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Greek and Roman Logic

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Introduction

In ancient philosophy, there is no discipline called “logic” in the contemporary sense of “the study of formally valid arguments.” Rather, once a subfield of philosophy comes to be called “logic,” namely in Hellenistic philosophy, the field includes (among other things) epistemology, normative epistemology, philosophy of language, the theory of truth, and what we call logic today. This entry aims to examine ancient theorizing that makes contact with the contemporary conception. Thus, we will here emphasize the theories of the “syllogism” in the Aristotelian and Stoic traditions. However, because the context in which these theories were developed and discussed were deeply epistemological in nature, we will also include references to the areas of epistemological theorizing that bear directly on theories of the syllogism, particularly concerning “demonstration.” Similarly, we will include literature that discusses the principles governing logic and the components that make up arguments, which are topics that might now fall under the headings of philosophy of logic or non-classical logic. This includes discussions of problems and paradoxes that connect to contemporary logic and which historically spurred developments of logical method. For example, there is great interest among ancient philosophers in the question of whether all statements have truth-values. Relevant themes here include future contingents, paradoxes of vagueness, and semantic paradoxes like the liar. We also include discussion of the paradoxes of the infinite for similar reasons, since solutions have introduced sophisticated tools of logical analysis and there are a range of related, modern philosophical concerns about the application of some logical principles in infinite domains. Our criterion excludes, however, many of the themes that Hellenistic philosophers consider part of logic, in particular, it excludes epistemology and metaphysical questions about truth. Ancient philosophers do not write treatises “On Logic,” where the topic would be what today counts as logic. Instead, arguments and theories that count as “logic” by our criterion are found in a wide range of texts. For the most part, our entry follows chronology, tracing ancient logic from its beginnings to Late Antiquity. However, some themes are discussed in several eras of ancient logic; ancient logicians engage closely with each other’s views. Accordingly, relevant publications address several authors and periods in conjunction. These contributions are listed in three thematic sections at the end of our entry.

General Overviews

For an introduction to the main themes of ancient logic, see Bobzien 2016, as well as the relevant sections of Bochenski 1961 and Kneale and Kneale 1962. Gabbay and Woods 2004 offers more detailed introductions to particular topics in ancient logic. Indispensable tools for research are Barnes 2007 and Barnes 2012. Still useful as the most comprehensive account of the history of logic ever written is Prantl 1855–1870. Gourinat and Lemaire 2016 is a recent collection of in-depth studies of Greek logic, broadly conceived, up to Proclus. Fink 2012, as well as Bénatouïl and Ierodiakonou 2018, survey the notion of dialectic from its beginnings in Plato and Aristotle into Hellenistic and Imperial times. Martijn, de Haas and Leunissen 2011 survey the notion of demonstration.

Barnes, Jonathan. 2007. *Truth etc.: Six lectures on ancient logic*. Oxford: Oxford Univ. Press.

The most comprehensive recent account of ancient logic. Based on his John Locke Lectures at Oxford, Barnes does not approach the topic chronologically, but topically. Working from the texts themselves, with no references to secondary literature, this book is challenging for the student but essential reading for serious scholarship.

Barnes, Jonathan. 2012. *Logical matters*. Oxford: Oxford Univ. Press.

A collection of twenty-seven essays on ancient logic by one of the foremost scholars of ancient logic, on authors ranging from Aristotle to Ammonius and Boethius.

Bénatouïl, Thomas, and Katerina Ierodiakonou, eds. 2018. *Dialectic after Plato and Aristotle*. Cambridge, UK: Cambridge Univ. Press.

The proceedings of the 13th Symposium Hellenisticum and the first volume dedicated to dialectic (a close cousin of and sometimes identified with logic) from Aristotle's immediate successors to Sextus Empiricus and Galen.

Bobzien, Susanne. 2016. Ancient Logic. In *The Stanford Encyclopedia of Philosophy*. Edited by Edward N. Zalta. Stanford, CA: Stanford Univ.

A succinct introduction to ancient logic, with a focus on Peripatetic and Stoic theories of syllogisms.

Bochenski, Józef Maria. 1961. *History of formal logic*. Notre Dame, IN: Univ. of Notre Dame Press.

A historical survey of logic, originally published in German as *Formale Logik*, from the point of view of modern logic, inspired by the work of Łukasiewicz. Part II discusses in detail the origins of logic, Aristotle, and Megarians/Stoics. Notably, there is very little on ancient logic after the Stoics and throughout, there is a narrow focus on syllogistic, although there is recognition that logic extends beyond these confines to include methodology and semiotics.

Fink, Jakob, ed. 2012. *The development of dialectic from Plato to Aristotle*. Cambridge, UK: Cambridge Univ. Press.

Collection of articles on dialectic, broadly construed, in Plato and Aristotle, dealing with topics such as the dialogue form and its relationship to dialectic, the types of question at issue in dialectical argumentation, and the sorts of arguments considered (refutation, induction).

Gabbay, Dov M., and John Woods, eds. 2004. *Handbook of the history of logic*. Vol. 1: *Greek, Indian and Arabic logic*. Amsterdam: Elsevier.

A recent collection of in-depth articles aiming for broad coverage of, inter alia, Greek and Roman logic.

Gourinat, Jean-Baptiste, and Juliette Lemaire, eds. 2016. *Logique et dialectique dans l'Antiquité*. Paris: J Vrin.

Collection of articles on ancient logic broadly conceived, starting with discussion of dialectic and Socratic elenchus and covering ancient Greek theories relevant to the history of logic up to and including Proclus.

Kneale, Martha, and William Kneale. 1962. *The development of logic*. Oxford: Clarendon Press.

A detailed chronological account of logic (understood narrowly as the study of valid argumentation) from antiquity through the time of writing. The first three chapters concern (1) the origins of logic, (2) Aristotle, and (3) the Stoics and Megarians, while the fourth chapter briefly touches on logical writings in Latin before moving to the medieval period.

Martijn, M., F. A. J. de Haas, and M. E. M. P. J. Leunissen, eds. 2011. *Interpreting Aristotle's Posterior Analytics in late antiquity and the Byzantine period*. *Philosophia Antiqua*, No. 124. Leiden, The Netherlands: Brill.

A collection of essays on the later Greek reception of Aristotle's treatise on demonstrative syllogisms, the *Posterior Analytics*.

Prantl, Karl von. 1855–1870. *Geschichte der Logik im Abendlande*. 4 vols. Leipzig: Hirzel.

Still an indispensable work on the entire history of logic, unparalleled in scope, although many of his judgments about the value of ancient logicians after Aristotle, particularly the Stoics, are no longer widely accepted. Unlike the tradition following Łukasiewicz, Bochenski, and later authors, Prantl does not take Aristotle to have developed a “formal” logic at all and he argues that all later formal logic was a corruption of the “pure” original, which was deeply connected with metaphysics.

Origins of Ancient Logic

One of the foundational questions in the study of ancient logic concerns its beginnings. While Aristotle may seem to have made great strides out of nowhere, Maier 1900 detected influence from late Platonic division, while Shorey 1924 sees Platonic causal reasoning, Kapp 1942 dialectical practice as described in the *Topics*, Allen 1995 rhetoric, and Smith 1978 ancient mathematics. Mueller 1974 and Netz 1999 argue against the relevance of ancient mathematics. Moravcsik 2004 argued that while some of the prerequisites of logic may have been discussed prior to Aristotle, none constituted a decisive influence. See Malink 2015 for an attempt to get clear about how Aristotle's *Prior Analytics* is properly called the “first” formal logic.

Allen, James. 1995. The development of Aristotle's logic: Part of an account in outline. In *Proceedings of the Boston Area Colloquium in Ancient Philosophy* 11. Edited by John J. Cleary, 177–205. Leiden, The Netherlands: Brill.

Argues for the importance of the rhetorical tradition in Aristotle's development of the first logic.

Kapp, Ernst. 1942. *Greek foundations of traditional logic*. New York: Columbia Univ. Press.

A series of lectures given at Columbia, comparing ancient and modern logic through a discussion of the origin of logic as a science of dialectic and comparing ancient logical vocabulary to modern uses to those concepts (e.g., term, definition, categories, judgment, etc.).

Maier, Heinrich. 1900. *Die Syllogistik des Aristoteles*. Vol. 2.2. Tübingen, Germany: Laupp.

The final volume of this monumental work argues for the origins of Aristotle's logic in Plato's method of division, refining what was the standard view in the 19th century.

Malink, Marko. 2015. The beginnings of formal logic: Deduction in Aristotle's *Topics* vs. *Prior Analytics*. *Phronesis* 60.3: 267–309.

Argues that what makes Aristotle's *Prior Analytics* (rather than the *Topics*) the starting point of “formal” logic is not that it is symbolic, in a formalized language, or that it uses schematic letters. Instead, it is “formal” in other senses. First, it only takes into account explicit meanings of sentences (not a speaker's intention). Second, it provides a criterion to determine when all premises necessary to deduce the conclusion are present. Third, the language used in arguments is supposed to be free of homonymy and ambiguity.

Moravcsik, Julius. 2004. Logic before Aristotle: Development or birth?. In *Handbook of the history of logic*. Vol. 1: *Greek, Indian and Arabic Logic*. Edited by Dov M. Gabbay and John Woods, 1–25. Amsterdam: Elsevier.

An attempt at an overview of the conceptual foundations required for logic prior to Aristotle. Argues against the method of division as an important precursor to Aristotle's logic.

Mueller, Ian. 1974. Greek mathematics and Greek logic. In *Ancient logic and its modern interpretations*. Edited by John Corcoran, 35–70. Boston: Reidel.

Argues that Aristotle's formulation of the syllogistic is independent of Greek mathematics and its use of proof (with a focus on Euclid). Further, argues that Stoic propositional logic shows no strong connection with mathematics, but that a debate between Zeno of Sidon and Posidonius over gaps in mathematical proof led to changes in the text of the *Elements*.

Netz, Reviel. 1999. *The shaping of deduction in Greek mathematics: A study in cognitive history*. Cambridge, UK: Cambridge Univ. Press.

An investigation into Greek mathematics inspired by Kuhn's work on scientific revolutions and Fodor's work on the modularity of mind. Provides a "cognitive history" that analyzes the tools and methods of Greek mathematics in order to locate what makes these types of arguments seem necessary and general, and further what made Greek mathematicians progress in the way that they did.

Shorey, Paul. 1924. The origin of the syllogism. *Classical Philology* 19.1: 1–19.

Argues that there is not sufficient evidence that Plato's method of division led Aristotle to his theory of the syllogism. Instead, another probable source is a passage in Plato's *Phaedo* that discusses the simple method of ideas, since both are concerned with the search for causes to be represented in the premises.

Smith, Robin. 1978. The mathematical origins of Aristotle's syllogistic. *Archive for History of Exact Sciences* 19.3: 201–209.

Building off of Einarson's papers, Smith suggests that Aristotle's syllogistic is more properly regarded as mathematics than logic. Hence modern attempts to formalize it in terms of modern formal logic are misguided. Aristotle's view is best interpreted as a mathematical theory concerning a technical notion of terms (and so is within mathematical epistemology), not as an investigation into the deductive relationships between propositions/sentences.

Translations and Commentaries

The primary sources for Greek and Roman logic come in a variety of texts from a wide array of figures. We organize them below roughly chronologically, providing modern editions of the text and pointing out translations where available.

Origins/Plato

Diels and Kranz 1951 is the classic collection of Presocratic fragments, and the reader interested in logic should look to fragments of Parmenides and Zeno, among others. With respect to Plato, some of the later dialogues are especially relevant, including the *Sophist*, the *Statesman*, and the *Parmenides*. Burnet 1900 provides a critical edition of those texts, and Cooper and Hutchinson 1997 provides standard translations.

Diels, Hermann, and Walter Kranz, eds. 1951. *Die Fragmente der Vorsokratiker*. Berlin: Weidmann.

Critical edition with German translation and commentary.

Burnet, John, ed. 1900–. *Platonis Opera Tomi I-V*. Oxford: Oxford Univ. Press.

Critical edition of the Greek text of Plato's complete works.

Cooper, John M., and Douglas Hutchinson, eds. 1997. *Plato: Complete works*. Indianapolis: Hackett.

Standard English language translation of Plato's work.

Aristotle

A set of fairly short writings, traditionally called the *Organon*, is the key source for Aristotle's logic. It includes the *Categories*, *On Interpretation*, the *Analytcs*, *Topics*, and *Sophistical Refutations*. There is also significant information on logic in the *Metaphysics*, particularly in its fourth book. Brunschwig 1967 and Brunschwig 2002, Jaeger 1957, Minio-Paluello 1961, and Dorion 1995 provide critical editions of these texts, and Smith 1997 provides a translation and commentary for *Topics* I and VIII. Ackrill 1963 provides translation and notes for the *Categories* and *On Interpretation*. Smith 1989 provides translation and commentary of *Prior Analytics*, with Striker 2009 focusing on Book 1.

Akrill, J. L. 1963. *Aristotle Categories and De Interpretatione*. Oxford: Clarendon Press.

Translation, with notes and a glossary, of the *Categories* and *On Interpretation*.

Brunschwig, Jacques. 1967. *Aristote: Topiques Livres I–IV*. Paris: Les Belles Lettres.

Critical edition of the Greek text of Aristotle's *Topics* I–IV with introduction and commentary in French.

Brunschwig, Jacques. 2002. *Aristote: Topiques Livres V–VIII*. Paris: Les Belles Lettres.

Critical edition of the Greek text of Aristotle's *Topics* V–VIII with introduction and commentary in French.

Dorion, Louis-André. 1995. *Les Réfutations sophistiques*. Paris: J. Vrin.

Critical edition of the Greek text with French translation and commentary of the Greek text of Aristotle's *Sophistical Refutations*.

Jaeger, Werner. 1957. *Aristotelis Metaphysica*. Oxford: Oxford Univ. Press.

