

Reply to Bronstein, Leunissen, and Beere

MARKO MALINK

New York University

1. Introduction

I am grateful to Jonathan Beere, David Bronstein, and Mariska Leunissen for their generous comments on *Aristotle's Modal Syllogistic*. They point out a number of difficulties my interpretation has in explaining how the modal syllogistic fits into the broader context of Aristotle's logic and theory of science. Bronstein and Leunissen raise the question of how the modal syllogistic relates to the theory of scientific demonstration expounded in the *Posterior Analytics*. Beere focuses on the question of how the modal syllogistic relates to the framework of propositional modal logic presented in *Prior Analytics* 1.15 and *Metaphysics* Θ 4. Neither of these questions is addressed in my book since its main purpose is to provide an account of the modal syllogistic in itself. Nevertheless, Leunissen, Bronstein, and Beere are right in emphasizing that a full account of the modal syllogistic should be able to answer these questions in a satisfactory way. I appreciate the opportunity to explain, at least in outline, how those questions might be answered on the basis of the account given in *Aristotle's Modal Syllogistic*.

2. Modal Syllogistic vs. Scientific Demonstration: Reply to Bronstein and Leunissen

It is notoriously unclear how Aristotle's modal syllogistic is supposed to relate to his theory of scientific demonstration (*apodeixis*). In the first edition of his admirable commentary on the *Posterior Analytics*, Jonathan Barnes maintains that, for Aristotle, 'a demonstration is a species of modal syllogism' (1994: xvi). On this view, scientific demonstrations take the form of modal syllogisms such as Barbara NNN. In the second edition of his

commentary, however, Barnes retracts this view on the grounds that the premises and conclusions of scientific demonstrations typically do not contain any explicit modal qualifiers such as ‘necessarily’:

It is in fact far from plain that the paradigm logical form for a demonstration is a *modal* syllogism in *Barbara*. . . . Aristotle nowhere says that this is his view, nor do any of his illustrative examples contain an explicit modal operator. (And in so far as his theorizing is done with an eye on actual scientific practice, we should not expect to find such operators in his examples.) . . . We must suppose that demonstrative propositions are necessary not in the sense that they are truths of the form “A holds necessarily of every B” but rather in the sense that they are propositions of the form “A holds of every B” which are true inasmuch A necessarily holds of every B. Modal syllogistic remains acutely relevant to demonstrative science—but it is not the logic of demonstrative science. (Barnes 1994: xxi–xxii)

In his *Truth, etc.*, finally, Barnes denies that any scientific demonstrations are modal syllogisms:

The sciences—even where they deal in necessities—do not use apodictic propositions. They therefore have no use for apodictic syllogisms. . . . Galen recognized that the sciences do not use modal propositions, and he therefore concluded that modal syllogistic is superfluous. (Barnes 2007: 486–7)

This last view has the disadvantage of rendering it difficult to explain why Aristotle decided to include the modal syllogistic in the *Prior Analytics* in the first place. As Leunissen points out in her comments, it would be odd if the modal syllogistic did not contribute in any way to Aristotle’s theory of scientific demonstration. Nevertheless, Barnes’s arguments suggest that the relationship between the modal syllogistic and the theory of scientific demonstration is not straightforward. Barnes may be wrong in claiming that the modal syllogistic is of no relevance to scientific demonstrations. But even if it turns out that *some* scientific demonstrations are modal syllogisms, we should not expect that the same is true of *all* scientific demonstrations.

Bronstein and Leunissen show that, on my account of the modal syllogistic, a certain class of scientific demonstrations discussed in the *Posterior Analytics* are not modal syllogisms. Specifically, this is the case for what Bronstein calls Model 2 demonstrations. These are demonstrations in which the middle term signifies the essence of the item signified by the *major* term. In Model 1 demonstrations, on the other hand, the middle term signifies the essence of the item signified by the *minor* term. Bronstein focuses on Model 2 demonstrations in which the minor term is a substance term while the middle and major terms are non-substance terms. He gives the following example of such a demonstration (*Post. An.* 2.2 90a33):

D1 2R necessarily belongs to all essence of 2R
Essence of 2R necessarily belongs to all triangle
 2R necessarily belongs to all triangle

Similarly, Leunissen cites demonstrations such as the following (*Post. An.* 2.17 99b5–6):

