Is Aristotle's syllogistic a logic?

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Some of the more prominent contributions to the last fifty years of scholarship on Aristotle's syllogistic suggest a conceptual framework under which the syllogistic is a logic, a system of inferential reasoning, only if it is not a theory, a system concerned with ontology or general facts. I argue that this a misleading interpretative framework. I begin by noting that the syllogistic exhibits one mark of contemporary logics: syllogisms are inferences and not implications. The debate on this question has focused on the interpretation of indirect proof. But I argue that this evidence is neutral on the question. Instead, I offer new considerations in favour of the interpretation of syllogisms as inferences. I next note that the syllogistic exhibits one mark of theories: it employs a distinct underlying logic so to derive derivative structures from primitive structures. So the syllogistic is something *sui generis*: by our lights, it is arguably neither clearly a logic, nor clearly a theory, but rather exhibits certain characteristic marks of logics and certain characteristic marks of theories. I conclude with a few remarks on the status of Aristotle as a founder of logic, and the use of modern systems to represent historical logics.

1. Introduction

Some of the more prominent contributions to the last fifty years of scholarship on Aristotle's syllogistic suggests a conceptual framework under which the syllogistic is a logic, a system of inferential reasoning, only if it is not a theory, a system concerned with ontology or general facts. In this paper, I argue that this a misleading interpretative framework. The syllogistic is something *sui generis*: by our lights, it is arguably neither clearly a logic, nor clearly a theory, but rather exhibits certain characteristic marks of logics and certain characteristic marks of theories.

In what follows, I will rehearse a debate between a theoretical and a logical interpretation of the syllogistic. The debate *centers* on the interpretation of syllogisms as either implications or inferences. But the *significance* of this question has been taken to concern the nature and subject-matter of the syllogistic, and how it ought to be represented by modern techniques. For suppose that syllogisms are implications, propositions with conditional form. Then the syllogistic, in so far as it is a systematic taxonomy of syllogisms, appears to be a theory or a body of knowledge concerned with general features of the world. Furthermore, if the syllogistic is a theory, then it arguably ought to be represented by an axiomatic system, a system deriving propositional theorems from axioms. On the other hand, suppose that syllogisms are inferences. Then the syllogistic appears to be a logic, a system of inferential reasoning. And furthermore, it arguably ought to be represented as a natural deduction system, a system deriving valid arguments by means of intuitively valid inferences. I will argue that one can disentangle these questions—are syllogisms inferences or implications, is the syllogistic a logic or a theory, is the syllogistic a body of worldly knowledge or a system of inferential reasoning, and ought we to represent the syllogistic as a natural deduction system or an axiomatic system?

The paper has two parts. I will begin by noting that the syllogistic exhibits one mark of contemporary logics: syllogisms are inferences and not implications. The debate on this question has focused on the interpretation of indirect proof. But I will argue that this evidence is neutral on the question. Instead, I will offer new considerations in favour of the interpretation of syllogisms as inferences (Section 2). I will next rehearse the observation that the syllogistic exhibits one mark of theories: it employs a distinct underlying logic so to derive derivative structures from primitive structures. So the syllogistic exhibits some of the marks we now find characteristic of logics and some of the marks we now find characteristic of theories. For this reason, the syllogistic is, by our lights, neither a paradigmatic logic nor a paradigmatic theory. Finally, I will discuss whether the syllogistic is better represented as a Fitch-style natural deduction system, a Gentzen-style sequent calculus or an axiomatic system. I will note that the underlying logic for the syllogistic exhibits some marks of natural deduction systems but fails to exhibit other marks. I will conclude with a few general remarks on the status of Aristotle as a founder of logic, and the use of modern systems to represent historical logics (Section 3).

2. The interpretation of moods

Aristotle characterizes syllogisms at APr 1.1 (24^b18-22) as follows, modifying the Smith translation in *Aristotle 1989*:

T1 a syllogism is a discourse in which, certain things having been supposed, something different from the things supposed results of necessity because they are so. By ‘because these things are so’ I mean ‘resulting through them,’ and by ‘resulting through them’ I mean ‘needing no further term from outside in order for the necessity to come about.’

συλλογισμὸς δέ ἐστι λόγος ἐν ὧι τεθέντων τινῶν ἕτερόν τι τῶν κειμένων ἐξ ἀνάγκης συμβαίνει τῶι ταῦτα εἶναι. λέγω δὲ τῶι ταῦτα εἶναι τὸ διὰ ταῦτα συμβαίνειν, τὸ δὲ διὰ ταῦτα συμβαίνειν τὸ μηδενὸς ἔξωθεν ὅρου προσδεῖν πρὸς τὸ γενέσθαι τὸ ἀναγκαῖον.

This characterization suggests that a syllogism is an ordered pair consisting of a set of suppositions and a set of results. So a syllogism will have the form $\langle\{\alpha_1, \ldots, \alpha_n\}, \{\sigma_1, ..., \sigma_m\}\rangle$ such that $\{\alpha_1, \ldots, \alpha_n\}$ and $\{\sigma_1, ..., \sigma_m\}$ stand in a certain relation of acceptability. The plural characterization of the suppositions in “certain things having been supposed” suggests that $n > 1$. The characterization of the result as “something different from the things supposed” suggests that for $1 \leq i \leq n$ and $1 \leq j \leq m$, $\alpha_i \neq \sigma_j$.

