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CAUSALITY AND COEXTENSIVENESS IN ARISTOTLE'S *POSTERIOR ANALYTICS* 1. 13

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1. Introduction

I N this paper I discuss an important feature of the notion of cause in *Post. An.* 1. 13, 78^{b}13–28. Some scholars have taken the passage as introducing a false principle about explanation[1] (or even a fallacy of conversion[2]). I claim that Aristotle is introducing *a logical requirement* for *being the strictly appropriate cause in a scientific demonstration*, namely: an appropriate cause must be coextensive with what it appropriately explains. Some interpretations tend in this direction, but do not account for the intricacies of the text and, furthermore, do not explain how Aristotle goes beyond negative causes expressed in the second-figure syllogisms. My interpretation provides a careful and full discussion of the intricate steps by which Aristotle presents the requirement. Furthermore, I argue that the requirement is completely consistent with an important feature of Aristotle's

[1] See J. Barnes, *Aristotle's* Posterior Analytics [*Posterior Analytics*], Clarendon Aristotle Series, 2nd edn. (Oxford, 1993), 157; also the bewilderment expressed by M. Mignucci, *Aristotele: Analitici secondi* [*Analitici*] (Rome and Bari, 2007), 197.

[2] Philoponus, *In An. Post.* 174. 34–175. 4 Wallies, exonerates Aristotle of such a charge. His diagnosis is correct: Aristotle is focusing on the relationships between causes and effects (cf. 175. 4–13).

notion of scientific explanation, namely, his insistence on *katholou* predications as understood in *Post. An.* 1. 4, 73^{b}26–74^{a}3.

The underlying subject of this paper is the notion of cause understood as one of the key notions involved in Aristotle's conception of scientific knowledge in the *Posterior Analytics*. For ease of reference, I shall use the expression 'primary cause' to refer to it. I shall not examine here Aristotle's general view on causes, or how it differs from other conceptions, such as the Humean one.[3] As for what 'cause' signifies for him, I shall assume that a cause for Aristotle is a real-world item (a substance's attribute, or a state of affairs, or a thing's essence, or an event, etc.) that grounds another real-world item—that makes it what it is. Perhaps 'ground' would be better than 'cause' as a translation of *aition*, but for simplicity's sake I shall retain the word 'cause'.[4]

The notion of causality in Aristotle's theory of demonstration is cast within the triadic framework of syllogisms: a cause is expressed as a *middle term* (*B*) which explains why a given attribute (*A*) is present in a given subject (*C*).[5] Aristotle's talk about causes can be very misleading, for sometimes (as in *Physics* 2. 3 or *Metaphysics Δ* 2) he does not make explicit the triadic structure of causal relations and,

[3] For more general accounts of Aristotle's notion of cause, which address many of those issues, see J. M. Moravcsik, 'Aristotle on Adequate Explanations', *Synthese*, 28 (1974), 3–17; id., 'What Makes Reality Intelligible? Reflections on Aristotle's Theory of *Aitia*' ['*Aitia*'], in L. Judson (ed.), *Aristotle's Physics* (Oxford, 1991), 31–47; M. Hocutt, 'Aristotle's Four Becauses', *Philosophy*, 49 (1974), 93–110; N. Stein, 'Causation and Explanation in Aristotle', *Philosophy Compass*, 6 (2011), 699–707; id., 'Aristotle's Causal Pluralism' ['Pluralism'], *Archiv für Geschichte der Philosophie*, 93 (2011), 121–47.

[4] See R. McKirahan, *Principles and Proofs: Aristotle's Theory of Demonstrative Science* [*Principles*] (Princeton, 1992), 2–3, 167, 231–2, for 'ground' as a translation of *aitia* or *aition* (my inspiration is not the current fashion regarding grounding in contemporary metaphysics). Many prefer 'explanation' as a translation of *aitia* (see Barnes, *Posterior Analytics*, 89). I stick with the traditional 'cause' just for the sake of simplifying my discussion. Another option would be to transliterate *aitia* and *aition* (see Moravcsik, '*Aitia*'). In this paper I cannot address the question of what is involved or implied in each translation.