D2 Being long-lived necessarily belongs to everything not having bile
Not having bile necessarily belongs to all four-footed animals
 Being long-lived necessarily belongs to all four-footed animals

It is not clear whether D2 is a Model 2 demonstration as described by Bronstein; this will depend on whether not having bile is taken to be (part of) the essence of being long-lived. In any case, D2 resembles D1 in important respects. In both demonstrations, the minor term is a substance term (or is treated as a substance term).¹ The major and middle terms, on the other hand, are non-substance terms. Since these non-substance terms are a_N - and a_X -predicated of a substance term, it follows that they are non-essence terms. At the same time, the middle term is the subject of an a_N -predication (since the major term is a_N -predicated of it). This contradicts my thesis that every subject of an a_N -predication is an essence term.² Moreover, the middle term in the two syllogisms is predicated non-essentially as a *per se* accident of the minor term. This contradicts my thesis that every subject of an a_N -predication is predicated essentially of everything of which it is predicated. Thus, my account of the modal syllogistic implies that demonstrations such as D1 and D2 do not count as modal syllogisms of the form Barbara NNN. They may appear to be modal syllogisms in Barbara NNN. But if both premises of D1 and D2 are true, they violate the truth-conditions for a_N -propositions in Aristotle's modal syllogistic.

In my view, there are good reasons for embracing this consequence. First, Aristotle never says that demonstrations such as D1 and D2 are modal syllogisms of the form Barbara NNN. Moreover, it is worth noting that, while such demonstrations appear frequently in the second book of the *Posterior Analytics*, they are absent from the first book. All examples of such demonstrations mentioned by Bronstein and Leunissen are from the second book. In the first book, Aristotle focuses on Bronstein's Model 1 demonstrations, in which the middle term signifies (part of) the essence of the minor term. In what follows, I argue that demonstrations such as

¹ In the *Analytics*, Aristotle seems to treat mathematical terms such as 'line', 'unit', 'number', and 'triangle' as substance terms (see Ross 1949: 633, Goldin 1996: 72–5, Malink 2013: 160 n. 15).

² See Thesis 2 in section 3 of the précis.

D1 and D2 are in tension not only with my account of the modal syllogistic, but also with the account of scientific demonstration given by Aristotle himself in the first book. In particular, I show that they violate the theory of predication developed by Aristotle in chapters 1.4 and 1.22 of the *Posterior Analytics*.

In chapter 1.4 of the *Posterior Analytics*, Aristotle distinguishes between two classes of items: *per se* items and accidents. He characterizes them as follows:³

Certain items are not said of some other underlying subject: e.g., whereas what is walking is walking in virtue of being something different (and similarly for what is white), substances and whatever signifies some 'this' are not just what they are in virtue of being something different. Thus, items which are not said of an underlying subject I call *per se* items, and those which are said of an underlying subject I call accidents. (*Post. An.* 1.4 73b5–10)

Per se items are not said of an underlying subject; they are what they are not in virtue of being something else. Since this is the third sense of '*per se*' introduced in chapter 1.4, they are often called *per se*₃ items. Accordingly, a linguistic expression which signifies such an item is called a *per se*₃ term. Examples of *per se*₃ terms are 'man' and 'log'.⁴ By contrast, accidents are said of an underlying subject. For example, walking is said of a man as an underlying subject. What is walking is walking in virtue of being something else, e.g. a man. An expression which signifies such an item is called an accidental term (e.g., 'white' and 'walking').

In chapter 1.22, Aristotle states that *per se*₃ terms are predicated essentially of everything of which they are predicated:

Items which signify substance signify just what or just a subspecies of what is that of which they are predicated. Items which do not signify substance but are said of some other underlying subject which is neither just that item or just a subspecies of that item, are accidents; e.g., white is said of man. (*Post. An.* 1.22 83a24–8)

In this passage, Aristotle invokes the distinction between *per se*₃ items and accidents introduced in chapter 1.4. In the second sentence of the passage, Aristotle discusses accidents such as white. The first sentence, on the other hand, deals with *per se*₃ items. Aristotle states that, for any C, if a *per se*₃ term is predicated of C, then this *per se*₃ term signifies just what C is or

³ See McKirahan 1992: 93–4, Barnes 1994: 114–17.

⁴ See *Post. An.* 1.22 83a9–14.

just a subspecies of what C is. Thus, *per se*₃ terms are predicated essentially of everything of which they are predicated:⁵

Thesis A: For any B, if B is a *per se*₃ term then B is predicated essentially of everything of which B is predicated.

