Every day, Antiochus] walked to the agora from his house, a road up to three stades long.... He had a room in his house that was heated by a furnace in the winter, but had temperate air in the summer, even apart from the fire. He had massages in it regularly, both in winter and in summer, *during the mornings*, apparently after having earlier produced a stool. At a place in the agora, around the *third hour* or later around the *fourth hour*, he ate bread with Attic honey, usually boiled, rarely raw. After this, he passed the time until the *seventh hour* sometimes by entering into debate with other people, at other times by reading on his own. Afterward, he got a rub-down at the public bathhouse and performed the exercises appropriate for an old man.... Then, after bathing, he ate an appropriate second meal, in which he set before himself basic things⁴⁷ In this way Antiochos tended himself in old age until he died, with his senses unimpaired and his limbs intact (143,21-144,3 Koch = VI.332.7-333.10 K).

⁴⁷ For other examples of old men eating light meals, see Suet. *Aug.* 75-77, Sen. *Ep.* 83.6, and Plin. *Ep.* 3.10.

In this passage, Galen carefully lists in succession each of the activities that Antiochus engaged in over the course of a typical day: his meals, his exercise, his massages, even his bowel movements. What is more, Galen is clearly concerned with the timing of these activities, whether absolute (e.g. “until the seventh hour”), general (e.g. “during the morning”), or relative (e.g. “after this”). In fact, after our investigations in the previous chapter, we might be inclined to compare the way in which Galen carefully tracks Antiochus’ activity cycle over time to the way in which he tracks the condition of fever patients over time in texts like *On Crises*. I submit that this is no coincidence; if Galen viewed elderly people as being somewhat akin to sick patients, it makes sense that he would subject their conditions to more rigorous observation and analysis.⁴⁸

It should be noted that Galen does not advise every aged person to adopt the *same* strict regimen. Each body - in old age, as in any other - still has its own constitution, needs, tastes, and customs. For this reason, it is sensible that Galen includes two distinct case histories back-to-back, so that no reader could get the unintended impression that he himself should adopt the exact same habits. Telephus the grammarian, the subject of the second case history, apparently surpassed one hundred years of age by maintaining a schedule very different from that of Antiochus.⁴⁹ Around the third hour, when Antiochus typically ate a light lunch of bread and honey, Telephus would receive massage. Then, at the seventh hour, the usual time for Antiochus to see the masseur, Telephus would be sitting down to dinner.⁵⁰ Each body, like each febrile

⁴⁸ Indeed, Galen himself compares the effects of old age to the effects of a ravaging fever: “For the thing that all men properly call old age is the dry and cold constitution of the body from having existed for many years. But sometimes it also arises from febrile disease, and we call that ‘old age from disease’ (ἐκ νόσου γῆρας), as I have said in my book *On Marasmus*” (154,19-23 Koch = VI.357.3-7 K).

⁴⁹ 144,3-12 Koch = VI.333.10-334.4 K.

⁵⁰ Examples of other old men who adhere to strict daily regimens occur at Cic. *Sen.* 10.34 (Masinissa, king of the Numidians) and Plin. *Ep.* 3.1 (Spurinna). Telephus’ habits aside, two mosaics suggest that the most common dinner hour among the Romans was around the 9th hour. One, from 4th c. CE Daphne in Turkey, depicts a man wearing a

illness - Galen seems to suggest - has its own natural rhythms. The physician is responsible for identifying these and working harmoniously with them.

But what does all of this mean for our understanding of the relationship between hourly timekeeping and the *kairoi* of the elderly? Shortly before embarking upon these two case histories, Galen makes an important observation about how the nature of *kairos* differs in health and in disease: “For in the case of these things [i.e. those that pertain to hygienic regimen], the *kairos* is not sharp (ὄξύς), as in diseases. Rather, it is possible to begin from the surest things in each measure, and then, once you have examined the outcome, reduce or increase a bit each day so as to correct what was omitted” (157,13-6 Koch = VI.326.13-327.2 K). We have seen that, for Galen, the concept of *kairos* is fundamental both in combatting disease and in maintaining relative health. But what Galen has learned is that *kairos* in each of these contexts has a very different margin of error. In healthy patients, who are unlikely to be affected even by substantial disruptions to their lifestyles, the “right moment” to engage in a particular activity can encompass a wide range of absolute times. The constitutions of sick patients, on the other hand, are so imbalanced and volatile that any minor change can cause their conditions to degenerate rapidly. In these cases, the window of opportunity for stabilizing the patient can be very narrow, which is why, as Galen so often insists, physicians must pay close attention to their patients’ conditions and have a plan of action ready in case things go awry. Because elderly people fall

toga and looking up at a sundial mounted on a column. Above his head is written “ΕΝΑΤΗ ΠΑΡΗΛΑΣΕΝ,” “The ninth hour has gone by,” and seems to be a summons to dinner (Hatay Archaeological Museum, Inv. 865). The second, recently excavated from Syrian Antioch and dated preliminarily to the 3rd c. CE, also shows men in togas looking up at a sundial that reads an evening hour (judging by the position of the sun rendered above it). The text over the men’s heads reads “ΤΡΕΧΕ ΔΙΠΝΟΣ / ΑΚΑΙΡΟΣ,” “Run to dinner! You’re late!” At the time of writing, no scholarly publication of the so-called “Skeleton Mosaic” had yet been completed, but international news outlets, such as Hurriyet Daily News and CNN, announced the find in April 2016. Dinner invitations from the Imperial period, preserved among the extant papyri from Egypt, corroborate the notion that dinner was typically around the 9th hour. In *P. Coll. Youtie* 1 52, for example, a woman named Herais invites the recipient to dine at the Sarapeion on the 11th of the month, “beginning from the ninth hour (ἀπὸ ὥρας θ’)” (6-7). Cf. *P. Oxy.* 62 4339, 75 5056, 75 5057. I am grateful to S. Toralles Tovar for bringing these papyri to my attention.

somewhere in the middle between sick patients and hale youngsters, their kairic aperture is similarly intermediate, and hence their behavior must be watched and regimented fairly closely.⁵¹

Conclusion

This chapter explored how Galen's interest in hourly timekeeping relates to his understanding of *kairos*, the "right time" to perform a given activity. By examining passages drawn first from *On Crises* and then from *On Hygiene*, we were able to see how Galen's interpretation of *kairoi*, and their relationship to hours, changes depending on whether the patient in question is sick, healthy, or of advanced age. If the patient is sick, Galen uses hourly timekeeping to track the progress of the disease and thereby to determine the *kairoi* at which the illness will transition from one stage to the next. If the patient is healthy, Galen still uses the time and duration of phenomena as indicators of *kairoi*, but he also considers the time of day and length of daylight as manipulable variables that can influence *kairoi*. If the patient is elderly, Galen considers him to fall in the middle of the spectrum between sickness and health, and therefore cautions against experimenting too much with that patient's *kairoi*. Furthermore, we saw that the process by which Galen recommends discovering individual *kairoi* involves a synthesis of reason and experience which is familiar to us, both from Plato's description of how to determine *kairoi* in rhetoric and from our earlier forays into Galen's other writings. Thus, once again, Galen's interest in hourly timekeeping appears to have been closely linked to his scientific method (*apodeixis*).

⁵¹ Galen seems to have been somewhat innovative in recognizing the elderly as a distinct medical class that required special treatment. See Cockayne 2003: 39.

Finally, we learned that Galen differs from his predecessors, such as Hippocrates, in discriminating between different kinds of *kairoi*: those for the sick, the elderly, and the healthy. Among the sick and elderly, the kairic window of action is narrow (more so for the sick, less so for the elderly). In the passage above, Galen refers to the notion, expressed in Plato and the Hippocratics, that a *kairos* is “sharp” (Gr. ὀξύς). Yet, in the context of healthy patients, Galen seems to disagree with this characterization. In health, Galen understands the kairic window actually to be relatively wide, as deviations in environment and regimen are less problematic for the young and hearty than for the old and ailing. Thus, here too, Galen does not simply inherit the ideas of his intellectual heroes, but refines them in order to bring them into closer alignment with his own lived experiences.

Conclusion

This study was motivated by two primary questions. First, why, how, and in what contexts does Galen exploit hourly timekeeping technology in his disputes with other doctors and philosophers? Second, how representative should we take Galen to be in this regard? In Chapters One and Two, we sought answers to these questions within Galen's *On the Affections and Errors of the Human Soul*, a text that contains surprisingly frequent and detailed references to clock-construction for a philosophical treatise. Chapters Three, Four, and Five, on the other hand, focused on how Galen incorporates references to seasonal and equinoctial hours into certain of his medical works, especially those that deal with cyclical phenomena like intermittent fevers. Let us review our findings from these chapters and then see what broader conclusions can be drawn.

Chapter One demonstrated how, in *Affections and Errors*, Galen uses the examples of sundial and water-clock construction to highlight the differences between his own method of scientific inquiry, *apodeixis*, and the methods typically used by sectarian philosophers. In this text, Galen associates clock-design with the positive concepts of verifiability, clarity, concord, utility, and long-term scientific progress. He also implies that clocks played important roles within the communities of his day. In Chapter Two, we probed this latter assumption by investigating the semiotic fields of sundials and water-clocks under the Roman Empire. We saw that clocks in this period, and especially sundials, had acquired a range of symbolic connotations across a variety of media. In particular, we observed that sundials had become symbolically linked to philosophers. This led me to argue that, in using sundials and water-clocks as models

within *Affections and Errors*, Galen was actually adapting a contemporary trope to suit his particular purpose. That purpose, I suggested, was to promote his own scientific method as the best way to lead a rational life.

In Chapter Three, we turned to sections of *On Critical Days* to see how Galen worked references to hourly timekeeping into his justifications and refinements of Hippocratic critical day theory. The chapter argued that, both in his fever case histories and in his astrological explanations for critical days, Galen uses hourly timekeeping to help himself defend two claims: first, that he has facility with astronomical principles; and second, that his own theories are in keeping with Hippocratic doctrine. I also drew attention to the fact that few, if any, of Galen's peers seem to have shared his medical priorities and rhetorical strategies. Chapter Four expanded upon this last idea within the context of Galen's *Against Those Who Have Written On Types*. We explored how, in this text, Galen employs hours in his critique of excessively complex fever-classification systems, and specifically to highlight his own empiricism and rationality in comparison to other doctors. Thus here, too, as in *Affections and Errors*, Galen links clocks (and the units they measure) with the exercise of his scientific method.

Finally, in Chapter Five, we investigated the relationship between Galen's attentiveness to hourly timekeeping and his conception of *kairos*, or "right timing." We saw how, for Galen, the nature of this relationship changes depending on whether the patient under consideration is sick, healthy, or somewhere in between, and that the identification of kairic hours involves the process of *apodeixis*. Furthermore, we noticed that Galen modifies the characterization of *kairos* frequently used by his intellectual heroes, such as Plato and Hippocrates; while they present all kairic moments as being "sharp" or "acute," Galen asserts that, in medicine, the window of kairic opportunity can vary in aperture according to a patient's condition.

