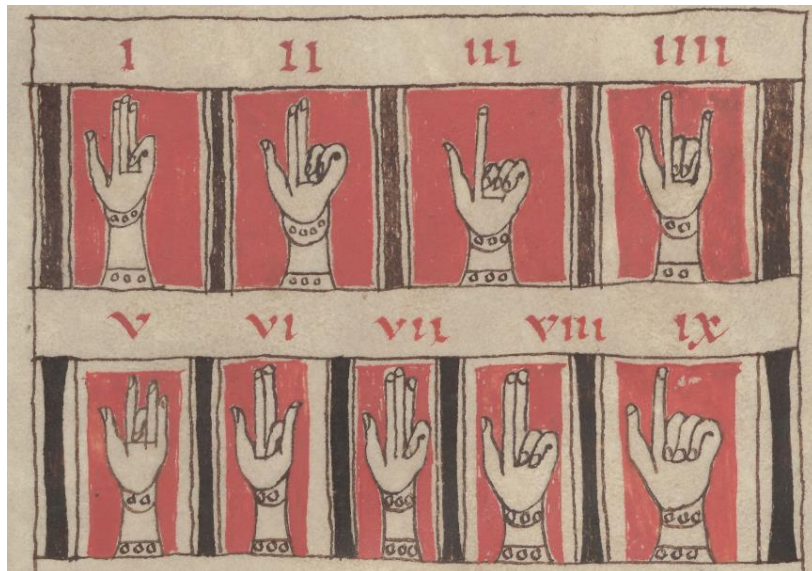


## FINGER-COUNTING IN TWO ILLUMINATED GRAMMATICAL MANUSCRIPTS (12<sup>TH</sup> – 13<sup>TH</sup> C.)



**Miguel José da Fontoura Müller da Cruz Fernandes**

**Master of Arts Dissertation in Medieval History**

Corrected and improved version after public defense

**July, 2021**

Dissertação apresentada para cumprimento dos requisitos necessários à obtenção do grau de Mestre em História Medieval, realizada sob a orientação científica de Prof. Dr. Maria João Branco e co-orientação científica de Prof. Dr. Alicia Miguélez Caveró

Para a Ana.

## Acknowledgements

First and foremost, I would like to thank my supervisors Prof. Maria João Branco and Prof. Alicia Miguélez for their enthusiastic and continuous support allied to a high academic standard, and for their diligence in getting me through the finish line.

I am particularly indebted to Prof. Henrique Leitão. His wisdom and energy were fundamental to the development of this dissertation. I would also like to thank Prof. Michael I. Allen for his insights on palaeography and medieval Latin; Prof. Maria Coutinho, for generously sharing her ideas and research on the Portuguese codices; Nuno Castel-Branco, for his precious advice at different stages of the writing process; Prof. Adam S. Cohen and Prof. James Trevor Palmer, for their useful and constructive criticism.

I am grateful to Biblioteca Nacional de Portugal for letting me see codex Alc. 426; and to Biblioteca Pública Municipal do Porto, especially in the person of Dr. Sílvio da Costa, whose goodwill was crucial for me to examine codex Santa Cruz 8. I would also like to thank the Staatsbibliothek zu Berlin; the Biblioteca Antoniana; the Biblioteca Nazionale Universitaria di Torino, especially in the person of Fabio Uliana, who kindly entrusted me with images of Ms. D III 19; the Morgan Library & Museum, especially in the person of Polly Cancro, who kindly entrusted me with images of MS M.925; the Biblioteca Medicea Laurenziana, especially in the person of Eugenia Antonucci, who kindly entrusted me with images of Amiatinus III; and the Bibliothèque Municipale de Rouen, especially in the person of Catherine Hubbard, who kindly entrusted me with images of Ms. Leber 1157. I am also indebted to Biblioteca João Paulo II, for giving me access to the indispensable *Corpus Christianorum*.

My gratitude extends to many of my professors, colleagues, and friends, for providing me with useful methodological tools and for encouraging my research. If I had to use my fingers to number them all, I would quickly arrive to the right hand. Still, I would like to expressly thank Prof. Bernardo de Vasconcelos e Sousa and Prof. Miguel Metelo de Seixas, who were always knowledgeable, enthusiastic, and accessible guides; the great RUTTER team, particularly Juan Acevedo, whose work played an important role in my research; and Pedro Gonçalves Rodrigues, who exposed me to McLuhan's theories.

I thank my parents, my siblings, and my niece, for their unconditional support. And I thank my extraordinary wife, Ana, for her uncommon sense of humour and patience.

I would finally like to thank Avô Duarte Rui. His magnanimity, sincerity, love of knowledge, and good humour set him as an inspiration and example for any scholar to follow.

## Abstract

Finger-counting in two illuminated grammatical manuscripts (12th – 13th c.)

Miguel José da Fontoura Müller da Cruz Fernandes

Keywords: middle ages; dactylonomy; Santa Cruz; Alcobça; monastic education; numeracy; embodied knowledge; visual culture; digital humanities; *De temporum ratione*; *De computo*; grammar; *computus*; memory; lexicography; Bede; Rabanus Maurus.

A sophisticated system of finger-counting was developed in Greco-Roman antiquity and was used until the middle ages. It enabled people to count to high amounts on their fingers. In the early middle ages, this system gave emergence to a pictorial tradition that lasted centuries: throughout the middle ages, large numbers of illuminated manuscripts with depictions of number-gestures circulated across Europe.

There is no doubt that finger-counting illuminated manuscripts carried a heavy cultural and intellectual weight in the middle ages. This is evident from the peculiar form of their images, the pervasiveness of the finger system in medieval society, and the diffusion and dynamism of the manuscript tradition. However, this tradition is still widely unexplored. Not only a broad comparative analysis is wanting, but many sources remain unexamined.

This dissertation analyses two twelfth-thirteenth centuries little-studied Portuguese grammatical codices. Although these codices include finger-counting images – typically associated with arithmetic and astronomy – they are grammatical compilations. To properly evaluate this seeming misplacement, this dissertation contextualizes the codices in the intellectual and cultural framework of coeval Portuguese and European monasticism.

As this dissertation shows, the finger system was a polyvalent medium that crossed discipline barriers and was even useful for the teaching of grammar. Furthermore, the finger-counting images are impregnated with rhetorical devices, including a variety of visual puns – functioning as “visual etymologies.” The Portuguese codices are thus a befitting framing for the finger-counting images.

The nature of the problem required a multidisciplinary approach that benefitted from art history, latin, neuroscience, mathematics, computer science, and paleography.

## Resumo

Contagem digital em dois manuscritos gramaticais iluminados (sécs. XII – XIII)

Miguel José da Fontoura Müller da Cruz Fernandes

Palavras-chave: idade média; dactilonomia; Santa Cruz; Alcobaça; educação monástica; números; conhecimento corporizado; cultura visual; humanidades digitais; *De temporum ratione*; *De computo*; gramática; *computus*; memória; lexicografia; Beda; Rábano Mauro.

Na antiguidade Greco-Romana, desenvolveu-se um sofisticado sistema de contagem digital, o qual foi usado até à idade média. Este sistema permitia contar até grandes quantidades usando apenas os dedos. Nos inícios da idade média, este sistema deu origem a uma tradição pictórica que se prolongou por séculos: ao longo da idade média, circularam pela Europa, em grandes números, manuscritos iluminados com representações de gestos numéricos.

Não existem dúvidas de que os manuscritos iluminados com contagem digital transportavam consigo um grande peso cultural e intelectual, na idade média. Isto é evidente pela forma peculiar das suas imagens, pela ubiquidade do sistema digital na sociedade medieval, e pela difusão e dinamismo da tradição manuscrita. No entanto, esta tradição permanece ainda largamente inexplorada. Não só uma análise comparativa alargada está por fazer, como muitas fontes ainda não foram examinadas.

Esta dissertação analisa dois manuscritos gramaticais Portugueses pouco estudados, dos séculos XII-XIII. Apesar destes códices incluírem imagens de contagem digital – tipicamente associada à aritmética e à astronomia – eles são compilações gramaticais. Para adequadamente avaliar o aparente extravio, este estudo contextualiza os códices no panorama cultural e intelectual do monasticismo coevo Português e Europeu.

Tal como revela esta dissertação, o sistema digital era um *medium* polivalente que cruzava fronteiras entre disciplinas, e que era útil mesmo no ensino da gramática. Para além disso, as imagens de contagem digital estão impregnadas de dispositivos retóricos, incluindo uma série de trocadilhos visuais – funcionando como “etimologias visuais.” Os códices portugueses são, pois, um enquadramento adequado para estas imagens.

A natureza do problema em estudo requereu uma abordagem multidisciplinar, que beneficiou da história da arte, do latim, da neurociência, da matemática, da informática, e da paleografia.

## Contents

Introduction.....	1
1. Finger-counting to 1,000,000: the ancient finger system .....	4
1.1. Dactylonomy in antiquity.....	6
1.2. The finger system in detail.....	14
1.3. The finger system in the western middle ages .....	18
2. Numbers, letters, gestures, and images: dactylonomy illuminated manuscripts .....	28
2.1. A corpus of illuminated sources.....	29
2.2. From arithmetic to scripture.....	37
2.3. Lexicographical manuscripts.....	43
3. Framing Alc. 426 and Santa Cruz 8: the codices in their libraries .....	50
3.1. The libraries of Alcobaça and Santa Cruz.....	51
3.2. Lexicography in Alcobaça and Santa Cruz.....	57
3.3. The transmission of the Portuguese codices .....	66
4. <i>Mirabilis et intensa</i> : dactylonomy and the art of memory.....	75
4.1. Disparities in the Portuguese codices.....	76
4.2. The art of memory.....	82
4.3. Dactylonomy images as memory <i>loci</i> .....	88
4.4. Rhetorical ornaments in the dactylonomy images .....	93
Conclusion .....	104
References.....	107
Manuscript Sources .....	107
Edited Sources.....	109
Literature .....	113
Appendix A – <i>Romana computatio</i> .....	129
“Romana computatio” .....	129
1,000+ variant: Milan Ambrosiana H 150, and Oxford Bodleian ms. 309.....	129
1,000+ variant: London British Library Cotton Calig. A XV .....	130
Appendix B – Bede’s <i>De temporum ratione</i> .....	131
“I. De computo uel loquela digitorum” .....	131

Appendix C – Rabanus Maurus’s <i>De computo</i> .....	135
“I. De numerorum potentia”.....	135
“II. Unde dictus sit numerus”.....	136
“III. De speciebus numerorum diversis”.....	136
“IV. De numeri demonstratione”.....	137
“V. Quomodo numeri litteris notentur”.....	137
“VI. Quomodo digitis significantur”.....	138
“VII. De Grecorum notis ad numeros aptatis”.....	139
Appendix D – Transcription of <i>De computo</i> .....	140
Abbreviations.....	140
Text with variants.....	140
Appendix E – The Portuguese dactylonomy images.....	145

## Abbreviations

BAV	Biblioteca Apostolica Vaticana
BL	The British Library
BNF	Bibliothèque Nationale de France
BNP	Biblioteca Nacional de Portugal
BPMP	Biblioteca Pública Municipal do Porto
DC	<i>De computo</i>
DCLD	<i>De computo uel loquela digitorum</i>
DTR	<i>De temporum ratione</i>
FS	Finger System (Number-gestures system as described by Bede)
NCD	Normalized Compression Distance

## Introduction

Nowadays, few people can count higher than ten using their fingers. But there once existed a system of finger-gestures that allowed going all the way up to one million! In Greco-Roman antiquity and throughout the middle ages, people of all social strata and across a wide geography used this sophisticated system for counting, calculation, and communication.

Despite being abundantly documented by ancient sources, the earliest complete descriptions of the finger system only date from the early middle ages. They appear in treatises of *computus Paschalis*, a discipline that relates to arithmetic and astronomy, and whose main purpose was to accurately set the date of Easter. One of the most famous such treatises is the eighth century *De temporum ratione* by Bede the Venerable (ca. 673 – 735), which, either complete or fragmented, circulated widely across Europe over the centuries. Indeed, this treatise starts with a detailed description of the ancient finger system. That description was copied out of its original context many times throughout the middle ages, regularly accompanied by depictions of hands and/or human figures making gestures. It ended up spawning its own enduring textual and pictorial tradition.

Dozens of medieval European manuscripts with finger-counting images have been preserved. Following ancient rhetoric principles, these images accord to specific patterns. Their arrangement and ornamentation are meticulously designed and visually captivating, hinting at a more critical function than the merely representative. Indeed, these images do not aim at simply embellishing text – sometimes they accompany no text at all. Their function is performative: they demand a response from the viewer.

There is no doubt that, in the middle ages, finger-counting illuminated manuscripts carried a heavy cultural and intellectual weight. This is evident from the peculiar form of the images, the pervasiveness of the finger system in medieval society, and the diffusion and dynamism of the manuscript tradition. However, this tradition is still widely unexplored. Not only a broad comparative analysis is wanting, but many sources remain unexamined.

Two of the least studied illuminated finger-counting manuscripts are also two of the most interesting, as they use rhetorical ornamentation more heavily than their counterparts, including a variety of visual puns. Both were produced in Portugal, between the end of the twelfth and the beginning of the thirteenth century. One is originally from the Cistercian monastery of Santa Maria de Alcobaça and is today preserved at the Biblioteca Nacional de Portugal (codex Alc. 426); and the other one comes from the Regular Canons monastery of

Santa Cruz de Coimbra and is preserved at the Biblioteca Pública Municipal do Porto (codex Santa Cruz 8).<sup>1</sup> Except for a few cursory studies, these large codices have never been properly analysed.<sup>2</sup> They contain images of finger-counting (Appendix E), together with short excerpts of *computus* treatises. But their unifying subject is not *computus*, or mathematics, or any “quadrivial” art (arithmetic, geometry, music, astronomy). Instead, they are grammar compilations, with an emphasis on lexicography.

What is the function and relevance of the finger-counting images and the *computus* texts within such a grammar context? This dissertation aims at answering this question. To do that, it carries out a comparative study over a corpus of illuminated sources and contextualizes both codices in the intellectual and cultural framework of coeval Portuguese and European monasticism.

Chapter 1 of this dissertation surveys the development of finger-counting over time and space, its relevance, and its various purposes, from antiquity to the middle ages. Finger-counting was a polyvalent medium used in arithmetic, finance, and rhetoric, even if it slowly fell in disuse throughout the middle ages.

Chapter 2 tackles the pictorial medieval tradition of finger-counting, by examining a collection of illuminated sources with similar characteristics. Not only it becomes clear that gestures and numbers are tightly linked, but these are also found in a wide variety of contexts, spreading from *computus* to exegesis and lexicography.

Chapter 3 explores the Portuguese manuscripts in the context of their monastic libraries and in the medieval lexicography tradition. These codices are shown to be witnesses of the important book-technology advances, such as alphabetical arrangement and cross-referencing. An excerpt of a *computus* treatise is given particular consideration and found out to be a fitting element in Alc. 426 and Santa Cruz 8.

---

<sup>1</sup> On codex Santa Cruz 8 see the catalogue: Aires Augusto Nascimento and José Francisco Meirinhos, ed., *Catálogo dos códices da Livraria de mão do Mosteiro de Santa Cruz de Coimbra na Biblioteca Pública Municipal do Porto* (Porto: Biblioteca Pública Municipal do Porto, 1997), 75-77. About codex Alc. 426, see the two catalogues: Thomas L. Amos, *The Fundo Alcobaça of the Biblioteca Nacional, Lisbon, Vol. III: Manuscripts 302-456 [and] Museu Nacional de Arte Antiga* (Collegeville, MN: Monastic Manuscript Microfilm Library, 1990), <http://archive.org/details/HMMLAlcobaca3> (accessed October 11, 2020), 199-202; *Inventário Dos Códices Alcobacenses*, 5 vols (Lisbon: Biblioteca Nacional, 1930-1978), 401-403.

<sup>2</sup> Maria Coutinho has carried two perfunctory comparative studies on these codices: “De computo de Rábano Mauro. O texto e as iluminuras do Santa Cruz 8 e do Alc. 426,” *Medievalista online* 15 (March 2014): 26-27, <https://doi.org/10.4000/medievalista.301>; “Dispositivos Visuais, Ordenação e Memorização. Breve Comentário Às Iniciais, Diagramas e Ao Loquela Dígitorum Dos Alc. 424 a 426,” in *Luz, Cor e Ouro. Estudos Sobre Manuscritos Iluminados*, edited by Catarina Fernandes Barreira (Lisboa: Biblioteca Nacional de Portugal, 2016), 65–88. The manuscripts are mentioned in other books and papers, but never with significant detail.

Chapter 4 is dedicated to the medieval images of finger-counting and how they use rhetorical ornaments. Expertly crafted mnemonic devices are uncovered across several illuminated sources, especially in the Portuguese manuscripts. The way in which these images combine semantic and formal features is visually analogous to how medieval verbal etymologies played with words.

The goal of this dissertation is not merely to fill in gaps and limitations of previous scholarly literature. Instead, it aims at providing novel interpretations of a variety of material and textual sources, by employing a multidisciplinary approach that benefits from art history, latin, ethnography, computer science, mathematics, and palaeography.

The relevance of this research topic extends far beyond the Portuguese codices. The present study intends to shed light onto the ubiquity of numeracy in medieval society, as well as monastic educational practices. Furthermore, it hopes to provide contributions for the study of media and books, medieval intellectual models, visual culture, and embodied knowledge.<sup>3</sup>

---

<sup>3</sup> “Embodied knowledge is a type of knowledge where the body knows how to act (e.g., how to touch type, how to ride a bicycle, etc.). One of the important features of this knowledge is that the body, not the mind, is the knowing subject.” Shogo Tanaka, “The notion of embodied knowledge,” in *Theoretical psychology: Global transformations and challenges*, edited by P. Stenner, J. Cromby, J. Motzkau, J. Yen, and Y. Haosheng (Concord, Canada: Captus Press, 2011), 149. See also: Marie Louise Stig Sorensen, and Katharina Rebay-Salisbury, ed., *Embodied Knowledge: Historical Perspectives on Belief and Technology* (Oxford: Oxbow Books, 2012).

## 1. Finger-counting to 1,000,000: the ancient finger system

For in numbers whatever comes to pass on the fingers while computing correctly, that without doubt must follow also in the things themselves.

Boethius (d. 524), *Commentaria in Porphyrium*<sup>4</sup>

For tens of thousands of years, human beings have used their fingers to count.<sup>5</sup> The universal cultural weight of dactylonomy – the practice of counting with fingers – can be attested by merely looking at the number-words of a variety of languages, across the world. In Zulu, “six” is translated as “*eziyisithupha*,” which means “take the thumb,” indicating that all the fingers in the one hand have already been counted and one must start with the thumb of the other hand.<sup>6</sup> Following a similar logic, the Dene-Dinje, a native American tribe, uses an expressive number-word scheme, where 5 translates to “my hand is finished,” and 10 to “my hands are dead.”<sup>7</sup> Even the English and Catalan word “*digit*,” and the Portuguese and Spanish word “*dígito*” – for numbers between 0 and 9 – originate from the Latin word “*digitus*,” for “finger.”<sup>8</sup>

As tetrapods and pentadactyls, that is, animals with four limbs and five fingers per limb, humans have recurrently found in dactylonomy a most functional technology for keeping track of high amounts. But across time and space, there has been some variation in finger-counting strategies: in the Middle East, individuals tend to begin counting with the left hand, whereas in

---

<sup>4</sup> “In numeris enim quicquid in digitis recte computantis eueniret, id sine dubio in res quoque ipsas necesse est euenire.” Boethius, *Commentaria in Porphyrium A Se Translatum* 1.2. Latin and English text taken from: Burma P. Williams and Richard S. Williams, “Finger Numbers in the Greco-Roman World and the Early Middle Ages,” *Isis* 86:4 (1995): 598, <https://doi.org/10.1086/357319>.

<sup>5</sup> Karenleigh Overmann studied the 27,000 years-old hand-signs found in the caves of Cosquer (Figure 1) and Gargas, compared them with modern finger-counting routines around the world, concluding that they all follow a cross-cultural pattern. See: Karenleigh A. Overmann, “Finger-counting in the Upper Palaeolithic,” *Rock Art Research* 31 (2014): 63–80.

<sup>6</sup> Claudia Zaslavsky, *Africa Counts: Number and Pattern in African Cultures*, 3<sup>rd</sup> ed (Chicago, Ill: Lawrence Hill Books, 1999), 37. Besides the Zulu, writes Zaslavsky, “there are many African societies in which the finger gestures have equal status with the spoken numerals and constitute a proper system of numeration which may or may not agree with the spoken number words in its derivation.”

<sup>7</sup> Likewise, 15 translates to “my hands are dead and one foot is dead,” and 20 to “a man dies.” Karl Menninger, *Number Words and Number Symbols: A Cultural History of Numbers*, transl. Paul Broneer (New York: Dover Publications, 1992), 35-36. Menninger provides a selection of finger-based number-words. One of the most interesting is that used by a tribe of Papuans: “some statements of numbers thus sound very strange. In translating the Bible for one tribe of Papuans, the passage (John 5: 5): ‘And a certain man was there, which had an infirmity thirty and eight years’ had to be expressed as ‘a man lay ill one man (20), both sides (10), 5 and 3.’ Even more picturesque is the expression for the number 99 in British New Guinea: ‘four men die (80), two hands come to an end (10), one foot ends (5), and 4.’”

<sup>8</sup> *Cassell's New Latin Dictionary*, 5th ed. (New York: Houghton Mifflin Harcourt, 1968), s.v. “Digitus.”

Western Europe people are more prone to start with the right; in Eastern Asia, fingers are usually bent as numbers are incremented, while in North America fingers tend to be stretched; some societies attribute the unity to the thumb, while others to the index finger.<sup>9</sup> But despite all this variability, most dactylonomy routines follow a pattern that consists of a one-to-one mapping between each integer number from 1 to 10 and some hand-gesture, incrementally defined, where each finger is worth 1.<sup>10</sup>



Figure 1. Three hand stencils in the Cosquer cave. Photography by Luc Vanrell, 2005.

Evidently, these simple dactylonomy systems do not take full advantage of the human hands. They are actually visual representations of the first positive integers in the unary numeral system, a number notation that uses but one symbol for all numbers, thus:

Dec.	Unary	Dec.	Unary	Dec.	Unary
2	11	5	11111	8	11111111
3	111	6	111111	9	111111111
4	1111	7	1111111	10	1111111111

<sup>9</sup> John Barrow provides a world map displaying the geographical distribution of finger-counting routines according to a number of variables, such as the finger that denotes 1; whether or not knuckles are used for counting; whether or not body parts other than the fingers are used. See: John D. Barrow, *Pi in the Sky: Counting, Thinking, and Being*, 1st ed (Boston: Little, Brown, and Company, 1996), 45-49. See also an ethnographic overview in K. A. Overmann, “Finger-counting in the Upper Palaeolithic”, 69-76; and the survey: Mateusz Hohol et al., “A Large-Scale Survey on Finger Counting Routines, Their Temporal Stability and Flexibility in Educated Adults,” *PeerJ* 6 (October 31, 2018): e5878, <https://doi.org/10.7717/peerj.5878>.

<sup>10</sup> Recent studies have looked into both the similarities and differences between dactylonomy schemes in different societies. One often-put question is the extent to which finger-counting-direction depends on reading-direction. Surprisingly or not, the data so far seems to indicate a relative level of independence between both variables. See: Martin H. Fischer, and Peter Brugger, “When Digits Help Digits: Spatial–Numerical Associations Point to Finger Counting as Prime Example of Embodied Cognition,” *Frontiers in Psychology* 2 (2011), <https://doi.org/10.3389/fpsyg.2011.00260>. Oliver Lindemann, Ahmad Alipour, and Martin H. Fischer, “Finger Counting Habits in Middle Eastern and Western Individuals: An Online Survey,” *Journal of Cross-Cultural Psychology* 42:4 (2011): 566–78. <https://doi.org/10.1177/0022022111406254>.

But the human hand allows for a lot more variation. Indeed, stronger dactylonomy systems have been conceived: for example, the Chinsanbop method enables counting from 0 to 99 using nothing but the fingers, and the binary finger-counting system allows counting to 1024, by mapping the fingers to the binary numbers.<sup>11</sup> Yet, however powerful they might appear to be, these methods still fall short of the amazing capabilities of the human hands. Moreover, they have only been developed in the twentieth century, and never reached widespread reception. Their acceptance and stability, both spatial and temporal, and their potential as a counting, reckoning, and communication technology, all pale in comparison to a far older and far more powerful dactylonomy method: the sophisticated finger system (henceforth, FS) that was used in Roman antiquity and kept being used in Europe throughout the middle ages, and that comprehended finger-gestures for numbers all the way up to 1,000,000.<sup>12</sup>

### 1.1. Dactylonomy in antiquity

The written and material evidence from Greek and Roman antiquity mentioning dactylonomy is abundant. Even if providing no explicit information on the number-gestures scheme in use, the earliest ancient witnesses present number-gestures as a powerful tool whose functionality surpasses mere counting.

Herodotus (ca. 484 – ca. 425 BC), for instance, tells the story of how Ariston rejected the paternity of Demaratus, because “in a shorter time than the full ten months his wife bore him a child (...) Knowing the time of his marriage, he reckoned the months on his fingers and said, with an oath, ‘The boy cannot be mine.’” (*The Histories* 6.63).<sup>13</sup> Here Herodotus is already employing dactylonomy in what would become one of its most common applications:

---

<sup>11</sup> The Chinsanbop method was created with a clear didactic purpose and is still used in classrooms. Hang Young Pai, *The Complete Book of Chinsanbop: Original Finger Calculation Method Created by Sung Jin Pai and Hang Young Pai*, ed. John Leonard (New York: Van Nostrand Reinhold Co., 1981).

<sup>12</sup> The actual origin of this system is obscure. Jean Gabriel Lemoine hypothesises that it was born in the southwest of Asia. However, he does not provide enough convincing evidence: “(...) paraît né dans le Sud-Ouest de l’Asie. Il pourrait bien avoir été inventé par les Sumériens et pour l’usage de leurs comptes astronomiques. En tous cas, il a été véhiculé en Occident en même temps que le comput de l’année solaire. On le rencontre en Égypte à l’époque romaine, mais il paraît avoir été commun dans toute la Méditerranée à une époque antérieure.” J. G. Lemoine, “Les anciens procédés de calcul sur les doigts en Orient et en Occident,” *Revue des Etudes Islamiques* 6 (1932):55.

<sup>13</sup> “ἐν δὲ οἱ χρόνων ἐλάσσονι καὶ οὐ πληρώσασα τοὺς δέκα μῆνας ἡ γυνὴ αὕτη τίκτει τοῦτον δὴ τὸν Δημάρητον. καὶ τίς οἱ τῶν οἰκετέων ἐν θόκῳ κατημένῳ μετὰ τῶν ἐφόρων ἐξαγγέλλει ὡς οἱ παῖς γέγονε. ὁ δὲ ἐπιστάμενός τε τὸν χρόνον τῷ ἡγάγετο τὴν γυναῖκα καὶ ἐπὶ δακτύλων συμβαλλόμενος τοὺς μῆνας, εἶπε ἁπομόσας Ὀὐκ ἂν ἐμὸς εἴη.” Herodotus, *The Persian Wars, Volume I: Books 1-2*, translated by A. D. Godley, Loeb Classical Library 117 (Cambridge, MA: Harvard University Press, 1920), 211, [https://doi.org/10.4159/DLCL.herodotus-persian\\_wars.1920](https://doi.org/10.4159/DLCL.herodotus-persian_wars.1920).

the reckoning of time.<sup>14</sup> Another early source witnessing the practice of dactylonomy in Greek antiquity is the *Wasps*, by Aristophanes (ca. 446 – ca. 386 BC), where Bdelycleon tells Philocleon: “first of all, calculate roughly, not with counters but on your fingers, how much tribute we receive altogether from the allied cities” (*Wasps* 655).<sup>15</sup> In this passage, the practical use of dactylonomy is financial reckoning, another of its typical applications. Also witnessing the use of dactylonomy for financial reckoning, centuries later, Cicero (106 – 43 BC) tells Atticus the capitalist that, knowing his fingers (*si tuos digitos novi*), he has certainly computed the difference between simple and compound interest.<sup>16</sup> Once again, there is no clue on the specific number-gesture scheme, but fingers are presented as a fundamental aid to trade.

In recent decades, the commercial facet of dactylonomy has been subject of special recognition, as a variety of ancient reliefs depicting number-gestures in scenes of accounting and commerce came to light.<sup>17</sup> Among them is the famous Isernia relief, exhibiting two figures with their right hands extended, accompanied by an inscription describing an exchange of goods (Figure 2).<sup>18</sup>

---

<sup>14</sup> The counting of sun and moon cycles is indeed one of the earliest applications of dactylonomy. After Herodotus, one finds multiple instances in literature throughout the centuries, such as the one narrated by Nonnos of Pannopolis (5<sup>th</sup> century AD), in *Dyonisiaca*, who tells the story of how Astraeus predicted the future of Demeter’s daughter Persephone: “he learnt the details of the day when her only child was new born, and the exact time and veritable course of the season which gave her birth; then he bent the turning fingers of his hands and measured the moving circle of the ever-recurring number counting from hand to hand in double exchange.” With the development of the *computus Paschalis*, in the early middle ages, this tradition was carried on and enriched. See: Nonnos, *Dionysiaca, Volume I: Books 1-15*, translated by W. H. D. Rouse, Loeb Classical Library 344 (Cambridge, MA: Harvard University Press, 1940), 219, <https://doi.org/10.4159/DLCL.nonnos-dionysiaca.1940>.

<sup>15</sup> “καὶ πρῶτον μὲν λόγισαι φαύλως, μὴ ψήφοις ἀλλ’ ἀπὸ χειρός, τὸν φόρον ἡμῖν ἀπὸ τῶν πόλεων συλλήβδην τὸν προσιόντα.” Aristophanes, *Clouds. Wasps. Peace*, edited and translated by Jeffrey Henderson, Loeb Classical Library 488 (Cambridge, MA: Harvard University Press, 1998), 304-305, <https://doi.org/10.4159/DLCL.aristophanes-wasps.1998>.

<sup>16</sup> “Hoc quid intersit, si tuos digitos novi, certe habes subductum.” Cicero, *Letters to Atticus, Volume II*, edited and translated by D. R. Shackleton Bailey, Loeb Classical Library 8 (Cambridge, MA: Harvard University Press, 1999), 102-103 (5.21.13), [https://doi.org/10.4159/DLCL.marcus\\_tullius\\_cicero-letters\\_atticus.1999](https://doi.org/10.4159/DLCL.marcus_tullius_cicero-letters_atticus.1999).

<sup>17</sup> Gérard Minaud analyses a selection of such reliefs in his paper “Des doigts pour le dire. Le comput digital et ses symboles dans l’iconographie romaine,” *Histoire & mesure* XXI:1 (2006): 3–34, <https://doi.org/10.4000/histoiremesure.1534>.

<sup>18</sup> Pierre Flobert reconstructed the inscription over the relief as follows: “L(ucius) Calidus Eroticus sibi et Fanniae Voluptati u(iuus) f(ecit). / – Copo computemus! / – Habes uini s(extarium) unum. Pani(s) : a(ss)e uno. Pulmentar(ium): a(ssibus) duobus. / – Conuenit. / – Puell(a) : a(ssibus) octo. / – Et hoc conuenit. / – Faenum mulo : a(ssibus) duobus. / – Iste mulus me ad factum dabit.” See: Pierre Flobert, “À propos de l’inscription d’Isernia,” *Mélanges de littérature et d’épigraphie latines, d’histoire ancienne et d’archéologie: hommage à la mémoire de Pierre Willeumier* (Paris: Les Belles Lettres, 1980), 121-128. On the Isernia relief, see also: G. Minaud, “Des doigts,” 7-9; Sylvia Diebner, *Aesernia-Venafrum: Untersuchungen Zu Den Römischen Steindenkmälern Zweier Landstädte Mittelitaliens*, *Archaeologica* 8 (Roma: G. Bretschneider, 1979).



Figure 2. Isernia relief, Paris, Musée du Louvre, Ma 3165. Photography by Hervé Lewandowski, 1992.

Many of the ancient sources offer more concrete information about the number-gesture scheme in use. It is the case of Plutarch (AD 46 – after 119), in *Moralia* (174b) where he tells of how Orontes once said that “as mathematicians’ fingers are able to represent tens of thousands at one time, and at another time only units, so it was the same with the friends of kings: at one time they are omnipotent and at another time almost impotent.”<sup>19</sup> Plutarch sets the range from 1 to 10,000, which is highly significant, as early medieval sources will indicate precisely the same range, in line with the same tradition.<sup>20</sup> Equally suggestive are the passages of Pliny the Elder (AD 23/24 – 79) and, later, Macrobius (fl. ca. AD 400), mentioning a statue of Janus holding the number 365 on its hands, with 300 on the right and 65 on the left.<sup>21</sup> Again, no explicit gesture is provided, but the fact that the units and tens are depicted on the left hand and the hundreds on the right is again coherent with medieval sources, evidencing a high level of continuity across the centuries.

---

<sup>19</sup> “Καθηάπερ οἱ τῶν ἀριθμητικῶν δάκτυλοι νῦν μὲν μυριάδας νῦν δὲ μονάδας τιθέναι δύνανται, τὸ αὐτὸ καὶ τοὺς τῶν βασιλέων φίλους, νῦν μὲν τὸ πᾶν δύνασθαι νῦν δὲ τὸλάχιστον.” Plutarch, *Moralia, Volume III: Sayings of Kings and Commanders. Sayings of Romans. Sayings of Spartans. The Ancient Customs of the Spartans. Sayings of Spartan Women. Bravery of Women*, translated by Frank Cole Babbitt, Loeb Classical Library 245 (Cambridge, MA: Harvard University Press, 1931), 20-23, [https://doi.org/10.4159/DLCL.plutarch-moralia\\_sayings\\_kings\\_commanders.1931](https://doi.org/10.4159/DLCL.plutarch-moralia_sayings_kings_commanders.1931).

<sup>20</sup> See: Marrou, “L’Évangile de vérité,” 333.

<sup>21</sup> “Praeterea Ianus geminus a Numa rege dicatus, qui pacis bellique argumento colitur digitis ita figuratis, ut cccclv diorum nota et aevi esse deum indicent.” Pliny, *Natural History, Volume IX: Books 33-35*, translated by H. Rackham, Loeb Classical Library 394 (Cambridge, MA: Harvard University Press, 1952), 152-153 (34.16), [https://doi.org/10.4159/DLCL.pliny\\_elder-natural\\_history.1938](https://doi.org/10.4159/DLCL.pliny_elder-natural_history.1938). “Inde et simulacrum eius plerumque fingitur manu dextera trecentorum et sinistra sexaginta et quinque numerum tenens ad demonstrandam anni dimensionem, quae praecipua est solis potestas.” Macrobius, *Saturnalia, Volume I: Books 1-2*, edited and translated by Robert A. Kaster, Loeb Classical Library 510 (Cambridge, MA: Harvard University Press, 2011), 94-95 (1.9.10), <https://doi.org/10.4159/DLCL.macrobius-saturnalia.2011>.

Oftentimes, the ancient witnesses of dactylonomy are more explicit than Plutarch and Pliny. One such example is a passage from the *Apologia* by Apuleius of Madaura (ca. 124 – ca. 170), where he makes a long speech defending his wife Pudentilla, explaining that she is forty years old, instead of sixty. In this passage, he gets to describe the gestures for 10, 30, and 40 (*Apologia* 89):

If you had said thirty years instead of ten, one might think you had made the wrong gesture in calculating, and that you had spread your fingers when you should have made a circle of them. But since the sign for forty is an open palm, an easier one than for other numbers, and you are adding half forty to forty, you cannot have mistaken the position of the fingers, unless perhaps you thought Pudentilla was thirty, and counted both consuls for each year.<sup>22</sup>

But the most telling piece of evidence from antiquity with information on dactylonomy is a large number of Roman game counters, or *tesserae*: circular coin-like objects made of bone or ivory, with depictions of hands in their obverses and numerals on their reverses, made since the first century BC in Alexandria (Figure 3).<sup>23</sup> So far, there have been found examples for all numbers between 1 and 15 except 11, and the images in their obverses are all coherent with medieval descriptions, with the exception of number 6.<sup>24</sup> The observed consistency between the *tesserae* and western medieval sources is a fascinating result, because it means that the FS

---

<sup>22</sup> “Si triginta annos pro decem dixisses, posses uideri computationis gestu errasse, quos circulare debueris digitos aperuisse. Cum uero quadraginta, quae facilius ceteris porrecta palma significantur, ea quadraginta tu dimidio auges, non potes digitorum gestu errasse, nisi forte triginta annorum Pudentillam ratus binos cuiusque anni consules numerasti.” Apuleius, *Apologia. Florida. De Deo Socratis*, edited and translated by Christopher P. Jones, Loeb Classical Library 534 (Cambridge, MA: Harvard University Press, 2017), 208-209, <https://doi.org/10.4159/DLCL.apuleius-apologia.2017>.

<sup>23</sup> On this topic, see the studies by Elisabeth Alföldi-Rosenbaum: “The Finger Calculus in Antiquity and in the Middle Ages Studies on Roman Game Counters I,” *Frühmittelalterliche Studien* 5:1 (2010): 1–9, <https://doi.org/10.1515/9783110242058.1>; *Characters and caricatures on game counters from Alexandria*, Studies on Roman counters 5 (Bretschneider, 1984). See also: Wilhelm Froehner, “Le Comput Digital,” *Annuaire de la Société française de numismatique et d’archéologie* 8 (1884): 232–38.

<sup>24</sup> The *tesserae* gesture for 6 is simply to keep the first three fingers (small, ring, medium) erect. Since there is more than one such *tessera*, it is unlikely that these finger representations are mistaken. See: Alföldi-Rosenbaum, “The Finger Calculus,” 7. This particular number-gesture must belong to a different tradition than the one that lasted until medieval times – to bend the ring finger and keeo the others stretched – consistent with Macrobius’s account, around the fifth century AD: “*complicatus enim senarium numerum digitus iste demonstrat, qui omnifariam plenus perfectus atque diuinus est.*” Macrobius, *Saturnalia*, Volume III: Books 6-7, edited and translated by Robert A. Kaster, Loeb Classical Library 510 (Cambridge, MA: Harvard University Press, 2011), 266-267 (7.13.9-10), <https://doi.org/10.4159/DLCL.macrobius-saturnalia.2011>.

must have achieved a high degree of stability and widespread, in order to successfully cross so many centuries and miles of distance, almost intact.<sup>25</sup>



Figure 3. *Tesserae*, ivory, approximately 3cm in diameter. From left to right: obverse: 4-gesture (Paris, Cabinet des Médailles, Froehner.320) / reverse: “IV” (Paris, Cabinet des Médailles, Froehner.320) / obverse: 7-gesture (Paris, Cabinet des Médailles, Froehner.317) / reverse: “VII” (Paris, Cabinet des Médailles, Froehner.317).

Going through all the ancient written and material evidence, there is no doubt that, over the course of Greek and Roman antiquity, the FS ended up spreading all across the Mediterranean Basin and beyond.<sup>26</sup> To explain this level of diffusion and stability, it has been argued that dactylonomy in the Roman empire was employed as a global trade language, since Latin and barbarian merchants alike would understand number-gestures even if they did not speak the same language.<sup>27</sup> However, this hypothesis contradicts the extant dactylonomy literary evidence, which, although wealthy in contexts and spreading across a wide chronology, contains no instance of communication between speakers of different languages.<sup>28</sup> Instead, ancient dactylonomy was likely used in two ways: “first, finger numbers became and remained an integral part of arithmetical computation. Second, finger numbers provided clarity of

---

<sup>25</sup> Alföldi-Rosenbaum states that “there are few cases in which the direct continuity between Antiquity and the Middle Ages is so clearly demonstrable as here.” “The Finger Calculus,” 9.

<sup>26</sup> Lemoine compared an Arabic dactylonomy text with the medieval records of the FS, and noticed that they are almost the same, the only significant difference being that the hands are reversed. See: J. G. Lemoine, “Les anciens procédés de calcul”. On Arabic dactylonomy, see also: Julius Ruska, “Arabische Texte über das Fingerrechnen,” *Der Islam* 10:1/2 (1924): 87-119. On the Oriental origin of the Roman system, see also: Henri-Irénée Marrou, “L’évangile de vérité et la diffusion du comput digital dans l’antiquité,” *Vigiliae Christianae* 12:1 (1958): 98–103.

<sup>27</sup> Karl Menninger, *Number Words*, 212.

<sup>28</sup> Burma P. Williams and Richard S. Williams “do not believe that multilanguage trade accounts for the use and continuity of this system; the extant sources do not support such a conclusion, nor does the reality of ancient commerce.” They list a number of ancient and early medieval examples. “In none of these cases is there any indication that finger numbers were being used to overcome language barriers.” Furthermore, they argue that language, with or without finger-numbers, was essential for commerce since trade required a more complex system of communication than the FS. Furthermore, not only were there international trade languages such as Aramaic, Koine Greek, and Latin, as merchants could acquire a translator slave, if they chose to. See: Williams and Williams, “Finger Numbers,” 593-594.

communication in everyday situations where noise, confusion, or distance made vocal communication difficult.”<sup>29</sup>

This twofold usage of dactylonomy is attested by Quintilian (ca. AD 35 – ca. AD 100), in his *Institutio Oratoria*, when he emphasizes the importance of the knowledge of numbers for oratory (1.10.35):

Knowledge of numbers is essential not only to the orator, but to anyone who has had even a basic education. It is indeed very frequently involved in actual cases. There the speaker is thought an ignoramus, I will not say if he hesitates in adding up, but if he contradicts his calculations by shaky and inappropriate movements with his fingers.<sup>30</sup>

Indeed, dactylonomy is shown as an ambivalent technique. For one, there is an unquestionable link between finger calculation and “knowledge of numbers,” as if numbers and their gestures were inalienable. Furthermore, Quintilian presents dactylonomy as a means of communication, not as a substitute for spoken language, but as *actio*, the delivery of speech, one of the five canons of rhetoric – the others being invention (*inventio*), arrangement (*dispositio*), style (*elocutio*), and memory (*memoria*).<sup>31</sup>

The use of dactylonomy as an aid to oratory becomes more evident than ever in the works of Augustine (354 – 430), who often uses the FS in his texts. He does so in his sermon on the second miraculous catch of fish, a Gospel episode in which the apostles catch 153 large fish, after Jesus tells them to throw their nets to the sea (John 21:1-14). Augustine discourses about the importance of the law, signified by the ten commandments, and of the spirit, signified by the seven gifts of the Holy Spirit, and that a Christian needs both law and spirit in alliance,

---

<sup>29</sup> Williams and Williams, “Finger Numbers,” 593-594.

<sup>30</sup> “Nam cum sit geometria divisa in numeros atque formas, numerorum guide in notitia non oratori modo, sed cuicunque saltern primis litteris erudito necessaria est. In causis vero vel frequentissime versari solet; in quibus actor, non dico, si circa summas trepidat, sed si digitorum saltern incerto aut indecoro gestu a computatione dissentit, iudicatur indoctus.” Quintilian, *The Orator's Education, Volume I: Books 1–2*, edited and translated by Donald A. Russell, Loeb Classical Library 124 (Cambridge, MA: Harvard University Press, 2002), 230-231, [https://doi.org/10.4159/DLCL.quintilian-orators\\_education.2002](https://doi.org/10.4159/DLCL.quintilian-orators_education.2002).

<sup>31</sup> Quintilian also lists a series of gestures to be used specifically for oratory, not FS gestures, in book 11, chapter 3 of the *Institutio oratoria*. See: Jon Hall, “Cicero and Quintilian on the Oratorical Use of Hand Gestures,” *The Classical Quarterly* 2, 54:1 (May 2004):143-160. On the relationship between the FS and *actio* see: Moritz Wedell, “Actio - loquela digitorum - computatio: Zur Frage nach dem numerus zwischen Ordnungsangeboten, Gebrauchsformen und Erfahrungsmodalitäten,” in *Was zählt: Ordnungsangebote, Gebrauchsformen und Erfahrungsmodalitäten des 'numerus' im Mittelalter*, edited by Moritz Wedell and Hermann von Helmholtz-Zentrum, (Köln: Böhlau, 2012), 15–63; Antonio Quacquarelli, “Ai Margini Dell’actio: La Loquela Digitorum (La Rappresentazione Dei Numeri Con La Flessione Delle Dita in Un Prontuario Trasmesso Dal Beda),” *Vetera Christianorum* 7 (1970): 199–224.

giving the sum:  $10 + 7 = 17$ . Hence, seventeen is the number to strive for. After that, like in a magic trick, Augustine sums all numbers from 1 to 17, and obtains 153 – the number of fish caught by the apostles:

From one to four equals ten, if you but add them up. Let two follow one: add and now they are three; let three follow two; then they are six; let four follow after three; then they are ten. Why do I interrupt myself? I am speaking what you know. Add the rest of the numbers and you will arrive. When you have reached seventeen, you will arrive, by increasing, at one hundred fifty-three. What is "by increasing"? By advancing in such steps you will reach the right hand. Obey me, calculate for yourselves.<sup>32</sup>

The episode of the second miraculous catch of fish is one of the few in the gospels with an explicit number written down – others include the parable of the lost sheep and the multiplications of the loaves and fish.<sup>33</sup> When commenting passages such as these, fathers of the Church recurrently use dactylogy as *enargeia* (ἐνάργεια), a rhetorical ornament that evokes the visual and gives vividness to the message, because, in Quintilian's words, "it is a great virtue to express our subject clearly and in such a way that it seems to be actually seen."<sup>34</sup>

A notable instance of dactylogy used as *enargeia* is Jerome's (ca. 345 – 420) commentary on the parable of the farmer that sowed his seed on the path, the rock, the thorns,

---

<sup>32</sup> "Ab uno usque ad quatuor decem sunt: sed si omnes addas. Unum sequantur duo: adde et duo jam tria sunt: post duo sequantur tria, jam sex sunt: post tria sequantur quatuor, jam decem sunt. quid me rumpo? Quod nostis loquor. Addite caeteros numeros, et pervenietis. Cum perveneritis ad decem et septem, ad centum et quinquaginta et tres crescendo pervenietis. Quid est crescendo? Proficiendo tanquam gradatim pervenietis ad dexteram. Obedite nobis, computate vobis." Augustine, *Sermones* 249.3. Translation taken from Williams and Williams, "Finger Numbers," 597. On this sermon, Edward A. Bechtel remarks that in "the congregation of this North African church, composed mainly of persons in humble circumstances and apparently with rather slight educational advantages, there were many who were able to perform rapidly on their fingers this calculation." Indeed, dactylogy was not just for the literate class, but crossed different social strata. Edward A. Bechtel, "Finger-Counting among the Romans in the Fourth Century," *Classical Philology* 4: 1 (1909): 26–28, <https://doi.org/10.1086/359239>.

<sup>33</sup> The parable of the lost sheep, in which a shepherd loses 1 of his 100 sheep, and leaves the remaining 99 to search for it, appears in Matthew 18:12–14 and Luke 15:3–7. The first multiplication, where 5,000 people, in groups of 50 and 100, are fed with 5 loaves and 2 fish, appears in Matthew 14:13–21, Mark 6:31–44, Luke 9:12–17, and John 6:1–14; the second multiplication, where 4,000 men plus women and children are fed with just 7 loaves and some small fish, appears in Matthew 15:32–39, and Mark 8:1–9.

<sup>34</sup> "Itaque ἐνάργειαν, cuius in praeceptis narrationis feci mentionem, quia plus est evidentia vel, ut alii dicunt, repraesentatio quam perspicuitas, et illud patet, hoc se quodam modo ostendit, inter ornamenta ponamus. Magna virtus res de quibus loquimur clare atque ut cerni videantur enuntiare. Non enim satis efficit neque, ut debet, plene dominatur oratio si usque ad aures valet, atque ea sibi iudex de quibus cognoscit narrari credit, non exprimi et oculis mentis ostendi." Quintilian, *The Orator's Education, Volume III: Books 6–8*, edited and translated by Donald A. Russell, Loeb Classical Library 126 (Cambridge, MA: Harvard University Press, 2002), 274–375 (8.3.61–63), [https://doi.org/10.4159/DLCL.quintilian-orators\\_education.2002](https://doi.org/10.4159/DLCL.quintilian-orators_education.2002).

and on good soil, the latter producing thirty-fold, sixty-fold, and a hundred-fold (Mark 4:20 and Matt 13:8).<sup>35</sup> The gestures presented along the text indeed bring Jerome's case before the reader's eyes:

Thirty refers to marriage: for the very joining of the fingers, as if embracing each other in a tender kiss and uniting, depicts husband and wife. Sixty indeed refers to widows, because they are placed in distress and affliction. Whence also is pressed down by the superior finger; the greater the difficulty of abstaining from the enticements of pleasure once experienced, so much the greater is the reward. Next, the number one hundred (please attend carefully, reader) is transferred from the left hand to the right and, to be sure with the same fingers but not the same hand on which are signified brides and widows, making a circle, portrays the crown of virginity.<sup>36</sup>

The number-gestures give the text a multi-sensory dimension – not just visual but also tactile. This was a highly desirable rhetorical effect. In order to turn the message truly memorable, *enargeia* should go beyond the visual sense.<sup>37</sup> And Jerome achieves an effective synesthetic impression, helping the reader/listener to firmly grasp the mind to the object.

Jerome and Augustine seem to play with dactylonomy in a somewhat bizarre way. They are not using the fingers to count nor to compute. They evoke the famous words by Abraham Maslow “I suppose it is tempting, if the only tool you have is a hammer, to treat everything as if it were a nail.”<sup>38</sup> In a society where dactylonomy was omnipresent, one could not help oneself

---

<sup>35</sup> On the varied tradition of the interpretations of this passage see: Antonio Quacquarelli, *Il triplice frutto della vita cristiana: 100, 60 e 30 (Matteo XIII-8, nelle diverse interpretazioni)* (Bari: Edipuglia, 1953).

<sup>36</sup> “Triginta referuntur ad nuptias. Nam et ipsa digitorum conjunctio quasi molli se complexans osculo, et foederans, maritum pingit et conjugem. Sexaginta vero ad viduas, eo quod in angustia et tribulatione sunt positae. Unde et superiori digito deprimuntur; quantoque major est difficultas expertae quondam voluptatis illecebris abstinere, tanto majus est praemium. Porro centesimus numerus (diligenter, quaeso, lector, attende) de sinistratransfertur ad dexteram, et iisdem quidem digitis, sed non eum manu, quibus in laeva nuptiae significantur et viduae, circulum faciens, exprimit virginitatis coronam.” Jerome, *Adversus iovinianum* 1.3. Latin and English text in: Williams and Williams, “Finger Numbers,” 599.

<sup>37</sup> “*Enargeia* addresses not just the eyes, but all the senses. It is easy to forget this when we read rhetoric texts, because the emphasis is so much on the visual sense. But the visual leads on to and is accompanied by an arrangement of all the other senses in a meticulous crafted fiction.” Mary Carruthers, *The Craft of Thought: Meditation, Rhetoric, and the Making of Images, 400-1200*, Cambridge Studies in Medieval Literature 34 (Cambridge: Cambridge University Press, 2008), 132.

<sup>38</sup> Abraham Harold Maslow, *The Psychology of Science: A Reconnaissance*, John Dewey lecture 8 (New York: Harper & Row, 1966), 15.

from applying it to all sorts of uses, even outside counting and computing. More than that, it is noticeable how the effects of dactylonomy tended to be “reversed.”<sup>39</sup>

That is what the fathers of the church accomplished with the FS: they reversed the original purpose of dactylonomy. Dactylonomy used to take “things,” count them, and transform them into abstract, mental objects.<sup>40</sup> But here, the opposite happens: numbers are reified. Jerome takes the numbers 30, 60, and 100 from the Gospel, gives them a spin, and they are not numbers any more. They have become powerful, vivid, sensory symbols.

## 1.2. The finger system in detail

Despite the abundance of ancient evidence, the oldest known full account of the FS – with descriptions of all gestures from 1 to 1,000,000 – only dates from the seventh century AD. It can be found in a copy of the short treatise known as *Romana computatio* (full text in Appendix A).<sup>41</sup>

After the *Romana computatio*, and still before AD 1000, other treatises were produced, of varying degree of importance, also containing the full FS enumeration: among them one finds the *Secunda Romana computatio* or *Alia Romana computatio*, the *Liber de computo sancti Cyrilli Alexandrini*, and Abbo of Fleury’s (ca. 945 – 1004) *Commentarius in calculum Victorii*.<sup>42</sup> But the most impactful of them all, in terms of the enduring textual and iconographic tradition they generated, were undoubtedly the first chapter of *De temporum ratione* (henceforth, DTR) by Bede, entitled “Of the Computation or the Discourse of the Fingers” (*De*

---

<sup>39</sup> The “reversion” concept was introduced by Marshall McLuhan, who described it as an inescapable effect of any medium (together with enhancement, retrieval, and obsolescence): “when pushed to the limits of its potential (...), the new form will tend to reverse what had been its original characteristics.” Marshall McLuhan, and Eric McLuhan, *Laws of Media: The New Science* (Toronto: University of Toronto Press, 1988), 99. For example, one purpose of the phone is to enhance communication. But, in a way, the phone ends up hampering communication: with the ones closest to us, to begin with; and even with the ones away from us – by giving the illusion of a suitable substitute for face-to-face conversation, when in fact it lacks most of what true communication is all about.