Critical edition of the Greek text of Aristotle's *Metaphysics*.

Minio-Paluello, L. 1961. *Aristotelis Categoriae et Liber de Interpretatione*. Oxford: Oxford Univ. Press.

Critical edition of the Greek text of Aristotle's *Categories* and *On Interpretation*.

Smith, Robin. 1997. *Aristotle Topics Books I and VIII*. Oxford: Oxford Univ. Press.

Translation, with introduction and commentary, of *Topics* I and VIII.

Smith, Robin. 1989. *Aristotle Prior Analytics*. Indianapolis: Hackett.

Translation, with introduction and commentary, of *Prior Analytics*.

Striker, Gisela. 2009. *Aristotle Prior Analytics, Book I*. Oxford: Clarendon Press.

Translation, with introduction and commentary, of Book I of *Prior Analytics*.

Dialectical School

The early Hellenistic logicians Diodorus Cronus and Philo the Logician are the two main figures of the so-called Dialectical School, whose works deal primarily with paradoxes and modality. Giannantoni 1983–1990 and Döring 1972 collect related testimonia and fragments, Montoneri 1984 provides an introduction, and Muller 1985 provides translation and commentary.

Giannantoni, Gabriele. 1983–1990. *Socratis et Socraticorum Reliquiae*. 4 vols. Elenchos 18. Naples: Bibliopolis.

The testimonia on Diodorus Cronus and Philo the Logician are in Volume 1, pp. 414–435.

Döring, Klaus. 1972. *Die Megariker. Kommentierte Sammlung der Testimonien*. Amsterdam: Grüner.

Part 3 covers Diodorus and Philo.

Montoneri, Luciano. 1984. *I Megarici. Studio Storico-Critico E Traduzione Delle Testimonianze Antiche*. Catania, Italy: Univ. di Catania.

Includes an introduction on the Socratic background of the philosophy of the Megarics.

Muller, Robert. 1985. *Les mégariques. Fragments et témoignages*. Paris: Vrin.

Translation and commentary.

Stoics

The early Stoics, in particular Chrysippus, were prolific writers in logic, but here no complete works survive. Chrysippus can be credited with the development of a logic that takes propositions (or rather, their Stoic cousin, *lekta*), as its basic elements. Much of our information about Stoic logic is based on reports, often critical, in Sextus Empiricus. Von Arnim 1964 provides a collection of Stoic fragments, and Huelser 1987 and Long and Sedley 1987 provide selections of translated texts with commentary in German and English, respectively. Mutschmann and Mau 1914–1961 provides a critical edition of Sextus Empiricus, while Mates 1996, Annas and Barnes 2000, and Bett 2005 provide complete translations of Sextus' two works most relevant for Stoic logic.

Annas, Julia, and Jonathan Barnes, trans. 2000. *Sextus Empiricus. Outlines of Scepticism*. 2d ed. New York: Cambridge Univ. Press.

English translation of Sextus' *Outlines* (*PH* 1–3) with preface and Greek-English glossary. *PH* 2 is an important source for Stoic logic.

Bett, Richard, trans. 2005. *Sextus Empiricus' Against the Logicians*. Cambridge, UK: Cambridge Univ. Press.

English translation with introduction and notes of Sextus Empiricus' work, an important source for Stoic logic.

Huelser, Karlheinz. 1987. *Die Fragmente zur Dialektik der Stoiker*. Vols. 1–4. Stuttgart: Bad Cannstatt.

Collection of fragments on Stoic logic, in the expansive sense where this includes not only what today we would consider “logic,” but also rhetoric, epistemology, etc. German translation and commentary.

Long, Anthony, and David Sedley. 1987. *The Hellenistic philosophers*. Vols. 1–2. Cambridge, UK: Cambridge Univ. Press.

Selection of texts on Stoic logic with English translation and commentary.

Mates, Benson. 1996. *The Skeptic way: Sextus Empiricus's outlines of Pyrrhonism*. New York: Oxford Univ. Press.

Translation and commentary of Sextus Empiricus' *Outlines of Pyrrhonism (PH)* Books 1–3; *PH 2* is an important source for Stoic logic.

Mutschmann, Hermann, and Jürgen Mau. 1914–1961. *Sexti Empirici Opera*. Leipzig: Teubner.

Critical edition of the Greek text of Sextus Empiricus. The second book of the *Outlines of Pyrrhonism* and the work *Against the Logicians* are invaluable sources for the history of Hellenistic logic.

Von Arnim, Johannes. 1964. *Stoicorum Veterum Fragmenta*. Vols. 1–4. Leipzig: Teubner.

Standard edition of the Greek and Latin fragments of the early Stoa.

Later Antiquity

The first logical text to survive in anything like a complete form after Aristotle is Galen's *Introduction to Logic* (See Kalbfleisch 1896 for the Greek text and Kieffer 1964 for a translation). In later antiquity, one finds short introductory treatises devoted to logic/dialectic (e.g., Alcinous' *Didaskalikos* chapters 4–6, Plotinus *Ennead* I.3, Porphyry *Introduction*, works by Olympiodorus) as well as paraphrases (e.g., Boethius' treatises on categorical and hypothetical syllogisms and the method of division, Apuleius' *De Interpretatione*, Themistius' paraphrase of the *Posterior Analytics*) and commentaries (by Alexander of Aphrodisias, Ammonius, Boethius, Simplicius, and John Philoponus). Barnes 2006 provides a translation and commentary for Porphyry's *Eisagoge*, Sharples 2010 provides translation and commentary for many Peripatetic figures before Alexander of Aphrodisias. Whittaker 1990 provides a critical edition and French translation and Dillon 1993 provides an English translation of Alcinous' *Handbook* and Theophrastus of Eresus 1992 collects together fragments of Theophrastus' writings on logic.

Barnes, Jonathan, ed. and trans. 2006. *Porphyry Introduction*. Oxford: Oxford Univ. Press.

English translation, with introduction and commentary on Porphyry's *Eisagoge*, which would eventually become the introductory logic textbook for philosophy in later antiquity and the Middle Ages.

Dillon, John, ed. and trans. 1993. *Alcinous: The handbook of Platonism*. Oxford: Clarendon Press.

English translation, with introduction and commentary on Alcinous' *Didaskalikos*, an important source for Platonist logic before Plotinus.

Kalbfleisch, Karl, ed. 1896. *Galen, Institutio Logica*. Leipzig: Teubner.

Edition of the Greek text of Galen's introductory handbook on logic. Reprinted 2012, San Bernardino, CA: Ulan Press.

Kieffer, J. S., trans. 1964. *Galen's Institutio logica*. Baltimore: Johns Hopkins Univ. Press.

Only English translation of Galen's *Institutio Logica*, but it is not totally reliable.

Sharples, Robert W., ed. and trans. 2010. *Peripatetic philosophy 200 BC to AD 200: An introduction and collection of sources in translation*. Cambridge, UK: Cambridge Univ. Press.

A valuable resource of translations and commentaries for a period of Peripatetic philosophy for which there are no complete surviving texts, on figures such as Adrastus of Alexandria, Alexander of Aegae, Andronicus of Rhodes, Ariston of Alexandria, Aspasius, Boethus of Sidon, Herminus, and Sosigenes. Topics include textual issues in Aristotle (the title and content of the *Categories*, the authenticity of *On Interpretation*) and philosophical issues (the number of syllogistic figures, the perfection of syllogisms, modality).

Whittaker, John, ed. 1990. *Alcinoos: Enseignement des doctrines de Platon*. Paris: Belles Lettres.

Critical edition of the Greek text of Alcinoos' *Handbook on Platonism* with French introduction, translation, and commentary.

Theophrastus of Eresus. 1992. *Sources for his life, writings, thought and influence*. Edited and translated by William W. Fortenbaugh, Pamela M. Huby, Robert W. Sharples (Greek and Latin), Dimitri Gutas (Arabic), et al. 2 vols. Leiden, The Netherlands: Brill.

Fragments of Theophrastus' writings on logic.

Commentaria in Aristotelem Graeca

This collection provides the standard edition of existing commentaries on Aristotle, some of which pertain to his work in logic. In particular, Alexander of Aphrodisias 1883, Ammonius 1899, Philoponus 1905 are commentaries on the *Prior Analytics*, Themistius 1900, Philoponus 1909, and Eustratius 1907 are commentaries on the *Posterior Analytics*. Porphyry 1887 provides the Isagoge and the commentary on the *Categories*, and Olympiodorus 1902 provides *Prolegomena* and another commentary on the *Categories*. Alexander of Aphrodisias 1891 focuses on the Topics, Ammonius 1897 and Stephanus 1885 on *On Interpretation*.

Alexander of Aphrodisias. 1883. *Commentary on Book 1 of the Prior Analytics*. Edited by M. Wallies. Berolini: typ. et empensis G. Reimeri.

Critical edition of Alexander of Aphrodisias' commentary on Book 1 of Aristotle's *Prior Analytics*.

Alexander of Aphrodisias. 1891. *Commentary on 8 Books of the Topics*. Edited by M. Wallies. Berolini: typ. et empensis G. Reimeri.

Critical edition of Alexander of Aphrodisias' commentary on Aristotle's *Topics*.

Ammonius. 1897. *Commentary on On Interpretation*. Edited by A. Busse. Berolini: typ. et empensis G. Reimeri.

Critical edition of Ammonius' commentary on Aristotle's *On Interpretation*.

Ammonius. 1899. *Commentary on Book 1 of the Prior Analytics*. Edited by M. Wallies. Berolini: typ. et empensis G. Reimeri.

Critical edition of Ammonius' commentary on Book 1 of Aristotle's *Prior Analytics*.

Eustratius. 1907. *Commentary on Book 2 of the Posterior Analytics*. Edited by M. Hayduck. Berolini: typ. et empensis G. Reimeri.

Critical edition of Eustratius' commentary on Book 2 of Aristotle's *Posterior Analytics*.

Olympiodorus. 1902. *Prolegomena and Commentary on the Categories*. Edited by A. Busse. Berolini: typ. et empensis G. Reimeri.

Critical edition of Olympiodorus' *Prolegomena* and commentary on Aristotle's *Categories*.

Philoponus. 1905. *Commentary on the Prior Analytics*. Edited by M. Wallies. Berolini: typ. et empensis G. Reimeri.

Critical edition of Philoponus' commentary on Aristotle's *Prior Analytics*.

Philoponus. 1909. *Commentary on the Posterior Analytics*. Edited by M. Wallies. Berolini: typ. et empensis G. Reimeri.

Critical edition of Philoponus' commentary on Aristotle's *Posterior Analytics*.

Porphyry. 1887. *Isagoge and Commentary on the Categories*. Edited by A. Busse. Berolini: typ. et empensis G. Reimeri.

Critical edition of Porphyry's *Isagoge* and commentary on Aristotle's *Categories*.

Stephanus. 1885. *Commentary on On Interpretation*. Edited by M. Hayduck. Berolini: typ. et empensis G. Reimeri.

Critical edition of Stephanus' commentary on Aristotle's *On Interpretation*.

Themistius. 1900. *Paraphrase of the Posterior Analytics*. Edited by M. Wallies. Berolini: typ. et empensis G. Reimeri.

Critical edition of Themistius' commentary on Aristotle's *Posterior Analytics*.

Ancient Commentators on Aristotle Series

The Ancient Commentators on Aristotle Series provides English translations of many of the texts edited in the *Commentaria in Aristotelem Graeca*. In particular: Alexander of Aphrodisias 1991, Alexander of Aphrodisias 1999a, Alexander of Aphrodisias 1999b, Alexander of Aphrodisias 2006a, and Alexander of Aphrodisias 2006b provide translations of Alexander of Aphrodisias 1883 (cited under *Commentaria in Aristotelem Graeca*). Ammonius 1996 and Ammonius 1998 provide translations of Ammonius 1897 (cited under *Commentaria in Aristotelem Graeca*). Philoponus 2008, Philoponus 2012a, Philoponus 2012b, and Philoponus 2009 provide translations of Philoponus 1909 (cited under *Commentaria in Aristotelem Graeca*). Philoponus 2000 provides translation of Stephanus 1885 (cited under *Commentaria in Aristotelem Graeca*). Elias and David 2018 provides a translation of the *Prolegomena* of Olympiodorus 1902 (cited under *Commentaria in Aristotelem Graeca*).

Alexander of Aphrodisias. 1991. *On Aristotle Prior Analytics 1.1–7*. Translated by J. Barnes, S. Bobzien, K. Flannery, and K. Ierodiakonou. London: Duckworth.

Translation of Book 1.1–7 of Alexander of Aphrodisias 1883.

Alexander of Aphrodisias. 1999a. *On Aristotle Prior Analytics 1.8–13*. Translated by I. Mueller and J. Gould. London: Duckworth.

Translation of Book 1.8–13 of Alexander of Aphrodisias 1883.

Alexander of Aphrodisias. 1999b. *On Aristotle Prior Analytics 1.14–22*. Translated by I. Mueller and J. Gould. London: Duckworth.

Translation of Book 1.14–22 of Alexander of Aphrodisias 1883.

Alexander of Aphrodisias. 2006a. *On Aristotle Prior Analytics 1.23–31*. Translated by I. Mueller. London: Duckworth.

Translation of Book 1.23–31 of Alexander of Aphrodisias 1883.

Alexander of Aphrodisias. 2006b. *On Aristotle Prior Analytics 1.32–46*. Translated by I. Mueller. London: Duckworth.

Translation of Book 1.32–46 of Alexander of Aphrodisias 1883.

Ammonius. 1996. *On Aristotle On Interpretation 1–8*. Translated by D. Blank. London: Duckworth.

Translation of Books 1–8 of Ammonius 1897.

Ammonius. 1998. *On Aristotle On Interpretation 9 with Boethius: On Aristotle On Interpretation 9*. Translated by D. Blank and N. Kretzmann. London: Duckworth.