So, to answer our central questions: first, it is clear that Galen's special interest in hourly timekeeping is intimately connected with his approach to scientific inquiry. The twin pillars of Galen's *apodeixis* are logical reasoning and empirical verification. Galen has found that one must engage both of these faculties, if one is either to construct or use a clock. In building sundials and water-clocks, as Galen emphasizes in *Affections and Errors*, one must first apply logical reasoning in order to progress from a set of trigonometric principles and a schematic *analemma* to the creation of a functioning, three-dimensional clock. To ensure the clock runs accurately, one then tests it against a variety of visual rubrics, asking, for example, whether the clock's lines are proportional, whether it is consistent with the sun's movements, and whether it keeps time in synchrony with other clocks. Likewise, sundials and water-clocks *qua* tools lend precision to one's empirical observations, by allowing one to record the exact hour of day or night at which a phenomenon occurs. By aggregating these "time-stamped" observations and looking for patterns among them, one can then begin to develop a rational model for predicting future occurrences. Thus clocks and hours are both products and facilitators of *apodeixis*. Since Galen insists that *apodeixis* is the surest way to prevent error and to adjudicate among competing claims, it makes sense that Galen appeals to hourly timekeeping when he weighs in on medical and philosophical controversies, such as the value of critical day schemes, the classification of irregular periodic fevers, and the best way to evaluate epistemological claims.

How innovative was Galen in this respect? The scarcity of comparative evidence makes it difficult to say, but we do know some things. First, we know that Galen located the seeds of these ideas within the Hippocratic writings of the late Classical and early Hellenistic periods. The writers of texts such as *Epidemics* I and III saw value in tracking the temporal cycles of intermittent fevers and of attempting to build predictive models from this observational data. At

this point in time, however, clocks and table-making technology were only beginning to enter the Greco-Roman world from the East. By Galen's day, in contrast, clocks of varying sizes could be found in many private and public spaces across the Empire, and the practice of table-making was spreading from astronomy and astrology to other scientific disciplines, like physiognomy and medical pulse theory.¹ In the Roman period, clocks begin to appear in literature as metaphors, and in art as iconographic symbols. Moreover, Galen's *Adversus typos* suggests that at least some physicians (perhaps Pneumatics) used the unit of the hour to structure their fever-classification systems. Thus clocks, both as symbols and as practical tools, seem to have been very much a part of Galen's cultural context.

Yet, among our admittedly limited extant sources, Galen seems to be unique in the manner and degree to which he applied horology to the spheres of philosophy and medicine. As we saw in Chapter Three, the patient case histories that have come down to us from the Imperial period show little interest in tracking the temporal cycles of diseases. Furthermore, Galen portrays his interlocutors in *Adversus typos* as armchair mathematicians, whose use of hours is entirely theoretical and unsupported by empirical evidence. On the philosophical side, too, Galen's *Affections and Errors* stands out among extant writings for the way in which it uses the process of clock-construction as a model for error-free decision-making. Galen, of course, makes no direct claims to innovation. While he is keen to distinguish his own non-sectarian mode of inquiry from the methods of contemporary medical and philosophical schools, Galen is equally keen to emphasize the continuities between his own theories and those of celebrated past masters, like Hippocrates and Hipparchus. But Galen is a critical consumer of earlier scholarship. We

¹ See Barton 1994.

have seen that, even when defending an ancient model like that of the critical days, Galen refines it and, in so doing, makes it at least partially his own.

The importance that Galen places on clocks and hours as practical and rhetorical tools suggests that this technology was much more influential in the ancient Mediterranean than has traditionally been appreciated. More in-depth case studies are needed, however, if we are to develop a fuller understanding of how individuals conceived of and interacted with both sundials and water-clocks. There is also more to be learned about the role of horology within the Galenic corpus itself. One might investigate, for instance, how Galen's engagement with hourly timekeeping relates to his engagement with other temporal units, such as the month, season, or year. It may also be enlightening to compare Galen's comments about the timing and severity of medical events with recent findings in the field of chronobiology. Over the last few decades, medical researchers have become increasingly interested in how the body's chemistry changes over the course of the 24-hour day, and in how these changes may impact the body's ability to process drugs and manage symptoms.² The aim of sub-disciplines like chronotoxicology, chronopharmacology, and chronotherapy is to better understand the circadian variations in our biologies and to enable doctors to maximize the benefits of particular treatments while minimizing their risks.³ As I have tried to demonstrate, the seeds of these modern investigations are present in Galen.

² The entire 59th issue of *Advanced Drug Delivery Reviews* (2007), for instance, is devoted to the subject of chronobiology.

³ See, e.g. Beauchamp and Labrecque 2007; Smolensky and Peppas 2007; Dallman, Okyar, and Lévi 2016.

Appendix

**Full Translation of *Aff. pec.* 54,21-60,7 DB = V.80.7-89.5 K
Based on W. de Boer, *Corpus Medicorum Graecorum* 5.4.1.1. Leipzig: Teubner, 1937, pp. 41-68.**

When a city is being built (πόλεως κτιζομένης), let the problem be set before those who will inhabit it (τοῖς οἰκήσουσιν): namely, that they wish to know, not roughly but with precision, on an everyday basis (μὴ στοχαστικῶς ἀλλ' ἀκριβῶς, ἐφ' ἑκάστης ἡμέρας), how much time has passed, and how much is left before sunset. This problem, according to the analytic method (κατὰ τὴν ἀναλυτικὴν μέθοδον), must be referred back to the first criterion if anyone intends to solve it in accordance with the method we learned in the study of gnomonics. It must be constructed by the analytic method, proceeding along the same path – but in reverse – as we also learned from the study of sundials.

When we have thus discovered the integral and common path, and once we have learned that such a measurement of periods of time within the day must be made by means of geometric lines, it is best then to acquire the materials (σώματα) that will receive the engraving of such lines and the gnomon. One must first ask which shapes of bodies (σχήματα σωμάτων) will be appropriate for the design that we have come up with. Next, by means of analysis and synthesis, we must figure out how each such design should be brought about. Then, since the logical method offers us clear trustworthiness in the discovery of the matters at hand, it is necessary to turn next to the practical realization of the things we have discovered, in order that we might create a level surface for the body that is about to be inscribed. And after we have found this by means of analysis and synthesis, then, having constructed some such body, we must find out with which instruments it should be inscribed; and when, again, these things have been discovered by

analysis and synthesis, we must attempt to construct them in the form which the method has taught us. Then, having inscribed many shapes in succession, we must give them to other men for empirical testing (δοῦναι τοῖς ἀνθρώποις ἔργω πειραθῆναι), to see whether the aim has been achieved. For when the first line receives the first ray of the sun and, likewise, the last line receives the last ray of the sun – and this is evident on all inscribed sundials – already we have one clear indication that we have found what we sought. We have a second indication when all the inscribed lines are in agreement with one another (ἀλλήλοισι ... συμφωνῆ), and a third when the level of water attests to it. For reason finds that this will be a criterion of the “truth” of inscribed sundials.

What I am saying is this. Having perforated a vessel, made out of whatever material you like, pour in clear water as soon as you have observed the first ray of the sun. Then, whenever the sundial’s lines tell you that the first hour has ended, record what portion of the vessel has been filled with water, and then, after emptying it out again straight away, pour in this same water. When the sundial announces the second hour, look at the vessel. Then when you find that the water in it has come to the same level as the one you indicated for the first hour, quickly pour it out again in the same way and check to see, whether at the third hour the clock indicates that the water has come to the same place in the vessel as it did after the first and second hours. When you find that it is so, pour the water out again and wait until the fourth hour, checking that the water has come up to the same place on the vessel. Pour it out right away and wait again. Check again at the fifth hour. When you discover, in this case, that the water has come to the same place, then repeat for the sixth and for all the successive hours up to the twelfth. Unless you are completely ignorant, you will perceive (πεισθήσῃ) that the sundial has been inscribed well, because what is before your eyes has indicated it (τὸ προκείμενον ἐπεδείξατο).

It was proposed that the duration of the whole day be divided into twelve equal parts. They chose the number because it was the most useful (χρησιμώτατον). For it has a half, a third, a fourth, a sixth, and a twelfth, which no other number has before nor after it until you reach 24. This number they rejected as too large, and having judged twelve to be appropriate (κύμμετρον), they cut the time of the whole day into that many pieces (<εἰς> τοσαῦτα μέρη τὸν χρόνον τῆς ὅλης ἡμέρας ἔτεμον). And because such a subdivision is so useful, the Romans and many others (ἄλλοι τε πολλοὶ καὶ Ῥωμαῖοι), having tried it out, use it when they manage their estates, dividing the whole into twelve portions. And they cut the majority of their everyday rules and measures into twelve portions, as well (τῶν ἐν τῷ βίῳ σταθμῶν τε καὶ μέτρων εἰς δώδεκα μοίρας τέμνοντες τὰ πλεῖστα). If you were to ask me, I could inscribe any clock for you in accordance with my method, regardless of whether you wish to divide the whole day into twelve or into some other of the successive numbers. For you will find that the task has been accomplished, both from its consistency (συμφωνεῖν) with the measures made with the perforated vessel and from the agreement (ὁμολογεῖν) of all the lines with one another, as well as from the fact that the outermost and innermost lines mark out the limits of the day.

Thus reason, having sought by analytical method, found a design for the water-clock (κλεψύδρας), of which the test is clear even to laymen. For the topmost line, which indicates the twelfth hour of the day, has the greatest height where the water-clock measures out the longest day and has the shortest height where it measures out the shortest day. In between the two is the line that marks the days at the equinoxes. In between the equinoctial sections on the edge of the water-clock you will see the four days after those mentioned. If you start from these sections, you will discover that the section next to the one that indicates the longest day shows how high on the highest line the water will reach on the following day, once the twelfth hour has come to

an end. After those, the third segment from the twelfth place will indicate to you the third day, and the next one in succession will indicate the fourth. If you go through all the days of the year in the same way, you will find that the one line on the water-clock that I called the highest measures all the days of the year. And indeed, you will find that all the lines below the highest measure out the other hours, on all the days of the year; the first line after the twelfth indicating the eleventh hour in its different parts, as I said before about the topmost line, and the one after that indicating the tenth hour in its different parts – and the next the ninth, and then the eighth, and so on as far as the lowest line, which will indicate the first hour, as on sundials. When the water in the water-clock is full, just as the first line and the remaining lines up to the twelfth seem equal to one another on any given day, so too they seem unequal to the hours in the days that came before or will come after [i.e. the hours are seasonal].

Then did you not set your heart on discovering what such a method is? Do you not perceive the conceit of wisdom (δοξοκοφία) in yourself, you who, being uneducated (ἀμαθής) in these arguments, could find nothing in a year or rather – one should say – in your whole life (ὄλῳ τῷ βίῳ)? For the theory of lines was not discovered in one lifetime (βίος ἀνδρὸς ἐνός), but came about little by little (κατὰ μικρὸν). First, elementary observations were sought, and once these had been found, the men who came after added to them the most marvelous theory, which is called “analytical,” and trained themselves in it, along with those who were especially willing. And indeed, they are able to produce no handiwork of the sort which I have discussed up to this point regarding sundials and water-clocks.

But they were neither reckless men nor quacks who, having sought such things, were able either to seek or to find wisdom in a manner similar to that which I mentioned. And, once they had honored themselves in this way, they were given the truest honor, namely to practice the best

faculty they had in their soul (ἦν εἶχον ἐν τῇ ψυχῇ δύναμιν ἀρίστην) and to lead it toward perfection. It is very clear that I mean logical method. When this is exercised and becomes vigorous, men are gladdened more greatly than those who are slaves to the pleasures of the body. For we do not differ from goats, puppies, pigs, cattle, and donkeys in respect to any other faculty, nor does any other theory more greatly please the soul of a naturally analytical man, at least when one is making progress in it. For it is painful in the beginning, as is the case with nearly everything else.