[5] The notion of cause as middle term is officially presented in *Post. An.* 1. 2, 90^{a}5–11 and is found throughout Aristotle's discussion of demonstration (especially *Post. An.* 1. 13 and 2. 16–17, but also 1. 6, 75^{a}34–7; 1. 17, 80^{b}20–2; 1. 23, 84^{b}19–28; 1. 33, 89^{a}16; 2. 8, 93^{a}29 ff.; 2. 11, 94^{a}20–4; 2. 12, 95^{a}11–12). Aristotle is also concerned with the triadic framework for causes in *Metaphysics Z* 17. Cf. D. Charles, *Aristotle on Meaning and Essence* (Oxford, 2000), 37, 285–94; id., 'Definition and Explanation in *Posterior Analytics* and *Metaphysics*', in id., *Definition in Greek Philosophy* (Oxford, 2010), 286–328; S. Williams and D. Charles, 'Essence, Modality and the Master Craftsman', in E. Feser (ed.), *Aristotle on Method and Metaphysics* (New York, 2013), 121–45 at 123.

more importantly for the purposes of this paper, he seems to give different criteria for sorting out what counts as a relevant explanandum: sometimes the explanandum is explicitly introduced as the relation between a subject and a predicate, but sometimes Aristotle seems to take the predicate as the explanandum.[6] I cannot address this complicated question here. But, as it is important for my purposes to focus on the logical relations between the *B*-term and the *A*-term as attributes of a given subject, I shall prefer to take *A* as the 'effect'[7] or that *of which* the cause is cause.

I cannot go into details about Aristotle's notion of scientific demonstration, including whether it has an axiomatic model, or how we should understand the role of necessity, principles, and *per se* predications, except to the extent that they figure in my interpretation of the passage that constitutes my main focus. I shall briefly indicate some assumptions that are indispensable for my points.

First of all, it is important to get clear about what exactly is the object of the definition Aristotle is giving at *Post. An.* 1. 2, 71^{b}9–12. I take the definiendum to be a higher-level form of knowledge that can be labelled scientific knowledge. Thus, Aristotle is not concerned with giving an analysis of the general concept of knowledge. I side with those who take Aristotle's object as the notion of scientific understanding.[8] But, more particularly, Aristotle is not

[6] The more articulated story which prevails in Aristotle's analysis is the following: the *B*-term being the cause as a middle term, the *A*-term is treated as 'that *of which* the cause is cause' in contrast with the *C*-term as 'that *for which* the cause is cause' (2. 17, 99^{a}17–18). Aristotle sometimes says or suggests that the conclusion of a syllogism (as a predicative fact *AC*) is that *of which* the cause is cause (1. 2, 71^{b}22; *Pr. An.* 2. 15, 64^{b}10; 2. 17, 70^{a}9), and sometimes he uses the word *pragma* as equivalent to the *A*-term (2. 16, 98^{b}30), but sometimes *pragma* refers to an explanandum with predicative form (1. 2, 71^{b}11). For a different view of *pragma* see D. Bronstein, *Aristotle on Knowledge and Learning* [*Learning*] (Oxford, 2016), 54–6.

[7] I use 'effect' just for brevity's sake. What I mean by 'effect' is just the *A*-term or a predicative explanandum (*A–C*).

[8] See L. A. Kosman 'Explanation, Understanding and Insight in Aristotle's *Posterior Analytics*', in H. Lee, A. Mourelatos, and R. Rorty (eds.), *Exegesis and Argument: Studies in Greek Philosophy Presented to Gregory Vlastos* (Assen, 1973), 374–92; J. H. Lesher, 'Aristotle on ἐπιστήμη as Understanding', *Ancient Philosophy*, 21 (2001), 45–55; M. F. Burnyeat, 'Aristotle on Understanding Knowledge', in E. Berti (ed.), *Aristotle on Science: The* Posterior Analytics (Padua, 1981), 97–140; Bronstein, *Learning*. My overall view regarding the theory of demonstration in the *Posterior Analytics* is closer to McKirahan, *Principles*, 209–34, and M. Ferejohn, *Formal Causes* [*Formal*] (Oxford, 2013), 64–120. See L. Angioni, 'Aristotle's Definition of Scientific Knowledge (*APo* 71^{b}9–12)' ['Definition'], *Logical Analysis and History of Philosophy*, 19 (2016), 79–105, and id., 'Aristotle on Necessary Principles and on Explaining X through the Essence of X', *Studia Philosophica Estonica*, 7 (2014), 88–112.