Aristotle characterizes the acceptability relation as obtaining when $\{\sigma_1, ..., \sigma_m\}$ results of necessity through $\{\alpha_1, \ldots, \alpha_n\}$. The nature of the acceptability relation is historically controversial and I will discuss the nature of this relation further below. Finally, it is standardly held that a syllogism has a single result and so m=1. I question this assumption in *Corkum forthcoming* but nothing hinges on the issue for our present concerns, so I will adopt here the standard view.

What Aristotle actually proceeds to do in APr 1.4-6 is to classify tertiary ordered sequences of categorical propositions. Call a *mood* the form of an ordered sequence $\langle\alpha_1, \alpha_2, \sigma\rangle$ where each member is a categorical proposition. I will assume a set of term variables A, B, C…. The assertoric categorical propositions have the forms:

BaA: pronounced 'B belongs to every A'

BeA: B belongs to no A

BiA: B belongs to some A

BoA: B belongs to not every A.

The moods are classified into three figures, which have the following format. The first two members of the sequence contain the two terms of the third member respectively and a common or middle term: in the first figure, the middle term is in the predicate position of the first member and in the subject position of the second member; in the second and third figures, the middle is the predicate or the subject, respectively, of both of the first two members. So, for example, one of the moods of the first figure, called by its medieval mnemonic, 'Barbara', is the pattern:

(Barbara) A belongs to every B.
B belongs to every C.

So A belongs to every C.

I will occasionally express a mood as an ordered sequence. So for example, Barbara may be represented as ⟨AaB, BaC, AaC⟩.

The syllogistic is in part a two-stage classification of moods. In chapters A4-7 of the *Prior Analytics*, Aristotle considers various combinations for the three figures and shows which are acceptable and which unacceptable. The acceptable moods of the first figure are taken to be evidentially acceptable: immediately following **T1**, Aristotle (24^b22-23) characterizes these moods as standing 'in need of nothing else besides the things taken in order for the necessity to be evident'. The acceptability of the acceptable syllogisms of the second and third figures is established by showing that these moods stand in a certain relation to one of the moods of the first figure—often, that of convertibility. That is to say, Aristotle takes such syllogisms as (one of the first figure moods) Celarent:

A belongs to no B; B belongs to every C; so A belongs to no C

as obviously acceptable. He then establishes the acceptability of such syllogisms as Cesare

M belongs to no N; M belongs to every O; so N belongs to no O

by converting the first member to

N belongs to no M

by means of the conversion rule *e-conversion* and then appealing to Celarent.

Another method to establish the acceptability of higher-order syllogisms is exposition. Take the first two members of Darapti

A belongs to every B;
C belongs to every B.

Now set out some particular B, say b. Then we may infer from the first member

A belongs to b

and from the second member

C belongs to b.

So it follows that A belongs of something to which C also belongs; hence

A belongs to some C.

For discussion of exposition, see *Smith 1982*. The third and final method to establish the acceptability of the acceptable sequences is indirect proof. The unacceptability of the unacceptable sequences is typically established by counter-instance. I will discuss these two methods in more detail below.

I have presented the syllogistic in interpretatively neutral terms of the acceptability of sequences. The historical interpretation and representation of these sequences, their acceptability and the resulting structure of the syllogistic is a bellwether of the logical concerns of the interpreter's time. In the 50's and 60's, Łukasiewicz (*1957*) and Patzig (*1968*) took syllogistic forms to be true generalized conditionals and so instances of these forms, implications.[1] In the early 70's, by contrast, Smiley (*1973*) and Corcoran (*1974b*) each argued that syllogistic forms are valid inference rules and instances of these forms, deductions. I will turn to the consequences of this debate for the interpretation and representation of the syllogistic in Section 3. But first, I will discuss the

[1] If p and q are open sentences and Q a string of universal quantifiers, one for each free variable in (p ⊃ q), then Q(p ⊃ q) is a universalized conditional. So the syllogistic form of Barbara looks like this: For all A, B, C: if B holds of every A and C holds of every B, then C holds of every A. In this paper, implications are truth evaluable and are expressed by conditional sentences; inferences are validity evaluable and are expressed by premise-conclusion arguments.

interpretation of syllogisms as implications or inferences. Is the acceptability relation obtaining between {$\alpha_1, \ldots, \alpha_n$} and {$\sigma_1, \ldots, \sigma_m$} that of implication between an antecedent and a consequent or that of entailment between a premise set and a conclusion set?

It is now fairly standardly held that syllogisms are inferences. So the reader might well wonder whether it is worthwhile to go through the evidence to follow. But the inferential reading is typically driven in the secondary literature more by technical and philosophical considerations, and less by textual support. We will see that there is good textual evidence for ascribing to Aristotle the view that syllogisms are inferences. And it will pay dividends in Section 3 to consider this evidence. The discussion in the secondary literature has focused on the evidence of indirect proof which, as I have mentioned, is one method of establishing the acceptability of the second and third figure moods.[2] For example, the indirect proof of Baroco, from 27ᵃ36-b1, is:

T2 if M belongs to every N but does not belong to some X, it is necessary for N not to belong to some X. (For if it belongs to every X and M is also predicated of every N, then it is necessary for M to belong to every X; but it was assumed not to belong to some.)[3]

πάλιν εἰ τῶι μὲν Ν παντὶ τὸ Μ, τῶι δὲ Ξ τινὶ μὴ ὑπάρχει, ἀνάγκη τὸ Ν τινὶ τῶι Ξ μὴ ὑπάρχειν· εἰ γὰρ παντὶ ὑπάρχει, κατηγορεῖται δὲ καὶ τὸ Μ παντὸς τοῦ Ν, ἀνάγκη τὸ Μ παντὶ τῶι Ξ ὑπάρχειν· ὑπέκειτο δὲ τινὶ μὴ ὑπάρχειν.