It follows from this that the middle and major terms in D1 and D2 are not *per se*₃ terms but accidental terms, since they are predicated non-essentially of the minor term.

In chapter 1.22, Aristotle sets forth a complex theory of predication that serves as the basis for his proof that there are no infinite chains of demonstration. According to this theory, only *per se*₃ terms can be subjects of predication, whereas accidental terms cannot be subjects of genuine predication:

We have supposed that one thing is predicated of one thing, and that items which do not signify what something is are not predicated of one another. For they are all accidental... and we say that all of them are predicated of some underlying subject, and that what is accidental is not an underlying subject; for we posit nothing of this type which is not called what it is called in virtue of being something different. (*Post. An.* 1.22 83b17–23)

The first sentence of this passage deals with ‘items which do not signify what something is’. These are items which fail to be *per se*₃ items, i.e., they are accidents. Aristotle states that accidents are not predicated of one another. In other words, if A and B are accidents, then A is not predicated of B.⁶ More generally, no accident can be the subject of a genuine predication. In Aristotle’s view, predications whose subject is an accident are deficient predications known as unnatural predications (83a1–18; cf. 81b23–29). Scientific demonstrations must not involve any unnatural predications, but only natural predications whose subject is a *per se*₃ item (83a18–21). In particular, this is true of any a_N -predications that might appear in the premises and conclusions of scientific demonstrations.⁷ Thus, the following holds for scientific demonstrations:

⁵ Similarly, Barnes (1994: 177) Barnes takes this passage to state that substance terms are predicated essentially of everything of which they are a_X -predicated. Thus, he takes the phrase ‘items which signify substance’ (τὰ μὲν οὐσίαν σημαίνοντα) at 83a24 to pick out the class of substance terms. However, it is clear from the context that this phrase is meant to pick out the class of *per se*₃ terms as described in 1.4 73b5–10, whether or not this class coincides with the class of substance terms. A case can be made that the class of *per se*₃ terms does not coincide with the class of substance terms but with the class of essence terms (see n. 8 below).

⁶ For this interpretation of αὐτὰ δὲ αὐτῶν, ὅσα μὴ τί ἐστι, μὴ κατηγορεῖσθαι at 83b18–19, see Hamlyn 1961: 120–1.

⁷ In chapter 1.22, Aristotle describes the chains of predications that underlie chains of universal affirmative demonstrations in Barbara, whether these are taken to be in assertoric Barbara or in Barbara NNN.

Thesis B: For any A and B, if A is a_N -predicated of B then B is a *per se*₃ term.

This thesis is violated by D1 and D2 because their middle terms are not *per se*₃ terms while being subjects of a_N -predications. Thus, D1–2 and the other examples of Model 2 demonstrations given by Bronstein and Leunissen are in conflict with the theory of predication that Aristotle presents in *Posterior Analytics* 1.22. In particular, their major premise violates Aristotle's requirement that unnatural predications are not admissible in scientific demonstrations. On the other hand, the theory from chapter 1.22 fits well with the Model 1 demonstrations that Aristotle discusses in the first book of the *Posterior Analytics*. The overall impression, then, seems to be that the two books of the *Posterior Analytics* focus on two distinct kinds of demonstration, and that the theory of predication in chapter 1.22 is intended to capture only Model 1 demonstrations but not demonstrations such as D1 and D2.

In the same way, I suggest, the modal syllogistic is intended to capture Model 1 demonstrations but not demonstrations such as D1 and D2. If this is correct, the scope of the modal syllogistic is restricted just as that of the theory of predication in chapter 1.22. My account of the validity of Barbara NXN is in accordance with Model 1 demonstrations and with the theory in chapter 1.22. In fact, Theses A and B above closely correspond to Theses 1 and 2 which I attribute to Aristotle on the basis of the theory of predication developed in the *Topics* (see section 3 of the précis).⁸ The former two theses justify the validity of Barbara NXN just as the latter two theses justify it. Thus, my account of the validity of Barbara NXN is supported not only by the theory of predication presented in the *Topics* but also by the one presented in the first book of the *Posterior Analytics*.