ultimately concerned with explicating what a body of full scientific knowledge amounts to: he is ultimately concerned with explicating what—within such a body of knowledge—is the most important factor that makes it so special and puts it on a higher level. And this factor, as Aristotle will develop as he goes on in the *Posterior Analytics*, is the explanation through the most appropriate cause. Now, appropriate explanation in this context is not mere justification. Appropriate explanation involves the identification of real-world items that are primarily responsible for making their explananda what they are. Aristotle is aware that it is really hard to find explanations that count as the appropriate ones (1. 9, 76^{a}26–30), but he is interested in explicating in what they consist. Now, one important ingredient of the notion of an appropriate explanation is the notion of reciprocation between cause and effect: being a primary cause that delivers the appropriate explanation of its effect involves (but does not collapse into) being a necessary and sufficient condition for its effect to obtain. When this reciprocation is cast within the syllogistic framework of demonstrations, the result is (besides other things) that the middle term encapsulating the cause is coextensive with the major term it is meant to explain.

Now, on my view, the passage *Post. An.* 1. 13, 78^{b}13–28, is advancing just such a point: a primary cause must be coextensive with its effect. Aristotle's phrasing in 78^{b}13–28 is complicated and perhaps convoluted. The few discussions of it that we find in the literature are not satisfactory: they either disconnect the passage from the previous discussion about primary causes and so attribute to Aristotle a false principle about explanation in general,[9] or they see the connection between coextensiveness and primary (or proximate) causes, but fail to explain how Aristotle's point is a general one about scientific demonstrations and is not restricted to the negative causes expressed in second-figure syllogisms.[10] Thus, in offering a careful discussion of each step in the passage 78^{b}13–28, my aim is to show how Aristotle is coherently advancing a general point about primary causes which is not restricted either to negative cases or to second-figure syllogisms: primary causes must be coextensive with their effects. This picture also helps us to understand Aristotle's

[9] Barnes, *Posterior Analytics*, 157.
[10] e.g. Philoponus' commentary on the *Posterior Analytics*; W. D. Ross, *Aristotle's* Prior *and* Posterior Analytics*: A Revised Text with Introduction and Commentary* [*Prior and Posterior Analytics*] (Oxford, 1949), 557; McKirahan, *Principles*, 214.

insistence on *katholou* predications and hence to attain a more coherent and unified interpretation of the overall theory of scientific demonstrations presented in the *Posterior Analytics*.

2. Examination of the key passage 78ᵇ13–28

I shall divide the passage into five sections and refer to it as [T1]. Starting with a neutral translation (based on Barnes's), I discuss each section and in due course present a different translation:[11]