It is controversial how to describe what happens in Aristotle's indirect proofs. But according to one plausible reading, the above passage assumes the premises of Baroco and shows that its conclusion follows by assuming the negation of one of its premises and

[2] See *Łukasiewicz 1951*, 58, *Austin 1952*, 397-8, *Corcoran 1974*, 280, *Smiley 1973*, 137-8.
[3] Except as noted, I follow Smith's translation of the *Prior Analytics* in *Aristotle 1989*.

using Barbara to derive a contradiction. Łukasiewicz noted that an indirect proof of a conditional must take as its hypothetical assumption not the negation of the conclusion, as Aristotle does in converting Baroco, but the negation of the conditional. So either the claim that syllogisms are implications is false, under the plausible assumption that the only propositions syllogisms could be are conditionals, or we must ascribe a serious error to Aristotle. Łukasiewicz (*1957,* 58) opts for the second disjunct, writing that 'Aristotle does not understand the nature of hypothetical arguments'. This allowed Łukasiewicz to continue to endorse the claim that syllogisms are implications.

It is more tempting to use the evidence as an argument against the claim that syllogisms are implications. For suppose that you were persuaded by the evidence from indirect proof to hold the disjunctive conclusion that either the claim that syllogisms are implications is false or Aristotle makes a blunder. Nonetheless, you adhere to some such hermeneutic principle as: ascribe errors to Aristotle only as a last resort. So against Łukasiewicz, you opt for the first disjunct, arguing that the claim that syllogisms are implications is false from this evidence. This is surely the more attractive line, if indeed we're forced to make this decision between the two disjuncts.

However, the evidence from indirect proof fails to support the disjunctive conclusion and so makes for a poor argument for either disjunct. Łukasiewicz is right to note that, if syllogisms are implications, propositions with conditional form, then an indirect proof of a syllogism would begin by assuming the negation of that syllogism. But the negation of a conditional, of course, can be expressed as a conjunction where the antecedent obtains and the consequent fails to obtain. And this is just what happens in the proof of Baroco. Admittedly, the indirect proof does not explicitly make the first move of assuming the negation of the conditional—along the lines of saying: ‘Suppose it’s not the case that if M belongs to every N, but not to some X, it’s necessary that N should not belong to some X’. But still, it is open for us to hold that the proof of Baroco starts *in medias res*, by explicitly assuming the truth of the two conjuncts of the antecedent and the falsity of the consequent under the tacit assumption of the negation of the conditional. That is, the absence of an explicit assumption of the negation of the conditional only shows that the passage is crabbed, not that either syllogisms are not implications or Aristotle was confused about the nature of indirect proofs. So the evidence from indirect proof is inconclusive support for the denial of the claim that syllogisms are implications.

The question whether syllogisms are implications or inferences has centered on the questions whether they in fact are expressed by conditional expressions, and whether they ought to be so expressed. Łukasiewicz (*1957*, 1-3 and 20-30) and Patzig (*1968*, 3-4), for example, defend their view that syllogisms are not inferences but implications in part by noting that Aristotle generally presents syllogisms in conditional form. For example, Barbara is stated at 25^b37-39 as: ‘if A is said of every B and B of every C, then it is necessary for A to be predicated of every C’. But the question whether syllogisms are presented as conditionals or not is germane to the question whether they are propositions only under the assumption that conditional grammatical constructions in Aristotle refer to propositions. This assumption may well be mistaken. For it would be natural in some contexts to express inferences as conditionals where, if the premises hold, then the conclusion follows. So it is open to us to ascribe to Aristotle the view that conditional express a license to take a step in an act of inference, a move from the antecedent to the consequent, which may be accepted or denied. Austin (*1952*), Rose (*1968*, 25) and

Corcoran (*1972*, 278) all make this observation. The view is venerable. Alexander (*in An Pr*. 373, 29-35) claims that 'if A, then B' means the same as 'B follows from A'. More recently, Morison (*2011*) holds that Aristotle uses conditionals to assert not the syllogism but the conditions under which a syllogism results—namely, the premises in the antecedent—and the conclusion which can be drawn when those conditions obtain.

Furthermore, there is evidence that Aristotle would deny that conditionals express truth-evaluable propositions. One point of evidence is the omission of implications from Aristotle's discussion of propositions. Aristotle suggests that every proposition is categorical at 24ª16-22:

T3 A proposition is a sentence affirming or denying something about something. This sentence may be universal, particular, or indeterminate. I call belonging to every or to none *universal*; I call belonging to some, not to some or not to every, *particular*; and I call belonging or not belonging (without a universal or particular) *indeterminate* (as for example, 'the science of contraries is the same' or 'pleasure is not a good').

Πρότασις μὲν οὖν ἐστὶ λόγος καταφατικὸς ἢ ἀποφατικός τινος κατά τινος· οὗτος δὲ ἢ καθόλου ἢ ἐν μέρει ἢ ἀδιόριστος. λέγω δὲ καθόλου μὲν τὸ παντὶ ἢ μηδενὶ ὑπάρχειν, ἐν μέρει δὲ τὸ τινὶ ἢ μὴ τινὶ ἢ μὴ παντὶ ὑπάρχειν, ἀδιόριστον δὲ τὸ ὑπάρχειν ἢ μὴ ὑπάρχειν ἄνευ τοῦ καθόλου ἢ κατὰ μέρος, οἷον τὸ τῶν ἐναντίων εἶναι τὴν αὐτὴν ἐπιστήμην ἢ τὸ τὴν ἡδονὴν μὴ εἶναι ἀγαθόν.