<sup>40</sup> For the Neoplatonists, there was a clear distinction between “pure numbers” and “material numbers,” the former being studied by arithmetic, while the latter by logistic. See: Jacob Klein, *Greek Mathematical Thought and the Origin of Algebra* (New York: Dover Publications, 1992), 20-37. It seems that dactylonomy was instrumental in transforming the latter kind of numbers into the former.

<sup>41</sup> The oldest copy is in London, The British Library, Cotton Caligula A XV, fols. 77r – 78v. This manuscript dates to AD 743. See: James T. Palmer, “Computus after the Paschal controversy of AD 740,” in *The Easter Controversy*, 217-218. See also: Alfred Cordoliani, “A propos du chapitre premier du De Temporum ratione, de Bède,” *Le Moyen âge: bulletin mensuel d’histoire et de philologie* 54 (1948): 212. A critical edition of *Romana computatio* exists: Charles Williams Jones, *Bedaes Pseudepigrapha: Scientific Writings Falsely Attributed to Bede* (Ithaca, NY: Cornell University Press, 1939).

<sup>42</sup> On these sources and their editions, see: Karl-August Wirth, “Fingerzahlen,” *RDK Labor* (1986), <http://www.rdklabor.de/w/?oldid=88931>.

*computo uel loquela digitorum*) (full text in Appendix B) and also, if to a lesser extent, the sixth chapter of the *Liber de computo* (henceforth, DC) by Rabanus Maurus (ca. 780 – 856), entitled “What is the significance of fingers” (*Quomodo digiti significantur*) (full text in Appendix C).<sup>43</sup>

Fully described in these treatises, the FS presents itself as a powerful dactylonomy method, because instead of devoting a finger to each number, thereby confining the range of gesturable numbers to ten, it splits each hand into two sections, and defines nine gestures for each section. Furthermore, it also defines nine possible hand-positions with reference to the body. Since there are two hands, this method greatly manifolds the number of possible combinations.

Bede’s text is devoted to the “the very useful and very easy skill of flexing the fingers” (*utilissimam promptissimamque flexus digitorum sollertiam*).<sup>44</sup> And like the *Romana computatio*, it includes detailed instructions of how to use the fingers to count from 1 to 1,000,000:

- i) A gesture is defined for each of the units (1-9) using the little finger, the ring finger, and the medium finger of the left hand. The gestures are described as follows: (1) the little finger is bent and fixed on the middle of the palm (*medium palmae*); (2) the ring finger is bent and fixed next to the little finger; (3) the middle finger is likewise bent and fixed next to the ring finger; (4) the little finger is lift up; (5) the ring finger is also lift up; (6) the middle finger is lift up and the ring finger is fixed in the middle of the palm; (7) the middle finger is lift up and the little finger alone is placed on the root of the palm (*radix palmae*); (8) the ring finger is placed beside the little finger; (9) the middle finger is placed beside the ring finger.<sup>45</sup>
- ii) A gesture is defined for each of the tens (10-90), using the index finger (*index*) and the thumb (*pollex*) of the left hand. They are described as follows: (10) the nail of the index finger is placed on the middle joint of the thumb; (20) the tip of the thumb is inserted

---

<sup>43</sup> See the critical editions: Beda Venerabilis, *Opera didascalica: 2. De temporum ratione*, Edited by C. W. Jones, Corpus Christianorum Series Latina 123B (Turnhout: Brepols, 1977); Rabanus Maurus, *Martyrologium. De computo*, ed. J. McCulloh and W. Stevens, *Corpus Christianorum Continuatio Mediaevalis* 44 (Turnhout: Brepols, 1979). See also the translated and commented edition of DTR: Beda Venerabilis, *Bede: The Reckoning of Time*, edited by Faith Wallis, Translated Texts for Historians 29 (Liverpool University Press, 1999); and the translation of the first eight chapters of DC to Spanish (first translation to a modern language) in: Ana Belén Sánchez Prieto, “Aprender a contar según el De Computo de Rabano Mauro,” *Educación XXI* 16:2 (2013): 44–55, <https://doi.org/10.5944/educxx1.2.16.10331>.

<sup>44</sup> Beda, *Opera didascalica*, 268.

<sup>45</sup> *Ibid.*, 269-270.

- between the middle joints of the index and middle fingers; (30) the tips of the index and middle fingers are joint in a “gentle embrace” (*blando coniunges amplexu*); (40) the thumb is placed beside or on top of the index finger while both are hold erect; (50) the thumb is bent inward, against the palm, into the shape of the Greek letter Γ (gamma); (60) the thumb, still bent, is encircled by curving the index finger forward; (70) the thumb, with its nail upright, is inserted through the middle joint of the index finger, which is still bent; (80) the index finger, still curved, is “filled” with the thumb extended full length and its tip placed against the middle joint of the index finger; (90) the tip of the bent index finger is placed against the base of the upright thumb.<sup>46</sup>
- iii) The gestures for the hundreds (100 – 900) are the same ones defined for the tens, using the index and the thumb, except this time employing the right hand (*in dextera quomodo in laeua*).<sup>47</sup>
  - iv) Likewise, the gestures for the thousands (1,000 – 9,000) are the same ones defined for the units but using the right hand.<sup>48</sup>
  - v) Nine different positions are defined for the left hand, corresponding to each ten of thousand (10,000 – 90,000): (10,000) the back of the hand is placed on the middle of the chest, with the fingers pointing upwards to the neck; (20,000) still on the chest, the hand is spread out sideways; (30,000) the hand is placed flat but upright with the thumb on the breastbone; (40,000) the back of the hand is placed upright against the belly; (50,000) the hand is laid flat but upright, with the thumb against the belly; (60,000) the hand grasps the left thigh; (70,000) the back of the hand is placed on the thigh; (80,000) the palm of the hand is placed on the thigh; (90,000) the hand grasps the hip with the thumb turned towards the groin.<sup>49</sup>
  - vi) The positions for the hundreds of thousands (100,000-900,000) are the same ones defined for the tens of thousands, except this time with the right hand.<sup>50</sup>

---

<sup>46</sup> Ibid., 270. Because of their respective gestures, units were called *digiti* (fingers), tens were called *articuli* (joints), and combinations of units and tens were called *compositi* (composites). Even after the FS had fallen into obsolescence, this nomenclature kept being used, giving rise to definition issues: “the attempts of the writers of the abacus treatises to describe *digiti* and *articuli* show how great were the difficulties that they faced in finding any point of common experience on which to hang their definitions.” Gillian R. Evans, “From Abacus to Algorithm: Theory and Practice in Medieval Arithmetic,” *The British Journal for the History of Science* 10:2 (1977): 118, <https://doi.org/10.1017/S0007087400015375>.

<sup>47</sup> Beda, *Opera didascalica*, 270.

<sup>48</sup> Ibid., 270.

<sup>49</sup> Ibid., 270-271.

<sup>50</sup> Ibid., 271.

vii) Finally, one gesture is described for 1,000,000: crossing both hands and linking the thumbs.<sup>51</sup>

The logic behind this scheme is unequivocally decimal, because in order to represent any number between 1 and 1,000,000 one has to decompose it in multiples of powers of 10 and combine the gestures of all terms into one single gesture. For example, the number 716,153 is equal to the sum of terms 700,000 + 10,000 + 6,000 + 100 + 50 + 3. Hence, its gesture is the following combination: the back of the left hand is placed on the middle of the chest with the fingers pointing upwards to the neck (10,000), so that the thumb is bent inward in the shape of the Greek letter  $\Gamma$  (50) and the small, ring, and middle fingers are placed in the middle of the palm (3); the back of the right hand is placed over the right thigh (700,000) with the nail of the index finger on the middle joint of the thumb (100), and the ring finger on the middle of the palm (6,000).

This system was obviously extremely useful, as it allowed going up to high amounts with little effort, without the help of any external device. Surely, learning it would require a high degree of finger-dexterity and coordination but, with enough time and patience, almost anyone would be able to work with it. It would then improve daily life in a variety of ways, speeding up calculations and enhancing communication.<sup>52</sup> But, perhaps more important than what people would do with the FS, it is worth asking what the FS would do to people.

“Natural” dactylonomy methods (where there is a one-to-one map between each number from 1 to 10, and a gesture) has received plenty of attention from neuroscientists in recent years. In particular, finger-counting is now known to play a key role in enabling human beings to conceptualize numbers and establish spatial-numerical associations (SNAs).<sup>53</sup> Human beings tend to associate smaller numbers to the left side (right hemisphere of the brain),

---

<sup>51</sup> Ibid., 271.

<sup>52</sup> Efficient algorithms for simple arithmetic operations with the FS, such as addition and multiplication are not yet known. But they must have existed, since the sources insist on the usefulness of the FS in calculation, and since there were efficient algorithms for mental calculation and abacus, as shown in: H. Hilton Turner, “Roman elementary mathematics: the operations,” *The Classical Journal* 47:2 (1951): 63-74; W. French Anderson, “Arithmetical computations in Roman Numerals,” *Classical Philology* 51:3 (1956): 145-150.

<sup>53</sup> On the relationship between finger-counting and the structure of natural numbers, see: Michael Andres, Samuel Di Luca, and Mauro Pesenti, “Finger Counting: The Missing Tool?,” *Behavioral and Brain Sciences* 31:6 (December 2008): 642–43, <https://doi.org/10.1017/S0140525X08005578>; and G Wood and M Fischer, “Numbers, Space, and Action – From Finger Counting to the Mental Number Line and Beyond,” *Cortex* 44:4 (April 2008): 353–58, <https://doi.org/10.1016/j.cortex.2008.01.002>. For the relationship between finger-counting and SNAs, see, for instance: M. Fischer, “Finger Counting Habits Modulate Spatial-Numerical Associations,” *Cortex* 44:4 (April 2008): 386–92, <https://doi.org/10.1016/j.cortex.2007.08.004>; Giulia Prete, and Luca Tommasi, “Exploring the Interactions among SNARC Effect, Finger Counting Direction and Embodied Cognition,” *PeerJ* 8 (May 12, 2020): e9155, <https://doi.org/10.7717/peerj.9155>. For a wider perspective, see the reference list in: M. H. Fischer and P. Brugger, “When Digits Help Digits.”

and larger numbers to the right (left hemisphere of the brain).<sup>54</sup> But SNAs go beyond these simple associations: they are “the expression of some general cognitive rule that reflects the ‘placement’ of an image in space (the spatialization of ideas) and the relative (in) compatibility that emerges from using lateral effectors to respond to these ideas.”<sup>55</sup>

These scientific findings bring a whole new perspective to our understanding of the FS. If the elementary 1-to-10 dactylonomy routines empower spatial perception, one can only imagine how a highly sophisticated system such as the FS would have enhanced the human brain.<sup>56</sup>

### 1.3. The finger system in the western middle ages

Both DTR and DC are treatises on *computus Paschalis*, the Christian science responsible for establishing the date of Easter. Since the third century, and until today, Easter was supposed to fall on the first Sunday after the first full moon after the spring equinox.<sup>57</sup> Easter being the most important Christian feast, it was remarkably important to fix it with the highest degree of accuracy possible. Hence, over the centuries, various mathematical models were put forth to coordinate the Julian calendar and the lunar cycles.<sup>58</sup> Eventually, by the seventh century, *computus* began a complex process of evolution that took it from being a “quadrivial” subject

---

<sup>54</sup> Even in Arabic and Hebrew, where the reading direction is right-left, the number reading direction is left-right.

<sup>55</sup> M. H. Fischer and P. Brugger, “When Digits Help Digits,” 5.

<sup>56</sup> Marshall McLuhan famously described *media* as “extensions of man.” Just like the car can be regarded as an extension of the legs and feet, and writing as an extension of memory, the FS can be seen as an extension of the hand. Humans have 10 fingers, but through the FS they can count to 1,000,000 – as if their fingers had been multiplied by a hundred thousand. Beyond that, being such a powerful artefact, the FS extends many other human capabilities, such as spatial awareness. But *media* are also “amputations of man”: cars produce people with weaker legs, and writing likewise hampers memory training. Which begs the question: in what way and to what extent was the FS an amputation? On McLuhan’s theory of *media*, see especially: Marshall McLuhan, *Understanding Media: The Extensions of Man*, Routledge Classics (London: Routledge, 2008); M. McLuhan, and E. McLuhan, *Laws of Media*. More generally, for an exploration of the hand as a medium across time and in a wide variety of contexts, see: Frank R. Wilson, *The Hand: How Its Use Shapes the Brain, Language, and Human Culture* (New York: Vintage Books, 1999).

<sup>57</sup> Immo Warntjes, “Introduction: state of research on late antique and early medieval computus,” in *Late Antique Calendrical Thought and its Reception in the Early Middle Ages*, ed. by Immo Warntjes and Dáibhí Ó Cróinín, *Studia Traditionis Theologiae* 26 (Turnhout: Brepols, 2017), 1, <https://doi.org/10.1484/m.stt-eb.5.114732>.

<sup>58</sup> To define *computus* as a science is actually simplistic, if not plainly wrong. As Faith Wallis puts it, “it is hard to claim that it is a science, because it is essentially an application of other sciences, particularly astronomy and mathematics. It does not seek to establish universal principles, and it boasts no theory. It has no ancestor in the ancient canon of the sciences, and no posterity in the modern one. On one level, it can be described as nothing more than a complicated mathematical problem: how to find the date of Easter. Solving this problem, however, involves elaborate coordination of lunar and solar data; it also demands some delicate interpretation of conflicting biblical texts.” F. Wallis, “Introduction,” In *The Reckoning of Time*, xviii.

– almost a subfield of astronomy – to a “wide-ranging subject explaining the natural world as part of the quest of understanding God’s creation.”<sup>59</sup>

From the writing of DTR onward, all throughout the middle ages, the tradition of dactylonomy is interconnected with the tradition of *computus*. Dactylonomy is presented as a fundamental requirement for *computus* – Bede’s main goal in exposing the FS is “investigating and explaining the sequence of time through calculation,” and so is Rabanus Maurus’s.<sup>60</sup> And just like *computus* would go far beyond mere calendrical calculations, to the point of being seen as a “division of Scripture,” so would dactylonomy be used in exegesis and homily.<sup>61</sup> *Computus* occupied the very center of the early medieval monastic intellectual framework – and so did dactylonomy.<sup>62</sup>

The most famous sources for the FS are Bede’s DTR and Rabanus Maurus’s DC, being that, more than likely, the latter used the former as its main source, taking the opportunity for making a number of improvements. For example, instead of jumping straight to the gestures enumeration as Bede had done, Rabanus Maurus, through the voice of a master talking to his disciple, starts by explaining the basic structure of the FS: how each hand is split into two groups of fingers, each group responsible for a different set of numbers. After that, the disciple asks the master for more detail (*discipulus: haec ergo omnia precor ut speciatim mihi patefacias*) and, only then, the master answers by quoting the full extent of Bede’s text

---

<sup>59</sup> I. Warntjes, “Introduction,” 1.

<sup>60</sup> See Appendix B and Appendix C.

<sup>61</sup> Faith Wallis defines *computus* as *doctrina christiana*. “Like the Irish scholars of his age, Bede saw *computus* as a ‘division of Scripture,’ that is, as a conjunct to exegesis. It was part of an undifferentiated body of Christian erudition that could be shaped as needed into exegesis, homily, or hagiography.” Faith Wallis, “Introduction,” In *The Reckoning of Time*, xxxiv.

<sup>62</sup> The literature on *computus* is never-ending. For a brief introduction to the topic, see: F. Wallis, “Introduction,” In *The Reckoning of Time*. For more comprehensive studies, see: Philipp Nothaft, *Scandalous Error: Calendar Reform and Calendrical Astronomy in Medieval Europe* (Oxford: Oxford University Press, 2018), and Arno Borst, *The Ordering of Time: From the Ancient Computus to the Modern Computer*, trans. Andrew Winnard (Chicago: University of Chicago Press, 1994). See also: A. N. Zélinisky, “Le calendrier chrétien avant la réforme grégorienne,” *Studi medievali* 3:23 (1982): 529-597; Alfred Cordoliani, “Comput, chronologie, calendriers,” in *L’Histoire et ses méthodes*, ed. Charles Samaran (Paris: Gallimard, 1961):37-51; Faith Wallis, “Images of Order in the Medieval Computus,” in *ACTA XIV: Ideas of Order in the Middle Ages*, edited by Warren Ginsberg (Binghamton: State University of New York Press, 1990):45-67; and also by Faith Wallis, “The Church, the World, and the Time,” in *Normes et pouvoirs à la fin du moyen âge*, edited by Marie-Claude Déprez-Masson, *Inedita et rara* 7 (Montreal: Ceres, 1990):15-29. The proceeding of the Galway biannual International Conference on the Science of Computus in Ireland and Europe are also of enormous interest to this topic: Immo Warntjes and D. Ó Cróinín, eds., *Computus and its cultural context in the Latin West, AD 300–1200*, *Studia Traditionis Theologiae* 5 (Turnhout 2010), <https://doi.org/10.1484/M.STT-EB.6.09070802050003050303010709>; Immo Warntjes and D. Ó Cróinín, eds., *The Easter Controversy of Late Antiquity and the Early Middle Ages*, *Studia Traditionis Theologiae* 10 (Turnhout 2011), <https://doi.org/10.1484/M.STT-EB.6.09070802050003050306060802>; Immo Warntjes and D. Ó Cróinín, eds., *Late Antique Calendrical Thought and its Reception in the Early Middle Ages*, *Studia Traditionis Theologiae* 26 (Turnhout 2017), <https://doi.org/10.1484/M.STT-EB.5.113899>.

(*magister: cum dicis unum, ...*).<sup>63</sup> Rabanus Maurus's version is clearer than Bede's, both because of the short preliminary exposition, guiding the unfamiliar reader through the FS structure, and also because of the dialog format.

The master-disciple dialogue – a common literary form – has special significance in the DC: there were actual masters teaching the FS to actual disciples during the early middle ages. It was the case of Walafrid Strabo (ca. 808 – 849), who was taught the FS in 822 by a certain master Tatto, with the aid of DTR, in the abbey of Reichenau.<sup>64</sup> Alcuin (735 – 804) also witnesses the presence of dactylonomy in a didactic context, in his collection of riddles, *Disputatio regalis et nobilissimi iuvenis Pippini cum Albini scholastico*, again written in dialog format – between Alcuin and Pepin.<sup>65</sup> At a certain point, Alcuin brings forth a strange riddle: “I saw a man holding eight in his hand, and from the eight he took seven and six remained.”<sup>66</sup> For the uninformed reader, these words make no sense, but Alcuin is in fact quoting the 96<sup>th</sup> Symphosius riddle, whose answer is “to take VII from VIII and have VI left,” because the gesture for 8 has the ring and little fingers bent, while the 7 gesture has only the little finger bent. Hence, taking 7 from 8 means having only the ring finger bent – the gesture for 6.<sup>67</sup> The most interesting about this passage, though, is not that Alcuin quotes the Symphosius's riddle, but what Pepin answers: “the boys in school know that.”<sup>68</sup> This apparent inclusion of dactylonomy in school curricula comes in fact from antiquity. As aforementioned, Quintilian insisted on the importance of acquiring finger dexterity skills through training since a young age, and Firmicus Maternus (4<sup>th</sup> c.) actually describes children slowly learning how to flex their

---

<sup>63</sup> See Appendix C.

<sup>64</sup> See: K. Menninger, *Number Words*, 215. Coincidentally (or not) Walafrid would later study under Rabanus Maurus, in Fulda, before returning to Reichenau and being made abbot.

<sup>65</sup> The text of *Disputatio* is edited in: Lloyd William Daly and Walther Suchier, *Altercatio Hadriani Augusti et Epicteti Philosophi*, (Urbana IL: The University of Illinois Press, 1939), 137-143. See also: Martha Bayless, “Alcuin's *Disputatio Pippini* and the Early Medieval Riddle Tradition,” In *Humour, History and Politics in Late Antiquity and the Early Middle Ages*, edited by Guy Halsall (Cambridge University Press, 2002), 157–78, <https://doi.org/10.1017/CBO9780511496325.009>.

<sup>66</sup> “Vidi hominem octo in manu tenentem, et de octonis rapuit septem, et remanserunt sex.” L. W. Daly and W. Suchier, *Altercatio Hadriani*, 142.

<sup>67</sup> See: Symphosius, *The Hundred Riddles of Symphosius*, trans. Elizabeth Hickman du Bois (Woodstock: Elm Tree Press, 1912). Symphosius's riddles date from the 4<sup>th</sup> century, but it seems that the 96<sup>th</sup> riddle is more recent. Tessa Morrison explores this riddle and some problems associated with it – in particular, the gestures for 7 and 8 require bending the fingers onto the root of the palm, *radix palmae*, while the gesture for 6, requires bending the finger onto the middle of the palm, *medium palmae*, rendering the solution to the riddle impossible. See: Tessa Morrison, “A Medieval Gesture Riddle— ‘To Take VII from VIII and Have VI Left’,” *JAEMA* 6 (2010): 25–46.

<sup>68</sup> “Pueri in schola hoc sciunt.” L. W. Daly and W. Suchier, *Altercatio Hadriani*, 142. “It is apparently so easy a question that Pippin scorns to give a direct answer, in words at least (...). I say ‘in words’ because it is very likely that a rapid bit of finger movement accompanied his answer.” Eva Matthews Sanford, “De Loquela Digitorum,” *The Classical Journal* 23:8 (1928): 588.

fingers, through a process comparable to the learning of other skills, such as reading and swimming.<sup>69</sup>

Going forward in time, dactylonomy seems to lose more and more of its social pervasiveness. In 1202, in the beginning of the famous treatise *Liber abacci*, Leonardo da Pisa (ca. 1170 – ca. 1250), better known as Fibonacci, writes that: “those who wish to know the art of calculating, its subtleties and ingenuities, must know computing with hand figures, a most wise invention of antiquity, according to its use by the masters of mathematics.”<sup>70</sup> Here, dactylonomy is treated as both an old and a specialized technique. Fibonacci recognizes the usefulness of the FS, and even teaches it, but as a tool of the “masters of the *abbacus*” (“*magistrorum abaci*”).

Another witness of the FS comes forty years after the *Liber abaci*, in the ornithology and falconry treatise *De arte venandi cum avibus* by the emperor Frederick II (1194 – 1250).<sup>71</sup> In order to properly explain how to hold a falcon, Frederick II describes the hand position as the same that the “masters of the *abbacus*” (“*abacistae*”) make when they express number 72:

The hand is held facing neither inward nor outward, but extended in the same direction that the arm is extended. The index finger is then laid over the extended thumb and bent forward over the end segment of the thumb: this is just the way in which the masters of computation form the number seventy with their fingers. The other fingers of the same hand are bent over the palm beneath these two fingers (the index finger and thumb), to support the latter, just as the

---

<sup>69</sup> “Sic prima litterarum signa cum quadam fastidii aspernatione cognoscimus, sic in incognito itinere constituti in primis vestigiis paene deficiamus; vides ut primos discentes computos digitos tarda agitatione deflectant; illum quem vides natantem ex crebra submersionis trepidatione deficere, post paululum assidua brachiorum agitatione firmatus per summas elapsus undarum spumas facili se mobilitatis levitate suspendit; quoniam haec omnia, id est litteras computum musicam ceteraque quae discimus, tunc facili ratione percurrimus, cum primae originis viam confirmata ingenii conceperit disciplina.” Firmicus Maternus, *Iulii Firmici Materni Matheseos libri VIII*, edited by W. Kroll, and F. Skutsch (Leipzig: Teubner, 1897), 14 (1.4.13). Marrou admits that the FS might have been taught in ancient primary schools: “I do not see why it cannot have been taught in the primary schools: by its qualitative character—one sign for each whole number—it seems to go quite naturally with the teaching of numbers.” H. I. Marrou, *A History of Education in Antiquity*, trans. George Lamb (New York: The New American Library, 1964), 522. Isabelle Cochelin emphasises the importance of the body in monastic education: Isabelle Cochelin, “Besides the Book: Using the Body to Mould the Mind - Cluny in the Tenth and Eleventh Centuries,” in *Medieval Monastic Education*, ed. George Ferzoco and Carolyn Muessig (London: Leicester University Press, 2000), 21–34.

<sup>70</sup> “Opportet eos qui arte abaci uti uoluerint, ut subtiliores et ingeniores appareant scire computum per figuram manuum, secundum magistrorum abaci usum antiquitus sapientissime inuentam.” Leonardo Pisano, *Liber abaci* 1. Translation taken from: Leonardo Pisano, *Fibonacci's Liber Abaci: a translation into modern English of Leonardo Pisano's Book of calculation*, translated by Laurence Sigler (New York: Springer, 2003), 20.

<sup>71</sup> The fact that Fibonacci worked in the court of Frederick II might have not been coincidental. His *Liber quadratorum* was dedicated to the emperor, and the *Liber abaci* itself was dedicated to the influential mathematician and scholar Michael Scot, also scientific adviser to Frederick II. See: L. E. Sigler, “Introduction,” in *The Book of Squares*, by Leonardo Pisano, trans. L. E. Sigler (Orlando FL: Academic Press, 1987).

number three is formed. Thus the index finger is bent over the thumb and the three other fingers beneath it, in the manner of a master of computation forming the number seventy-three.<sup>72</sup>

Fredrick II assumes that his readers are acquainted with the FS, but his account does not necessarily mean that in the thirteenth century dactylonomy still enjoyed the same popularity as in the first centuries AD. The impression one gets from the coeval sources (or lack thereof) is actually the opposite. For example, the Franciscan preacher Berthold of Regensburg (ca. 1220 – 1272), talks about finger-counting as pertaining to a remote, and ancient, elite.<sup>73</sup>

One of the most important usages of dactylonomy is exegesis. Arguing in favour of the importance of learning the FS, Bede states that “almost all the exegetes of Holy Scripture have shown themselves well acquainted, no less than they are with verbal expressions (...) and even Jerome, that translator of the sacred narrative,” then proceeding to quote the Jerome passage on the parable of the sower.<sup>74</sup> In fact, not only Jerome and Augustine, but Tertullian (ca. 155 – ca. 220), Ambrose (ca. 340 – 397), and John Cassian (ca. 360 – ca. 435), mention dactylonomy in their writings.<sup>75</sup>

Throughout the middle ages, dactylonomy keeps being mentioned in exegetic contexts. One of its most common references is the passage from 99 to 100, that is, from the left hand to the right hand. In Christian symbolism, the right side is the side of virtue, eternity, and happiness, while the left is the side of sin, death, and unhappiness.<sup>76</sup> Two examples of this

---

<sup>72</sup> “Manum vero non plicet interius neque exterius, sed in rectitudine brachii teneat, conjugendo pollicem extensum indici, et replicet indicem ad extremitatem pollicis, et erit modus, secundum quem abacistae tenent septuaginta cum manu, et alii digiti eiusdem manus replicentur in palmam sub illis duobus digitis, ut firmius sustententur, ad similitudinem tenentis numerum ternarium, et sic ex replicatione indicis super pollicem, et trium digitorum in palma sub illis, teteat manum ad formam abacistae tenentis septuaginta tria.” Frederick II, *De arte venandi* 2.42. Translation taken from: Menninger, *Number Words*, 217.

<sup>73</sup> “Man zalte in der alten è an den vingern, des kunnet ir ungelerten liute niht, wan es ist der gelerten vil, di es niht kunnen.” Berthold of Regensburg, *Predigten* 55 (“Von den deien fürstenamten”). Translation to English: “in former times people counted on their fingers. But unlettered people could not do this, and even among the educated there were many who could not.” See: Menninger, *Number Words*, 215.

<sup>74</sup> See Appendix B.

<sup>75</sup> “Ambobus in digitis usurarum repetitur saepius calculatio.” Ambrosius, *De Tobia* 7.25. “Centenarius enim numerus de sinistra transfertur in dexteram; et licet eadem in supputatione digitorum figuram tenere videatur, nimium tamen quantitatis magnitudinem supercrescit.” Joannes Cassianus, *Collationes* 24.26.7. “Multis instrumentis cum digitorum supputariis gesticulis adsidendum est.” Tertullianus, *Apollogeticum* 19.5. Passages from: Ambrosius, “De Tobia Liber Unus,” in *Sancti Ambrosii Mediolanensis Episcopi: Opera Omnia*, edited by Jacques-Paul Migne, *Patrologia Latina* 14, (Paris: Vrayet de Surcy, 1845), 805; Williams and Williams, “Number Words,” 598; Minucius Felix Tertullian, *Apology. De Spectaculis. Minucius Felix: Octavius*, translated by T. R. Glover, Gerald H. Rendall, *Loeb Classical Library* 250 (Cambridge, MA: Harvard University Press, 1931), 98-99, <https://doi.org/10.4159/DLCL.tertullian-apology.1931>.

<sup>76</sup> Antonio Quacquarelli explores the biblical, patristic, and medieval symbolism of the left/right sides in connection with the FS. “Femandoci ai Padri della Chiesa, il computo sulla sinistra, per indicare i numeri sino a

image have already been provided: the aforementioned quotes of Augustine and Jerome. Augustine writes that while adding from 1 to 17, one moves to the right hand – meaning that we are following the “right” path; and Jerome gives great emphasis to the fact that the gesture for 100 is at the right side, to underscore how profound is the difference between marriage or widowhood – at the left – and virginity – at the right. This symbolism continues on into the high middle ages. For example, Richard of Saint Victor (d. 1173) compares the transition from the left hand to number 100 in the right hand, with the transition of the soul from this world to celestial beatitude, and Peter of Poitiers (c. 1130 – 1215) also makes a similar remark.<sup>77</sup> Although tempting, these high medieval sources do not enable too many conclusions. Indeed, they are but echoes of patristic commonplaces, and writing them would not necessarily require expertise in dactylonomy.

Beyond time reckoning and the study of scripture, in the DTR, Bede presents another purpose for the FS:

One can represent a sort of manual language, whether for the sake of exercising one’s wits, or as a game. By this means one can, by forming one letter at a time, transmit the words contained by those letters to another person who knows this procedure, so that he can read and understand them even at a distance. Thus one may either signify necessary information by secret intimation, or else fool the uninitiated as if by magic.<sup>78</sup>

Bede’s secret language is a simple fingerspelling scheme in which, to each letter corresponds a gesture, following the sequential order of the alphabet: A corresponds to 1, B to 2, and so on. Bede gives an example: “if you wish to warn a friend who is among traitors to act cautiously, show with your fingers 3, 1, 20, 19, 5 and 1, 7, 5; in this order, the letters signify *caute age* [‘act cautiously’].”<sup>79</sup> Bede’s example presents similarities with the story told by Ermoldus Nigellus (fl. 824–830) in *De rebus gestis Ludovici Pii*, where Zadum the moor is captured by the Franks. When asked to tell his men to surrender, he cries to them to open the gates, but in

---

99, ha un valore diverso dal computo sulla destra. Attribuiscono alla destra la vita eterna, alla sinistra quella contingente e terrena.” See: A. Quacquarelli, “Ai margini dell’actio,” 201-204.

<sup>77</sup> “Centenarius namque qui in computatione de laeva transit ad dexteram, beatitudinem supernam ad quam de mundo transimus figurat.” Richard of St. Victor, *Apocalypsim Joannis 7*. “Centenarius, quia a leva transit ad dexteram, significat celestam vitam.” Petri Pictaviensis, *Allegoriae super tabernaculum Moysi*, edited by Philip S. Moore and James A. Corbett (Notre-Dame IN: The University of Notre Dame Press, 1938), 2.3.

<sup>78</sup> Bede, *Opera didascalica*, 271-272.

<sup>79</sup> *Ibid.*, 272.

secret gestures tells them to continue their resistance.<sup>80</sup> Dactylonomy's usage for military purposes is also present in the first book of the *Etymologies* by Isidore of Seville (c. 560 – 636), a book dedicated to grammar:

Finger signals (*De notis digitorum*): There are also some signals for the fingers, and for eyes as well, by which those at a distance can silently communicate with each other. This is the custom with the military: when the army is agreeing on an action they signal assent with their hands, because they cannot use their voices.<sup>81</sup>

Due to the silence restrictions imposed by the rule of Saint Benedict, Benedictines and reformed Benedictines, notably, Cluniacs and Cistercians, developed highly sophisticated silent codes (*signa loquendi*) that have been classified as sign languages.<sup>82</sup> Could there be a connection between Bede's silent code and the monastic sign languages? It is clear that Bede did not intend the FS to be used as the basis for an actual silent language. Not only does he start every gesture description with "when you say" (*cum dicis*) denying from the outset the possibility of silence, but he also clearly states that the fingerspelling code is to be used "for the sake of exercising one's wits, or as a game." Indeed, "there is no evidence to suggest that any medieval monastic community ever adopted Roman finger numbers as a medium for silent conversation."<sup>83</sup> Still, monastic silent codes could have used the FS gestures at least for expressing the numerals. These monastic codes have never-ending lists of signs, including

---

<sup>80</sup> "Tum manus ad muros tendens vocitabat amicos: / 'Pandite iam, socii, claustra vetata diu.' / Ingeniosus item digitos curvabat et unguis / Fingebat palmis, haec simulanter agens. / Hoc autem indicio signabat castra tenenda, / Sed tamen invitus 'pandite' voce vocat." Ermoldus Niggelus, "De rebus gestis Ludovici Pii," in *A Primer of Medieval Latin*, edited by Charles H. Beeson, The Lake Classical Series (Chicago IL: Scott Foresman and Company, 1925), 330.

<sup>81</sup> "Sunt quaedam et digitorum notae, sunt et oculorum, quibus secum taciti proculque distantes conloquuntur. Sicut mos est militaris, ut quotiens consentit exercitus, quia voce non potest, manu promittat." Isidore of Seville, *Etymologiae: edición bilingüe*, edited by Jose Oroz Reta, and Manuel-A. Marcos Casquero (Madrid: Biblioteca de Autores Cristianos, 2018), 304-305 (1.26). See translation: Isidore of Seville, *The Etymologies of Isidore of Seville*, edited by Stephen A. Barney, W. J. Lewis, J. A. Beach, and Oliver Berghof (New York: Cambridge University Press, 2006), 52.

<sup>82</sup> Monastic sign languages have been abundantly studied. See, for instance: Scott G. Bruce, *Silence and Sign Language in Medieval Monasticism: The Cluniac Tradition c.900-1200*, Cambridge Studies in Medieval Life and Thought 68 (Cambridge: Cambridge University Press, 2007); Robert A. Barakat, "On Ambiguity in the Cistercian Sign Language," *Sign Language Studies* 8 (1975): 275–89; Jean Umiker-Sebeok, ed., *Monastic sign languages, Approaches to semiotics* 76 (Berlin: Mouton de Gruyter, 1987). Related to this topic, see also: Ambrose G. Wathen, *Silence: The Meaning of Silence in the Rule of St. Benedict*, Cistercian Studies Series 22 (Washington: Cistercian Publications, 1973).

<sup>83</sup> S. G. Bruce, *Silence and Sign Language*, 60. Jean-Claude Schmitt, in a subchapter dedicated to "Le comput digital et les signa monastiques," establishes a link between the two families of signs. But this link seems to be based solely on the fact that both were practiced in monasteries. Jean-Claude Schmitt, *La Raison Des Gestes Dans l'Occident Médiéval*, Bibliothèque Des Histoires (Paris: Gallimard, 1990), 253-257.

several types of foods, liturgical objects, and actions.<sup>84</sup> Although the FS appears to provide the perfect set of signs for numbers, so far, there is no evidence supporting such a hypothesis.<sup>85</sup>

After explaining how to use the FS for silent communication, by associating each letter with a number-gesture, at the end of the first chapter of DTR, Bede writes that “this can be more easily learned and manipulated using the letters and numbers of the Greeks, who (...) depict the figures of numbers with individual signs, by means of all the letters of the alphabet.”<sup>86</sup> Bede is talking about the Greek Milesian system, “a fully alphanumeric writing system, that is, a system in which the same set of alphabet signs is used both for everyday language and for mathematics.”<sup>87</sup> Rabanus Maurus dedicates the entire seventh chapter to this, “of the signs of the Greeks adapted to numbers” (*De Grecorum notis ad numeros aptatis*). Both Bede and Rabanus Maurus write down a table of alphanumeric correspondence:

A	1	H	8	Ξ	60	Υ	400
B	2	Θ	9	Ο	70	Φ	500
Γ	3	I	10	Π	80	X	600
Δ	4	K	20	Q	90	Ψ	700
E	5	Λ	30	P	100	Ω	800
ϸ	6	M	40	Σ	200	↑	900
Z	7	N	50	T	300		

---

<sup>84</sup> Paula Barata Dias analyses an interesting list of Cluniac gestures for communicating at the dining table, taken from the eleventh century *Epistola Bernardi monachi ad Hugonem abbatem*. See: Paula Barata Dias, “‘À mesa do mosteiro, silêncio’: alimentos e linguagem gestual na ordem de Cluny,” *Boletim de Estudos Clássicos* 56 (2011): 81–97, [https://doi.org/10.14195/0872-2110\\_56\\_9](https://doi.org/10.14195/0872-2110_56_9).

<sup>85</sup> The “Cistercian numerals,” a number notation developed in Cistercian monasteries in the early 13<sup>th</sup> century, that allowed representing any number from 1 to 10,000 with a single symbol, followed a logic similar to that of the FS. However, a possible connection between this numeric system and the FS has never been hypothesized. On Cistercian numerals, see: David A. King, *The Ciphers of the Monks: A Forgotten Number-Notation of the Middle Ages* (Stuttgart: F. Steiner, 2001). Coincidentally, Giraldus Cambrensis’s complaints on the monastic silent signs – that made monks look like jesters – seem to echo Martianus Capella’s disavowal of gestures above 9,999 – that transformed numbers into a twisted dance of the arms. “Tot etenim prior ad monachos servientes, et illi e contra ad mensas inferiores exenia ferendo, et hi quibus ferebantur gratias referendo, digitorum et manuum ac brachiorum gesticulationibus et sibilis ore pro sermonibus longe levius atque licentius quam deceret effluebant; ut quasi ad ludos scenicos aut inter histriones et joculariores sibi viderentur constitutus. Esset itaque magis ordini consonum et honestati verbis humanis cum modestia loqui, quam muta in hunc modum garrulitate signis et sibilis tam joculariter uti.” Giraldus Cambrensis, “De Rebus a se gestis,” edited by George F. Warner, in *Giraldi Cambrensis Opera*, edited by J. S. Brewer and James F. Dimock, Cambridge Library Collection - Rolls (Cambridge: Cambridge University Press, 2012), 1:51, <https://doi.org/10.1017/CBO9781139163378.005>. “Mihi vero solus numerus approbatur qui digitis coeretur; alias quaedam brachiorum contorta saltatio sit.” Martianus Capella, *Martianus Capella*, edited by James Willis (Leipzig: Teubner, 1983), 270-271.

<sup>86</sup> “Sed haec Graecorum computo literisque facilius disci simul atque agi possunt.” Bede, *Opera didascalica*, 272.

<sup>87</sup> Juan Acevedo, *Alphanumeric Cosmology From Greek into Arabic: The Idea of Stoicheia Through the Medieval Mediterranean* (Tübingen: Mohr Siebeck, 2020), 41

This system includes the 24 letters of the alphabet plus three Phoenician characters: *digamma*, *koppa*, and *sampi*, resulting in a symbol for each number from 1 to 9, from 10 to 90, and from 100 to 900. This alphanumeric merger is particularly useful for the Greek-speaking people, because, as Rabanus Maurus comments, when Greeks learn number-gestures, they immediately learn letter-gestures.<sup>88</sup> In effect, Nikolaos Rhabdas of Smyrna (14<sup>th</sup> c.), author of the earliest known Byzantine FS sources, starts one of his arithmetic letters by exposing the Milesian system, even before describing any gesture, unlike Rabanus Maurus and Bede, who leave the Greek alphabet to the end, treating it almost as a piece of cultural trivia.<sup>89</sup>

The adoption of the Indian numerals by the Greeks, Latins, Arabs, and others, from around the eighth century AD onwards, over a long period of time, lead to the “alphanumeric scission,” the split between letters and numbers – a change that was “so fundamental in nature and so momentous in its incalculable effect, that I can only liken it to the great shifts of tectonic plates, determining in discreet yet decisive ways the future of the great cultures built upon them.”<sup>90</sup> But the alphanumeric scission was also gestural. As ancient sources make clear, number-gestures and numbers themselves were inalienable.

Hence, the FS slowly fell into obsolence largely due to the introduction of other *media* such as the Indian numerals, but also the *abbacus*, and even writing. The coexistence of these *media* and dactylonomy is not up to debate: just like the radio stayed alive after the introduction of TV and the Internet, the FS did live simultaneously with supposedly competing *media*, even if becoming less popular and less relevant, even if being forced to change and adapt.<sup>91</sup> Fibonacci was already employing Indian numerals and, at the same time, advocating for the use of the FS. Centuries later, Luca Pacioli (ca. 1447–1517), also in an *abbacus* treatise, would likewise use the FS with Indian numerals.<sup>92</sup> In any case, not only Fibonacci’s and Pacioli’s

---

<sup>88</sup> “Qui et ideo mox numeros digitis significare didicerint; nulla interstante mora, litteras quoque pariter hisdem prefigurere sciunt.” Rabanus Maurus, *Martyrologium*, 213.

<sup>89</sup> The letters of Nikolaos Rhabdas, dated c. 1430, are edited and translated to French: M. Paul Tannery, *Notice sur les deux lettres arithmétiques de Nicolas Rhabdas* (Paris: Imprimerie Nationale, 1886), 28-37.

<sup>90</sup> J. Acevedo, *Alphanumeric Cosmology*, 277.

<sup>91</sup> The decline of the FS does not imply a decline in the use of fingers. Using different, ever more complex, finger systems, in the late middle ages and early modernity, fingers kept being used for a variety of purposes, such as reckoning, rhetoric, meditation, and magic. See: Wolfgang Brückner, *Die Hand für das Bildgedächtnis: Digitale Kulturtechniken der Verständigung* (Schnell & Steiner 2019).

<sup>92</sup> Pacioli introduced a significant change to the FS, that remained in *abbacus* literature: the little, ring, and medium fingers of the right hand would be devoted to the hundreds; the thumb and index of the right hand would be devoted to the thousands. The logic motivating this swap is simple: the smaller fingers are attributed to the smaller numbers, the larger fingers to the larger numbers. The fact that Pacioli was able to question an authority

mentions of the FS are only indicative of the dactylonomy practice within the circumscribed elite of the “*abbacus* masters,” as they are part of a centuries-long transition period from one numeration system to another.

The evolution of the writing technology, ever cheaper and more disseminated, certainly had a relevant role in the decline of the FS. Bede himself challenged the compatibility between both *media*, when he said that “many aspects of this discipline [finger-reckoning], just as of the other arts, are better conveyed by the utterance of a living voice than by the labor of an inscribing pen.”<sup>93</sup>

---

such as Bede, breaking with a centuries-old tradition, signals an important intellectual change, fitting to a “renaissance man” such as himself.

<sup>93</sup> “Sed innumera hujusce disciplinae, sicut et caeterarum artium, melius vivae vocis alloquio quam stili signantis traduntur officio.” Bede, *Opera didascalica*, 445.

## 2. Numbers, letters, gestures, and images: dactylonomy illuminated manuscripts

De numeri meta dat scriptum signaque Beda.

His signis curas curis addendo figuras.

Ne quasi dicatur nichili seu despiciatur.

Anonymous, Latin verses on dactylonomy (12<sup>th</sup> c.)<sup>94</sup>

Bede's DTR benefitted from enormous popularity all throughout the middle ages. Reflecting Bede's experience as a teacher, it was abundantly used as a manual in monastic schools.<sup>95</sup> The first chapter of DTR, "*De computo uel loquela digitorum*" (henceforth, DCLD), where Bede describes the ancient finger system (FS), not only shared that popularity as it furthermore generated its own textual tradition. Indeed, complete or fragmented, this chapter is often found emancipated from its original context.

Along with a textual tradition of its own, the first chapter of DTR spawned an enduring pictorial tradition. Since at least the ninth century, one finds illuminated manuscripts containing diagrammatic images of hands or human bodies depicting either a selection or each of the gestures described by Bede. Typically, drawings of hands are used to represent number-gestures below 10,000; human busts are used to represent the gestures between 10,000 and 900,000; and a full-bodied human figure interlacing both hands represents 1,000,000. Although it is possible to identify certain common characteristics among all illuminated sources, this tradition allows for a wide range of variability: sometimes manuscripts only include the hands; sometimes, full human figures are used to represent every number; most of the times the hand/bust depictions are arranged in a kind of grid, horizontally and vertically

---

<sup>94</sup> This poem is written at the end of fol. 124v of manuscript Berlin, Staatsbibliothek zu Berlin, Ms. Theol. Lat. Fol. 337. It is the only medieval text whose subject is medieval images of dactylonomy. There is no indication of the author. Full text: "De numeri meta dat scriptum signaque Beda./ His signis curas curis addendo figuras./ Ne quasi dicatur nichili seu despiciatur./ Quod sonat in dictis domini sacris quoque scriptis./ Hac contra vanum contendens Iovinianum./ Ex magna parte Ieronimus utitur arte./ Ipsius exactor laudabilis artis et auctor./ Hoc auctore satis lectori sint data gratis."

<sup>95</sup> "In the preface to *The Reckoning of Time*, Bede states that he not only 'gave' his earlier works on *computus* to his fellow monks, but also that he 'began to expound' these books to them. This suggests that he expected these works to be used not only for private study, but also as the basis for some kind of instruction. At several points in *The Reckoning of Time*, Bede actually lets us glimpse him at work, teaching *computus*." F. Wallis, "Introduction" in *The Reckoning*, xxxi. On this topic, see also: Charles William Jones, "Bede's place in medieval schools," in *Jones, Bede, the schools and the Computus*, ed. Wesley M. Stevens, Variorum collected studies series 436 (Aldershot, 1994), 261-285.

aligned; sometimes they are disposed in rows; and sometimes in columns, along the text of DCLD.

In most cases, the FS images come along with the text of DCLD, but they are also found supplementing the sixth chapter of Rabanus Maurus's DC, other *computus* texts, and, sometimes, even non-computistical texts. As this chapter shall show, although intimately connected with the *computus* tradition, the FS images show up in a wider variety of contexts, including arithmetic treatises, scripture commentaries, and grammar compilations.

Through the collection and analysis of a corpus of medieval illuminated manuscripts from all over western Europe, this chapter intends to shed light on the medieval usages of dactylonomy, as well as the conceptualizations of "number." It also aims at providing a proper frame of reference for the understanding of Portuguese codices Alc. 426 and Santa Cruz 8. Although these two manuscripts display unique characteristics that set them aside from the rest of the corpus, they are still part of the broader FS iconographic tradition.

## **2.1. A corpus of illuminated sources**

The illuminated manuscripts with dactylonomy images are unsurpassable sources for the understanding of how dactylonomy was used in medieval monastic settings. More than that, they help understanding the place, or places, of dactylonomy in the involved spectrum of medieval knowledge. But the importance of these sources goes beyond dactylonomy. They enable a finer apprehension of numeracy and visual culture in medieval intellectual and cultural history.

A set of medieval illuminated manuscripts with dactylonomy images was gathered, with the following criteria defined, in order to limit the corpus of sources to a manageable extension:

- i) Manuscripts containing sequential depictions of hands or human figures making gestures, according to Bede's DCLD. The purpose of this criterion is to exclude from the corpus a large number of illuminated manuscripts that, although they include diagrams of hands, they are not referring to the FS. Indeed, this criterion leaves behind a variety of interesting sources, such as codex Ross. 247 from the Biblioteca Apostolica Vaticana (henceforth, BAV) and Cotton Vitellius A XII from the British Library (henceforth, BL), both containing sequences of hand diagrams (Figure 4 and Figure 5),

but referring to systems other than the FS.<sup>96</sup> The latter, in particular, refers to a system that uses the finger knuckles to count moon and sun cycles, as described by Bede in the 55<sup>th</sup> chapter of DTR, “The cycle of both epacts, and how to calculate them using the fingers” (*De reditu et computu articulari utrarumque epactarum*).<sup>97</sup>



Figure 4. Vatican City, BAV, Ross. 247, fol. 69v (detail).

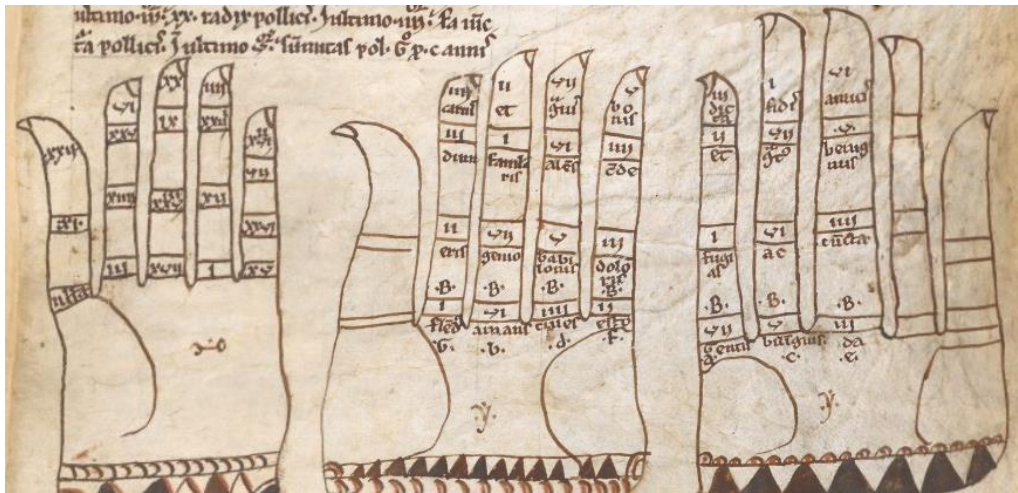


Figure 5. London, BL, Cotton Vitellius A XII, fol. 100r (detail).

- ii) Manuscripts produced until the thirteenth century. The main reason for fixing this end-limit is that the Portuguese manuscripts are not later than 1250. Furthermore,

<sup>96</sup> London, British Library, Cotton Vitellius A XII is a eleventh – twelfth c. *computus* collection, that contains some of the most important medieval *computus* works, such as Rabanus Maurus’s DC and Abbo of Fleury’s *De Cursu Septem Planetarum per Zodiacum Circulum*. See: Joseph Planta, *A Catalogue of the Manuscripts in the Cottonian Library Deposited in the British Museum* (London: British Museum, 1802), 379-80. Vatican, Biblioteca Apostolica Vaticana, Ross. 247 is another *computus* compilation, produced in Mainz in 1018. See: *Catalogo Dei Codici Miniati Della Biblioteca Vaticana. I: I Manoscritti Rossiani*, Edited by Biblioteca Apostolica Vaticana, Silvia Maddalo, Eva Ponzi, and Michela Torquati, Studi e Testi 481 (Città del Vaticano: Biblioteca apostolica vaticana, 2014).

<sup>97</sup> The same system is described by Rabanus Maurus in chapter 76 of DC. On this dactylonomy method see: Florence A. Yeldham, “An early method of determining Calendar dates by Finger reckoning,” *Archeion* 9:2–3 (1928): 325–26, <https://doi.org/10.1484/J.arch.3.313>. See also: Florian Cajori, “Comparison of Methods of determining Calendar Dates by Finger reckoning,” *Archeion* 9:1 (1928): 31–42. <https://doi.org/10.1484/J.arch.3.291>.

manuscripts dated later, such as Florence’s fifteenth century Plutei 30.26 and Berlin’s sixteenth century Ms. Lat. Fol. 436, display characteristics that fall outside the observable patterns in the remaining of the corpus – the most remarkable being that they use Indian numerals (Figure 6 and Figure 7).<sup>98</sup>



Figure 6. Florence, Biblioteca Medicea Laurenziana, Ms. Plut. 30.26, fol. 5v (detail).



Figure 7. Berlin, Staatsbibliothek zu Berlin, Ms. Lat. Fol. 436, fol. 1v (detail).

Under these constraints, it was possible to compile a corpus of 21 illuminated sources.<sup>99</sup> Their archives and shelf marks are listed in the table below, together with the placement of the images

<sup>98</sup> Both Berlin, Staatsbibliothek zu Berlin, Ms. lat. fol. 436 and Firenze, Biblioteca Medicea Laurenziana, ms. Plut. 30.26 are *computus* compilations. On the Berlin manuscript, see: Menso Folkerts, “Mittelalterliche mathematische Handschriften in westlichen Sprachen in der Berliner Staatsbibliothek. Ein vorläufiges Verzeichnis,” in *Mathematical perspectives: essays on Mathematics and its Historical Development*, ed. Joseph W. Dauben (New York: Academic Press, 1981), 65. On the Florence manuscript, see: *I manoscritti datati della Biblioteca Medicea Laurenziana. 1: Plutei 12 – 34*, ed. Teresa De Robertis, Cinza di Deo, Michaelangiola Marchiaro, *Manoscritti datati d’Italia 19* (Firenze: SISMEL - Edizioni del Galluzzo, 2008).