Yet even if [the method] offers no enjoyment, the very prospect of using it for the greatest tasks makes it a good thing to practice, on account of its unique ability, as I said, to provide evidence of its own success – an ability that does not exist among those who make discoveries via philosophy. And because of this, it is possible for those who talk nonsense foolishly in philosophy to be shameless (φλυαροῦσιν ἔξεστιν ἀναισχυντεῖν). For it is not the case that, just as the one who has badly marked a sundial or water-clock becomes plainly aware of his error by the fact itself, there is also clear refutation for theories in philosophy. Rather, it is possible for people to speak as they like, once they have maintained shamelessly and without logical method (ἀναισχύντως ἄνευ μεθόδου λογικῆς) that they were taught by the very matters in question (αὐτῶν τῶν πραγμάτων). Certainly, if these “facts,” taking up a voice, have indeed spoken to those men [i.e. philosophers] alone, then they are bragging with good reason (εὐλόγως ἀλαζονεύονται). But since the matters in question are always silent, and speak neither to us nor to the philosophers, it is clear that our reason alone will discover their nature. Therefore, let the one who can first discover what that nature is provide evidence clearly to himself about the matters at hand, and let him tell us the method by which every problem of analysis is solved, and let him show, after he has determined the true and false arguments from

among those that look the same, where it is possible to detect badness. Otherwise he will no longer be trustworthy (οὐκ ἂν ἔτι πιστὸς ... εἴη) in matters pertaining to unclear things.

Bibliography

- Abascal, J.-M. 2002. "Fasti consulares, fasti locales y horologia en la epigrafía hispania." *Archivo Español de Arqueología* 75: 269-286.
- Adam, S. 1997. "Sundials in Israel." *Bulletin of the British Sundial Society* 97: 3-7.
- Adler, A., ed. 1928. *Suidae lexicon* 1. Leipzig: Teubner.
- Albani, M. and U. Glessmer. 1991. "An Astronomical Measuring Instrument from Qumran." *The Provo International Conference on the Dead Sea Scrolls*. D. W. Parry and E. Ulrich, eds. Leiden: Brill, 407-442.
- Alexiou, S. 1968. *Guide to the Archaeological Museum of Heraclion*. Archaeological Guides of the General Direction of Antiquities and Restoration 19. Athens: General Direction of Antiquities and Restoration.
- Allen, D. 1996. "A Schedule of Boundaries: An Exploration, Launched from the Water-Clock, of Athenian Time." *Greece & Rome* 43: 157-168.
- Al-Rawi, F.N.H. and A.R. George. 1991-1992. "Enūma Anu Enlil XIV and Other Early Astronomical Tables." *Archiv für Orientforschung* 38/39: 52-73.
- Álvarez Millán, C. 1999. "Graeco-Roman Case Histories and their Influence on Medieval Islamic Clinical Accounts." *Social History of Medicine* 12: 19-43.
- 2010. "The Case History in Medieval Islamic Medical Literature: *Tajārib* and *Mujarrabāt* as Source." *Medical History* 54: 195-214.
- Arias, E.F., dir. 2015. *BIPM Annual Report on Time Activities* 10. Pavillon de Breteuil: Bureau International des Poids et Mesures.
- Armisen-Marchetti, M. 1989. *Sapientiae facies: étude sur les images de Sénèque*. Collection d'études anciennes 58. Paris: Les Belles Lettres.
- 1995. "Sénèque et l'appropriation du temps." *Latomus: Revue d'études latines* 54: 545-567.
- Armstrong, J.E. and J.M. Camp II. 1977. "Notes on a Water Clock in the Athenian Agora." *Hesperia* 46: 147-161.
- Arnaldi, M. 1996. "Due frammenti di orologio solare romano al Museo Nazionale di Ravenna." *Ravenna Studi e Ricerche* 3: 13-28.

- Arnaldi, M. and K. Schaldach. 1997. "A Roman Cylinder Dial: Witness to a Forgotten Tradition." *Journal for the History of Astronomy* 28: 107-117.
- Asper, M. 2013. "Explanation between nature and text: Ancient Greek commentators on science." *Studies in History and Philosophy of Science Part A* 44: 43-50.
- Aveni, A. F. 2000. *Empires of time: Calendars, clocks, and cultures*. London and New York: Tauris Parke Paperbacks.
- Baiocchi, V., M. Barbarella, M. T. D'Alessio, K. Lelo, S. Troisi. 2016. "The sundial of Augustus and its survey: unresolved issues and possible solutions." *Acta Geodaetica et Geophysica* 51: 527-540.
- Barnes, J. 1991. "Galen on Logic and Therapy." *Galen's Method of Healing: Proceedings of the 1982 Galen Symposium*. F. Kudlien and R. J. Durling, eds. Leiden: Brill, 50-102.
- 1993. "Galen and the utility of logic." *Sudhoffs Archiv. Beihefte* 32: 33-52.
- Barnett, J. E. 1998. *Time's Pendulum: From Sundials to Atomic Clocks, the Fascinating History of Timekeeping and How our Discoveries Changed the World*. Orlando: Harcourt.
- Barras, V., T. Birchler, A.-F. Morand, and J. Starobinski. 1995. *L'âme et ses passions: Les passions et les erreurs de l'âme. Les facultés de l'âme suivent les tempéraments du corps*. Collection Budé. Paris: Les Belles Lettres.
- Barton, T. 1994. *Power and Knowledge: Astrology, Physiognomics, and Medicine under the Roman Empire*. Ann Arbor: University of Michigan Press.
- 1995. "Augustus and Capricorn: Astrological Polyvalency and Imperial Rhetoric." *The Journal of Roman Studies* 85: 33-51.
- Bartoš, H. 2009. "Dietetic Therapy and its Limitations in the Hippocratic *On Regimen*." *Sokratika: Sebapoznanie a Starost' o Seba*. V. Suvák, ed. Prešov: Acta Facultatis Philosophicae Universitatis Prešovensis, 8-16.
- Bartsch, S. and D. Wray, eds. 2009. *Seneca and the Self*. Cambridge: Cambridge University Press.
- Bates, D.G. 1981. "Thomas Willis and the Fevers Literature of the Seventeenth Century." *Medical History*, Suppl. 1: 45-70.
- Baumlin, J.S. 1984. "Decorum, *Kairos*, and the 'New' Rhetoric" *PRE/TEXT* 5: 171-83.
- Beauchamp, D. and G. Labrecque. 2007. "Chronobiology and chronotoxicology of antibiotics and aminoglycosides." *Advanced Drug Delivery Reviews* 59: 896-903.

- Beckby, H. 1965-1968. *Anthologia Graeca*. 2nd ed. 4 vols. Munich: E. Heimeran.
- Bekker, I. 1845. *Aristotelis Ethica Nicomachea*. Oxford: J. Abrams.
- Bilfinger, M. 1886. *Die Zeitmesser der antiken Völker*. Stuttgart: W. Kohlhammer.
- 1888. *Die Antiken Stundenangabe*. Stuttgart: W. Kohlhammer.
- Bodel, J. 1997. "Monumental Villas and Villa Monuments." *Journal of Roman Archaeology* 10: 5-35.
- Bonefas, S. 1989. "The Musical Inscription from Epidauros." *Hesperia: The Journal for the American School of Classical Studies at Athens* 58: 51-62.
- Bonnin, J. 2010a. "Les *Horologia Romana* en Hispanie, Mobilier, Histoire et Realités Archéologiques." *Archivo Español de Arqueología* 83: 183-198.
- 2010b. "Timekeepers in Britain, 43-780 AD: Origins, the Roman contribution, and Anglo-Saxon continuity." *British Sundial Society Bulletin* 22: 34-37.
- 2012a. "Horologia Romana: Cadrans et instruments à eau." *Les Dossiers d'Archéologie* 354: 18-25.
- 2012b. "Les horloges au quotidien dans l'Antiquité romaine." *Les Dossiers d'Archéologie* 354: 70-75.
- 2012c. "Le temps et l'éternité: Les horloges en image." *Les Dossiers d'Archéologie* 354: 80-83.
- 2013. "*Horlogia et memento mori*... Les Hommes, la mort et le temps dans l'Antiquité gréco-romaine." *Latomus: Revue d'études latines* 72: 468-491.
- 2015. *La mesure du temps dans l'Antiquité*. Paris: Les Belles Lettres.
- Bonnin, J. and D. Savoie. 2013. "Report on the Greek Dial from Delos Stored in the Louvre (Ma 4823)." *British Sundial Society Bulletin* 25: 20-22.
- Bos, G. and Y.T. Langermann, eds. 2015. *The Alexandrian Summaries of Galen's On Critical Days*. Islamic Philosophy, Theology, and Science 92. Leiden: Brill.
- Boudon-Millot, V., ed. 2007. *Galien I: Introduction générale. Sur l'ordre de ses propres livres. Sur ses propres livres. Que l'excellent médecin est aussi philosophe*. Paris: Les Belles Lettres.

- 2008. "Galien de Pergame, témoin de son temps: l'acculturation de la médecine grecque à la société romaine du IIe siècle de notre ère." *Semitica et Classica* 1: 71-80.
- 2009. "Galen's *Bios* and *Methodos*: From Ways of Life to Paths of Knowledge." *Galen and the World of Knowledge*. T. Whitmarsh, C. Gill, and J. Wilkins, eds. Cambridge: Cambridge University Press, 175-189.
- Bowen, A. C. and B. R. Goldstein. 1988. "Meton of Athens and Astronomy in the Late Fifth Century BC." *A Scientific Humanist: Studies in Memory of Abraham Sachs*. M. de J. Ellis, E. Leichty, and P. Gerardi, eds. Philadelphia, PA: The Samuel Noah Kramer Fund, The University Museum, 39-81.
- Brauneiser, M. 1944. *Tagzeiten und Landschaft im Epos der Griechen und Römer*. Diss. Würzburg.
- Breitenstein, N. 2009. *Petronius, Satyrical, 1-15*. Berlin and New York: De Gruyter.
- Brown, D., J. Fermor, and C. Walker. 1999/2000. "The Water-clock in Mesopotamia." *Archiv für Orientforschung* 46/47: 130-148.
- Brumbaugh, R.S. 1966. *Ancient Greek Gadgets and Machines*. New York: Crowell.
- Buchner, E. 1976. "Römische Medaillons als Sonnenuhren." *Chiron* 6: 329-346.
- 1982. *Die Sonnenuhr des Augustus*. Mainz: P. von Zabern.
- Burke, P. F. 1996. "Malaria in the Greco-Roman World: A Historical and Epidemiological Survey." *Aufstieg und Niedergang der römischen Welt* II.37.3. W. Haase and H. Temporini, eds. Berlin and New York: De Gruyter, 2252-81.
- Burnet, J., ed. 1899-1907 (repr. 1968). *Platonis opera*. 5 vols. Oxford: Clarendon Press.
- Bynum, W. F. and V. Nutton, eds. 1981. *Theories of Fever from Antiquity to the Enlightenment*. London: Wellcome Institute for the History of Medicine.
- Camp, J. M. 1986. *The Athenian Agora: Excavations in the Heart of Classical Athens*. New York: Thames & Hudson.
- Campbell-Kelly, M., ed. 2003. *The History of Mathematical Tables: From Sumer to Spreadsheets*. Oxford: Oxford University Press.
- Capriglione, J. C. 2000. "La 'diaita' secondo Galeno." *Cuadernos de Filología Clásica. Estudios Griegos e Indoeuropeos* 10: 155-172.