Aristotle implies that any proposition is either an universal affirmation, universal negation, particular affirmation or particular negation. Aristotle mentions a third quantity, indeterminate propositions, in **T3** at 24ª17 and elsewhere but these are not obviously a class of propositions distinct from universal and particular propositions. Rather, Aristotle may be pointing out that some object language sentences are ambiguous with respect to their quantity and need to be disambiguated as either a particular or a universal proposition.

Aristotle goes on to add modality to the classification of propositions at 25a1-5:

T4 Now, every proposition expresses either belonging, or belonging of necessity, or being possible to belong; and some of these, for each prefix respectively, are affirmative and others negative; and of the affirmative and negative premises, in turn, some are universal, some are in part, and some indeterminate.

δὲ πᾶσα πρότασίς ἐστιν ἢ τοῦ ὑπάρχειν ἢ τοῦ ἐξ ἀνάγκης ὑπάρχειν ἢ τοῦ ἐνδέχεσθαι ὑπάρχειν, τούτων δὲ αἱ μὲν καταφατικαὶ αἱ δὲ ἀποφατικαὶ καθ᾽ ἑκάστην πρόσρησιν, πάλιν δὲ τῶν καταφατικῶν καὶ ἀποφατικῶν αἱ μὲν καθόλου αἱ δὲ ἐν μέρει αἱ δὲ ἀδιόριστοι

With this addendum to **T3**, he appears to hold that the classification is exhaustive: he claims at 25a1 in **T4** that *every* proposition (*pasa protasis*) falls under one of these headings. So Aristotle holds that there are only eight kinds of propositions. My translation of *protasis* as 'proposition' in **T3** and **T4** would be controversial. Some translate *protasis* instead as 'premise'. So one might respond that Aristotle is only claiming in **T3** and **T4** that the *premises* of a syllogism is a categorical proposition, and so may allow a syllogism itself to be truth-evaluable. As Smith (*1989*, 106) notes, the characterization of a *protasis* in **T3** suggests its interpretation as a proposition, and not a premise. However, perhaps little weight can be placed on this evidence, given its reliance on a controversial interpretation.

Nonetheless, Aristotle seems to hold that the compound premises familiar from propositional logic—conjunctions, disjunctions, and so on—do not express single propositions. And, of course, the syllogistic does not include such inferences as conjunction introduction or disjunction elimination. Aristotle does discuss hypothetical syllogisms. But it is now well established that such syllogisms employ ordinary syllogisms under an assumption, so to show what follows from that assumption. A hypothetical syllogism is not an argument with conditional premises, such as *modus ponens* or *modus tollens*. On this point, see *Lear 1980*, *Striker 1998* and *Ebrey 2015*.

Aristotle's discussion of truth and falsity provides further evidence that conditionals do not express truth-evaluable propositions. Aristotle associates truth and falsity with notions of combination and separation. See, for example, *De Interpretatione* 1, 16ᵃ9-18:

T5 Just as some thoughts in the soul are neither true nor false while some are necessarily one or the other, so also with spoken sounds. For falsity and truth have to do with combination and separation. Thus names and verbs by themselves—for instance 'man' or 'white' when nothing further is added—are like the thoughts that are without combination and separation; for so far they are neither true nor false.

ἔστι δέ, ὥσπερ ἐν τῇ ψυχῇ ὁτὲ μὲν νόημα ἄνευ τοῦ ἀληθεύειν ἢ ψεύδεσθαι ὁτὲ δὲ ἤδη ᾧ ἀνάγκη τούτων ὑπάρχειν θάτερον, οὕτω καὶ ἐν τῇ φωνῇ· περὶ γὰρ σύνθεσιν καὶ διαίρεσίν ἐστι τὸ ψεῦδός τε καὶ τὸ ἀληθές. τὰ μὲν οὖν ὀνόματα αὐτὰ καὶ τὰ ῥήματα ἔοικε τῷ ἄνευ συνθέσεως καὶ διαιρέσεως νοήματι, οἷον τὸ ἄνθρω- πος ἢ λευκόν, ὅταν μὴ προστεθῇ τι· οὔτε γὰρ ψεῦδος οὔτε ἀληθές πω. σημεῖον δ' ἐστὶ τοῦδε· καὶ γὰρ ὁ τραγέλαφος σημαίνει μέν τι, οὔπω δὲ ἀληθὲς ἢ ψεῦδος, ἐὰν μὴ τὸ εἶναι ἢ μὴ εἶναι προστεθῇ ἢ ἁπλῶς ἢ κατὰ χρόνον.

Compare 1ᵃ16-19 and 13ᵇ11. A sentence is composed of terms; a thought, of the significations of these terms. But Aristotle cannot mean by combination here merely the composition of a sentence or a thought. For the association of falsity with separation is unintelligible on this reading, since thoughts which fail to resemble the facts are composed of the significations of the terms, no less than thoughts which succeed in resembling the facts. Moreover, Aristotle recognizes that there are well-formed sentences which are not assertions and so express neither true thoughts nor false: at 17ᵃ4, he gives the example of a prayer. These sentences are composed of the same sentential components as assertions but, differing in linguistic force, arguably do not involve the relevant notion of combination and separation. So it cannot be linguistic items that are combined and separated. Rather, it is the constituents of the conditions, under which a thought is true, that bear relations of combination and separation.