<sup>99</sup> The corpus is mostly drawn from the list of dactylonomy sources put together by Karl August Wirth in 1986. Wirth’s list is based on the work of renowned historians in the last decades: one should underscore Alfred Cordoliani’s work on *computus* manuscripts and the critical edition of the *De temporum ratione* by C. W. Jones, that includes a list of 245 manuscripts of DTR. Although extensive, Wirth’s list is not all-encompassing, as it excludes Santa Cruz 8. Of course that the incompleteness of the corpus is a fatality in any history project, as is the fact that many sources never reached modern times, because they were destroyed or otherwise lost along the way.

within the manuscripts, as well as their likely geographical origin and their estimated date of production:

City	Archive	Shelf mark	Fols.	Date	Origin
Berlin	Staatsbibliothek zu Berlin	Ms. theol. lat. fol. 337	124r-124v	1100-1200	Liesborn (OSB)
Florence	Biblioteca Medicea Laurenziana	Amiatinus III	212v	1056-1086	San Salvatore di Monte Amiata (OSB)
Leiden	Universiteitsbibliotheek Leiden	BPL 191 BD	4r-5v	1100-1150	?
Lisboa	Biblioteca Nacional de Portugal	Alc.426	251v-252r	1175-1225	Santa Maria de Alcobaça (Cistercian)
London	The British Library	Royal 13 A XI	33v	1075-1125	Centre or north of France
Madrid	Biblioteca Nacional de España	Ms. 19	2v-4v	1100-1200	Italy
Munich	Bayerische Staatsbibliothek	Clm 10270	4v-5v	1100-1125	Strasbourg
Munich	Bayerische Staatsbibliothek	Clm 14436	113v	1000-1100	St. Emmeram of Regensburg (OSB)
New York City	The Morgan Library & Museum	MS M.925	38r-39r	1018-1032	North of Italy

---

Even more so in this case, as Wirth points out: “Für den Lehrbetrieb erforderliche Darstellungen des F.systems dürfte es in sehr großer Zahl gegeben haben. Sie teilten das Schicksal aller Schulbücher und Lehrtafeln: Sie wurden im Gebrauch verschlissen oder gingen, als nutzlose Überbleibsel mißachtet, verloren, als man ihrer nicht mehr bedurfte, weil neue pädagogische Hilfsmittel verfügbar geworden waren. Es ist daher bei der Musterung der erhaltenen bildlichen Wiedergaben von F. stets in Rechnung zu stellen, daß die noch vorhandenen Zeugnisse wohl nur ein verschwindend geringer Teil des ehemals Vorhandenen sind.” K.-A. Wirth, “Fingerzahlen,” 4.C. See reference list in: K.-A. Wirth, “Fingerzahlen.” For Jones’ handlist of manuscripts, see: Beda, *Opera didascalica*, 242-256. Cordoliani’s academic production is vast and important. See, especially: “Les Traités de Comput Du Haut Moyen Age (526-1003),” *Archivum Latinitatis Medii Aevi* 17 (1943): 51–72; “Un Manuscrit de Comput Ecclesiastique Mal Connu de La Bibliotheque Nationale de Madrid,” *Revista de Archivos, Bibliotecas y Museos* 57 (1951): 5–35; “A propos du chapitre premier du De Temporum ratione, de Bède.” *Le Moyen âge : bulletin mensuel d’histoire et de philologie* 54 (1948): 209–23.

Padua	Biblioteca Antoniana	Ms. 27	116r-118r	900-950	South of Italy
Paris	Bibliothèque Nationale de France	Latin 3352B	1v-2r	1100-1200	France
Porto	Biblioteca Pública Municipal do Porto	Santa Cruz 8	180r	1175-1225	Santa Cruz de Coimbra (Regular Canons)
Reims	Bibliothèque Municipale de Reims	Ms. 431	44r-44v	1150-1200	Saint-Nicaise (OSB)
Rouen	Bibliothèque Municipale de Rouen	Ms. Leber 1157	3v-4r	1200-1300	Northeast of France
Turin	Biblioteca Nazionale Universitaria di Torino	Ms. D III 19	135r-136v	900-1100	North of Italy
Vatican City	Biblioteca Apostolica Vaticana	Pal. lat. 1449	118v	800-850	Lorsch (OSB)
Vatican City	Biblioteca Apostolica Vaticana	Urb. Lat. 290	31r-31v	1030-1180	Brauweiler (OSB)
Vatican City	Biblioteca Apostolica Vaticana	Vat. Lat. 642	16v-17r	1100-1300	France
Vatican City	Biblioteca Apostolica Vaticana	Reg. Lat. 1263	58r-60v	975-1007	Micy-Saint-Mesmin (OSB)
Vienna	Österreichische Nationalbibliothek	Cod. 12600	22r-23r	1100-1300	Prüfening (OSB)
Cava de' Tirreni	Biblioteca statale del Monumento nazionale dell'Abbazia Benedettina della Ss. Trinità	Cod. 3	3v,4v	1000-1100	Italy

The earliest source in the corpus is Vatican Pal. Lat. 1449, a manuscript from the Benedictine monastery of Lorsch dating from the first half of the ninth century.<sup>100</sup> Among its contents, there

---

<sup>100</sup> See: "Vatikan, Biblioteca Apostolica Vaticana, Pal. lat. 1449," *Bibliotheca Laureshamensis – digital* (2014): <https://doi.org/10.11588/diglit.4534>.

are several treatises authored by Bede, such as *De natura rerum* (105r-112v) and *De temporibus liber* (112v-118r), and other works related with *computus Paschalis* – such as *De ratione paschali* (14v-16r) by Dionysius Exiguus (ca. 470 – ca. 544) and the *Calculatio Albini* (11v-12r), attributed to Alcuin (ca. 735 – 804). The FS images (Figure 8) are inserted in fol. 118v, right after *De temporibus*. They consist of a sequence of thirty-six drawings of hands aligned horizontally and vertically, i.e., disposed in a  $6 \times 6$  grid-layout, depicting all the gestures presented in DCLD for numbers smaller than 10,000. From left to right, from top to bottom: units (1 – 9), tens (10 – 90), hundreds (100 – 900), and thousands (1000 – 9000). The hands are unlabeled, and unaccompanied by any descriptive text.



Figure 8. Vatican City, BAV, Pal. Lat. 1449, fol. 118v (detail).

The absence of text could imply an assumption that the reader would be acquainted with the FS – in a didactic framework, this assumption would be sensible. Or instead, the illuminations might be unfinished, as hinted by the fact that the following page (119r) is empty, perhaps

because it was destined to the remaining nineteen number-gestures: for the tens of thousands (10,000 – 90,000), for the hundreds of thousands (100,000 – 900,000), and for 1,000,000.

Vatican Pal. Lat. 1449 is a *computus* compilation. It is a collection of works, completed or fragmented, related with the *computus Paschalis*. In fact, out of the 21 illuminated manuscripts in the corpus, 12 are compilations that are either altogether or partially devoted to *computus*. Together with Bede's DTR and Rabanus Maurus's DC, Bede's *De temporibus* and *De natura rerum*, Isidore's *De natura rerum* and the *Liber de computo* by Helperic of Auxerre (d. 9<sup>th</sup> c.), are among the most regular works found in these compilations, alongside with *computus* poems, Paschal tables, and calendars.<sup>101</sup>

Some of these *computus* compilations, such as the Vatican Lat. 642, Vienna 12600, and Vatican Reg. Lat. 1263, contain the full DTR.<sup>102</sup> Some only contain excerpts. It is the case of codex London Royal, which also includes excerpts from the *Etymologies*, Pseudo-Hyginus's *De Astrologia*, and other scientific texts.<sup>103</sup> Likewise, Vatican Urb. Lat 290, Padua 27, and New York 925 are interesting compilations of *Computus*, that, besides DTR, contain excerpts from prominent works such as *De temporibus*, by Bede; and less famous ones, such as *De curso stellarum* by Gregory of Tours.<sup>104</sup>

The manuscripts Madrid 19 and Cava 3, along with the thirteenth century manuscript Latin 7418 from the Bibliothèque Nationale de France (henceforth, BNF), follow their own tradition. In fact, these all share a common ancestor, probably compiled in Monte Cassino in

---

<sup>101</sup> On the content of medieval *computus* compilations, see: Ivana Dobcheva, "The Umbrella of Carolingian Computus," In *La Compilación Del Saber En La Edad Media*, edited by María José Muñoz, Patricia Cañizares Ferris, and Cristina Martín, Textes et Études Du Moyen Âge (Turnhout: Brepols Publishers, 2013), 69:211–29, <https://doi.org/10.1484/M.TEMA-EB.4.01053>.

<sup>102</sup> On the Vatican Lat. 642, see: Arno Borst, *Schriften zur Komputistik im Frankenreich von 721 bis 818*, Monumenta Germaniae Historica, Quellen zur Geistesgeschichte des Mittelalters 21 (Hannover: Hahnsche Buchhandlung, 2006): 1: 258-60, 309-10. On Vatican Reg. Lat. 1263, see: Charlotte Denoël, "Imaging Time, Computation and Astronomy: A Computus Collection from Micy-Saint-Mesmin (Vatican, BAV, MS Reg. Lat. 1263) and Early Eleventh-Century Illumination in the Loire Region," In *After the Carolingians*, edited by Beatrice Kitzinger and Joshua O'Driscoll (Boston: De Gruyter, 2019), 118–60, <https://doi.org/10.1515/9783110579499-005>. On the Vienna 12600, see: H. J. Hermann, *Die deutschen romanischen Handschriften: Beschreibendes Verzeichnis der illuminierten Handschriften in Österreich. II. Band: Die illuminierten Handschriften und Inkunabeln der Nationalbibliothek in Wien* (Leipzig: Karl W. Hiersemann, 1926), 73-73.

<sup>103</sup> On the London Royal, see: George F. Warner, and Julius P. Gilson, *Catalogue of Western Manuscripts in the Old Royal and King's Collections* (London: British Museum, 1921) 2:80-81.

<sup>104</sup> On the Vatican Urb. Lat. 290, see: Arno Borst, *Schriften zur Komputistik im Frankenreich von 721 bis 818*, Monumenta Germaniae Historica, Quellen zur Geistesgeschichte des Mittelalters 21 (Hannover: Hahnsche Buchhandlung, 2006): 1: 258-60, 309-10. On the New York 925, see: "Computus Collection," *Medieval & Renaissance Manuscripts*, <https://www.themorgan.org/manuscript/160011> (accessed April 4, 2021). On the Padua 27, see: Giuseppe Abate, and Giovanni Luisetto, *Codici e manoscritti della Biblioteca Antoniana col Catalogo delle miniature a cura di François Avril, Francesca d'Arcais, Giordana Mariani Canova*, Fonti e studi per la storia del Santo a Padova 1-2 (Vicenza: Neri Pozza Editore, 1975): 28-33.

the beginning of the eleventh century, a *florilegium*, with texts of an assorted nature but a large portion dedicated to *computus*, including the DCLD.<sup>105</sup> These three manuscripts display unique pictorial features, such as the presentation of all gestures using full-bodied human figures (Figure 9).

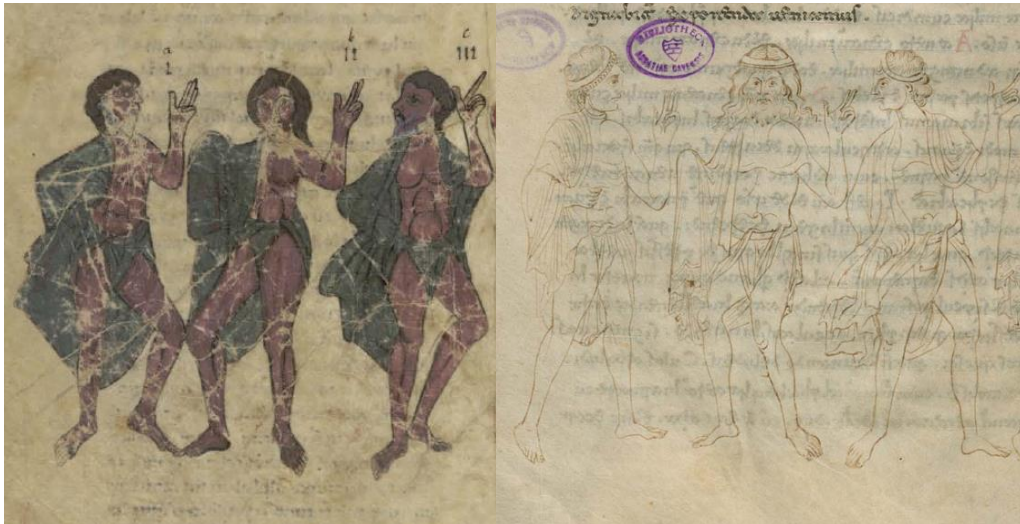


Figure 9. Madrid, Biblioteca Nacional de España, Ms. 19, fol. 2v (detail) / Cava de' Tirreni, Biblioteca statale del Monumento nazionale dell'Abbazia Benedettina della Ss. Trinità, Cod. 3, fol. 3v (detail).

It is not always the case that FS images accompany the DCLD text. For example, the early twelfth century manuscript Leiden 191 contains no DTR excerpt: here, the FS images accompany the text of Rabanus Maurus's DC.<sup>106</sup> Analogously, in Munich 10270, also from the early twelfth century, the images accompany Helperic's *De computo*.<sup>107</sup>

The fact that the majority of the corpus sources are related to *computus* seems to prove that, in the period under study, the FS was first and foremost seen as a computistical tool. As it has been already stated, *computus* was not limited to its functionality of setting the date of Easter. Instead, it was defined by an ever expanding and varied body of scientific knowledge that "touched upon the broader context of music, prosody, prognostics, medicine, and

---

<sup>105</sup> On the Cava 3, Madrid 19, and Paris 7418, see: Elizabeth Susan Lott, "The Florilegium of Cava 3, Madrid 19 and Paris 7418," PhD diss., (Harvard University, 1980).

<sup>106</sup> On the Leiden 191, see: *Bibliotheca Academiae Lugduno-Batavae, Catalogus deel XIV inventaris van de handschriften eerste afdeeling*, (Leiden: Universiteits Bibliotheek, 1932).

<sup>107</sup> On the Munich 10270, see: Arno Borst, *Schriften zur Komputistik im Frankenreich von 721 bis 818*, Monumenta Germaniae Historica, Quellen zur Geistesgeschichte des Mittelalters 21 (Hannover: Hahnsche Buchhandlung, 2006): 1: 258-60, 309-10.

astronomy.”<sup>108</sup> Being dactylonomy at the very foundations of *computus* and being *computus* at the core of the medieval natural world knowledge, this is not a small remark. Fingers were valuable scientific tools, and their gestures were necessary for comprehending the mysteries of the universe.

## 2.2. From arithmetic to scripture

Comprising no *computus* text at all, but in the “quadrivial” sphere, is the twelfth century manuscript Paris 3352B.<sup>109</sup> This manuscript begins with another diagrammatic set of thirty-six hand depictions (1v-2r), but this time they are spread over two  $6 \times 3$  grids and are labeled with the corresponding Roman numerals (Figure 10).



Figure 10. Paris, BNF, Latin 3352B, fol. 1v (detail).

The images are followed by the arithmetic-philosophy-theology treatise titled *Analytica numerorum et rerum in theographiam*, attributed to the Cistercian Odo of Morimond (d. ca. 1200), on the symbolism of numbers. By putting the Roman letters and the gesture representations together, this type of diagram is able to, in a single move, set the basic groundwork required to move forward in a work heavily dependent on numbers, as it coalesces the two ways in which numbers can be demonstrated, according to Rabanus Maurus:

Disciple: Hence, in what manner is the demonstration of numbers done?

---

<sup>108</sup> I. Dobcheva, “The Umbrella of Carolingian Computus,” 214.

<sup>109</sup> See: “Latin 3352B,” *Archives et manuscrits, BNF*, <https://archivesetmanuscrits.bnf.fr/ark:/12148/cc61243s> (accessed April 7, 2021).

Master: In two ways.

Disciple: How?

Master: Well, either numbers are written through words, or they are expressed through the flexing of fingers.<sup>110</sup>

Indeed, the diagram in the beginning of Latin 3352B serves the same purpose as chapters 4-6 in DC: to explain the demonstration of numbers (chapter 4 – *de numeri demonstratione*) via letters (chapter 5 - *quomodo numeri litteris notentur*) and via gestures (chapter 6 - *quomodo digitis significantur*).<sup>111</sup>

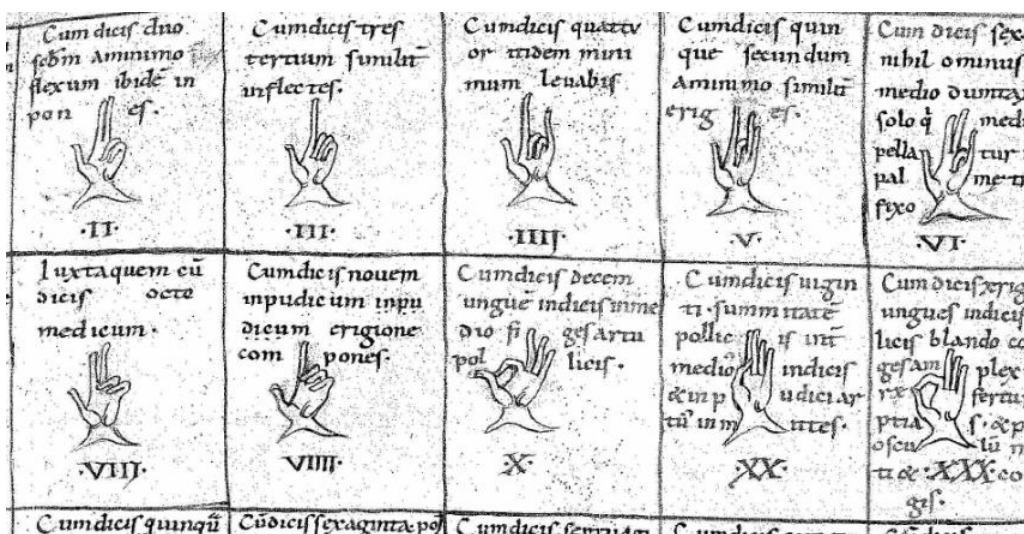


Figure 11. Munich, Bayerische Staatsbibliothek, Clm 14436, fol. 113v (detail).

Munich 14436, an eleventh century study book from the Benedictine monastery of St. Emmeram of Regensburg, seems to follow the same logic as Paris 3352B.<sup>112</sup> Here, right before a small treatise on arithmetic – “*De numerorum divisione*” – one finds a hand diagram in a 6 × 6 grid-layout accompanied by descriptions of each gesture taken from the DCLD (Figure 10). This codex is particularly interesting for its encyclopedic character, for it comprises works that

<sup>110</sup> “Discipulus: Demonstratio ergo numerorum quomodo constat? Magister: Duobus modis. D: Quomodo? M: Aut enim litteris numeri notantur aut digitorum inflexionibus exprimentur.” Rabanus Maurus, *Martyrologium*, 209.

<sup>111</sup> See Appendix C.

<sup>112</sup> On manuscript Munich 14436, see: *Katalog der lateinischen Handschriften der Bayerischen Staatsbibliothek in München. Die Handschriften aus St. Emmeram in Regensburg IV Clm 14401-14540*, edited by Friedrich Helmer, Julia Knödler, and Günter Glauche, *Catalogus codicum manu scriptorum Bibliothecae Monacensis IV, Series nova 2, 4* (Wiesbaden: Harrassowitz, 2015), 111-119. See also the study by Harriet Pratt Lattin: “The Eleventh Century MS Munich 14436: Its Contribution to the History of Co-Ordinates, of Logic, of German Studies in France,” *Isis* 38:3/4 (February 1948): 205–25, <https://doi.org/10.1086/348075>.

spread from rhetoric, including the famous *Rhetorica ad Herennium*, to dialectic, including Boethius's commentary on the *Isagogue* by Porphyry; and it also contains excerpts from Pliny's *Natural History*, and Macrobius's *Commentarii in somnium Scipionis*. The presence of dactylonomy in this type of a compilation only confirms its pervasiveness and basic importance in medieval intellectual culture.

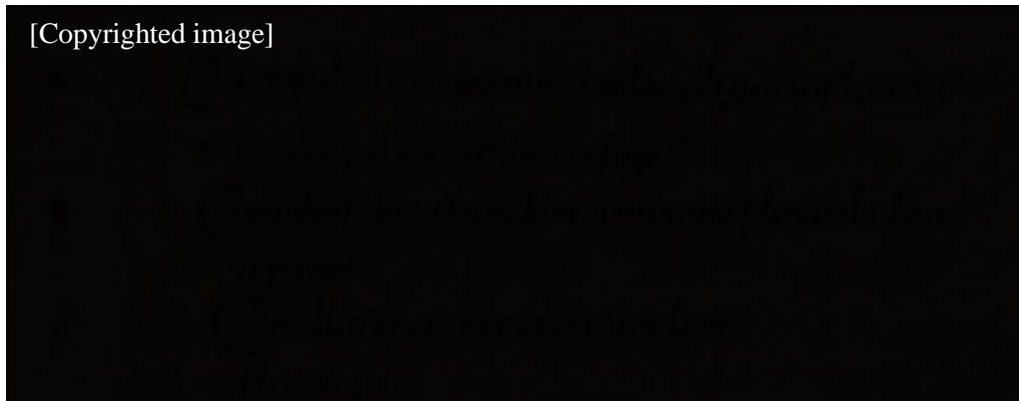


Figure 12. Florence, Biblioteca Medicea Laurenziana, Codex Amiatinus III, fol. 212v (detail).

In a wholly different context are the images of Codex Amiatinus III.<sup>113</sup> These follow Bede's emphasis on the study of scripture. Besides containing an excerpt of DCLD, accompanied by depictions of hands, this large manuscript is mostly composed of homilies and biblical commentaries, by renowned authors such as Jerome, Origen, Augustine, Bede and Rabanus Maurus. Interestingly, this is the only source in the corpus where hand depictions are labeled with *abecedarium* letters, instead of numerals (Figure 12). As noted in the previous chapter, Bede links the FS gestures not just to numbers, but also to letters: "when you wish to show the first letter of the alphabet, hold up 'one' with your hand; for the second, 'two'; for the third, 'three' and so on in that order."<sup>114</sup> This fact is all the more significant as this DCLD excerpt is preceded by Rabanus Maurus's *De laudibus Sanctae Crucis*, the first book of which comprises a sequence of twenty-eight poems inscribed in squares overlapped with thematic images; and the second contains explanations on the figured poems (*carmina figurata*) of the first book.<sup>115</sup>

---

<sup>113</sup> Angelus Maria Bandinius, *Bibliotheca Leopoldina Laurentiana seu Catalogus manuscritorum qui [...] in Laurentianam translati sunt – tomus I* (Florence: typis Caesaris, 1791), 637-694.

<sup>114</sup> "Cum primam alphabeti literam intimari cupis, unum manu teneto; cum secundam, duo; cum tertiam, tria; et sic ex ordine ceteras." Beda, *Opera didascalica*, 272. See Appendix B.

<sup>115</sup> For a study on the relationship between image and text on Rabanus Marus's *De laudibus Sanctae Crucis*, see: Vânia Maria Coutinho, "Carmina figurata e a teoria da imagem carolíngia: contributos para uma reflexão

Rabanus Maurus's *carmina figurata* are masterful games of letters, numbers, and images, where every element is interconnected: letters are pictorial, figures are textual, everything is numerical. Each poem, depicted as a grid made of letters, is designed according to complex mathematical criteria, attempting to mimic the geometrical and arithmetical inventiveness of a mathematician God.<sup>116</sup> Hence, the DCLD alpha-gestural code is not simply “for the sake of exercising one’s wits, or as a game,” as it was for Bede. Now, letters, tied to numbers, have a cosmic significance.<sup>117</sup>

Apart from the Amiatinus III, two manuscripts in the corpus can be placed in the exegesis sphere. The first is the intriguing twelfth century Berlin 337, from the Benedictine monastery of Liesborn, that contains Augustine’s *City of God*, interleaved by a folio written by a different hand, beautifully decorated, with the text of DCLD and images of dactylonomy (124r-124v) (Figure 13).<sup>118</sup>



Figure 13. Berlin, Staatsbibliothek zu Berlin, Ms. Theol. Lat. Fol. 337, fol. 124r (detail).

sobre a relação texto-imagem,” PhD diss., (Universidade Nova de Lisboa, 2016), <https://run.unl.pt/handle/10362/19090>.

<sup>116</sup> Michel Perrin carries out a numerical analysis of Rabanus Maurus’s *carmina figurata*. He observes that there are 28 poems – a perfect number, because it is equal to the sum divisors: 1, 2, 4, 7, 14, and 28. Surprisingly or not, 14 poems have 36 letters per verse; 7 have 35; 4 have 39; 2 have 36; 1 has 41. This means that the poems are split by the divisors/summands of 28. However, despite all the emphasis that Rabanus Maurus clearly gives to numerical symbolism, Perrin insists that the poems have no esoteric purposes. Instead, they aim at praising a perfect, geometric and numerologic God. See: M. Perrin, *L’iconographie de la Gloire à la sainte croix de Raban Maur*, Le Corpus du Rilma 1 (Turnhout: Brepols, 2009), 36-40.

<sup>117</sup> “An immediate striking visual parallel is found in the lattice-work of Rabanus Maurus’ *Liber sanctae crucis*, where letters, rhythm, Christic motifs and a rigorous grid pattern combine in what must count as one of the summits of alphanumeric art.” J. Acevedo, *Alphanumeric Cosmology*, 227.

<sup>118</sup> On the Berlin 337, see: Valentin Rose, *Verzeichniss der Lateinischen Handschriften der Königlichen Bibliothek zu Berlin, Zweiter Band: Die Handschriften der Kurfürstlichen Bibliothek und der Kurfürstlichen Lande*, Die Handschriften-Verzeichnisse der Königlichen Bibliothek zu Berlin 13 (Berlin: Asher, 1901), 83-84; Andreas Fingernagel, *Die illuminierten lateinischen Handschriften deutscher Provenienz der Staatsbibliothek zu Berlin Preussischer Kulturbesitz: 8 - 12 Jahrhundert: Teil 1* (Wiesbaden: Harrassowitz, 1991), 35-37.

The *City of God* is neither a work on *computus*, nor on arithmetic – hence, the connection between Augustine’s treatise and DCLD is not immediate, and until now it had remained unsolved. It is necessary to read the text surrounding the supposedly foreign folio. Folio 124 is inserted in a clearly deliberate manner, in the middle of chapter 16 of book 16, where Augustine gives an account of the two cities – the city of God and the earthly city – since the time of Noah to the time of the kings of Israel. But, as it turns out, this entire book is filled with numbers and calculations, particularly of generations and of time periods. For example, in chapter 3, Augustine makes the following sum: “adding together then all the descendants of the 3 sons of Noe – that is, the 15 from Japheth, the 31 from Cham and the 27 from Sem – we get 73”<sup>119</sup>; and in chapter 24 he calculates the time when Isaac was born:

By calculating from the 75<sup>th</sup> year of Abraham, when the 1<sup>st</sup> of the promises was made, down to the exodus of Israel from Egypt, we get 430 years (...) at the time when Isaac was born in his father's 100<sup>th</sup> year, which was 25 years after the 1<sup>st</sup> of the promises. Taking away those 25 from the 430 would leave 405.<sup>120</sup>

The choice of chapter 16 to introduce the FS images is not arbitrary. In this chapter, Augustine faces a complicated calculation problem: God made two promises to Abraham. The first one was made in Mesopotamia, before Abraham had moved to the land of Haran; the second was made when Abraham was 75 years old; however, Abraham was already 75 when he traveled to Haran. The only option, Augustine concludes with a flawless reasoning, is that the two promises were made in the same year, when Abraham was 75.<sup>121</sup>

---

<sup>119</sup> “In summa igitur omnes progeniti de tribus filiis Noe, id est quindecim de Iapheth, triginta unus de Cham, viginti septem de Sem fiunt septuaginta.” Augustine, *City of God, Volume V: Books 16-18.35*, translated by Eva M. Sanford, William M. Green, Loeb Classical Library 415 (Cambridge, MA: Harvard University Press, 1965), 22-23.

<sup>120</sup> “Computantur enim, sicut superius iam diximus, ab anno septuagesimo et quinto Abrahae, quando ad eum facta est prima promissio, usque ad exitum Israel ex Aegypto quadringenti et triginta anni; quorum apostolus ita meminit: Hoc autem dico, inquit: testamentum confirmatum a Deo post quadringentos triginta annos facta lex non infirmat ad euacuandam promissionem. Iam ergo isti quadringenti et triginta anni quadringenti poterant nuncupari, quia non sunt multo amplius: quanto magis cum aliquot iam ex isto numero praeterissent, quando illa in uisu demonstrata et dicta sunt Abrahae, uel quando Isaac natus est centenario patri suo, a prima promissione post uiginti quinque annos, cum iam ex istis quadringentis triginta quadringenti et quinque remanerent, quos Deus quadringentos uoluit nominare.” Augustine, *City of God*, 116-117.

<sup>121</sup> “Hanc promissionem factam arbitratur Eusebius septuagesimo quinto anno aetatis Abrahae, tamquam mox ut facta est de Charra exierit Abraham; quoniam scripturae contradicere non potest, ubi legitur: Abram erat quinque et septuaginta annorum, cum exiit ex Charra. Sed si eo anno facta est ista promissio, iam utique in Charra cum patre suo demorabatur Abraham. Neque enim exire inde posset, nisi prius ibi habitasset. Numquidnam ergo contradicatur Stephano dicenti: Deus gloriae apparuit Abrahae patri nostro, cum esset in Mesopotamia, priusquam habitaret in Charra? Sed intellegendum est, quod eodem anno facta sint omnia, et Dei promissio, antequam in

The other “exegetic” manuscript is thirteenth century Rouen 1157.<sup>122</sup> Together with the text of DCLD and another hand diagram labeled with Roman numerals (Figure 14), this small manuscript only contains a fragment from the book of Exodus (38:26-40:36) and a commented excerpt from the Book of Jeremiah (51: 6-8).



Figure 14. Rouen, Bibliothèque Municipale de Rouen, Ms. Leber 1157, fol. 4r (detail).

As in the Berlin manuscript, one must inspect the context to properly frame the dactylonomy text and images. The Exodus excerpt deals with the construction of the sanctuary of God and includes detailed guidelines on the items to be placed in the tabernacle, as well as the exact measurements of the courtyard, and the garments that Aaron and his descendants are supposed to wear. Again, it is a piece of text filled with numbers. For example, when describing the courtyard, it is said:

There were moreover *a hundred* talents of silver, whereof were cast the sockets of the sanctuary, and of the entry where the veil hangeth. *A hundred* sockets were made of *a hundred* talents, *one* talent being reckoned for every socket. And of the *thousand seven hundred* and *seventy-five* he made the heads of the pillars, which also he overlaid with silver. And there were offered of brass also *seventy-two thousand* talents, and *four hundred* sicles besides.<sup>123</sup>

---

Charra habitaret Abraham, et in Charra habitatio eius et inde profectio; non solum quia Eusebius in chronicis ab anno huius promissionis computat et ostendit post quadringentos et triginta annos exitum esse de Aegypto, quando lex data est, uerum etiam quia id commemorat apostolus Paulus.” Augustine, *City of God*, 88-91.

<sup>122</sup> On Rouen 1157, see: Henri Omont, *Catalogue général des manuscrits des bibliothèques publiques de France: Départements – Tome II* (Paris: Plon, Nourrit & cie, 1888), 79.

<sup>123</sup> “Fuerunt praeterea centum talenta argenti e quibus conflatae sunt bases sanctuarii, et introitus, ubi velum pendet. Centum bases factae sunt de talentis centum, singulis talentis per bases singulas supputatis. De mille autem

The images in the Rouen manuscript could be meant as rhetorical aids to deliver sermons – *actio* – or they could be visual ornaments aimed at providing vividness to the sacred narrative – *enargeia*. In any case, their presence would enrich the experience of the *lectio divina*, turning it into a multisensory and absorbing experience.

### 2.3. Lexicographical manuscripts

The four remaining illuminated manuscripts are Reims 431, Turin D.III.19, and the Portuguese manuscripts Alc. 426 and Santa Cruz 8. What distinguishes these sources from the rest is their grammatical framing. Surely, there are other medieval European compilations combining *computus* and *grammatica*, however, unlike these codices and other few exceptions, most of those compilations are *computus* anthologies with small *grammatica* excerpts, not the other way around. Furthermore, those grammar elements typically focus on elements of prosody: pronunciation, orthography, quantity, accent, and meter, because “computists implicitly or explicitly claimed that prosody had an innate affinity with *computus*.”<sup>124</sup> But the emphasis of these manuscripts is not on prosody, but instead on lexicography.

Reims 431, dated from the second half of the twelfth century, from the Benedictine monastery of Saint-Nicaise, contains Isidore’s *Etymologies*.<sup>125</sup> Some of the aforementioned *computus* collections include fragments from the *Etymologies*, especially from the section dedicated to astronomy (3.24-71), but here, the *Etymologies* is presented in its full extent, only “interrupted” by the text of DCLD and dactylonomy images (44r-44v) (Figure 15), between the sixth book of the *Etymologies*, “Books and ecclesiastical offices” (*De libris et officiis ecclesiasticis*), and book 7, “God, angels, and saints” (*De Deo, angelis et sanctis*).<sup>126</sup>

---

septingentis et septuaginta quinque, fecit capita columnarum, quas et ipsas vestivit argento. A Eris quoque oblata sunt talenta septuaginta duo millia, et quadringenti supra sicli.” *Exodus* 38:26-29. Translation taken from the Douay-Rheims version.

<sup>124</sup> Faith Wallis, “13. Grammar: 1. Overview,” *The Calendar and the Cloister: Oxford, St John's College MS17*, McGill University Library, Digital Collections Program (2007), <https://digital.library.mcgill.ca/ms-17/folio.php?p=167r> (accessed October 16, 2020). Several examples of such manuscripts are given, such as: Paris, Bibliothèque Nationale de France, lat. 7518; Oxford, St. John’s College, Ms. 17.

<sup>125</sup> On Reims 431, see: Henri Loriquet, *Catalogue général des manuscrits des bibliothèques publiques de France: Départements – Tome XXXVIII* (Paris: Plon-Nourrit & cie, 1904), 579-584.

<sup>126</sup> For example, London Royal contains chapters 58 (*de eclipsi solis*) and 59 (*de eclipsi lunae*) from book 3 (fols. 126v-127r).

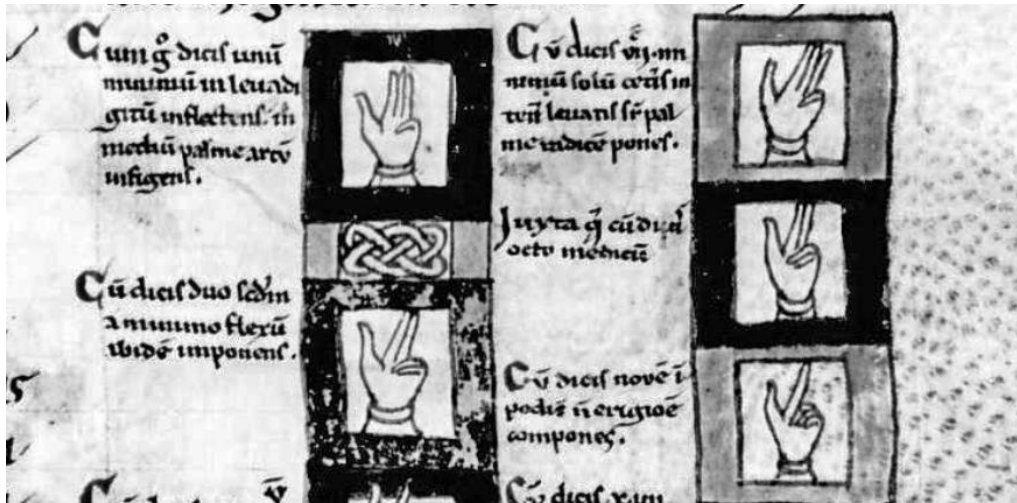


Figure 15. Reims, Bibliothèque Municipale de Rouen, Ms. 431, fol. 44r (detail).

It makes sense that these images are at the end of book 6, because chapter 17 of book 6 is about “the Easter cycle” (*De cyclo Paschali*), giving an introduction to *computus*, and mentioning, among other concepts, the lunar and solar cycles, the Jewish Passover, epacts, and leap years. The location of the images is thus explained both by the content of the text and by the available space between chapters.

The other *Etymologies* exemplar interleaved with FS images is the tenth or eleventh century manuscript Turin D.III.19 (Figure 16).<sup>127</sup> Unlike the Reims manuscript, at first sight, the images in this manuscript seem to have no justifiable reason for their location. And this time, instead of being placed in a book break or chapter break, this two-folio-long sequence of hands and human figures seems to appear out of nowhere, unaccompanied by any descriptive text, after a completely unrelated entry: that of “throat” (*gurgulio*).<sup>128</sup> The images are located in the middle of book 11, dedicated to “men and prodigious beings” (*de homine et portentis*) in the middle of chapter 1, dedicated to “men and his parts” (*de homine et partibus eius*). From a certain point on, the chapter goes through each part of the human body, in a descending motion, e.g., forehead is defined before eyes, and nose before tongue. Little after “*gurgulio*,” among many other body parts, Isidore defines “fingers” (*digiti*), thus:

<sup>127</sup> On the Turin D.III.19, see: Albano Sorbelli, *Inventari dei manoscritti delle biblioteche d'Italia: Volume XXVIII – Torino* (Florence: Casa Editrice Leo S. Olschki, 1922), 51.

<sup>128</sup> “Gurgulio a gutture nomen trahit, cuius meatus ad os et nares pertendit: habens viam qua vox ad linguam transmittitur, ut possit verba concludere. Vnde et garrere dicimus.” Isidore, *Etimologías*, 854-855 (11.1.58).

The fingers are so called, either because there are ten (*decem*) of them, or because they are connected handsomely (*decenter*), for they combine in themselves both the perfect number and the most appropriate order. The first finger is called thumb (*pollex*), because among the rest it prevails (*pollere*) in strength and power. The second is the index finger (*index*), which is also called the ‘greeter’ (*salutaris*) or ‘pointer’ (*demonstratorius*), because we greet someone (*salutare*) or point something out (*ostendere*) usually with it. The third finger is called ‘immodest’ (*impudicus*), because often an accusation of a shameful action is expressed by it. The fourth is the ring (*anularis*) finger, because it is the one on which the ring (*anulus*) is worn. It is also called medical (*medicinalis*) because physicians (*medicus*) use it to scoop up ground eye-salves. The fifth is called *auricularis*, because we use it to scrape out the ear (*auris*).<sup>129</sup>



Figure 16. Turin, Biblioteca Nazionale Universitaria di Torino, Ms. D.III.19, fol. 135r (detail).

But the relationship between this section of the *Etymologies* and the images displayed in the Turin manuscript is stronger still. Following the habitual 36 depictions of hands representing the units, tens, hundreds, and thousands, this manuscript also includes 18 depictions of human busts making the gestures for the tens of thousands (10,000-90,000) and the hundreds of thousands (100,000-900,000). As described in DCLD, the gestures for these higher values

---

<sup>129</sup> “*Digiti noncupati, vel quia decem sunt, vel quia decentur iuncti existunt. Nam habent in se et numerum perfectum et ordinem decentissimum. Primus pollex vocatus, eo quod inter ceteros polleat virtute et potestate. Secundus index et salutaris seu demonstratorius, quia eo fere salutamus vel ostendimus. Tertius impudicus, quod plerumque per eum probri insectatio exprimitur. Quartus anularis, eo quod in ipso anulus geritur. Idem et medicinalis, quod eo trita collyria a medicis colliguntur. Quintus auricularis, pro eo quod eo aurem scalpimus.*” Isidore, *Etimologías*, 856-857 (11.1.70-71). Translation taken from Isidore, *The Etymologies*, 235.

require moving the hands to specific body parts: for instance, to represent 100,000 one must place the right hand flat on the middle of the chest (*pectus*), with the fingers pointing upwards to the neck (*collum*); and to represent 80,000 one must lay the left hand flat on the left thigh (*femur*).<sup>130</sup> As it happens, soon after “*gurgulio*,” in the eleventh book of the *Etymologies*, Isidore defines all those body parts except one – “groin” (*inguen*), which is previously defined, in book 4 – going through: “neck” (*collum*); “chest” (*pectus*); “cartilage” (*cartilagine*); “navel” (*umbilicus*); “thigh” (*femur*); “loin” (*lumbus*).<sup>131</sup>

The role played by the FS images in each of two *Etymologies* manuscripts differ considerably. In both sources, they are perfectly integrated in the text. But the Turin manuscript gives a new meaning to the images, as the focus is shifted from numbers to body-parts. While the link between text and image in the Reims manuscript is computistical, in the Turin manuscript it is anatomical. As for the Portuguese manuscripts, they beg a wholly different set of challenging questions.

The Portuguese manuscripts are, in many ways, outliers of the European tradition. For one, as it shall be shown in chapter 4, the depictions of hands and busts are disposed in a unique combination of layouts. These images are preceded by the first three chapters of Rabanus Maurus’s DC and, in Santa Cruz 8, Bede’s DCLD. But, although both DTR and DC are *computus* treatises, these manuscripts are not computistical. In fact, approximately 99% of the content of Alc. 426 and Santa Cruz 8 is related to grammar.



Figure 17. Porto, Biblioteca Pública Municipal do Porto, Santa Cruz 8, fol. 180r (detail).

<sup>130</sup> See: Bede, *Opera didascalica*, 270-271. See Appendix B.

<sup>131</sup> The placement of each entry in the *Etymologies* is as follows: “*inguen*”: 4.6.19; “*collum*”: 11.1.60; “*pectus*”: 11.1.74; “*cartilagine*”: 11.1.88; “*umbilicus*”: 11.1.99; “*femur*”: 11.1.106; “*lumbus*”: 11.1.98.



Figure 18. Lisbon, Biblioteca Nacional de Portugal, Alc. 426, fol. 251v (detail).

Codices Alc. 426 and Santa Cruz 8 contain three works of lexicographical nature, comprising approximately 72% of their entire content: a section of the famous encyclopaedia *Elementarium doctrinae rudimentum* by Papias the Lombard (fl. 1040s-1060s), a large alphabetically-ordered dictionary with definitions, derivations, and etymologies; Jerome's biblical glossary *Liber interpretationis hebraicorum nominum*, with the definitions for all the Hebrew names found in the Bible; and Bede's dictionary of toponyms in the Acts of the Apostles *Nomina regionum atque locorum de actibus apostolorum*.<sup>132</sup> Furthermore, they also include Papias's grammar treatise *De arte grammatica*, a treatise introducing basic concepts of grammar, such as nouns, pronouns, and verbs; Alc. 426 also adds an excerpt of the *Ars minor* by Donatus, dealing with the same topics.<sup>133</sup> The Papias's and Donatus's grammar excerpts comprise approximately 27% of the total size of the Portuguese manuscripts. Furthermore, small texts of grammatical nature were appended by later hands to Alc. 426. Little doubt remains as to the underlying theme of these codices: these are books devoted to words.<sup>134</sup>

<sup>132</sup> The *Liber interpretationis* and *Nomina regionum* have been edited: Hieronymus, *Hebraicae quaestiones in libro Geneseos. Liber interpretationis hebraicorum nominum. Commentarioli in psalmos. Commentarius in Ecclesiasten*, edited by P. de Lagarde, M. Adriaen, and G. Morin, Corpus Christianorum Series Latina 72 (Turnhout: Brepols, 1959); Beda Venerabilis, *Opera exegetica: Expositio Actuum apostolorum. Retractatio in Actus apostolorum. Nomina regionum atque locorum de Actibus apostolorum. In epistulas VII catholicas*, edited by D. Hurst and M.L.W. Laistner, Corpus Christianorum Series Latina 121 (Turnhout: Brepols, 1983). An open-access electronic critical edition is in the making for the *Elementarium*. See: Anne Grondeux, "L'Elementarium ou Vocabularium de Papias," *European Lexicography in the Middle Ages*, (Paris: 2018), elma.linguist.univ-paris-diderot.fr/spip.php?article23 (accessed April 28, 2021).

<sup>133</sup> For an analysis of the Donatus's fragment in Alc. 426, see: Gonçalo Fernandes, "A *Ars minor* donatiana do mosteiro de Alcobaça (séc. XIII) e a edição crítica de Holtz (1981)," *Beitrage zur Geschichte der Sprachwissenschaft* 26 (December 2016): 229–42. Editions of Papias's and Donatus's *Ars grammatica* are available: Donatus Ortigraphus, *Grammatici Hibernici Carolini aevi IV: Ars grammatica*, edited by J. Chittenden, Corpus Christianorum Continuatio Mediaevalis 40D (Turnhout: Brepols, 1982); Roberta Cervani, *Papiae Ars grammatica*, Testi e manuali per l'insegnamento universitario del latino 50, (Bologna: Patron, 1998).

<sup>134</sup> At least two other grammatical manuscripts deserve attention for their similarities to Alc. 426 and Santa Cruz 8. The first is Bern, Burgerbibliothek, Cod. 207 (Corpus Grammaticorum Latinorum). Dated from the end of the eighth century or the beginning of the ninth, it is the oldest grammar manuscript from Fleury, containing

<b>Alc. 426</b>	<b>Work</b>	<b>Santa Cruz 8</b>
fols. 1v-155v	Papias, <i>Vocabularium</i> [Q-Z]	fols. 1r-105v
fols. 155v-220r	Papias, <i>De arte grammatica</i>	fols. 105v-155r
fols. 220r-249r	Hieronymus, <i>Liber interpretationis hebraicorum nominum</i>	fols. 155r-177r
fols. 249r-250v	Beda Venerabilis, <i>Nomina regionum atque locorum de actibus apostolorum</i>	fols. 177r-178v
fols. 250v-251v	Hrabanus Maurus, <i>De computo</i>	fols. 178v-179r
–	Beda Venerabilis, <i>De temporum ratione</i>	fols. 179r-180r
fols. 251v-252r	Dactylonomy images	fol. 180r
fols. 252v-258r	Aelius Donatus, <i>Ars grammatica</i>	–
fol. 258r	<i>Versus accentuales</i>	–
fol. 258v	<i>De pronuntiatione huius littere “x”</i>	–
fol. 259r	Alcuinus, <i>De psalmorum usu</i>	–

In this grammatical framing, the inclusion of excerpts of DC and DTR, and the FS images that accompany them, might look odd. Unlike the Reims and Turin manuscripts, where the DCLD and the FS images were referring to another passage, here, the texts and images stand on their own. So, what is their significance? One could expect that finger-counting to be closer to the *quadrivium* liberal arts (arithmetic, geometry, music, and astronomy) than to the *trivium* (grammar, logic, rhetoric). But this evaluation is questionable in a number of ways. Firstly, as the remaining of the corpus sources clearly demonstrated, dactylonomy is a cross-disciplinary *medium*, that is used for exegesis and rhetoric.<sup>135</sup> Furthermore, there is a close connection

---

ancient and early medieval grammar treatises, such as the *Ars grammatica* by Donatus, and also the DCLD. Alc. 426 also contains Donatus’s treatise. Another relevant example of an inclusion of DCLD among seemingly unrelated works is the thirteenth or fourteenth century manuscript Princeton, NJ, Princeton University Library, Garrett Ms. 71. Together with other texts, it includes Bede’s *Nomina regionum atque locorum de Actibus apostolorum*, also contained in Alc. 426 and Santa Cruz 8. On Garrett Ms. 71, see: Don C. Skemer, *Medieval and Renaissance Manuscripts in the Princeton University Library*, Publications of the Department of Art and Archaeology, Princeton University (Princeton, NJ: Princeton University Press, 2013), 1: 139-143. On Bern 207, see: *Catalogus Codicum Bernensium: Bibliotheca Bongarsiana*, ed. Stadtbibliothek Bern, Hermann Hagen, and Jacques Bongars (Hildesheim: Olms, 1974).

<sup>135</sup> For a wider exploration of gesture in Iberian medieval art, not limited to dactylonomy, see: Alicia Miguélez Cavero, *La gestualidad en el arte románico de los reinos hispanos* (Madrid: Círculo Románico, 2010). See in particular the section dedicated to finger-counting iconography. See also: Alicia Miguélez Cavero, “El poder gestual de la mano en la sociedad medieval y su reflejo en la iconografía de los siglos del románico en la Península Ibérica,” *Medievalismo* 20 (2010): 125–147; and *Actitudes gestuales en la iconografía del románico peninsular*

between dactylonomy and grammar. The fact that the first chapter of DTR is called “calculating or speaking with the fingers” already puts dactylonomy in the ambivalent position where arithmetic and grammar overlap, grammar being, according to Isidore, the “skill in speaking,” and arithmetic the liberal art that “contains the principles and classifications of numbers.”<sup>136</sup> Numbers themselves are not just mathematical objects. Numerals are also words, and therefore subject of grammar. The FS images are not misplaced at all in the Portuguese codices.

Running through all the extant FS medieval illuminated sources, one finds that dactylonomy gestures are deep-rooted in numbers. Whether these numbers are for complex calendrical calculations or for simple arithmetical computations, for studying and preaching the Bible or for praising God in symbolic patterns, they provide a glimpse to a culture imbued with numeracy, “a landscape heavily forested with numbers, with numerical relationships, and with numerical concepts of all kinds.”<sup>137</sup>

---

*hispano: el sueño, el dolor espiritual y otras expresiones similares* (León: Servicio de Publicaciones de la Universidad de León, 2007).

<sup>136</sup> “Disciplinae liberalium artium septem sunt. Prima grammatica, id est loquendi peritia. (...) Quarta arithmetica, quae continet numerorum causas et divisiones.” Isidore, *Etimologías*, 266-267 (1.2.1-2). Also note that Isidore mentions the signs of the fingers (*notis digitorum*) in the book dedicated to grammar (1.26).

<sup>137</sup> John J. Contreni, “Counting, Calendars, and Cosmology: Numeracy in the Early Middle Ages,” in *Word, Image, Number: Communication in the Middle Ages*, ed. John J. Contreni and Santa Casciani (Florence: SISMELE - Edizioni del Galluzzo, 2002), 74. See the interesting study on medieval numeracy by Moritz Wedell, *Zählen: semantische und praxeologische Studien zum numerischen Wissen im Mittelalter*, Historische Semantik 14 (Göttingen: Vandenhoeck & Ruprecht, 2011).

### 3. Framing Alc. 426 and Santa Cruz 8: the codices in their libraries

They wrote in parchment many books, composed, and copied others from other authors for their use. From some and others, they left us a copious library; in which we justly admire and revere their tireless work in writing from their hand.

Manuel dos Santos (ca. 1674 – 1740),  
*Description of the Royal Monastery of Alcobaça*.<sup>138</sup>

Codices Alc. 426 and Santa Cruz 8 were produced between the last quarter of the twelfth century and the first quarter of the thirteenth century, in the two largest and most influential Portuguese monastic houses of their time: the Cistercian abbey of Santa Maria de Alcobaça and the Regular Canons monastery of Santa Cruz de Coimbra. In this period, both of these monasteries hosted highly productive *scriptoria*, held impressively large libraries with hundreds of volumes on all manner of topics, and maintained monastic schools.

Grammar was one of the subjects taught in these monastic schools. Without a robust education on grammar, one would be unable to read, to write, or to speak properly. In particular, a monk without grammar would not be able to do his own duty: he would not be able to read the Scripture, to recite the hours, to preach, or even to study. Grammar had a high-priority status among all areas of knowledge. Not necessarily for its preeminence, but for its precedence. For that reason, monastic – and cathedral – libraries usually had a large section dedicated to grammar, that would include treatises on orthography, syntax, prosody, and lexicography.<sup>139</sup> The importance of lexicography, in particular, is to be highlighted, because glossaries and dictionaries were the store-houses of words, the basic elements of speech.

---

<sup>138</sup> “Escreveram em pergaminho muitos livros, compuzerão e copiaram outros de outros Autores para seu uzo. De huns e outros nos deixaram huma livraria copiosa; na qual justamente admiramos e veneramos o seu incansavel trabalho em escreverem da sua mam, com tam grande asseyo, e limpeza, que sendo muitos os livros, as letras na maior parte sam excellentes, e tam limpas, que em todas naam vereis hum borram, ou riscado.” Manoel dos Santos, *Descrição do Real Mosteiro de Alcobaça: B.N.L. Alc. 307 Fols. 1-35*, edited by Aires Augusto Nascimento, *Alcobaciana 3* (Alcobaça: Associação para a Defesa e Valorização do Património Cultural da Região de Alcobaça, 1979): 61-62. Manuscript Alc. 307 dates from between the end of the 17<sup>th</sup> and the beginning of the 18<sup>th</sup> centuries.

<sup>139</sup> There is an enormous amount of literature on the medieval teaching of grammar and its sources. See, in particular: Geoffrey L. Bursill-Hall, “Teaching Grammars of the Middle Ages: Notes on the Manuscript Tradition,” *Historiographia Linguistica* 4:1 (1977): 1–29, <https://doi.org/10.1075/hl.4.1.02bur>; and Suzanne Reynolds, *Medieval Reading: Grammar, Rhetoric and the Classical Text* (Cambridge: Cambridge University Press, 2004).

The contents of codices Alc. 426 and Santa Cruz 8 are mostly lexicographical. Both manuscripts start with a section from the dictionary *Elementarium doctrinae rudimentum* written by Papias – the entries starting with letters Q to Z – followed by a grammar treatise, and two biblical glossaries. But these codices are not merely a pair of collected lexicons. They are witnesses of important lexicography techniques, such as source tags and alphabetic arrangement. A close examination of their contents and forms sheds light into the medieval use of books and language, and moreover, it provides insights into the cognitive models of their time.

Beautifully illuminated and well preserved, both manuscripts largely share the same textual variants of the works they enclose, and follow an identical illumination structure, displaying similar images in the same contexts. There is little doubt that they are related. However, the specifics of this relationship are not self-evident. After contextualizing the Alc. 426 and Santa Cruz 8 in their respective libraries and the medieval lexicography tradition, this chapter tackles the problem of manuscript tradition.