Translation of Book 9 of Ammonius 1897.

Olympiodorus. 2018. *Elias and David: Introductions to Philosophy with Olympiodorus: Introduction to Logic*. Translated by S. Gertz. London: Bloomsbury.

Contains a translation of the *Prolegomena* of Olympiodorus 1902.

Philoponus. 2000. *On Aristotle On the Soul 3.9–13 with Stephanus: On Aristotle On Interpretation*. Translated by W. Charlton. London: Duckworth.

Translation of Stephanus 1885 (cited under *Commentaria in Aristotelem Graeca*), paired with the later section of Philoponus' commentary on *On the Soul* to argue that Stephanus should be taken as the author of the latter as well.

Philoponus. 2008. *On Aristotle Posterior Analytics 1.1–8*. Translated by R. McKirahan. London: Duckworth.

Translation of Book 1.1–8 of Philoponus 1909.

Philoponus. 2009. *On Aristotle Posterior Analytics 2*. Translated by O. Goldin. London: Duckworth.

Translation of Book 2 of Philoponus 1909.

Philoponus. 2012a. *On Aristotle Posterior Analytics 1.9–18*. Translated by R. McKirahan. London: Bloomsbury.

Translation of Book 1.9–18 of Philoponus 1909.

Philoponus. 2012b. *On Aristotle Posterior Analytics 1.19–34*. Translated by O. Goldin and M. Martjin. London: Bloomsbury.

Translation of Book 1.19–34 of Philoponus 1909.

Texts in Latin

Boethius wrote several works in logic and commentaries on earlier works in logic in Latin. Boethius 1998 provides commentary on Plato's method of division and Boethius 1887/1880 provides his commentaries on Aristotle's *On Interpretation*. Boethius 1969a is his treatise on hypothetical syllogisms, Boethius 2008a and Boethius 2008b his work on categorical syllogisms, and Boethius 1969b his treatise on topics (with Boethius 1978 providing a translation and commentary). Boethius 1988 provides a translation of his work on Cicero's *Topica*. Sullivan 1967 provides the Latin text and English translation for another important early Latin work on categorical syllogisms attributed to Apuleius.

Boethius. 1887/1880. *Commentaries on On Interpretation*. Edited by C. Meiser. Leipzig: Teubner.

Latin text of both of Boethius' commentaries on Aristotle's *On Interpretation*.

Boethius. 1969a. *De hypotheticis syllogismis*. Edited and translated by L. Obertello. Brescia, Italy: Paideia.

Latin text and Italian translation of Boethius' treatise on hypothetical syllogisms.

Boethius. 1969b. *De topicis differentiis kai hoi buzantines metafraseis tou Manouel Holobolou kai Prochorou Kudone*. Edited by D. Z. Nikitas. Athens, Greece: Academy of Athens.

Latin edition of Boethius' major treatise on topics.

Boethius. 1978. *De topicis differentiis*. Edited by Eleanor Stump. Ithaca, NY, and London: Cornell Univ. Press.

English translation and commentary.

Boethius. 1988. *In Ciceronis Topica*. Edited by Eleanor Stump. Ithaca, NY/London: Cornell Univ. Press.

English translation and commentary.

Boethius. 1998. *De divisione*. Edited by John Magee. Leiden, The Netherlands, and Boston: Brill.

Latin text, English translation, with introduction and commentary on a treatise on Plato's method of division, drawing significantly on Porphyry's lost commentary on Plato's *Sophist*.

Boethius. 2008a. *De syllogismo categorico*. Edited by Christina Thomsen Thörnqvist. Gothenburg, Sweden: Univ. of Gothenburg.

Latin text of Boethius' treatise on categorical syllogisms.

Boethius. 2008b. *Introductio ad syllogismos categoricos*. Edited by Christina Thomsen Thörnqvist. Gothenburg, Sweden: Univ. of Gothenburg.

Latin edition of Boethius' introductory text on categorical syllogisms.

Sullivan, W. M. 1967. *Apuleian Logic. The Nature, Sources and Influences of Apuleius' Peri Hermeneias*. Amsterdam: North-Holland

Latin text and English translation, introduction and commentary on Apuleius' text *On Interpretation*, an important source for logical theorizing in the Platonic tradition.

Aristotle

Aristotle is generally credited with being the first systematic logical theorist. While Plato and the Sophists explored many logical topics, they did not unite them into a single *discipline*. Aristotle developed the doctrines in a work he called “the Analytics” (later divided into prior and posterior), which dealt with demonstrative syllogisms and demonstrative knowledge. According to Aristotle, in order to investigate these, one must first grasp what a syllogism is. The development of the doctrine of the syllogism is generally taken to be the first exploration of what is now known as “logical validity.” The *Prior Analytics* contains a general account of syllogisms, as well as a number of important meta-theoretical results. The *Posterior Analytics* deals with demonstration, which one needs to have scientific knowledge. But Aristotle wasn't only interested in syllogisms in his works on demonstration. In the *Topics* and *Sophistical Refutations*, his treatises on dialectical and sophistical argument respectively, he had already given a definition of the syllogism and described how certain arguments did or did not count as syllogisms because of that.

General Overviews

General research on Aristotle's logic has focused on the question of whether there is any unity to Aristotle's logical works (both taken singly and together), and if so, what that unity is, as well as how Aristotle's logical thinking may have developed from earlier works such as the *Topics* to the *Analytics*. A concise introduction to his logic is Crivelli 2012. Crubellier 2008 and Detel 2009 argue for the unity of Aristotle's *Analytics*. For his logical works generally, see Burnyeat 2001 and Leszl 2004. For the connection between Aristotle's logical language and mathematical terminology, see Einarson 1936.

Burnyeat, Myles. 2001. *A map of Metaphysics Zeta*. Pittsburgh: Mathesis.

Argues in chapter 5 that what was historically designated the Organon is unified by a focus on methodology.

Crivelli, Paolo. 2012. Aristotle's Logic. In *Oxford handbook of Aristotle*. Edited by Christopher Shields, 113–149. Oxford: Oxford Univ. Press.

Excellent introduction to the basic views of Aristotle's Organon.

Crubellier, Michel. 2008. The programme of Aristotelian analytics. In *Dialogues, logics and other strange things: Essays in honor of Shahid Rahman*. Edited by C. Degremont, L. Keiff, and H. Ruchert, 121–147. London: College Publications.

Argues that Aristotle's *Analytics* is a unified work, and that its unity comes about through the notion of “analysis” of arguments. While in modern logic, one aims to generate or construct arguments, in the *Analytics*, the goal is rather to break up either syllogisms generally or demonstrations in particular into their constituent parts.

Detel, Wolfgang. 2009. Aristotle's logic and theory of science. In *A companion to ancient philosophy*. Edited by Mary Louise Gill and Pierre Pellegrin, 245–269. Chichester, UK: Wiley-Blackwell.

An introduction to Aristotle's *Prior* and *Posterior Analytics*. Argues for a unified reading of Aristotle's *Analytics* as a methodology not for discovering new facts, but for discovering causal explanations.

Einarson, Benedict. 1936. On certain mathematical terms in Aristotle's logic: Part I. *The American Journal of Philology* 57. 1: 33–54.

A mapping between mathematical terms as used in Aristotle and suggested origins/mathematical uses. Part 1 focuses on terms related to Aristotle's views re: structure of a syllogism and demonstration, while Part II focuses on terms related to proportion and progression. Continued: "On certain mathematical terms in Aristotle's logic: Part II." *The American Journal of Philology* 57.2 (1936): 151–172.

Leszl, Walter. 2004. Aristotle's logical works and his conception of logic. *Topoi* 23:71–100.

Argues that there is no unifying conception of logic to be found in the various treatises grouped under the Organon.

Maier, Heinrich. 1896–1900. *Die Syllogistik des Aristoteles*. Tübingen, Germany: Laupp.

The first two volumes provide detailed exegesis of Aristotle's logical works, while the last deals with general issues concerning the development of the syllogistic and what Maier takes to be foundational issues in the syllogistic. This is the most detailed exegetical work on the entire Organon in the 19th and 20th centuries.

Solmsen, Friedrich. 1929. *Die Entwicklung der aristotelischen Logik und Rhetorik*. Hildesheim, Germany: Weidmannsche Verlagsbuchhandlung.

A developmental account of Aristotle's logic, written under the influence of Werner Jaeger's larger project of charting Aristotle's philosophical development generally. Reprinted 2001.

Syllogistic

Aristotle's greatest achievement in logic, from the contemporary perspective, was probably the first book of the *Prior Analytics*, which gives an account of the "genesis" of syllogisms through various figures and proves a number of important meta-theoretic claims about them. Patzig 1969 argues that Aristotle's syllogisms are not arguments but universally quantified conditionals, while Lear 1980 takes Aristotle to have developed a natural deduction system. In addition to the nature of syllogisms, Aristotle's proof techniques have received extensive attention. Patzig 1969 and Morison 2015 consider reduction, Smith 1982 and Malink 2013 discuss ecthesis. Becker 1933, Patterson 1995, and Malink 2013 are important for understanding current debates surround the status of Aristotle's modal logic. Crivelli 2011 gives a comprehensive treatment of syllogisms from a hypothesis. Malink 2012 argues that Aristotle developed a theory of proleptic syllogisms.

Becker, Albrecht. 1933. *Die Aristotelische Theorie der Möglichkeitsschlüsse*. Berlin: Junker und Dunnhaupt.

The first to point out many of the difficulties in translating Aristotle's modal logic into contemporary modal logic.

Crivelli, Paolo. 2011. Aristotle on syllogisms from a hypothesis. *Elenchos* 59:95–184.

Comprehensive, but rightly tentative, discussion of which syllogisms count as syllogisms from a hypothesis and why based on scant evidence in the *Prior Analytics*.

Lear, Jonathan. 1980. *Aristotle's logical theory*. Cambridge, UK: Cambridge Univ. Press.

The first book-length study of Aristotle's syllogistic from the starting point of the natural deduction systems of Smiley and Corcoran. Lear gives in-depth accounts of the main results of the first book of the *Prior Analytics* as serious proof-theoretical investigations. The work is accessible to those interested in logic without a background in Aristotle.

Malink, Marko. 2012. Figures of prosleptic syllogisms in *Prior Analytics* 2.7. *Classical Quarterly* 62:163–178.

Argues that Aristotle's discussion of circular proof in the *Prior Analytics* provides our earliest evidence for syllogisms of the form "For every X, if every B is X, then every X is A. Every B is C. So, every C is A."

Malink, Marko. 2013. *Aristotle's modal syllogistic*. Cambridge, MA: Harvard Univ. Press.

Groundbreaking work on Aristotle's modal logic, which aims to show that, contrary to contemporary consensus, it is coherent, through providing a formal model that validates all of Aristotle's inferences. In the case of the "apodeictic syllogistic" (which concerns necessity but not possibility), Malink also provides evidence that Aristotle himself could motivate the formal model.

Morison, Benjamin. 2015. What is a perfect syllogism? *Oxford Studies in Ancient Philosophy* 48:107–166.

Argues that Aristotle's so-called "perfect syllogisms," those to which other syllogisms are reduced, are not immediately obvious, but are proved to hold through the *dictum de omni et nullo*, which is interpreted not as an explicit definition, but as a basic rule of inference that characterizes the universal affirmative and negative propositions.

Patterson, Richard. 1995. *Aristotle's modal logic: Essence and entailment in the Organon*. Cambridge, UK: Cambridge Univ. Press.

Argues that Aristotle's modal logic cannot be understood without reference to his metaphysical essentialism, i.e., to Aristotle's distinction between essential and accidental predication.

Patzig, Günther. 1969. *Aristotle's theory of the syllogism*. Translated by Jonathan Barnes. Dordrecht, The Netherlands: D. Reidel.

The first philologically sophisticated treatment of Aristotle's syllogistic (especially, reduction, modal notions, and the figures) in the tradition of *Łukasiewicz*. The English translation is revised from the second edition of the German version.

Smith, Robin. 1982. What is Aristotelian ecthesis? *History and Philosophy of Logic* 3:113–127.

Aristotle appeals to "ecthesis" or "setting out" on a number of occasions in his reductions of syllogisms. Smith argues that Aristotle's use of ecthesis is closely related to his way of understanding existential instantiation.

Mathematical Models

In addition to scholarly, philological work, beginning with *Łukasiewicz* there has been a significant tradition of using the tools of modern logic to reconstruct Aristotle's syllogistic. There has been a wide variety of attempts to do so, for instance by treating Aristotle's syllogisms as quantified conditionals (*Łukasiewicz* 1957) or natural deduction proofs (Smiley 1973, Corcoran 1974, Martin 1997). While current scholarly consensus is that syllogisms are natural deduction proofs, there is still significant debate about how to understand the semantic values of terms in Aristotle's logic, leading to different systems. For example, Corcoran/Smiley use sets and Martin uses semi-lattices. For comparisons of a variety of systems all sound and complete for Aristotle's proof theory, see Andrade-Lotero and Dutilh Novaes 2010 as well as Vlasits 2019. Boger 2004 provides a proof-theoretic approach. For a mathematical logic approach to Aristotle's modal logic, see Johnson 2004.

Andrade-Lotero, A., and C. Dutilh Novaes. 2010. Validity, the squeezing argument and alternative semantic systems: The case of Aristotelian syllogistic. *Journal of Philosophical Logic* 41.2: 387–418.

Shows how, despite various semantic systems for Aristotle's assertoric syllogistic being sound and complete with respect to his proof system, they are not all equivalent and introduces a general, first-order translation that, although it is not plausible as an interpretation of Aristotle, is useful as the most general possible semantic system.

Boger, George. 2004. Aristotle's underlying logic. In *Handbook of the history of logic. Vol. 1: Greek, Indian and Arabic logic*. Edited by Dov M. Gabbay and John Woods, 101–246. Amsterdam: Elsevier.