It is implausible that a conditional assertion combines terms in the relevant sense of combination or that a negated conditional separates terms. This is certainly true for an interpretation of the separation and combination terminology associated with predication advocated by Mignucci (*1996*, *2000*) and subsequently endorsed by Corkum (*2015*, *2018*, *2024*). In this previous work, I commit myself to the view that combination is mereological containment of the referent of the subject term within the referent of the predicate term. It is not plausible to view a conditional expression as relating the antecedent and the consequent in this way. For this reason, Aristotle would deny that conditionals express truth-evaluable propositions. And so syllogisms, even if expressed by conditionals, are not implications. However, the point that it is implausible that the antecedent and the consequent are combined or separated in an implication, is independent of my specific interpretation of this terminology. For example, Crivelli (*2004*) views separation and combination terminology as referring to set-theoretic inclusion and exclusion. Malink (*2009*) and Vlasits (2019) view the relation between subject and predicate in certain categorical propositions as a preorder. Bäck (*2000*) holds that predicates adverbially modify existential claims. I discuss these interpretations in *Corkum 2015* and *2018*. All of these interpretations are inconsistent with viewing conditionals as expressing combinations and separations.

Let me float a final reason to believe that syllogisms are not truth evaluable. There is evidence that, for Aristotle, a *sullogismos* is an event or action. Nouns with the *mos* suffix are often substantives denoting actions. For example, see Smyth (*1984*, §861.1, p. 241). Aristotle often uses the expression, the syllogism 'arises' or 'comes about' (*gignetai*: for example, APr 1.4, $25^{b}27$). This expression is likely a mere stylistic variant for the verb form related to *sullogismos*, *sullogizomai*. This verb is a middle deponent meaning the same as 'to infer'. The verb takes as its object the proposition inferred. Thus Aristotle speaks of syllogizing *to A kata tou B* (for example, APo $40^{b}30$) and *huparchein to A tōi B* (APo $79^{b}30$), two of the expressions Aristotle uses for categorical propositions. The conclusion is thus syllogized from the premises. Aristotle speaks of syllogizing one thing from other things: *tina ek tinown* (Rh $1357^{a}8$), using a genitive of origin; or of syllogizing a proposition, with the extreme terms of the premises as subject and predicate, through the middle term: *to akron tōi mesōi* ($66^{b}16$), with a dative of means. Just as 'perception' is ambiguous between the act of perceiving and the object directly perceived, so too 'syllogism' (and 'inference') is ambiguous between the act of syllogizing (inferring) and the resulting argument. In its primary sense, however, a syllogism is an act of inferring (constrained of course by certain restrictions) a conclusion from given premises. I put this evidence, as a final reason to believe that syllogisms are not truth evaluable, forward tentatively. And although these various considerations each fall short of conclusively *establishing* that syllogisms are not implications, taken together they do weigh against the implicative interpretation.

I will begin to bring this Section to a close. Syllogisms are not truth evaluable propositions and *a fortiori*, they are not implications. This falls short of establishing that syllogisms are inferences. But I will assume that, if syllogisms are not implications, then they are inferences. And so going forward I will take the acceptability relation—the relation between a premise set $\{\alpha_1, \ldots, \alpha_n\}$ and a conclusion set $\{\sigma_1, ..., \sigma_m\}$ in a syllogism—to be inferential. To sum up, the debate whether syllogisms are inferences or implications has centered the interpretation of indirect proof. I have argued that this evidence is inconclusive, but I have brought to bear other textual evidence for ascribing to Aristotle the view that syllogisms are not implications. For these reasons, the syllogistic arguably exhibits one mark that is by our lights characteristic of logics: syllogisms are inferences.

3. The representation of the syllogistic

Let me turn to the interpretation of the syllogistic and its representation by modern systems. Recall, Łukasiewicz and Patzig took syllogistic forms to be true generalized conditionals and so instances of these forms, implications. If syllogisms are implications, propositions with factual content, then it seems that the syllogistic, insofar as it is partly a systematic taxonomy of syllogisms, concerns logical truths. A natural corollary is that the syllogistic is, for this reason, a formal ontology or a system of general facts. And furthermore, the most natural modern representation of the syllogistic arguably would be as an axiomatic system.[4] By contrast, recall, Smiley (*1973*) and Corcoran (*1974b*) argued that syllogistic forms are valid inference rules and instances of these forms, deductions. If

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[4] Łukasiewicz (*1957*, 88ff.) takes the constants a and i as primitive terms. For axioms in the Łukasiewicz system, the two laws of identity governing the primitive terms, AaA and AiA, and the syllogistic implications corresponding to Barbara (in Polish notion, CKAbcAabAac) and Datisi. Łukasiewicz uses two rules of inference, substitution and detachment, and as an auxiliary theory the C-N-system of the theory of deduction with K as a defined function.

particular syllogisms are inferences, arguments proceeding from premises to a conclusion, then it seems that the syllogistic is a logic or system of inferential reasoning. And it may seem that a strong contender for a modern representation of the syllogistic would be as a natural deduction system.