### 3.1. The libraries of Alcobaça and Santa Cruz

The foundation and flourishing of the monasteries of Alcobaça and Santa Cruz is intimately tied to the foundation and expansion of the Portuguese kingdom itself. The monastery of Santa Cruz was founded in 1131 by archdeacon Tellus, St. Theotonius, and ten other canons, who abandoned the Coimbra cathedral chapter and later would receive the protection of Afonso Henriques, the soon-to-be first king of Portugal (r. 1139-1185).<sup>140</sup> The establishment of Santa Cruz happened about the same time that Afonso moved his court to Coimbra, not long after he had taken over the county of *Portucale*.<sup>141</sup> Coimbra was already an important cultural and religious axis, with the monastery of Lorvão and its famous *scriptorium*, as well as the

---

<sup>140</sup> The scholarship on the Santa Cruz monastery is extensive. For a general survey over its history, see: Agostinho Figueiredo Frias, “O Mosteiro de Santa Cruz: Perspectivação Histórica,” in *Catálogo dos códices*, XXXI-LXVIII. For a deeper study of the medieval monastery, see: Armando Alberto Martins, *O Mosteiro de Santa Cruz de Coimbra na Idade Média*, Textos Universitários 2 (Lisboa: Centro de História da Universidade de Lisboa, 2003). On the foundation of Santa Cruz, see especially the critical edition of three of the earliest sources of the Santa Cruz monastery, with introductory remarks and translation by Aires Nascimento: Aires A. Nascimento, *Hagiografia de Santa Cruz de Coimbra : vida de D. Telo, vida de D. Teotónio, vida de Martinho de Soure* (Lisboa: Colibri, 1998).

<sup>141</sup> “A sua fundação, em 1131, coincide, curiosamente, com a data provável em que D. Afonso Henriques transfere de Guimarães para Coimbra o centro da corte, nas suas deslocações frequentes às fronteiras norte e sul. Para a sua dotação contribuiu também o rei, oferecendo os banhos régios que tinha na cidade. Todavia, os seus principescos favores ao mosteiro só começaram entre 1137 e 1139, precisamente entre o tratado de Tui e a batalha de Ourique, no momento em que executava os actos mais decisivos para a reivindicação da independência.” José Mattoso, *Portugal Medieval: Novas Interpretações*, 2nd ed. (Lisboa: INCM, 1992), 109.

Cathedral of Coimbra and its well-furnished library as beacons of Christian and Mozarabic knowledge in the region.<sup>142</sup> But now it had truly become the political, intellectual, and spiritual capital of the land. In fact, the proximity of Santa Cruz to these three institutions – the Court, the Cathedral, and the Lorvão monastery – helped boosting the development of the monastery through the interchange of books between libraries, among many other ways. Although the primeval collection of fundamental texts was brought from the Regular Canons house of Saint-Ruf of Avignon, part of the initial library of Santa Cruz was drawn from the Cathedral library, and the cultural exchange continued on over the years, unhampered by the rivalry that defined much of the relationship between both institutions.<sup>143</sup>

Throughout the reigns of Afonso Henriques and his son, Sancho I (r. 1185-1211), the magnitude and influence of Santa Cruz kept increasing, as the fondness of the kings for Santa Cruz manifested itself through a variety of privileges, honors, and nominations, and as eventually both kings decided to be buried in the grounds of the monastery.<sup>144</sup> As for Alcobaça, it was founded in 1153 in a strategic location, during a period of swift expansion of the Portuguese kingdom. While it was also founded during the time of Afonso Henriques, a patron of the Cistercian order, it took time to be built and to gain relevance.<sup>145</sup> Only under the rule of Afonso II (r. 1211-1223) it became one of Portugal's greatest religious and cultural powerhouses.<sup>146</sup> As a sign of this shift, Afonso II and his successors Sancho II (r. 1223-1247)

---

<sup>142</sup> On the medieval library of the Coimbra cathedral, see the study by Avelino da Costa, which includes as an appendix a transcription of all the extant medieval inventories of the library: Avelino de Jesus da Costa, *A Biblioteca e o Tesouro da Sé de Coimbra nos séculos XI a XVI*, 2nd ed. (Coimbra: 1983). On the *scriptorium* and library of the old Lorvão monastery, see: Aires A. Nascimento, *Os Antigos Códices de Lorvão: Balanço de Pesquisa e Recuperação de Tradições* (Penacova: Município de Penacova, 2016).

<sup>143</sup> The primitive library of Santa Cruz also benefitted from a number of private donations, such as one from bishop Mendo Eanes, who gave Santa Cruz a collection of “*libros latinos et sarracenos*.” On this topic, see: Saúl António Gomes, *In Limine Conscriptio: Documentos, chancelaria e cultura no Mosteiro de Santa Cruz de Coimbra (Séculos XII a XIV)* (Braga: Palimage, 2007): 197-201. The rivalry between Santa Cruz and the Coimbra Cathedral is extensively documented. See for instance the chapter “A diocese e o Bispo: da tensão à confluência”, in A. A. Martins, *O Mosteiro de Santa Cruz*, 144-163.

<sup>144</sup> Besides the vast amounts of land and other privileges that D. Afonso conceded to Santa Cruz, he left 8,000 *maravedis* to the monastery in his will. Sancho I, in his turn, left 10,000 *maravedis*, plus an invaluable treasure. See: Joaquim Veríssimo Serrão, “Santa Cruz de Coimbra e Santa Maria de Alcobaça: um caso de rivalidade cultural?,” in *A Historiografia Portuguesa Anterior a Herculano: Actas do Colóquio* (Lisboa: Academia Portuguesa de História, 1977), 88.

<sup>145</sup> Maria Alegria Fernandes Marques states that the introduction of the Cistercian Order in medieval Portugal is not yet fully understood – why and how Cistercian abbeys were founded in the Portuguese kingdom, often replacing functioning hermitages or Benedictine monasteries. See: Maria Alegria Fernandes Marques, “A Introdução da Ordem de Cister em Portugal”, in *Estudos sobre a Ordem de Cister em Portugal*, Estudos da Faculdade de Letras da Universidade de Coimbra 24 (Lisboa: Colibri, 1998), 29-65.

<sup>146</sup> Maur Cocheril splits the chronology of Alcobaça in two periods: Alcobaça I, founded by Saint Bernard of Clairvaux, lasted up to the decade of 1190. Alcobaça II, with a far larger and more magnificent building, was established in the early thirteenth century. Alcobaça II would be the one gaining greater influence and power in the kingdom. Maur de Cocheril, “Abadias Cistercienses Portuguesas,” *Lusitania Sacra* 4 (1959): 29-34. See also:

and Afonso III (r. 1248-1279), expressed their wish to be buried in Alcobaça – even though Sancho was to be exiled and subsequently entombed in Toledo – and all these kings left significantly larger amounts to Alcobaça than to Santa Cruz in their wills, contrastingly to the first two kings.<sup>147</sup>

Both Alcobaça and Santa Cruz had strong international ties and were thus able to stay updated with the cultural demands of their time. Alcobaça, as a Cistercian house, would keep in contact with its motherhouse, Clairvaux, and other Cistercian abbeys, and would attend the annual general chapter meetings.<sup>148</sup> Santa Cruz was analogously part of the wide Augustinian network. Although the Regular Canons were not a centralized religious order like the Cistercians, Santa Cruz would coordinate with Saint-Ruf of Avignon, as well as other monastic houses. And, of course, although belonging to different orders, being the two most important monastic houses in the kingdom, both monasteries influenced one another and exchanged books, as demonstrated by the considerable overlap that exists between both libraries – this overlap includes the identical codices Alc. 426 and Santa Cruz 8.<sup>149</sup>

Alcobaça and Santa Cruz were also centers of irradiation. Their prolific *scriptoria* generated books for themselves, and for their associate monasteries: for example, the monastery of Santa Cruz de Cortes in Ciudad Rodrigo, in present-day Spain, started its library with a collection of books taken from Santa Cruz, and Santa Cruz loaned books on medicine to a certain Peter Vincent from the monastery of São Vicente de Fora.<sup>150</sup> It is also not unlikely

---

Maur de Cocheril, *Alcobaça, Abadia Cisterciense de Portugal*, translated by André Mansuy Diniz Sila (Lisboa: INCM, 1989).

<sup>147</sup> Afonso Henriques only left 500 *maravedis* to Alcobaça, and Sancho I only left 5,000 (in whopping contrast with the 8,000 and 1,000 that each respectively left to Santa Cruz). The subsequent kings were far more generous to Alcobaça than to Santa Cruz. For example, Sancho II left 3,000 *maravedis* to Alcobaça and only 500 to Santa Cruz, for each anniversary of his death. See: J. V. Serrão, “Santa Cruz,” 89.

<sup>148</sup> “A participação em actos comuns como os Capítulos Gerais cistercienses proporcionaria a Alcobaça ocasião para aumentar ou actualizar a sua livraria. Assim, a versão da *Nauigatio Brendani* conservada em Alcobaça, que é nada menos que uma tradução latina do texto anglo-normando de Benedeit, explica-se pelo conhecimento tomado em Claraval.” Aires A. Nascimento, “Percurso do Livro na História da Cultura Portuguesa Medieval,” in *Ler Contra o Tempo: Condições dos Textos na Cultura Portuguesa (Recolha de Estudos em Hora de Vésperas)* (Lisboa: Centro de Estudos Clássicos da Universidade de Lisboa, 2012), 312.

<sup>149</sup> On the relationship between the two monasteries, see: Saul António Gomes, “Relações Entre Santa Cruz de Coimbra e Santa Maria de Alcobaça Ao Longo Da Idade Média. Aspectos Globais e Particulares,” in *IX Centenário Do Nascimento de S. Bernardo, Encontros de Alcobaça e Simpósio de Lisboa. Actas*. (Braga: Universidade Católica Portuguesa - Câmara Municipal de Alcobaça, 1991).

<sup>150</sup> The loan to Peter Vincent, dated from 1207, is part of a list of 3 separate book loans, recorded at the end of codex Santa Cruz 34, in the Biblioteca Pública Municipal do Porto. It has been transcribed as: “In era M.<sup>a</sup> CC.<sup>a</sup> <XLV.<sup>a</sup>>. In mense decembrio. Dedimus Petro Vicentij Canonjco Sanctj Vincentij Ulixbone Libri Viaticum et Passionarum et Liber Gradius ad Fisicam pertinentes:” For an analysis of this document, see: António Cruz, *Santa Cruz de Coimbra na Cultura Portuguesa da Idade Média, Volume 1: Observações sobre o ‘Scriptorium’ e os estudos claustrais*, (Porto: 1964): 190-232.

that lesser Cistercian abbeys such as Santa Maria de Bouro and Santa Maria de Seiça depended to a great extent on the book production of Alcobaça.

The actual size and content of the medieval libraries of Alcobaça and Santa Cruz is unknown, because no contemporary catalogue reached us, and many books were lost throughout the centuries. As of today, there exist 97 codices known to have belonged to the Santa Cruz library. They are assembled in the collection *Livraria de Mão de Santa Cruz de Coimbra* at Biblioteca Pública Municipal do Porto (henceforth, BPMP). Of these codices, 60 are dated from the twelfth or the thirteenth centuries.<sup>151</sup> Taking into account the sheer centrality of Santa Cruz in the Portuguese intellectual framework and its importance in the European context, it is clear that these numbers do not provide an accurate representation of the scale of this library, especially considering that the BPMP's Santa Cruz collection includes manuscripts that cannot be properly called codices, and even some that originally belonged to other libraries.<sup>152</sup> The library of Santa Cruz must have been much larger, as less important monasteries are known to have had far bigger libraries than this: for instance, the library of the also-Augustinian monastery of São Vicente de Fora, in Lisbon, contained 116 volumes, in the early thirteenth century.<sup>153</sup>

The library of Alcobaça is likewise supposed to have been much larger than what it is today. Its remaining codices have been reunited in the *fundo Alcobaça* at the Biblioteca Nacional de Portugal (henceforth, BNP), in Lisbon, that contains 456 codices, 165 of which date from the twelfth or thirteenth centuries.<sup>154</sup> Again, it is certain that the original amount surpassed this, and one does not need to recede too much to attest that: the late eighteenth century inventory *Index codicorum bibliothecae Alcobatiae* included 476 manuscripts.<sup>155</sup>

---

<sup>151</sup> For a detailed analysis of the extant Santa Cruz library, see: Armando Gomes do Norte, "Letrados e cultura letrada em Portugal (séculos XII e XIII)," PhD diss., (Universidade de Lisboa, 2013), 406-477. See also: Aires A. Nascimento "O Scriptorium de Santa Cruz de Coimbra," in *Catálogo dos códices*, LXIX-XCVI.

<sup>152</sup> See: S. A. Gomes, *In Limine* Conscriptio, 188.

<sup>153</sup> There is a thirteenth century inventory of the library of São Vicente de Fora in the last folio of a obituary, at the end of codex Santa Cruz 84, in Biblioteca Pública Municipal do Porto (*Hii sunt libri monasterii Sancti Vincentii...*). For a study on this inventory, see: Aires A. Nascimento, "Livros e Claustro no Século XIII em Portugal: o inventário de S. Vicente de Fora, em Lisboa," *Didaskalia* 15 (1985): 229-242. See also: Francisco da Gama Caeiro, *Santo António de Lisboa: 1º volume: Introdução ao estudo da obra Antoniana*, Estudos Gerais - Série Universitária (Lisboa: Imprensa Nacional – Casa da Moeda, 1995): 31-37.

<sup>154</sup> For a detailed analysis of the extant Alcobaça library, see: A. G. do Norte, "Letrados e cultura letrada," 316-405. See also: Mário Martins, "Os Monges de Alcobaça Perante Os Códices," *Brotéria* 68 (1959): 155-63.

<sup>155</sup> Aires A. Nascimento notes that the current size of the library "não corresponde sequer ao inventário do *Index codicum* de 1775 [(registava 476, mas entre 1755 e 1834 deram entrada na biblioteca manuscrita de Alcobaça mais 7 mss, perfazendo 483); para o Fundo de Iluminados da BN foram deslocados 2 mss]; e as lacunas não ficariam sanadas mesmo se lhes adicionássemos o conjunto de códices alcobacenses mantidos, por rotina algo inexplicável, no Arquivo Nacional da Torre do Tombo. Um total de 21 códices registados no *Index* não deu entrada

Both Alcobaça and Santa Cruz housed monastic schools, where books were a basic instrument for teaching and learning. An analysis of what remains of these libraries shows that they were attuned with the coeval European cultural trends, as they possessed such fundamental works as the *Church History* by Eusebius of Caesarea (ca. 260 – ca. 340), *The City of God* by Augustine, the *Etymologies* by Isidore, and the *Historia scholastica*, by Petrus Comestor (ca. 1100 – 1178). Unsurprisingly, both libraries prioritized religiously themed works: books of the Bible, theology treatises, liturgy, homilies, scripture commentaries, patristical literature, and hagiography.<sup>156</sup> Indeed, “*sapientia* was approached through liturgy and Scripture rather than through knowledge of the world and its ways.”<sup>157</sup> This does not mean that the Portuguese monastic schools neglected subjects like grammar, *computus*, or music. Rather, these subjects were regarded as means to achieve the ends of monastic life: the service of God, which would materialize in specific acts, such as the prayer of the psalms in the Divine Office, the celebration of the eucharist, and the reading and “ruminantion” of the Bible.

The Portuguese monastic schools were obviously aware of the seven liberal arts model, comprising the *trivium* – grammar, logic, and rhetoric – and the *quadrivium* – arithmetic, geometry, music, and astronomy. In the case of Santa Cruz, this is evidenced by the insertion of a popular poem about the liberal arts at the end of codex Santa Cruz 9, and by the drawing of a schematic diagram displaying the division of sciences at the beginning of codex Santa Cruz 17, right before a copy of the *Etymologies* (Figure 19).<sup>158</sup> However, it is not likely that either Alcobaça or Santa Cruz ever followed the seven-fold model in a strict manner. Instead, like most medieval monastic schools, here, disciplines would be organically articulated through reading and recitation lessons, according to the skills of the pupils, the expertise of the schoolmasters, and the needs of the monastery.<sup>159</sup>

---

nem num lado nem no outro.” Aires A. Nascimento, “Em Busca dos Códices Alcobacenses Perdidos,” *Didaskalia* 9 (1979): 279-280.

<sup>156</sup> In the Alcobaça library, Armando do Norte identified 121 works under the category “Patristics,” 73 under “hagiography,” 64 under “Theology,” 52 under “liturgy,” 47 under “scripture commentary,” 43 under “non-patristic homilies.” See: A. Norte, “Letrados e Cultura Letrada,” 372. As for Santa Cruz, he classified 258 under “Homily,” 222 under “Commentary,” 151 under “Theology,” 113 under “Bible,” 112 under “Hagiography,” 83 under “Liturgy.” See: A. Norte, “Letrados e Cultura Letrada,” 452.

<sup>157</sup> W. Stevens, “De computo: Introduction,” in *Martyrologium. De computo*, edited by J. McCulloh and W. Stevens, *Corpus Christianorum Continuatio Mediaevalis* 44, (Turnhout: Brepols, 1979), 166.

<sup>158</sup> The diagram (*stemma omnia scientiarum*) is in Porto, BPMP, Santa Cruz 9, fol. Iv (see: *Catálogo dos códices*, 112). The poem is in Porto, BPMP, Santa Cruz 9, fol. Iir (see: *Catálogo dos códices*, 89). It is titled “Haec est Grammatica,” or “Versus septem de Septem artes liberales.” See: Hans Walter, *Initia carminum ac versuum medii aevi posterioris Latinorum Auctor*, *Carmina Medii Aevi Posterioris Latina I* (Göttingen: Vandenhoeck and Ruprecht, 1959), 832.

<sup>159</sup> Regular Canons and, to a certain extent, Alcobaça Cistercians were not typical monks. They would leave the cloister, they would preach, and they would deal with temporal matters. Still, like in most cathedral and

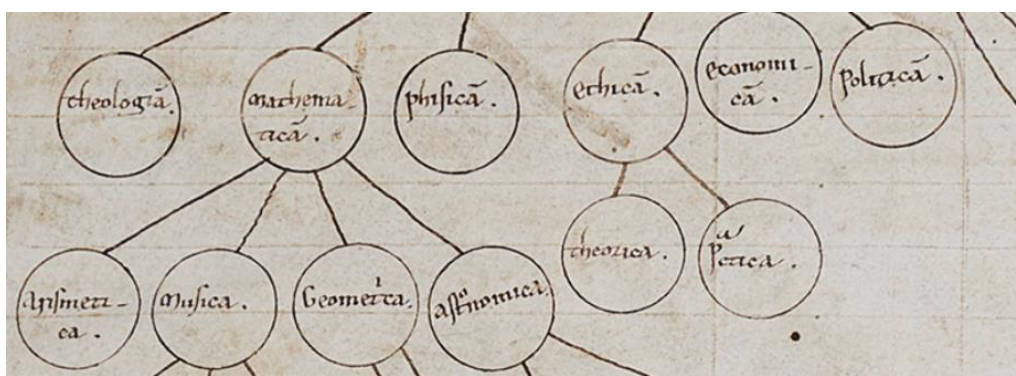


Figure 19. Porto, BPMP, Santa Cruz 17, fol. Iv (detail).

Nowadays, the extant Santa Cruz library is practically void of science books.<sup>160</sup> However, this has not always been the case. A record of book loans from Santa Cruz from the beginning of the thirteenth century gives account of a remarkable sample of science books once held in its library. It registers three loans, the second of which was made in 1218 to a certain master Egidius, containing thirteen entries, including Isidore's *De natura rerum* (*Ysidorus ad regem Siburtum De Naturis*), and the *De computo* of Helpericus of Auxerre (*Liber Comptj <scilicet> Elpericus*), plus books in geometry, medicine, botanic, and astronomy.<sup>161</sup> Alcoaça, on the

---

monastic schools, their education “served a limited range of purposes: the rudiments of letters and the liberal arts, the reading and understanding of the Bible within the traditions of patristic scholarship; preaching and converting; a Christian life according to the Benedictine rule; other more specific purposes within the sphere of church functions, among which music and the performance of the liturgy were especially prominent. The liberal arts occupied an important position, but were ancillary to the study of scripture.” C. Stephen Jaeger, *The Envy of Angels: Cathedral Schools and Social Ideals in Medieval Europe, 950-1200* (Philadelphia: University of Pennsylvania Press, 1994): 21.

<sup>160</sup> The term “science” here is used to mean the study of nature and the *quadrivium*. This term must be used with caution, as it is somewhat anachronistic. Indeed, contrary to the modern custom, in medieval times “*scientia*” was not limited to the knowledge of the natural world. Furthermore, it did not occupy the same authoritative place it currently has in the hierarchy of subjects. Nowadays, the scientific method is generally taken as the most trustworthy way of attaining knowledge, thereby setting the experimental sciences as the standard to follow for all areas of knowledge. In the middle ages, though, not only the scientific method was still at an embryonic state, as the modes of perceiving the natural world were different.

<sup>161</sup> The book loan to Egidius also contains Cicero's *De inventione* and Priscian's *Intituciones gramaticae*. At the end of codex Santa Cruz 34, at BPMP: “In anno ab incarnatione Domini millesimo. CC.XVIII. in mense julij Presbiter [...] Iohannes Cancellarius iussu domnj Prioris d. Didacj dedit magistro Egidio tridecjm libros quorum Ius nonus ab Almanzor. Ysidorus ad regem Siburtum De Naturis. Alcabitius optimus liber de Astrolomia. Macer cum Lapidario et cum suis apendicijs et cum Mapa Caluicula ad aurum faciendum et cum [...] ad plantandas arbores et cum multjs experimentis. Liber circulj celestis spere. Libri Fisicales duo optimj. Duo libri de Geometria magnj. Duo libri de Retorjca <scilicet> Tulij. Liber Comptj <scilicet> Elpericus. Liber de Astronomia et sunt XIII. Preter Priscianum quem dedit Juliano Julianj decano. et preter Mapa Mundi.” For the full transcription and a study, see António Cruz's study, where he suggests that master Egidius was no other than the famous Dominican scholar Giles of Santarém (c. 1185 - 1265): António Cruz, *Santa Cruz*, 190-232. For an overview of medieval science books in Portugal see: Saul António Gomes, “Livros de ciência em bibliotecas medievais portuguesas,” *Ágora. Estudos Clássicos em Debate* 14:1 (2012): 13-26.

other hand, has no record of science books.<sup>162</sup> Still, there was a liberal art that was highly valued by the Cistercians of Alcobaça, more than any other: the art of grammar.

The study of Latin grammar was elemental in any medieval monastic school. How could one read, pray, or preach, without grammar? Grammar was the first liberal art, and the basis of all knowledge, as John of Salisbury (ca. 1120 – 1180) states in the *Metalogicon* (1.13):

Grammar is ‘the science of speaking and writing correctly – the starting point of all liberal studies.’ Grammar is the cradle of all philosophy, and in a manner of speaking, the first nurse of the whole study of letters. It takes all of us as tender babes, newly born from nature’s bosom. It nurses us in our infancy, and guides our every forward step in philosophy. With motherly care, it fosters and protects the philosopher from the start to the finish.<sup>163</sup>

The teaching of grammar was largely drawn from the work of the late Roman Latin grammarians, the most popular being Donatus (4<sup>th</sup> c.), with his *Ars grammatica*, and Priscian (fl. AD 500), with his *Institutiones grammaticae*.<sup>164</sup> Incidentally, the library of Alcobaça still contains a fragment of Donatus’s treatise – in Alc. 426 – and Santa Cruz is known to have had a copy of Priscian’s book – as mentioned in the loan list to master Egidius.

### 3.2. Lexicography in Alcobaça and Santa Cruz

Few grammar codices remain in the library of Santa Cruz to this day. The only ones that can be clearly categorized as grammatical are both lexicographical: Santa Cruz 17, with Isidore’s

---

<sup>162</sup> This could be due to the more contemplative and austere style of the Cistercian spirituality, in contrast with the more worldly Augustinian way, even though the Alcobaça Cistercians, just like the Santa Cruz Canons, often deviated from the tenets of their own orders. On the defining differences between canons and monks, see especially: Caroline Walker Bynum, *“Docere verbo et exemplo”: An Aspect of Twelfth-Century Spirituality*, Harvard Theological Studies 31 (Missoula MT: Scholars Press, 1979).

<sup>163</sup> “Est enim grammatica scientia recte loquendi scribendique, et origo omnium liberalium disciplinarum. Eadem quoque est totius philosophiae cunabulum, et ut ita dixerim totius litteratorii studii altrix prima, quae omnium nascentium de sinu naturae teneritudinem excipit, nutrit infantiam, cuiusque gradus incrementa in philosophia prouehit, et sedulitate materna omnem philosophantis producit et custodit aetatem.” Ioannes Saresberiensis, *Metalogicon*, edited by J. B. Hall, K. S. B. Keats-Rohan, Corpus Christianorum Continuatio Mediaevalis 98 (Turnhout: Brepols, 1991), 32.

<sup>164</sup> “Donatus’ *Ars grammatica* was brief and concise, and in part already cast in the favorite teaching mode of the Middle Ages, the catechism (‘Partes orationis quot sunt? Octo. Quae? Nomen, pronomen, verbum, adverbium, participium, coniunctio, praepositio, interiectio’). It occupies fifty pages of modern print. Priscian’s *Institutiones grammaticae*, by contrast, is immensely long, very full of detail, some of its statements being justified by theoretical argument, and throughout it is enriched by numerous quotations from classical authors. It was in truth a reference grammar and the source of most grammatical scholarship throughout the Middle Ages. Several hundred manuscript copies are known to have existed.” Robert Henry Robins, “Grammar” In *Dictionary of the Middle Ages. Volume 5. Famine in the Islamic World – Groote, Geert*, edited by Joseph R. Strayer (New York: Charles Scribner’s Sons, 1985), 648.

*Etymologies*, and, of course, Santa Cruz 8.<sup>165</sup> The emphasis of Alcobaça’s grammar collection is also on lexicography. Its library contains at least 12 codices with grammar texts, including the famous poem *Graecismus* by Eberhard of Béthune (d. ca. 1212), the *Ars grammatica* by Donatus, and treatises on the accentuation of Latin words.<sup>166</sup> Beyond Jerome’s *Liber interpretationis*, Bede’s *Nomina*, and a few glossaries of Latin words by anonymous authors, Alcobaça has some of the most popular encyclopedias/dictionaries/glossaries of the time: the *Etymologies*, by Isidore; the *Derivationes* by Osbern of Gloucester (1123-1200); the *Doctrinale* by Alexander of Villedieu (ca. 1175 – ca. 1240); and the *Elementarium* by Papias.<sup>167</sup> This sample is relevant not only because it reveals a particular interest for lexicography by the monks of Alcobaça, but because the importance and variety of these titles demonstrates that Alcobaça was part of the cultural forefront of western monasticism.

Both libraries hold a copy of the seminal *Etymologies* by Isidore. The *Etymologies* is an encyclopedia, an all-encompassing compilation of knowledge, that remained an indispensable learning source for the entire medieval period.<sup>168</sup> It is the starting point of medieval lexicography, because it is one of the main sources used by all medieval lexicographers, and because of how it used and set the tone of a fundamental – despite intriguing for modern eyes – medieval lexicographical device: the etymology.<sup>169</sup> Far away from the modern approach, medieval etymologies often seem to be little interested in the actual historical origin of the words. They appear to be made of word-games, filled with puns, rhymes, and impossible mixes of languages. Isidore defines “etymology” as “the origin of words, when the force (*vis*) of a verb or a noun is gathered through interpretation.”<sup>170</sup> He is interested in the historical origin of each word, but only as a means to get to its *vis*, the power, or energy, of the

---

<sup>165</sup> On the *Etymologies* codices in Alcobaça and Santa Cruz, see: Maria Adelaide Miranda, “Hipertexto e Medievalidade,” in *Enciclopédia e Hipertexto* (Lisboa: Edições Duarte Reis, 2006), <http://www.educ.fc.ul.pt/hyper/resources/amiranda/index.htm> (accessed May 21, 2021).

<sup>166</sup> Eberhard’s *Graecismus*: Lisbon, BNP, Alc. 48. Treatises on accentuation: Lisbon, BNP, Alc. 37 and Alc. 149.

<sup>167</sup> Osberns’s *Derivationes*: Lisbon, BNP, Alc. 151; Huguccio’s *Derivationes*: Lisbon, BNP, Alc. 277; Alexander’s *Doctrinale*: Lisbon, BNP, Alc. 52; Isidore’s *Etymologiae*: Lisbon, BNP, Alc. 446.

<sup>168</sup> For a general introduction to the *Etymologies*, see: Manuel C. Diaz y Diaz, “Introducción General,” In *Etimologías: edición bilingüe*, by Isidore of Seville, edited by J. Oroz Reta and M.-A- Marcos Casquero (Madrid: Biblioteca de Autores Cristianos, 2018), 1-257.

<sup>169</sup> For an introduction to the concept of etymology in the early middle ages and late antiquity, especially the impact of Isidore, see Mark Amsler, *Etymology and Grammatical Discourse in Late Antiquity and the Early Middle Ages*, (Philadelphia: J. Benjamins Pub. Co, 1989).

<sup>170</sup> “Etymologia est origo vocabulorum, cum vis verbi vel nominis per interpretationem colligitur.” Isidore, *Etimologías*, 310-311 (1.29.1).

word.<sup>171</sup> Isidore provides a number examples of etymologies to illustrate his definition, such as “kings” (*rex, regis*), that comes from “ruling” (*regendum*), that comes from “acting correctly” (*recte agendum*), due to its rationale; and “man” (*homo*), that comes from “earth” (*humus*), due to its origin.<sup>172</sup> Occasionally, Isidore happens to agree with modern philologists, but in most cases, by using parasyonyms – words similar in meaning but different in sounding – and *paronomasiae* – words similar in sounding but different in meaning – he devotes himself to an exercise of creativity, whose mnemonic usefulness should not be undervalued.

Starting with Isidore, the Alcobaça library presents a spectrum of lexicographical works authored in a wide chronology, displaying a number of techniques that were developed throughout the ages, from etymology to gloss, from distinction to derivation. One should highlight the presence of the *Derivationes* by Huguccio Pisanus (d. 1210), likely the most famous medieval dictionary, drawn from Isidore, Papias, and Osbern, among others. In the *Derivationes*, Huguccio takes the derivation method to its maximum height, as he tries “to explain all of the medieval Latin vocabulary by the origin of words, and so arranges it entirely according to the etymological families or derivations.”<sup>173</sup>

Developed earlier than the derivation method, was the gloss. The technique of glossing, typically in the margins of a text or between its lines, is as old as codices themselves, but soon enough in book history, the need came for aggregating large amounts of glosses into one place, giving rise to glossaries.<sup>174</sup> One such early glossary is the famous *Book of Interpretations of Hebrew Names* (*Liber interpretationibus Hebraicorum nominum*), written by Jerome to complement the reading of his own translation of the Bible.<sup>175</sup> It consists of a list of all the names and places that appear in the Bible, ordered by book, from Genesis to Revelations, each word with the respective gloss. These glosses are extremely succinct, useful more as a

---

<sup>171</sup> Parasyonyms of “vis” include: “strength,” “force,” “vigor,” “power,” “energy,” “virtue.” *Dictionary of Medieval Latin from British Sources (DMLBS)*, s. v. “vis,” <https://logeion.uchicago.edu/vis> (accessed November 9, 2020).

<sup>172</sup> “Sunt autem etymologiae aut ex causa datae, ut ‘reges’ a [regendo et] recte agendo, aut ex origine, ut ‘homo,’ quia sit ex homo.” Isidore, *Etimologías*, 312-313 (1.29.3).

<sup>173</sup> Olga Weijers, “Lexicography in the Middle Ages,” *Viator* 20 (January 1989): 143, <https://doi.org/10.1484/J.VIATOR.2.301351>.

<sup>174</sup> On medieval glossaries, see: Wallace Martin Lindsay, “Note on the Use of Glossaries for the Dictionary of Medieval Latin,” *Archivum Latinitatis Medii Aevi-Bulletin Du Cange* (ALMA), 1924; Augusto Marinoni, “Du glossaire au dictionnaire,” *Quadrivium* 9 (1968):127-141. See also the collection of essays: Wallace Martin Lindsay and Michael Lapidge, *Studies in Early Mediaeval Latin Glossaries*, Variorum Collection Studies (Brookfield VT: Routledge, 1996).

<sup>175</sup> On the *Liber interpretationibus* and its variants, see: Eyal Poleg, “The Interpretations of Hebrew Names in Theory and Practice,” in *Form and Function in the Late Medieval Bible*, edited by Eyal Poleg and Laura Light, Library of the Written Word 27 (Brill, 2013), 217-236, [https://doi.org/10.1163/9789004248892\\_011](https://doi.org/10.1163/9789004248892_011).

mnemonic aid than as an actual dictionary entry: for instance, “Anna,” is glossed as “her grace” (*gratia eius*) (Figure 20) and “Job” is merely “suffering” (*dolens*).<sup>176</sup>

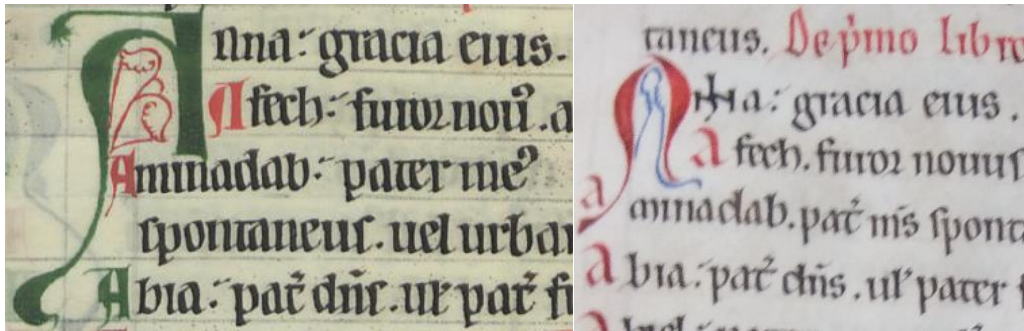


Figure 20. Lisbon, BNP, Alc. 426, fol. 223r (detail). / Porto, BPMP, Santa Cruz 8, fol. 157v (detail).

Over the centuries, Jerome’s glossary was copied many times, and was subject to a variety of additions, truncations, and restructurations. One of the most radical restructurations of Jerome’s glossary was the reshuffling in the entry ordering. Originally, the entries used to be grouped according to the books where they appeared: the word “Manasses” would come before “Anna,” because the former shows up in the Book of Numbers and the latter shows up in the First Book of Kings. But around the thirteenth century, after a slow transition process, most of the glossary copies had been fully alphabetized, that is, the entries were reshuffled and alphabetically sorted: “Anna” started preceding “Manasses.”<sup>177</sup> Alcobça holds two copies of Jerome’s glossary, both alphabetized, but from different traditions. One is in codex Alc. 3, and is a copy of the *Adam* variant, a thirteenth-century expansion and restructuring of the original glossary, thus called because it starts with the entry “Adam.”<sup>178</sup> The other is in Alc. 426, similar to the one in Santa Cruz 8.

<sup>176</sup> Hieronymus, *Hebraicae quaestiones*, 102; 133. Mary Carruthers argues that both the structure of Jerome’s glossary and the short size of its glosses are aimed at facilitating memorization: “the individual glosses are very brief (about one colon apiece) (...). It would be a simple task to slip these glosses into one’s memorial places, and bring them out at the proper locations (*loci*) in the text.” See: Mary Carruthers, *The Book of Memory: A Study of Memory in Medieval Culture*, 2nd ed., Cambridge Studies in Medieval Literature, (Cambridge: Cambridge University Press, 2008): 144-146.

<sup>177</sup> The alphabetized versions of Jerome’s glossary got so popular that “few thirteenth-century Bible manuscripts lack this ‘standard apparatus.’” Mary A. Rouse and Richard M. Rouse, “Alphabetization, History of,” In *Dictionary of the Middle Ages. Volume 1. Aachen - Augustinianism*, edited by Joseph R. Strayer (New York: Charles Scribner’s Sons, 1982), 205.

<sup>178</sup> Eyal Poleg mentions three major alphabetized variants, identified by their first entry: *Adam*, *Aaron* and *Aaz*. The *Adam* is the closest to the original and the one with the fewest entries. See: E. Poleg, “The Interpretations of Hebrew Names.”

There are yet three other biblical alphabetized glossaries in Alcobaça worthy of notice. Two of them are in codex Alc. 410: the *Summa Abel* by Peter Cantor (d. 1197) and the *Summa Angelus* by Garnier de Rochefort. These are vast collections of “distinctions” (*distinctiones*), a lexicographic technique whose goal is to distinguish between the various figurative and symbolic meanings of a single word. The other biblical glossary, in codices Alc. 426 and Santa Cruz 8, is Bede’s *Names of regions and of places of the Acts of the Apostles* (*Nomina regionum atque locorum de Actibus Apostolorum*).

A most interesting aspect of the copies of Bede’s glossary from Alcobaça and Santa Cruz is the use of interlinear glosses for cross-referencing. In both Alc. 426 and Santa Cruz 8, Bede’s glossary is preceded by Jerome’s glossary. Since Jerome glosses almost all names in the Bible, and Bede is only concerned with the names of places in one book of the Bible – a small subset of Jerome’s names – there is an overlap. Hence, instead of forcing readers to turn the pages to compare or combine entries, all entries on the Acts of the Apostles in Jerome’s glossary have been summarized and interlinearly added to Bede’s text. For example, Jerome’s entry for Apollonia is “*disciplina uel synagoga eorum. Sed et hoc uiolentum*” (see Figure 21 and Figure 22).<sup>179</sup>

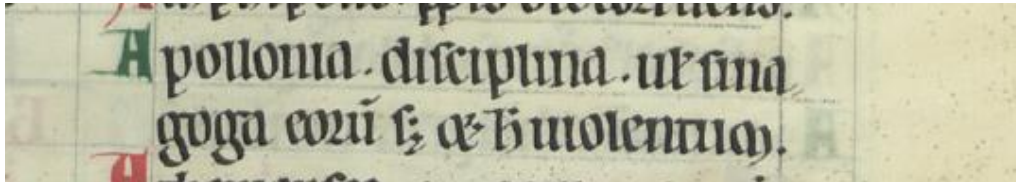


Figure 21. Lisbon, BNP, Alc. 426, fol. 225r (detail).

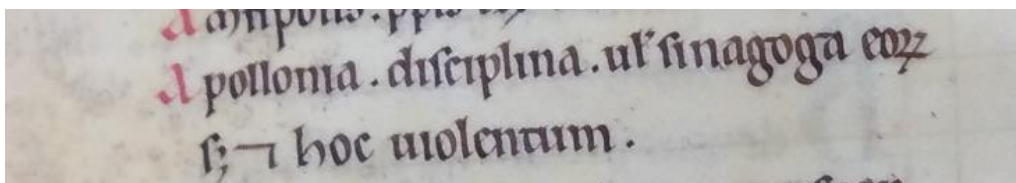


Figure 22. Porto, BPMP, Santa Cruz 8, fol. 159r (detail).

Bede’s entry for Apollonia is “*ciuitas et ipsa Macedoniae; est et altera eiusdem nominis in Syri.*”<sup>180</sup> But, in Alc. 426 and Santa Cruz 8, the word “Apollinia” in Bede’s glossary is

<sup>179</sup> Hieronymus, *Hebraicae quaestiones*, 143.

<sup>180</sup> Bede, *Opera exegetica*, 168.

superscripted with a very shortened version of Jerome’s gloss: simply the word “*disciplina*,” (Figure 23 and Figure 24).

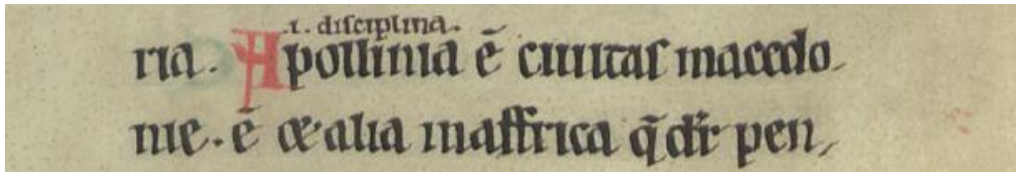


Figure 23. Lisbon, BNP, Alc. 426, fol. 249r (detail).

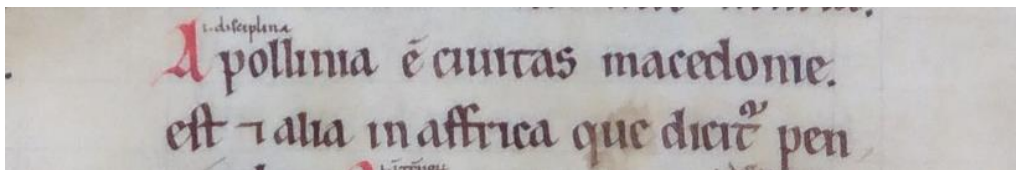


Figure 24. Porto, BPMP, Santa Cruz 8, fol. 177r (detail).

The change of rational ordering – that followed a *ratio* – be it scriptural, thematic, chronological, or some other, to the pragmatic alphabetical ordering, signals a shift in the way individuals dealt with books, and even in the way they viewed the world. Instead of submitting readers to a pre-made structure, alphabetization allowed them to bring their own mental structure, while providing an efficient way for looking up anything, for any purpose.<sup>181</sup> Alphabetization is not just a useful piece of technology. It represents a transfer of authority from the book to the reader.

A major turning-point in medieval lexicography was Papias’s *Basic Introduction to Education (Elementarium doctrinae rudimentum)*. This book is far closer to a modern dictionary than the biblical glossaries thus far considered, as Papias himself explains in the prologue:

Although it was once called Glossary because it adhered literally and simply to the interpretation of each individual word, now that definitions and notations according to the rules

---

<sup>181</sup> “The compilers of these collections were seemingly the first to recognize that, far from being detrimental, the nonrationality—hence, neutrality—of alphabetical arrangement was advantageous in some circumstances as an approach to the Scriptures. It was a recognition of the fact that each user of such a work would bring to it his own *ratio*, shaped by needs peculiar to himself. Thereafter, alphabetization became a frequent tool of the thirteenth-century effort to make the written tradition not merely readable but searchable. The application of alphabetical order to new purposes was slow and never inevitable, but it increased steadily from that time onward.” M. A. Rouse and R. M. Rouse, “Alphabetization,” 205.

as well as quotations and many other features of this sort have been added, may more profoundly and appropriately be called a Basic Introduction to Education.<sup>182</sup>

Indeed, Papias introduces a variety of innovations, offering for some words grammatical information, such as declensions or conjugations; and appending source tags, when quoting external authors: “the names of some authors will be written in the margin by means of their first several letters for the identification of their words.”<sup>183</sup> For example, Papias bases his definition of “rustic” (*rusticus*) on Isidore’s: “rustic (*rusticus*), because such a one works the countryside (*rus*), that is, the ground,” and, in conformity, adds the abbreviation of Isidore – *hi* or *hi* – to the margin of his own definition (Figure 25 and Figure 26).<sup>184</sup>

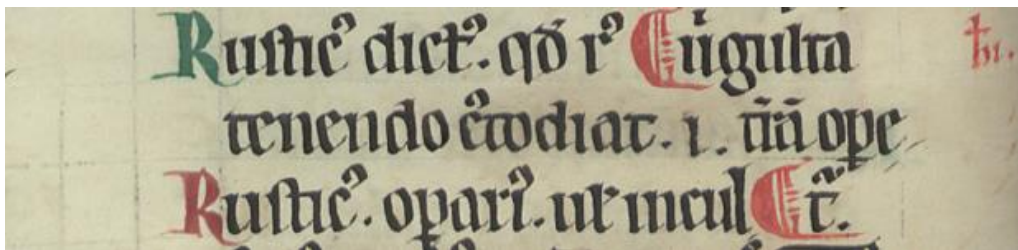


Figure 25. Lisbon, BNP, Alc. 426, fol. 33v (detail).

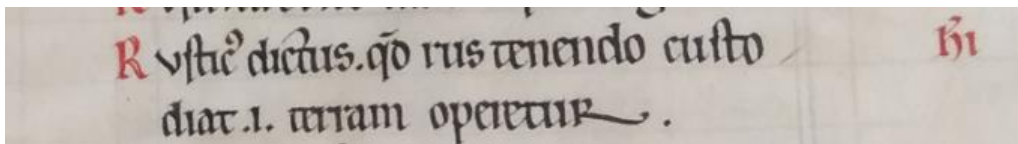


Figure 26. Porto, BPMP, Santa Cruz 8, fol. 20r (detail).

But perhaps the most remarkable revolution operated by Papias’s *Elementarium* is the introduction of alphabetic arrangement at least to the third letter:

Anyone who wishes to find anything quickly must also notice that this whole book is composed according to the alphabet, not only in the first letters of the parts but also in the second, third

---

<sup>182</sup> “Iam vero de huius artis nomine non pretermittendum videtur, que quidem, etsi olim, quia ad verbum et simpliciter unius alicuius dictionis retinebat interpretationem, glossarium vocaretur, iam vero, diffinitionibus et secundum regulas notationibus, sententiis quoque et multis id genus superadditis, altius atque aptius elementarium doctrine erudimentum nominari poterit.” Lloyd W. Daly and B. A. Daly, “Some Techniques in Mediaeval Latin Lexicography,” *Speculum* 39:2 (1964): 232, <https://doi.org/10.2307/2852727>.

<sup>183</sup> “At vero quorundam etiam auctorum nomina ad eorundem verborum autenticum primis quibusdam litteri.” L. W. Daly and B. A. Daly, “Some Techniques,” 233.

<sup>184</sup> “Rusticus dicitur quod rus operetur, id est terram.” Isidore, *Etimologías*, 834-835 (10.R.239).

and sometimes even in the further determinative arrangement of the letters. The first indication of division, then, will be made by .a.b.c. and the other letters in order. This will be subdivided in the second order of differentiation by the same letters .a.b.c. etc. in larger form before any change of letters.<sup>185</sup>

Surely, alphabetization is not an invention by Papias, as already shown: Isidore, and others before him, had employed it.<sup>186</sup> But before Papias, alphabetical ordering was commonly used only on the first letter. Papias took it a step further. Arrangements such as: *Anularis-Anna-Index-Ibidem*, that could be accepted under the former system, were reformed to: *Anna-Anularis-Ibidem-Index*.

In the same codices where one finds the Papias's dictionary and the glossaries by Bede and Jerome, there is a seemingly foreign element that apparently has little or nothing to do with any of these lexicographic works: the first three chapters of Rabanus Maurus's ninety-two-chapters treatise DC. In the DC – written in dialogue between a master and a disciple – the master explains natural phenomena and solves calendar problems, on an ascending level of difficulty. But before getting to the more complex questions of *computus*, the first eight chapters simply deal with numbers. The first one, “of the power of numbers” (*de numerorum potentia*), is on the importance of the study of proportions and numbers.<sup>187</sup> The master says that numbers come directly from God, because they showed up at the beginning of times, on the “first” day. Furthermore, all creation is made in numerical proportions, as stated in the often-quoted passage from the Book of Wisdom (11:21): “thou hast ordered all things in measure, and number, and weight” (*omnia in mensura, et numero et pondere disposuisti*).<sup>188</sup>

The second chapter of DC, “Whence it has been said ‘number’” (*Unde dictus sit numerus*), gives three possible etymological explanations for the word “number” (*numerus*): Augustine's etymology, associated with a certain goddess Numeria; Isidore's, that relates *numerus* with *nummus*, “coin”; and another, inspired by Isidore, that combines *nummus* and

---

<sup>185</sup> “Notare quoque cuilibet aliquid citius invenire volenti oportebit quoniam totus hie liber per alfabetum non solum in primis partium litteris verum etiam in secundis et tertiis et ulterius interdum ordinabili litterarum dispositione compositus erit. Prima igitur divisionis notatio per .a.b.c. et ceteras sequentes fiet litteras, que in secundo quidem distinctionis ordine per easdem .a.b.c. ceterasque maiores litteras ante quaslibet commutatas subdividetur.” L. W. Daly and B. A. Daly, “Some Techniques,” 233.

<sup>186</sup> Book 10 of the *Eymologies*, “Of words” (*De vocabulis*), is alphabetically ordered by the first letter.

<sup>187</sup> Rabanus Maurus, *Martyrologium. De computo*, 205-206. See Appendix C.

<sup>188</sup> “Every reader of medieval Latin knows that few Bible verses are so often quoted and alluded to as the phrase from the Book of Wisdom , 11:21 ‘omnia in mensura et numero et pondere disposuisti.’ (...) God's disposition was arithmetical!” Ernst Robert Curtius, *European Literature and the Latin Middle Ages*, trans. Willard R. Trask, Bollingen Series 36 (Princeton: Princeton University Press, 2013), 504-505.

*rius*, “coin” and “river,” getting “river of coins,” being that the word *numerus* would have originated from the large amount of taxes imposed by ancient emperors and kings.<sup>189</sup> Then, the master presents the definitions of “number” by Isidore, Augustine and Donatus: for Isidore, number is plural, “a multitude constituted by unities”; Augustine and Donatus, on the other hand, claim that “number” is singular.<sup>190</sup> The structure of this chapter resembles the structure of a medieval dictionary entry – the entries of Papias’s *Elementarium* also include etymological and grammatical information.<sup>191</sup>

After defining “number,” Rabanus Maurus increases the granularity of his inquiry. The topic of the third chapter of DC, titled “of the different species of numbers” (*de speciebus numerorum diuersis*), is the categorization of numbers.<sup>192</sup> In modern times, the problem of categorizing numbers is seen as an exclusively mathematical problem. Mathematicians define and study different numerical classes: there are natural numbers, integers, reals, complex numbers, hypercomplex numbers, and the list goes on endlessly.<sup>193</sup> In the middle ages, this task of enumeration and delimitation of the several types of numbers did not belong to arithmetic alone, but also to grammar. Of course that numbers were split into odd and even, and there were a variety of arithmetic categories such as triangular numbers, squared numbers, *antelongior* numbers, and spheric numbers.<sup>194</sup> But the *ars grammatica* also had its own categorizations. The first known instance of *species numerorum* is in the *Liber de figuris numerorum* by Priscian (6<sup>th</sup> c.), where numbers are systematically split in categories.<sup>195</sup> Following the same tradition, in the third chapter of DC, Rabanus Maurus describes a typology

---

<sup>189</sup> Rabanus Maurus, *Martyrologium. De computo*, 206-207. See Appendix C.

<sup>190</sup> In ancient and medieval mathematics, there was an essential difference between unity and the remaining numbers. In fact, “it should be noted that, according to the Pythagoreans and to Boethius, 1 is not a number but is the unity from which numbers are developed.” Menso Folkerts and Barnabas Hughes, “The Latin mathematics of medieval Europe,” in *Sourcebook in the Mathematics of Medieval Europe and North Africa*, edited by Victor J. Katz (Princeton: Princeton University Press, 2016), 23.

<sup>191</sup> Brian Merrilees analyses the types of entries in Papias’s *Elementarium*. For many words, Papias includes information on etymology, grammar, orthography, and phonetics. See B. Merrilees, “The Shape of the Medieval Dictionary Entry,” *Digital Studies/Le champ numérique* 0, n. 4 (1996), <https://doi.org/10.16995/dscn.201>.

<sup>192</sup> Rabanus Maurus, *Martyrologium*, 206-209. See Appendix C.

<sup>193</sup> For a compilation of various types of numbers and a succinct explanation for each of them, see: Wikipedia contributors, “List of types of numbers,” *Wikipedia*, The Free Encyclopedia, [https://en.wikipedia.org/w/index.php?title=List\\_of\\_types\\_of\\_numbers&oldid=980865789](https://en.wikipedia.org/w/index.php?title=List_of_types_of_numbers&oldid=980865789) (accessed October 18, 2020).

<sup>194</sup> In his influential treatise *De institutione arithmetica*, Boethius writes on these types of numbers. For an English translation, together with a number of studies, see: Boethius, *Boethian number theory: a translation of the ‘De institutione arithmetica’*, translated by Michael Masi, *Studies in Classical Antiquity* 6 (New York: Rodopi, 1983).

<sup>195</sup> See: Moritz Wedell, “Numbers,” in *Handbook of Medieval Culture: Fundamental Aspects and Conditions of the European Middle Ages*, ed. Albrecht Classen, trad. Erik Born, 2:1252 (Berlin: De Gruyter, 2015).

of numbers with seven different classes, including some that are still used nowadays, such as the cardinal numbers (*numeri cardinales*), i.e., one (*unus*), two (*duo*), three (*tres*), etc., and the adverbial numbers (*numeri adverbialis*), i.e. once (*semel*), twice (*bis*), thrice (*ter*), etc.<sup>196</sup> But after this enumeration, Rabanus Maurus adds another 14 classes, a lot less abstract, including the number of muscle fibres (*biceps*, *triceps*, ...) and the number of tongues one speaks (*bilinguis*, *trilinguis*, ...).<sup>197</sup> These extra classes give “number” a material dimension that overflows the strict categories of grammar and arithmetic.

The fifth and sixth chapters of DC are also part of a rich exposition on the nature and usage of numbers. The fifth chapter is about Roman numerals and the sixth chapter is on dactylonomy. Although the Portuguese codices omit these chapters, they append to the DC excerpt the FS images and – in the case of Santa Cruz 8 – the text of DCLD. As it happens, these images/texts effectively act as substitutes for chapters 5-6, as they carry the same contents – each gesture is depicted via a figure and is labeled with the respective Roman numeral.