A detailed study of Aristotle's deduction system that argues Aristotle intended to develop an underlying logic similar to "modernist thinking." The authors construct a proof-theoretic representation of Aristotle's syllogistic and suggest that he did have an implicit understanding of the difference between syntax and semantics.

Corcoran, John. 1974. Aristotle's natural deduction system. In *Ancient logic and its modern Interpretations: Proceedings of the Buffalo Symposium on Modernist Interpretations of Ancient Logic, 21 and 22 April, 1972*. Edited by John Corcoran, 85–131. Dordrecht, The Netherlands, and Boston: Reidel.

Defense of Aristotle's underlying logic in *Analytics* as a natural deduction system (not an axiomatic science via Łukasiewicz) that suggests the theory captures every semantically valid argument expressible in his system.

Johnson, Fred. 2004. Aristotle's modal syllogisms. In *Handbook of the history of logic. Vol. 1: Greek, Indian and Arabic logic*. Edited by Dov M. Gabbay and John Woods, 247–307. Amsterdam: Elsevier.

An examination of Łukasiewicz's decision procedure for assertion or rejection of formal sentences and McCall's extension of it. Suggests a modified system to better deal with contingent syllogisms that provides formal countermodels for a range of syllogisms explicitly taken to be invalid in the text.

Łukasiewicz, Jan. 1957. *Aristotle's syllogistic from the standpoint of modern formal logic*. 2d ed. Oxford: Clarendon Press.

A landmark study that attempts to systematize the assertoric syllogistic with a decision procedure (first edition) and the modal syllogistic (second edition). Interprets syllogisms as quantified conditionals.

Martin, J. N. 1997. Aristotle's natural deduction reconsidered. *History and Philosophy of Logic* 18.1: 1–15.

Provides a variation on Corcoran's interpretation of Aristotle's natural deduction system and proves a soundness and completeness theorem for an order-theoretic semantics that generalizes Corcoran's set-theoretic semantics.

Smiley, T. J. 1973. What is a syllogism? *Journal of Philosophical Logic* 2:136–154.

Argues, against Łukasiewicz that Aristotle's proof system was a natural deduction system like Corcoran. However, the natural deduction system here proposed has certain advantages to Corcoran's, in particular it does not allow contradictory sentences to derive anything at all.

Vlasits, J. 2019. Mereology in Aristotle's assertoric syllogistic. *History and Philosophy of Logic* 40.1: 1–11.

Using an algebraic semantics for Aristotle's assertoric syllogistic and Corcoran's natural deduction system, this paper unifies previous completeness results, arguing that Corcoran, Smiley, and Martin attribute superfluous structure to Aristotle's quantificational predications and that, merely with mereological principles, one can validate all and only the arguments Aristotle took to be valid.

Demonstration

Aristotle's theory of syllogisms in the *Prior Analytics* seemed to have been developed in service of his theory of demonstration, as developed in the *Posterior Analytics*. A demonstration is a kind of syllogism in which the premises serve as first principles which can **explain** the conclusion. Most of the *Posterior Analytics* seeks to understand the structure of demonstration and the nature of its first principles. However, integrating Aristotle's accounts in the two *Analytics* is more difficult than it might initially seem, since his theory of syllogistic does not seem adequate for the formalization of even very basic demonstrations in, for instance, geometry. There is no work that gives a general overview of Aristotle's views on demonstration, but the current debate stems from Barnes 1975 and essays in Berti 1981, particularly Barnes 1981. More recent contributions include the very accessible Ferejohn 1980 and McKirahan 1992, as well as Mendell 1998 and Bronstein 2016.

Barnes, Jonathan. 1975. Aristotle's theory of demonstration. In *Articles on Aristotle*. Vol. 1, *Science*. Edited by Jonathan Barnes, Malcolm Schofield, and Richard Sorabji, 123–152. London: Duckworth.

Gives an account of Aristotelian demonstration not as a methodology of science but as a way of presenting scientific findings. Argues that, despite the fact that it is defined as a kind of syllogism, demonstration should not be understood to conform to the strictures of the *Prior Analytics*.

Barnes, Jonathan. 1981. Proof and the syllogism. In *Aristotle on Science: The Posterior Analytics*. Edited by Enrico Berti, 17–59. Padua, Italy: Antenore.

Examines the different senses in which one might say syllogistic is prior to demonstration and argues that even if the syllogistic was not used explicitly in Aristotle's own work and could not capture ancient geometry, his theory of demonstration provides a fruitful tool both for thinking about Aristotle's own work and his influence on science and mathematics.

Berti, Enrico, ed. 1981. *Aristotle on Science: The Posterior Analytics*. Padua, Italy: Antenore.

Important collection of essays from the eight Symposium Aristotelicum on the *Posterior Analytics*.

Bronstein, D. 2016. *Aristotle on knowledge and learning*. Oxford: Oxford Univ. Press.

Argues for the unity of Aristotle's *Posterior Analytics* as a response to various versions of the Paradox of Inquiry in Plato's *Meno*. Gives an account of several varieties of demonstration in Aristotle and argues that one can learn through demonstration.

Ferejohn, Michael. 1980. *The origins of Aristotelian science*. New Haven, CT: Yale Univ. Press.

Argues against Barnes' anti-syllogistic interpretation of demonstration, claiming that demonstration is a two-step process beginning with division and then syllogizing a conclusion.

McKirahan, Richard. 1992. *Principles and proofs*. Princeton, NJ: Princeton Univ. Press.

A reconstruction of Aristotle's theory of demonstrative science, focusing on the nature and varieties of demonstrations and principles of demonstrations, with comparisons to Greek mathematics. Still the best introduction to the *Posterior Analytics*.

Mendell, Henry. 1998. Making sense of Aristotelian demonstration. *Oxford Studies in Ancient Philosophy* 16:161–225.

An attempt at justifying Aristotle's claim that geometrical proofs can proceed through the syllogistic. Argues that Aristotle did not think of geometrical proofs as containing demonstrative syllogisms whose premises, although undemonstrated, are nonetheless "proved" in other ways. Furthermore, Aristotelian syllogistic propositions are much more flexible than traditionally conceived and are adequate for the formalization of many kinds of mathematical claims.

Dialectical Argumentation

Aristotle's treatise entitled *Topics*, of which the *Sophistical Refutations* is the ninth book, concerns dialectical syllogisms. While these are supposed to only be distinguished from demonstrative syllogisms by the character of their premises (which are "reputable"), the conception of the syllogism here seems to be radically different and the project of the *Topics* does not seem to coincide with that of the *Analytics*. The *Topics* is primarily interested in giving *topoi*, which are intended to help one construct a syllogism to refute one's opponent on a particular question. General accounts can be found in Primavesi 1996 and Slomkowski 1997, as well as the groundbreaking collection Owen 1968. Woods and Irvine 2004 provides a contemporary perspective on the logical doctrines, while Rapp 2000 explores the doctrine of "syllogism" therein, and Smith 1993 discusses the purposes of dialectic. Hambruch 1904 uses the *Topics* as a clue to logical debates in the Early Academy. The *Sophistical Refutations*, Aristotle's treatise on fallacies, gives a typology of fallacious arguments and explains why they are fallacious. See Rapp and Hasper 2013 for the most recent collection on fallacies. Aristotle discusses non-deductive inferences in these works as well, for which see Burnyeat 2012.

Burnyeat, Myles. 2012. *Explorations in ancient and modern philosophy*. Vol. 1. Cambridge, UK: Cambridge Univ. Press.

Chapters 6 and 7 contain important contributions to the understanding of non-deductive inferences in Aristotle, in particular inferences from signs and enthymemes.

Hambruch, E. 1904. *Logische Regeln der Platonischen Schule in der Aristotelischen Topik*. Berlin: Weidmannsche Buchhandlung.

Argues that many passages in Aristotle's *Topics* reflect ongoing debates in Plato's Academy, particularly concerning the method of division. Taking his cue from the transmitted *Divisiones Aristoteleae*, he argues that these divisions of concepts represent discussions in the Academy that are paralleled in some of Plato's dialogues as well as in the *Topics*.

Owen, G. E. L. 1968. *Aristotle on dialectic—The Topics*. Oxford: Oxford Univ. Press.

This collection of essays (the proceedings of the third Symposium Aristotelicum) marks the beginning of contemporary scholarship on Aristotle's *Topics*.

Primavesi, Oliver. 1996. *Die Aristotelische Topik: Ein Interpretationsmodell und seine Erprobung am Beispiel von Topik B*. Munich: Beck.

Explores a tension within the *Topics*, namely that on the one hand the treatise is concerned with a method for conversation and on the other hand it is concerned with method in philosophy. The tension arises when we observe that Aristotle's own philosophical writing does not appeal to conversation. Argues that *gymnasia* (exercise) is the most important of the three uses that Aristotle ascribes in A.2 to the method of the *Topics* and proposes that this view can resolve the tension between the method's conversational and philosophical dimensions.

Rapp, Christof. 2000. *Topos und Syllogismus in Aristoteles' <Topik> in Topik und Rhetorik: Ein interdisziplinäres Symposium*. Edited by Thomas Schirren and Gert Ueding. Tübingen: Niemeyer.

Argues that in the *Topics* the *topoi* are to be used in the construction of deductive arguments (syllogisms) to force opponents to accept a conclusion when they accept the premises, against the claim that the *topoi* aim at non-deductive arguments or are merely heuristic methods.

Rapp, Christof, and Pieter Sjoerd Hasper, eds. 2013. *Special issue: Fallacious arguments in ancient philosophy. Logical Analysis and History of Philosophy* 15:122–158.

Collection of articles on fallacies, mostly in Aristotle's *Sophistical Refutations*.

Slomkowski, Paul. 1997. *Aristotle's Topics*. Leiden, The Netherlands: Brill.

Argues that a topos is a universal proposition used as a premise in a hypothetical syllogism, building on the work of Brunschwig and Solmsen, by interpreting the formal structure of dialectical discussion in Book 8 and comparing it to particular examples of topoi in the central books. Comes to many of the same conclusions as Primavesi, but independently.

Smith, Robin. 1993. Aristotle on the uses of dialectic. *Synthese* 96:335–358.

Argues against the common views in the literature that dialectic is a method for arguing from “common beliefs” and that Aristotle took to it be the way to achieve scientific knowledge.

Woods, John Hayden, and Andrew Irvine. 2004. Aristotle's early logic. In *Handbook of the history of logic. Vol. 1, Greek, Indian and Arabic logic*. Edited by Dov M. Gabbay, and John Woods, 27–99. Oxford and Amsterdam: North-Holland

An overview of Aristotle's logic with a focus on the contributions the authors see arising from the *Topics* and *On Sophistical Refutations*, which they see as providing key insights before the *Prior Analytics*. They take the two earlier works to implicitly provide a theory of syllogisms and classical validity.

Dialectical School

Diodorus and his student Philo are the main proponents of the so-called Dialectical School. Clinomachus of Thurii, a student of Eubulides of Miletus, who works in the Socratic tradition, is considered the founder of the school. Bobzien 1999 and Bobzien 2018, Muller 1988, and Ebert 2008 offer overviews of the groundbreaking work that Diodorus Cronus and Philo did in the later 4th to mid-3rd centuries BCE by coming up with a logic of propositions. Ebert 1993 examines the classification of propositions in both the Dialectical School and in the Stoics. Sedley 2018 focuses on Diodorus' interest in paradoxes and includes discussion of Eubulides, who is credited with the paradox of the Liar. No original writings are preserved. Sedley 1977 analyzes later reports, which contain material on conditionals and modalities and are often discussed in comparison with Stoic proposals. Diodorus is especially well-known for his so-called Master Argument. The argument seems to have been intended to support his revisionary definition of possibility: only the actual is possible; there are no future contingents. Given the Master Argument's role in wider ancient discussions of modality, we include relevant contributions in our section Modality and the Future.

Bobzien, Susanne. 2018. “Dialectical School.” In *The Stanford encyclopedia of philosophy*. Edited by Edward N. Zalta. Stanford, CA: Stanford Univ.

Survey of main figures and contributions.

Bobzien, Susanne. 1999. Logic: The Megarics. In *The Cambridge history of Hellenistic philosophy*. Edited by Keimpe Algra, Jonathan Barnes, Jaap Mansfeld, and Malcolm Schofield, 83–92. Cambridge, UK: Cambridge Univ. Press.

Survey of main themes in Megaric logic.

Ebert, Theodor. 1993. Dialecticians and Stoics on classifying propositions. In *Dialektiker und Stoiker. Zur Logik der Stoiker und ihrer Vorläufer*. Edited by K. Döring, and Th. Ebert, 111–127. Stuttgart: Steiner.

Argues that the report in Diogenes Laertius on the classification of propositions goes back to Chrysippus, while the report in Sextus Empiricus goes back to the Dialectical school.

Ebert, Theodor. 2008. In defence of the dialectical school. In *Anthropine Sophia*. Edited by F. Alesse, F. Aronadio, M. Dalfino, et al., 275–293. Naples: Bibliopolis.

Responds to criticism of Döring and Barnes and defends the claims that (i) the Dialectical and Megarian schools are not the same sect, and (ii) the Dialecticians are responsible for several advancements in propositional logic sometimes attributed to the Stoics.

Muller, Robert. 1988. *Introduction À La Pensée Des Mégariques*. Paris: Vrin.

General introduction to the philosophy of the so-called Megarics.

Sedley, David. 1977. Diodorus Cronus and Hellenistic philosophy. *Proceedings of the Cambridge Philological Society* 203, n.s. 23: 74–120.

Explores Diodorus' influence on the three Hellenistic schools (Stoics, Epicureans, Sceptics), based on the evidence collected in Döring 1972 (cited under Dialectical School).

Sedley, David. 2018. Diodorus Cronus. In *The Stanford Encyclopedia of Philosophy*. Edited by Edward N. Zalta. Stanford, CA: Stanford Univ.