The contrast between axiomatic and natural deduction systems is partly between the derivation of theorems and the derivation of deductions. Theorems are established as true by deriving them from other propositions, axioms or theorems, whose truth has already been established or, in the case of axioms, accepted without derivation. Deductions, on the other hand, are established as valid by assuming the truth of the premises and deriving the conclusion using accepted rules of inference. However, there is also a relevant difference between an axiomatic system and a natural deduction system in terms of the logic or reasoning underlying the derivation process which establishes theorems as true or arguments as valid. In an axiomatic system, the reasoning underlying the derivation process is not explicated *within* the axiomatic system. But in a natural deduction system, the initial structures are themselves the basic inferences used in the derivation process used to prove the validity of derivative arguments

The question whether the syllogistic *employs* or *embodies* a reasoning process has centered on the interpretation of perfection. Recall, the syllogistic is a structured classification relating two kinds of sequences. The acceptability of second and third figure sequences is established by showing that they stand in a suitable relation to the evidentially acceptable sequences of the first figure: Aristotle calls a fundamental syllogism *teleios,* an adjective whose root is *telos* and which means the same as 'pertaining to the last part of a process or series, to the end of a duration, or to a goal'. A derivative syllogism is called by the alpha-privative *atelês* and the process of establishing the acceptability of these syllogisms, *teleiousthai* or *epiteleisthai*. Aristotle writes at 24^b22-26, modifying the Smith translation in *Aristotle, 1989*:

T6 I call a syllogism *teleios* if it stands in need of nothing else besides the things taken in order for the necessity to be evident; I call it *atelês* if it still needs either one or several additional things which are necessary because of the terms assumed, but yet were not taken by means of the premises.

τέλειον μὲν οὖν καλῶ συλλογισμὸν τὸν μηδενὸς ἄλλου προσδεόμενον παρὰ τὰ εἰλημμένα πρὸς τὸ φανῆναι τὸ ἀναγκαῖον, ἀτελῆ δὲ τὸν προσδεόμενον ἢ ἑνὸς ἢ πλειόνων, ἃ ἔστι μὲν ἀναγκαῖα διὰ τῶν ὑποκειμένων ὅρων, οὐ μὴν εἴληπται διὰ προτάσεων.

The terminology of this distinction is ambiguous between two readings; the debate might be seen as a dispute over the disambiguation of this terminology. The Greek *teleios* has traditionally been translated as ‘perfect’. This translation suggests that a mood of the first figure is the end result of the process of establishing the acceptability of the derivative syllogisms. Those who interpret the syllogistic as a theory, and represent it by an axiomatic system, tend to view perfection as the *transformation* of an imperfect syllogism into a perfect syllogism. On this interpretation, the process of perfection need not be itself syllogistic: it may be a reasoning process employed, but not embodied, by the syllogistic.

Smith, by contrast, translates *teleios* as ‘complete’. This translation suggests that the moods of the second and third figures are incomplete. On this reading, Aristotle’s characterization of these moods with merely two premises is abbreviated. Those who interpret the syllogistic as a logic, and so represent it by a natural deduction system, tend to view the process of establishing the acceptability of the derivative syllogisms as the completion of incompletely stated syllogisms. The fully stated syllogism would contain a first figure syllogism. On this interpretation, the process of completion may seem to be itself syllogistic: it is a reasoning process not merely employed, but embodied, by the syllogistic.

The debate over perfection is inconclusive. On the one hand, the view that second and third figure moods are perfected and so the process of perfection *yields* first figure moods, is open to certain objections. As Striker (*2009*, 83) notes, the view handles poorly indirect proof. In an indirect proof of an imperfect syllogism, recall, one assumes that the conclusion of the syllogism is false and uses a first figure mood to derive a contradiction. It is implausible to view such a method as the transformation of the imperfect mood into a first figure syllogism. So not every method of establishing the acceptability of the derivative syllogisms can be viewed as a process of perfection. On the other hand, the view that second and third figure moods are completed and so, when fully stated, *contain* first figure moods, is also open to certain objections. Certain second and third figure syllogisms can be proven acceptable by more than one method. For example, Aristotle recognizes at $28^{b}20$-21 that Bocardo can be shown to be acceptable by both indirect proof and exposition. So on the view that imperfect syllogisms are deductions containing perfect syllogisms, one must say either that one and the same syllogism can have distinct sequences of deductive steps, or that distinct syllogisms can have the same initial premises and conclusion. On either option, it is misleading to identify the imperfect syllogism with any particular sequence of deductive steps. Rather, one must identify the imperfect syllogism with a class of deductions with the same initial two premises and conclusion.

However, independently of one's interpretation of perfection, it is clear that the syllogistic relies at least in part on an 'alien' underlying logic. Regardless of whether or not we view conversion rules as contained as premises in second and third figure moods, the conversion rules *themselves* are not syllogisms. As noted in Section 2, the definition of a syllogism in **T1** as 'a discourse in which, certain things having been supposed, something different from what is supposed results of necessity by their being so' appears to require that there be more than one premise. And Aristotle asserts at 40ᵇ35-36 that nothing follows necessarily from a single premise.[5] Of course, Aristotle is unlikely to mistakenly hold that single premise inferences such as repetition or conjunction elimination are invalid; rather, he is denying that these are syllogistic inferences.

Moreover, Aristotle proves the validity of the conversion rules. And indeed, the classification of assertoric syllogisms presupposes a background logic the basic inferences of which resist representation as syllogisms. For example, Aristotle proves e-conversion at 25ᵃ5-17 as follows:

T7 It is necessary for a universal privative premise of belonging to convert with respect to its terms. For instance, if no pleasure is a good, neither will any good be a pleasure…. First, then, let premise AB be universally privative. Now, if A belongs to none of the Bs, then neither will B belong to any of the As. For if it does belong to some (for instance to C), it will not be true that A belongs to none of the Bs, since C is one of the Bs.