[T1] [1] καὶ γὰρ ἐν τούτοις τοῦ ὅτι καὶ οὐ τοῦ διότι ἡ ἀπόδειξις· οὐ
γὰρ λέγεται τὸ αἴτιον. οἷον διὰ τί οὐκ ἀναπνεῖ ὁ τοῖχος;   15
ὅτι οὐ ζῷον. [2] εἰ γὰρ τοῦτο τοῦ μὴ ἀναπνεῖν αἴτιον, ἔδει τὸ
ζῷον εἶναι αἴτιον τοῦ ἀναπνεῖν, [3a] οἷον εἰ ἡ ἀπόφασις αἰτία τοῦ
μὴ ὑπάρχειν, ἡ κατάφασις τοῦ ὑπάρχειν, [3a′] ὥσπερ εἰ τὸ ἀσύμ-
μετρα εἶναι τὰ θερμὰ καὶ τὰ ψυχρὰ τοῦ μὴ ὑγιαίνειν, τὸ
σύμμετρα εἶναι τοῦ ὑγιαίνειν—[3b] ὁμοίως δὲ καὶ εἰ ἡ κατάφα-   20
σις τοῦ ὑπάρχειν, ἡ ἀπόφασις τοῦ μὴ ὑπάρχειν. [4] ἐπὶ δὲ
τῶν οὕτως ἀποδεδομένων οὐ συμβαίνει τὸ λεχθέν· οὐ γὰρ
ἅπαν ἀναπνεῖ ζῷον. [5] ὁ δὲ συλλογισμὸς γίνεται τῆς τοιαύ-
της αἰτίας ἐν τῷ μέσῳ σχήματι. οἷον ἔστω τὸ Α ζῷον, ἐφ᾽
ᾧ Β τὸ ἀναπνεῖν, ἐφ᾽ ᾧ Γ τοῖχος. τῷ μὲν οὖν Β παντὶ   25
ὑπάρχει τὸ Α (πᾶν γὰρ τὸ ἀναπνέον ζῷον), τῷ δὲ Γ οὐ-
θενί, ὥστε οὐδὲ τὸ Β τῷ Γ οὐθενί· οὐκ ἄρα ἀναπνεῖ ὁ τοῖ-
χος. (78ᵇ14–28)

[1] For also in these cases the [attempted] demonstration is of the fact *that* but not of the reason *why*, for the cause is not stated. For instance: why do walls not breathe? Because walls are not animals. [2] If this were the cause of not breathing, being an animal would have to be the cause of breathing, [3a] that is, if the negation is the cause of something's not being attributed, then the affirmation is the cause of its being attributed ([3a′] thus if an imbalance of the hot and cold elements is the cause of not being healthy, their balance is the cause of being healthy), [3b] and, similarly, if the affirmation is the cause of something's being attributed, then the negation is the cause of its not being attributed. [4] But what was said does not obtain in the cases introduced (or explained) in that way: indeed, not every animal breathes. [5] The syllogism of this sort of cause comes about in the middle figure: for example, let *A* be animal, *B* breathing, *C* wall. *A* holds of every *B* (for everything which breathes is an animal), but of no *C*: hence *B* too holds of no *C*—therefore walls do not breathe. (trans. Barnes, modified)

[11] The Greek text is from Ross, *Prior and Posterior Analytics*, here preserving the lineation.

Aristotle is presenting an attempted demonstration in which the cause is not stated (step [1]). Although 'cause' does not go with any adjective there, I submit that Aristotle is talking about the cause which yields scientific understanding of the fact expressed in the conclusion of a demonstration: the *appropriate* or *primary cause*. Actually, he has mentioned the notion of a primary cause (τὸ πρῶτον αἴτιον) a few lines earlier: 'this syllogism is of the reason *why*, for the primary cause [τὸ πρῶτον αἴτιον] has been captured' (78ᵇ3–4). Aristotle refers to the syllogism that explains why planets do not twinkle through the middle term 'being near the Earth', which he has contrasted with the syllogism in which one infers that planets are near the Earth by their non-twinkling.¹² Thus, I argue that Aristotle's use of 'the cause' (τὸ αἴτιον) in *Post. An.* 78ᵇ15, 16, 17, picks up this same notion of a primary cause.¹³

In step [1] Aristotle is talking about a pattern of explanation which will be spelt out in step [5] as the following Camestres syllogism:

> Everything which breathes is an animal.
> Walls are not animals.
> ∴ Walls do not breathe.

Aristotle claims that such a syllogism does not capture the appropriate cause which would ultimately explain why walls do not breathe. Aristotle's point has not been understood: he is not interested in a general principle about explanations which will allow one to infer positive causes from negative ones (and vice versa), nor is he exclusively concerned with negative causes expressed in second-figure syllogisms.¹⁴ It might be useful to give a survey of the claims I shall argue for in what follows:

- In steps [2] and [3] Aristotle is introducing *a requirement* which

¹² More on this on sect. 5.