Refers to Bobzien 2018 for Diodorus' contributions to propositional logic, and focuses on other themes in Diodorus' philosophy, in particular the Sorites paradox and the so-called "Veiled" paradox.

Stoics

The Stoics are regarded as developing the first propositional logic, or rather, a logic that works with an ancestor of propositions, so-called **lekta** (plural of **lekton**). The current near-consensus among scholars is to translate **lekton** as "sayable," which has a predecessor in Augustine's translation **dicibile**. Complete **lekta**, called **axiomata**, translated standardly as "assertibles," are either true or false. Chrysippus, third head of the Stoic school, is credited with the greatest innovations in Stoic logic. He wrote more than three hundred treatises in logic. The Stoics offer among other things accounts of definition, propositional negation ("it is not the case that p") and of sentential connectives, theories of logical consequence, the validity of arguments, and deduction, as well as extensive discussions in modal logic. Several lines of inquiry, including on bivalence, truth and time, truth-value changes, conditionals, as well as agency and causality, led the Stoics to be intensely interested in modalities (see entries under Modality and the Future). Chrysippus covered a number of themes repeatedly, including paradoxes, fallacies, and ambiguities. Stoic logic, including the discussion of paradoxes, has a normative dimension. The Stoics take it that logic is one of the three virtues, the others being physics and ethics. The study of logic helps us to become better assenters.

General Overviews

Bobzien 1986, Bobzien 1999, and Bobzien 2003 offer detailed and comprehensive analysis of key themes in Stoic logic. Ierodiakonou 2006 offers a succinct survey of key themes and situates logic within Stoic philosophy. Like Bobzien and Ierodiakonou, Brochard 1892, Łukasiewicz 1935, Mates 1953, Egli 1967, and Frede 1974 focus on early Stoic logic, in particular the innovations that are ascribed to Chrysippus. Each of these contributions played an important role in the rediscovery of Stoic logic and in the illumination of aspects of Stoic logic that are of interest to philosophers today. Barnes 1997 examines the evidence for interest in logic in the Imperial Stoa. Gourinat 2000

is especially broad, in particular with respect to including themes in the philosophy of language, definitions, and normative dimensions of Stoic logic.

Barnes, Jonathan. 1997. *Logic and the Imperial Stoa*. Leiden, The Netherlands: Brill.

Later Stoic thinkers are commonly thought to be less interested in logic than their predecessors. Barnes analyzes those dimensions of work in the Imperial Stoa that relate to questions in logic.

Bobzien, Susanne. 1986. *Die stoische Modallogik*. Würzburg, Germany: Königshausen & Neumann.

Part 1 of the book offers an overview of fundamental notions and ideas in Stoic logic, exploring particular disputed issues in more detail than Bobzien 1999. Part 2 is devoted to Stoic modal logic.

Bobzien, Susanne. 1999. Stoic logic. In *The Cambridge history of Hellenistic philosophy*. Edited by Keimpe Algra, Jonathan Barnes, Jaap Mansfeld, and Malcolm Schofield, 92–157. Cambridge, UK: Cambridge Univ. Press.

In-depth survey of key themes in Stoic logic, offers more detail than Bobzien 2003 as well as the section on the Stoics in Bobzien 2016, cited under General Overviews.

Bobzien, Susanne. 2003. Logic. In *The Cambridge companion to the Stoics*. Edited by B. Inwood, 85–123. Cambridge, UK: Cambridge Univ. Press.

Succinct survey of key themes in Stoic logic. See notes on Bobzien 1999 above.

Brochard, Victor. 1892. *Sur la logique des stoïciens*. *Archiv für Geschichte der Philosophie* 5:449–468.

Played an important role in the re-discovery of Stoic logic.

Egli, Urs. 1967. *Zur stoischen Dialektik*. Basel, Switzerland: Sandoz.

Comprehensive study of Stoic logic. Covers similar terrain as Frede 1974; in some ways superseded by Frede and Bobzien.

Frede, Michael. 1974. *Die stoische Logik*. Göttingen, Germany: Vandenhoeck & Ruprecht.

Seminal study of Stoic theory of simple and complex assertibles (axiomata), as well as Stoic syllogistic.

Gourinat, Jean-Baptiste. 2000. *La dialectique des stoïciens*. Paris: J. Vrin.

Comprehensive study of key themes in Stoic logic, as well as coverage of normative dimensions of Stoic logic, Stoic philosophy of language, and the Stoic approach to definitions.

Ierodiakonou, Katerina. 2006. Stoic logic. In *A companion to ancient philosophy*. Edited by Mary Louise Gill and Pierre Pellegrin, 505–529. Blackwell Companions to Philosophy 31. Oxford.

Succinct survey of Stoic logic, framed by an account of the centrality of logic in Stoic philosophy and of logic's role in the Stoic normative ideal of clear and correct thinking.

Long, Anthony A. 1971. *Problems in Stoicism*. London: Duckworth.

Contains three chapters on themes in (or related to) Stoic logic, specifically on the Stoic categories and their uses, Stoic views in grammar, and the relation of language and thought in Stoic philosophy.

Łukasiewicz, Jan. 1935. Zur Geschichte der Aussagenlogik. *Erkenntnis*. In *Selected Works*. Edited by L. Borkowski, 197–217. Amsterdam and London.

Played an important role in the re-discovery of Stoic logic. Previously published 1934 in Polish. Reprinted in English translation under the title “On the History of the Logic of Propositions.” In *Selected Works*. Edited by L. Borkowski. Amsterdam and London.

Mates, Benson. 1953. *Stoic logic*. Berkeley: Univ. of California Press.

Covers similar terrain as Frede 1974; in some ways superseded by Frede and Bobzien.

Sayables (*lekta*) and Assertibles (*axiomata*)

Since Bréhier 1997 (originally published 1908), the philosophical origin of the Stoic conception of *lekta* has been disputed. Gaskin 1997 and Alessandrelli 2013 examine how the Stoic conception of *lekta* relates to Stoic views on language. *Lekta* are what linguistic items such as words and sentences signify (*sêmainomenon*). According to Caston 1999, they are the intentional contents of thoughts. *Lekta* correspond to (or supervene on, *paruphistanenon*) human impressions, that is, to rational impressions or thoughts. Impressions (*phantasiai*) are corporeal movements in the soul. The Stoics conceive of the universe and all parts of it, including the human soul, as corporeal. Alongside time, void, and space, *lekta* are classified as so-called incorporeals. Frede 1980 and Frede 1994 examine how *lekta* relate to Stoic physics and in particular the Stoic conception of causality. Totschnig 2013 aims to revive Bréhier’s position, which focuses on the analysis of the Stoic theory of incorporeals. *Lekta* are either predicates and thereby incomplete (for example, “walk”) or they are assertibles (*axiomata*) and thereby complete (for example, “it is day”). The Stoics are greatly invested in arguing that each assertible has a truth value. Vogt 2012 examines epistemological upshots of the Stoic claim that each assertible is true or false, while impressions can also be both true and false or neither true nor false. Crivelli 2010 interprets Stoic definitions as a special kind of *lekta*, and examines why the Stoics consider definitions both a part of logic and of ethics.

Alessandrelli, Michele. 2013. *Il problema del λεκτόν nello stoicismo antico: origine e statuto di una nozione controversa. Lessico Intellettuale Europeo, 121*. Florence: Leo S. Olschki editore.

Defends the view that *lekta* are derivative on rational impressions and on linguistic items.

Bréhier, Émile. 1997. *La théorie des incorporels dans l’ancien stoïcisme*. Paris.

Argues that the Stoic theory of incorporeals is, quite generally, motivated by the theory of causality. Effects are *lekta* and thereby not part of the corporeal world. Originally published 1908.

Cameron, Margaret. 2015. On what is said: The Stoics and Peter Abelard. In *Linguistic content: New essay on the history of philosophy of language*. Edited by Margaret Cameron and Robert J. Stainton, 55–72. Oxford: Oxford Univ. Press.

Offers an up-to-date overview of the theory of *lekta*, and discusses that Abelard held similar views, seemingly without having had access to Stoic theory.

Caston, Victor. 1999. Something and nothing: The Stoics on concepts and universals. *Oxford Studies in Ancient Philosophy* 17:145–214.

Discusses the relation between the Stoic theories of concepts and preconceptions on the one hand, and of *lekta* on the other hand. Argues that *lekta* play an important role in the Stoics' rejection of Platonic metaphysics. In Chrysippus and in Stoics later than Chrysippus, Caston argues, *lekta* help resolve problems relating to concepts that originate in Plato's theory of the forms.

Crivelli, Paolo. 2010. The Stoics on definitions. In *Definitions in Greek philosophy*. Edited by David Charles, 359–423. Oxford: Oxford Univ. Press.

Offers analysis of a wide range of sources on Stoic views on definition, including Chrysippus' view that the study of definitions is a part of logic. Argues that definitions are a special kind of *lekta*, and examines the role of definitions in sharpening our conceptions, so that they are more successfully applied to things.

Frede, Michael. 1980. The original notion of cause. In *Doubt and dogmatism*. Edited by Malcolm Schofield, Jonathan Barnes, and Myles Burnyeat, 125–150. Cambridge, UK: Cambridge Univ. Press.

On Stoic notion of causality including discussion of *lekta* as incorporeal effects. Reprinted in Michael Frede, *Essays in Ancient Philosophy* (Minnesota: Minnesota Univ. Press, 1996). Pp. 125–150.

Frede, Michael. 1994. The Stoic notion of a *lekton*. In *Companions to ancient thought 3: Language*. Edited by S. Everson, 109–128. Cambridge, UK: Cambridge Univ. Press.

General introduction on the role of *lekta* in Stoic philosophy of language, Stoic ontology, and physics, in particular the theory of causality.

Gaskin, Richard. 1997. The Stoics on cases, predicates and the unity of the proposition. In *Aristotle and after*. Edited by R. Sorabji, 91–108. London: Institute of Classical Studies.

Classifies *lekta* as “quasi-linguistic,” because they are neither identified with the relevant words nor with physical objects in the world. Examines the main components of a complete *lekton*, cases and predicates.

Totschnig, Wolfhart. 2013. Bodies and their effects: The Stoics on causation and incorporeals. *Archiv für Geschichte der Philosophie* 95:119–147.

Defends the view that Stoic incorporeals are to be understood as effects of the causality of bodies, explores how *lekta* fit into the category of incorporeals, and revives a claim by Bréhier, namely that the theory of causality motivates core features of the theory of *lekta*.

Vogt, Katja Maria. 2012. Why beliefs are never true: A reconstruction of Stoic epistemology. In *Belief and truth: A skeptic reading of Plato*. By Katja Maria Vogt, 158–183. New York: Oxford Univ. Press.

Argues that assertibles are the primary bearers of truth values, that impressions are derivatively truth-apt, and that assents to impressions (beliefs, cognitions, pieces of knowledge) are not characterized as true or false.

Arguments

Brunschwig 2006, Goulet 2006, and Bobzien 2011 examine the distinction between complete *lekta* that are simple, i.e., consisting just of one *axioma*, and those that are non-simple, i.e., they consist of more than one assertible (or one assertible taken more than once, DL 7.68–

9) and they contain a connective particle. Brunschwig 2006 and Goulet 2006 focus specifically on the reconstruction of DL 7.68–9. Bobzien 2011 examines an ancient debate about Chrysippus' claim that the number of conjunctions constructible from ten propositions exceeds one million. Arguments and syllogisms are compounds of assertibles. The Stoics offer accounts of the validity of arguments, including one account according to which an argument is valid and a syllogism if it is possible to reduce it to five indemonstrable argument forms via the so-called *themata*, four inference rules (DL 7.78). Ierodiakonou 1993 examines the five so-called indemonstrables, especially with a view to a longer list of indemonstrables offered in the later Latin tradition. Gould 1974 and Mueller 1979 are early, but still relevant, studies of Stoic deduction and propositional logic. Bobzien 1996 offers a by now classic account of the Stoic notion of a syllogism, while Milne 1995 gives reconstructions of a number of the most prominent interpretations in the literature. Brunschwig 1980 analyzes Stoic definitions of proof, while Barnes 1980 discusses Stoic theory of proof with a view to challenges raised by the skeptics. Bobzien 1997 reconstructs Stoic hypothetical arguments.

Barnes, Jonathan. 1980. Proof destroyed. In *Doubt and dogmatism. Studies in Hellenistic epistemology*. Edited by M. Schofield, M. Burnyeat, and J. Barnes, 161–181. Oxford: The Clarendon Press.

On Hellenistic disputes of the Stoic theory of proof, including skeptical challenges.

Bobzien, Susanne. 1996. Stoic syllogistic. *Oxford Studies in Ancient Philosophy* 14:133–192.

Seminal account of what, for the Stoics, a syllogism is.

Bobzien, Susanne. 1997. The Stoics on hypotheses and hypothetical arguments. *Phronesis* 42.3: 299–312.

Argues that the hypothetical arguments about which Chrysippus wrote several books are to be understood in the context of a dialectical setting. In these arguments, one or more premises are replaced by suppositions, which have no truth value.

Bobzien, Susanne. 2011. The combinatorics of Stoic conjunction. *Oxford Studies in Ancient Philosophy* 40:157–188.

Examines Chrysippus' claim that the number of conjunctions constructible from ten propositions exceeds one million, as well as a claim by Hipparchus which rejects this. Bobzien reconstructs Chrysippus' calculations, finds them correct, and relates the dispute to 3rd century BCE combinatorics.

Brunschwig, Jacques. 1980. Proof defined. In *Doubt and dogmatism*. Edited by Jonathan Barnes, Myles Burnyeat, and Malcolm Schofield, 125–160. Oxford: Oxford Univ. Press.

Analyzes two passages of Sextus on proof which provide a sense of proof in terms of the argument being progressive and revelatory in the right way. Finds four different definitions of proof in the text based on differences in recapitulations, maps out how they can be found in the two passages, and provides a speculative chronological story.