τὴν μὲν ἐν τῶι ὑπάρχειν καθόλου στερητικὴν ἀνάγκη τοῖς ὅροις ἀντιστρέφειν, οἷον εἰ μηδεμία ἡδονὴ ἀγαθόν, οὐδ᾽ ἀγαθὸν οὐδὲν ἔσται ἡδονή … Πρῶτον μὲν οὖν ἔστω στερητικὴ καθόλου ἡ Α Β πρότασις. εἰ οὖν μηδενὶ τῶι Β τὸ Α ὑπάρχει, οὐδὲ τῶι Α οὐδενὶ ὑπάρξει τὸ Β· εἰ γάρ τινι, οἷον τῶι Γ, οὐκ ἀληθὲς ἔσται τὸ μηδενὶ τῶι Β τὸ Α ὑπάρχειν· τὸ γὰρ Γ τῶν Β τί ἐστιν.

[5] τῶι γὰρ ἓν καθ᾽ ἑνὸς ληφθῆναι οὐδὲν συμβαίνει ἐξ ἀνάγκης.

Aristotle establishes e-conversion by employing a reductio principle and a portion of the square of opposition, the contradictory opposition between e- and i-propositions. He goes on to establish the other conversion rules by reductio proofs that employ the established e-conversion rule. As we have seen, Aristotle does not view reductio proofs as syllogisms. As such, the syllogistic exhibits a mark of contemporary theories: the employment of a primitive inference rule—here, a reductio rule—that, insofar as it lies outside the classification of syllogisms, might be said to be itself non-syllogistic.

The syllogistic then might be fruitfully thought of as a two-tier system. On one tier is a structured classification of syllogisms, with certain syllogisms taken to be basic and others, derivative. On the other tier is a logic or system of reasoning, used to establish the derivative syllogisms. Such a structure is redolent of a theory, even if the elements are not truth-evaluable propositions. In endorsing this point, I owe a debt to Martin (*1997*, 9), who shows that the rejection of the interpretation of syllogisms as implications does not entail the rejection of the view that 'that the set of valid syllogisms is to be construed as an inductive set, defined as the closure of the basic elements Barbara and Celarent are under some construction rules'. Martin (*1997*, 10) goes on to note that 'any perceived inconsistency between syllogisms as arguments and the perfect syllogisms as basic elements in a construction is specious'.

For these reasons, the label 'syllogistic' might be thought of as being ambiguous between a narrow sense of the structured classfication of syllogisms, and a wide sense that includes both this classification and the logical apparatus used to derive the derivative syllogisms from the basic syllogisms. With this disambiguation in mind, we might ask, what representation in a contemporary system of the underlying logic of the wide syllogistic is the most historically accurate? The options for an interpretation of perfection, discussed above, might prove relevant evidence for answering this question. Both Smiley and Corcoran represented the syllogistic as a Fitch-style natural deduction system. Such systems establish that an argument is valid by employing a step-wise derivation from the premises of the argument to its conclusion. Each step of the derivation is a proposition. In a Gentzen-style natural deduction system or sequent calculus, by contrast, an argument is established as valid by a step-wise derivation of the argument itself. Each step of the derivation is an argument. The interpretation of perfection as the transformation of an imperfect syllogism into a perfect syllogism suggests the representation of the syllogistic as a sequent calculus. Crabbé (*2003*) and Tennant (*2014*) represent the syllogistic as a sequent calculus; but neither aim to follow Aristotle's own presentation. Corkum (*2010*) floats the suggestion that the representation might be historically accurate. However, the assessment of whether the evidence form perfection supports the representation faces the interpretative difficulties discussed above.

Moreover, the reasoning Aristotle uses to show the acceptability of the second and third figure moods is recalcitrant to representation as a sequent calculus. The method of indirect proof (such as that which recall Aristotle presents in **T2**) and Aristotle's proofs for the conversion rules (such as in **T7**) both rely on a reductio rule. A characteristic mark of Fitch-style natural deduction systems, in contradistinction to sequent calculi, is the facility to perspicuously make, track and subsequently discharge arbitrary assumptions. This feature is key to Gentzen's original presentation and is the sense in which such a deduction system is 'natural': its employment reflects actual reasoning. Gentzen's (*1934,* 74) professed aim was 'to set up a formalism that reflects as accurately as possible the actual logical reasoning involved in mathematical proofs'. In this respect, Aristotle's use of indirect proof arguably resembles a Fitch-style natural deduction system more closely than a Gentzen-style sequent calculus.

On the other hand, the underlying logic for the wide syllogistic lacks other characteric marks of natural deduction systems. One such mark arguably is the use of a set of logical connectives along with introduction and elimination rules for each connective. Pelletier and Hazen (*2012*, *2024*) note that this feature is not a necessary condition for a system to be a natural deduction system. But it is typical feature of such systems. However, it strains credibility to think of the conversion rules as providing introduction and elimination rules for a set of logical connectives. For example, e-conversion (which, recall, licenses BeA from AeB) is not a rule governing a logical connective. And it is not so much a rule eliminating AeB or introducing BeA as it is a transformation rule, allowing the flipping of subject and predicate within a universal negation.