Together, the excerpt from DC, plus the FS images and the DCLD, fit naturally in a lexicographical collection. They work as an encyclopedic entry for “number” with an interdisciplinary, or even a pre-disciplinary, approach. Here, “number” is a multifaceted object, simultaneously grammatical, mathematical, material, and more.

### 3.3. The transmission of the Portuguese codices

From about the same time period, Alc. 426 and Santa Cruz 8 are strongly connected. Discounting the later additions to Alc. 426, there are only two textual differences between them: Santa Cruz 8 contains the first chapter of Bede’s DTR, which is absent from Alc. 426; and Alc. 426 alone contains a fragment of Donatus’s *Ars grammatica*. Otherwise, they share most of the same textual and pictorial content. Probably one was copied from the other or, at least, they originated from a common ancestor.

The fact that each codex has their own unique elements turns the problem of understanding their tradition into an intricate riddle. Pieces of evidence such as the exclusion of the DCLD from Alc. 426 hint that Santa Cruz 8 cannot have been copied from Alc. 426. However, as it will be shown, the hypothesis that Alc. 426 was copied from Santa Cruz 8 does

---

<sup>196</sup> The other *species numerorum* are: *cardinales*, *ordinales*, *adverbiales*, *dispertitui*, *ponderales*, *denuntiatiui*, *multiplicatiui*. For an explanation of each class, see: M. Wedell, “Numbers,” 2:1252. See also Appendix C.

<sup>197</sup> For an explanation of each of the 14 *aliae species deriuatiuorum numerorum*, see: M. Wedell, “Numbers,” 2:1253-1254. See also Appendix C.

not find full support in the sources. Hence, a reasonable scenario is that none was copied from the other, but both shared a common ancestor, with a similar composition. However, no single manuscript has yet been found sharing the peculiar composition of Santa Cruz 8 and Alc. 426. The *Elementarium* and the *Ars grammatica* by Papias show up together in many manuscripts all across Europe; the same happens with the glossaries by Jerome and Bede; and with excerpts of DC and DTR.<sup>198</sup> But it is hard to find sources with more than a pair of texts in common with the Portuguese codices. In fact, manuscript Latin 7616 from the BNF might be the only extant medieval manuscript that shares three texts with Alc. 426 and Santa Cruz 8: the *Elementarium*, the *Ars grammatica*, and Jerome's *Liber interpretationibus*.<sup>199</sup>

Alc. 426 contains the third volume of a copy of Papias's *Elementarium*, the other volumes being in Alc. 424 and Alc. 425. The first two volumes of the Santa Cruz copy – if they ever existed – are now lost. But besides Alcobaça and Santa Cruz, other Portuguese monasteries are known to have held Papias's dictionary.<sup>200</sup> In a 1408 inventory of the library

---

<sup>198</sup> Examples of manuscripts with both works by Papias include: Florence, Biblioteca Medicea Laurenziana, Ashburnham 63; and Auxerre, Bibliothèque Jacques Lacarrière 70 (67). With both biblical glossaries: Klosterneuburg, Bibliothek des Augustiner Chorherrenstiftes, 209; and Heiligenkreuz, Bibliothek des Zisterzienserstiftes, 78.

<sup>199</sup> Paris, BNF, Latin 7616. For information on this manuscript, see: "Latin 7617," in *Archives et manuscrits*, <https://archivesetmanuscrits.bnf.fr/ark:/12148/cc66853q> (accessed May 18, 2021). In the BNF catalogue Papias's *Ars grammatica* is mistaken for a fragment by Priscian.

<sup>200</sup> It has been hypothesised that the Alc. 426 was not produced in Alcobaça. Several eighteenth-century inventories of the Alcobaça library, such as the *Index codicorum bibliothecae Alcobatiae* (1775), and Diogo Barbosa Machado's *Summario da Bibliotheca Lusitana* (1786-1787), not only give a full account of the codices in the library, but they also provide a short biographical note for each of the scribes that supposedly wrote each codex. Even if, due to their high level of detail, these notes have oftentimes been considered useful, they were deemed unreliable by recent historiography because they lack sound evidence: Aires Nascimento states that "as tradições recolhidas pelo Index Codicum, ou as que Frei Manuel de Figueiredo transcreveu e que, com algumas variantes, aliás, já anteriormente haviam sido passadas a Barbosa Machado para a sua Bibliotheca Lusitana, não merecem crédito, como já a seu tempo denunciou Frei Fortunato de S. Boaventura e como se pode verificar pela contraposição e os dados comprovadamente atestados nos próprios códices." The note regarding codex Alc. 426 attributes the writing of codices Alc. 424, 425, and 426 to a monk from the monastery of Santa Maria de Seíça called Afonso, originally from the parish of Louriçal ("Frei Affonso do Louriçal monge de Ceíça escreveu em tres grandes columes de pergaminho de gentil letra com algumas illuminadas o famozo e doutissimo Vocabulario de Papias autor antiquissimo, e no fim do dito Vocabulario escreveu mais a Arte de Latim do mesmo author. O livro de S. Hieronimo, que se intitula Liber interpretationum nominum haebraicorum. Floreceo o dito Frei Affonso pelos annos de Christo 1200. Estes volumes estão na Livraria de mão de Alcobaça"). Formerly Benedictine, the abbey of Seíça became Cistercian in 1195, as a daughter house of Alcobaça. Soon after, when, at the beginning of the thirteenth century, the Lorrvão monastery became a Feminine monastery, it is possible that many of its former monks migrated to Seíça, which must have enabled a significant intellectual and technical stimulus for the Cistercian abbey. Seíça was close to Coimbra, strategically placed right next to the borders of Louriçal, a parish long disputed between the Cathedral of Coimbra and Santa Cruz. So, could Alc. 426 actually have been produced in Seíça, geographically closer to Santa Cruz, and perhaps benefitting from the experience and tradition of the Lorrvão scribes? Although it is nearly impossible to invalidate such an hypothesis, it is but a remote possibility. One of the main reasons for its remoteness is provided by a 1408 inventory of the Seíça library – the only extant record of its books – that does not mention Papias. In fact, this inventory reports a very small book collection – only 42 entries – and all of them are liturgical or otherwise religious. See: Aires A. Nascimento, "A experiência do livro no primitivo meio alcobacense," In *IX Centenário do Nascimento de S. Bernardo: Encontros de Alcobaça*

of the Cistercian abbey of Santa Maria do Bouro, there is an entry for one Papias volume (*item huũ Papias*), and in the aforementioned inventory of the Augustinian São Vicente de Fora library, there is an entry for two Papias volumes (*De Papias. II partes*).<sup>201</sup> Little can be asserted from this information, as the entries are too succinct and the volumes in question have been lost. Or perhaps they were loans: given the proximity between Santa Cruz and São Vicente, and between Alcobaça and Bouro, these books would naturally circulate. In any case, these entries certainly indicate a level of synchronization between the Portuguese monastic houses, as they are also part of collections with an emphasis on lexicography. Apart from Papias's *Elementarium*, both Bouro and São Vicente libraries included the *Ethymologies* (*Item huũ liuro Ethimologiarum* in Bouro, and *De Ysidoro, II partes* in São Vicente); São Vicente also held Peter Cantor's *Summa Abel* (*Abel*); and Bouro included Maurice of Provins' *Distinctiones* (*Item huũ liuro de distincçooês de Mauricio*), a work that is also present in Alcobaça, in the fourteenth century codex Alc. 25.<sup>202</sup>

The transcription of the DC excerpt from each codex (Appendix D) sheds some light into the tradition problem. Both versions mostly coincide. Only a small number of variants were identified between them, including word omissions, transpositions, and additions. For example, Santa Cruz 8 adds the numbers “*quinarius senarius septenarius octonarius nonarius decenarius undenarius duodenarius trecenarius*” to the class that comprises “*singularis*” (in Alc. 426, “*singulis*”), “*dualis*,” “*ternarius*,” and “*quaternarius*.” The fact that both versions

---

*e Simpósio de Lisboa – Actas* (Braga: Universidade Católica Portuguesa – Câmara Municipal de Alcobaça, 1991), 139-140; José Marques, “Desconhecidas Instituições Culturais Portuguesas: alguns scriptoria Cistercienses,” *Sep. Bracara Augusta* 39 (Braga: Correio do Minho, 1986): 9-12,21. For a somewhat cursory history of the Seiça monastery: António Ferreira Cabete, *O Mosteiro de Santa Maria de Seiça : das origens aos alvares da modernidade* (Figueira da Foz: Câmara Municipal da Figueira da Foz, 2015). On the extant Seiça documentation, see: Adriana Duarte Antunes, “Inventário do acervo documental do Mosteiro de Santa Maria de Seiça,” *Boletim do Arquivo da Universidade de Coimbra* 25 (2012), [https://doi.org/10.14195/2182-7974\\_25\\_1](https://doi.org/10.14195/2182-7974_25_1). For a transcription and a study of the Seiça inventory, see: José Mattoso, “Leituras Cistercienses Do Século XV,” *Do Tempo e Da História* V (1972): 101–41.

<sup>201</sup> The fact that Bouro only had one volume and São Vicente only had two volumes, while Alcobaça – and probably Santa Cruz – had three, is intriguing. Perhaps there was more than one textual tradition of Papias circulating in Portugal at the time, or maybe São Vicente was missing one volume and Bouro was missing two volumes. Could the missing volumes of Santa Cruz be at São Vicente? Given the close relationship between both monasteries, it is not an impossible scenario. On the Bouro inventory, see: José Mattoso, “Leituras Cistercienses.” On the São Vicente inventory, see: A. A. Nascimento, “Livros e Claustro.” Possibly of interest is an entry of an 1393 inventory of the library of the Coimbra cathedral: “Item. Outro livro que se diz Glosimiarom, galego,” where “galego” refers to the visigothic script – “antiqua littera, que vulgariter appellatur gallega.” Could this “Glosimiarom” might be a “Glossary”? For a transcription of this inventory and a study, see: A. J. da Costa, *A Biblioteca e o Tesouro*.

<sup>202</sup> The Coimbra cathedral library also held a copy of Isidore's *Etymologies*. See: A. J. da Costa, *A Biblioteca e o Tesouro*, 16.

have their own unique word omissions and additions reinforces the hypothesis that they were not copied from one another.

The comparison of the transcriptions with the DC critical edition also proved valuable.<sup>203</sup> For one, there are variants shared by the Portuguese manuscripts that appear nowhere else, setting them apart from the rest of the tradition. One curious such variant is the replacement of the word “*nummus*” by “*numerus*,” maybe originally made by a scribe with the intention of correcting a seeming mistake, but with bizarre consequences: when explaining the etymology of “*numerus*,” the Portuguese variants state that the word “number” comes from the words “number” and “river” (*apud latinos uero numerus ex nummero et riuo uidetur nomen traxisse*), or that “number” gave the name to “number” (*Numerus numero dedit nomen*). With these word-replacements, these sentences lose their original meaning and become redundant, if not downright absurd.

The text in Santa Cruz 8 and Alc. 426 coincides to a large extent with the textual version in the Leiden illuminated manuscript B.P.L 191 BD and, to a smaller degree, also with BL manuscript Harley 3092.<sup>204</sup> An analysis of the DC excerpt transcription, with the aid of the apparatus provided by the critical edition, enables a partial reconstruction of a *stemma codicum* (Figure 27), where the Leiden manuscript antecedes the Portuguese manuscripts, and the observed textual proximity of the Harley 3092 to the Portuguese codices is also reflected.

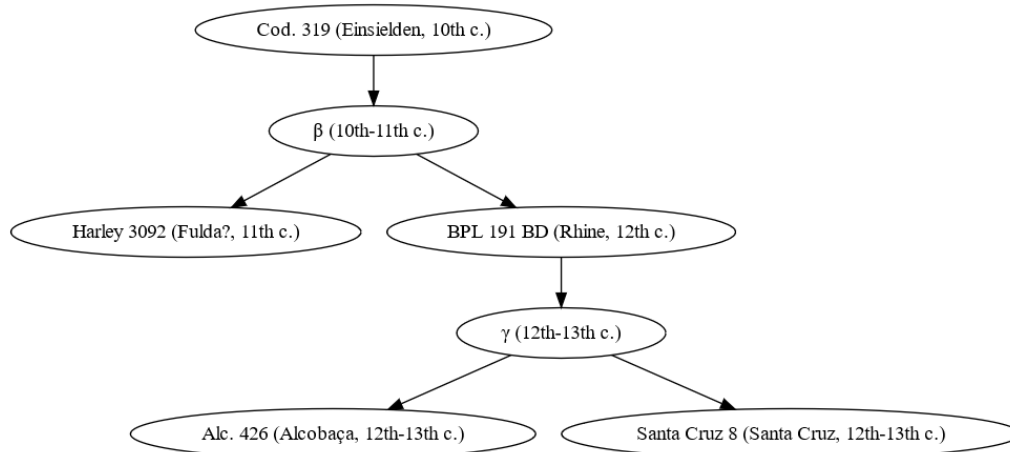


Figure 27. Hypothetical partial stemma codicum of the first three chapters of *De computo*.

<sup>203</sup> Rabanus Maurus, *Martyrologium*.

<sup>204</sup> Eleventh century manuscript London, British Library, Harley 3092 “was written in the central western Germanic area of Trier or Fulda, (...) and was once possessed by Nicholas of Cusa.” W. Stevens, “Introduction,” in *Martyrologium*, 192.

Computational methods were used to quantitatively measure the similarities between each manuscript in the corpus of the critical edition plus the Portuguese variants. Each manuscript was transcribed, and the normalized compression distances (hereafter NCD) between each pair of transcriptions was computed. The NCD is a mathematical function that is used to measure the similarity between any two objects, whether they are texts, images, or other types of objects: if the distance is small, it means that the objects are similar; if it is 0, it means that the objects are the same.<sup>205</sup> It approximates the normalized information distance, a theoretical information metric that is not computable – hence the need for approximations.<sup>206</sup> The NCD has been successfully used in a variety of applications, such as the reconstruction of language trees, SPAM e-mail detection and classification, and the prediction of useful *vs.* useless stem cells.<sup>207</sup> It has never been used in manuscript studies. In order to calculate the NCD for all pairs of transcriptions and visualize the result in an easy-to-understand image, this dissertation made use of the software CompLearn and QSearch.<sup>208</sup>

The output of the experiment (Figure 28) is coherent with the proposed *stemma*. The automated tool clustered the Portuguese manuscripts (Q and S) together with the Harley 3092 (H) and the Leiden manuscripts (L), not too distant from the Einsiedeln manuscript (D).<sup>209</sup> Furthermore, it reflects other information given by the critical edition, such as the proximity between Add. 10801 from the BL (B) and Can. Misc. 353 from the Bodleian Library (C), and the fact that Ms. 3507 from the Exeter Cathedral Library (E) and the Cotton Vitellius A.XII from the BL (V) were transcribed from the same exemplar.<sup>210</sup> Although the text samples are small, which does not allow for a high degree of confidence, the results are compelling. But above all, they are encouraging. Information theory might – and certainly will – prove valuable in manuscript studies in the years to come.

---

<sup>205</sup> For a detailed explanation, see: R. Cilibrasi and P. M. B. Vitányi, “Clustering by compression,” in *IEEE Transactions on Information Theory* 51:4 (April 2005):1523-1545, <https://doi.org/10.1109/TIT.2005.844059>.

<sup>206</sup> For an introduction to the NID and the necessary theoretical background see: M. Li and P. Vitányi, *An Introduction to Kolmogorov Complexity and Its Applications*, 4<sup>th</sup> ed. (New York: Springer-Verlag, 2019).

<sup>207</sup> See: A. Cohen, F. Gomes, B. Roysam et al., “Computational prediction of neural progenitor cell fates,” *Nature Methods* 7 (2010) : 213–218, <https://doi.org/10.1038/nmeth.1424>; Ming Li, et al., “The similarity metric,” in *IEEE Transactions on Information Theory* 50:12 (Dec. 2004) : 3250-3264, <https://doi.org/10.1109/TIT.2004.838101>. My own BSc (in applied mathematics and computation) final project was an application of this method to the prediction of trade in the world commodity market.

<sup>208</sup> CompLearn was developed and written by Rudi Cilibrasi, Anna Lissa Cruz, Steven de Rooij, and Maarten Keijzer, based on the research of Cilibrasi, Paul Vitányi, and Ming Li. See: “What is CompLearn?,” *CompLearn*, <https://complearn.org/index.html> (accessed July 3, 2021).

<sup>209</sup> W. Stevens, “Introduction,” in *Martyrologium*, 190-192.

<sup>210</sup> *Ibid.*, 190-196.

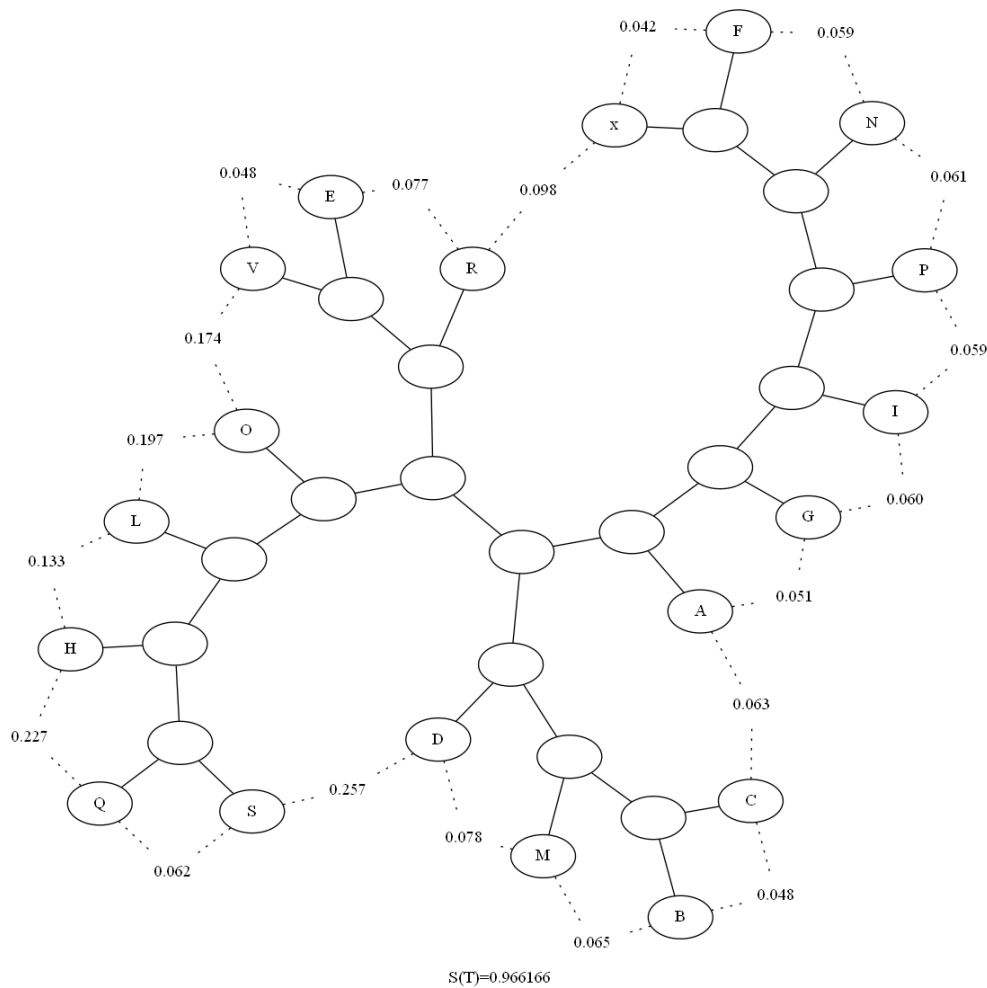


Figure 28. Graphical representation of NCD matrix for manuscript transcriptions of the first three chapters of *De computo*.

But for understanding these manuscripts' tradition, the text is not enough. Indeed, the images often hold many answers – as well as a multitude of new questions. The illumination structure of both manuscripts coincides.<sup>211</sup> Both contain sixteen large decorated capitals, using the style of each respective *scriptorium*.<sup>212</sup> In Alc. 426, these are painted in red, green, blue, and orange, often including floral, vegetative, and animal motifs: one striking such foliate initial is the blue “U” in fol. 124r, filled with a rolled red leaved stalk, over a green pattern, topped by a

<sup>211</sup> For a succinct commentary to the illumination of the Portuguese manuscripts, see: M. Coutinho, “Dispositivos Visuais.”

<sup>212</sup> See Maria Adelaide Miranda’s work on the illumination of Santa Cruz and Alcobaça, especially: “A iluminura românica em Santa Cruz de Coimbra e Santa Maria de Alcobaça: subsídios para o estudo da iluminura em Portugal,” PhD diss., (Universidade Nova de Lisboa, 1966). Also: *A iluminura de Santa Cruz no tempo de Santo António* (Lisboa : Edições Inapa, 1996); *A iluminura românica em Portugal* (Lisboa : Biblioteca Nacional, 1999).

fire-spitting wyvern (Figure 29). Not as magnificent as their counterparts, the Santa Cruz 8 large capitals are painted in red and blue and are embellished by abstract and rhythmic patterns.



Figure 29. Lisbon, BNP, Alc. 426, fol. 124r (detail). / Porto, BPMP, Santa Cruz 8, fol. 82r (detail).

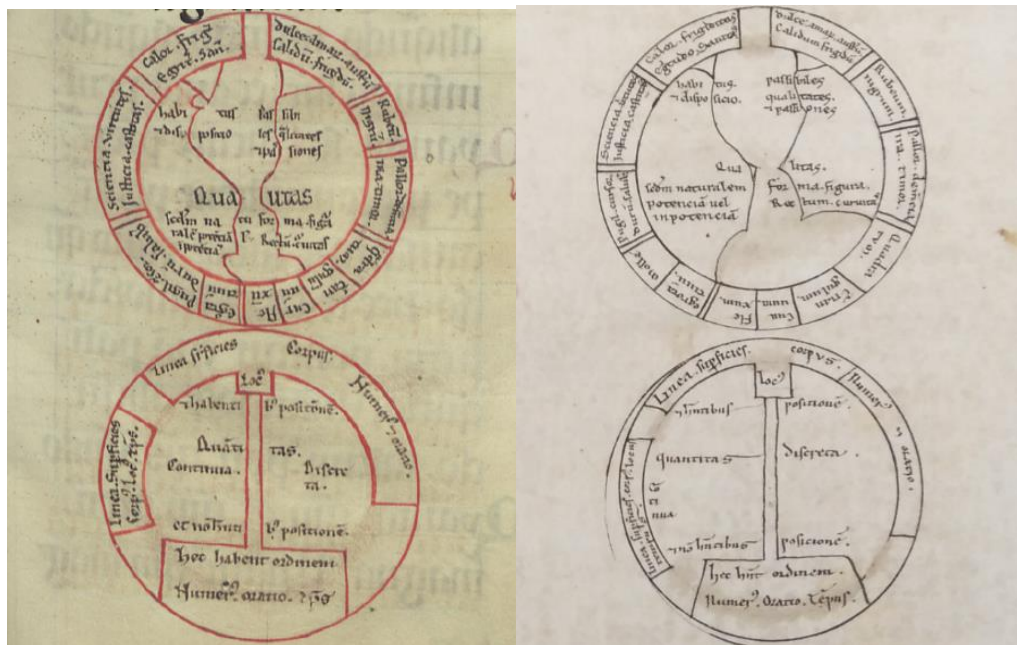


Figure 30. Lisbon, BNP, Alc. 426, fol. 3r (detail). / Porto, BPMP, Santa Cruz 8, fol. 1v (detail).

Apart from these sixteen capitals, plus a vast number of smaller decorated initials and the FS images, both codices contain two diagrams, inserted in between Papias's *Elementarium*. The

first is a pair of circular schemes placed after the entry for “quality” (*qualitas*), representing the Aristotelian categories of “quantity” (*quantitas*) and “quality” (*qualitas*).<sup>213</sup>

The differences between both versions of the *qualitas/quantitas* diagrams are minimal (Figure 30).<sup>214</sup> It is not so with the other diagram present in both codices. Placed after the entry for “stars” (*stelle*), in both manuscripts, it is a kind of Plinian diagram.<sup>215</sup> In both manuscripts, it consists of a set of ten concentric circles, forming nine annuli. In Santa Cruz 8, each of the annulus is empty, whereas in Alc. 426 they are cut by eight radial straight lines and are labeled with the names of the seven stars: the sun (*Sol*), the moon (*Luna*), and the five planets – Jupiter, Saturn (*Saturnus*), Mars, Venus, Mercury (*Mercurius*). Additionally, the outer annulus holds the name of the first sign of the Zodiac: Aries (Figure 31).

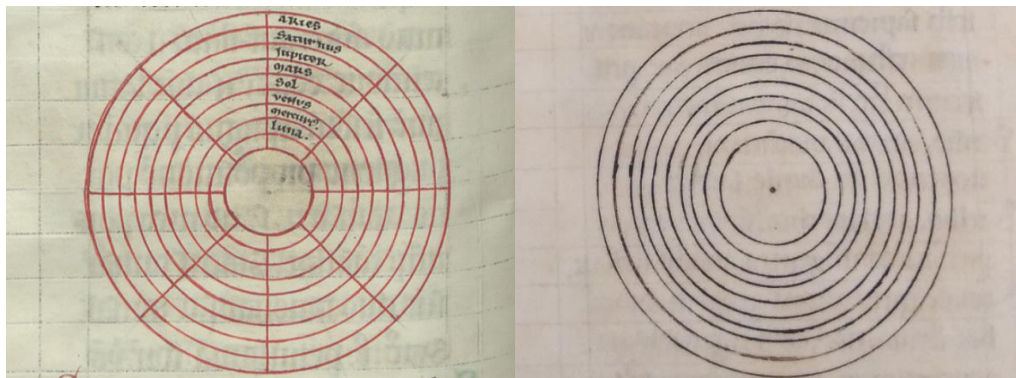


Figure 31. Lisbon, BNP, Alc. 426, fol. 83v (detail). / Porto, BPMP, Santa Cruz 8, fol. 53r (detail).

A comparison between the Plinian diagrams strongly suggests that the Alc. 426 codex was not copied from the Santa Cruz 8, at least not in its entirety, since the Santa Cruz 8 diagram is evidently unfinished. This does not mean that the Alc. 426 diagram is complete either. In fact, one strange element calls the attention of the beholder: the isolated presence of *Aries*. Looking

<sup>213</sup> On the Aristotelian categories, see: Paul Studtmann, “Aristotle’s Categories,” *The Stanford Encyclopedia of Philosophy* (2021), <https://plato.stanford.edu/archives/spr2021/entries/aristotle-categories/> (accessed May 14, 2021). Specifically on quality/quantity from the standpoint of medieval science, see the studies collected in: Erwin Neuenchwander, ed., *Wissenschaft Zwischen Qualitas und Quantitas* (Basel: Springer Basel AG, 2003).

<sup>214</sup> Maria Coutinho identifies some differences, such as the inclusion of a partition for *molle* in the Santa Cruz 8 diagram, that does not exist in its Alc. 426 counterpart. See: Maria Coutinho, “De computo de Rábano Mauro.”

<sup>215</sup> “The Plinian diagram for planetary order is extremely simple. It contains either seven or eight concentric circles, equally spaced. In Plinian/Ptolemaic order (Saturn, Jupiter, Mars, Sun, Venus, Mercury, Moon) the seven planetary names are written in a vertical list, one name on each circle. When an eighth circle appears in the middle, it has a label for Earth. In any case, the label for Earth appears at the centre of the diagram.” Bruce Eastwood and Gerd Graßhoff, *Planetary Diagrams for Roman Astronomy in Medieval Europe, ca. 800–1500*, Transactions of the American Philosophical Society (Philadelphia: American Philosophical Society, 2004): 23.

into other medieval *Elementarium* manuscripts, one sees that this type of diagram is usually not split in eight sectors, but in twelve, for the twelve Zodiac signs, the first of which is *Aries*. For example, the twelfth century manuscript Latin 7616 from the BNF, that also contains the *Elementarium*, also followed by Papias's *Ars grammatica* and Jerome's glossary, has a diagram that is remarkably similar to Alc. 426, but only with eight annuli instead of nine; and with twelve radial lines, instead of eight. Also, worth mentioning is the twelfth century Latin 7619 from the BNF, a manuscript that also contains the Papias's *Elementarium* and *Ars grammatica*, from the great Cistercian Fontenay abbey.<sup>216</sup> Here, the diagram has 9 annuli, like in Alc. 426 diagram, and like in Alc. 426 the inner annulus is unlabeled.

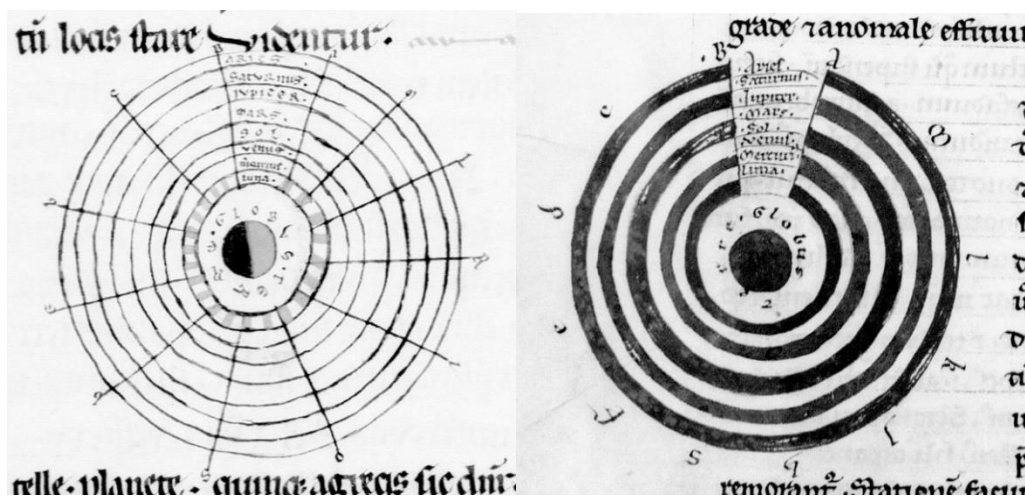


Figure 32. Paris, BNF, Latin 7616, fol. 46v (detail). / Paris, BNF, Latin 7619, fol. 97v (detail).

The problem of the manuscript tradition behind Alc. 426 and Santa Cruz 8 is still far from being solved. Among other endeavors, it requires a large-scale survey of all extant medieval sources containing the *Elementarium* and the remaining works encompassed in the Portuguese codices, articulated with a refined paleographic and iconographic analysis.

The FS images, in particular, deserve special attention, for there are several FS pictorial sub-traditions. Hence, a comparative analysis at the European level can lead to valuable results. The FS images are the focus of next chapter.

---

<sup>216</sup> Paris, BNF, Latin 7619 contains *Elementarium* entries from N to Z. For information on this manuscript, see: "Latin 7619," in *Archives et manuscrits*, <https://archivesetmanuscrits.bnf.fr/ark:/12148/cc66856f> (accessed May 18, 2021).

#### 4. *Mirabilis et intensa: dactylonomy and the art of memory*

Memory is most powerfully affected by sensory impression, and especially by vision; therefore, something appears to your memory just as it ordinarily appears to your vision.

Thomas Bradwardine (ca. 1300 – 1349),  
*De memoria artificiale acquirenda*<sup>217</sup>

Pursuing a valid understanding of medieval FS images is an alluring but arduous task. The scarcity of sources, their variety and remoteness prevent us from taking definite conclusions about transmission, use, and relevance. Still, the hints one keeps getting point to a powerful phenomenon that pervaded the whole medieval intellectual culture. These hints are not just about dactylonomy, but about medieval teaching and learning, visual culture, embodied knowledge, and, most significantly, mnemonic devices.

The FS images are a great case study of the central position that the art of memory (*ars memorativa*) occupied in the medieval monastic framework. They are carefully crafted according to the precepts laid down by ancient rhetoric treatises, such as *Rhetorica ad Herennium*, arranging the objects in aligned frames, and making heavy use of a variety of rhetorical ornaments, such as *enargeia* and *paronomasia*, while at the same time revealing impressive levels of creativity – memory and invention would always go hand in hand.

The FS images convey their message in a vivid and captivating manner, perfectly suitable for memorization. This is markedly true in the Portuguese manuscripts, Alc. 426 and Santa Cruz 8. While following many of the same patterns as their European counterparts, these manuscripts exhibit unique pictorial features, such as distinctive layouts for the hands and busts, and multiple visual puns.

This chapter treats the FS images and the way they use mnemonic techniques. After presenting some of the challenges brought forth by an iconographic analysis of the FS images in Alc. 426 and Santa Cruz 8, the chapter provides a brief introduction to the art of memory,

---

<sup>217</sup> “Memoria vero maxime causatur a sensu, maxime quoque a visu, quare in memoria accidit sicut in visi accidere consuevit.” Mary Carruthers, “Thomas Bradwardine, ‘De memoria artificiale acquirenda’,” *The Journal of Medieval Latin* 2 (1992): 25. A translation of this treatise is available in: Thomas Bradwardine, “Thomas Bradwardine, On Acquiring a Trained Memory,” trans. Mary Carruthers, in *The Medieval Craft of Memory: An Anthology of Texts and Pictures*, ed. Mary Carruthers, and Jan M. Ziolkowski (Philadelphia: University of Pennsylvania Press, 2002), 205-214.

followed by an exploration of two applications of this art in the dactylonomy iconographic tradition.

#### 4.1. Disparities in the Portuguese codices

The FS images contained in Alc. 426 (Plate 2 and Plate 3) and Santa Cruz 8 (Plate 1) are seemingly close to one another. Both contain depictions of thirty-six hands, representing the units (1-9), the tens (10-90), the hundreds (100-900), and the thousands (1,000-9,000). These hand depictions are ornamented in a similar manner: the hands are displayed over white-framed colored rectangles – red in Santa Cruz 8; green/red alternatingly in Alc. 426 – separated by thick vertical lines – black in Santa Cruz 8; blue in Alc. 426 – labeled with red Roman numerals over each frame.<sup>218</sup> Furthermore, both codices contain human busts representing higher amounts. These busts are all opulently clothed male figures and in most cases, they hold similar objects. However, between the FS images in Alc. 426 and Santa Cruz 8, there are as many differences as there are similarities.

There are eight busts in Santa Cruz 8, arranged in four rows, each row with two busts. The first six busts are coherent with Bede's text and clearly represent numbers 10,000-60,000. But the last two are harder to interpret (Figure 33). Following a sequential logic, the seventh bust should represent 70,000. However, the gesture for 70,000 is to hold the left thigh with the back of the hand (*eandem supinam femori super pones*).<sup>219</sup> The figure, however, holds the right thigh with the palm of the hand. It could be that this is a twice-deviated interpretation of Bede's model, where "left" became "right" and "back" became "palm." Or perhaps it represents some other number: as it is holding the right thigh with the palm, it could mean either 600,000 (*eadem*

---

<sup>218</sup> Blue, green and red were the most frequent colors employed in Alcobaça. Red would mostly be achieved by mixing vermilion and/or an organic red pigment; lazurite would be used for blue; and "green is defined as bottle green, commonly seen in Portuguese medieval manuscripts, evidencing the loss of cohesion and adhesion to the support. RM and  $\mu$ -Fourier Transform Infrared Spectroscopy identify a copper complex with a protein, possibly verdigris based." See: Vânia S. F. Muralha, Catarina Miguel, Maria João Melo, "Micro-Raman study of Medieval Cistercian 12–13th century manuscripts: Santa Maria de Alcobaça, Portugal," *Journal of Raman Spectroscopy* 43:11 (September 2012): 1737-1747, <https://doi.org/10.1002/jrs.4065>. Over the past decade, several interdisciplinary studies – that combine molecular science, art history, and codicology – have been published on the use of color by the *scriptoria* of Alcobaça, Santa Cruz, and Lorvão. See: Maria João Melo, Rita Castro and Adelaide Miranda, "Colour in Medieval Portuguese Manuscripts: Between Beauty and Meaning," in *Science and Art: The Painted Surface*, edited by Antonio Sgamellotti, Brunetto Giovanni Brunetti, and Costanza Miliani (Cambridge: Royal Society of Chemistry, 2014), 170-193, <https://doi.org/10.1039/9781839161957-00170>; Maria Adelaide Miranda, and Maria João Melo, "O esplendor da cor nos manuscritos românicos alcobacenses," *De Cister a Portugal: o tempo e o(s) modo(s)*, edited by Maria Alegria Fernandes Marques, and Luís Carlos Amaral, (São Cristovão de Lafões : Associação dos Amigos do Mosteiro de São Cristovão de Lafões, 2016), 142-148.

<sup>219</sup> Beda Venerabilis, *Opera didascalica*, 270.

*prona femur desuper comprehendes*) or 800,000 (*eandem pronam femori superpones*).<sup>220</sup> But any of these numbers seem to lack a sound rationale for their position: why would such a number be placed here, decontextualized, blatantly interrupting a numerical series of a much lower order of magnitude? A reasonable answer for this riddle is yet to be found. As for the last bust, it is even more complicated, if not impossible, to decode, as it was left unfinished and has no limbs.



Figure 33. Porto, BPMP, Santa Cruz 8, fol. 180rb (detail).

Like in Santa Cruz 8, only the first six busts in Alc. 426 are straightforwardly identifiable. Alc. 426 has a total of ten busts, spread over two pages: the first two busts (10,000 and 20,000) show up in fol. 251v and are horizontally aligned; the remaining eight, in fol. 252r, are disposed in two columns of four. The first column in fol. 251v displays the gestures for 30,000-60,000, probably following the same pictorial model as Santa Cruz 8. Similarly to what happens in Santa Cruz 8, the four busts in the second column of fol. 252r (Figure 34) break the sequential order: they do not represent 70,000, 80,000, and so forth.<sup>221</sup> Instead, they appear to be representing the gestures for 200,000-500,000. However, this interpretation comes with a high level of ambiguity: all four busts hold a kind of tablet, like the one held by the seventh Santa

<sup>220</sup> Beda Venerabilis, *Opera didascalica*, 271.

<sup>221</sup> The fact that the two manuscripts coincide until the sixth bust but diverge afterwards is meaningful: if they had a common model, or a common ancestor, it could be that this model lacked the depictions for the gestures starting with 70,000. Even the divergence between them is not absolute: the last Alc. 426 bust is actually quite similar to the seventh Santa Cruz 8 bust.

Cruz 8 bust; the first three of these tablets are labeled with numbers 20, 30, and 90, and the last is unlabeled; and none of these labels corresponds to the depicted gestures.<sup>222</sup>



Figure 34. Lisbon, BNP, Alc. 426, fol. 252rb (details).

When working with visual culture, one often finds deviations from the norm, disparities between text and image, and branches from tradition. These can easily be evaluated as “mistakes” on the part of distracted or ill-advised monks. However, these assumptions are often precipitated or even presentist, as medieval monks thought and communicated through complex codes of meaning, that combined text and image, form and content.<sup>223</sup> Many of the divergences from Bede’s text observed in Alc. 426 and Santa Cruz 8 remain a mystery, and they might even be the product of ignorance or negligence of medieval artists. But before classifying a discrepancy as an “iconographic error,” other hypotheses must be considered.<sup>224</sup>

Numbers 1 and 7 roughly share the same gesture, and so do the pairs 2-8, 3-9, 1000-7000, 2000-8000, and 3000-9000, all identically described by Bede. The only difference

---

<sup>222</sup> One explanation for the dissociation between the labels and the gestures is that these labels are referring to the alphanumeric system. In that case, they would read “LMS.” Another, very remote, hypothesis would be an uncommon numerical notation strategy, that would associate symbol X with 100,000 and C with 500,000, instead of the usual overlined C and D.

<sup>223</sup> See: Kirk Ambrose, “Visual poetics of the Cluny hemicycle capital inscriptions,” *Word & Image* 20:2 (2004): 156, <https://doi.org/10.1080/02666286.2004.10444012>.

<sup>224</sup> For a reflection on the concept of iconographic error and the use of models in medieval art, see Pierre-Olivier Dittmar, “Lapsus figurae, Notes sur l’erreur iconographique,” in *Quand l’image relit le texte. Regards croisés sur les manuscrits médiévaux*, (Paris: Presses de la Sorbonne Nouvelle, 2013), 319–335. On this topic, see also: Monika E. Müller ed., *The Use of Models in Medieval Book Painting* (Newcastle upon Tyne: Cambridge Scholars Publishing, 2014).

between them is that the gestures for numbers 1, 2, 3, 1000, 2000, and 3000, use the “medium of the palm” (*medium palmae*), and the gestures for 7, 8, 9, 7000, 8000, and 9000, use the “root of the palm” (*radix palmae*).<sup>225</sup> Analogously, 10 and 100 use the middle of the thumb (*medium pollicis*), while 90 and 900 use its root (*radix pollicis*). Otherwise, the pairs 10-90 and 100-900 have the same gesture.<sup>226</sup> But Alc. 426 only shows a noticeable distinction between “*radix*” and “*medium*” in the depictions of the 2 and 8 gestures, where the knuckles of the index and middle fingers differ in height (Figure 35). As for Santa Cruz 8, it is able to clearly distinguish pairs 1-7, 2-8, and 3-9 (Figure 36), but it remains ambiguous regarding the remaining pairs.



Figure 35. Lisbon, BNP, Alc. 426, fol. 251v (details).



Figure 36. Porto, BPMP, Santa Cruz 8, fol. 180ra (details).

The words *radix* and *medium*, both present in the *Romana computatio*, Bede’s, and Rabanus Maurus’s treatises, have given rise to ambiguity not only in the Portuguese manuscripts, but all across the FS pictorial tradition. The meaning of “medium of the palm” seems clear enough, but what is the “root of the palm”? Some manuscripts, like Turin D.III.19 and New York 925, conflate “medium” and “root,” placing the tips of the fingers on the middle of the palm in either case (Figure 37). Others interpret “root” as the metacarpophalangeal joint, at the knuckle, where the finger joins the hand: it is the case of manuscripts Munich 10270 and Munich 14436

<sup>225</sup> Beda Venerabilis, *Opera didascalica*, 269-270.

<sup>226</sup> Beda Venerabilis, *Opera didascalica*, 270.

(Figure 38). And finally, there are manuscripts like London Royal and Paris 3352B, that interpret “root” as meaning the bottom of the palm, at the carpometacarpal joint (Figure 39).



Figure 37. New York City, The Morgan Library & Museum, MS M.925, fol. 38r (details) / Turin, Biblioteca Nazionale Universitaria di Torino, Ms. D III 19, fol. 135r (details).

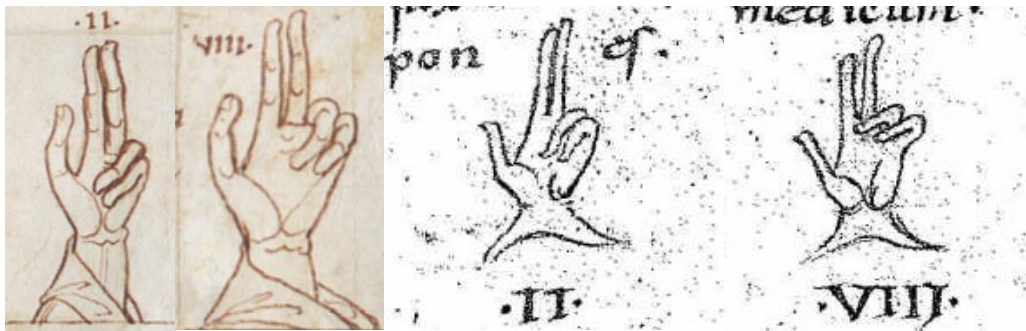


Figure 38. Munich, Bayerische Staatsbibliothek, Clm 10270, fol. 4v (details) / Munich, Bayerische Staatsbibliothek, Clm 14436, fol. 113v (details).



Figure 39. London, BL, Royal 13 A XI, fol. 33v (details) / Paris, BNF, Latin 3352B, fol. 1v (details).

The fact that Santa Cruz 8 follows the latter interpretation – where the “root” is the “base” – with respect to 1-7, 2-8, 3-9, but not with respect to the higher values 1,000-7,000, 2,000-8,000, 3,000-9,000, is mysterious in itself, since the descriptions for the units’ gestures are exactly the

same as the ones for the thousands. Manifestly, the level of accuracy and detail applied to the smaller numbers is much higher than that applied to the larger values, possibly because the smaller numerical gestures were more often put to practice in daily life. And it might have been that this difference was already present in the pictorial model employed by the Santa Cruz scribes. Whatever be the case, the Portuguese manuscripts can hardly be said to be “mistaken.” They are part of a long, complex, and non-linear verbal-visual tradition that carries with it a wide range of perceptions and experiences.

One of the deviations from Bede’s model that stands out the most in Alc. 426 is the depiction of the 100 gesture. For Bede, the gestures for 10 and 100 are the same, except that the 10 gesture uses the left hand and the 100 gesture uses the right (*centum uero in dextera, quomodo decem in laeua facies*).<sup>227</sup> In both cases, one has to place the index nail over the middle of the thumb (*unguem indicis in medio figes artu pollicis*).<sup>228</sup> In Alc. 426, the 10 gesture follows Bede’s text, but not so the 100 gesture, which joins the thumb and index fingertips in a round shape, much like the 30 gesture: (*ungues indicis et pollicis blando coniunges amplexus*).<sup>229</sup> Such a shape evokes the passages of Jerome and Augustine about the 100 gesture as a circular “crown of virginity.” As it has already been mentioned, Jerome is quoted by Bede himself in the chapter 1 of DTR, asking for the reader’s attention (*quaeso, diligenter lector, attende*) and saying that, by making a circle, the fingers express the crown of virginity (*circulum faciens exprimit uirginitatis coronam*).<sup>230</sup> Although Alc. 426 does not comply with Bede’s description, it seems to be following Jerome’s request.



Figure 40. Porto, BPMP, Santa Cruz 8, fol. 180ra (details) / Lisbon, BNP, Alc. 426, fol. 251v (details).

<sup>227</sup> Bede, *Opera didascalica*, 270.

<sup>228</sup> *Ibid.*

<sup>229</sup> *Ibid.*

<sup>230</sup> Bede, *Opera didascalica*, 269.

But the most conspicuous disparity between the two manuscripts is not the extra busts, or the different hand-gestures. It is the fact that each one arranges the depictions of hands and busts in a different layout. While the busts in Santa Cruz 8 are arranged in rows, the busts in Alc. 426 – except for the first two – are disposed in columns. The hands in Santa Cruz 8 are again arranged in rows, although this time not vertically aligned – which is fairly uncommon in the FS iconographic tradition. But more unique still is the arrangement of the hands in Alc. 426, which are displayed in the intriguing shape of a chair. There is no parallel for this format in any other known illuminated source.

Like most other FS illuminated sources, it is clear that these layouts are meant to accomplish some significant practical effect.<sup>231</sup> In point of fact, not only the layouts but the richly adorned busts and the glaring colorful hand-frames reveal an expertise in handling rhetorical devices: these images are eye-catching and easy to memorize.

#### 4.2. The art of memory

In modern times, the concept of memory has evolved to become exceedingly distant from the ancient and medieval *memoria*, to the point of rendering the pre-modern art of memory alien and unrecognizable to lay eyes. As of the writing of this thesis, the entry for “memory” in *Wikipedia* starts as follows: “‘memory’ is the faculty of the brain by which data or information is encoded, stored, and retrieved when needed. It is the retention of information over time for the purpose of influencing future action.”<sup>232</sup> It is interesting to compare that cold, “mechanizing,” definition – that indeed would more easily be assigned to a computer than to a

---

<sup>231</sup> For a comprehensive study on the layout, see: K.-A. Wirth, “Fingerzahlen,” 4.C. Wirth challenges the usual typology defined for these sources. In the recent historiography devoted to this topic, illuminated manuscripts are commonly split into three categories: (1) the ones that only display hands; (2) the ones that display both hands and human busts; (3) the ones that only display full-bodied human figures. But for Wirth, “diese Unterscheidungen - beide - sind nur hinsichtlich der zuletztgenannten Gruppe sinnvoll. Gegen die Dreiteilung spricht, daß formal in der Darstellung der Einer bis Tausender zwischen den beiden erstgenannten Gruppen kein Unterschied besteht; der kommt erst dadurch zustande, daß man im ersten Falle nur die Zahlenwerte bis einschließlich der Tausender ins Bild brachte, im zweiten auch die höheren Zahlenwerte (oft samt der fast immer als Ganzfigur vorgestellten F. für die Million, die nach der für die zweite Gruppe gegebenen Charakterisierung in jener nicht unterzubringen, auch nicht zur dritten Gruppe zu rechnen ist). Der Unterschied liegt in der Konzeption, nicht in der Ikonographie; zudem beschwört die Unterscheidung bisweilen die Gefahr unzutreffender Zuweisung herauf (z. B. können nicht vollständig ausgeführte Bildfolgen der zweiten Gruppe unversehens zu Zeugen der ersten werden). Die Dreiteilung wird erst dann akzeptabel, wenn die Kriterien für die Zugehörigkeit vor allem zur ersten, aber auch zur zweiten Gruppe um solche vermehrt werden, die außerhalb des Bereichs bildlich formaler Unterscheidungen liegen.”

<sup>232</sup> Wikipedia contributors, “Memory,” *Wikipedia, The Free Encyclopedia*, <https://en.wikipedia.org/w/index.php?title=Memory&oldid=1016132229> (accessed April 14, 2021).

human – to the passionate words written by Boncompagno da Signa (c. 1170 – after 1240) in his treatise *On Memory*:

Memory is a glorious and wonderful gift of nature, by which we recall the past, comprehend the present, and contemplate the future through its similarities with the past. (...) Memory is an indescribable good; for this reason human skill cannot find the necessary words of praise to extol it; for he who remembers well, by either natural or artificial means, gleams like the sun and, like light in the darkness, provides brightness.<sup>233</sup>

Boncompagno refers to the classical distinction between natural memory (*memoria naturalis*) and artificial memory (*memoria artificialis*). Natural memory is the one with which human beings are born. Most are not gifted with a prodigious natural memory, and therefore are at the mercy of this flawed organ, with limited storage, and always running the risk of forgetfulness or confusion. But thankfully, there are artificial ways of enhancing memory, giving it an almost-unlimited storage capacity – “artificial” because they pertain to an art, the “art of memory,” *ars memorativa* or *ars memoriae*, whose basic techniques were developed in Greek antiquity, but mainly set down in three Roman treatises: *De oratore* by Cicero (106–43 BC); *Institutio oratoria* by Quintilian (ca. 35–ca. 100 AD); and, the most influential of the three in medieval times, *Rhetorica ad Herennium*, produced around 86–82 BC and long attributed to Cicero, but whose authorship is not known by modern scholars.<sup>234</sup>

To explain the basic tenets of the *ars memorativa*, Cicero tells the story of its invention, attributed to the Greek poet Simonides of Ceos (ca. 556 – ca. 468 BC): a wealthy aristocrat had commissioned Simonides to chant a lyric poem in his honor at dinner, in his house. Simonides did so, but dedicated a large portion of the poem to the gods Castor and Pollux. The nobleman did not enjoy this move and decided to pay only half the agreed fee. A little while after, Simonides was called outside by two strange men. As soon as he left, the roof of the dining

---

<sup>233</sup> Boncompagno da Signa, “On Memory,” trans. Sean Gallagher, in *The Medieval Craft of Memory*, 105. See also: Mary Carruthers, “Boncompagno at the Cutting-Edge of Rhetoric: Rhetorical ‘Memoria’ and the Craft of Memory,” *The Journal of Medieval Latin* 6 (1996): 44–64.

<sup>234</sup> On these three treatises, see especially the first chapter of the seminal work by Frances A. Yates, “Three Latin sources for the classical art of memory,” in *The Art of Memory* (London: The Bodley Head, 2014): 17–41. See also: Janet Coleman, *Ancient and Medieval Memories: Studies in the Reconstruction of the Past* (Cambridge: Cambridge University Press, 1992). The techniques described in these treatises are not obsolete. North American journalist Joshua Foer has put them in practice, having achieved the most astonishing results. After one year of memory training, he was able to memorize inhuman amounts of information. See: Joshua Foer, *Moonwalking with Einstein: The Art and Science of Remembering Everything* (New York: Penguin Group, 2011).

room fell and killed everybody inside. As for the two mysterious men, they had vanished. Later, when it was time to bury the dead, that was when the *ars memorativa* was finally born (*De oratore* 2.86.353-354):

When their friends wanted to bury them but were altogether unable to know them apart as they had been completely crushed, the story goes that Simonides was enabled by his recollection of the place in which each of them had been reclining at table to identify them for separate interment; and that this circumstance suggested to him the discovery of the truth that the best aid to clearness of memory consists in orderly arrangement. He inferred that persons desiring to train this faculty must select localities and form mental images of the facts they wish to remember and store those images in the localities, with the result that the arrangement of the localities will preserve the order of the facts, and the images of the facts will designate the facts themselves, and we shall employ the localities and images respectively as a wax writing tablet and the letters written on it.<sup>235</sup>

Through this exemplary tale, Cicero states the basic steps for memory training: the selection of localities, the formation of mental images, and the orderly storage of these images in those localities. These features of artificial memory shall be present in memory systems proposed by ancient and medieval authors alike, from Quintilian to Hugh of St. Victor (ca. 1096 – 1141), from Cicero to Jacobus Publicius (fl. 1462-70).