¹³ According to Philoponus, *In An. Post.* 174. 9–10 Wallies, Alexander has understood Aristotle as referring to the προσεχὴς αἰτία (proximate cause). Aristotle's use of τὸ αἴτιον (with no adjective) picks up the stricter notion of *primary* cause in many passages (1. 6, 75ᵃ35; 1. 13, 78ᵃ27; 1. 24, 85ᵇ25–6; *Post. An.* 2. 16).

¹⁴ See Barnes, *Posterior Analytics*, 157–8; Mignucci, *Analitici*, 197. Philoponus, *In An. Post.* 176. 8–177. 15 Wallies (esp. 176. 24–6, 177. 1–4), thinks that Aristotle's point is that a cause for a negative fact must be expressed in the second figure. Ross, *Prior and Posterior Analytics*, 553, gets the essentials of Aristotle's point (the same goes for McKirahan, *Principles*, 213–15), but is far from disentangling the argument and understanding its general reach. On the other hand, it is surely a disappointment that many scholars addressing Aristotle's theory of explanation avoid this passage.

a cause must satisfy for being the *appropriate and primary cause*
to explain a given explanandum; step [2] implies the require-
ment in contrast with the particular counter-example at stake,
but step [3] *moves* to a general introduction of the require-
ment: Aristotle presents the *logical features* which a cause must
display in order to be the primary cause capable of providing
strictly scientific understanding about a given explanandum;
(these logical features are only necessary but not sufficient con-
ditions for a cause to be primary).[15]

- In step [4] Aristotle explains what was implied in [2], namely,
  why the Camestres syllogism suggested at step [1] and spelt
  out in step [5] *fails at satisfying* the requirement. Then, the
  Camestres syllogism at [5] is employed as a *foil* for highlighting
  the requirement.

Let me develop these points as I proceed to step [2] of [T1]:

[2] εἰ γὰρ τοῦτο τοῦ μὴ ἀναπνεῖν αἴτιον, ἔδει τὸ
ζῷον εἶναι αἴτιον τοῦ ἀναπνεῖν. (78ᵇ16–17)

If this [=wall's *not being an animal*] were the cause of [wall's] *not breath-
ing*, being an animal would have to be the cause of [wall's] *breathing*. (my
translation)

It is clear not only from the previous context but also from the next
steps in Aristotle's discussion that τοῦτο at 78ᵇ16 means 'wall's not
being an animal': otherwise, the contrast between τοῦτο and τὸ ζῷον
(translated as 'being an animal') would be pointless. It is also im-
portant to note that τὸ ζῷον in this context works as shorthand for a
predicate attributed to wall (see Barnes's translation). What is most
important is that Aristotle is using a counterfactual mode[16] in [2],
and this fact points to step [4], which I translate as follows:

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[15] Aristotle *is not* saying that walls' not being an animal does not give *any* expla-
nation of walls' not breathing. He is saying that our Camestres does not capture
the primary cause (or 'the precise ground', as phrased by Ross, *Prior and Posterior
Analytics*, 553) that would give scientific understanding of walls' not breathing—and
this is compatible with the obvious truth that our Camestres gives at least *some* ex-
planation of its explanandum. Aristotle is not relying on a 'general principle about
explanation' (Barnes, *Posterior Analytics*, 157) that would allow him to pass from
any explanation of negative facts through negations to the explanation of the cor-
related positive fact through affirmations. His point is more specific: he is stating a
requirement for a cause to be the primary one for its explanandum.

[16] There is no ἄν particle in the apodosis etc., but Philoponus (*In An. Post.*
174. 26–8 Wallies), Ross (*Prior and Posterior Analytics*, 551, 553), and most trans-
lators (Barnes, *Posterior Analytics*, 20; Mignucci, *Analitici*, 39; G. R. G. Mure,

[4] ἐπὶ δὲ
τῶν οὕτως ἀποδεδομένων οὐ συμβαίνει τὸ λεχθέν· οὐ γὰρ
ἅπαν ἀναπνεῖ ζῷον. (78ᵇ21–3)

But what was said does not obtain in the cases introduced (or explained) in that way: indeed, not every animal breathes. (my translation)

Now, 'what was said' refers exactly to the requirement expounded in steps [2] and [3], so that Aristotle's point is that the Camestres syllogism to be spelt out in [5] and already implied in [1] and [2] ('the cases explained in that way') falls short of satisfying the requirement and so works as a foil to it. Thus—coming back to [2]—Aristotle's use of the counterfactual mode in step [2] *presupposes* the requirement and *actually states* that the present foil case does not meet it.