- Carman, C. C., A. Thorndike, and J. Evans. 2012. "On the Pin-and-Slot Device of the Antikythera Mechanism, with a New Application to the Superior Planets." *Journal for the History of Astronomy* 43: 93-116.
- Catamo, M., N. Lanciano, K. Locher, M. Lombardero, and M. Valdès. 2000. "Fifteen further Greco-Roman sundials from the Mediterranean area and Sudan." *Journal for the History of Astronomy* 31: 203-221.
- Chiaradonna, R. 2014. "Galen on What is Persuasive (pithanon) and What Approximates to the Truth." *Philosophical Themes in Galen*. Bulletin of the Institute of Classical Studies Supplement 114. R. Hansberger, P. Adamson, and J. Wilberdings, eds. London: Institute of Classical Studies, School of Advanced Study, University of London, 61-88.
- Clagett, M. 1989-1999. *Ancient Egyptian Science: A Source Book*. Memoirs of the American Philosophical Society 184, 214, 232. Philadelphia: American Philosophical Society.
- Clarke, K. 2008. *Making Time for the Past: Local History and the Polis*. Oxford: Oxford University Press.
- Clarke, M. L. 1963. "The Architects of Greece and Rome." *Architectural History* 6: 9-22.
- Cockayne, K. 2003. *Experiencing Old Age in Ancient Rome*. New York and London: Routledge.
- Cooper, G.M. 2004. "Numbers, Prognosis, and Healing: Galen on Medical Theory." *Washington Academy of Sciences* 90: 45-60.
- 2011a. "Galen and Astrology: A Mésalliance?" *Early Science and Medicine* 16: 120-146.
- 2011b. "Astronomy, Medicine, and Galen: The Beginnings of Empirical Science." *The Traditional Mediterranean: Essays from the Ancient to the Early Modern Era*. J. Che and N. C. J. Pappas, eds. Athens: Athens Institute for Education and Research, 161-172.
- 2011c. *Galen, De diebus decretoriis, from Greek into Arabic: A Critical Edition, with Translation and Commentary, of Hunayn ibn Isḥāq, Kitāb Ayyām al-buḥrān*. Farnham and Burlington: Ashgate.
- Cotterell, B., F.P. Dickson, and J. Kamminga. 1986. "Ancient Egyptian Water-Clocks: A Reappraisal." *Journal of Archaeological Science* 13: 31-50.
- Craik, E.M. 1995. "Diet, Diaita, and Dietetics." *The Greek World*. A. Powell, ed. London and New York: Routledge, 387-402.

- Cramer, F.H. 1954. *Astrology in Roman Law and Politics*. Philadelphia: American Philosophical Society.
- Csapo, E. and M. Miller. 1998. "Democracy, Empire, and Art: Toward a Politics of Time and Narrative." *Democracy, Empire, and the Arts in Fifth-Century Athens*. D. Boedeker and K. A. Raaflaub, eds. Cambridge: Harvard University Press, 87-125.
- Cumont, F. 1942. *Recherches sur le symbolisme funéraires des Romains*. Paris: Franz Valery Marie.
- Cuomo, S. 2007. "Measures for an Emperor: Volusius Maecianus' Monetary Pamphlet for Marcus Aurelius." *Ordering Knowledge in the Roman Empire*. J. König and T. Whitmarsh, eds. Cambridge and New York: Cambridge University Press, 206-228.
- Curtis, T. 2014. "Genre and Galen's Philosophical Discourses." *Philosophical Themes in Galen*. R. Hansberger, P. Adamson, and J. Wilberdings, eds. London: Institute of Classical Studies, School of Advanced Study, University of London. Bulletin of the Institute of Classical Studies Supplement 114: 39-58.
- Dallmann, R., A. Okyar, and F. Lévi. 2016. "Dosing Time Makes the Poison: Circadian Regulation and Pharmacotherapy." *Trends in Molecular Medicine* 22: 430-445.
- Darbo-Peschanski, C., ed. 2000. *Constructions du temps dans le monde grec ancien*. Paris: CNRS Éditions.
- Davis, H.H. 1956. "The Horologium and Symbolism." *The Classical Weekly* 49: 69-71.
- De Boer, W., ed. 1937. *Galen de animi cuiuslibet affectuum et peccatorum dignotione et curatione*. Corpus Medicorum Graecorum V.4.1.1. Leipzig: Teubner.
- De Falco, V. and M. Krause, eds. and trans. 1966. *Die Aufgangzeiten der Gestirne (Anaphorikos, polyglott) von Hypsikles*. With an introduction by O. Neugebauer. Abhandlungen der Akademie der Wissenschaften in Göttingen Philologisch-Historische Klasse 3, Nos. 62-65. Göttingen: Vandenhoeck and Ruprecht.
- Deichgräber, K. 1933 (repr. 1971). *Die Epidemien und das Corpus Hippocraticum*. Berlin and New York: De Gruyter.
- De Lacy, P. H. 1979. "Galen's Concept of Continuity." *Greek, Roman, and Byzantine Studies* 20: 355-369.
- Dewald, C. 2006. "Paying Attention: History as the Development of a Secular Narrative." *Rethinking Revolutions Through Ancient Greece*. S. Goldhill and R. Osborne, eds. Cambridge: Cambridge University Press, 164-182.

- 2007. "The Construction of Meaning in the First Three Historians." *A Companion to Greek and Roman Historiography*, Vol. 1. J. Marincola, ed. Malden and Oxford: Blackwell, 89-101.
- De Zulueta, J. 1973. "Malaria and Mediterranean History." *Parassitologia* 15: 1-15.
- Dicks, D.R. 1955. "The ΚΑΙΜΑΤΑ in the Greek Geography." *Classical Quarterly* 5: 248-255.
- Diels, H. 1904. "Laterculi Alexandrini aus einem Papyrus ptolemaïscher Zeit." *Abhandlungen der Königlich preussischen Akademie der Wissenschaften, phil.-hist. Kl.* 2: 1-16.
- Diller, A. 1934. "Geographical Latitudes in Eratosthenes, Hipparchus and Posidonius." *Klio* 27: 258-269.
- Dillon, J.M. 1977. *The Middle Platonists: A Study of Platonism, 80 B.C. to A.D. 220*. London: Duckworth.
- Dohrn-Van Rossum, G. 1996. *History of the Hour: Clocks and Modern Temporal Orders*. Chicago: University of Chicago Press.
- Donderer, M. 1996. *Die Architekten der späten römischen Republik und der Kaiserzeit. Epigraphische Zeugnisse*. Erlangen: Universitätsbund Erlangen-Nürnberg e.V., Universitätsbibliothek Erlangen.
- Donini, P. 1988. "Tipologia degli errori e loro correzione secondo Galeno." *Le opere psicologiche di Galeno: Atti del terzo Colloquio galenico internazionale, Pavia, 10-12 Settembre 1986*. P. Manuli and M. Vegetti, eds. Naples: Bibliopolis, 65-116.
- Drachmann, A.G. 1963. *The Mechanical Technology of Greek and Roman Antiquity*. Copenhagen, Madison, London: University of Wisconsin Press.
- Ducrey, P. and H. Van Effenterre. 1973. "Un règlement d'époque romaine sur les bains d'Arcades." *Kretika Chronika* 25: 281-290.
- Dunbabin, K.M.D. 1986. "Sic erimus cuncti... The Skeleton in Graeco-Roman Art." *Jahrbuch des deutschen archäologischen Instituts* 101: 185-255.
- Dunst, G. and E. Buchner. 1973. "Aristomenes-Uhren in Samos." *Chiron* 3: 119-129.
- Edelstein, L. 1967a. *The Idea of Progress in Classical Antiquity*. Baltimore: Johns Hopkins University Press.
- 1967b (repr. 1987). "The dietetics of antiquity." *Ancient Medicine: Selected Papers of Ludwig Edelstein*. C.L. Temkin, trans. O. Temkin and C.L. Temkin, eds. Baltimore and London: Johns Hopkins University Press, 303-316.

- Elliott, C. J. 2005. *Galen, Rome and the Second Sophistic*. Diss., Australian National University.
- Elsner, J., ed. 1996. *Art and Text in Roman Culture*. Cambridge: Cambridge University Press.
- 2007. *Roman Eyes: Visuality and Subjectivity in Art and Text*. Princeton: Princeton University Press.
- Enos, R.L. 1995. *Roman Rhetoric: Revolution and the Greek Influence*. Prospect Heights: Waveland Press.
- Eskin, C.R. 2002. "Hippocrates, Kairos, and Writing in the Sciences." *Rhetoric and Kairos: Essays in History, Theory, and Praxis*. P. Sipiora and J. S. Baumlin, eds. Albany: State University of New York Press, 97-113.
- Étienne, R. 1992. "L'horloge de la Civitas Igaeditanorum et la création de la province de Lusitanie." *Revue des études anciennes* 94: 355-362.
- Evans, J. 1999. "The Material Culture of Greek Astronomy." *Journal for the History of Astronomy* 30: 238-307.
- 2004. "The Astrologer's Apparatus: a picture of professional practice in Greco-Roman Egypt." *Journal for the History of Astronomy* 35: 1-44.
- 2005. "Gnōmonikē Technē." *The New Astronomy: Opening the Electromagnetic Window and Expanding Our View of Planet Earth*. Dordrecht: Springer, 273-292.
- 2015. "Material Culture of Greek and Roman Astronomy." *Handbook of Archaeoastronomy and Ethnoastronomy* 9. C.L.N. Ruggles, ed. New York: Springer, 1589-1602.
- Ewald, B.C. 1999. *Der Philosoph als Leitbild: Ikonographische Untersuchungen am römischen Sarkophagreliefs*. Mainz: P. von Zabern.
- Fantoni, G. 1991. "Due orology solari greci: i globi di Prosymna e di Matelica (differenze e analogie)." *Colloquio internazionale archeologia e astronomia, Venezia 3-6 maggio 1989*. M. F. Santi, ed. Rome: Bretschneider. Supplementi alla RdA 9, 100-106.
- Feeney, D. C. 2007. *Caesar's Calendar: Ancient Time and the Beginnings of History*. Berkeley: University of California Press.
- Fermor, J. and J. M. Steele. 2000. "The Design of Babylonian Waterclocks: Astronomical and Experimental Evidence." *Centaurus* 42: 210-222.
- Finley, M. I. 1965. "Technical Innovation and Economic Progress in the Ancient World." *The Economic History Review* 18: 29-45.

- Firatli, N. 1971. *Ismi Sehri ve Eski Eserleri Rehberi*. Istanbul: Millî Eğitim Basımevi.
- Flemming, R. 2007. "Galen's Imperial Order of Knowledge." *Ordering Knowledge in the Roman Empire*. J. König and T. Whitmarsh, eds. Cambridge and New York: Cambridge University Press, 241-277.
- Fontaine, M. 2014. "A Note on Philolaches' Simile of the House in Plautus' *Mostellaria*." *Plautine Trends: Studies in Plautine Comedy and its Reception*. N. Perysinakis and E. Karakasis, eds. Berlin: De Gruyter, 143-149.
- Frankfort, H. 1933. *The Cenotaph of Seti I at Abydos*. 2 vols. London and Antrim: Egypt Exploration Society.
- Frede, M. 1981. "On Galen's Epistemology." *Galen: Problems and Prospects. A Collection of Papers Submitted at the 1979 Cambridge Conference*. V. Nutton, ed. London: Wellcome Institute for the History of Medicine, 65-86.
- Freeth, T., A. Jones, J.M. Steele, and Y. Bitsakis. 2008. "Calendars with Olympiad display and eclipse prediction on the Antikythera Mechanism." *Nature* 454: 614-617.
- Finzenhagen, U. 1939. *Die geographische Terminologie des Griechischen*. Berlin: Friedrich Wilhelms Universität.
- Furtwängler, A. 1900. *Die antiken Gemmen*. Geschichte der Steinscheidekunst im klassischen Altertum 3. Leipzig and Berlin: Gesecke & Devrient.
- Gaiser, K. 1980. *Das Philosophenmosaik in Neapel. Eine Darstellung der platonischen Akademie*. Heidelberg: Winter.
- Garofolo, I. 2003. "Note sui giorni critici in Galeno." *Rationnel et irrationnel dans la médecine ancienne et médiévale: aspects historiques, scientifiques et culturels. Actes du colloque international organisé par le centre Jean Palerne à l'Université Jean Monnet de Saint-Etienne les 14 et 15 novembre 2002*. N. Palmieri, ed. Série Mémoires 26. Saint-Etienne: Publications de l'Université de Saint-Etienne.
- Gibbon, E. 1776 (repr. 1963). *The Decline and Fall of the Roman Empire*. Everyman's Library 475. London: Dent.
- Gibbs, S.L. 1976. *Greek and Roman Sundials*. New Haven: Yale University Press.
- 1979. "The First Scientific Instruments." *Astronomy of the Ancients*. K. Brecher and M. Feirtag, eds. Cambridge: MIT Press, 47-59.