Simonides was successful in recalling the exact placement of each guest because he used his spatial memory.<sup>236</sup> And that is why all *ars memorativa* models are, in one way or another, locational, requiring one to store (mental) images in (mental) places. The reasoning behind these topological models is set forth in a simple manner by Quintilian in *Institutio oratoria* (11.2.17): “when we return to a certain place after an interval, we not only recognize it but remember what we did there, persons are recalled, and sometimes even unspoken

---

<sup>235</sup> “Ea ruina ipsum cum cognatis oppressum suis interiisse; quos cum humare vellent sui neque possent obritos internoscere ullo modo, Simonides dicitur ex eo quod meminisset quo eorum loco quisque cubisset demonstrator uniuscuiusque sepeliendi fuisse; hac turn re admonitus invenisse fertur ordinem esse maxime qui memoriae lumen afferret. Itaque eis qui hanc partem ingeni exercerent locos esse capiendos et ea quae memoria tenere vellent effingenda animo atque in eis locis collocanda : sic fore ut ordinem rerum locorum ordo conservaret, res autem ipsas rerum effigies notaret, atque ut locis pro cera, simulacris pro litteris uteremur.” Cicero, *On the Orator: Books 1-2*, trans. by E. W. Sutton, H. Rackham, The Loeb Classical Library 348 (Cambridge, MA: Harvard University Press, 1942), 464-467, [https://doi.org/10.4159/DLCL.marcus\\_tullius\\_cicero-de\\_oratore.1942](https://doi.org/10.4159/DLCL.marcus_tullius_cicero-de_oratore.1942).

<sup>236</sup> For a modern neuroscientific explanation of the inner workings behind the ancient mnemonic techniques, see: John O’Keefe and Lynn Nadel, *The Hippocampus as a Cognitive Map* (Oxford: Oxford University Press, 1978).

thoughts come back to mind.”<sup>237</sup> Quintilian proposes a fully architectural model, in which one should mentally picture a “spacious house divided into a number of rooms” and mentally associate to each room the objects to remember. This can also be done “with public buildings, a long journey, the ramparts of a city, or even pictures. Or we may even imagine such places to ourselves.”<sup>238</sup>

One also finds 3-dimensional *memoria* models in the middle ages, such as Hugh of St. Victor’s *De arca Noe mystica*, but most medieval systems of localities (*loci*) tend to be 2-dimensional: for instance, Jacobus de Cessolis, in the memory treatise *Libellus super ludo schachorum*, proposes using a chess board.<sup>239</sup> The Guidonian hand, developed around the 11th century, is another great example of a sophisticated non-architectural mnemonic system. Associated with the treatises *Micrologus* and *Epistola de Ignoto Cantu* by Guido d’Arezzo (ca. 991 – after 1033), this device (mentally) stores sound-intervals in specific places of the hand, thereby transforming the auditory into the visual. In fact, the Guidonian hand is synesthetic in more dimensions than the auditory and the visual: it is also tactile, for the index of the right hand is supposed to touch the left hand.<sup>240</sup>

At the core of any system of *ars memorativa* is the formation of mental images. In pre-modern neurological models, memory was believed to store information via mental images (*phantasmata*), that were printed in the mind.<sup>241</sup> Coincidentally, all the modern scientific data

---

<sup>237</sup> “Nam cum in loca aliqua post tempus reversi sumus, non ipsa agnoscimus tantum, sed etiam, quae in his fecerimus, reminiscimur personaeque subeunt, nonnunquam tacitae quoque cogitationes in mentem revertuntur.” Quintilian, *The Orator’s Education, Volume V: Books 11-12*, ed. and trans. by Donald A. Russell, The Loeb Classical Library 494 (Cambridge, MA: Harvard University Press, 2002), 66-67, [https://doi.org/10.4159/DLCL.quintilian-orators\\_education.2002](https://doi.org/10.4159/DLCL.quintilian-orators_education.2002).

<sup>238</sup> “Domum forte magnam et in multos diductam recessus (...) quod de domo dixi, et in operibus publicis et in itinere longo et urbium ambitu et picturis fieri potest.” Quintilian, *The Orator’s Education, Volume V*, 66-69 (11.2.17;21). Augustine also mentions memory palaces: “Transibo ergo et istam naturae meae, gradibus ascendens ad eum, qui fecit me, et venio in campos et lata praetoria memoriae, ubi sunt thesauri innumerabilium imaginum de cuiuscemodi rebus sensis invectarum.” Augustine, *Confessions, Volume II: Books 9–13*, edited and translated by Carolyn J.-B. Hammond, Loeb Classical Library 27 (Cambridge, MA: Harvard University Press, 2016), 88-87 (10.8), [https://doi.org/10.4159/DLCL.augustine-confessions\\_2014.2014](https://doi.org/10.4159/DLCL.augustine-confessions_2014.2014). In striking contrast with Augustine’s grandiose image, about 1500 years later, Arthur Conan Doyle had Sherlock Holes describing his memory as being “like a little empty attic, and you have to stock it with such furnitue as you choose.” Arthur Conan Doyle, *A Study in Scarlet* (Saint-Petersburg: Palmyra, 2017), 15.

<sup>239</sup> Hugh of St. Victor’s *De arca Noe* is edited in Hugh of St. Victor, “A Little Book About Constructing Noah’s Ark,” trans. Jessica Weiss, in *The Medieval Craft of Memory*, 41-70. On Jacobus de Cessolis’s treatise, see: Raymond D. Di Lorenzo, “The Collection Form and the Art of Memory in the Libellus Super Ludo Schachorum of Jacobus de Cessolis,” *Mediaeval Studies* 35 (1973): 205–21, <https://doi.org/10.1484/J.MS.2.306137>.

<sup>240</sup> See: Carol Berger, “The Hand and the Art of Memory,” *Musica Disciplina* 3 (1981): 87–120, and Carol Berger, “The Guidonian Hand,” in *The Medieval Craft of Memory*, 71-82.

<sup>241</sup> “The idea that the memory stores, sorts, and retrieves material through the use of some kind of mental image was not attacked until the eighteenth century. (...) According to the Greek tradition, all perceptions, however presented to the mind, are encoded as phantasmata, ‘representations’ or a ‘kind of eikon.’ Because they are

has been showing that visual memory is systematically superior to other forms of memory.<sup>242</sup> So, whether to memorize things (*memoria rerum*) or words (*memoria verborum*), *memoria* models consistently suggested using images. These images did not need to accurately represent the things to be remembered. Instead, as Thomas Bradwardine states, “their nature should be wondrous and intense, because such things are impressed in memory more deeply and are better retained.”<sup>243</sup> The reason for this is given by the author of *Rhetorica ad Herennium* (3.35-37):

When we see in everyday life things that are petty, ordinary, and banal, we generally fail to remember them, because the mind is not being stirred by anything novel or marvelous. But if we see or hear something exceptionally base, dishonorable, extraordinary, great, unbelievable, or laughable, that we are likely to remember a long time. (...) We ought, then, to set up images of a kind that can adhere longest in the memory. And we shall do so if we establish likenesses as striking as possible; if we set up images that are not many or vague, but doing something; if we assign to them exceptional beauty or singular ugliness.<sup>244</sup>

In this way, *inventio* and *memoria* were intimately connected, for it is not always an easy task to generate an image that is “wondrous and intense” (*mirabilis et intensa*) and, at the same time, having a firm grasp to the object, by association. To illustrate this notion, Bradwardine gives vivid examples of “memory of things” and “memory of words.” For the latter, he teaches how to memorize the Latin text “*Benedictus Dominus qui per regem Anglie Berwicum fortissimum et totam Scotiam subiugavit*,” i.e., “blessed be the Lord who by means of the English king subjugated most mighty Berwick and all Scotland.” He starts by splitting the

---

themselves ‘sort-of pictures,’ these representations were thought to be best retained for recollection by marking them in an order that was readable, a process the ancients thought to be most like the act of seeing.” Mary Carruthers, *The Book of Memory: A Study of Memory in Medieval Culture*, 2nd ed., Cambridge Studies in Medieval Literature (Cambridge: Cambridge University Press, 2008): 19-20.

<sup>242</sup> See: Michael A. Cohen, Todd S. Horowitz, and Jeremy M. Wolfe, “Auditory Recognition Memory Is Inferior to Visual Recognition Memory,” *Proceedings of the National Academy of Sciences* 106:14 (April 7, 2009): 6008–10, <https://doi.org/10.1073/pnas.0811884106>.

<sup>243</sup> “Qualitas vero sit mirabilis et intensa, quia talia in memoria imprimuntur profundius et melius retinentur.” Mary Carruthers, “Thomas Bradwardine, De memoria,” 36. See translation: Thomas Bradwardine, “Thomas Bradwardine, On Acquiring,” 208.

<sup>244</sup> “Nam si quas res in vita videmus parvas, usitatas, cotidianas, meminisse non solemus, propterea quod nulla nova nee admirabili re commovetur animus; at si quid videmus aut audimus egregie turpe, inhonestum, inusitatum, magnum, incredibile, ridiculum, id diu meminisse consuevimus (...). Imagines igitur nos in eo genere constituere oportebit quod genus in memoria diutissime potest haerere. Id accidet si quam maxime notatas similitudines constituemus; si non multas nee vagas, sed aliquid agentes imagines ponemus; si egregiam pulcritudinem aut unicam turpitudinem eis adtribuemus.” [Cicero], *Rhetorica ad Herennium*, translated by Harry Caplan, Loeb Classical Library 403 (Cambridge, MA: Harvard University Press, 1954), 218-221, [https://doi.org/10.4159/DLCL.marcus\\_tullius\\_cicero-rhetorica\\_ad\\_herennium.1954](https://doi.org/10.4159/DLCL.marcus_tullius_cicero-rhetorica_ad_herennium.1954).

sentence into smaller segments, not following any semantic criteria – simply on the basis of word-count – and then uses a variety of puns and spectacular images. The first segment to memorize is “*Benedictus Dominus qui per*”:

For the first phrase, if you know someone named Benedict, or even Saint Benedict the Abbot, place him at the front of the first location; and if you have a lord you know, whom you just call ‘dominus,’ not using his actual name, place him injured in the face, pulled by the hair, mangled, or in some way touched by the right hand of Benedict; or you might place there Saint Dominic or Emperor Domitian or someone known to you called by a similar name. For the third word and the fourth, which are monosyllables, proceed according to the technique for syllables; or for ‘qui’ place a very white cow with very large, very red teats, erect upon her hind legs, whose right front foot Benedict might hold with his left hand as though dancing with her. For indeed, a cow is called ‘qui’ in northern English. In addition the cow, in a strange manner, holds in her left front foot a partridge (*perdix*), which will give the word ‘per’ to your memory.<sup>245</sup>

Bradwardine applies the principles of “division and composition” (*divisio et compositio*), by dividing the text in short sections – *divisiones* – and memorizing them separately.<sup>246</sup> Because each division is small enough, it is possible to encompass it with a single glance (*conspetus*) of the “mental eye.”<sup>247</sup> The orderly arrangement (*dispositio*) of many of these divisions is what allows the memorization of larger texts, such as Bede’s DCLD.

---

<sup>245</sup> “Hiis taliter expeditis, restat de memoria orationum dicere; talis autem conclusio premittatur quamlibet orationem propositam recitare. Hec sequitur ex secunda. ‘Benedictus Dominus qui per regem anglie Berwicum fortissimum et totam Scotiam subiugavit.’ Pro prima igitur dictione, si noveris aliquem Benedictum nomine vel etiam Sanctum Benedictum Abbatem, pone in principium primi loci; et si habueris aliquem dominum tibi notum qui absoluto nomini Dominus appelletur, pone eum vulneratum in facie tractum per capillos lceratum vel aliter contrectatum per dextram Benedicti; vel ponas ibi Sanctum Dominicum vel Domitianum imperatorem vel alium tibi notum tali nomine vocitatum. Pro tertia dictione et quarta, que sunt monasillabe, per conclusionem de sillabis operare; vel pro ‘qui’ pone vaccam albissimaam cum ulberibus maximis valde rubeis, erectam super pedes posteriores cuius anteriores pedem dextrum sinistra sua tripudians teneat Benedictus. Vacca vero vocatur ‘qui’ in anglico boreali. Vacca igitur in pede anteriori sinistro perdicem teneat miro modo, que hanc dictionem ‘per’ memorie tue dabit.” Mary Carruthers, “Thomas Bradwardine, De memoria,” 40. See translation: Thomas Bradwardine, “Thomas Bradwardine, On Acquiring,” 213.

<sup>246</sup> See: M. Carruthers, *The Book of Memory*, 106-109.

<sup>247</sup> “In extent (as all the books on memory advise), no picture should exceed what can be seen and kept in mind in a single ‘look’ or *conspetus* of the mind’s eye. In medieval texts, it is described as the size and shape of a single page; in both classical and medieval texts, it is also described as the size of a waxed tablet, such as those children wrote on in school, and those that were commonly used throughout one’s lifetime for notes, memoranda, and sketches of all sorts. It is also sometimes described as the size of a room of moderate size, or a small garden or orchard. Onto (or within) these various spaces, memory images could be “written,” as in a book, or arranged in “scenes,” like those in a theater. These spaces should not be too small either, lest the mind’s eye have difficulty seeing clearly and readily what is in them. It is worth emphasizing that the memory *conspetus*, or gaze, is fundamentally a spatial concept.” Mary Carruthers, “General Introduction,” in *The Medieval Craft of Memory*, 12.

### 4.3. Dactylonomy images as memory loci

The FS images are a prime example of medieval monastic *ars memorativa*. Bede’s text is split into many smaller *divisiones*, corresponding to each gesture description. For each of these pieces of text, an image is fabricated, and, in the end, all the images are placed in specific locations, arranged in a certain order. The division principle is particularly well illustrated in Munich 14436 (Figure 41), where the text segments for the numbers below 10,000 are disposed in a 6 × 6 grid, accompanied by the respective hand depictions and Roman numerals. All the steps described by Cicero and Quintilian are present here: the grid defines the memory *loci*, where the images are to be stored in order, and the drawings are placed next to the words, to make the association between them easier.

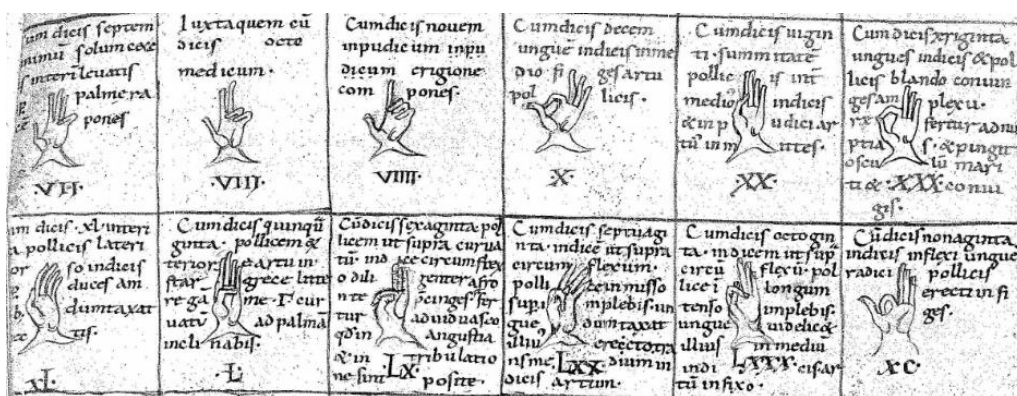


Figure 41. Munich, Bayerische Staatsbibliothek, Clm 14436, fol. 113v (detail).

Manuscripts New York 925, Reims 431, and Vienna 12600, also follow these mnemonic principles. They all display Bede’s text, split in paragraphs, one for each number, illustrated with the corresponding gesture (Figure 42). The Vienna manuscript actually includes an extended version of the DCLD, with descriptions for all number gestures, even those that Bede jumps ahead to avoid repetition (e.g., “one hundred thousand, two hundred thousand and so forth up to nine hundred thousand, you perform in the same manner as we said, but on the right side of the body”).<sup>248</sup> In all these manuscripts, the human busts are inside circular frames, and in the Reims manuscript, the hands are enclosed by square frames. Florence Amiat. III also follows this pattern, despite excluding gestures above 9,000. The framing and vertical

<sup>248</sup> “At vero centum millia et ducentum millia et caetera usque ad dccc millia, eodem quo diximus ordine in dextera corporis parte complebis.” Bede, *Opera didascalica*, 271.

disposition of these images, as well as their close relationship with the text, indicate that they are not a mere set of decorative pictures aimed at embellishing words: they configure a full-blown system of ordered *loci* populated with *verborum imagines*.

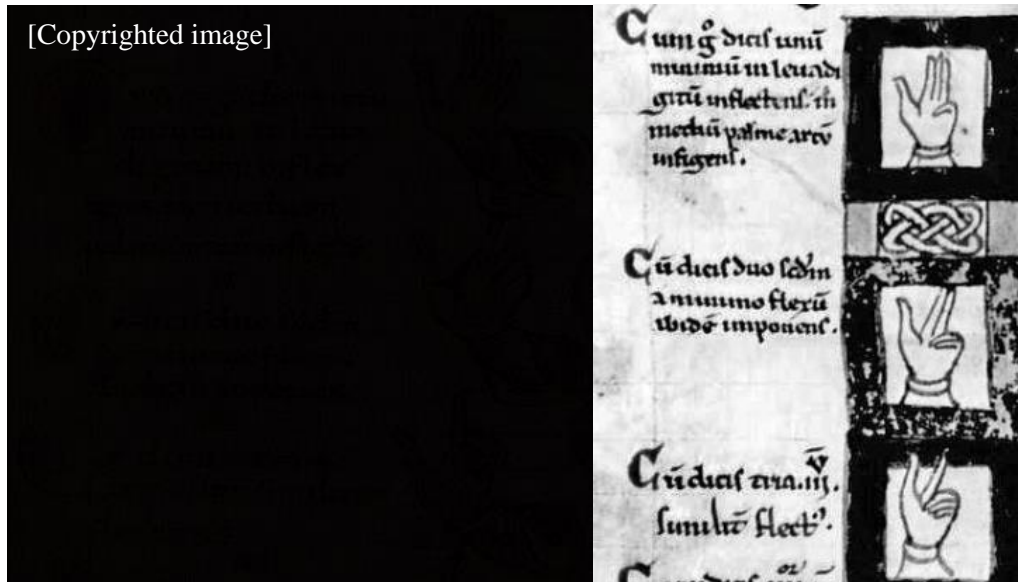


Figure 42. New York, The Morgan Library & Museum, MS M.925, fol. 38r (detail) / Reims, Bibliothèque Municipale de Reims, Ms. 431, fol. 44r (detail).

Despite the examples just provided, it is not common in the corpus for images to be labeled by the full number-gestures descriptions as written by Bede. For the sake of shortness – *brevitas* is an important memorial principle – the human busts in manuscripts London Royal, Leiden 191, and Vatican Reg. Lat. 1263, are labeled with shortened versions of each *divisio* of DCLD (Figure 43).<sup>249</sup> For example, instead of labeling 10,000 with “*Porro decem millia cum dicitis, laeuam medio pectoris supinam appones, digitis tantum ad collum erectis,*” they merely use “*decem milia - pectori supina,*” and instead of “*sexaginta millia cum dicitis, eadem prona femur laeuum desuper comprehendes,*” they use “*lx milia - in femore levo.*”<sup>250</sup> But in most FS images the economy efforts go beyond just summarizing the text, limiting the image labels to only the Roman numerals, as in Turin D.III.19 and Munich 10270 (Figure 44). There is even the rare case of Vatican Pal. Lat. 1449, that includes no label at all.

<sup>249</sup> “As Hugh of St. Victor writes, the memory rejoices in shortness (‘*memoria breuitate gaudet*’) (...). Any long work can be considered as a number of short series joined together – indeed, this is exactly Quintilian’s advice. And as a separate series, a virtually limitless number can be retained in a good, trained memory.” M. Carruthers, *The Book of Memory*, 98.

<sup>250</sup> See: Bede, *Opera didascalica*, 270-271. See Appendix B.



Figure 43. London, BL, Royal 13 A XI, 33v (detail) / Vatican City, BAV, Reg. Lat. 1263, 59r (detail).

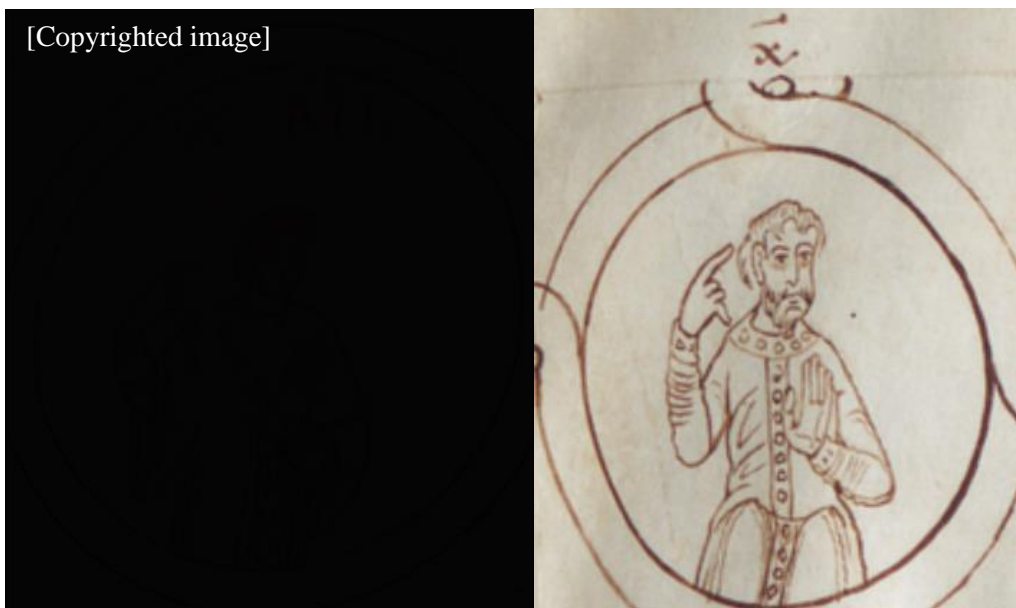


Figure 44. Turin, Biblioteca Nazionale Universitaria di Torino, Ms. D III 19, fol. 135v (detail) / Munich, Bayerische Staatsbibliothek, Clm 10270, fol. 5r (detail).

Most FS images are arranged in a grid structure, that is, the hand and body depictions are both horizontally and vertically aligned. The most frequent grid-layout for hand depictions has 6 rows and 6 columns. This layout has the benefit of splitting the left-hand-gestures (from 1 to 90) and the right-hand-gestures (from 100 to 9,000), the former on the upper half of the page (first 6 rows) and the latter on the lower half (last 6 rows); additionally, each row only holds 6 images, which is about the number of objects that the average person can hold in working

memory.<sup>251</sup> The hand depictions in Berlin 337 and Munich 14436, for example, follow this pattern. Another option is taken by manuscripts Vatican Urb. Lat. 290 and Rouen 1157, that have 9-hand-rows (Figure 45), which allows them to split not only the left-hand-gestures from the right-hand gestures, but also the gestures made with the thumb and index from the gestures made with the middle, ring and small fingers, that is, the units from the tens and the hundreds from the thousands. The mnemonic usefulness of these splits is obvious, as they allow grouping same-category-gestures inside the same row.



Figure 45. Vatican City, BAV, Urb. Lat. 290, fol. 31r (detail).

The hand depictions in codex Santa Cruz 8 are presented in a particularly clever layout, that maintains all the advantages of the 9-hand-rows structure (splitting units/tens/hundreds/thousands) while limiting the row-size to a maximum of five hands per row, in order to stay within the breadth of the “mental eye.” The way to do this is to split each 9-hand-row in two: one with 4 hands and the other with 5 (Figure 46).

---

<sup>251</sup> This number has been established to be in the range between five and nine. See the influential paper by George A. Miller, “The Magical Number Seven, plus or Minus Two: Some Limits on Our Capacity for Processing Information,” *Psychological Review* 63:2 (1956): 81–97, <https://doi.org/10.1037/h0043158>.

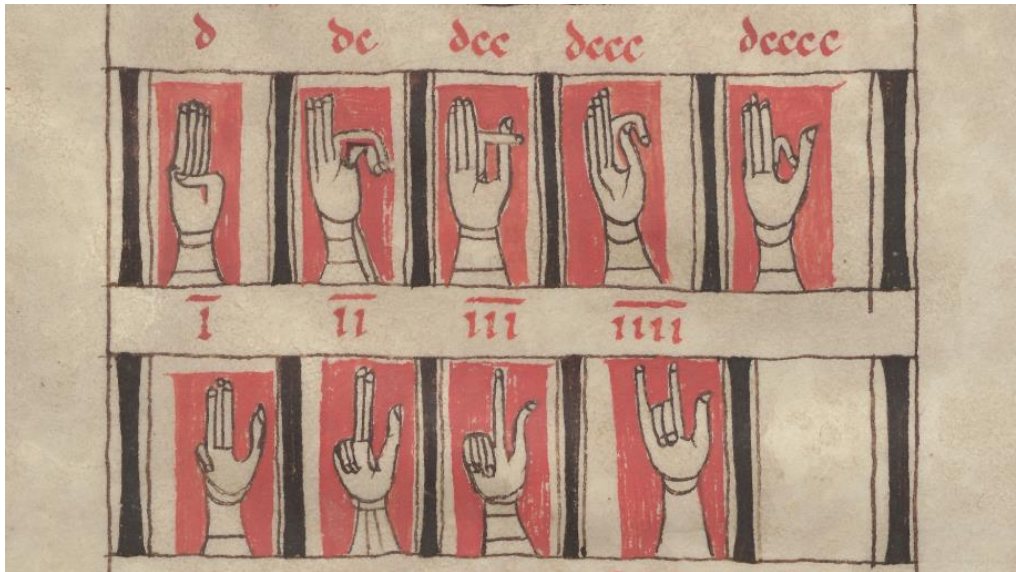


Figure 46. Porto, BPMP, Santa Cruz 8, fol. 180r (detail).

The usage of grids as memory *loci* is typically medieval. Indeed, medieval book art abounds with grid diagrams, from illuminated calendars with depictions of the labors of the month, to the famous illuminated codices with the *Cantigas de Santa Maria*.<sup>252</sup> Oftentimes, these grids are ornamented with stone columns, which is a true commonplace in medieval illumination. Images drawn *intercolumnia* – in the space between columns – are one of the oldest medieval *locus*, that evokes the ancient mnemonic architectural models.<sup>253</sup> The hand depictions in Berlin 337 are very notably *intercolumnia*: the grid is presented as a series of colonnades, each column decorated with its distinct pattern. Each pair of columns supports an arch, and below each arch there is a hand depiction labeled with a Roman numeral (Figure 47).<sup>254</sup> Another interesting *intercolumnia* instance in the corpus is the 1-million figure in Munich 10270 (Figure 48), a giant full-bodied human figure standing under an arch supported by two stone columns. The fact that the hands of this human figure touch the top of the arch only highlights its size. Adding to that, the decorative motives that ornament its garments, the columns, and the arch, result in a truly “wondrous and intense” image.

<sup>252</sup> Of the four surviving codices with the *Cantigas de Santa Maria*, two are richly illuminated with narrative images in grid layouts: the *Códice Rico* from El Escorial (Madrid, Biblioteca de El Escorial, MS T.I.1) and the so-called *códice the Florencia* (Florence, Biblioteca Nazionale, MS b.r. 20).

<sup>253</sup> See: M. Carruthers, *The Book of Memory*, 118.

<sup>254</sup> The hands and figures in Berlin’s Lat. Fol. 436 (excluded from the corpus) are also *intercolumnia*.



Figure 47. Berlin, Staatsbibliothek zu Berlin, Ms. theol. lat. fol. 337, fol. 124r (detail).



Figure 48. Munich, Bayerische Staatsbibliothek, Clm 10270, fol. 5v (detail).

#### 4.4. Rhetorical ornaments in the dactylogy images

For the tens of thousands (10,000 – 90,000), Bede indicates gestures that only use the left hand, and for the hundreds of thousands (100,000 – 900,000), gestures that only use the right hand. In the manuscripts that depict these gestures, they are represented via  $\frac{3}{4}$  or full-bodied human figures. So, while one hand is placed on the chest, or on the belly, or on the thigh, an iconographic choice must be made as to what to do with the other hand. The human figures in

manuscripts Madrid 19, Paris 7418, Vatican Urb. Lat. 290, and to a large extent Berlin 337, are depicted making the FS gesture with the corresponding hand, and keeping the other hand hidden, either behind the back or veiled (Figure ). In this way, not only the principle of *brevitas* is once again observed, but potential confusion between hands is also avoided.



Figure 49. Madrid, Biblioteca Nacional de España, Ms. 19, fol. 3v (detail) / Vatican City, BAV, Urb. Lat. 290, 31r (detail).

The remaining illuminated sources with human figures follow another route: while one hand makes the FS gesture, the other hand either makes yet another gesture or holds an object. The most common such objects are books and scrolls, that can be opened or closed, as in the figures of Turin D.III.19 and Vatican Reg. Lat. 1263 (Figure 49). One of the functions of these objects is to help distinguish each image, rendering each one unique among the rest. Other attributes share this function: many of the busts are ornamented with rich garments, clerical tonsures, and hats – the figures in Leiden 191 display a variety of headwear, including a Phrygian cap and a crown, echoing the advice in the *Rhetorica ad Herennium* (3.22) “if we dress some of them with crowns or purple cloaks, for example, so that the likeness may be more distinct to us.”<sup>255</sup>

<sup>255</sup> “Si aliquas exornabimus, ut si coronis aut veste purpurea, quo nobis notatior sit similitudo.” [Cicero], *Rhetorica ad Herennium*, 220-221.



Figure 49. Turin, Biblioteca Nazionale Universitaria di Torino, Ms. D III 19, fol. 136r (detail) / Vatican City, BAV, Reg. Lat. 1263, fol. 60r (detail).



Figure 50. Leiden, Universiteitsbibliotheek Leiden, BPL 191 BD, fol. 4v (detail) / Leiden, Universiteitsbibliotheek Leiden, BPL 191 BD, fol. 5r (detail).

In many cases, another role is enacted by the object held by the second hand (the one not making the FS gesture): it is used as a rhetorical ornament called *paronomasia*, the association of phonetically similar words with different semantic meanings. By producing a verbal-visual pun, these objects truly work as visual labels that can be read just as easily as a text. An example of a *paronomasia* is given by the 90,000 figure in Leiden 191. This figure follows Bede's text, by grasping the left hip, with the thumb turned towards the groin (*eadem lumbos apprehendes, pollice ad inguina uerso*).<sup>256</sup> The Latin word *inguina,ae* is polysemic: it stands for "groin," but it also refers to the "sexual organs."<sup>257</sup> It is no coincidence, therefore, that the Leiden figure's right hand, labeled with the short text "*xc milia pollice ad inguinem verso*," has the right thumb (*pollex*) touching the middle finger, the *digitus impudicus*.<sup>258</sup>

<sup>256</sup> See: Bede, *Opera didascalica*, 271. See Appendix B.

<sup>257</sup> See: *Dictionary of Medieval Latin from British Sources*, s.v. "Inguen," <https://logeion.uchicago.edu/inguen> (accessed April 14, 2021).

<sup>258</sup> The middle finger has long been considered an insulting finger with sexual connotations. Its use for the purpose of insulting, even in a somewhat different manner than the modern "flip the bird," is extensively verified



Figure 51. Leiden, Universiteitsbibliotheek Leiden, BPL 191 BD, fol. 5r (detail).

The creation of verbal-visual puns is a central aspect of the art of memory for the memorization of words (*memoria verborum*), as recommended in the *Rhetorica ad Herennium* (3.20):

For example, the prosecutor has said that the defendant killed a man by poison, has charged that the motive for the crime was an inheritance, and declared that there are many witnesses and accessories to this act. If in order to facilitate our defence we wish to remember this first point, we shall in our first background form an image of the whole matter. We shall picture the man in question as lying ill in bed (...) And we shall place the defendant at the bedside, holding in his right hand a cup, and in his left hand tablets, and on the fourth finger a ram's testicles. In this way we can record the man who was poisoned, the inheritance, and the witnesses.<sup>259</sup>

---

by Greek and Roman sources. See: Max Nelson, "Insulting Middle-Finger Gestures among Ancient Greeks and Romans," *Phoenix* 71, 1/2 (2017): 66–88, <https://doi.org/10.7834/phoenix.71.1-2.0066>.

<sup>259</sup> "Rei totius memoriam saepe una nota et imagine simplici comprehendimus; hoc modo, ut si accusator dixerit ab reo hominem veneno necatum et hereditatis causa factum arguerit et eius rei multos dixerit testes et conscios esse. Si hoc primum, ut ad defendendum nobis expeditum sit, meminisse volumus, in primo loco rei totius imaginem conformabimus; aegrotum in lecto cubantem faciemus ipsum illum de quo agetur, si formam eius detinebimus; si eum non agnoverimus, at aliquem aegrotum non de minimo loco sumemus, ut cito in mentem venire possit. Et reum ad lectum eius adstituemus, dextera poculum, sinistra tabulas, medico testiculos arietinos tenentem. Hoc modo et testium et hereditatis et veneno necati memoriam habere poterimus." [Cicero], *Rhetorica ad Herennium*, 214-215.

The introduction of ram's testicles, a "memorable" element in this picture to be sure, is not arbitrary. Not only it immediately calls the beholder's attention, as it forms a *paronomasia*: the word "*testiculi*," which means "testicles," resembles "*testes*," which means "witnesses."

There is an abundance of instances of visual *paronomasiae* in medieval art.<sup>260</sup> It is the case of the images of Adam holding his throat after committing the sin of gluttony, being that "gluttony" and "throat" are homonyms in Latin: *gula,ae*; or holding his "chest" (*pectus, pectoris*) because he is a "sinner" (*peccator, peccatoris*).<sup>261</sup> It is well known that manuscript marginalia are a wealthy source of visual puns, where one often finds the snail (*limax*), a mud (*limus*) creature, that is assigned to the limit (*limes*) or threshold (*limen*) of the page.<sup>262</sup> Another spring of medieval puns is heraldry and its canting arms: for example, the coat of arms of the kingdom of Castille has a castle; the coat of arms of the Portuguese family Costa has ribs (*costelas*); and the municipal coat of arms of Borba, in Portugal, has barbels (*barbo*).<sup>263</sup>

Several FS figures also display *paronomasiae*, either through objects or through gestures. For instance, the 700,000 figure in Leiden 191 turns the right hand on its back over the right thigh (*eandem supinam femori super pones*), but on the left hand it holds what looks to be a bone (Figure 52), taking advantage of the polysemy of "*femur*," which equally means thigh and thigh-bone.<sup>264</sup> Another curious pun is generated by 40,000 gesture, that requires one to turn the left hand on its back upright against the belly (*eandem in umbilico erectam supinabis*).<sup>265</sup> As it happens, the Latin word *umbilicus,i* has multiple meanings: apart from "navel," it can also mean "middle" or "centre," the "projecting end of the cylinder on which an ancient book was rolled," a "small circle," and the "the pin or index on a sundial".<sup>266</sup> This last meaning is conspicuous in Vienna 12600 and Munich 10270, where the figures hold an object

---

<sup>260</sup> The mnemotechnic usefulness of visual puns has been attested by Farough Abed, who investigated the potential of visual puns to enhance the impact and interactivity of a given message, and to facilitate recognition memory. See: Farough Abed, "Visual Puns as Interactive Illustrations: Their Effects on Recognition Memory," *Metaphor and Symbolic Activity* 9:1 (1994): 45–60.

<sup>261</sup> See: Kirk Ambrose, "A Visual Pun at Vézelay: Gesture and Meaning on a Capital Representing the Fall of Man," *Traditio* 55 (2000): 112, <https://doi.org/10.1017/S0362152900000040>.

<sup>262</sup> See: Carruthers, *The Craft of Thought*, 163. For a more general approach to this topic, see: Michael Camille, *Image on the Edge: The Margins of Medieval* (London: Reaktion Books, 1992).

<sup>263</sup> For an introduction to canting arms, see: Michel Pastoureau, "Une Écriture en Images: les Armoiries Parlantes," *Extrême-Orient Extrême-Occident* 30 (2008): 187–98, <https://doi.org/10.4000/extrêmeorient.110>.

<sup>264</sup> See: Beda, *Opera didascalica*, 271. See Appendix B. For the various meanings of "femur," see: *Dictionary of Medieval Latin from British Sources*, s.v. "Femur," <https://logeion.uchicago.edu/femur> (accessed April 14, 2021).

<sup>265</sup> See: Beda, *Opera didascalica*, 271. See Appendix B.

<sup>266</sup> See: Lewis & Short: *A Latin Dictionary* (1879), s.v. "Umbilicus," <https://logeion.uchicago.edu/umbilicus> (accessed April 14, 2021).

that resembles a sundial gnomon (Figure ). In fact, other figures in Munich 10270 play with the word *umbilicus*,<sup>i</sup>: the 400,000 figure, with the same gesture as 40,000 but on the right hand, is holding a small disk; and the 50,000 figure, supposed to lay the left hand flat but upright, with the thumb against the belly (*eiusdem pronae, sed erectae, pollicem umbilico impones*), holds what looks to be a closed scroll.<sup>267</sup>



Figure 52. Leiden, Universiteitsbibliotheek Leiden, BPL 191 BD, fol. 5r (detail).



Figure 54. Vienna, Österreichische Nationalbibliothek, Cod. 12600, fol. 22v (detail) / Munich, Bayerische Staatsbibliothek, Clm 10270, fol. 5r (detail).

<sup>267</sup> See: Beda, *Opera didascalica*, 271. See Appendix B.



Figure 53. Munich, Bayerische Staatsbibliothek, Clm 10270, fol. 5r (detail) / Munich, Bayerische Staatsbibliothek, Clm 10270, fol. 5v (detail).

Manuscripts Alc. 426 and Santa Cruz 8 do not escape this phenomenon. Each of the first six busts in either manuscript follows the same pattern: one hand depicts the FS gesture, while the other hand holds an object, which is associated to the respective gesture by means of a verbal-visual pun. For instance, in both codices, the 50,000 figure holds what looks to be the axis of a scroll, again playing with the word *umbilicus* (Figure ). In both of them the thumb is leaning on the scroll axis (*pollicem umbilico impones*), but while the axis held by the Alc. 426 figure is attached to an open scroll, the Santa Cruz 8 figure is only holding the axis. Again, the similarities are enough to endorse the hypothesis of a common model, even though these different approaches hint at a certain distance between them.



Figure 56. Lisbon, BNP, Alc. 426, fol. 252r (detail) / Porto, BPMP, Santa Cruz 8, fol. 180r (detail).

Both 60,000 figures in Alc. 426 and Santa Cruz 8 hold a bone, again playing with the word *femur* (Figure 54). There is, however, an interesting difference between them: Santa Cruz 8 holds the bone (*femur*) with the right-hand, while the left-hand grasps the thigh (also *femur*), as indicated by Bede (*eadem prona femur laeuum desuper comprehendes*). The Alc. 426 figure, though, holds the bone with the left-hand. One possible explanation for this divergence is that the Alc. 426 figure is actually representing 100,000: indeed, it is placing its right hand on the chest with the fingers pointed upwards (*medio pectoris supinam appones, digitis tantum ad collum erectis*). However, this hypothesis contradicts both the depiction of the bone, the label – that reads 60,000 – and the numerical sequence followed up until that point. A seemingly more valid hypothesis would be that the figure is in fact representing 60,000: it is grasping the *femur* on the left side (*femur laeuum*). Hence, the thighbone would not be just a pun, but a substitution proper.



Figure 54. Lisbon, BNP, Alc. 426, fol. 252r (detail) / Porto, BPMP, Santa Cruz 8, fol. 180r (detail).

As already noted, the hand depictions in most of the corpus manuscripts are arranged in grids, rows, or columns. There is, however, a remarkable exception: Alc. 426. Here, the hands are disposed in an odd layout: the shape of a chair. Three rows with four hands each (numbers 1-10, 20, and 30) correspond to the back of the chair; one row with six hands (40-90) corresponds to the arms of the chair; three rows with three hands each (100-900) correspond to the back-half of the base of the chair; and another three rows with three hands each (1,000-9,000) correspond to the front-half of the base. As with the Santa Cruz 8 layout, the size of each row is limited to a manageable number of units, never surpassing six hands per row.

This shape is by no means a mere decorative motif. It is instead a full-fledged *paronomasia*: standing over the shoulders of two human figures – the 10,000 and 20,000 figures – it is not just a chair, but a *sedes gestatoria*. The *sedes* (or *sella* or *sedia*) *gestatoria*, meaning “seat for carrying”, originated in Roman antiquity for the transportation of upper-class citizens, and was typically carried on the shoulders of slaves.<sup>268</sup> In the middle ages, carrying-chairs became progressively associated with the clergy. Indeed, one of the decrees issued by the third council of Braga, in 561, mentions – and disapproves – that some bishops had the habit of hanging relics on their necks on the feasts of martyrs, while being carried on their seats by deacons clothed in albs.<sup>269</sup> But the most famous carrying-seat of all carrying-seats is, of course, the Papal *sedia gestatoria*, that was used in coronations of Popes and other outdoor ceremonies since the early middle ages.<sup>270</sup> It remained in use over the centuries until the twentieth century – Paul John Paul I (r. 1978) was the last pope who was carried over shoulders. The *gestatoria* was then replaced by the motorized “popemobile.”

---

<sup>268</sup> “*Sella gestatoria*: (Suet. Ner. 26, Vitell. 16; Amm. Marc. XXIX.2) or *Fertoria*. (Caelius Aurelianus. I.5, II.1), a sedan used both in town and country (Tacit. Ann. XIV.4; Suet. Claud. 25), by men (Tacit. Hist. I.35, III.85; Juven. VII.141; Martial. IX.23), as well as by women (Tacit. Ann. XIV.4; Juv. I.124, VI.353;° hence *muliebris sella*, Suet. Otho, 6). It is expressly distinguished from the *Lectica* (Suet. Claud. 25; Martial. X.10, XI.98; Senec. brev. vit. 12), a portable bed or sofa, in which the person carried lay in a recumbent position, while the *sella* was a portable chair in which the occupant sat upright, but they are sometimes confounded, as by Martial (IV.51). (...) It appears, however, not to have been introduced until long after the *lectica* was common, since we scarcely, if ever, find any allusion to it until the period of the empire.” William Ramsay, “Sella,” In *A Dictionary of Greek and Roman Antiquities*, edited by William Smith (Cambridge: Cambridge University Press, 2013), 846-847.

<sup>269</sup> “Ut enim quorundam episcoporum detestanda praesumptio nostro se cetui intulit dirimenda, agnovimus quosdam de episcopis quod in sollempnitatibus martyrum ad ecclesiam progressuri reliquias collo suo inponant. Ut maioris fastus apud homines gloria intumescant, quasi ipsi sint reliquiarum arca, levitè albas induti in sellulis eos deportant.” Transcribed by Annette Grabowsky from Vatican City, Biblioteca Apostolica Vaticana, Vat. Lat. 1341, fol. 155vb. See: Annette Grabowsky, Dominik Lorenz, and Clemens Radl, eds., “Concilium Bracarense tertium,” in *Collectio Hispana Gallica Augustodunensis (Vat. lat. 1341)*, (2008), [http://www.benedictus.mgh.de/quellen/chga/chga\\_060t.htm](http://www.benedictus.mgh.de/quellen/chga/chga_060t.htm) (accessed May 31, 2021). On this council, see also: Karl Joseph Hefele, *A History of the Councils of the Church: From the Original Documents. Vol. IV: A.D. 451 to A.D. 680* (Edinburgh: T. & T. Clark, 1883), 490–491.

<sup>270</sup> Ennodius of Pavia (ca. 474 – 521), in his *Libellus pro Synodo* goes to the extent of equating the terms *sedes gestatoria* to the chair of Peter “ecce nunc ad gestatoriam sellam apostolicæ confessionis uda mittunt limina candidatos.” See: Charles G. Herbermann, “Chair of Peter,” *The Catholic Encyclopedia* (2014), [https://www.heiligenlexikon.de/CatholicEncyclopedia/Petrus\\_Fest\\_Cathedra\\_Petri.html](https://www.heiligenlexikon.de/CatholicEncyclopedia/Petrus_Fest_Cathedra_Petri.html) (accessed May 31, 2021). Indeed, the throne of Saint Peter itself – nowadays ensconced in Bernini’s Altar of the Chair, in Saint Peter’s Basilica – has metal rings attached to each side, to be used as a *gestatoria*. The throne was given to Pope John VIII (r. 872 – 882) by Charles the Bald (823 – 877) in 875 and probably does not date from earlier than the sixth century. It was last shown publicly in 1867 (Figure 58).



Figure 55. Throne of Saint Peter, on its last public display. Photography by Antonio Alessandri and Paolo Francesco Alessandri, 1867.

The pun in the Alc. 426 hand-layout is straightforward: a *sedes gestatoria* is a chair for “carrying” (*gero*), but is also a seat or a dwelling-place of “gestures” (*gestus*).<sup>271</sup> Besides *paronomasia*, this image is the effective fusion of various other rhetorical ornaments: it uses *enargeia* by rendering the gestures in a visual and ostentatious form; it uses *allegoria* by transforming such a long sequence of complicated gestures into a simple and familiar shape; and, moreover, it is a remarkable example of visual etymology.<sup>272</sup> Analogously to the Isidorian verbal etymology, it serves a pedagogical and mnemotechnical end, rather than philological. Its goal is not to “find the true nature of an object (*res*) but to unlock and gather up the energy of the word.”<sup>273</sup> And the energy, force, or power (*vis*), of the FS gestures is here represented through a carrying chair, which is an unmistakable symbol of power, eminently of a spiritual kind. A truly “wondrous and intense” image.

---

<sup>271</sup> The verb *gero* means to bear about, bear, carry, wear, have, hold, sustain; the noun *gestus* means bearing, carriage, posture, attitude, motion, gesture, movement, action, sign. See: *Lewis & Short: A Latin Dictionary* (1879), s.v. “Gestus,” <https://logeion.uchicago.edu/gestus> (accessed May 31, 2021). See: *Lewis & Short: A Latin Dictionary* (1879), s.v. “Gero,” <https://logeion.uchicago.edu/gero> (accessed May 31, 2021).

<sup>272</sup> Mary Carruthers explores all the medieval use of these ornaments in the chapter “Cognitive images, meditation, and ornament,” in *The Craft of Thought*, 116-170.

<sup>273</sup> Carruthers, *The Craft of Thought*, 156.

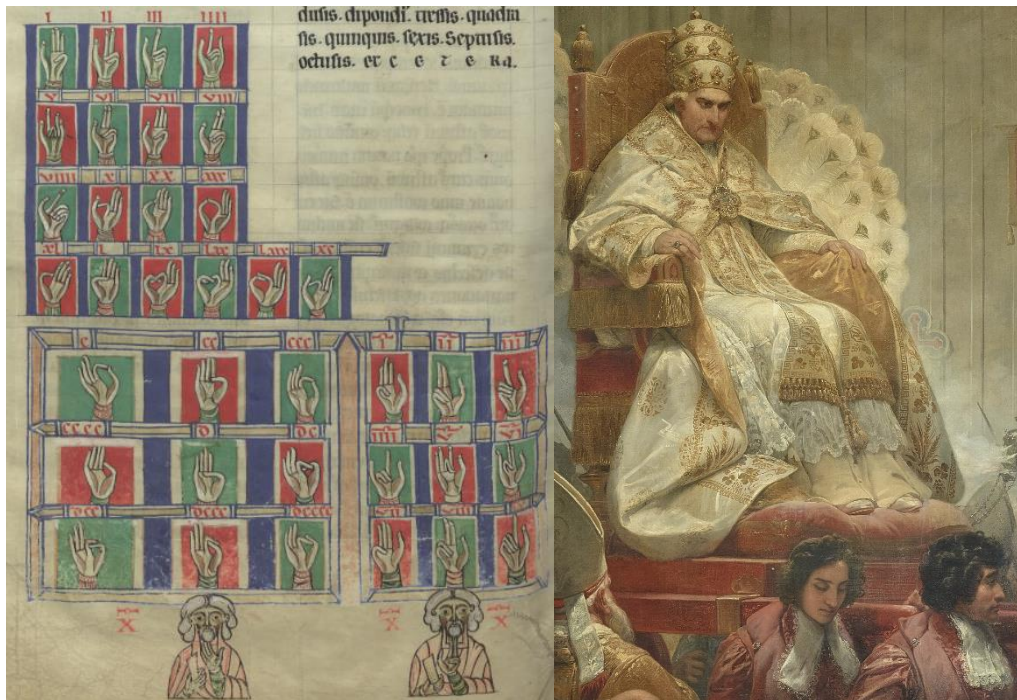


Figure 59. Lisbon, BNP, Alc. 426, fol. 251v (detail) / Versailles, Château de Versailles, Horace Vernet, Pope Pius VIII in St. Peter's on the Sedia Gestatoria, 1829 (detail).

When analysing the FS images in the corpus, it is impossible not to recognize the overwhelming presence of *ars memorativa*. One finds the formation of images that are closely associated with the text, that are small enough to be fully grasped by the “mental eye,” and that are striking enough to not be confused or forgotten. These images are arranged in an orderly manner along systems of localities, following the teachings of the ancient rhetoricians.

Codices Alc. 426 and Santa Cruz 8, in particular, are an outstanding case of the practice of *ars memorativa* conventions in the western medieval framework. From their peculiar layouts to their use of rhetorical ornaments, they showcase the ingenuity of medieval scribes in combining memory and invention, and they provide glimpses into the medieval, overwhelmingly visual, cognitive models.

## Conclusion

With a large section of a dictionary, plus two glossaries and a grammar treatise, codices Alc. 426 and Santa Cruz 8 are grammar compilations with an emphasis on lexicography. In such a *trivium* context, the inclusion of an excerpt of a *computus* treatise and images of finger-counting, habitually associated with the *quadrivium*, is initially puzzling. But the puzzlement dissipates as soon as one carries out a proper contextualization of the sources and begins pursuing a deeper understanding of the complex nature of dactylonomy, *computus*, and grammar.

This dissertation expounded the ancient dactylonomy system and revealed it as a powerful polyvalent medium, not merely used as a tool for counting and simple arithmetic operations but employed in complex financial and calendrical computations, in preaching and meditating on Scripture, in secret military communications, and more. The multifaceted nature of dactylonomy was further explored while surveying a number of medieval illuminated manuscripts with FS images. Indeed, the framing of the dactylonomy images in their surrounding texts enabled a better understanding of the all-pervading medieval concept of “number.” This is visually and eloquently conveyed in *computus* compilations, theology treatises, excerpts from the Bible, and encyclopedias, in line with Rabanus Maurus’s words: “through the number, we are not to be confused but instructed. Take the number away from all things and everything perishes.”<sup>274</sup>

Beyond comprising a varied body of important grammar works by celebrated authors, the Portuguese manuscripts were shown to be witnesses of major lexicographic techniques such as alphabetic arrangement and cross-referencing. Given such a lexicographic context, this dissertation uncovered the rationale for the placement of the DC excerpt, suitably complemented by the dactylonomy images: the DC text works as an effective encyclopedic entry for “number,” including definitions, derivations, and etymologies.

The dissertation explored the usage of mnemonic devices in dactylonomy images. The way in which these images are arranged, framed, and decorated, follows distinct patterns, in tune with the rhetoric practices of antiquity, and is oriented to assist the memory in firmly grasping the pictured objects. Furthermore, the images are tightly linked to the text and are

---

<sup>274</sup> “Per numerum siquidem ne confundamur instruimur. Tolle numerum a rebus omnibus et omnia pereunt.” See Appendix C.

permeated with rhetorical ornaments, such as visual puns – remarkably so in the Portuguese codices – analogously to the devices used by Isidore of Seville and other lexicographers, in etymology composition. This analogy between the dactylonomy images and verbal etymologies was discussed at the end of this study, where the dactylonomy images, especially those in the Portuguese manuscripts, were reinterpreted as “visual etymologies.”

It makes sense that a lexicography compilation contains an entry on “number” written by the eminent Rabanus Maurus, plus a set of visual etymologies that, besides illustrating the concept of number and representing their gestures and Roman numerals, successfully heighten the cosmic importance of “number” in a mnemonic, “wondrous and intense,” manner.

The dactylonomy images and the *De computo* excerpt are not displaced in the Portuguese codices. On the contrary, Alc. 426 and Santa Cruz 8 provide a most befitting framing: dactylonomy is a many-sided medium, *computus* is intimately connected with grammar, the FS iconographic tradition is extremely versatile, and numeracy is all-encompassing.

This dissertation opened a large number of research avenues for the future. For example, the usage of dactylonomy in the middle ages deserves to be further studied. Even now, it is unclear the extent to which dactylonomy was employed in daily life, and by whom, in the high and late middle ages, and the extent to which it evolved to become solely a bookish phenomenon. Obviously, such an investigation would require significantly broadening the corpus of sources, to encompass other types of literary and material evidence.<sup>275</sup> The importance of this potential research path can hardly be undervalued, as its outcomes could change in momentous ways how we perceive intellectual models, embodied cognition, and visual culture in the middle ages.

Another problem that remained enshrouded in mystery is the origin and transmission of the Portuguese codices. No European manuscripts were found with similar characteristics, and the critical edition of *De computo* provided only a few clues. Hopefully, the coming publication of a Papias’s *Elementarium* critical edition will be helpful in deciphering Alc. 426 and Santa Cruz 8.