According to *Posterior Analytics* 1.22, accidental terms cannot serve as subjects of any predication (i.e., of any natural predication). In particular, they cannot serve as subjects of any genus-predication or differentia-predication. This means that they do not have a definition by genus and differentia nor an essence that could be described by such a definition.⁹ If by definition is meant definition by genus and differentia, these items do not

⁸ The correspondence is especially close if the class of *per se*₃ terms turns out to coincide with the class of essence terms. It is generally agreed that every substance term is a *per se*₃ term. Moreover, it may be argued that the class of *per se*₃ terms as described in the first book of the *Posterior Analytics* coincides with the class of essence terms. It is beyond the scope of this essay to argue for this claim, but a possible starting point for such an argument might be Michael Frede's observation that the phrase $\tau\acute{\iota}\ \acute{\epsilon}\sigma\tau\acute{\iota}\nu$ at *Post. An.* 1.22 83a21 picks out predications whose predicate is an essence term (i.e., a term that falls into the category of $\tau\acute{\iota}\ \acute{\epsilon}\sigma\tau\acute{\iota}$ introduced at *Topics* 1.9 103b22); see Frede 1981: 19 and Malcolm 1981: 669.

⁹ See Hamlyn 1961: 121.

have a definition.¹⁰ However, this does not exclude that they have some other kind of definitional account. Bronstein shows that, in the second book of the *Posterior Analytics*, Aristotle takes accidental terms to have some kind of definitional account.¹¹ Crucially, however, this cannot be a definition by genus and differentia but must be another kind of definition.¹² Likewise, when I claim that non-essence terms do not have a definition or essence, I mean that they do not have a definition by genus and differentia or an essence specifiable by such a definition (since this is the only kind of definition recognized in the *Topics*).¹³ Again, this does not exclude that they have another kind of definition or essence, one not amenable to analysis by genus and differentia.

3. Strong Essentialism: Reply to Bronstein

My account of the validity of Barbara NXN relies on the principle that every subject of an a_N -predication is the subject of an essential predication:

S11: If there is an A such that $Aa_N B$, then there is a C such that C is predicated essentially of B. (p. 126¹⁴)

I justify this principle by appealing to David Charles's view that, for Aristotle, 'the essence is the one cause of all the kind's derived necessary properties'. Thus, Charles attributes to Aristotle the following form of strong essentialism:

Strong Essentialism: The essence of a subject is the sole (one and only) cause of all of that subject's necessary accidents.

Bronstein argues that Strong Essentialism is an implausible view, since the necessary accidents of a given subject might have causes other than that subject's essence. It is true that, by referring to Charles's view, I am invoking Strong Essentialism. However, Strong Essentialism is dispensable in my account of the validity of Barbara NXN; for its only function in that account is to justify S11, but this is equally justified by the following principle of Weak Essentialism:

¹⁰ In *Posterior Analytics* 1.22, Aristotle takes definitions to consist of genus and differentia (see 83a39–b1; cf. McKirahan 1992: 90, 111–15 and Goldin 2010: 158).

¹¹ See footnote 10 of Bronstein's comments.

¹² Similarly, Ross argues that, according to *Posterior Analytics* 2.9 and 2.13, substances are defined by means of genus and differentia, whereas attributes and properties are defined not by means of genus and differentia but by another kind of definition discussed in chapter 2.8 (Ross 1949: 78 and 633; see also Goldin 1996: 12 and 126–41).

¹³ See Malink 2013: 123–4 and 136–9.

¹⁴ Here and in what follows, page references are to *Aristotle's Modal Syllogistic* (Malink 2013), unless otherwise noted.

Weak Essentialism: The essence of a subject is a cause (perhaps one among several) of all of that subject's necessary accidents.

To justify S11 it suffices that every necessary accident is caused at least in part by the subject's essence, whether or not there are other causes apart from this essence. In *Aristotle's Modal Syllogistic*, I fail to distinguish between Strong and Weak Essentialism, and give the misleading impression that my account relies on the former where in fact it only relies on the latter. In view of Bronstein's helpful comments, it is preferable to justify S11 by appealing to Weak Essentialism instead of Strong Essentialism.

Now, Bronstein also argues that I am committed to Strong Essentialism because it is a consequence of my S9–11 (see section 7 of his comments). However, Bronstein's argument relies on the assumption that every scientific demonstration of a universal affirmative truth is a modal syllogism of the form Barbara NNN. This assumption is not correct, nor do I endorse it in *Aristotle's Modal Syllogistic*. For example, as I argued above, D1 and D2 are scientific demonstrations of universal affirmative truths, but they cannot be viewed as syllogisms of the form Barbara NNN. Given that the assumption is rejected, Bronstein's argument from S9–11 to Strong Essentialism fails. Contrary to what Bronstein suggests, then, my account of the validity of Barbara NXN does not commit Aristotle to Strong Essentialism.