- Gill, C. 2010. *Naturalistic Psychology in Galen and Stoicism*. New York and Oxford: Oxford University Press.
- Glaser, F. 1982. "Die Klepsydra im Amphiareion bei Oropos." *Pro arte antiqua. Festschrift für Hedwig Kenner* 1. W. Alzinger, ed. Vienna: Koska, 130-136.
- Gleason, M. 2007. *Making Men: Sophists and Self-Representation in Ancient Rome*. Princeton: Princeton University Press.
- Glennie, P. and N. Thrift. 1996. "Reworking E. P. Thompson's 'Time, Work-Discipline, and Industrial Capitalism.'" *Time & Society* 5: 275-299.
- 2009. *Shaping the Day: A History of Timekeeping in England and Wales 1300-1800*. Oxford: Oxford University Press.
- Goldin, O. 1996. *Explaining an Eclipse: Aristotle's Posterior Analytics 2.1-10*. Ann Arbor: University of Michigan Press.
- Gourevitch, D. 1998. "The Paths of Knowledge: Medicine in the Roman World." *Western Medical Thought from Antiquity to the Middle Ages*. M.D. Grmek, B. Fantini, A. Shugaar, eds. Cambridge: Harvard University Press, 104-138.
- Grabar, A. 1967. *L'arte paleocristiana (200-395)*. Milan: Rizzoli.
- Gratwick, A.S. 1979. "Sundials, Parasites, and Girls from Boeotia." *The Classical Quarterly* 29: 308-323.
- Grimaudo, S. 2008. *Difendere la Salute. Igiene e disciplina del soggetto nel De sanitate tuenda di Galeno*. Naples: Bibliopolis.
- Grmek, M. D. 1989. *Diseases in the Ancient Greek World*. M. and L. Muellner, trans. Baltimore and London: Johns Hopkins University Press.
- Briscoe, J., ed. 1998. *Factorum et dictorum memorabilium libri novem / Iulii Paridis et Ianuarii Nepotiani epitomis adiectis*. Leipzig: Teubner.
- Hankinson, R.J. 1994a. "Galen's Concept of Scientific Progress." *Aufstieg und Niedergang der Römischen Welt II*. 37.2: W. Haase and H. Temporini, eds. New York: De Gruyter, 1775-1789.
- 1994b. "Usage and Abusage: Galen on Language." *Language. Companions to Ancient Thought* 3. S. Everson, ed. Cambridge: Cambridge University Press, 166-187.
- 2008. "The Man and His Work." *Cambridge Companion to Galen*. R. J. Hankinson, ed. Cambridge: Cambridge University Press, 1-33.

- Hannah, R. 2001. "From Orality to Literacy? The Case of the Parapegma." *Speaking Volumes: Orality and Literacy in the Greek and Roman World*. J. Watson, ed. Boston: Brill, 139-159.
- 2008. "Timekeeping." *The Oxford Handbook of Engineering and Technology in the Classical World*. J. P. Oleson, ed. Oxford and New York: Oxford University Press.
- 2009. *Time in Antiquity*. London and New York: Routledge.
- 2011. "The Horologium of Augustus as a Sundial." *Journal of Roman Archaeology* 24: 87-95.
- 2013. "Greek Government and the Organization of Time." *A Companion to Ancient Greek Government*. H. Beck, ed. Malden, Oxford, and Chichester: Wiley-Blackwell, 349-365.
- Haselberger, L. 2011. "A Debate on the Horologium of Augustus: Controversy and Clarifications." *Journal of Roman Archaeology* 24: 47-73.
- Heitsch, E., ed. 1963. *Die griechischen Dichterfragmente der römischen Kaiserzeit*. 2nd ed. 2 vols. Göttingen: Vandenhoeck & Ruprecht.
- Hense, O., ed. 1914. *L. Annaei Senecae Opera quae supersunt*. 3 vols. Leipzig: Teubner.
- Heslin, P. 2007. "Augustus, Domitian and the so-called Horologium Augusti." *The Journal of Roman Studies* 97: 1-20.
- Himmelfmann-Wildschutz, N. 1973. *Typologische Untersuchungen an römischen Sarkophagreliefs des 3. und 4. Jahrhunderts n. Chr.* Mainz: P. von Zabern.
- Hintikka, J. 1981. "Aristotelian Axiomatics and Geometrical Axiomatics." *Theory Change, Ancient Axiomatics, and Galileo's Methodology*. Synthese Library 145: 133-44.
- Holmes, B. 2012. "Sympathy between Hippocrates and Galen: The Case of Galen's *Commentary on Hippocrates' 'Epidemics', Book Two*." *Epidemics in Context: Greek Commentaries on Hippocrates in the Arabic Tradition*. P. Pormann, ed. Berlin and Boston: De Gruyter, 49-70.
- 2015. "Galen's Sympathy." *Sympathy: A History*. E. Schliesser, ed. Oxford: Oxford University Press, 61-69.
- Honigmann, E. 1929. *Die sieben Klimata und die πόλεις ἐπίσθημοι: eine Untersuchung zur Geschichte der Geographie und Astrologie im Altertum und Mittelalter*. Heidelberg: Winter.

- Høyrup, J. 1997/1998. "A Note on Water-Clocks and on the Authority of Texts." *Archiv für Orientforschung* 44/45: 192-194.
- Hueber, F. 1997. *Ephesos: Gebaute Geschichte*. Mainz: P von Zabern.
- Jaeger, W. 1957. "Aristotle's Use of Medicine as Model of Method in his Ethics." *Journal of Hellenic Studies* 77: 54-61.
- Jenzen, I.A. ed. 1989. *Uhrzeiten: Die Geschichte der Uhr und ihres Gebrauches*. Kleine Schriften Historischen Museums Frankfurt 42. Marburg: Jonas.
- Jones, A. 1991. "The Adaptation of Babylonian Methods in Greek Numerical Astronomy." *Isis* 82: 440-453.
- 1996. "Babylonian Astronomy and its Greek Metamorphoses." *Tradition, Transmission, Transformation: Proceedings of Two Conferences on Pre-Modern Science Held at the University of Oklahoma*. F. J. Ragep and S. Ragep, eds. Leiden: Brill, 139-155.
- 1999. *Astronomical Papyri from Oxyrhynchus: P. Oxy. 4133-4300a*. 2 vols. Philadelphia: American Philosophical Society.
- 2009. "Mathematics, Science, and Medicine in the Papyri." *Oxford Handbook of Papyrology*. R. Bagnall, ed. Oxford and New York: Oxford University Press, 338-357.
- 2011. "The Nakovana Zodiac: Fragments from an Astrologer's Board from an Illyrian-Hellenistic Cave Sanctuary." *Journal for the History of Astronomy* 42: 425-438.
- 2012a. "The Cosmos in the Antikythera Mechanism." *ISAW Papers* 4.
- 2012b. "The Antikythera Mechanism and the Public Face of Greek Science." *Proceedings of Science* 38: 1-22.
- , ed. 2016. *Time and Cosmos in Greco-Roman Antiquity*. Princeton: Princeton University Press.
- 2017. *A Portable Cosmos: Revealing the Antikythera Mechanism, Scientific Wonder of the Ancient World*. Oxford and New York: Oxford University Press.
- Jones, W.H.S. 1907. *Malaria: A Neglected Factor in the History of Greece and Rome*. Cambridge: Macmillan & Bowes.
- 1909. *Malaria and Greek History*. Manchester: Manchester University Press.
- 1947. *The medical writings of Anonymus Londinensis*. Cambridge: Cambridge University Press.

- Jouanna, J. 1999. *Hippocrates*. M. B. DeBevoise, trans. Baltimore: Johns Hopkins University Press.
- 2000. *Hippocrate, Epidémies V et VII*, t. IV.3. Paris: Les Belles Lettres.
- Kassel, R. and C. Austin, eds. 1983. *Poetae comici graeci IV*. Berlin: De Gruyter.
- Ker, J. 2009. "Drinking from the Water-Clock: Time and Speech in Imperial Rome." *Arethusa* 42: 279-302.
- Keyser, P. T. 2013. "The Name and Nature of Science: Authorship in Social and Evolutionary Context." *Writing Science: Medical and Mathematical Authorship in Ancient Greece*. M. Asper, ed. Berlin: De Gruyter.
- Keyser, P. T. and G. L. Irby-Massie, eds. 2008. *The Encyclopedia of Ancient Natural Scientists: The Greek Tradition and its Many Heirs*. London and New York: Routledge.
- Kieffer, J.S., ed. 1964. *Galen's Institutio Logica: English Translation, Introduction, and Commentary*. Baltimore: Johns Hopkins University Press.
- King, H. ed. 2005. *Health in Antiquity*. London and New York: Routledge.
- Kinneavy, J.L. and C.R. Eskin. 2000. "Kairos in Aristotle's Rhetoric." *Written Communication* 17: 432-444.
- Knorr, W. 1982. "Techniques of fractions in ancient Egypt and Greece." *Historia Mathematica* 9: 133-171.
- Koch, G. and H. Sichtermann. 1982. *Römische Sarkophage*. Munich: Beck.
- Koch, K., ed. 1923. *Galen De Sanitate Tuenda*. Corpus Medicorum Graecorum V 4,2. Leipzig and Berlin: Teubner.
- Kondoleon, C. 1999. "Timing Spectacles: Roman Domestic Art and Performance." *The Art of Ancient Spectacle*. B. Bergmann and C. Kondoleon, eds. New Haven and London: Yale University Press, 320-341.
- Krohn, F., ed. 1912. *De architectura, libri decem*. Leipzig: Teubner.
- Kucharski, P. 1963. "Sur la notion pythagoricienne du kairos." *Revue philosophique* 153: 141-169.
- Kühlewein, H., ed. 1894-1902. *Hippocratis opera quae feruntur omnia*. 2 vols. Leipzig: Teubner.
- Kühn, C.G., ed. 1821-1833. *Claudii Galeni Opera omnia*. 20 vols. Leipzig: Knobloch.