---

<sup>275</sup> Consider for instance the relief in the abbey church of St-Gilles-du-Gard depicting the payment of Judas, where two Jewish men are counting money with their fingers. See: Jacqueline E. Jung, “The Passion, the Jews, and the Crisis of the Individual on the Naumburg West Choir Screen,” in *Beyond the Yellow Badge: Anti-Judaism and Antisemitism in Medieval and Early Modern Visual Culture*, ed. Mitchell B. Merbeck, Brill’s Series in Jewish Studies 37 (Boston: Brill, 2008), 153.

Technology based on information theory such as the CompLearn NCD might also prove fruitful in future research. These methods might be of value for the academic community carrying out work in manuscript studies, as they can be used for making comparative iconographic and textual analysis, for establishing *stemmata*, and other types of tasks.

This dissertation proves the effectiveness of a multidisciplinary approach. By combining methodologies from different areas of knowledge, it was possible to reach further than the habitual limits of a traditional approach. Actually, one could argue that this intermixing of methods helped us getting closer to the less constrained medieval spirit of inquiring and problem-solving.

## References

### Manuscript Sources

- Auxerre, Bibliothèque Jacques Lacarrière 70 (67)
- Avranches, Bibliothèque municipale, Ms. 114
- Berlin, Staatsbibliothek zu Berlin, Ms. Lat. Fol. 436
- Berlin, Staatsbibliothek zu Berlin, Ms. theol. lat. fol. 337
- Bern, Burgerbibliothek, Cod. 207
- Cava de' Tirreni, Biblioteca statale del Monumento nazionale dell'Abbazia Benedettina della Ss. Trinità, Cod. 3
- Einsiedeln, Stiftsbibliothek, Codex 319
- Exeter, Cathedral Library, Ms. 3507
- Florence, Biblioteca Medicea Laurenziana, Amiatinus III
- Florence, Biblioteca Medicea Laurenziana, Ashburnham 63
- Florence, Biblioteca Medicea Laurenziana, Plut. 30.26
- Florence, Biblioteca Riccardiana, 885
- Heiligenkreuz, Bibliothek des Zisterzienserstifts, 78
- Klosterneuburg, Bibliothek des Augustiner Chorherrenstiftes, 209
- Leiden, Universiteitsbibliotheek Leiden, BPL 191 BD
- Lisbon, Biblioteca Nacional de Portugal, Alc. 3
- Lisbon, Biblioteca Nacional de Portugal, Alc. 25
- Lisbon, Biblioteca Nacional de Portugal, Alc. 37
- Lisbon, Biblioteca Nacional de Portugal, Alc. 48
- Lisbon, Biblioteca Nacional de Portugal, Alc. 52
- Lisbon, Biblioteca Nacional de Portugal, Alc. 149
- Lisbon, Biblioteca Nacional de Portugal, Alc. 151
- Lisbon, Biblioteca Nacional de Portugal, Alc. 277
- Lisbon, Biblioteca Nacional de Portugal, Alc. 307
- Lisbon, Biblioteca Nacional de Portugal, Alc. 410
- Lisbon, Biblioteca Nacional de Portugal, Alc. 424
- Lisbon, Biblioteca Nacional de Portugal, Alc. 425
- Lisbon, Biblioteca Nacional de Portugal, Alc. 426
- Lisbon, Biblioteca Nacional de Portugal, Alc. 446

London, The British Library, Additional 10801  
London, The British Library, Cotton Vitellius A XII  
London, The British Library, Royal 13 A XI  
London, The British Library, Cotton Caligula A XV  
London, The British Library, Harley 3092  
Madrid, Biblioteca Nacional de España, Ms. 19  
Munich, Bayerische Staatsbibliothek, Clm 10270  
Munich, Bayerische Staatsbibliothek, Clm 14221  
Munich, Bayerische Staatsbibliothek, Clm 14436  
Munich, Bayerische Staatsbibliothek, Clm 14523  
Munich, Bayerische Staatsbibliothek, Clm 17145  
New York City NY, The Morgan Library & Museum, MS M.925  
Oxford, Bodleian Library, Canon. Misc. 353  
Oxford, St. John's College, Ms. 17  
Padua, Biblioteca Antoniana, Ms. 27  
Paris, Bibliothèque Nationale de France, Latin 3352B  
Paris, Bibliothèque Nationale de France, Latin 4860  
Paris, Bibliothèque Nationale de France, Latin 7418  
Paris, Bibliothèque Nationale de France, Latin 7518  
Paris, Bibliothèque Nationale de France, Latin 7616  
Paris, Bibliothèque Nationale de France, Latin 7619  
Porto, Biblioteca Pública Municipal do Porto, Santa Cruz 8  
Porto, Biblioteca Pública Municipal do Porto, Santa Cruz 9  
Porto, Biblioteca Pública Municipal do Porto, Santa Cruz 17  
Porto, Biblioteca Pública Municipal do Porto, Santa Cruz 34  
Porto, Biblioteca Pública Municipal do Porto, Santa Cruz 84  
Princeton NJ, Princeton University Library, Garrett Ms. 71  
Reims, Bibliothèque Municipale de Reims, Ms. 431  
Rouen, Bibliothèque Municipale de Rouen, Ms. Leber 1157  
St. Gall, Stiftsbibliothek St. Gallen, Cod. Sang. 878  
St. Gall, Stiftsbibliothek St. Gallen, Cod. Sang. 902  
Turin, Biblioteca Nazionale Universitaria di Torino, Ms. D III 19  
Vatican City, Biblioteca Apostolica Vaticana, Pal. lat. 1449

Vatican City, Biblioteca Apostolica Vaticana, Urb. Lat. 290  
Vatican City, Biblioteca Apostolica Vaticana, Reg. Lat. 1263  
Vatican City, Biblioteca Apostolica Vaticana, Ross. 247  
Vatican City, Biblioteca Apostolica Vaticana, Vat. Lat. 642  
Vienna, Österreichische Nationalbibliothek, Cod. 12600

### Edited Sources

- [Cicero]. *Rhetorica ad Herennium*. Translated by Harry Caplan. Loeb Classical Library 403. Cambridge, MA: Harvard University Press, 1954. [https://doi.org/10.4159/DLCL.marcus\\_tullius\\_cicero-rhetorica\\_ad\\_herennium.1954](https://doi.org/10.4159/DLCL.marcus_tullius_cicero-rhetorica_ad_herennium.1954).
- Ambrosius. “De Tobia Liber Unus.” In *Sancti Ambrosii Mediolanensis Episcopi: Opera Omnia*. Edited by Jacques-Paul Migne. Patrologia Latina 14. Paris: Vrayet de Surcy, 1845.
- Apuleius. *Apologia. Florida. De Deo Socratis*. Edited and translated by Christopher P. Jones. Loeb Classical Library 534. Cambridge, MA: Harvard University Press, 2017. <https://doi.org/10.4159/DLCL.apuleius-apologia.2017>.
- Aristophanes. *Clouds. Wasps. Peace*. Edited and translated by Jeffrey Henderson. Loeb Classical Library 488. Cambridge, MA: Harvard University Press, 1998. <https://doi.org/10.4159/DLCL.aristophanes-wasps.1998>.
- Augustine. *City of God, Volume V: Books 16-18.35*. Translated by Eva M. Sanford, and William M. Green. Loeb Classical Library 415. Cambridge, MA: Harvard University Press, 1965.
- . *Confessions, Volume II: Books 9–13*. Edited and translated by Carolyn J.-B. Hammond. Loeb Classical Library 27. Cambridge, MA: Harvard University Press, 2016. [https://doi.org/10.4159/DLCL.augustine-confessions\\_2014.2014](https://doi.org/10.4159/DLCL.augustine-confessions_2014.2014).
- Beda Venerabilis [Bede]. *Bede: The Reckoning of Time*. Edited by Faith Wallis. Translated Texts for Historians 29. Liverpool: Liverpool University Press, 1999.
- . *Opera didascalica: 2. De temporum ratione*. Edited by C. W. Jones. Corpus Christianorum Series Latina 123B. Turnhout: Brepols, 1977.
- . *Opera exegetica: Expositio Actuum apostolorum. Retractatio in Actus apostolorum. Nomina regionum atque locorum de Actibus apostolorum. In epistulas VII catholicas*. Edited by D. Hurst and M.L.W. Laistner. Corpus Christianorum Series Latina 121. Turnhout: Brepols, 1983.

- Boethius. *Boethian number theory: a translation of the 'De institutione arithmetica'*. Translated by Michael Masi. Studies in Classical Antiquity 6. New York: Rodopi, 1983.
- Boncompagno da Signa. "On Memory." Translated by Sean Gallagher. In *The Medieval Craft of Memory: An Anthology of Texts and Pictures*, 103-117. Edited by Mary Carruthers, and Jan M. Ziolkowski. Philadelphia: University of Pennsylvania Press, 2002.
- Carruthers, Mary. "Thomas Bradwardine, 'De memoria artificiale adquirenda'." *The Journal of Medieval Latin* 2 (1992): 25-43.
- Cicero. *Letters to Atticus, Volume II*. Edited and translated by D. R. Shackleton Bailey. Loeb Classical Library 8. Cambridge, MA: Harvard University Press, 1999. [https://doi.org/10.4159/DLCL.marcus\\_tullius\\_cicero-letters\\_atticus.1999](https://doi.org/10.4159/DLCL.marcus_tullius_cicero-letters_atticus.1999).
- . *On the Orator: Books 1-2*. Translated by E. W. Sutton, H. Rackham. The Loeb Classical Library 348. Cambridge, MA: Harvard University Press, 1942. [https://doi.org/10.4159/DLCL.marcus\\_tullius\\_cicero-de\\_oratore.1942](https://doi.org/10.4159/DLCL.marcus_tullius_cicero-de_oratore.1942).
- Daly, Lloyd William, and B. A. Daly. "Some Techniques in Mediaeval Latin Lexicography." *Speculum* 39:2 (1964): 229-239, <https://doi.org/10.2307/2852727>.
- Daly, Lloyd William, and Walther Suchier, Eds. *Altercatio Hadriani Augusti et Epicteti Philosophi*. Urbana IL: The University of Illinois Press, 1939.
- Donatus Ortigraphus. *Grammatici Hibernici Carolini aevi IV: Ars grammatica*. Edited by J. Chittenden. Corpus Christianorum Continuatio Mediaevalis 40D. Turnhout: Brepols, 1982.
- Ermoldus Niggelus. "De rebus gestus Ludovici Pii." In *A Primer of Medieval Latin*, edited by Charles H. Beeson. The Lake Classical Series. Chicago, IL: Scott Foresman and Company, 1925.
- Firmicus Maternus. *Iulii Firmici Materni Matheseos libri VIII*. Edited by W. Kroll, and F. Skutsch. Leipzig: Teubner, 1897.
- Giraldus Cambrensis [Gerald of Wales]. "De Rebus a se gestis." Edited by George F. Warner. In *Giraldi Cambrensis Opera*, 1:3–122. Edited by J. S. Brewer and James F. Dimock. Cambridge Library Collection – Rolls. Cambridge: Cambridge University Press, 2012. <https://doi.org/10.1017/CBO9781139163378.005>.
- Grabowsky, Annette, Dominik Lorenz, and Clemens Radl, Eds. "Concilium Bracarense tertium." In *Collectio Hispana Gallica Augustodunensis (Vat. lat. 1341)*. 2008. [http://www.benedictus.mgh.de/quellen/chga/chga\\_060t.htm](http://www.benedictus.mgh.de/quellen/chga/chga_060t.htm) (accessed May 31, 2021).

- Herodotus. *The Persian Wars, Volume I: Books 1-2*. Translated by A. D. Godley. Loeb Classical Library 117. Cambridge, MA: Harvard University Press, 1920. [https://doi.org/10.4159/DLCL.herodotus-persian\\_wars.1920](https://doi.org/10.4159/DLCL.herodotus-persian_wars.1920).
- Hieronymus [Jerome]. *Hebraicae quaestiones in libro Geneseos. Liber interpretationis hebraicorum nominum. Commentarioli in psalmos. Commentarius in Ecclesiasten*. Edited by P. de Lagarde, M. Adriaen, and G. Morin. Corpus Christianorum Series Latina 72. Turnhout: Brepols, 1959.
- Hugh of St. Victor. "A Little Book About Constructing Noah's Ark." Translated by Jessica Weiss. In *The Medieval Craft of Memory: An Anthology of Texts and Pictures*, 41-70. Edited by Mary Carruthers, and Jan M. Ziolkowski. Philadelphia: University of Pennsylvania Press, 2002.
- Ioannes Saresberiensis [John of Salisbury]. *Metalogicon*. Edited by J. B. Hall, K. S. B. Keats-Rohan. Corpus Christianorum Continuatio Mediaevalis 98. Turnhout: Brepols, 1991.
- Isidore of Seville. *Etimologías: edicion bilingüe*. Edited by Jose Oroz Reta, and Manuel-A. Marcos Casquero. Madrid: Biblioteca de Autores Cristianos, 2018.
- . *The Etymologies of Isidore of Seville*. Edited by Stephen A. Barney, W. J. Lewis, J. A. Beach, and Oliver Berghof. New York: Cambridge University Press, 2006.
- Jones, Charles Williams. *Beda's Pseudepigrapha: Scientific Writings Falsely Attributed to Bede*. Ithaca, NY: Cornell University Press, 1939.
- Leonardo Pisano [Fibonacci]. *Fibonacci's Liber Abaci: a translation into modern English of Leonardo Pisano's Book of calculation*. Translated by Laurence Sigler. New York: Springer, 2003.
- Macrobius. *Saturnalia, Volume I: Books 1-2*. Edited and translated by Robert A. Kaster. Loeb Classical Library 512. Cambridge, MA: Harvard University Press, 2011. <https://doi.org/10.4159/DLCL.macrobius-saturnalia.2011>.
- . *Saturnalia, Volume III: Books 6-7*. Edited and translated by Robert A. Kaster. Loeb Classical Library 510. Cambridge, MA: Harvard University Press, 2011. <https://doi.org/10.4159/DLCL.macrobius-saturnalia.2011>.
- Martianus Capella. *Martianus Capella*. Edited by James Willis. Leipzig: Teubner, 1983.
- Nascimento, Aires Augusto, ed. *Hagiografia de Santa Cruz de Coimbra : vida de D. Telo, vida de D. Teotónio, vida de Martinho de Soure*. Lisboa: Colibri, 1998.

- Nonnos. *Dionysiaca, Volume I: Books 1-15*. Translated by W. H. D. Rouse. Loeb Classical Library 344. Cambridge, MA: Harvard University Press, 1940. <https://doi.org/10.4159/DLCL.nonnos-dionysiaca.1940>.
- Papias Vocabulista. *Papiae Ars grammatica*. Edited by Roberta Cervani. Testi e manuali per l'insegnamento universitario del latino 50. Bologna: Pàtron, 1998.
- Petri Pictaviensis [Peter of Poitiers]. *Allegoriae super tabernaculum Moysi*. Edited by Philip S. Moore and James A. Corbett. Notre-Dame IN: The University of Notre Dame Press, 1938.
- Pliny the Elder. *Natural History, Volume IX: Books 33-35*. Translated by H. Rackham. Loeb Classical Library 394. Cambridge, MA: Harvard University Press, 1952. [https://doi.org/10.4159/DLCL.pliny\\_elder-natural\\_history.1938](https://doi.org/10.4159/DLCL.pliny_elder-natural_history.1938).
- Plutarch. *Moralia, Volume III: Sayings of Kings and Commanders. Sayings of Romans. Sayings of Spartans. The Ancient Customs of the Spartans. Sayings of Spartan Women. Bravery of Women*. Translated by Frank Cole Babbitt. Loeb Classical Library 245. Cambridge, MA: Harvard University Press, 1931. [https://doi.org/10.4159/DLCL.plutarch-moralia\\_sayings\\_kings\\_commanders.1931](https://doi.org/10.4159/DLCL.plutarch-moralia_sayings_kings_commanders.1931).
- Quintilian. *The Orator's Education, Volume I: Books 1–2*. Edited and translated by Donald A. Russell. Loeb Classical Library 124. Cambridge, MA: Harvard University Press, 2002. [https://doi.org/10.4159/DLCL.quintilian-orators\\_education.2002](https://doi.org/10.4159/DLCL.quintilian-orators_education.2002).
- . *The Orator's Education, Volume III: Books 6–8*. Edited and translated by Donald A. Russell. Loeb Classical Library 126. Cambridge, MA: Harvard University Press, 2002. [https://doi.org/10.4159/DLCL.quintilian-orators\\_education.2002](https://doi.org/10.4159/DLCL.quintilian-orators_education.2002).
- . *The Orator's Education, Volume V: Books 11-12*. Edited and translated by Donald A. Russell. The Loeb Classical Library 494. Cambridge, MA: Harvard University Press, 2002. [https://doi.org/10.4159/DLCL.quintilian-orators\\_education.2002](https://doi.org/10.4159/DLCL.quintilian-orators_education.2002).
- Rabanus Maurus. *Martyrologium. De computo*. Edited by J. McCulloh and W. Stevens. Corpus Christianorum Continuatio Mediaevalis 44. Turnhout: Brepols, 1979.
- Santos, Manoel dos. *Descrição do Real Mosteiro de Alcobaça: B.N.L. Alc. 307 Fols. 1-35*. Edited by Aires Augusto Nascimento. Alcobaciana 3. Alcobaça: Associação para a Defesa e Valorização do Património Cultural da Região de Alcobaça, 1979.
- Symphosius. *The Hundred Riddles of Symphosius*. Translated Elizabeth Hickman du Bois. Woodstock: Elm Tree Press, 1912.

- Tertullian. *Apology. De Spectaculis. Minucius Felix: Octavius*. Translated by T. R. Glover, Gerald H. Rendall. Loeb Classical Library 250. Cambridge, MA: Harvard University Press, 1931. <https://doi.org/10.4159/DLCL.tertullian-apology.1931>.
- Thomas Bradwardine. “Thomas Bradwardine, On Acquiring a Trained Memory.” Translated by Mary Carruthers. In *The Medieval Craft of Memory: An Anthology of Texts and Pictures*, 205-214. Edited by Mary Carruthers, and Jan M. Ziolkowski. Philadelphia: University of Pennsylvania Press, 2002.
- Walter, Hans, ed. *Initia carminum ac versuum medii aevi posterioris Latinorum Author*. Carmina Medii Aevi Posterioris Latina I. Göttingen: Vandenhoeck and Ruprecht, 1959.
- Williams, Burma P., and Richard S. Williams, eds. “Appendix A.” In “Finger Numbers in the Greco-Roman World and the Early Middle Ages.” *Isis* 86:4 (1995): 596-604. <https://doi.org/10.1086/357319>.

## Literature

- Abate, Giuseppe, and Giovanni Luisetto, ed. *Codici e manoscritti della Biblioteca Antoniana col Catalogo delle miniature a cura di François Avril, Francesca d'Arcais, Giordana Mariani Canova*. Fonti e studi per la storia del Santo a Padova 1-2. Vicenza: Neri Pozza Editore, 1975.
- Abed, Farough. “Visual Puns as Interactive Illustrations: Their Effects on Recognition Memory.” *Metaphor and Symbolic Activity* 9:1 (1994): 45–60.
- Acevedo, Juan. *Alphanumeric Cosmology From Greek into Arabic: The Idea of Stoicheia Through the Medieval Mediterranean*. Tübingen: Mohr Siebeck, 2020.
- Alföldi-Rosenbaum, Elisabeth. “The Finger Calculus in Antiquity and in the Middle Ages Studies on Roman Game Counters I.” *Frühmittelalterliche Studien* 5:1 (2010): 1–9. <https://doi.org/10.1515/9783110242058.1>.
- . *Characters and caricatures on game counters from Alexandria*. Studies on Roman counters 5. Bretschneider, 1984.
- Ambrose, Kirk, “Visual poetics of the Cluny hemicycle capital inscriptions.” *Word & Image* 20:2 (2004): 155-164. <https://doi.org/10.1080/02666286.2004.10444012>.
- . “A Visual Pun at Vézelay: Gesture and Meaning on a Capital Representing the Fall of Man.” *Traditio* 55 (2000): 112. <https://doi.org/10.1017/S0362152900000040>.
- Amos, Thomas L., ed. *The Fundo Alcobaça of the Biblioteca Nacional, Lisbon, Vol. III: Manuscripts 302-456 [and] Museu Nacional de Arte Antiga*. Collegeville, MN:

- Monastic Manuscript Microfilm Library, 1990.  
<http://archive.org/details/HMMLAlcobaca3> (accessed October 11, 2020).
- Amsler, Mark. *Etymology and Grammatical Discourse in Late Antiquity and the Early Middle Ages*. Philadelphia: J. Benjamins Pub. Co, 1989.
- Anderson, W. French. "Arithmetical computations in Roman Numerals." *Classical Philology* 51:3 (1956): 145-150.
- Andres, Michael, Samuel Di Luca, and Mauro Pesenti. "Finger Counting: The Missing Tool?." *Behavioral and Brain Sciences* 31:6 (December 2008): 642–43.  
<https://doi.org/10.1017/S0140525X08005578>.
- Antunes, Adriana Duarte. "Inventário do acervo documental do Mosteiro de Santa Maria de Seíça." *Boletim do Arquivo da Universidade de Coimbra* 25 (2012).  
[https://doi.org/10.14195/2182-7974\\_25\\_1](https://doi.org/10.14195/2182-7974_25_1).
- Ashdowne, Richard, D. R. Howlett, R. E. Latham, British Academy, eds. *Dictionary of Medieval Latin from British Sources*. Oxford: Oxford University Press, 2018.
- Bandinius, Angelus Maria. *Bibliotheca Leopoldina Laurentiana seu Catalogus mancriptorum qui [...] in Laurentianam translati sunt – tomus I*. Florence: typis Caesaris, 1791.
- Barakat, Robert A. "On Ambiguity in the Cistercian Sign Language." *Sign Language Studies* 8 (1975): 275–89.
- Barrow, John D. *Pi in the Sky: Counting, Thinking, and Being*. Boston: Little, Brown, and Company, 1996.
- Bayless, Martha. "Alcuin's Disputatio Pippini and the Early Medieval Riddle Tradition." In *Humour, History and Politics in Late Antiquity and the Early Middle Ages*, 157–78. Edited by Guy Halsall. Cambridge University Press, 2002.  
<https://doi.org/10.1017/CBO9780511496325.009>.
- Bechtel, Edward A. "Finger-Counting among the Romans in the Fourth Century." *Classical Philology* 4:1 (1909): 25–31. <https://doi.org/10.1086/359239>.
- Berger, Carol. "The Guidonian Hand." In *The Medieval Craft of Memory: An Anthology of Texts and Pictures*, 71-82. Edited by Mary Carruthers, and Jan M. Ziolkowski. Philadelphia: University of Pennsylvania Press, 2002.
- . "The Hand and the Art of Memory." *Musica Disciplina* 3 (1981): 87–120.

- Borst, Arno. *Schriften zur Komputistik im Frankenreich von 721 bis 818*. Monumenta Germaniae Historica, Quellen zur Geistesgeschichte des Mittelalters 21. Hannover: Hahnsche Buchhandlung, 2006.
- . *The Ordering of Time: From the Ancient Computus to the Modern Computer*. Translated by Andrew Winnard. Chicago, IL: University of Chicago Press, 1994.
- Bruce, Scott G. *Silence and Sign Language in Medieval Monasticism: The Cluniac Tradition c.900-1200*. Cambridge Studies in Medieval Life and Thought 68. Cambridge: Cambridge University Press, 2007.
- Brückner, Wolfgang. *Die Hand für das Bildgedächtnis: Digitale Kulturtechniken der Verständigung*. Schnell & Steiner, 2019.
- Bursill-Hall, Geoffrey L. "Teaching Grammars of the Middle Ages: Notes on the Manuscript Tradition." *Historiographia Linguistica* 4:1 (1977): 1–29. <https://doi.org/10.1075/hl.4.1.02bur>.
- Bynum, Caroline Walker. *'Docere verbo et exemplo': An Aspect of Twelfth-Century Spirituality*. Harvard Theological Studies 31. Missoula MT: Scholars Press, 1979.
- Cabete, António Ferreira. *O Mosteiro de Santa Maria de Seça : das origens aos alvares da modernidade*. Figueira da Foz: Câmara Municipal da Figueira da Foz, 2015.
- Caeiro, Francisco da Gama. *Santo António de Lisboa: 1º volume: Introdução ao estudo da obra Antoniana*. Estudos Gerais - Série Universitária. Lisboa: Imprensa Nacional – Casa da Moeda, 1995.
- Cajori, Florian. "Comparison of Methods of determining Calendar Dates by Finger reckoning." *Archeion* 9:1 (1928): 31–42. <https://doi.org/10.1484/J.arch.3.291>.
- Camille, Michael. *Image on the Edge: The Margins of Medieval*. London: Reaktion Books, 1992.
- Carruthers, Mary. "Boncompagno at the Cutting-Edge of Rhetoric: Rhetorical 'Memoria' and the Craft of Memory." *The Journal of Medieval Latin* 6 (1996): 44–64.
- . *The Book of Memory: A Study of Memory in Medieval Culture*. 2nd ed. Cambridge Studies in Medieval Literature. Cambridge: Cambridge University Press, 2008.
- . *The Craft of Thought: Meditation, Rhetoric, and the Making of Images, 400-1200*. Cambridge Studies in Medieval Literature 34. Cambridge: Cambridge University Press, 2008.
- Catalogus deel XIV inventaris van de handschriften eerste afdeeling*. Bibliotheca Academiae Lugduno-Batavae. Leiden: Universiteitsbibliotheek, 1932.

- Cilibrasi, Rudi, and Paul M. B. Vitanyi. "Clustering by compression." *IEEE Transactions on Information Theory* 51:4 (April 2005): 1523-1545. <https://doi.org/10.1109/TIT.2005.844059>.
- Cilibrasi, Rudi, Anna Lissa Cruz, Steven de Rooij, and Maarten Keijzer. "What is CompLearn?," *CompLearn*, <https://complearn.org/index.html> (accessed July 3, 2021).
- Cochelin, Isabelle. "Besides the Book: Using the Body to Mould the Mind - Cluny in the Tenth and Eleventh Centuries." In *Medieval Monastic Education*, 21–34. Edited by George Ferzoco and Carolyn Muessig. London: Leicester University Press, 2000.
- Cocheril, Maur de. *Alcobaça, Abadia Cisterciense de Portugal*. Translated by André Mansuy Diniz Sila. Lisboa: INCM, 1989.
- . "Abadias Cistercienses Portuguesas." *Lusitania Sacra* 4 (1959): 61-92.
- Cohen, Andrew R, Francisco L A F Gomes, Badrinath Roysam, and Michel Cayouette. "Computational prediction of neural progenitor cell fates." *Nature Methods* 7 (2010) : 213–218. <https://doi.org/10.1038/nmeth.1424>.
- Cohen, Michael A., Todd S. Horowitz, and Jeremy M. Wolfe. "Auditory Recognition Memory Is Inferior to Visual Recognition Memory." *Proceedings of the National Academy of Sciences* 106:14 (April 7, 2009): 6008–10. <https://doi.org/10.1073/pnas.0811884106>.
- Coleman, Janet. *Ancient and Medieval Memories: Studies in the Reconstruction of the Past*. Cambridge: Cambridge University Press, 1992.
- Contreni, John J. "Counting, Calendars, and Cosmology: Numeracy in the Early Middle Ages." In *Word, Image, Number: Communication in the Middle Ages*. Edited by John J. Contreni and Santa Casciani. Florence: SISMELE - Edizioni del Galluzzo, 2002.
- Cordoliani, Alfred. "A propos du chapitre premier du De Temporum ratione, de Bède." *Le Moyen âge : bulletin mensuel d'histoire et de philologie* 54 (1948): 209-224.
- . "Comput, chronologie, calendriers." In *L'Histoire et ses méthodes*, 37-51. Edited by Charles Samaran. Paris: Gallimard, 1961.
- . "Les Traités de Comput Du Haut Moyen Âge (526-1003)." *Archivum Latinitatis Medii Aevi* 17 (1943): 51–72.
- . "Un Manuscrit de Comput Ecclésiastique Mal Connu de La Bibliothèque Nationale de Madrid." *Revista de Archivos, Bibliotecas y Museos* 57 (1951): 5–35.
- Costa, Avelino de Jesus da. *A Biblioteca e o Tesouro da Sé de Coimbra nos séculos XI a XVI*. 2nd ed. Coimbra: 1983.

- Coutinho, Maria. “De computo de Rábano Mauro. O texto e as iluminuras do Santa Cruz 8 e do Alc. 426.” *Medievalista online* 15 (March 3, 2014). <https://doi.org/10.4000/medievalista.301>.
- . “Dispositivos Visuais, Ordenação e Memorização. Breve Comentário Às Iniciais, Diagramas e Ao Loquela Digitorum Dos Alc. 424 a 426.” In *Luz, Cor e Ouro. Estudos Sobre Manuscritos Iluminados*, 65–88. Edited by Catarina Fernandes Barreira. Lisboa: Biblioteca Nacional de Portugal, 2016.
- . “Carmina figurata e a teoria da imagem carolíngia: contributos para uma reflexão sobre a relação texto-imagem.” PhD diss. Universidade Nova de Lisboa, 2016. <https://run.unl.pt/handle/10362/19090>.
- Cruz, António. *Santa Cruz de Coimbra na Cultura Portuguesa da Idade Média, Volume 1: Observações sobre o ‘Scriptorium’ e os estudos claustrais*. Porto: 1964.
- Curtius, Ernst Robert. *European Literature and the Latin Middle Ages*. Translated by Willard R. Trask. Bollingen Series 36. Princeton: Princeton University Press, 2013.
- Denoël, Charlotte. “Imaging Time, Computation and Astronomy: A Computus Collection from Micy-Saint-Mesmin (Vatican, BAV, MS Reg. Lat. 1263) and Early Eleventh-Century Illumination in the Loire Region.” In *After the Carolingians*, 118–60. Edited by Beatrice Kitzinger and Joshua O’Driscoll. Boston: De Gruyter, 2019. <https://doi.org/10.1515/9783110579499-005>.
- Dias, Paula Barata. “‘À mesa do mosteiro, silêncio’: alimentos e linguagem gestual na ordem de Cluny.” *Boletim de Estudos Clássicos* 56 (2011): 81–97. [https://doi.org/10.14195/0872-2110\\_56\\_9](https://doi.org/10.14195/0872-2110_56_9).
- Díaz y Díaz, Manuel C. “Introducción General.” In *Etimologías: edición bilingüe* by Isidore of Seville, 1-257. Edited by J. Oroz Reta and M.-A. Marcos Casquero. Madrid: Biblioteca de Autores Cristianos, 2018.
- Diebner, Sylvia. *Aesernia-Venafrum: Untersuchungen Zu Den Römischen Steindenkmälern Zweier Landstädte Mittelitaliens*. Archaeologica 8. Roma: G. Bretschneider, 1979.
- Dittmar, Pierre Olivier. “Lapsus figurae, Notes sur l’erreur iconographique.” In *Quand l’image relit le texte. Regards croisés sur les manuscrits médiévaux*, 319–335. Paris: Presses de la Sorbonne Nouvelle, 2013.
- Dobcheva, Ivana. “The Umbrella of Carolingian Computus.” In *La Compilación Del Saber En La Edad Media*, 211–229. Edited by María José Muñoz, Patricia Cañizares Ferris, and

- Cristina Martín. *Textes et Etudes Du Moyen Âge*. Turnhout: Brepols Publishers, 2013.  
<https://doi.org/10.1484/M.TEMA-EB.4.01053>.
- Eastwood, Bruce, and Gerd Graßhoff. *Planetary Diagrams for Roman Astronomy in Medieval Europe, ca. 800–1500*. Transactions of the American Philosophical Society. Philadelphia: American Philosophical Society, 2004.
- Evans, Gillian R. “From Abacus to Algorism: Theory and Practice in Medieval Arithmetic.” *The British Journal for the History of Science* 10:2 (1977): 114-131.  
<https://doi.org/10.1017/S0007087400015375>.
- Fernandes, Gonçalo. “A Ars minor donatiana do mosteiro de Alcobaça (séc. XIII) e a edição crítica de Holtz (1981).” *Beitrage zur Geschichte der Sprachwissenschaft* 26 (December 2016): 229–42.
- Fingernagel, Andreas. *Die illuminierten lateinischen Handschriften deutscher Provenienz der Staatsbibliothek zu Berlin Preussischer Kulturbesitz: 8 - 12 Jahrhundert: Teil 1*. Wiesbaden: Harrassowitz, 1991.
- Fischer, Martin H. “Finger Counting Habits Modulate Spatial Numerical Associations.” *Cortex* 44:4 (April 2008): 386–92. <https://doi.org/10.1016/j.cortex.2007.08.004>.
- Fischer, Martin H., and Peter Brugger. “When Digits Help Digits: Spatial–Numerical Associations Point to Finger Counting as Prime Example of Embodied Cognition.” *Frontiers in Psychology* 2 (2011). <https://doi.org/10.3389/fpsyg.2011.00260>.
- Flobert, Pierre. “À propos de l’inscription d’Isernia.” In *Mélanges de littérature et d’épigraphie latines, d’histoire ancienne et d’archéologie: hommage à la mémoire de Pierre Willeumier*, 121-128. Paris: Les Belles Lettres, 1980.
- Foer, Joshua. *Moonwalking with Einstein: The Art and Science of Remembering Everything*. New York: Penguin Group, 2011.
- Folkerts, Menso, and Barnabas Hughes. “The Latin mathematics of medieval Europe.” In *Sourcebook in the Mathematics of Medieval Europe and North Africa*. Edited by Victor J. Katz. Princeton: Princeton University Press, 2016.
- Folkerts, Menso. “Mittelalterliche mathematische Handschriften in westlichen Sprachen in der Berliner Staatsbibliothek. Ein vorläufiges Verzeichnis.” In *Mathematical perspectives: essays on Mathematics and its Historical Development*. Edited by Joseph W. Dauben. New York: Academic Press, 1981.
- Frias, Agostinho Figueiredo. “O Mosteiro de Santa Cruz: Perspectivação Histórica.” In *Catálogo dos códices da Livraria de mão do Mosteiro de Santa Cruz de Coimbra na*

- Biblioteca Pública Municipal do Porto*, XXXI-LXVIII. Edited by Aires Augusto Nascimento, and José Francisco Meirinhos. Porto: Biblioteca Pública Municipal do Porto, 1997.
- Froehner, Wilhelm. “Le Comput Digital.” *Annuaire de la Société française de numismatique et d’archéologie* 8 (1884): 232–38.
- Gomes, Saul António. *In Limine Conscriptio: Documentos, chancelaria e cultura no Mosteiro de Santa Cruz de Coimbra (Séculos XII a XIV)*. Braga: Palimage, 2007.
- . “Livros de ciência em bibliotecas medievais portuguesas.” *Ágora. Estudos Clássicos em Debate* 14:1 (2012): 13-26.
- . “Relações Entre Santa Cruz de Coimbra e Santa Maria de Alcoçaba Ao Longo Da Idade Média. Aspectos Globais e Particulares.” In *IX Centenário Do Nascimento de S. Bernardo, Encontros de Alcoçaba e Simpósio de Lisboa. Actas*. Braga: Universidade Católica Portuguesa - Câmara Municipal de Alcoçaba, 1991.
- Grondeux, Anne. “L’Elementarium ou Vocabularium de Papias.” *European Lexicography in the Middle Ages* (2018). <https://elma.linguist.univ-paris-diderot.fr/spip.php?article23> (accessed April 28, 2021).
- Hagen, Hermann, and Jacques Bongars, eds. *Catalogus Codicum Bernensium: Bibliotheca Bongarsiana*. Hildesheim: Olms, 1974.
- Hall, Jon. “Cicero and Quintilian on the Oratorical Use of Hand Gestures.” *The Classical Quarterly* 2, 54:1 (May 2004):143-160.
- Hefele, Karl Joseph. *A History of the Councils of the Church: From the Original Documents. Vol. IV: A.D. 451 to A.D. 680*. Edinburgh: T. & T. Clark, 1883.
- Helmer, Friedrich, Julia Knödler, and Günter Glauche, eds. *Katalog der lateinischen Handschriften der Bayerischen Staatsbibliothek in München. Die Handschriften aus St. Emmeram in Regensburg IV Clm 14401-14540*. *Catalogus codicum manu scriptorum Bibliothecae Monacensis IV, Series nova 2, 4*. Wiesbaden: Harrassowitz, 2015.
- Herbermann, Charles G. “Chair of Peter.” In *The Catholic Encyclopedia* (2014). [https://www.heiligenlexikon.de/CatholicEncyclopedia/Petrus\\_Fest\\_Cathedra\\_Petri.html](https://www.heiligenlexikon.de/CatholicEncyclopedia/Petrus_Fest_Cathedra_Petri.html) (accessed May 31, 2021).
- Hermann, H. J., ed. *Die deutschen romanischen Handschriften: Beschreibendes Verzeichnis der illuminierten Handschriften in Österreich. II. Band: Die illuminierten Handschriften und Inkunabeln der Nationalbibliothek in Wien*. Leipzig: Karl W. Hiersemann, 1926.

- Hohol, Mateusz, Kinga Wołoszyn, Hans-Christoph Nuerk, and Krzysztof Cipora. "A Large-Scale Survey on Finger Counting Routines, Their Temporal Stability and Flexibility in Educated Adults." *PeerJ* 6 (October 31, 2018). <https://doi.org/10.7717/peerj.5878>.
- Inventario Dos Códices Alcobacenses*. 5 vols. Lisbon: Biblioteca Nacional, 1930-1978.
- Jaeger, C. Stephen. *The Envy of Angels: Cathedral Schools and Social Ideals in Medieval Europe, 950-1200*. Philadelphia: University of Pennsylvania Press, 1994.
- Jones, Charles William. "Bede's place in medieval schools." In *Jones, Bede, the schools and the Computus*, 261-285. Edited by Wesley M. Stevens. Variorum collected studies series 436. Aldershot, 1994.
- Jung, Jacqueline E. "The Passion, the Jews, and the Crisis of the Individual on the Naumburg West Choir Screen." In *Beyond the Yellow Badge: Anti-Judaism and Antisemitism in Medieval and Early Modern Visual Culture*, 143-177. Edited by Mitchell B. Merback. Brill's Series in Jewish Studies 37. Boston: Brill, 2008.
- King, David A. *The Ciphers of the Monks: A Forgotten Number-Notation of the Middle Ages*. Stuttgart: F. Steiner, 2001.
- Klein, Jacob. *Greek Mathematical Thought and the Origin of Algebra*. New York: Dover Publications, 1992.
- Lattin, Harriet Pratt. "The Eleventh Century MS Munich 14436: Its Contribution to the History of Co-Ordinates, of Logic, of German Studies in France." *Isis* 38:3/4 (February 1948): 205–25. <https://doi.org/10.1086/348075>.
- Lemoine, Jean Gabriel. "Les anciens procédés de calcul sur les doigts en Orient et en Occident." *Revue des Etudes Islamiques* 6 (1932).
- Lewis, Charlton T., and Charles Short. *A Latin Dictionary*. Oxford: Clarendon Press, 1879.
- Li, Ming, and Paul Vitanyi. *An Introduction to Kolmogorov Complexity and Its Applications*. 4th ed. New York: Springer-Verlag, 2019.
- Li, Ming, Xin Chen, Xin Li, Bin Ma, and Paul M. B. Vitanyi. "The similarity metric." *IEEE Transactions on Information Theory* 50:12 (Dec. 2004) : 3250-3264. <https://doi.org/10.1109/TIT.2004.838101>.
- Lindemann, Oliver, Ahmad Alipour, and Martin H. Fischer. "Finger Counting Habits in Middle Eastern and Western Individuals: An Online Survey." *Journal of Cross-Cultural Psychology* 42:4 (2011): 566–78. <https://doi.org/10.1177/0022022111406254>.
- Lindsay, Wallace Martin, and Michael Lapidge. *Studies in Early Mediaeval Latin Glossaries*. Variorum Collection Studies. Brookfield VT: Routledge, 1996.

- Lindsay, Wallace Martin. "Note on the Use of Glossaries for the Dictionary of Medieval Latin," *Archivum Latinitatis Medii Aevi-Bulletin Du Cange* (ALMA), 1924.
- Di Lorenzo, Raymond D. "The Collection Form and the Art of Memory in the *Libellus Super Ludo Schachorum* of Jacobus de Cessolis." *Mediaeval Studies* 35 (1973): 205–21. <https://doi.org/10.1484/J.MS.2.306137>.
- Loriquet, Henri, ed. *Catalogue général des manuscrits des bibliothèques publiques de France: Départements – Tome XXXVIII*. Paris: Plon, Nourrit & cie, 1904.
- Lott, Elizabeth Susan. "The Florilegium of Cava 3, Madrid 19 and Paris 7418." PhD diss. Harvard University, 1980.
- Marinoni, Augusto. "Du glossaire au dictionnaire." *Quadrivium* 9 (1968):127-141.
- Marques, José. "Desconhecidas Instituições Culturais Portuguesas: alguns scriptoria Cistercienses." *Bracara Augusta* 39. Braga: Correio do Minho, 1986.
- Marques, Maria Alegria Fernandes. "A Introdução da Ordem de Cister em Portugal." In *Estudos sobre a Ordem de Cister em Portugal*, 29-65. Estudos da Faculdade de Letras da Universidade de Coimbra 24. Lisboa: Colibri, 1998.
- Marrou, Henri-Iréné. *A History of Education in Antiquity*. Translated by George Lamb. New York: The New American Library, 1964.
- . "L'évangile de vérité et la diffusion du comput digital dans l'antiquité." *Vigiliae Christianae* 12:1 (1958): 98–103.
- Martins, Armando Alberto. *O Mosteiro de Santa Cruz de Coimbra na Idade Média*. Textos Universitários 2. Lisboa: Centro de História da Universidade de Lisboa, 2003.
- Martins, Mário. "Os Monges de Alcobaça Perante Os Códices." *Brotéria* 68 (1959): 155–63.
- Maslow, Abraham Harold. *The Psychology of Science: A Reconnaissance*. John Dewey lecture 8. New York: Harper & Row, 1966.
- Mattoso, José. *Portugal Medieval: Novas Interpretações*. 2nd ed. Lisboa: INCM, 1992.
- McLuhan, Marshall, and Eric McLuhan. *Laws of Media: The New Science*. Toronto: University of Toronto Press, 1988.
- McLuhan, Marshall. *Understanding Media: The Extensions of Man*. Routledge Classics. London: Routledge, 2008.
- Melo, Maria João, Rita Castro, and Adelaide Miranda. "Colour in Medieval Portuguese Manuscripts: Between Beauty and Meaning." In *Science and Art: The Painted Surface*, 170-193. Edited by Antonio Sgamellotti, Brunetto Giovanni Brunetti, and Costanza

- Miliani. Cambridge: Royal Society of Chemistry, 2014.  
<https://doi.org/10.1039/9781839161957-00170>.
- Menninger, Karl. *Number Words and Number Symbols: A Cultural History of Numbers*. Translated by Paul Broneer. New York: Dover Publications, 1992.
- Merrilees, Brian. “The Shape of the Medieval Dictionary Entry.” *Digital Studies/Le champ numérique* 4 (1996). <https://doi.org/10.16995/dscn.201>.
- Miguélez Cavero, Alicia. *Actitudes gestuales en la iconografía del románico peninsular hispano: el sueño, el dolor espiritual y otras expresiones similares*. León: Servicio de Publicaciones de la Universidad de León, 2007.
- . “El poder gestual de la mano en la sociedad medieval y su reflejo en la iconografía de los siglos del románico en la Península Ibérica.” *Medievalismo* 20 (2010): 125–147.
- . *La gestualidad en el arte románico de los reinos hispanos*. Madrid: Círculo Románico, 2010.
- Miller, George A. “The Magical Number Seven, plus or Minus Two: Some Limits on Our Capacity for Processing Information.” *Psychological Review* 63:2 (1956): 81–97.  
<https://doi.org/10.1037/h0043158>.
- Minaud, Gérard. “Des doigts pour le dire. Le comput digital et ses symboles dans l’iconographie romaine.” *Histoire & mesure* XXI:1 (2006): 3–34.  
<https://doi.org/10.4000/histoiremesure.1534>.
- Miranda, Maria Adelaide, and Maria João Melo. “O esplendor da cor nos manuscritos românicos alcobacenses.” In *De Cister a Portugal: o tempo e o(s) modo(s)*, 142-148. Edited by Maria Alegria Fernandes Marques, and Luís Carlos Amaral. São Cristovão de Lafões : Associação dos Amigos do Mosteiro de São Cristovão de Lafões, 2016.
- Miranda, Maria Adelaide. “A iluminura românica em Santa Cruz de Coimbra e Santa Maria de Alcobça: subsídios para o estudo da iluminura em Portugal.” PhD diss. Universidade Nova de Lisboa, 1996.
- . “Hipertexto e Medievalidade.” In *Enciclopédia e Hipertexto*. Lisboa : Edições Duarte Reis, 2006. <http://www.educ.fc.ul.pt/hyper/resources/amiranda/index.htm> (accessed May 21, 2021).
- . *A iluminura de Santa Cruz no tempo de Santo António*. Lisboa : Edições Inapa, 1996.
- . *A iluminura românica em Portugal*. Lisboa: Biblioteca Nacional, 1999.
- Morrison, Tessa. “A Medieval Gesture Riddle— ‘To Take VII from VIII and Have VI Left’.” *JAEMA* 6 (2010): 25–46.

- Müller, Monika E., ed. *The Use of Models in Medieval Book Painting*. Newcastle upon Tyne: Cambridge Scholars Publishing, 2014.
- Muralha, Vânia S. F., Catarina Miguel, and Maria João Melo. “Micro-Raman study of Medieval Cistercian 12–13th century manuscripts: Santa Maria de Alcobaça, Portugal.” *Journal of Raman Spectroscopy* 43:11 (September 2012): 1737-1747. <https://doi.org/10.1002/jrs.4065>.
- Nascimento, Aires Augusto. “A experiência do livro no primitivo meio alcobacense,” In *IX Centenário do Nascimento de S. Bernardo: Encontros de Alcobaça e Simpósio de Lisboa – Acta*, 121-145. Braga: Universidade Católica Portuguesa – Câmara Municipal de Alcobaça, 1991.
- . “Em Busca dos Códices Alcobacenses Perdidos.” *Didaskalia* 9 (1979): 279-288.
- . “Livros e Claustro no Século XIII em Portugal: o inventário de S. Vicente de Fora, em Lisboa.” *Didaskalia* 15 (1985): 229-242.
- . “O Scriptorium de Santa Cruz de Coimbra,” in *Catálogo dos códices da Livraria de mão do Mosteiro de Santa Cruz de Coimbra na Biblioteca Pública Municipal do Porto, LXIX-XCVI*. Edited by Aires Augusto Nascimento, and José Francisco Meirinhos. Porto: Biblioteca Pública Municipal do Porto, 1997.
- . *Os Antigos Códices de Lorvão: Balanço de Pesquisa e Recuperação de Tradições*. Penacova: Município de Penacova, 2016.
- . “Percursos do Livro na História da Cultura Portuguesa Medieval.” In *Ler Contra o Tempo: Condições dos Textos na Cultura Portuguesa (Recolha de Estudos em Hora de Vésperas)*, 269-318. Lisboa: Centro de Estudos Clássicos da Universidade de Lisboa, 2012.
- Nascimento, Aires Augusto, and José Francisco Meirinhos, eds. *Catálogo dos códices da Livraria de mão do Mosteiro de Santa Cruz de Coimbra na Biblioteca Pública Municipal do Porto*. Porto: Biblioteca Pública Municipal do Porto, 1997.
- Nelson, Max. “Insulting Middle-Finger Gestures among Ancient Greeks and Romans.” *Phoenix* 71:1/2 (2017): 66–88, <https://doi.org/10.7834/phoenix.71.1-2.0066>.
- Neuenschwander, Erwin, ed. *Wissenschaft Zwischen Qualitas und Quantitas*. Basel: Springer Basel AG, 2003.
- Norte, Armando Gomes do. “Letrados e cultura letrada em Portugal (séculos XII e XIII).” PhD diss. Universidade de Lisboa, 2013.

- Nothaft, Philipp. *Scandalous Error: Calendar Reform and Calendrical Astronomy in Medieval Europe*. Oxford: Oxford University Press, 2018.
- O’Keefe, John, and Lynn Nadel. *The Hippocampus as a Cognitive Map*. Oxford: Oxford University Press, 1978.
- Omont, Henri, ed. *Catalogue général des manuscrits des bibliothèques publiques de France: Départements – Tome II*. Paris: Plon, Nourrit & cie, 1888.
- Overmann, Karenleigh A. “Finger-counting in the Upper Palaeolithic.” *Rock Art Research* 31 (2014): 63–80.
- Pai, Hang Young. *The Complete Book of Chisanbop: Original Finger Calculation Method Created by Sung Jin Pai and Hang Young Pai*. Edited by John Leonard. New York: Van Nostrand Reinhold Co., 1981.
- Palmer, James T. “Computus after the Paschal controversy of AD 740,” in *The Easter Controversy of Late Antiquity and the Early Middle Ages*. Immo Warntjes, and D. Ó Cróinín, eds. *Studia Traditionis Theologiae* 10. Turnhout: Brepols, 2011.
- Pastoureau, Michel. “Une Écriture en Images: les Armoiries Parlantes.” *Extrême-Orient Extrême-Occident* 30 (2008): 187–98. <https://doi.org/10.4000/extremeorient.110>.
- Perrin, Michel. *L’iconographie de la Gloire à la sainte croix de Raban Maur*. Le Corpus du Rilma 1. Turnhout: Brepols, 2009.
- Poleg, Eyal. “The Interpretations of Hebrew Names in Theory and Practice.” In *Form and Function in the Late Medieval Bible*, 217-236. Edited by Eyal Poleg and Laura Light. *Library of the Written Word* 27. Brill, 2013. [https://doi.org/10.1163/9789004248892\\_011](https://doi.org/10.1163/9789004248892_011).
- Prete, Giulia, and Luca Tommasi. “Exploring the Interactions among SNARC Effect, Finger Counting Direction and Embodied Cognition.” *PeerJ* 8 (May 12, 2020). <https://doi.org/10.7717/peerj.9155>.
- Quacquarelli, Antonio. “Ai Margini Dell’actio: La Loquela Digitorum (La Rappresentazione Dei Numeri Con La Flessione Delle Dita in Un Prontuario Trasmesso Dal Beda).” *Vetera Christianorum* 7 (1970): 199–224.
- Quacquarelli, Antonio. *Il triplice frutto della vita cristiana: 100, 60 e 30 (Matteo XIII-8, nelle diverse interpretazioni)*. Bari: Edipuglia, 1953.
- Ramsay, William. “Sella.” In *A Dictionary of Greek and Roman Antiquities*, 846-847. Edited by William Smith. Cambridge: Cambridge University Press, 2013.

- Reynolds, Suzanne. *Medieval Reading: Grammar, Rhetoric and the Classical Text*. Cambridge: Cambridge University Press, 2004.
- Robertis, Teresa De, Cinza di Deo, and Michaelangiola Marchiaro, eds. *I manoscritti datati della Biblioteca Medicea Laurenziana. 1: Plutei 12 – 34*. Manoscritti datati d'Italia 19. Florence: SISMELE - Edizioni del Galluzzo, 2008.
- Robins, Robert Henry. "Grammar." In *Dictionary of the Middle Ages. Volume 5. Famine in the Islamic World – Groote, Geert*. Edited by Joseph R. Strayer. New York: Charles Scribner's Sons, 1985.
- Rose, Valentin, ed. *Verzeichniss der Lateinischen Handschriften der Königlichen Bibliothek zu Berlin, Zweiter Band: Die Handschriften der Kurfürstlichen Bibliothek und der Kurfürstlichen Lande*. Die Handschriften-Verzeichnisse der Königlichen Bibliothek zu Berlin 13. Berlin: Asher, 1901.
- Rouse, Mary A., and Richard M. Rouse. "Alphabetization, History of." In *Dictionary of the Middle Ages. Volume 1. Aachen – Augustinianism*. Edited by Joseph R. Strayer. New York: Charles Scribner's Sons, 1982.
- Ruska, Julius. "Arabische Texte über das Fingerrechnen." *Der Islam* 10:1/2 (1924): 87-119.
- Sánchez Prieto, Ana Belén. "Aprender a contar según el De Computo de Rabano Mauro." *Educación XXI* 16:2 (2013): 39–62. <https://doi.org/10.5944/educxx1.2.16.10331>.
- Sanford, Eva Matthews. "De Loquela Digitorum." *The Classical Journal* 23:8 (1928): 588-593.
- Serrão, Joaquim Veríssimo. "Santa Cruz de Coimbra e Santa Maria de Alcobaça: um caso de rivalidade cultural?" In *A Historiografia Portuguesa Anterior a Herculano: Actas do Colóquio*, 87-101. Lisboa: Academia Portuguesa de História, 1977.
- Schmitt, Jean-Claude. *La Raison Des Gestes Dans l'Occident Médiéval*. Bibliothèque Des Histoires. Paris: Gallimard, 1990.
- Sigler, Laurence E. "Introduction." in *The Book of Squares*, by Leonardo Pisano. Translated by Laurence E. Sigler. Orlando FL: Academic Press, 1987.
- Skemer, Don C., ed. *Medieval and Renaissance Manuscripts in the Princeton University Library*. Publications of the Department of Art and Archaeology, Princeton University. Princeton, NJ: Princeton University Press, 2013.
- Sorbelli, Albano, ed. *Inventari dei manoscritti delle biblioteche d'Italia: Volume XXVIII – Torino*. Florence: Casa Editrice Leo S. Olschki, 1922.