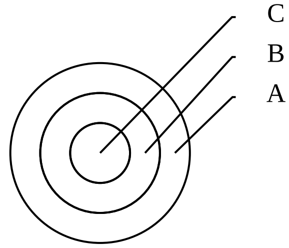
What hinges on the issue whether the syllogistic is better represented as an axiomatic system or a natural deduction system is, for Corcoran, the foundation of logic itself. Corcoran (*1974,* 280, italics removed) writes:

> if the Łukasiewicz view [that the syllogistic is an axiomatic system] is correct then Aristotle cannot be regarded as the founder of the science of logic. Indeed Aristotle would merit this title no more than Euclid, Peano, or Zermelo, regarded as founders, respectively, of axiomatic geometry, axiomatic arithmetic and axiomatic set theory. Each of these three men set down axiomatizations of bodies of information without explicitly developing the underlying logic.

Compare Corcoran (*1994*), where he draws the contrast between axiomatic and natural deduction systems in terms of a distinction between epistemic and ontic roles. I've argued in support of the now standard view that syllogisms are not logical truths but are instead inferences. But even were syllogisms logical truths and the syllogistic an axiomatic theory, it would not follow that the syllogistic is not a logic. Euclid, Peano and Zermelo are engaged in, respectively, the axiomatization of geometric, arithmetic and set theoretic truths, not logical truths; it is for this reason that their work deserves the titles of, respectively, geometry, arithmetic and set theory, and not of logic. It is idiosyncratic and mistaken to deny that an axiomatic systematization of logical truths is similarly deserving of the title of logic. Moreover, although the syllogistic employs itself a non-syllogistic underlying reasoning process, Aristotle shows a logician's interest in this underlying reasoning. Unlike Euclid, Peano and Zermelo, Aristotle is concerned to *defend* much of this reasoning: for example, as we have seen, he proves the validity of the conversion rules.

A wide range of systems can provide a logical interpretation of the syllogistic. In addition to, as we have seen, an axiomatic theory (*Łukasiewicz 1957*, *Patzig 1968*), or a natural deduction system (*Corcoran 1972, Smiley 1973*), proposals over the years have included viewing the syllogistic as a diagrammatic reasoning system (*Euler 1768*), a semantic tableau (*Carroll 1887, Beth 1955*), a logic of multiple sorted quantification (*Smiley 1962*), a connexive logic (*McCall 1967*), a fragment of a generalized quantifier theory (*van Benthem 1984*, *van Eijck 1985*, *Westerståhl 1989*, *Ludlow and Živanović 2022*), an inductive construction (*Martin 1987*, *1997*), a sequent calculus (*Crabbé 2003, Tennant 2014*), a relevant logic (*Irvine and Woods 2004*), a natural logic (*van Benthem 2008*), a metatheory (*Pelletier and Hazen 2012*), a linear logic (*Englebretsen 1991, Pagnan 2013*), and a dialogical logic (*Dutilh Novaes 2015*). This diversity of representations is a testament to the flexibility of Aristotle's acheivement.

It might be helpful to introduce some terminology from Shapiro (*1998*). Contrast a representation with that which is so represented. Call the features of a representation which correspond to features of that which is represented the ‘representors’ of the representation; and call the features which don’t correspond the ‘artefacts’ of the representation. For example, consider the use of Euler diagrams to represent valid syllogisms. Here’s one such representation of Barbara, the syllogism, recall, expressible by the conditional, ‘if A belongs to all B and B belongs to all C, then A belongs to all C’:



Barbara

That the spatial relations among the circles are *spatial* is an artefact of the representation. That spatial containment, like the *belongs to every* relation, is *transitive* is a representor of the representation. This talk of representors and artefacts is rough and ready; to make the talk more precise would require unpacking what it is for features to correspond. But the rough distinction suffices for our purposes. With this terminology, we might offer the following partial summary. Paradigmatic theories have, as representors for the representation of the syllogistic, a two-tier structure and the use of an underlying logic, and, as an artefact, the classification of truth-evaluable propositions. Paradigmatic logics have, as a representor, the classification of validity-evaluable inferences and, as a typical artefact, the feature of being one-tier systems. Natural deduction systems have, as a representor, the facility to make and subsequently discharge arbitrary assumptions and typically, as an artefact, a set of logical connectives, each associated with introduction and elimination rules.

Indeed, one artefact of most contemporary systems, for the representation of the syllogistic, is systematicity itself. For although the syllogistic is systematic in so far as it attempts an exhaustive classification of arguments satisfying certain restrictions, it is not by intention a system. As we have seen, Aristotle uses a variety of methods for establishing validity and invalidity – conversion, indirect proof, contrasted instances and ecthesis among them – without apparent concern for proving the consistency of these methods.

Let me end with a short summary and a remark. The syllogistic exhibits a mark characteristic of contemporary logics: syllogisms are inferences and not implications. But the syllogistic also exhibits a mark of theories: it employs a distinct underlying logic so to derive derivative structures from primitive structures. The syllogistic is then something *sui generis*: by our lights, it is arguably neither clearly a logic, nor clearly a theory, but rather exhibits certain characteristic marks of logics and certain characteristic marks of theories. This hybrid character makes the syllogistic resistant to representation by contemporary systems. More generally, the choice of representation of a historical logic by a contemporary system brings certain features to the fore and allows other features to recede. The use of a contemporary system risks introducing anachronism into the historical logic, through characteristic marks or typical features of the contemporary system which are artefacts. Such artifacts are perhaps unavoidable in any representation. A wide variety of systems can shed light on the syllogistic. But I am unaware of any representation of the syllogistic with an extant modern system that is entirely satisfactory.

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