Brunschwig, Jacques, ed. 2006. *Bibliothèque d'Histoire de la philosophie*. Paris: Vrin.

Explores a disputed report on simple and complex *axiomata* in Diogenes Laertius (7.69–70) in the light of passages in Sextus Empiricus and Alexander of Aphrodisias. See pp. 193–221.

Gould, Josiah. 1974. Deduction in Stoic logic. In *Ancient logic and its modern interpretations: Proceedings of the Buffalo Symposium on Modernist Interpretations of Ancient Logic, 21 and 22 April, 1972*. Edited by John Corcoran, 151–168. Dordrecht, The Netherlands: Kluwer.

Overview of Stoic deduction that provides a taxonomy of arguments. Suggests that Sextus Empiricus' charge that the Stoic test for the validity of arguments is undermined by disagreement over conditionals misses the point that Stoics rarely used the test and instead relied

on a calculus of propositions.

Goulet, Richard. 2006. La classification stoïcienne des propositions simples selon Diogène Laërce VII 69–70. In *Les Stoïciens et leur logique* (Actes du colloque de Chantilly, 1976). Edited by Jacques Brunschwig, 171–198. Paris: Librairie philosophique J. Vrin.

On the classification of simple propositions in Diogenes Laertius 7.69–70. Cf. Brunschwig 2006 above. Second and updated version in *Les stoïciens et leur logique*.

Ierodiakonou, Katerina. 1993. The Stoic indemonstrables in the later tradition. In *Dialektiker und Stoiker. Zur Logik der Stoa und ihrer Vorläufer*. Edited by Klaus Döring and Theodor Ebert, 187–200. Stuttgart: Steiner.

On five types of argument that are called indemonstrables, and on the question of whether two additional indemonstrables that are mentioned in later authors belong to the Stoic tradition.

Milne, Peter. 1995. On the completeness of non-Philonian Stoic logic. *History and Philosophy of Logic* 16:39–64.

Gives formalizations of a number of possible systems of Stoic logic and argues that they are all incomplete given the Stoic semantics for disjunction and the conditional. Also shows that it is very likely that the Stoics did not accept a rule of conditional proof.

Mueller, Ian. 1979. The completeness of Stoic propositional logic. *Notre Dame Journal of Formal Logic* 20:201–215.

Discusses Becker's and the Kneales' reconstructions of Stoic propositional logic, finds them historically not compelling, and argues for a modified reconstruction that comes with stronger completeness.

Ambiguity and Paradoxes

The study of ambiguity, which is examined in Atherton 1993 and more recently Bobzien 2006, is a core theme in Stoic logic. Similarly, the Stoics are greatly interested in fallacies and presuppositions. Cavini 1993 and Mignucci 2002 reconstruct the Stoic take on the Paradox of the Liar. Bobzien 2012 examines Stoic ancestors of what are today called Paradoxes of Presupposition. We also have evidence for extensive Stoic discussions of vagueness, which Barnes 1982 analyzes in the broader context of Stoic epistemological views and which Sedley 1984 discusses with respect to a range of Stoic usages of negated conjunctions. Williamson 1994 considers the Stoics as proponents of the view he holds on vagueness, namely epistemicism. Bobzien 2002 rejects this characterization by drawing attention to the difference between impressions and *lekta*, as the Stoics conceive of it.

Atherton, Catherine. 1993. *Stoics on ambiguity*. Cambridge, UK: Cambridge Univ. Press.

On Chrysippus' (and more generally the Stoics') interest in ambiguity, which, like fallacies and related themes, concern the Stoics with respect to how the wise person assents to impressions.

Barnes, Jonathan. 1982. Medicine, experience and logic. In *Science and speculation*. Edited by J. Barnes, Jacques Brunschwig, Myles Burnyeat, and Malcolm Schofield, 24–65. Cambridge, UK: Cambridge Univ. Press.

Includes discussion of the Stoic position on vagueness.

Bobzien, Susanne. 2002. Chrysippus and the epistemic theory of vagueness. *Proceedings of the Aristotelian Society* 102.1: 217–238.

Argues against an epistemicist reconstruction of Chrysippus' theory of vagueness. For Chrysippus, some cases in a Sorites series do not have truth-values.

Bobzien, Susanne. 2006. The Stoics on fallacies of equivocation. In *Language and learning, Proceedings of the 9th Symposium Hellenisticum*. Edited by D. Frede, and B. Inwood, 239–265. Cambridge, UK: Cambridge Univ. Press.

On the Stoic view that listeners do not need to disambiguate what is said, because any given utterance has only one meaning. Offers two readings of the Stoic norm that one should “be silent” when confronted with a fallacy of ambiguity in dialectical discourse.

Bobzien, Susanne. 2012. How to give someone horns. Paradoxes of presupposition in Antiquity. *Logical Analysis and History of Philosophy* 15:159–184.

Discusses ancient analogues of what today are called Paradoxes of Presupposition and reconstructs a Stoic solution.

Cavini, Walter. 1993. Chrysippus on speaking truly and the liar. In *Dialektiker und Stoiker*. Edited by K. Döring and Th. Ebert, 85–109. Stuttgart: Franz Steiner.

Discusses the probably oldest formulation of the Liar paradox, which is found in Cicero's *Academica*, and argues that the liar simply says “*mentior*.”

Mignucci, Mario. 2002. The liar paradox and the Stoics. In *Topics in Stoic philosophy*. Edited by Katerina Ierodiakonou, 54–70. Oxford: Clarendon Press.

Aims to reconstruct Chrysippus' formulation of the Liar paradox and to refute the view that ancient formulations of the paradox fail to be truly paradoxical.

Sedley, David. 1984. The negated conjunction in Stoicism. *Elenchos* 5:311–316.

Explores the role of negated conjunctions in Stoic logic, for example, in arguments from similarity and with respect to sorites arguments, where the evidence suggests that the Stoics avoid conditionals (“If 2 is few, 3 is few”) and prefer negated conjunctions (“It is not the case that while 2 is few 3 is not”).

Williamson, Timothy. 1994. *Vagueness*. London: Routledge.

Argues that Stoics are epistemicists about vagueness.

Later Antiquity

Philosophers in Late Antiquity engaged with Aristotle's syllogistic and to a lesser extent with Stoic logic. This is the area in the history of ancient logic for which there are the most gaps, primarily due to the extremely lengthy commentaries that must be analyzed. So far, we know that in the early Peripatos there were important modifications and extensions to Aristotle's logic already with Theophrastus, whose work particularly on modality and hypothetical syllogistic broke new ground. Later Peripatetics such as Alexander of Aphrodisias continued in this tradition, but also argued against theses of Stoic logic, particularly the centrality of their indemonstrable syllogisms and their conception of logic as a part and not merely an instrument of philosophy. Galen, the great doctor cum philosopher of the Roman Empire,

was in some respects the most original logical thinker of this period, who argued for the insufficiency of both Peripatetic and Stoic logic for scientific demonstration. The Platonist tradition, broadly construed, was the conduit through which ancient logic reached the Byzantine, Latin, and Arabic traditions. Drawing mostly on the texts of Aristotle, but also later Peripatetic sources, mathematical practice, and of course Plato, Platonists tend to assign logic an important but subordinate role in philosophy.

Early Peripatos

Huby 2007 discusses all of the preserved fragments of Theophrastus on logic. Bochenski 1947 provides the only comprehensive account of his logic to date. Bobzien 2000, Bobzien 2002a, and Bobzien 2002b give an account of the development of hypothetical reasoning in Theophrastus and Eudemus.

Bobzien, Susanne. 2000. Wholly hypothetical syllogisms. *Phronesis* 45:87–137.

Argues that the early Peripatetic conception of wholly hypothetical syllogisms was firmly based in term logic and was eventually influenced by Stoic propositional logic in later Antiquity.

Bobzien, Susanne. 2002a. The development of modus ponens in antiquity: From Aristotle to the 2nd century AD. *Phronesis* 47.4: 359–394.

Traces the development of the four traditional “hypothetical syllogisms” such as modus ponens and modus tollens familiar in late antique logic texts from Aristotle and the early Peripatos through Galen. Argues that, although there was some Stoic influence in the later texts, the fundamental classification between hypothetical and categorical syllogisms does not derive from the Stoics.

Bobzien, Susanne. 2002b. Pre-Stoic hypothetical syllogisms in Galen. *The Bulletin of the Institute of Classical Studies Suppl.* 77:57–72.

Argues that Galen’s *Institutio Logica* contain evidence for a hypothetical syllogistic that predates Stoic logic, and that may go back to Theophrastus and Eudemus.

Bochenski, I. M. 1947. *La Logique de Théophraste*. Fribourg, Switzerland: Librairie de l’Université.

The only monograph on Theophrastus’ logic, with a discussion of the sources for his logical theories and comprehensive treatment of his theory of assertoric syllogisms, modality, and hypothetical syllogisms, using tools from then-contemporary logic. Reprint 1987.

Huby, Pamela. 2007. *Theophrastus of Eresus: Sources for his life, writings, thought, and influence. Commentary Vol. 2. Logic*. Leiden, The Netherlands: Brill.

Commentary on the preserved fragments of Theophrastus’ logical works.

Later Peripatos

Lee 1984 is the only comprehensive account of later Peripatetic logic. Flannery 1995 and Gili 2011 are useful sources on the logic of Alexander of Aphrodisias, the first major Peripatetic whose works are preserved. Mueller 1969, Frede 1974, and Bobzien 2014 discuss Peripatetic engagement with Stoic logic.

Bobzien, Susanne. 2014. Alexander of Aphrodisias on Aristotle's theory of the Stoic indemonstrables. In *Strategies of argument: Essays in ancient ethics, epistemology, and logic*. Edited by Mi-Kyoung Lee, 199–228. New York: Oxford Univ. Press.

Treats Alexander not as a source for Aristotelian and Stoic logic, but looks at his role in the transmission and development of ancient logic.

Flannery, Kevin L. 1995. *Ways into the logic of Alexander of Aphrodisias*. Leiden, The Netherlands: E. J. Brill.

Detailed discussions of Alexander's treatment of ekthesis, modal logic, and the notion that the premises are, somehow, the "matter" of a syllogism.

Gili, L. 2011. *La sillogistica di Alessandro di Afrodisia*. Hildesheim, Germany: Olms.

An up-to-date discussion of a variety of topics treated in Alexander's commentary on Aristotle's *Prior Analytics*: the nature of logic as an instrument, the definitions of proposition and syllogism, conversion and the assertoric and modal syllogistic.

Mueller, Ian. 1969. Stoic and Peripatetic logic. *Archiv für Geschichte der Philosophie* 51:173–187.

Reconstructs the debate between Stoic and Peripatetic logic up to Galen and Alexander of Aphrodisias as a debate about whether (Stoic) propositional logic or (Peripatetic) categorical term logic is *prior*. Each side held the other to be discussing real syllogisms (valid deductive arguments), but Aristotelians wanted to represent Stoic syllogisms as categorical, while the Stoics wanted to represent Aristotelian syllogisms as hypothetical.

Frede, Michael. 1974. Stoic vs. Peripatetic syllogistic. *Archiv für Geschichte der Philosophie* 56.1: 1–32.

Argues against the Kneales and Mueller that the debate between the Stoics and Peripatetics was not one of priority, but that, in fact, each school rejected the argument forms of the other as *non-syllogistic*.

Lee, T. S. 1984. *Die griechische Tradition der aristotelischen Syllogistik in der Spätantike*. Hypomnemata 79. Göttingen, Germany: Vandenhoeck & Ruprecht.

A study of the commentaries on the *Prior Analytics* by Alexander of Aphrodisias, Ammonius, and Philoponus dealing in particular with the question of logic as a tool or part of philosophy, the nature of premises of syllogisms, conversion, and the definition of the syllogism.

Galen

For a general overview of Galen's logic, see Morison 2008. For specific logical doctrines, see Barnes 1993 on relational syllogisms and Bobzien 2004 on hypothetical syllogisms. For Galen's conception of the use of logic, see Lloyd 2001.

Barnes, Jonathan. 1993. A third sort of syllogism: Galen and the logic of relations. In *Modern thinkers and ancient thinkers*. Edited by R. W. Sharples, 172–194. Boulder, CO: Westview Press.

Discusses Galen's introduction of a variety of arguments using two-place relational predicates and his argument that they cannot be reduced to either Peripatetic or Stoic syllogisms.

Bobzien, Susanne. 2004. Hypothetical syllogistic in Galen—Propositional logic off the rails? *Rhizai: Journal for Ancient Philosophy and Science* 2:57–102.

Argues against the consensus that Galen's propositional logic was Stoic in origin. Instead, it was developed in the Peripatos and bears distinct resemblances to contemporary logical thought.

Lloyd, G. E. R. 2001. Theories and practices of Demonstration in Galen. In *Rationality in Greek thought*. Edited by M. Frede and G. Striker, 255–278. Oxford: Oxford Univ. Press.

Survey of Galen's views about the role of logic in medicine and scientific practice more generally, arguing that his insistence on a quasi-geometrical ideal of axiomatized science at times leads him astray.

Morison, Benjamin. 2008. Galen's logic. In *Cambridge companion to Galen*. Edited by R. J. Hankinson, 116–156. Cambridge, UK: Cambridge Univ. Press.

Survey of our knowledge of Galen's views of syllogistic.

Platonic Tradition

Even though Platonism was the lens through which logic was transmitted to the Byzantine, Arabic, and medieval Latin traditions, there are no general accounts of late antique Platonist logic. Schiaparelli 2009 discusses Plotinus' comparison of Aristotelian logic and Platonic dialectic. Martin 2001 and Martin 2004 give technical accounts of Neoplatonist syllogistic. Lloyd 1955a and Lloyd 1955b discuss the logic of Aristotle's categories in the Neoplatonic tradition. Martin 1991 discusses Boethius' use of Aristotle. Bobzien 2002, on the basis of an anonymous scholium on Aristotle's *Analytics*, identifies a Peripatetic, but non-Aristotelian, source for Boethius' treatise on hypothetical syllogisms. Martijn 2015 discusses the role of mathematical practice in Proclus. Ebbesen 1990 gives an account of Porphyry's importance to the later tradition.