- Lackeit, C. 1916. *Aion: Zeit und Ewigkeit in Sprache und Religion der Griechen*. Königsberg: Hartungische Buchdruckerei.
- Lain-Entralgo, P. 1987. "El sentido de la *dáita* en la Grecia clásica, II." *Athlon: Satura grammatica in honorem Francisci R.z Adrados*, vol. 2. A. Bernabé, ed. Gredos: Editorial Gredos, 485-497.
- Landels, J.G. 1978. *Engineering in the Ancient World*. Berkeley: University of California Press.
- 1979. "Water-Clocks and Time Measurement in Classical Antiquity." *Endeavor* 3: 32-37.
- Landes, D.S. 1983. *Revolution in Time: Clocks and the Making of the Modern World*. Cambridge: Belknap Press of Harvard University Press.
- Lang, J. 2012. *Mit Wissen geschmückt? Zur bildlichen Rezeption griechischer Dichter und Denker in der römischen Lebenswelt*. Monumenta Artis Romanae 39. Wiesbaden: Reichert.
- Langermann, Y.T. 2012 "Critical Notes on a Study of Galen's *On Critical Days* in Arabic or A Study in Need of Critical Repairs." *Aestimatio* 9: 220-240.
- Langholf, V. 1973. "Ὠρα – Stunde. Zwei Belege aus dem Anfang des 4. Jh. v.Chr." *Hermes* 101: 382-384.
- 1990. *Medical Theories in Hippocrates. Early Texts and the 'Epidemics.'* Berlin and New York: De Gruyter.
- Langmann, G., M.G. Firneis, and G. Hölbl. 1984. "Die ägyptische Wasserauslaufuhr aus Ephesos." *Jahreshefte des Österreichischen archäologischen Instituts in Wien* 55: 1-68.
- Lasserre, F., ed. 1966. *Die Fragmente des Eudoxos von Knidos*. Berlin and New York: De Gruyter.
- Leach, E.W. 1969. "De Exemplo meo Ipse Aedificato: An Organizing Idea in the Mostellaria." *Hermes* 97: 318-332.
- Lehoux, D. 2005. "The Parapegma Fragments from Miletus." *Zeitschrift für Papyrologie und Epigraphik* 152: 125-140.
- 2007. *Astronomy, Weather, and Calendars in the Ancient World: Parapegmata and Related Texts in Classical and Near Eastern Societies*. Cambridge and New York: Cambridge University Press.

- 2012. *What did the Romans Know? An Inquiry into Science and Worldmaking*. Chicago and London: University of Chicago Press.
- Lentz, W. and W. Schlosser. 1978. "Ein Gnomon aus einem südwestdeutschen Mithräum." *Hommages à M. J. Vermaseren*. M. B. de Boer and T. A. Edridge, eds. Leiden: Brill, 590-608.
- Levi, D. 1923. "Il *kairos* attraverso la letteratura greca." *Reconditi della Reale Accademia Nazionale dei Lincei classe di scienza morali*, RV 32: 260-281.
- Lewis, M. 2000. "Theoretical Hydraulics, Automata, and Water Clocks." *Handbook of Ancient Water Technology*. O. Wikander, ed. Leiden: Brill, 343-369.
- Liewert, A. 2015. *Die meteorologische Medizin des Corpus Hippocraticum*. Berlin and Boston: De Gruyter.
- Lin, J.-L. and H.-S. Yan. 2016. *Decoding the Mechanisms of Antikythera Astronomical Device*. Berlin and Heidelberg: Springer.
- Littré, E., ed. 1839-1861. *Oeuvres complètes d'Hippocrate*, 10 vols. Paris: Les Belles Lettres.
- Lloyd, G.E.R. 1979. *Magic, Reason, and Experience: Studies in the origin and development of Greek science*. Cambridge and New York: Cambridge University Press.
- 1988. "Scholarship, Authority and Argument in Galen's *Quod animi mores*." *Le opere psicologiche di Galeno: atti del terzo Colloquio galenico internazionale, Pavia, 10-12 settembre 1986*. P. Manuli and M. Vegetti, eds. Naples: Bibliopolis, 11-42.
- 2006. "Mathematics as a Model of Method in Galen." *Principles and Practices in Ancient Greek and Chinese Science*. Aldershot and Burlington: Ashgate/Variorum, 110-130.
- 2008. "Galen and His Contemporaries." *Cambridge Companion to Galen*. R. J. Hankinson, ed. Cambridge: Cambridge University Press, 34-48.
- 2009. "Galen's Un-Hippocratic Case Histories." *Galen and the World of Knowledge*. T. Whitmarsh, C. Gill, and J. Wilkins, eds. Cambridge: Cambridge University Press, 115-131.
- Locher, K. 1995. "Three further Greco-Roman conical sundials from Palmyra, Naples, and Abu Mina." *Journal for the History of Astronomy* 26: 159-163.
- Long, A. A. 2002. *Epictetus: A Stoic and Socratic Guide to Life*. Oxford and New York: Oxford University Press.

- Longrigg, J. 1998. *Greek Medicine. From the Heroic to the Hellenistic Age: A Source Book*. London: Duckworth.
- Lonie, I. M. 1981. "Fever Pathology in the Sixteenth Century: Tradition and Innovation." *Medical History* 25, Supplement I: 19-44.
- Lotito, G. 2001. *Suum esse: forme dell'interiorità senecana*. Bologna: Pàtron.
- Lowrie, M. 2009. *Writing, Performance, and Authority in Augustan Rome*. Oxford: Oxford University Press.
- Maher, D. W. and J. F. Makowski. 2001. "Literary Evidence for Roman Arithmetic with Fractions." *Classical Philology* 96: 376-399.
- Manetti, D. 2003. "Galeno, la lingua di Ippocrate e il tempo." *Galien et la philosophie. Entretiens sur l'Antiquité Classique XLIX*. J. Barnes and J. Jouanna, eds. Geneva: Fondation Hardt, 171-220.
- 2009. "Galen and Hippocratic Medicine: Language and Practice." *Galen and the World of Knowledge*. T. Whitmarsh, C. Gill, and J. Wilkins, eds. Cambridge: Cambridge University Press, 157-174.
- Manetti, D. and A. Roselli. 1994. "Galeno commentatore di Ippocrate." *Aufstieg und Niedergang der Römischen Welt II* 37.2. W. Haase and H. Temporini, eds. Berlin and New York: De Gruyter, 1529-1637.
- Manitius, C., ed. 1894. *Hipparchi in Arati et Eudoxi Phaenomena Commentariorum Libri Tres*. Leipzig: Teubner.
- Mansfeld, J. 1991. "The Idea of the Will in Chrysippus, Posidonius, and Galen." *Proceedings of the Boston Area Colloquium in Ancient Philosophy* 7: 107-145.
- Manuli, P. 1983. "Lo stile del commento: Galeno e la tradizione ippocratica." *Formes des Pensée dans la collection Hippocratique*. F. Lasserre and P. Mudry, eds. Geneva: Droz, 471-478.
- Marrou, H.I. 1938. *Mousikòs Anèr: Étude sur les scènes de la vie intellectuelle figurant sur les monuments funéraires romains*. Grenoble: Didier & Richard.
- Mattern, S.P. 2008. *Galen and the Rhetoric of Healing*. Baltimore: Johns Hopkins University Press.
- 2013. *The Prince of Medicine: Galen in the Roman Empire*. Oxford and New York: Oxford University Press.

- McKirahan, R. D. 1992. *Principles and Proofs: Aristotle's Theory of Demonstrative Science*. Princeton: Princeton University Press.
- Meritt, B. D. 1961. *The Athenian Year*. Berkeley: University of California Press.
- 1964. "Greek Inscriptions." *Hesperia* 33: 168-227.
- 1969. *The Athenian calendar in the fifth century: based on a study of the detailed accounts of money borrowed by the Athenian state, IG I², 324*. Cambridge: Harvard University Press.
- 1974. "The count of days at Athens." *The American Journal of Philology* 95: 268-279.
- Miller, C. R. 1992. "Kairos in the Rhetoric of Science." S.P. Witte, N. Nakadate, and R.D. Cherry, eds. *A Rhetoric of Doing: Essays on Written Discourse in Honor of James L. Kinneavy*. Carbondale: Southern Illinois University Press, 310-327.
- Mills, A. A. 1996. "Altitude sundials for seasonal and equal hours." *Annals of Science* 53: 75-84.
- Morison, B. 2008a. "Logic." *Cambridge Companion to Galen*. R. J. Hankinson, ed. Cambridge: Cambridge University Press, 66-115.
- 2008b. "Language." *Cambridge Companion to Galen*. R. J. Hankinson, ed. Cambridge: Cambridge University Press, 116-156.
- Mueller, I., ed. 1884-93. *Claudii Galeni Pergameni. Scripta Minora* II. Leipzig: Teubner.
- Müller, W. 1989. *Architekten in der Welt der Antike*. Zurich: Architektur Artemis.
- Mumford, L. 1934. *Technics and civilization*. New York: Harcourt, Brace & World.
- Neugebauer, O. 1969. *The Exact Sciences in Antiquity*. 2nd ed. New York: Dover.
- 1975. *A History of Ancient Mathematical Astronomy*. 3 vols. New York, Heidelberg, Berlin: Springer.
- 1983. "Astronomical Fragments in Galen's Treatise on Seven-Month Children." *Astronomy and History: Selected Essays*. New York: Springer, 298-300. Originally published in *Revista degli Studi Orientali* XV (1935): 323-57.
- Neugebauer, O. and H. B. Van Hoesen. 1957, repr. 1987. *Greek Horoscopes*. Philadelphia: American Philosophical Society.
- Neugebauer, O. and R. A. Parker. 1960. *Egyptian Astronomical Texts*. Providence: Brown University Press.

- Nicolet, C. 1991. *Space, Geography, and Politics in the Early Roman Empire*. Ann Arbor: University of Michigan Press.
- Nutton, V. 1984. "Galen in the Eyes of His Contemporaries." *Bulletin of the History of Medicine* 58: 315-24.
- 1992. "Healers in the Medical Market Place: Towards a Social History of Graeco-Roman Medicine." *Medicine in Society*. A. Wear, ed. Cambridge: Cambridge University Press, 1-58.
- 1993. "Galen and Egypt." *Sudhoffs Archiv. Beihefte* 32: 11-31.
- 2004 (repr. 2013). *Ancient medicine*. London and New York: Routledge.
- 2008. "The Fortunes of Galen." *Cambridge Companion to Galen*. R. J. Hankinson, ed. Cambridge and New York: Cambridge University Press, 355-390.
- Oestmann, G., H.D. Rutkin, and K. von Stuckrad. 2005. *Horoscopes and public spheres: essays on the history of astrology*. Berlin and New York: De Gruyter.
- Orlandos, A.K. and J.N. Tavlos. 1986. *Lexicon archaiôn architektonikôn horôn*. Athens: The Athens Archaeological Association.
- Orth, H. 1963. "Diaita γερόντων, die Geriatrie der griechischen Antike." *Centaurus* 8: 19-47.
- Pampana, E. 1963. *A Textbook of Malaria Eradication*. Oxford: Oxford University Press.
- Parrish, D. 1993. "The mosaic of Aion and the seasons from Haïdra (Tunisia): an interpretation of its meaning and importance." *Antiquité Tardive* 3: 167-191.
- Pattenden, P. 1981. "A Late Sundial at Aphrodisias." *Journal of Hellenic Studies* 101: 101-112.
- Patterson, R. 2007. "Diagrams, Dialectic, and Mathematical Foundations in Plato." *APEIRON* 40: 1-34.
- Pearcy, L.T. 1985. "Galen's Pergamum." *Archaeology* 38: 33-39.
- 1992. "Diagnosis as Narrative in Ancient Literature." *The American Journal of Philology* 113: 595-616.
- Peek, W. 1973. "Inscription einer Sonnenuhr aus Traianopolis." *Zeitschrift für Papyrologie und Epigraphik* 10: 98-100.
- Perutelli, A. 2000. "Il Tema della Casa nella *Mostellaria*." *Maia* 52: 19-34.