4. *Prior Analytics* 1.34: Reply to Leunissen

In chapter 1.34 of the *Prior Analytics*, Aristotle considers the following two syllogisms of the form Celarent NXN (see pp. 153–6):

- S1 Health necessarily belongs to no illness
 Illness belongs to all man
 Therefore, health necessarily belongs to no man
- S2 Being healthy necessarily belongs to no ill
 Being ill belongs to all man
 Therefore, being healthy necessarily belongs to no man

Aristotle introduces S1 as an apparent counterexample to Celarent NXN (48a2–8). He mentions S2 in the course of explaining why S1 is not a genuine counterexample to Celarent NXN (48a8–12). My interpretation of Aristotle's discussion of S1–2 in chapter 1.34 is not original but is the one given by Alexander of Aphrodisias in his commentary on the *Prior Analytics* (353.8–354.31). Leunissen rejects this interpretation on the following grounds:

Note, however, that while under Malink's interpretation the major premise [of S1] is set out correctly (because the premise in its original formulation is true), Aristotle's own strategy for dealing with the counterexample involved pointing to the falsity of this premise, which becomes apparent once the terms have been set out correctly.

This is not correct. Aristotle's strategy for dealing with S1 does not involve pointing to the falsity of the major premise of S1. On the contrary, Aristotle states that the major premise of S1 is true.¹⁵ He does so in the second sentence of the following passage:

Mistakes frequently will happen because the terms in the premise have not been well set out, as, for example, if A is health, B stands for illness, and C for man. For it is true to say that it is not possible for A to belong to any B, for health belongs to no illness, and again that B belongs to all C, for every man is susceptible of illness. It might seem to result, then, that it is not possible for health to belong to any man. (*Prior Analytics* 1.34 47b40–48a8)

Aristotle states that the major premise of S2 is false (48a11–12), but he does not state that the major premise of S1 is false.

Moreover, Leunissen writes:

Given Malink's model and its emphasis on essential predication, one would expect that 'good' examples of syllogisms (such as here of the Celarent-type) involve essential predications and B-terms that pick out essence terms. In contrast, what seems to be doing the 'fixing' of the premises (i.e. the kind of fixing through which one can avoid mistakes and can formulate valid deductions) in this particular example—and possibly many others—is the replacement of non-substance essence terms by non-essence terms, which yield non-essential predications.

Again, this is not convincing. Both S1 and S2 are valid syllogisms in Celarent NXN. The problem with them is not that they are invalid, but that they have a false premise: S1 has a false minor premise, and S2 has a false major premise. When Aristotle claims in chapter 1.34 that essence terms should be replaced by non-essence terms, he does not state a general prohibition against using essence terms in syllogisms. Rather, his point is that in syllogisms such as S1 the essence term which serves as the middle term should be replaced by a non-essence term because otherwise the minor premise will be false (since no non-substance essence term is a_X -predicated of a substance term).¹⁶

¹⁵ See Alexander's commentary at 353.25–6 and 354.9–12.

¹⁶ See Alexander's commentary at 353.16–17, 354.2–6, and 354.16–18.

5. Modal Syllogistic vs. Propositional Modal Logic: Reply to Beere

The modalized propositions which serve as premises and conclusions of Aristotle's modal syllogisms have a tripartite syntax. They consist of a predicate term, a subject term, and a modally qualified copula (pp. 23–8). For example, the proposition

$Ae_M B$ A one-sided-possibly belongs to no B

consists of a predicate term 'A', the subject term 'B', and a modally qualified copula ' e_M '. Thus, the modal qualifier 'one-sided-possibly' is regarded as part of the copula. Accordingly, the propositions of Aristotle's modal syllogistic do not involve any propositional modal operators or modal predicates such as 'Poss(...)' and 'Nec(...)'. On the other hand, Aristotle also employs a framework of propositional modal logic that does involve such propositional modal qualifiers. He introduces this framework in *Prior Analytics* 1.15 and *Metaphysics* Θ 4, and puts it to wide-ranging use throughout his writings. In particular, he uses it in *Prior Analytics* 1.15 to establish the validity of XQM-syllogisms such as Celarent XQM:

Major premise:	$Ae_X B$	A belongs to no B
Minor premise:	$Ba_Q C$	B two-sided-possibly belongs to all C
Conclusion:	$Ae_M C$	A one-sided-possibly belongs to no C

Aristotle's proof of Celarent XQM (34b22–7) can be represented as follows:¹⁷

- | | | |
|-----|-------------------------|---|
| 1. | $Ae_X B$ | [major premise] |
| 2. | $Ba_Q C$ | [minor premise] |
| 3. | Not $Ae_M C$ | [assumption for <i>reductio</i>] |
| 4. | Nec(Not $Ae_M C$) | [from 3, by principle of necessitation] |
| 5. | $Ba_Q C$ | [iterated from 2] |
| 6. | Poss($Ba_X C$) | [from 5, by AQ-POSS] |
| 7. | $Ba_X C$ | [assumption for possibility rule] |
| 8. | Not $Ae_M C$ | [importation: 4] |
| 9. | Not $Ae_M B$ | [from 7, 8, by contraposited version of Celarent MXM] |
| 10. | Poss(Not $Ae_M B$) | [possibility rule: 6, 7–9] |
| 11. | $Ae_M B$ | [from 1] |
| 12. | Not Poss(Not $Ae_M B$) | [from 11, by principle of necessitation] |
| 13. | $Ae_M C$ | [<i>reductio</i> : 3–10, 12] |

This proof relies on two bridging principles connecting the propositions of Aristotle's modal syllogistic with his framework of propositional modal logic. These bridging principles are invoked in lines 4, 6, and 12 of the proof. One of them is:

¹⁷ See Malink & Rosen 2013: 973–8.

AQ-POSS: If $Ba_Q C$, then $Poss(Ba_X C)$

The other is a principle of necessitation for modalized propositions:

Principle of necessitation: Where 'Y' stands for any N-, Q-, or M-proposition:
If Y then $Nec(Y)$;
If Not Y then $Nec(Not Y)$

While the principle of necessitation is invalid for assertoric (non-modalized) propositions, it is plausible for modalized N-, Q-, and M-propositions.

Now, Beere appeals to two similar bridging principles in his argument for the inconsistency of $Aa_N B$ and $Ae_Q B$. These principles can be formulated as follows (where 'y' is a placeholder for 'a', 'e', 'i', 'o'):

EQ-POSS: If $Be_Q C$, then $Poss(Be_X C)$
N-NEC: If $Ay_N B$, then $Nec(Ay_N B)$

The former principle is a version of AQ-POSS for e_Q -propositions instead of a_Q -propositions; the latter is a special case of the principle of necessitation applied to N-propositions. Each of these principles is plausible in itself. Nevertheless, as Beere points out, I must reject one of them in order to block his argument for the inconsistency of a_N - and e_Q -propositions.¹⁸ Beere suggests that I should reject EQ-POSS. In what follows, I argue that it is preferable to retain EQ-POSS and to reject N-NEC instead.

It is true that Aristotle does not appeal to EQ-POSS in chapter 1.15 or elsewhere in the *Prior Analytics*. Still, this principle closely corresponds to AQ-POSS, which plays a vital role in his proofs of XQM-syllogisms in *Prior Analytics* 1.15. Rejecting the one while endorsing the other seems to be an ad hoc and unmotivated solution. Moreover, the reasons Beere gives for rejecting EQ-POSS apply equally to AQ-POSS. Beere argues that EQ-POSS should be rejected on the grounds that the sense of 'possible' that pertains to the e_Q -copula is different from the sense of 'possible' that pertains to 'Poss(...)' . The former, he argues, is a wide notion of possibility which he tentatively labels 'conceptual' possibility, whereas the latter is an extensionally narrower notion of possibility which he tentatively labels 'real' possibility. The same reasoning, when applied to a_Q -propositions, leads to rejection of AQ-POSS. For, given that the e_Q -copula is associated with a wide notion of possibility, the a_Q -copula should be associated with the same wide notion of possibility, too (especially since Aristotle takes $Aa_Q B$ to be equivalent to $Ae_Q B$).

¹⁸ In addition, Beere's argument relies on ACT (i.e., N-X-subordination). I follow Beere in accepting this principle and not calling it into doubt (see pp. 130–2).