Bobzien, Susanne. 2002. A Greek parallel to Boethius' de Hypotheticis Syllogismis. *Mnemosyne* 55.3: 285–300.

Text, translation, and commentary of a long anonymous scholium to Aristotle's *Analytics*. Argues that it is a Greek parallel to Boethius' *De Hypotheticis Syllogismis*.

Ebbesen, Sten. 1990. Porphyry's legacy to logic. In *Aristotle transformed—The ancient commentators and their influence*. Edited by Richard Sorabji, 141–171. London: Duckworth.

Argues that Porphyry, in some respects like later logicians such as William of Ockham and John Buridan, considers logic to be a guide not to the structure of the world as it is "in itself." Rather, humans conceptualize the world, which is useful for many purposes.

Lloyd, A. C. 1955a. Neoplatonic logic and Aristotelian logic I. *Phronesis* 1.1: 58–72.

Argues that early Neoplatonists, such as Porphyry, strove to strip Aristotelian categories of their metaphysical baggage and transform it into a "logical" doctrine. Traces the development of this philosophical move from the Platonists before Plotinus, who accepted Aristotelian inherent forms, to Plotinus, who critiqued it.

Lloyd, A. C. 1955b. Neoplatonic logic and Aristotelian logic II. *Phronesis* 1.2: 146–159.

Continues the argument of the previous paper, beginning with Plotinus' view of genera and species in *Ennead* VI.2. Plotinus' view allows him to save the formal aspect of Aristotelian logic. After detailing Porphyry's view of universals, further developments in the Neoplatonic approach to universals are surveyed, along with their connection to the medieval debate about the problem of universals.

Martijn, Marije. 2015. Proclus' geometrical method. In *A companion to Neoplatonism*. Edited by Svetla Slaveva-Griffin, and Pauliina Remes, 145–162. Abingdon, UK: Routledge.

Gives an account of how Proclus understood geometrical method, arguing that it is a didactic method which orders the materials to be taught in the proper ontological order, which includes both analytic movement to first principles and synthetic movement to theorems. Assesses the extent to which this method is followed in Proclus' own treatises.

Martin, Christopher. 1991. The logic of negation in Boethius. *Phronesis* 36:277–304.

Argues that in Boethius' logical treatises, he makes no use of what would now be thought of as "propositional connectives" and thus has no "propositional logic" in the strict sense.

Martin, John N. 2001. Proclus and the Neoplatonic syllogistic. *Journal of Philosophical Logic* 30:187–240.

Reconstructs a syllogistic system from various texts of Proclus. Provides a soundness and completeness theorem with an order-theoretic semantics and natural deduction proof system.

Martin, John N. 2004. *Themes in Neoplatonic and Aristotelian logic: Order, negotiation, and abstraction*. Farnham, UK: Routledge.

A collection of essays mostly concerning technical developments in Neoplatonic logic (Proclus, Ammonius, and Boethius) concerning the notion of order, applying contemporary logical methods in order to argue that the Platonic tradition had a more rational and less mystical basis than is normally thought.

Schiaparelli, Annamaria. 2009. Plotinus on dialectic. *Archiv für Geschichte der Philosophie* 91.3: 253–287.

In depth analysis of Plotinus' *Ennead* I.3 on dialectic. Argues that for Plotinus dialectic is to be identified with the method of division and has as its object real intelligible beings, as opposed to Peripatetic/Stoic logic, which deal with verbal expressions.

Contradiction/Negation

Understanding both how negated sentences could be true and what principles governed the behavior of negation were key topics of focus among many ancient authors (see Horn and Wansing 2017 for a general overview). Areas of interest include puzzles concerning how negated statements could be true when they seem to say something about what-is-not, why non-contradiction must be accepted, and arguments that seem to refute themselves in virtue of concluding the negation of one of its own premises. Here we include adjacent discussions of oppositeness or contrariness, like Plato's principle of opposites, which while not directly touching on negation are clearly closely related (Duncombe 2015). Brown 2008, Crivelli 2012, and Frede 1992 examine Plato's view of negation in the *Sophist*. Łukasiewicz 1910, Code 1986, and Wedin 1990 focus on Aristotle's view, while Barnes 1968 and Cavini 1985 look at views in later commentaries on Aristotle. Castagnoli 2010 provides a general look at self-refutation arguments, which appear, for example, in Aristotle's discussion of non-contradiction.

Barnes, Jonathan. 1968. Peripatetic negation. *Oxford Studies in Ancient Philosophy* 4:201–215.

Examination of Alexander of Aphrodisias' essay on negation in his commentary on the *Prior Analytics*, which defends the Aristotelian view that negation applies to predicates and not propositions. Discusses the challenge against the Peripatetic view that in some cases contradictory opposites will both be false when the subject does not exist, and Alexander's response that involves an analysis of when propositions have existential import that locates the force in the predicate.

Brown, Lesley. 2008. The Sophist on statements, predication, and falsehood. In *The Oxford handbook of Plato*. Edited by Gail Fine, 437–462. Oxford: Oxford Univ. Press.

An overview of the secondary literature covering solutions to the late-learner's problem and the problem of false statements. Suggests that the solutions depend not on a distinction between senses of "is" but on a distinction between types of sentences and a background notion of incompatible properties underlying false statements.

Castagnoli, Luca. 2010. *Ancient self-refutation: The logic and history of the self-refutation argument from Democritus to Augustine*. Cambridge, UK: Cambridge Univ. Press.

A broad survey of self-refutation arguments in antiquity, considered as arguments that attempt to show that some thesis forces one to accept its opposite or contradictory. Groups the arguments together under: (i) those concerning theses about truth or falsehood, (ii) those that lead to pragmatic self-refutations, and (iii) those that appear in discussions of the skeptics.

Cavini, Walter. 1985. La Negazione di Frase Nella Logica Greca. In *Studi su papyri greci di logica e medicina*. Edited by Walter Cavini, M. C. Donnini Macchio, M. S. Funghi, and D. Manetti, 7–126. Florence: Olschki.

Reconstructs and compares two main theories of propositional negation in ancient logic: Aristotle's internal negation and the Stoic external negation. The appendix contains a critical edition of an early testimony of external negation, the Paris Papyrus 2, with translation and commentary.

Code, Alan. 1986. Aristotle's investigation of a basic logical principle: Which science investigates the principle of non-contradiction?. *Canadian Journal of Philosophy* 16:341–358.

A response to Irwin that suggests the elenctic demonstration of non-contradiction in *Metaphysics Gamma* 4 is not meant to provide a reason for the truth of the Principle of Non-Contradiction (PNC) or to lead the audience to knowledge of the principle. Rather, Code suggests the discussion assumes the principle is already known by the intended audience and the demonstration is intended to give a reason why anyone engaged in significant discourse must accept it.

Crivelli, Paolo. 2012. *Plato's account of falsehood: A study of the Sophist*. Cambridge, UK: Cambridge Univ. Press.

A resolution to the problem of false statements that relies on a distinction for "is" where it has both an incomplete and complete use. Combines aspects of Frede 1992 (incomplete use) and Brown 2008 (complete use).

Duncombe, Matthew. 2015. The role of relatives in Plato's partition argument Republic 4, 436b9–439c9. *Oxford Studies in Ancient Philosophy* 158:37–60.

Includes discussion of the Principle of Opposites in Plato's *Republic* IV, 436b8–c1. This principle is sometimes misleadingly cited as the first formulation of the Principle of Non-Contradiction.

Frede, Michael. 1992. Plato's Sophist on false statements. In *The Cambridge companion to Plato*. Edited by Richard Kraut, 397–424. Cambridge, UK: Cambridge Univ. Press.

Critical exposition of Plato's *Sophist*, focusing on how to interpret the senses of being and not being that play a role in uses of "not" and "is" in statements. Suggests that Plato's view disambiguates "is" by distinguishing between a sense that an object "is" in virtue of itself and a sense that it "is" in virtue of standing in a relation to something else.

Łukasiewicz, Jan. 1910. *O Zasadzie Sprzeczności u Arystotelesa. Studium Krytyczne*. Krakow, Poland: Polska Akademia Umiejętności.

(On the principle of contradiction in Aristotle. A critical study.) An analysis of Aristotle's arguments for non-contradiction in *Metaphysics Gamma*, suggesting that not only do Aristotle's arguments fail but that no direct argument can be given for non-contradiction. Suggests one accept it anyway for normative reasons, since without it all arguments would in some sense be undermined. English translation: M. Wedin, trans., "On the Principle of Contradiction in Aristotle." *Review of Metaphysics* 24 (1971):485–509.

Horn, Laurence R., and Heinrich Wansing. Negation. 2017. In *The Stanford Encyclopedia of Philosophy*. Edited by Edward N. Zalta. Stanford, CA: Stanford Univ.

Though this article is not primarily about negation in ancient philosophy, it covers the comparison between Aristotle's and the Stoics' account, as well as the relation between negation and contrariety and contradiction.

Wedin, Michael V. 1990. Negation and quantification in Aristotle. *History and Philosophy of Logic* 11.2: 131–150.

Argues against Martha Kneale and defends the view that Aristotle does not take negative categoricals to have existential import with respect to the square of opposition. Wedin then points out that there is only scarce evidence that Aristotle took negative categoricals to have existential import in syllogistic, despite the common view that they do, and that evidence seems to only apply in the special case of *ecthesis* in proof.

Modality and the Future

Claims about the future are closely connected to claims of possibility and necessity. When one says that tomorrow there will be snow or that tomorrow there will be a sea-battle, one makes a prediction. The former kind of prediction can be based on experience and observation. In some cases, the latter kind of prediction can be considered knowledge-based, namely by philosophers such as the Stoics who view divination as a science. Either way, a prediction is not simply a guess. But presumably it is not necessary that it will snow or that there will be a sea-battle and each prediction seems to be about a contingent state of affairs. If something goes differently than expected, there will be no snow or no sea-battle. In that sense, one deals with possibilities. That is, in making predictions, one presumably presupposes that it is possible that tomorrow it is true that it snows or that there is a sea-battle. This connection between modal concepts and tensed claims is of great interest to the ancient world. A number of positions and debates are controversial among interpreters: Aristotle's work related to the contingency of future events and whether future contingent claims must fail to have truth-values; the so-called Master Argument of Diodorus Cronus and the question of whether the impossible might follow from the possible (see section on the Dialectical School); the Stoic attempt to combine bivalence of *axiomata*, including future contingents, with contingency and with the rejection of the critique that their physics commits them to the necessity of all actions and movements in the universe.

Aristotle

Aristotle's views of modality are closely connected to his work on truth, propositional analysis, and negation. His famous case of the future sea battle and its precise interpretation are matters of debate in the secondary literature, and possible views can be found in Frede 1970, Frede 1985, Whitaker 1996, and Crivelli 2004. Mignucci 1996 looks at the related view of Ammonius independent of his role as an interpreter of Aristotle.

Crivelli, Paolo. 2004. *Aristotle on truth*. Cambridge, UK: Cambridge Univ. Press.

Comprehensive treatment of the bearers of truth, assertion, negation, as well as future contingents in Aristotle.

Frede, Dorothea. 1970. *Aristoteles und die "Seeschlacht". Das Problem der Contingentia Futura in De Interpretatione. Hypomnemata 27. Göttingen, Germany: Vandenhoeck & Ruprecht.*

An analysis of *De Interpretatione* 9 that connects it to the so-called Master Argument of Diodorus Cronus and Cicero's *De Fato*, as well as covers late antique and medieval views about Aristotle's position in *De Interpretatione*.

Frede, Dorothea. 1985. *The sea-battle reconsidered. A defence of the traditional interpretation. Oxford Studies in Ancient Philosophy 3:31–87.*

An analysis of *De Interpretatione* 9 that defends what Frede calls the classical interpretation of Boethius and Ammonius that restricts the validity of the principle of bivalence in the case of future contingents. Discusses in detail many alternate interpretations while working through the text.

Mignucci, Mario. 1996. *Ammonius on future contingent propositions. In Rationality in Greek thought. Edited by Michael Frede and Gisela Striker, 279–310. New York: Clarendon Press.*

Offers an interpretation of Ammonius' view under which the distinction between definite and indefinite truth of propositions is modeled by a tree where nodes are branching states of the world at a time. Indefinitely true propositions are not yet settled in the sense that later branches are split on the truth of the proposition but in the "real history" (the path representing the actual future) the proposition is true.

Whitaker, C. W. A. 1996. *Aristotle's De Interpretatione: Contradiction and Dialectic. Oxford: Clarendon Press.*

Offers a detailed analysis of the whole of *De Interpretatione*, suggesting that the text provides an explication of contradictory pairs, rather than the notion of proposition as traditionally supposed, and argues that it lays the foundations for the *Topics*, rather than the *Analytics*.

Diodorus' Master Argument

The Master Argument of Diodorus Cronus (see Seel 2018 and Kneale and Kneale 1962 for overviews) addresses many of the same issues regarding modality and determinism found in Aristotle's work in *De Interpretatione* 9, and so many pieces touch on both. We include such pieces, like Frede 1970 (cited under Aristotle) and Gaskin 1995. Denyer 1998, Weidemann 1993, and Weidemann 2008 discuss various texts that inform Diodorus interpretation. Prior 1955, Prior 1958, and Prior 1967 provide a series of attempts to connect the views of Diodorus to modern modal logic, a strategy suggested to be ineffective in Denyer 2009. The literatures on the Master Argument and on Stoic modal logic are closely intertwined. See also the next section on the Stoics.