- Pfeiffer, R. 1923. *Callimachi Fragmenta Nuper Reperta*. Bonne: Marcus and Weber.
- Phillips, J.H. 1983. "The Hippocratic Physician and Astronomy." *Formes de pensée dans la collection Hippocratique: actes du IVe Colloque international hippocratique: Lausanne, 21-26 septembre 1981*. F. Lasserre and P. Mudry, eds. Geneva: Droz, 427-434.
- Pogo, A. 1936. "Egyptian Water-clocks." *Isis* 25: 403-425.
- Pomata, G. 2014. "The Medical Case Narrative: Distant Reading of an Epistemic Genre." *Literature and Medicine* 32: 1-23.
- Potter, P., ed. and trans. 2010. *Hippocrates Vol. IX. Coan Prenotions. Anatomical and Minor Clinical Writings*. Loeb Classical Library 509. Cambridge: Harvard University Press.
- Poulakos, J. 2002. "Kairos in Gorgias' Rhetorical Compositions." *Rhetoric and Kairos: Essays in History, Theory, and Praxis*. P. Sipiora and J. S. Baumlin, eds. Albany: State University of New York Press, 89-96.
- Price, D. J. de Solla. 1969. "Portable Sundials in Antiquity, Including a New Account of an Example from Aphrodisias." *Centaurus* 14: 242-266.
- Pritchett, W. K. 1947. "Julian Dates and Greek Calendars." *Classical Philology* 42: 235-243.
- 1957. "Calendars of Athens again." *Bulletin de correspondance hellénique* 81: 269-301.
- 1963. *Ancient Athenian calendars on stone*. Berkeley: University of California Press.
- 1999. "Postscript: The Athenian Calendars." *Zeitschrift für Papyrologie und Epigraphik* 128: 79-93.
- 2001. *Athenian calendars and ekklesias*. Amsterdam: J. C. Gieben.
- Pritchett, W.K. and O. Neugebauer. 1947. *The calendars of Athens*. Cambridge: Harvard University Press.
- Raya Roman, J. M. 1989. *Los cuadrantes solares en la arquitectura*. Seville: Junta de Andalucia.
- Reckford, K. J. 1997. "Horatius: The Man and the Hour." *The American Journal of Philology* 118: 583-612.
- Rehm, A. 1911. "Eine Zwillingssonenuhr aus Pergamum." *Athener Mitteilungen* 36: 251-268.

- 1913. "Horologium." *Paulys Real-Encyclopädie der classischen Altertumswissenschaft*. A. Pauly and G. Wissowa, eds. Stuttgart: J.B. Metzler, 2416-2432.
- Reichardt, W. 1893. *De Artemidoro Daldiano librorum onirocriticorum auctore*. Leipzig: Teubner.
- Riese, W., ed. 1963. *Galen on the passions and errors of the soul*. P. W. Harkins, trans. Columbus: Ohio University Press.
- Remijsen, S. 2007. "The Postal Service and the Hour as a Unit of Time in Antiquity." *Historia: Zeitschrift für alte Geschichte* 56: 127-140.
- Riggsby, A.M. 2009. "For Whom the Clock Drips." *Arethusa* 42: 271-278.
- Ripat, P. 2011. "Expelling Misconceptions: Astrologers at Rome." *Classical Philology* 106: 115-154.
- Ritner, R. 2016. "Oriental Institute Museum Notes 16: Two Egyptian Clepsydrae (OIM E16875 and A7125)." *Journal of Near Eastern Studies* 75: 361-389.
- Robert, C. 1919. *Einzelmythen. Niobiden bis Triptolemos. Ungedeutet*. Die antiken Sarkophag-Reliefs III.3. Berlin: Gebr. Mann.
- Rocca, J. 2003. *Galen on the Brain: Anatomical Knowledge and Physiological Speculation in the Second Century AD*. Leiden: Brill.
- 2006. "Plato will tell you': Galen's use of the Phaedrus in *De Placitis Hippocratis et Platonis IX*." *Reading Plato in Antiquity*. H. Tarrant and D. Baltzly, eds. London: Duckworth, 49-59.
- Rochberg, F. 1998. "Babylonian Horoscopes." *Transactions of the American Philosophical Society, New Series* 88: 1-164.
- Rochberg-Halton, F. 1989. "Babylonian seasonal hours." *Centaurus* 32: 146-170.
- Rostagni, A. 2002. "A New Chapter in the History of Rhetoric and Sophistry." *Rhetoric and Kairos: Essays in History, Theory, and Praxis*. P. Sipiora and J.S. Baumlin, eds. P. Sipiora, trans. Albany: State University of New York Press, 23-45.
- Rüpke, J. 2011. *The Roman Calendar from Numa to Constantine: Time, History, and the Fasti*. Chichester and Malden: Wiley-Blackwell.
- Şahin, S. 1973. *Neufunde von antiken Inschriften in Nikomedia und in der Umgebung der Stadt*. Diss., Westfälischen Wilhelms-Universität zu Münster.

- Sallares, R. 2002. *Malaria and Rome: A History of Malaria in Ancient Italy*. Oxford: Oxford University Press.
- Samama, E. 2003. *Les médecins dans le monde grec: sources épigraphiques sur la naissance d'un corps médical*. Geneva: Droz.
- Samuel, A.E. 1972. *Greek and Roman chronology: Calendars and years in classical antiquity*. Munich: C.H. Beck.
- Sauter, M. J. 2007. "Clockwatchers and Stargazers: Time Discipline in Early Modern Britain." *The American Historical Review* 112: 685-709.
- Schaldach, K. 1998. *Römische Sonnenuhren: eine Einführung in die antike Gnomonik*. 2nd ed. Frankfurt: Deutsch.
- 2004. "The arachne of the Amphiareion and the origin of gnomonics in Greece." *Journal for the History of Astronomy* 35: 435-445.
- 2006. *Die antiken Sonnenuhren Griechenlands*. Vol.2. Frankfurt: Deutsch.
- 2011. "Eine seltene Form antiker Sonnenuhren: Der Meridian von Chios." *Archäologisches Korrespondenzblatt* 41: 73-83.
- Schaldach, K. and O. Feustel. 2013. "The Globe Dial of Prosymna." *British Sundial Society Bulletin* 25: 6-12.
- Scheidel, W. 2001. *Death on the Nile: Disease and Demography of Roman Egypt*. Leiden: Brill.
- Scheidt, W.R. 1967. "Die azentrische sphärische Sonnenuhr aus Herdonia. Eine Analyse des Fragments 79. OR. 167." *Ordonia IX, Rapports et Etudes; Institut historique belge de Rome. Études de Philologie, d'Archäologie et d'Histoire anciennes* 34: 383-406.
- Schenkl, H., ed. 1916. *Epicteti dissertationes ab Arriano digestae*. Leipzig: Teubner.
- Schlange-Schöningh, H. 2003. *Die römische Gesellschaft bei Galen. Biographie und Sozialgeschichte*. Berlin and New York: De Gruyter.
- Schmidt, M. C. P. 1912. *Kulturhistorische Beiträge zur Kenntnis des griechischen und römischen Altertums, Zweites Heft; Die Entstehung der antiken Wasseruhr*. Leipzig: Teubner.
- Schöne, H. 1907. "Markellinos' Pulslehre. Ein griechisches Anekdoton." *Festschrift zur 49. Versammlung deutscher Philologen und Schulmänner*. Basel: E. Birkhäuser, 448-72.

- 1933. "Galenos' Schrift über die Siebenmonatskinder." *Quellen und Studien zur Geschichte der Naturwissenschaften und Medizin* 3.4: 127-130.
- Schütz, M. 1990. "Zur Sonnenuhr des Augustus auf dem Marsfeld: Eine Auseinandersetzung mit E. Buchners Rekonstruktion und seiner Deutung der Ausgrabungsergebnisse, aus der Sicht eines Physikers." *Gymnasium* 97: 432-457.
- Schwindt, J. P. 1994. *Das Motiv der "Tagesspanne": ein Beitrag zur Ästhetik der Zeitgestaltung im griechisch-römischen Drama*. Paderborn: Schöningh.
- Shcheglov, D. A. 2003-2007. "Hipparchus' Table of Climata and Ptolemy's Geography." *Orbis Terrarum* 9: 159-192.
- Simpson, C. J. 1992. "Unexpected References to the 'Horologium Augusti' at Ovid *Ars Amatoria* 1,68 and 3,388." *Athenaeum* 80: 478-484.
- Singer, P.N., ed. 2013. *Galen: Psychological Writings. Translated with Introduction and Notes by Vivian Nutton, Daniel Davies, and P. N. Singer; with the collaboration of Piero Tassinari*. New York and Cambridge: Cambridge University Press.
- 2014. "Galen and the Philosophers: Philosophical Engagement, Shadowy Contemporaries, Aristotelian Transformations." *Philosophical Themes in Galen*. R. Hansberger, P. Adamson, and J. Wilberdings, eds. London: Institute of Classical Studies, School of Advanced Study, University of London. *Bulletin of the Institute of Classical Studies Supplement* 114: 7-38.
- Sipiora, P. 2002. "The Ancient Concept of Kairos." *Rhetoric and Kairos: Essays in History, Theory, and Praxis*. P. Sipiora and J.S. Baumlin, eds. Albany: State University of New York Press, 1-22.
- Sipiora, P. and J.S. Baumlin, eds. 2002. *Rhetoric and Kairos: Essays in History, Theory, and Praxis*. Albany: State University of New York Press.
- Slater, W.J. 1971a. "Pindar's House." *Greek, Roman and Byzantine Studies* 12: 141-152.
- 1971b. "Simonides' House." *Phoenix* 26: 232-240.
- Smith, J. E. 2002. "Time and Qualitative Time." *Rhetoric and Kairos: Essays in History, Theory, and Praxis*. P. Sipiora and J.S. Baumlin, eds. Albany: State University of New York Press, 46-57.
- Smith, R. 2009. "Aristotle's Theory of Demonstration." *A Companion to Aristotle*. G. Anagnostopoulos, ed. Oxford: Blackwell, 51-65.
- Smith, W. D. 1979. *The Hippocratic Tradition*. Ithaca: Cornell University Press.

- 1980. "The Development of Classical Dietetic Theory." *Hippocratica: actes du Colloque hippocratique de Paris, 4-9 Septembre 1978*. M.D. Grmek, ed. Paris: Éditions du Centre national de la recherche scientifique, 439-448.
- 1981. "Implicit Fever Theory in *Epidemics* 5 and 7." *Medical History* 25, Supplement I: 1-18.
- Smolensky, M. H. and N. A. Peppas. 2007. "Chronobiology, Drug Delivery, and Chronotherapeutics." *Advanced Drug Delivery Reviews* 59: 828-851.
- Sontheimer, W. 1932. "Tageszeiten." *Paulys Real-Encyclopädie der klassischen Altertumswissenschaft*. Vol. 2. A. Pauly and G. Wissowa. Stuttgart: J.B. Metzler, 2011-2023.
- Sorabji, R. 1983. *Time, Creation and the Continuum: Theories in Antiquity and the Early Middle Ages*. Chicago: University of Chicago Press.
- Stern, S. 2012. *Calendars in Antiquity: Empires, States, and Societies*. Oxford: Oxford University Press.
- Sticker 1928, 1929, 1930. "Fieber und Entzündung bei den Hippokratikern." *Archiv für Geschichte der Medizin* 20, 22, 23: 150-174; 313-343 and 361-381; 40-67.
- Strohmaier, G. 1993. "Hellenistische Wissenschaft im neugefundenen Galenkommentar zur hippokratischen Schrift 'Über die Umwelt'." *Galen und das hellenistische Erbe: Verhandlungen des IV. Internationalen Galen-Symposiums, Berlin 18-20 Sept. 1989, Sudhoffs Archiv, Beihefte* 32. J. Kollesch and D. Nickel, eds. Stuttgart: Steiner, 157-164.
- 1997. "La question de l'influence du climat dans la pensée arabe et le nouveau commentaire de Galien sur le traité hippocratique des Airs, eaux et lieux." *Perspectives arabes et médiévales sur la tradition scientifique et philosophique grecque. Actes du colloque e la Société internationale d'histoire des sciences et de la philosophie arabes et islamiques. Paris, 31 mars - 3 avril 1993*. A. Elamrani-Jamal. A Hasnawi, M. Aouad, eds. Paris and Leuven: Peeters, 209-216.
- Stützing, D. 2001. *Eine römische Wasserauslaufuhr*. Berlin: Kulturstiftung der Länder.
- Swain, S. 2008. "Social Stress and Political Pressure: On Melancholy in Context." *Rufus of Ephesus: On Melancholy*. P.E. Pormann, ed. Tübingen: Mohr Siebeck.
- Symons, S. 1998. "Shadow Clocks and Sloping Sundials of the Egyptian New Kingdom and Late Period: Usage, Development, and Structure." *The British Sundial Society Bulletin* 98: 30-36.