In view of this, we may consider retaining EQ-POSS and rejecting N-NEC instead.¹⁹ This is promising because there is independent reason to deny the principle of necessitation for N-propositions. For, if the principle is accepted for N-propositions, Aristotle's framework of propositional modal logic allows him to prove the validity of modal syllogisms which he rejects. For example, the validity of Barbara NQN (which he rejects) could be proved as follows:²⁰

1.	Aa _N B	[major premise]
2.	Ba _Q C	[minor premise]
3.	Not Aa _N C	[assumption for <i>reductio</i>]
4.	Nec(Not Aa _N C)	[from 3, by principle of necessitation]
5.	Ba _Q C	[iterated from 2]
6.	Poss(Ba _X C)	[from 5, by AQ-POSS]
7.	Ba _X C	[assumption for possibility rule]
8.	Not Aa _N C	[importation: 4]
9.	Not Aa _N B	[from 7, 8, by contraposposed version of Barbara NXN]
10.	Poss(Not Aa _N B)	[possibility rule: 6, 7–9]
11.	Not Poss(Not Aa _N B)	[from 1, by principle of necessitation]
12.	Aa _N C	[<i>reductio</i> : 3–10, 11]

In this proof, the principle of necessitation is applied to N-propositions in lines 4 and 11. The latter application is an instance of N-NEC, provided that 'Nec(...)' is equivalent to 'Not Poss(Not ...)'. Similar proofs can be given to establish the validity of other NQN-syllogisms that are rejected by Aristotle, such as Celarent, Ferio, Felapton, and Ferison NQN (see n. 20).

In Aristotle's own proofs of XQM-syllogisms, on the other hand, the principle of necessitation is only applied to M-propositions but not to N-propositions. Thus, the best way to block the unwanted proofs of NQN-syllogisms while preserving Aristotle's proofs of XQM-syllogisms is to restrict the principle of necessitation to M- and Q-propositions, and deny it for N-propositions. The same restriction also blocks Beere's argument for

¹⁹ As Jonathan points out, accepting EQ-POSS and AQ-POSS leads to difficulties in my predicable semantics since any two non-substance essence terms are e_Q- and a_Q-predicated of one another in this semantics (at least if they are not a_X-predicated of any substance term; see pp. 151 and 324–5). For present purposes, however, this difficulty is of less concern because it is due to a specific limitation of the predicable semantics rather than to Aristotle's modal syllogistic itself (see pp. 259–60). In *Aristotle's Modal Syllogistic*, I claim that any two non-substance terms are a_Q-predicated of one another in the predicable semantics (p. 259). As Adam Cramer pointed out to me, this is not correct. Instead, any two non-substance terms are i_Q-predicated of one another in the predicable semantics, and any non-substance term is a_Q-predicated of every atomic non-substance term (for atomic terms, see p. 244).

²⁰ See Malink & Rosen 2013: 979–82. Aristotle does not explicitly discuss Barbara NQN. However, he denies the validity of Barbara NQX (1.16 35b26–8). Given N-X-subordination, this implies the invalidity of Barbara NQN. Moreover, Aristotle denies the validity of Celarent and Ferio NQN (1.16 35b34–6; see Ebert and Nortmann 2007: 591) and of Felapton and Ferison NQN (1.22 40a9–11). Given this, it is clear that he rejects Barbara NQN.

the inconsistency of a_N - and e_Q -propositions, since N-NEC is no longer available.

In an earlier paper, Jacob Rosen and I dismissed this restriction of the principle of necessitation to M- and Q-propositions as an ad hoc solution with little intrinsic plausibility.²¹ But now it turns out that this restriction solves not only the problem with NQN-syllogisms but also the problem raised by Beere. So there seems to be good reason for accepting the restriction since it allows us to solve two independent problems concerning the interaction of Aristotle's modal syllogistic with his propositional modal logic.

By rejecting N-NEC we attribute to Aristotle the view that an N-proposition can be true without being necessary. In some cases, Aristotle will have to claim:

$Aa_N B$ and Not Nec($Aa_N B$)

Adapting Beere's suggestion to the case of N-propositions, we may take this to show that the sense of 'necessary' that pertains to the a_N -copula is different from the sense of 'necessary' that pertains to 'Nec(...)'. The former is a wide notion of necessity, whereas the latter is an extensionally narrower notion of necessity. Thus, an a_N -proposition may be true on the grounds that A necessarily belongs to all B in the wide sense, and yet it need not be necessary in the narrower sense that A necessarily belongs to all B in the wide sense.