- Sorensen, Marie Louise Stig, and Katharina Rebay-Salisbury, ed. *Embodied Knowledge: Historical Perspectives on Belief and Technology*. Oxford: Oxbow Books, 2012.
- Stevens, Wesley. "De computo: Introduction." In *Martyrologium. De computo*. Edited by J. McCulloh and W. Stevens. Corpus Christianorum Continuatio Mediaevalis 44. Turnhout: Brepols, 1979.
- Stevens, Wesley. "Introduction," in *Martyrologium. De computo*. Edited by J. McCulloh and W. Stevens. Corpus Christianorum Continuatio Mediaevalis 44. Turnhout: Brepols, 1979.
- Studtmann, Paul. "Aristotle's Categories." In *The Stanford Encyclopedia of Philosophy* (2021). <https://plato.stanford.edu/archives/spr2021/entries/aristotle-categories/> (accessed May 14, 2021).
- Tanaka, Shogo. "The notion of embodied knowledge." In *Theoretical psychology: Global transformations and challenges*, 149-157. Edited by P. Stenner, J. Cromby, J. Motzkau, J. Yen, and Y. Haosheng. Concord, Canada: Captus Press, 2011.
- Tannery, M. Paul. *Notice sur les deux lettres arithmétiques de Nicolas Rhabdas*. Paris: Imprimerie Nationale, 1886.
- Turner, H. Hilton. "Roman elementary mathematics: the operations." *The Classical Journal* 47:2 (1951): 63-74.
- Umiker-Sebeok, Jean, ed. *Monastic sign languages. Approaches to semiotics* 76. Berlin: Mouton de Gruyter, 1987.
- Wallis, Faith. "13. Grammar: 1. Overview." In *The Calendar and the Cloister: Oxford, St John's College MS17*. McGill University Library, Digital Collections Program (2007). <https://digital.library.mcgill.ca/ms-17/folio.php?p=167r> (accessed October 16, 2020).
- . "Images of Order in the Medieval Computus." In *ACTA XIV: Ideas of Order in the Middle Ages*, 45-67. Edited by Warren Ginsberg. Binghamton: State University of New York Press, 1990.
- . "Introduction." In *Bede: The Reckoning of Time*. Edited by Faith Wallis. Translated Texts for Historians 29. Liverpool: Liverpool University Press, 1999.
- . "The Church, the World, and the Time." In *Normes et pouvoirs à la fin du moyen âge*, 15-29. Edited by Marie-Claude Déprez-Masson. Inedita et rara 7. Montreal: Ceres, 1990.
- Warner, George F., and Julius P. Gilson, ed. *Catalogue of Western Manuscripts in the Old Royal and King's Collections*. London: British Museum, 1921.

- Warntjes, Immo, and D. Ó Cróinín, eds. *Computus and its cultural context in the Latin West, AD 300–1200*. Studia Traditionis Theologiae 5. Turnhout: Brepols, 2010. <https://doi.org/10.1484/M.STT-EB.6.09070802050003050303010709>.
- . *Late Antique Calendrical Thought and its Reception in the Early Middle Ages*. Studia Traditionis Theologiae 26. Turnhout: Brepols, 2017. <https://doi.org/10.1484/M.STT-EB.5.113899>.
- . *The Easter Controversy of Late Antiquity and the Early Middle Ages*. Studia Traditionis Theologiae 10. Turnhout: Brepols, 2011. <https://doi.org/10.1484/M.STT-EB.6.09070802050003050306060802>.
- Warntjes, Immo. “Introduction: state of research on late antique and early medieval computus.” In *Late Antique Calendrical Thought and its Reception in the Early Middle Ages*. Edited by Immo Warntjes and Dáibhí Ó Cróinín. Studia Traditionis Theologiae 26. Turnhout: Brepols, 2017. <https://doi.org/10.1484/m.stt-eb.5.114732>.
- Wathen, Ambrose G. *Silence: The Meaning of Silence in the Rule of St. Benedict*. Cistercian Studies Series 22. Washington: Cistercian Publications, 1973.
- Wedell, Moritz. “Actio - loquela digitorum - computatio: Zur Frage nach dem numerus zwischen Ordnungsangeboten, Gebrauchsformen und Erfahrungsmodalitäten.” In *Was zählt: Ordnungsangebote, Gebrauchsformen und Erfahrungsmodalitäten des ‘numerus’ im Mittelalter*, 15–63. Edited by Moritz Wedell and Hermann von Helmholtz-Zentrum. Köln: Böhlau, 2012.
- . “Numbers.” Translated by Erik Born. In *Handbook of Medieval Culture: Fundamental Aspects and Conditions of the European Middle Ages*. Edited by Albrecht Classen. Berlin: De Gruyter, 2015.
- . *Zählen: semantische und praxeologische Studien zum numerischen Wissen im Mittelalter*. Historische Semantik 14. Göttingen: Vandenhoeck & Ruprecht, 2011.
- Weijers, Olga. “Lexicography in the Middle Ages.” *Viator* 20 (January 1989): 139-154. <https://doi.org/10.1484/J.VIATOR.2.301351>.
- Wikipedia contributors. “Memory.” In *Wikipedia, The Free Encyclopedia*. <https://en.wikipedia.org/w/index.php?title=Memory&oldid=1016132229> (accessed April 14, 2021).
- Williams, Burma P., and Richard S. Williams. “Finger Numbers in the Greco-Roman World and the Early Middle Ages.” *Isis* 86:4 (1995): 587-596. <https://doi.org/10.1086/357319>.

- Wilson, Frank R. *The Hand: How Its Use Shapes the Brain, Language, and Human Culture*. New York: Vintage Books, 1999.
- Wirth, Karl-August. "Fingerzahlen." *RDK Labor* (1986). <http://www.rdklabor.de/w/?oldid=88931>.
- Wood, Guilherme, and Martin H. Fischer. "Numbers, Space, and Action – From Finger Counting to the Mental Number Line and Beyond." *Cortex* 44:4 (April 2008): 353–58. <https://doi.org/10.1016/j.cortex.2008.01.002>.
- Yates, Frances A. *The Art of Memory*. London: The Bodley Head, 2014.
- Yeldham, Florence A. "An early method of determining Calendar dates by Finger reckoning." *Archeion* 9:2–3 (1928): 325–26. <https://doi.org/10.1484/J.arch.3.313>.
- Zaslavsky, Claudia. *Africa Counts: Number and Pattern in African Cultures*. 3rd ed. Chicago, IL: Lawrence Hill Books, 1999.
- Zélinsky, André Nicolaávitich. "Le calendrier chrétien avant la réforme grégorienne." *Studi medievali* 3:23 (1982): 529-597.

## Appendix A – *Romana computatio*

Full text of the *Romana computatio*, taken from Jones' edition.<sup>276</sup>

### “*Romana computatio*”

*Romana computatio* Ita digitorum flexibus servatur per primum digitorum trium in leva ab extremo inflexionem in medio palmae artum dicitur unum, duo, tres. cum dicis quatuor extremum digitum leves. cum dicis v secundum ab extremo similiter erigis. cum dicis sex medicum in medium palmae extremo et medio levatis figes. quando pervenies ad septem minimum solum caeteris levatis super palmae radicem pones. iuxta quem in viii medicum. in novem autem impudicum e regione compones.

decem unguem indicis in medio fixus artu pollicis. xx summitas pollicis in medio artu inter indicem impudicumque. xxx in mollis in summitate pollicis indicisque amplexus. xl pollicis summitas adiacens artui in medio latere paene a dorsu indicis. l curvatus pollex ad palmam caeteris erectis instar [gamma] littere. lx pollicem curvatum indice circumflexo diligenter a fronte precinges. lxx pollicis artu curvato trans medium indicis artum radicem pollicis a latere circuivit indicis. lxxx pollicem in longum tendens indice illius summitatem unguamque circumpone. xc indicis unguam in pollicis radice figes.

c in dextera quomodo x in leva. cc in dextera quomodo xx in leva. ccc in dextera quomodo xxx in leva. cccc in dextera quomoda xl in leva. d in dextera quomodo l in leva. dc in dextera quomodo lx in leva. dcc in dextera quomodo lxx in leva. dccc in dextera quomodo lxxx in leva. dcccc in dextera quomodo xc in leva.

mille in dextera quomodo unum in leva.

### 1,000+ variant: Milan Ambrosiana H 150, and Oxford Bodleian ms. 309

sicque ab uno mille currit in dextera comptus usque viiii mll. quomodo currunt in leva monades ab uno usque in viiii. X in dextera palma super verticem supinata aut retro ponas. XX eadem sita pronam super malum colli. XXX eadem sita pronam in medio pectoris. XL eadem sita pronam in latere dextro. L pollex in umbilico. LX dextera palma sub umbilico supina. LXX eadem sita in inguine pronam. LXXX eadem sita in femore dextro. XC eadem in femore dextra sita pronam sed foris.

---

<sup>276</sup> Jones, *Bedae pseudepigrapha*, 106-108.

ita facitur in sinistra cum dicis C millia.

cum autem dicis decies centena millia, duae palmae apertae erga faciem e regione interpositae sed ante aures retro respicientes.

**1,000+ variant: London British Library Cotton Calig. A XV**

II [sic] in dextera quomodo duo in leva. III in dextera quomodo tres in leva, et ceta. usque ad VIII. porro X [sic] cum dicis levam medio pectori supinam adpones digitis tantum ad collum erectis. XX quum dicis eandem pectori expansam latae superpones. XXX cum dicis eadem prona sed erecta pollicem cartilagine medio pectoris inmittes. XL cum dicis eandem in umbilico erectam supinabis. vel (L) cum icis eiusdem prona sed erectae pollicem umbilico inpones. LX cum dicis eadem prona femor levum desuper comprehendes. LXX cum dicis eadem supinam femori superpones. LXXX cum dicis eadem pronam femori superpones. XC cum dicis eandem lumbos adprehendes pollice ad inguine verso.

at vero C et CC et cetera usque DCCCC eodem quo diximus ordine in dextera corporis parte complebis.

decies autem centena milia cum dicis ambas sibi mani [insertis invicem digitis implicabis].

## Appendix B – Bede’s *De temporum ratione*

Full text of the first chapter of *De temporum ratione*, taken from Jones’ edition.<sup>277</sup>

### “I. De computo uel loquela digitorum”

De temporum ratione, domino iuuante, dicturi necessarium duximus utilissimam primo promptissimamque flexus digitorum paucis praemonstrare solertiam, ut cum maximam computandi facilitatem dederimus, tum paratiore legentum ingenio ad inuestigandam dilucidandamque computando seriem temporum ueniamus.

Neque enim contemnenda paruiue pendenda est regula cuius omnes pene sacrae expositores scripturae, non minus quam literarum figuras, monstrantur amplexi. Denique et multi alii alias, et ipse diuinae interpres historiae Hieronimus in euangelicae tractatu sententiae, huius adiumentum disciplinae non dubitauit assumere:

Centesimus, inquit, et sexagesimus et tricesimus fructus, quamquam de una terra et de una semente nascatur, tamen multum differt in numero. Triginta referuntur ad nuptias : nam et ipsa digitorum coniunctio et, quasi molli osculo se complectens et foederans, maritum pingit et coniugem. Sexaginta ad uiduas : eo quod in angustia et tribulatione sint positae ; unde et in superiore digito deprimuntur, quantoque maior est difficultas expertae quondam uoluntatis illecebras abstinere, tanto maius et praemium. Porro centesimus numerus, quaeso, diligenter lector, attende, a sinistra transfertur ad dexteram et, hisdem quidem digitis, sed non eadem manu, quibus in laeua manu nuptae significantur et uiduae, circulum faciens exprimit uirginitatis coronam.

Cum ergo dicis unum, minimum in laeua digitum inflectens, in medium palmae artum infiges. Cum dicis duo, secundum a minimo flexum, ibidem impones. Cum dicis tria, tertium similiter adflectes. Cum dicis quattuor, itidem minimum leuabis. Cum dicis quinque, secundum a minimo similiter eriges. Cum dicis sex, tertium nihilominus eleuabis, medio dumtaxat solo, qui medicus appellatur, in medium palmae fixo. Cum dicis septem, minimum solum, caeteris interim leuatis, super palmae radicem pones. Iuxta quem cum dicis octo, medicum. Cum dicis nouem, impudicem e regione compones.

Cum dicis decem, unguem indicis in medio figes artu pollicis. Cum dicis uiginti, summitatem pollicis inter medios indicis et impudicis artus immittes. Cum dicis triginta, unguis indicis et

---

<sup>277</sup> Beda, *Opera didascalica*, 268-273.

pollicis blando coniunges amplexu. Cum dicis quadraginta, interiora pollicis lateri uel dorso indicis superduces, ambobus dumtaxat erectis. Cum dicis quinquaginta, pollicem exteriori artu instar graecae literae gammae curuatum, ad palmam inclinabis. Cum dicis sexaginta, pollicem (ut supra) curuatum, indice circumflexo diligenter a fronte praecinges. Cum dicis septuaginta, indicem (ut supra) circumflexum pollice immisso superimplebis, ungue dumtaxat illius erecto trans medium indicis artum. Cum dicis octoginta, indicem (ut supra) circumflexum, pollice in longum tenso implebis, ungue uidelicet illius in medium indicis artum infixo. Cum dicis nonaginta, indicis inflexi unguem radici pollicis erecti infiges.

Hactenus in laeua, Centum uero in dextera, quomodo decem in laeua facies. Ducenta in dextera, quomodo uiginti in laeua. Trecenta in dextera, quomodo triginta in laeua. Eodem modo et caetera usque ad -dcccc-. Item mille in dextera, quomodo unum in laeua. Duo millia in dextera, quomodo duo in laeua. Tria millia in dextera, quomodo tria in laeua. Et cetera usque ad nouem millia.

Porro decem millia cum dicis, laeuam medio pectoris supinam appones, digitis tantum ad collum erectis. Viginti millia cum dicis, eandem pectori expansam late superpones. Triginta millia cum dicis, eadem prona, sed erecta, pollicem cartilagini medii pectoris immittes. Quadraginta millia cum dicis, eandem in umbilico erectam supinabis. Quinquaginta millia cum dicis, eiusdem prona, sed erectae, pollicem umbilico impones. Sexaginta millia cum dicis, eadem prona femur laeuum desuper comprehendes. Septuaginta millia cum dicis, eandem supinam femori super pones. Octoginta millia cum dicis, eandem pronam femori superpones. Nonaginta millia cum dicis, eadem lumbos apprehendes, pollice ad inguina uerso. At uero centum millia et ducentum millia et caetera usque ad dcccc millia, eodem quo diximus ordine in dextera corporis parte complebis. Decies autem centena millia cum dicis, ambas sibi manus, insertis inuicem digitis implicabis.

Est et alterius modi computus, articulatim decurrens, qui, quoniam specialiter ad paschae rationem pertinet, cum ad hanc ex ordine uentum fuerit, opportunius explicabitur.

Potest autem et de ipso quem praenotauimus computo quaedam manualis loquela, tam ingenii exercendi quam ludi agendi gratia figurari; qua literis quis singillatim expressis uerba, quae hisdem literis contineantur, alteri qui hanc quoque nouerit industriam, tametsi procul posito, legenda atque intellegenda contradat, uel necessaria quaeque per haec occultius innuendo significans uel imperitos quosque quasi diuinando deludens.

Cuius ordo ludi uel loquela talis est: cum primam alphabeti literam intimari cupis, unum manu teneto; cum secundam, duo; cum tertiam, tria; et sic ex ordine ceteras. Verbi gratia, si

amicum inter insidiatores positum ut caute se agat admonere desideras, .iii., et.i., et .xx., et .xix., et .v., et .i., et vii, et .v., digitis ostende; huius namque ordinis literae, 'caute age, significant. Potest et ita scribi, si causa secretior exigat.

Sed haec Graecorum computo literisque facilius disci simul atque agi possunt, qui non, ut Latini, paucis hisdemque geminatis suos numeros solent exprimere literis ; uerum toto alphabeti sui caractere in numerorum figuras expenso, tres qui plus sunt numeros notis singulis depingunt, eundem pene numeri figurandi, quem scribendi alphabeti ordinem sequentes, hoc modo:

A	I	I	X	P	C
B	II	K	XX	Σ	CC
Γ	III	Λ	XXX	T	CCC
Δ	IIII	M	XL	Y	CCCC
E	V	N	L	Φ	D
G	VI	Ξ	LX	X	DC
Z	VII	O	LXX	Ψ	DCC
H	VIII	Π	LXXX	Ω	DCCC
Θ	VIIII	Ϡ	XC	↑	DCCCC

Qui et ideo mox numeros digitis significare didicerint, nulla interstante mora, literas quoque pariter hisdem praefigere sciunt; uerum haec hactenus. Nunc ad tempora, quantum ipse temporum conditor ordinatorque dominus adiuuare dignabitur, exponendaa ueniamus.

## Appendix C – Rabanus Maurus’s *De computo*

Full text of the first seven chapters of *De computo*, taken from Stevens’ edition.<sup>278</sup>

### “I. De numerorum potentia”

MAGISTER: Bene etiam, dilecte frater, rogas quia huius disciplinae cupis habere notitiam, quam constat omnium disciplinarum esse magistram. Non enim ratio numerorum contempnenda est, quia in multis Sanctarum Scripturarum locis quantum mysterium habet elucet. Non enim frustra in laudibus Dei dictum est: «Omnia in mensura et in numero et in pondere fecisti». Per numerum siquidem ne confundamur instruimur. Tolle numerum a rebus omnibus et omnia pereunt. Adime seculo computum et omnia caeca ignorantia complectuntur. Nec differe possunt a ceteris animalibus, qui calculi nesciunt rationem. Sed tu quia ad exponendam huius uim et rationem me prouocasti, de his quibus te instruere uelis precede interrogando, et sic te subsequar quantum DOMINVS concesserit respondendo.

Discipulus: Haec ergo ratio numerorum unde primum processit?

Magister: A DEO scilicet, quia omnis sapientia a Domino DEO est, ex quo sunt omnia.

Discipulus: Dic ergo quando primum inuenta est ista ratio.

Magister: Ex illo tempore quo factae sunt creaturae, hoc est ab origine seculi. Tunc enim primum numerus rebus innotuit. Sicut in Genesi legitur, «Et factum est uespere et mane dies unus». Tunc ergo dixit de nocte et de die, quando dixit de uespere et mane. Numeri autem rationem ostendit, quando dixit dies unus et dies secundus et dies tertius, sicque usque ad septimum. Item numerum significauit DEVS quando dixit de sole et luna, «Et sint in signa et tempora et dies et annos». Quando dixit dies et tempora et annos, tunc de numero dixit. Quis enim potest intellegere dies et tempora et annos nisi per numerum?

Inde dixit BOETIVS, «Omnia quaecumque a primeua rerum natura constructa sunt, numerorum uidentur ratione formata. Hoc enim fuit principale exemplar in animo conditoris. Hinc enim quattuor elementorum multitudo mutata est. Hinc temporum uices, hinc motus astrorum caelique conuersio intellegitur. Proprie ipsa natura numerorum omnis astrorum cursus omnisque stronomica ratio constituta est. Sic enim ortus occasusque colligimus, sic tarditates uelocitatesque errantium siderum custodimus, sic defectus et multiplices lunae uariationes agnoscimus».

---

<sup>278</sup> Rabanus Maurus, *Martyrologium*, 205-213.

## **“II. Unde dictus sit numerus”**

Discipulus: Numeri namque nomen eiusque ethymologiam mihi explana.

Magister: Numeri scilicet nomen apud quamque gentem secundum proprietatem linguae suae constat. Apud latinos uero numerus ex nummo et riuo uidetur nomen traxisse. Siue enim ex riuo nummorum, id est ex multitudine census, qui reddebatur regibus uel imperatoribus numerus nomen accepit: unde HISIDORVS dicit: «Nummus numero nomen dedit et a sui frequentatione uocabulum indidit». Siue a numeria; hinc AVGVSTINVS ait: «Numerus a numeria quadam dea nominatur, cuius sacerdotes retrouersis uultibus dona ferebant, et post oblata munera retro pergebant».

Discipulus: Numerus quomodo diffinitur?

Magister: HISIDORVS ergo ita diffiniuit dicens: «Numerus est multitudo ex unitatibus constituta. Nam unum semen numeri esse, non numerum», dicimus. Item alibi scriptum est: «Vnus non est numerus sed ab eo crescunt numeri». Tamen DONATVS etiam unum pro numero posuit dicens: «Numerus est singularis, ut hic magister». Item AVGVSTINVS dicit: «Numerus est singularis corporis ac uocis et significationis collectio».

## **“III. De speciebus numerorum diversis”**

Discipulus: Quot species sunt numerorum?

Magister: Plures quidem species numerus habet, sed tamen omnes ab una origine nascuntur; quia aut cardinales sunt numeri, ut unus, duo, tres, quattuor, quinque, sex et ceteri iuxta hunc ordinem; aut ordinales ut primus, secundus, tertius, quartus, quintus et cetera; aut aduerbiales ut semel, bis, ter, quater, quinquies, sexies et reliqua; aut dispertitiui ut singuli, bini, terni, quaterni, quini, seni et cetera; aut ponderales ut simplum, duplum, triplum, quadruplum et reliqua; aut denuntiatiui ut solus, alter uel alius.

Insuper uero ad alios numeros reuertere, sunt item numeri multiplicatiui ut simplex, duplex, triplex, quadruplex et cetera. Sunt item aduerbialiter rolati ut simpliciter, dupliciter, tripliciter et reliqua. Sunt et aliae species deriuatiuorum numerorum a superioribus deriuatae ut est singularis, dualis, ternarius, quaternarius, atque in hunc modum ceteri. Item assis, dussis uel dipondius, tressis, quadrasis, quinquis, sexies, septusis, octusis, nonusis, decus uel decusis, uicesis, trecesis, quadragesis, quinquagesis, sexagesis, septuagesis, octagesis, nonagesis, centusis, post quem numerum teste VARRONE non componuntur cum asse numeri.

Item nomina unciarum ut deunx, dextans, dodrans, bessis, septunx, quincunx, triens, quadrans, sextans (sexcunx, sextula); libra et inde deriuata bilibris, trilibris, quadrilibris et similia alia.

Item ab anno deriuata ut anniculus uel annuus, biennis, triennis, quadriennis et his similia; biennium, triennium, quadriennium et his similia. Item bimus, trimus, quadrimus et similia; bipes, tripes, quadrupes, decempes et decempeda et his similia; biceps, triceps, quadriceps, centiceps et similia; bifariam, trifariam, quadrifariam et similia; biduum, quadriduum et his similia; bicorpor, tricorpor et similia; bipatens, tripatens et similia; bilinguis, trilinguis et similia; biuium, triuium et similia; bifidus, trifidus, quadrifidus et similia; bisulcus, trisulcus et similia; geminus, ter geminus, centum geminus et similia; unimanus, centimanus et similia; uniformis, biformis, triformis et reliqua; duumuir, triumuir, quinqueuir, septemuir, decemuir, centumuir et similia; bigae, trigae, quadrigae et similia; biiugus (unde VERGILIUS in quinto: «Biiugo certamine campus corripuere», et bigati nummi), triiugus, quadriiugus et similia; triangulum, quadrangulum, quinquangulum, sexangulum et similia».

#### **“IV. De numeri demonstratione”**

Discipulus: Demonstratio ergo numerorum quomodo constat?

Magister: Duobus modis.

Discipulus: Quomodo?

Magister: Aut enim litteris numeri notantur aut digitorum inflexionibus exprimuntur.

#### **“V. Quomodo numeri litteris notentur”**

Discipulus: Primum de litterarum notatione dic.

Magister: Septem ergo litteris numeri notantur, id est I, V, X, L, C, D, M, quae aut solae positae numeros significant, ut I unum, V quinque, X decem, L quinquaginta, C centum, D quingentos, M mille: aut compositae cum aliis, ut V et I sex significant, X et I undecim, X et L quadraginta, L et X sexaginta; et X anteponitur C quando nonaginta significant, D et C sexcentos; aut multiplicatae per se, ueluti I duplicatum duo significat, triplicatum tres, quadruplicatum quattuor; X duplicatum uiginti, triplicatum triginta; C duplicatum ducentos, triplicatum tricentos, quadruplicatum quadringentos. Nulla autem nota apud Latinos multiplicatur per se magis quam per quattuor uices.

Aut cum aliis multiplicantur, ut I cum V quando septem significat uel octo uel nouem; et X cum L quando septuaginta uel octoginta significat; item C cum D quando septingenta, octingenta, uel nongenta figurat.

## **“VI. Quomodo digitis significantur”**

Discipulus: Quomodo ergo numeri digitorum inflexionibus exprimuntur?

Magister: Igitur tres digiti in sinistra manu, id est auricularis, medicus, et impudicus, ab uno usque ad nouem continent numerum; et duo digiti in eadem manu, id est index et pollex, a decimo usque XC continent numerum.

Item duo digiti in dextera manu, id est pollex et index, a centum usque nongentos continent numerum. Et res digiti in eadem manu a mille usque ad nouem milia continent numerum, id est auricularis, impudicus, et medicus.

Item sinistra manus per artus diuersos corporis continet numerum a decimo milibus usque ad nonaginta milia. Et a contrario dextra manus continet numerum per iuncturas et dispositiones membrorum a centum milibus usque ad nongentos milia.

Discipulus: Haec ergo omnia precor ut speciatim mihi patefacias.

Magister: Cum ergo dicis unum, minimum in leua digitum inflectens in medium palmae artum infiges. Cum dicis duo, secundum a minimo flexum ibidem impones. Cum dicis tria, tertium similiter adflectes. Cum dicis quattuor, itidem minimum leuabis. Cum dicis quinque, secundum a minimo similiter eriges. Cum dicis sex, tertium nihilominus eleuabis medio dumtaxat solo, qui medicus appellatur, in medium palmae fixo. Cum dicis septem, minimum solum, ceteris interim leuatis super palmae radicem pones. Iuxta quem cum dicis octo, medicum. Cum dicis nouem, impudicem e regione compones. Cum dicis decem, unguem indicis in medio figes artu pollicis. Cum dicis uiginti, summitatem pollicis inter medios indicis et impudicis artus immittes. Cum dicis triginta, unguis indicis et pollicis blando coniunges amplexu. Cum dicis quadriginta, interiora pollicis lateri uel dorso indicis superduces, ambobus dumtaxat erectis. Cum dicis quinquaginta, pollicem exteriore artu instar graecae litterae gammae curuatum ad palmam inclinabis. Cum dicis sexaginta, pollicem ut supra curuatam, indice circumflexo diligenter a fronte precinges. Cum dicis septuaginta, indicem ut supra circumflexum pollice immisso superimplebis ungue dumtaxat illius erecto trans medium indicis artum. Cum dicis octoginta, indicem ut supra circumflexum pollice in longum tenso implebis ungue uidelicet illius in medium indicis artum infixio. Cum dicis nonaginta, indicis inflexi unguem radici pollicis erecti infiges. Hactenus in leua.

Centum uero in dextera quomodo decem in leua facies; ducenta in dextera quomodo uiginti in leua; trecenta in dextera, quomodo triginta in leua; eodem modo et cetera usque ad DCCCC.

Item mille in dextera, quomodo unum in leua; duo milia in dextera, quomodo duo in leua; tria milia in dextera, quomodo tria in leua; et cetera usque ad nouem milia.

Porro decem milia cum dicis, leuam medio pectoris supinam adpones, digitis tantum ad collum erectis; uiginti milia cum dicis, eandem pectori expansam late superpones; triginta milia cum dicis, eadem prona sed erecta pollicem cartillagini medii pectoris immittes; quadraginta milia cum dicis, eandem in umbilico erectam supinabis; quinquaginta milia cum dicis, eiusdem pronae sed erectae pollicem ubilico inpones; sexaginta milia cum dicis, eadem prona femur leuum desuper comprehendis; septuaginta milia cum dicis, eandem supinam femori superpones; octoginta milia cum dicis, eandem pronam femori superpones; nonaginta milia cum dicis, eadem lumbos adprehendes, pollice ad inguinem uerso.

At uero centum milia et ducenta milia usque ad DCCCC milia, eodem quo diximus ordine, in dextera corporis parte complebis. Decies autem centena milia cum dicis, ambas sibi manus insertis inuicem digitis implicabis.

Est et alterius modi computus articulatim decurrens qui, quoniam specialiter ad paschae rationem pertinet cum ad hanc ex ordine uentum fuerit, oportunius explicabitur.

### “VII. De Grecorum notis ad numeros aptatis”

Discipulus: Quid de Grecorum computo ais, qui ut audiui numeros propriis litteris denotant?

Magister: Verum ut asseris ita est: cum toto alphabeti sui karactere in numerorum figuras expenso (tres qui plus sunt) numeros notis singulis depingunt, eundem pene numeri figurandi, quem scribendi alphabeti ordinem sequentes, hoc modo:

A	I	I	X	P	C
B	II	K	XX	C	CC
Γ	III	Λ	XXX	T	CCC
Δ	IIII	M	XXXX	Υ	CCCC
E	V	N	L	Φ	D
G	VI	3	LX	X	DC
Z	VII	O	LXX	Ψ	DCC
N	VIII	Π	LXXX	W	DCCC
Θ	VIIII	Q	LXXXX	↑	DCCCC

Qui et ideo mox numeros digitis significare didicerint; nulla interstante mora, litteras quoque pariter hisdem prefigere sciunt.

## Appendix D – Transcription of *De computo*

Transcriptions of the *De computo* excerpts from Alc. 426 (fols. 250v-251v) and Santa Cruz 8 (fols. 178v-179r), together with the critical apparatus in Stevens edition.<sup>279</sup>

### Abbreviations

A	Avranches, Bibliothèque municipale, Ms. 114	L	Leiden, Universiteitsbibliotheek Leiden, BPL 191 BD
B	London, The British Library, Additional 10801	M	Munich, Bayerische Staatsbibliothek, Clm 14221
C	Oxford, Bodleian Library, Canon. Misc. 353	N	Munich, Bayerische Staatsbibliothek, Clm 14523
D	Einsiedeln, Stiftsbibliothek, Codex 319	O	Munich, Bayerische Staatsbibliothek, Clm 17145
E	Exeter, Cathedral Library, Ms. 3507	P	Padua, Biblioteca Antoniana, Ms. 27
F	Paris, Bibliothèque Nationale de France, Latin 4860	Q	Lisbon, Biblioteca Nacional de Portugal, Alc.426
G	St. Gall, Stiftsbibliothek St. Gallen, Cod. Sang. 878	R	Florence, Biblioteca Riccardiana, 885
H	London, The British Library, Harley 3092	S	Porto, Biblioteca Pública Municipal do Porto, Santa Cruz 8
I	St. Gall, Stiftsbibliothek St. Gallen, Cod. Sang. 902	V	London, The British Library, Cotton Vitellius A.XII
		x	Editio princeps

### Text with variants

/CC205/ /Q250va/ /S178va/

<sup>280</sup>LIBER<sup>281</sup> HRABANI<sup>282</sup> DE COMPVTO<sup>283</sup>

---

<sup>279</sup> Rabanus Maurus, *Martyrologium*, 205-208.

<sup>280</sup> *ante tit.* incipit ipse EFINVx, incipit AR

<sup>281</sup> *om.* D

<sup>282</sup> *om.* O, doctoris *add.* A

<sup>283</sup> *tit. om.* BCMQS

DISCIPVLVS<sup>284</sup>: Quia te, uenerande preceptor, sepius<sup>285</sup> audiui de numeris disputantem discipulisque tuis huius<sup>286</sup> artis disciplinam demonstrantem, precor ut nobis etiam<sup>287</sup> qui<sup>288</sup> maturioris<sup>289</sup> iam sumus aetatis non pigriteris aliquod conficere<sup>290</sup> opusculum, quo nostram<sup>291</sup> possimus excitare<sup>292</sup> inertiam<sup>293</sup> et aliquantulum<sup>294</sup> de numerorum<sup>295</sup> capere peritia<sup>296</sup>.

“I. De numerorum potentia”<sup>297</sup>

MAGISTER<sup>298</sup>: Bene etiam<sup>299</sup>, dilecte<sup>300</sup> frater, rogas quia huius disciplinae cupis habere notitiam, quam constat omnium disciplinarum esse magistram. Non enim ratio numerorum contempnenda<sup>301</sup> est, quia in multis Sanctarum<sup>302</sup> Scripturarum<sup>303</sup> locis quantum mysterium<sup>304</sup> habet<sup>305</sup> elucet<sup>306</sup>.

Non enim<sup>307</sup> frustra<sup>308</sup> in /Q250vb/ laudibus Dei dictum est: «Omnia in<sup>309</sup> mensura et in<sup>310</sup> numero et in<sup>311</sup> pondere fecisti<sup>312</sup>».

Per numerum siquidem ne<sup>313</sup> confundamur<sup>314</sup> instruimur. Tolle numerum a rebus omnibus<sup>315</sup> et<sup>316</sup> omnia pereunt. Adime seculo<sup>317</sup> computum<sup>318</sup> et omnia caeca ignorantia complectuntur. Nec differere<sup>319</sup> possunt<sup>320</sup> a ceteris animalibus<sup>321</sup>, qui calculi nesciunt<sup>322</sup> rationem.

Sed tu quia<sup>323</sup> ad exponendam<sup>324</sup> huius<sup>325</sup> uim et rationem<sup>326</sup> me prouocasti, de his quibus te<sup>327</sup> instruere<sup>328</sup> uelis precede interrogando, et sic te subsequar quantum DOMINVS<sup>329</sup> concesserit respondendo<sup>330</sup>.

<sup>284</sup> *om.* FQSx

<sup>285</sup> sepe ERV, *corr. ex* sepius A, *om.* HLQS

<sup>286</sup> *om.* R

<sup>287</sup> *om.* HLQS

<sup>288</sup> in *add.* QS

<sup>289</sup> mmaturois Q

<sup>290</sup> conficem H

<sup>291</sup> nostrum? QS

<sup>292</sup> exercitare HLMQS, excitere B

<sup>293</sup> ingeniolum H, ingenium LQS, inherciam R

<sup>294</sup> aliquantum BCGH, aliquantu R

<sup>295</sup> numero GRQS

<sup>296</sup> peritiam BRQS

<sup>297</sup> *tit. om.* RQS

<sup>298</sup> *om.* A

<sup>299</sup> *om.* O

<sup>300</sup> *om.* QS

<sup>301</sup> contenenda QS

<sup>302</sup> sanctorum LQS

<sup>303</sup> *om.* HLQS

<sup>304</sup> misterii O

<sup>305</sup> habeat OLQS

<sup>306</sup> eluceat *corr. ex* elucet P, lucet QS

<sup>307</sup> etiam Fx

<sup>308</sup> frustram S

<sup>309</sup> *om.* HLR

<sup>310</sup> *om.* QS

<sup>311</sup> *om.* LQS

<sup>312</sup> disposuisti O

<sup>313</sup> non ERV, ne non BH

<sup>314</sup> confundimur R, condimur V, sed *add.* ERV

<sup>315</sup> *om.* O

<sup>316</sup> *om.* S

<sup>317</sup> scelero? S

<sup>318</sup> computum QS

<sup>319</sup> differri *ex* differre N

<sup>320</sup> potest QS

<sup>321</sup> animantibus M

<sup>322</sup> nescit QS

<sup>323</sup> qui HLMQS

<sup>324</sup> exponendum FIMNOPx

<sup>325</sup> eius BLQS

<sup>326</sup> et rationem *om.* O

<sup>327</sup> tem I, *om.* QS

<sup>328</sup> intrui FIMNOPQSx

<sup>329</sup> *om.* R

<sup>330</sup> respondebo P

D. Haec ergo<sup>331</sup> ratio numerorum unde primum processit?

M. A DEO scilicet, quia omnis sapientia a Domino DEO est, ex quo sunt omnia.

D. Dic ergo quando<sup>332</sup> primum inuenta est ista ratio.

/CC206/ M. <sup>333</sup> Ex illo tempore<sup>334</sup> quo factae sunt creaturae, hoc est ab origine seculi<sup>335</sup>. Tunc enim<sup>336</sup> primum nu- /S178vb/ merus<sup>337</sup> rebus innotuit<sup>338</sup>. Sicut in Genesi<sup>339</sup> legitur, «Et factum est uespere et mane dies unus». Tunc ergo dixit<sup>340</sup> de nocte et de<sup>341</sup> die, quando dixit de uespere et<sup>342</sup> mane. Numeri autem rationem ostendit, quando dixit dies<sup>343</sup> unus et<sup>344</sup> dies<sup>345</sup> secundus et<sup>346</sup> dies<sup>347</sup> tertius, sicque<sup>348</sup> usque ad septimum<sup>349</sup>. Item numerum significauit DEVS<sup>350</sup> quando dixit de sole et luna, «Et<sup>351</sup> sint /Q251ra/ in signa et<sup>352</sup> tempora et dies<sup>353</sup> et<sup>354</sup> annos». Quando dixit<sup>355</sup> dies et tempora et annos<sup>356</sup>, tunc<sup>357</sup> de numero dixit. Quis enim potest intellegere<sup>358</sup> dies et tempora<sup>359</sup> et annos nisi per numerum?

Inde dixit BOETIVS, «Omnia<sup>360</sup> quaecumque a primeua<sup>361</sup> rerum natura constructa sunt, numerorum uidentur ratione<sup>362</sup> formata<sup>363</sup>. Hoc enim fuit principale exemplar in animo conditoris<sup>364</sup>. Hinc enim quattuor elementorum multitudo mutata<sup>365</sup> est. Hinc temporum uices, hinc motus astrorum caelique conuersio intellegitur<sup>366</sup>. Proprie ipsa natura numerorum omnis astrorum cursus<sup>367</sup> omnisque astronomica<sup>368</sup> ratio constituta est. Sic enim ortus occasusque colligimus<sup>369</sup>, sic tarditates uelocitatesque<sup>370</sup> errantium siderum custodimus, sic defectus<sup>371</sup> et multiplices lunae uariationes<sup>372</sup> agnoscimus<sup>373</sup>».

---

<sup>331</sup> *om. P*

<sup>332</sup> *quomodo QS*

<sup>333</sup> *add. A, om. O*

<sup>334</sup> *ex add. LQS*

<sup>335</sup> *mundi LQS*

<sup>336</sup> *erit corr. m. rec. ex enim P*

<sup>337</sup> *numeros P, numerum corr. ex numerus L*

<sup>338</sup> *om. O*

<sup>339</sup> *libro geneseos O*

<sup>340</sup> *om. ERVQS*

<sup>341</sup> *om. H*

<sup>342</sup> *de add. LQS*

<sup>343</sup> *om. OQS*

<sup>344</sup> *uel O*

<sup>345</sup> *om. O*

<sup>346</sup> *uel O*

<sup>347</sup> *om. O*

<sup>348</sup> *et sic DOQS*

<sup>349</sup> *septem QS*

<sup>350</sup> *lac. in N*

<sup>351</sup> *ut AEHLRQSV, om. O*

<sup>352</sup> *om. QS*

<sup>353</sup> *et dies usque tempora om. D*

<sup>354</sup> *om. O*

<sup>355</sup> *om. V*

<sup>356</sup> *tempora et annos : annos et tempora transp. QS*

<sup>357</sup> *nunc S, utique add. HLQS*

<sup>358</sup> *intelligere BHOQSVx*

<sup>359</sup> *lac. in N*

<sup>360</sup> *omnea H*

<sup>361</sup> *primoeua E*

<sup>362</sup> *uidentur ratione om. R*

<sup>363</sup> *firmata Rx*

<sup>364</sup> *exemplar in animo conditoris : in animo conditoris exemplar QS*

<sup>365</sup> *mutuata LQS, corr. ex mutuate D*

<sup>366</sup> *intelligitur ABHOPRQSVx*

<sup>367</sup> *astrorum cursus : cursus astrorum transp. QS*

<sup>368</sup> *astronomie HLQS*

<sup>369</sup> *collegimus BC, cognoscimus D*

<sup>370</sup> *om. HLQS*

<sup>371</sup> *defemus N*

<sup>372</sup> *uarietates LO*

<sup>373</sup> *agoscimus P*

“II. Unde dictus sit<sup>374</sup> numerus<sup>375</sup> »<sup>376</sup>

D. <sup>377</sup> Numeri<sup>378</sup> namque<sup>379</sup> nomen eiusque ethymologiam mihi explana.

M. Numeri scilicet<sup>380</sup> nomen apud quamque<sup>381</sup> gentem secundum proprietatem linguae suae constat. Apud<sup>382</sup> latinos uero numerus<sup>383</sup> /CC207/ ex nummo<sup>384</sup> et riuo uidetur nomen<sup>385</sup> traxisse. Siue<sup>386</sup> enim ex riuo nummorum<sup>387</sup>, id est ex<sup>388</sup> multitudine census, qui reddebatur regibus uel imperatoribus numerus nomen /S179ra/ accepit: unde HISIDORVS dicit: «Nummus<sup>389</sup> /Q251rb/ numero nomen dedit<sup>390</sup> et a<sup>391</sup> sui frequentatione uocabulum indidit». Siue a<sup>392</sup> numeria<sup>393</sup>; hinc<sup>394</sup> AVGVSTINVS<sup>395</sup> ait<sup>396</sup>: «Numerus<sup>397</sup> a numeria<sup>398</sup> quadam<sup>399</sup> dea<sup>400</sup> nominatur, cuius<sup>401</sup> sacerdotes retrouersis uultibus dona ferebant, et post oblata<sup>402</sup> munera retro pergebant».

D. Numerus quomodo diffinitur?

M. HISIDORVS ergo<sup>403</sup> ita diffiniuit<sup>404</sup> dicens: «Numerus est multitudo ex unitatibus constituta. Nam unum semen<sup>405</sup> numeri esse<sup>406</sup>, non numerum», dicimus. Item alibi scriptum est: «Vnus non est numerus sed ab eo crescunt numeri». Tamen<sup>407</sup> DONATVS etiam<sup>408</sup> unum pro numero posuit dicens: «Numerus est singularis, ut hic magister». Item<sup>409</sup> AVGVSTINVS dicit<sup>410</sup> <sup>411</sup>: «Numerus est singularis corporis ac uocis et significationis collectio<sup>412</sup>».

“III. De speciebus numerorum diversis<sup>413</sup> »<sup>414</sup>

D. <sup>415</sup> Quot<sup>416</sup> species sunt<sup>417</sup> numerorum?

---

<sup>374</sup> est V

<sup>375</sup> om. O

<sup>376</sup> tit. om. QS

<sup>377</sup> om. LO

<sup>378</sup> numerum QS

<sup>379</sup> om. LOQS

<sup>380</sup> om. O

<sup>381</sup> unamquaque O

<sup>382</sup> apud C

<sup>383</sup> nomen add. O

<sup>384</sup> numero HQS

<sup>385</sup> tr. ad lineam supram O

<sup>386</sup> om. O

<sup>387</sup> numerorum QS

<sup>388</sup> om. M, del. H

<sup>389</sup> numerus QS

<sup>390</sup> nomen dedit : dedit nomen *transp.* QS

<sup>391</sup> om. H

<sup>392</sup> om. CDFIPx

<sup>393</sup> siue a numeria om. O

<sup>394</sup> unde QS

<sup>395</sup> austinus P

<sup>396</sup> dicit OR

<sup>397</sup> nummus L

<sup>398</sup> numeraria Q

<sup>399</sup> quandam QS

<sup>400</sup> dea I

<sup>401</sup> cui M

<sup>402</sup> ablata BC

<sup>403</sup> om. HLOQS

<sup>404</sup> finiuit M

<sup>405</sup> semel QSV

<sup>406</sup> numeri esse om. QS

<sup>407</sup> tunc IN, inde R

<sup>408</sup> om. QS

<sup>409</sup> idem B

<sup>410</sup> om. O

<sup>411</sup> Augutinus dicit : dicit Augutinus *transp.* QS

<sup>412</sup> lectio N

<sup>413</sup> om. H, in marg. O

<sup>414</sup> tit. om. QS

<sup>415</sup> om. FL

<sup>416</sup> quod E

<sup>417</sup> species sunt : sunt species *transp.* QS

M. Plures quidem<sup>418</sup> species numerus<sup>419</sup> habet, sed tamen omnes ab una origine nascuntur<sup>420</sup> ; quia aut<sup>421</sup> cardinales sunt numeri, ut unus<sup>422</sup> , duo, tres, quattuor<sup>423</sup> , quinque, sex<sup>424</sup> et ceteri<sup>425</sup> iuxta hunc ordinem<sup>426</sup> ; aut ordinales ut primus, secundus, tertius, quartus, quintus<sup>427</sup> et cetera<sup>428</sup>; aut aduerbiales ut semel, bis, ter, quater, quinquies<sup>429</sup> , sexies<sup>430</sup> et reliqua<sup>431</sup>; aut dispartitiui ut singuli<sup>432</sup> , bini, terni, quaterni<sup>433</sup> , quini, seni et cetera<sup>434</sup> ; aut ponderales ut sim- /CC208/plum, duplum, triplum, quadruplum<sup>435</sup> et reliqua<sup>436 437</sup>; aut denuntiatiui<sup>438</sup> /Q251va/ ut solus, alter<sup>439</sup> uel alius<sup>440</sup>.

Insuper<sup>441</sup> uero ad alios numeros reuertere, sunt<sup>442</sup> item numeri multiplicatiui<sup>443</sup> ut simplex, duplex, triplex, quadruplex<sup>444</sup> et cetera<sup>445</sup> . Sunt item aduerbialiter prolati /S179rb/ ut<sup>446</sup> simpliciter, dupliciter, tripliciter<sup>447</sup> et reliqua<sup>448</sup> . Sunt et<sup>449</sup> aliae species /Q251vb/ deriuatiuorum<sup>450</sup> numerorum a superioribus deriuatae<sup>451</sup> ut est singularis<sup>452</sup> , dualis, ternarius, quaternarius<sup>453 454</sup> , atque<sup>455</sup> in hunc modum ceteri.

Item assis, dussis uel<sup>456</sup> dipondius<sup>457</sup> , tressis, quadrasis, quinquis, sexies<sup>458</sup> , septusis, octusis<sup>459</sup> .

<sup>418</sup> *add.* sunt HLQS

<sup>419</sup> *usque* quia *om.* HLQS

<sup>420</sup> nascitur R

<sup>421</sup> autem O

<sup>422</sup> unum ABCDILS, uel unus *ss.* A

<sup>423</sup> *usque* sex *om.* OS

<sup>424</sup> quinque sex *om.* Q

<sup>425</sup> cetera QS

<sup>426</sup> iuxta hunc ordinem : secundum eundem ordinem HL, secundum eiusdem ordinem QS

<sup>427</sup> quartus quintus *om.* O

<sup>428</sup> quintus *om.* EVQS, sextus *add.* L

<sup>429</sup> *usque* reliquia *om.* O

<sup>430</sup> sexcies R

<sup>431</sup> et reliquia : septies occies nouies decies QS

<sup>432</sup> singulari S

<sup>433</sup> *usque* cetera *om.* O

<sup>434</sup> et cetera : septeni octoni noni deni QS

<sup>435</sup> quincuplum sextuplum septuplum *add.* QS

<sup>436</sup> quadruplum et reliqua *om.* O

<sup>437</sup> cetera ADEHNORQSV, reliqui B

<sup>438</sup> denuntiaui CF, adnuntiaui D

<sup>439</sup> aliter B

<sup>440</sup> et cetera *add.* QS

<sup>441</sup> *d. praem.* DEHILRV, *ss.* A, *usque* reuertere *om.* QS

<sup>442</sup> *m. praem.* DEHILRV, sint Fx

<sup>443</sup> multiplicauit F

<sup>444</sup> *om.* L

<sup>445</sup> quadruplex et cetera *om.* O

<sup>446</sup> *om.* O

<sup>447</sup> quadrupliciter, quinquepliciter *add.* QS

<sup>448</sup> *om.* O, cetera QS

<sup>449</sup> *om.* QS

<sup>450</sup> deriuatorum DS, deriuatorum Q

<sup>451</sup> deriuatae x, *om.* O

<sup>452</sup> singularis Q

<sup>453</sup> *om.* DO

<sup>454</sup> quinarius senarius septenarius octonarius nonarius decenarius undenarius duodenarius trecentarius *add.* S

<sup>455</sup> *usque* ceteri : et cetera QS

<sup>456</sup> dussis uel : uel dussis *transp.* QS

<sup>457</sup> dispondis V, dispondius R, dipondius *ex* dispondius E

<sup>458</sup> sexis QS

<sup>459</sup> et cetera *add.* QS

## Appendix E – The Portuguese dactylonomy images

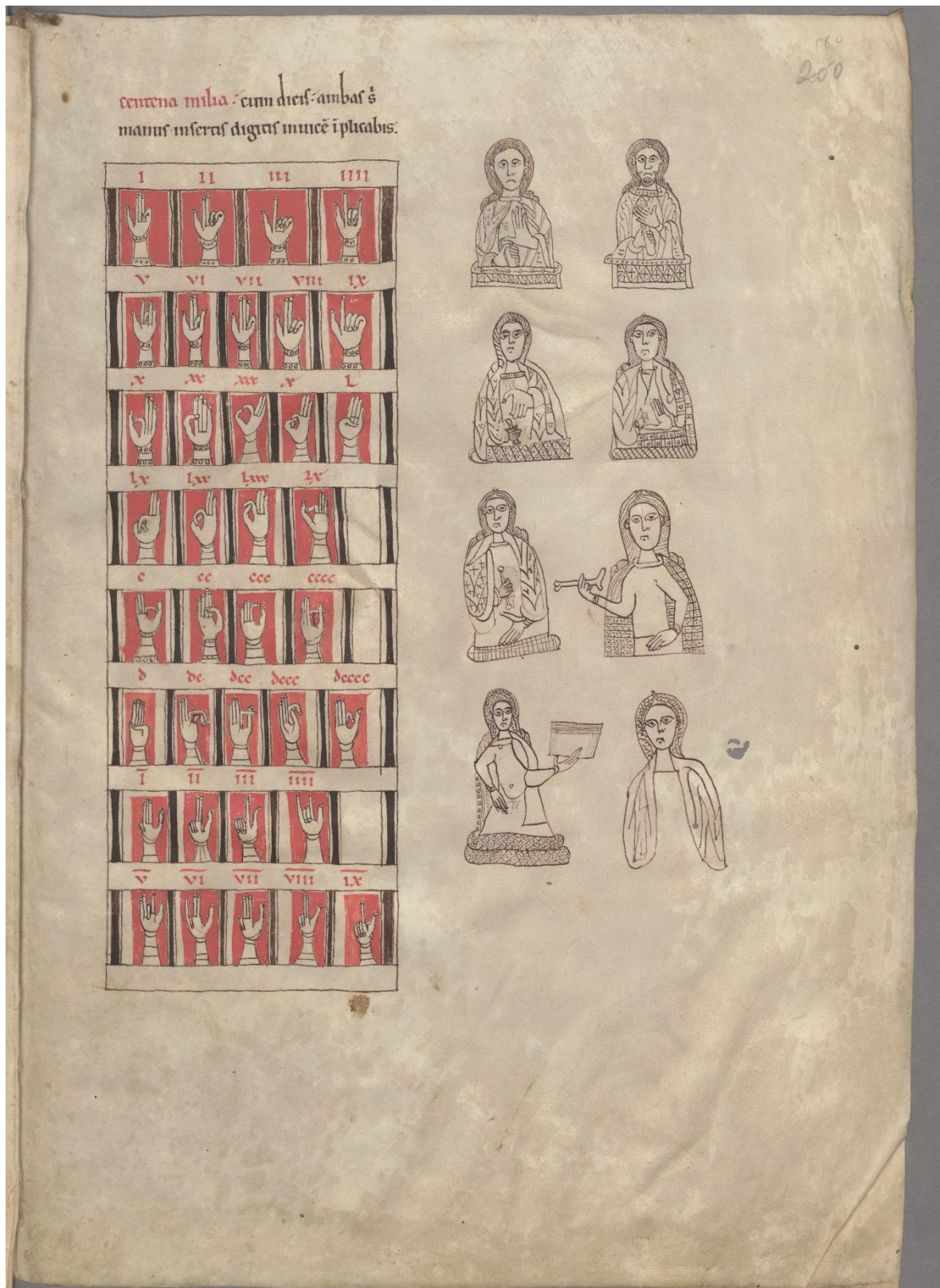


Plate 1. Porto, Biblioteca Pública Municipal do Porto, Santa Cruz 8, fol. 180r.

ut solus. alē. ut alī. & cetera. Sūt  
 item numeri multiplicati. ut  
 simplex. duplex. triplex. qua-  
 druplex. & cetera. Sunt item ad  
 uerbaliē prolata. ut simpliciē. du-  
 pliciē. tripliciē. quadrupliciē. q̄inq̄-  
 pliciē. & cetera. Sunt alie species

derivatorum numerorum a su-  
 pioribus derivare. ut ē singul.  
 dualis. ternarius. quaternari.  
 quinari. senari. septenarius.  
 octonari. nonari. denarius.  
 undenari. duodenari. trece-  
 nari. & cetera. Item. assis. uel  
 dufis. dipondi. tressis. quadra-  
 sis. quinq̄sis. sexis. Septasis.  
 octasis. et cetera.



Plate 2. Lisboa, Biblioteca Nacional de Portugal, Alc. 426, fol. 251v.

XXX



XLI



LX



Plate 3. Lisboa, Biblioteca Nacional de Portugal, Alc. 426, fol. 252r.