- 2002a. "Egyptian Shadow Clocks." *Proceedings of the XXth International Congress of History of Science* 16. M. Dorikens, ed. Turnhout: Brepols, 16-20.
- 2002b. "The 'Transit Star Clock' in the Book of Nut." *Under One Sky: Astronomy and Mathematics in the Ancient Near East*. J. M. Steele and A. Imhausen, eds. Münster: Ugarit, 429-446.
- 2013. "Astronomy, Egyptian." *The Encyclopedia of Ancient History*. K. Broderson, R. S. Bagnall, C. B. Champion, A. Erskine, and S. R. Huebner, eds. Oxford: Blackwell, 879-881.
- Tassinari, P. 1994. "Il trattato dello ps. Alessandro d'Afrodisia." *Aufstieg und Niedergang der römischen Welt* 37.2. W. Haase and H. Temporini, eds. Berlin and New York: De Gruyter, 2019-2034.
- Taubes, G. 1996. "A Clock More Perfect than Time." *Discover* 17: 68-72.
- Taylor, B.N. and A. Thompson, eds. 2006. *The International System of Units (SI)*. NIST Special Publication 330. Gaithersburg: National Institute of Standards and Technology.
- Tecusan, M. 2007. *The Fragments of the Methodists. Methodism Outside Soranus. Volume One: Text and Translation*. Studies in Ancient Medicine 24. Leiden: Brill.
- Temkin, O. 1973. *Galenism: Rise and Decline of a Medical Philosophy*. Ithaca: Cornell University Press.
- Thalheim, T. 1921. "Klepsydra 2". *Paulys Real-Encyclopädie der klassischen Altertumswissenschaft*. Vol. 1. A. Pauly and G. Wissowa, eds. Stuttgart: J.B. Metzler, 807-809.
- Theodossiou, E., M. Katsiotis, V.N. Manimanis, and P. Mantarakis. 2010. "The Large Built Water-clock of Amphiaraeion." *Mediterranean Archaeology and Archaeometry* 10: 159-167.
- Thom, J. C. 2001 "Cleanthes, Chrysippus and the Pythagorean *Golden Verses*" *Acta Classica* 44: 197-219.
- Thomas, E. 2007. *Monumentality and the Roman Empire: Architecture in the Antonine Age*. Oxford: Oxford University Press.
- Thompson, E.P. 1967. "Time, Work-Discipline, and Industrial Capitalism." *Past and Present* 38: 56-97.

- Thomssen, H. 1994. "Die Medizin des Rufus von Ephesos." *Aufstieg und Niedergang der Römischen Welt II* 37.2. W. Haase and H. Temporini, eds. Berlin and New York: De Gruyter, 1254-1292.
- Tieleman, T. 1996. *Galen and Chrysippus on the Soul: Argument and Refutation in the De Placitis Books II-III*. Leiden and New York: Brill.
- 2008. "Methodology." *Cambridge Companion to Galen*. R. J. Hankinson, ed. Cambridge: Cambridge University Press, 49-65.
- Tölle, R. 1969. "Uhren auf Samos." *Opus nobile. Festschrift zum 60. Geburtstag von Ulf Jantzen*. P. Zazof, ed. Wiesbaden: Steiner, 164-171.
- Tonchéva, G. 1969. "Skulptura v Odesos ot V-I v.pr.n.e." *Izvestiya na Narodniya Muzei Varna* 5: 3-18.
- Toomer, G. J. 1985. "Galen on the Astronomers and Astrologers." *Archive for the History of Exact Sciences* 32: 193-206.
- Traversari, G. 1991. "Il 'pelecinum' – un particolare tipo di orologio solare raffigurato su alcuni rilievi di sarcophagi di età romana." *Colloquio internazionale archeologia e astronomia, Venezia 3-6 Maggio 1989*. M. F. Santi, ed. Rome: Bretschneider, 66-73.
- Tucci, P.L. 2003. "Galen's storeroom, Rome's libraries, and the fire of A.D. 192." *Journal of Roman Archaeology* 21: 133-149.
- Turcan, R. 1968. "Note sur les sarcophages 'au Prométhée'." *Latomus: Revue d'études latines* 27: 630-634.
- 1999. *Messages d'outre-tombe. L'iconographie des sarcophages romains*. Paris: De Boccard.
- Turner, A. J. 1989. "Sun-dials: History and Classification." *History of Science* 27: 303-318.
- Ullman, M. 1978. *Rufus von Ephesus. Krankenjournal*. Wiesbaden: Harrassowitz.
- Ulonska, K. 1927. *T. Maccius Plautus Mostellaria*. Leipzig: Teubner.
- Van der Eijk, P. J. 2012. "Exegesis, Explanation and Epistemology in Galen's Commentaries on Epidemics, Books One and Two." *Epidemics in Context: Greek commentaries on Hippocrates in the Arabic tradition*. P.E. Pormann, ed. Berlin and Boston: De Gruyter, 25-48.
- 2014. "An Episode in the Historiography of Malaria in the Ancient World." *Medicine and Healing in the Ancient Mediterranean World*. D. Michaelides, ed. Oxford: Oxbow Books, 112-117.

- Van Nijf, O. 2001. "Local Heroes: Athletics, Festivals, and Elite Self-Fashioning in the Roman East." *Being Greek Under Rome: Cultural Identity, the Second Sophistic, and the Development of Empire*. S. Goldhill, ed. Cambridge and New York: Cambridge University Press, 306-334.
- Veyne, P. 1985. "Les saluts aux dieux, le voyage de cette vie et la 'réception' en iconographie." *Revue Archéologique Paris* 16: 47-61.
- Von Gerkan, A. 1921. *Das Theater von Priene: Als Einzelanlage und in seiner Bedeutung für das hellenistische Bühnenwesen*. Munich: Verlag für Praktische Kunstwissenschaft.
- Von Mackensen, L. 1978. "Neue Ergebnisse zur ägyptischen Zeitmessung." *Alte Uhren* 1: 13-18.
- Von Staden, H. 1975. "Experiment and Experience in Hellenistic Medicine." *Bulletin of the Institute of Classical Studies* 22: 178-199.
- 1989. *Herophilus: the art of medicine in early Alexandria: edition, translation and essays*. Cambridge and New York: Cambridge University Press.
- 1997. "Galen and the Second Sophistic." *Aristotle and After: Bulletin of the Institute of Classical Studies, Supplement 68*. R. Sorabji, ed. London: Institute of Classical Studies, School of Advanced Study, University of London, 33-54.
- 2002. "'A woman does not become ambidextrous'. Galen and the Culture of the Scientific Commentary." *The Classical Commentary: Histories, Practices, Theory*. R. K. Gibson and C. S. Kraus, eds. Leiden: Brill, 109-140.
- Walzer, R. 1935. "Galens Schrift 'Ueber die Siebenmonatskinder'." *Rivista degli Studi Orientali* 15: 323-357.
- Webb, R. 2009. *Ekphrasis, Imagination and Persuasion in Ancient Rhetorical Theory and Practice*. Farnham and Burlington: Ashgate.
- Wee, J. 2015. "Case History as Minority Report in the Hippocratic Epidemics I." *Homo Patiens: Approaches to the Patient in the Ancient World*. G. Petridou and C. Thumiger, eds. Leiden: Brill, 138-165.
- Wegner, M. 1966. *Die Musensarkophage*. Berlin: Mann.
- Wendland, P. 1892. *Philos Schrift über die Vorsehung: ein Beitrag zur Geschichte der nacharistotelischen Philosophie*. Berlin: R. Gaertner.
- Wiegand, T. and H. Schrader. 1904. *Priene: Ergebnisse der Ausgrabungen und Untersuchungen in den Jahren 1895-1898*. Berlin: G. Reimer.

- Wiemer, H.-U. 1998. "Zwei Epigramme und eine Sonnenuhr im kaiserzeitlichen Sillyon." *Epigraphica Anatolica* 30: 149-153.
- Wilkins, J. 2007. "Galen and Athenaeus in the Hellenistic Library." *Ordering Knowledge in the Roman Empire*. J. König and T. Whitmarsh, eds. Cambridge and New York: Cambridge University Press, 69-87.
- 2015. "Treatment of the Man: Galen's Preventive Medicine in the *De Sanitate Tuenda*." *Homo Patiens: Approaches to the Patient in the Ancient World*. G. Petridou and C. Thumiger, eds. Leiden: Brill, 411-431.
- Williams, J. and A. Meadows. 2001. "Moneta and the Monuments: Coinage and Politics in Republican Rome." *Journal of Roman Studies* 91: 27-49.
- Wilson, M. 2008. "Seneca's Epistles to Lucilius." *Oxford Readings in Classical Studies: Seneca*. J. G. Fitch, ed. Oxford: Oxford University Press, 59-83.
- Wittern, R. 1989. "Die Wechselfieber bei Galen." *History and Philosophy of the Life Sciences* 11: 3-22.
- Wöhrle, G. 1990. *Studien zur Theorie der antiken Gesundheitslehre*. Stuttgart: Steiner.
- Wolfsdorf, D. 2008. *Trials of Reason: Plato and the Crafting of Philosophy*. Oxford: Oxford University Press.
- Wolkenhauer, A. 2011. *Sonne und Mond, Kalender und Uhr: Studien zur Darstellung und poetischen Reflexion der Zeitordnung in der römischen Literatur*. Berlin and New York: De Gruyter.
- Wright, M. T. 2000. "Greek and Roman Portable Sundials: An Ancient Essay in Approximation." *Archive for History of Exact Sciences* 55: 177-187.
- Yegül, F. 2010. *Bathing in the Roman World*. Cambridge and New York: Cambridge University Press.
- Yeo, R. 2005. "Hippocrates in the Context of Galen: Galen's Commentary on the Classification of Fevers in *Epidemics VI*." *Medicine and Philosophy in Classical Antiquity. Doctors and Philosophers on Nature, Soul, Health and Disease*. P. J. van der Eijk, ed. Cambridge and New York: Cambridge University Press, 433-443.
- Young, S. 1939. "An Athenian Clepsydra." *Hesperia* 8: 272-284.
- Zaccaria Ruggiu, A. 2006. *Le forme del tempo: Aion Chronos Kairos*. Padua: Il Poligrafo.

Zhelezcheva, T. and J. S. Baumlin 2002. "A Bibliography on Kairos and Related Concepts."
Rhetoric and Kairos: Essays in History, Theory, and Praxis. P. Sipiora and J. S.
Baumlin, eds. Albany: State University of New York Press, 237-245.

Zuntz, G. 1989. *Aion, Gott des Römerreichs*. Heidelberg: Winter.

--- 1991. *Aiōn im Römerreich: Die archäologischen Zeugnisse*. Heidelberg: Winter.

--- 1992. *Aiōn in der Literatur der Kaiserzeit*. Vienna: Österreichischen Akademie der
Wissenschaften