The wide notion of necessity corresponds to a narrow notion of possibility, whereas the narrower notion of necessity corresponds to a wider notion of possibility.²² Using Beere's terminology, the former may be labeled 'real' necessity whereas the latter may be labeled 'conceptual' necessity. Alternatively, the two notions might be distinguished according to the source of the necessity in question. For example, one may suggest that A necessarily belongs to all B in the narrow sense if the necessity in question derives from the essence of B alone, whereas A necessarily belongs to all B in the wider sense if the necessity derives not only from the essence of B but also from other sources.²³ Consider the following example from *Metaphysics Z 15*:

²¹ Malink & Rosen 2013: 981.

²² Thus, the present suggestion differs from Beere's suggestion in that it takes Aristotle's propositional modal logic to be associated with a narrow notion of necessity which corresponds to a wide notion of possibility, whereas Beere takes it to be associated with a narrow notion of possibility which corresponds to a wide notion of necessity.

²³ I am indebted to Alan Code for this suggestion and for the reference to the passage from *Metaphysics Z 15*.

The impossibility of defining particulars escapes notice in the case of eternal things, especially those that are unique, like the sun and the moon. People err in including attributes which could be removed without preventing it still being the sun, for instance 'going round the earth' or 'hidden at night'. For from their view it follows that if it stood still, or was visible at night, it would no longer be the sun. But this is absurd, for the sun signifies a certain substance. (*Metaphysics* Z 15 1040a29–33)

According to this passage, going round the earth is not an essential attribute of the sun. Nevertheless, Aristotle regards it as a necessary attribute, since he takes it to be necessary that the sun is going round the earth.²⁴ At the same time, the passage makes it clear that the necessity of the sun's going round the earth does not derive from the essence of the sun alone. For Aristotle states that even if, *per impossibile*, the sun stood still and stopped going round the earth, it would still be the same substance, namely, the sun. Thus, not going round the earth is compatible with the essence of the sun. This means that the necessity of the sun's going round the earth does not derive from the essence of the sun alone but must have other sources (including, e.g., the essence of the earth). The same is presumably true for the planets: the necessity of their going round the earth does not derive from their essence alone but must have other sources too.

Now, let an a_N -proposition be true if the necessity with which the predicate belongs to all of the subject derives at least in part from the essence of the subject but may also derive from other sources (see the reply to Bronstein in section 3 above). By contrast, $Nec(Aa_XB)$ and $Nec(Aa_NB)$ are taken to be true only if the necessity of the underlying a_X - or a_N -proposition derives from the essence of B alone. Consequently, if 'A' stands for 'going round the earth' and 'B' stands for 'planets', Aa_NB is true but both $Nec(Aa_XB)$ and $Nec(Aa_NB)$ are false. As a result, N-NEC and the principle of necessitation fail for a_N -propositions.

A similar strategy can be used to account for the compatibility of a_N - and e_Q -propositions to which Aristotle is committed. The e_Q -copula may be associated with a wide notion of possibility according to which Ae_QB requires that Ae_XB be compatible with the essence of B without requiring that it be compatible with the essence of other items. On this interpretation, Ae_QB will be true if 'A' stands for 'going round the earth' and 'B' stands for 'planets', because it is compatible with the essence of the planets that they are not going round the earth (even if it is incompatible with the essence of other items). Thus, Aa_NB and Ae_QB are true at the same time.

In this way, a number of problems in Aristotle's modal logic can be solved by associating the a_N -copula with a wide notion of necessity and the

²⁴ See Bostock 1994: 222.

e_Q -copula with a wide notion of possibility, while ‘Nec(. . .)’ is associated with a narrow notion of necessity and ‘Poss(. . .)’ with the corresponding wide notion of possibility. Of course, this is a schematic sketch of a solution which needs to be worked out in more detail (e.g., it needs to be extended to the e_N -, i_N -, and o_N -copulae). Nevertheless, this seems to be a promising way to solve not only the problem raised by Beere, but also the problems concerning NQN-syllogisms and the compatibility of a_N - and e_Q -propositions. If the solution is correct, Aristotle’s modal syllogistic coheres with his propositional modal logic better than is often thought.²⁵

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