Denyer, Nicholas. 1998. *Philoponus, Diodorus, and Possibility. The Classical Quarterly 48.1: 327.*

A short note on a report by Philoponus of Diodorus' definition of possibility.

Denyer, Nicholas. 2009. *Diodorus Cronus: Modality, the Master Argument and formalisation. Humana Mente 3.8: 33–46.*

Argues that a variety of modern attempts to formalize the ideas of Diodorus are not adequate for the purpose.

Gaskin, Richard. 1995. *The sea-battle and the master argument: Aristotle and Diodorus Cronus on the metaphysics of the future. Berlin: W. de Gruyter.*

Discusses a wide range of interpretations of Aristotle's *De Interpretatione* 9, Diodorus' Master Argument, and Stoic responses. An appendix on Arabic and medieval interpretation of *De Interpretatione* 9.

Kneale, Martha, and William Kneale. 1962. *The development of logic*. Oxford: Clarendon Press.

On the Master Argument and its role in the history and development of logic. See pp. 117–128.

Prior, Arthur N. 1955. Diodorean modalities. *The Philosophical Quarterly* 5:205–213.

Sketch of a modal system based on Diodorus' definition of the possible as "what is or will be true." Argues that this system contains all the laws of the Lewis system S4.

Prior, Arthur N. 1958. Diodorus and modal logic: A correction. *The Philosophical Quarterly* 8:226–230.

Correction of Prior 1955 as well as of Prior's discussions of this issue in his *Time and Modality* (1955).

Prior, Arthur N. 1967. *Past, present, and future*. Oxford: Clarendon Press.

Chapter 2 provides a survey of work attempting to precisely axiomatize "Diodorian" modal logic using contemporary resources. Chapter 3 uses the Master Argument to investigate the topological structures of time more generally.

Seel, G. 2018. The puzzles of the master argument and their solutions. *Philosophical Inquiry, International Quarterly* 41.2–3: 81–93.

Analysis of three problems associated with the Master Argument: (i) What does it refer to? (ii) How do we classify it? (iii) Does a reconstruction of it require us to provide a missing premise? Suggests that one cannot reconstruct a logically sound representation of the argument that respects the historical evidence and does not add additional principles.

Weidemann, Hermann. 1993. Zeit und Wahrheit bei Diodor. In *Dialektiker und Stoiker*. Edited by K. Döring and Th. Ebert, 319–329. Stuttgart: Franz Steiner.

Analysis of Cicero's account of Diodorus' views in *De fato*, including the observation that Cicero does not present a rationale for Diodorus' views and may not have understood their implications.

Weidemann, Hermann. 2008. Aristotle, the megarics, and Diodorus Cronus on the notion of possibility. *American Philosophical Quarterly* 45.2: 131–148.

Close examination of Aristotle's *Metaphysics* IX.4–5, which contains a report of the Megaric definition of possibility. Analysis of how the discussion of the Megaric view as well as an extreme anti-Megaric position matters for Aristotle's own account of what it is for something to have a certain possibility.

Stoic Modal Logic

The Stoics defend a theory in physics according to which there are "world cycles." At some point, the world perishes in conflagration and the world's history begins again. In each cycle, the world's history is identical to its history in previous cycles. Add to this the Stoics' commitment to divination as well as their strong endorsement of the principle of bivalence: all assertibles (*axiomata*), including ones about future actions and movements, are either true or false. In sum, the Stoics may seem compelled to the view that all actions and movements are necessary. However, this is not the position they take. Bobzien 1986, Bobzien 1998, and De Harven 2016 provide general discussions. Bobzien 1993, De Vincentis 2018, Donini 1973, Gould 1967, Ide 1992, and Papazian 2001 all offer interpretations of various aspects of the modal views of Chrysippus.

Bobzien, Susanne. 1986. *Die stoische Modallogik*. Würzburg, Germany: Königshausen & Neumann.

Also cited under Stoics: General Overviews. Part 2 is devoted to Stoic modal logic, including discussion of the relation between the Stoic modal notions and those of Diodorus Cronus and Philo of Megara.

Bobzien, Susanne. 1993. Chrysippus' modal logic and its relation to Philo and Diodorus, In *Dialektiker und Stoiker*. Edited by K. Döring and Th. Ebert, 63–84. Stuttgart: Franz Steiner.

Argues that Chrysippus combines Philo's and Diodorus' modal notions in such a way that he obtains a modal system that suits his Stoic philosophy and reflects on the metaphysical ambition of Hellenistic modal logic, namely to adequately describe what is necessary and what is possible in the world as it is.

Bobzien, Suzanne. 1998. Modality, determinism, and freedom. In *Determinism and freedom in Stoic philosophy*. Oxford: Oxford Univ. Press.

Analyzes the connection between the Stoic doctrine of determinism and views of modality. Lays out the modal theories of Diodorus, Philo, and Chrysippus, and then analyzes a series of objections and replies centered on the worry that Stoic modal views are incompatible with physical determinism.

De Harven, Vanessa. 2016. Necessity, possibility and determinism in Stoic thought. In *Logical modalities from Aristotle to Carnap: The story of necessity*. Edited by Max Cresswell, Edwin Mares, and Adriane Rini, 70–90. Cambridge, UK: Cambridge Univ. Press.

Argues that underlying Stoic views of modality and determinism is a distinction between logical, metaphysical, and providential necessity and possibility, locating those three senses in an analysis of a report on Stoic modality from Diogenes. Defends the Stoics against the charge that their determinism collapses into necessity and argues that the Stoics can combine future truth and contingency.

De Vincentis, Mauro Nasti. 2018. Chrysippus' counterargument against the Master Argument: A reappraisal. *Northern European Journal of Philosophy* 19.2:

Argues that Chrysippus, in his response to Diodorus' Master Argument, was not committed to the view that there are deductions and conditionals where the impossible follows from the possible. Instead, his discussion is employing a dialectical move to instrumentally agree with Diodorus on the admissibility of some single-premised arguments.

Donini, Pier Luigi. 1973. Crisippo e la Nozione des Possibile. *Rivista di Filologia* 101:333–351.

Analysis of chapters 6–8 in Cicero's *De fato*, where Cicero lays out how Chrysippus' notion of possibility relates to his physics, his acceptance of divination, and to Diodorus' and Philo's positions.

Gould, J. B. 1967. Chrysippus on the criteria for the truth of a conditional proposition. *Phronesis* 12.2: 156–161.

Analyzes a passage from Cicero's *De Fato* to argue that Chrysippus' view of the truth of conditionals must be that the antecedent and consequent are *empirically* incompatible, not logically incompatible as another well-known passage by Sextus Empiricus has been taken to suggest. Gould argues that Chrysippus *is* represented by one of the views Sextus Empiricus details, but the right interpretation is not in terms of logical incompatibility.

Ide, Harry. 1992. Chrysippus's response to Diodorus's Master Argument. *History and Philosophy of Logic* 13:133–148.

Argues against the standard interpretation of Chrysippus' response to the Master Argument and suggests that "perished" conditionals are false, not truth-value-less, and that the consequents of those conditionals are possible prior to the event that makes them perish, not impossible.

Papazian, M. B. 2001. Chrysippus and the destruction of propositions: A defence of the standard interpretation. *History and Philosophy of Logic* 22:1–12.

A response to the interpretation of Ide 1992 that "destroyed" propositions persist and are false. Argues that such a view (along with the standard view) conflicts with Stoic views about the nature of propositions and offers an interpretation based on Frede 1994 (cited under *Sayables (lekta) and Assertibles (axiomata)*) of the Stoic theory of propositions (see the section on the Stoics).

Paradoxes of Infinity

In addition to paradoxes of vagueness and the liar, paradoxes related to the infinite are of interest to those studying the history of logic. Zeno's arguments for the impossibility of motion, plurality, and infinite divisibility were not only influential within natural science and metaphysics, but also served as touchstone examples of logical rigor in the development of dialectic. Further, many solutions to these paradoxes relied on sophisticated tools of linguistic analysis in order to distinguish between permissible and impermissible uses of the infinite in arguments. These techniques of analysis played an important role in the development of logical method and theories of quantification, and their influence can be found in later debates over the eternity of the world, the composition of continua, and the foundations of mathematics and logic.

Zeno

Zeno's paradoxes provide a series of challenges to seemingly obvious commitments concerning the divisibility of space, the possibility of motion, and the plurality of objects. These arguments appear deceptively simple, and providing a precise interpretation and resolution has not only led to historical developments in logical method but also remains a favorite problem case for application of modern tools of formal analysis. Vlastos 1993 and Hasper 2006 focus on the metrical paradox and the associated mereological principles, while Davey 2007 focuses on how to interpret the stadium paradox and assumptions about how to measure motion.

Davey, Kevin. 2007. Aristotle, Zeno, and the stadium paradox. *History of Philosophy Quarterly* 24.2: 127–146.

Suggests that one should not read the stadium paradox as either a fallacy correctly resolved by Aristotle or as a persuasive argument that Aristotle fails to address, but instead as a conflict between two ways of disambiguating how one measures time. One can then read from the example of the stadium two different early attempts to grapple with mathematical and logical concepts that are not systematized until much later.

Hasper, Pieter Sjoerd. 2006. Zeno unlimited. *Oxford Studies in Ancient Philosophy* 30:49–85.

Argues that interpreting Zeno's dichotomy as making a mathematical claim about a sum of parts of some size is incorrect. Rather, the argument should be interpreted as using a mereological assumption that the whole is just its parts to move from the premise that the number of parts is unlimited to the conclusion that the whole itself has no limit.

Vlastos, Gregory. 1993. A Zenonian argument against plurality. In *Studies in Greek Philosophy. i. The Presocratics*. Princeton, NJ: Princeton Univ. Press.

An analysis of DK B1 and B2, with a structured translation and commentary that builds off of Fränkel and suggests an explanation of why Zeno made a mistake in his claim that an infinite number of parts led to the claim that the corresponding whole must be of infinite size.

Aristotle

Aristotle's response to Zeno depends on his view that the parts of continua are merely potential until made actual by some process of division, and, consequently, those parts only form a potential, and not actual, infinity. While his solution is sometimes seen as an early attempt to distinguish between different types of quantificational claims, his general comments about the infinite are brief, somewhat cryptic, and possibly not fully consistent. Hintikka 1966 and Lear 1977 provide competing attempts to make sense of Aristotle's claim that the infinite is only potential but also like a day or contest, and Bostock 1972, Charlton 1991, and Coope 2012 are further attempts to provide more sophisticated refinements of those initial interpretations. Hussey 1993 provides a valuable introduction to the text.

Hussey, Edward. 1993. *Physics: Books III and IV. Vol. 2. Oxford: Oxford Univ. Press.*

Translation of Book 3, which contains the relevant passages for Aristotle's view of the infinite. The introduction by Hussey is useful for an overview of Aristotle's view and its place in the context of the *Physics*.

Hintikka, Jaakko. 1966. Aristotelian infinity. *The Philosophical Review* 75.2: 197–218.

Interpretation of Aristotle's view that finds the potentiality of the infinite in its being a process so that Hintikka's commitment to the Principle of Plenitude is satisfied (i.e., an infinite process is "actual" in the same way the Olympics are actual when the events that make them up are occurring).

Lear, Jonathan. 1977. Aristotelian infinity. *Proceedings of the Aristotelian Society* 80:187–210.

Response to Hintikka that argues that no infinite process in Hintikka's sense is ever occurring (only finite sub-processes), but these finite sub-processes "bear witness" to the infinite process, which is potential in the sense that it is not completable.

Bostock, David. 1972. Aristotle, Zeno, and the potential infinite. *Proceedings of the Aristotelian Society* 73:37–51.

Focuses on how the distinction between the potential and actual infinite is supposed to play a role in Aristotle's response to Zeno. Offers a new Zeno-style paradox involving a bouncing ball that causes problems for Aristotle's solutions since the ball would actualize an infinite number of points when it changes directions in the bounce.

Charlton, William. 1991. Aristotle's potential infinities. In *Aristotle's Physics: A collection of essays*. Edited by L. Judson, 129–149. Oxford Univ. Press.

Discusses Bostock's case and suggests series of possible, precise interpretations of potential infinity with set-theoretic concepts (e.g., member) in order to locate Aristotle's position.

Coope, Ursula. 2012. Aristotle on the infinite. In *The Oxford handbook of Aristotle*. Edited by Christopher Shields, 267–286. Oxford Univ. Press.

Attempts to offer a middle-ground position between Hintikka and Lear that focuses on the distinction between a process occurring and having occurred, and infinite processes are special in that they can only ever be incompletely fulfilled unlike contests or days.

Philoponus

John Philoponus, as a Christian Neoplatonist, was concerned by the tension between Aristotle's commitment to the eternity of the world and the impossibility of actual infinities. His arguments focus on the claims that if there were an infinite past: (i) one would have to traverse an infinity to get to the present, and (ii) there would be various sizes of infinity that would be susceptible to increase. Both of these

consequences were taken to be absurd and to lead to a **reductio** of the view that the world was eternal, and his arguments can be seen as early attempts to evaluate the commitments of quantificational claims. Wildberg 1987 provides a version of the text, while Sorabji 1983 provides a general introduction of the arguments.

Wildberg, Christian. 1987. *Philoponus: Against Aristotle on the eternity of the world*. London: Bloomsbury.

Collection and translation of the fragments of Philoponus' *de Aeternitate Mundi contra Aristotelem*. Also contains a general introduction by Richard Sorabji.

Sorabji, Richard. 1983. Infinity arguments in favor of a beginning. In *Time, Creation, and the Continuum: Theories in antiquity and the early middle ages*. By Richard Sorabi, 210–231. Ithaca, NY: Cornell Univ. Press.

Discusses Philoponus' counterarguments against Aristotle's view of an eternal world used to argue for a beginning to the universe. These arguments suggest that Aristotle's views prohibiting the actual infinite should rule out an eternal past.

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