The requirement is then explicated in step [3] of [T1], which is the most difficult to unpack. The main difficulties involved in this step are the following: (i) what 'the negation' (ἡ ἀπόφασις) and 'the affirmation' (ἡ κατάφασις) are referring to; (ii) whether Aristotle's point is or is not restricted to negative explanations formulated in the second figure; (iii) why Aristotle needs [3b], which seems to be a redundant repetition of [3a].[17]

There are two ways of handling difficulty (i). A first option is to take the expression 'the negation' as an abbreviated reference to the negative sentence in which 'animal' is denied of 'wall' and, similarly, to take 'the affirmation' as an abbreviated reference to the affirmative sentence in which 'animal' would be universally predicated of 'wall'.[18] In this way, step [3] would remain entirely in the counterfactual mode: Aristotle would be indirectly introducing the requirement for being a primary cause by reporting a case in which the requirement is not fulfilled. The expression οἷον ('i.e.') would be indicating, then, a mere rephrasing of the same point made at step [2].

A second option is to take the expression 'the negation' not as

Posterior Analytics, in W. D. Ross (ed.), *The Complete Works of Aristotle Translated into English* (Oxford, 1925); P. Pellegrin, *Aristote: Seconds Analytiques* (Paris, 2005), 133) are right in translating or paraphrasing the sentence as a counterfactual.

[17] Another issue is (iv) why Aristotle has shifted from αἴτιον to αἰτία. But this shift is not important to my claims here. Aristotle just moves from the notion of an *explanatory factor* to the notion of an *explanation*.

[18] A Greek article can have demonstrative force in many contexts, and it might be misleading to translate it with a non-committal 'the' when the context makes it clear that the referent is *a given one*. See e.g. *NE* 6. 12, 1144ᵃ28 (with *dunamis*).

an abbreviated reference to the *specific* negative sentence in which 'animal' is denied of 'wall', but as an abbreviated reference to a *general* pattern of sentence in which a term (expressing a cause) is denied of another term—as if Aristotle has dropped the concrete terms ('wall', 'animal', 'breathe') and had in mind schematic letters ('*C*', '*B*', '*A*') instead. A similar story will apply to 'the affirmation'. In this option, Aristotle will be extracting a general point from his previous example. The expression οἷον ('i.e.') should be taken not as introducing a mere rephrasing, but as a sort of generalizing clarification.[19]

In any case, it is clear from the context that Aristotle has a syllogistic framework in mind: 'ἀπόφασις' ('the negation') and 'κατάφασις' ('the affirmation') pick up particularly the denial/affirmation *of a middle term* (be it the schematic letter *B* or a concrete term replacing *B*), and 'ὑπάρχειν' ('being attributed') and 'μὴ ὑπάρχειν' ('not being attributed') refer to the major term's being or not being attributed to something (either to the schematic letter *C* or to a concrete term replacing *C*). Thus, the middle term can be attributed or not to the minor term, and the major term can be attributed or not to the minor term: Aristotle is particularly concerned with settling whether the attributive tie between the middle term and the minor term is a ground for the major's being attributed (or not) to the minor term. Aristotle's issue is whether and how the minor premiss (*B–C*) grounds the conclusion (*A–C*).

Now, according to the first option, the translation of step [3] will be the following (let me call it 'Version 1' of step [3]):

[3a] *οἷον εἰ ἡ ἀπόφασις αἰτία τοῦ*
μὴ ὑπάρχειν, ἡ κατάφασις τοῦ ὑπάρχειν, . . .
. . .
—[3b] *ὁμοίως δὲ καὶ εἰ ἡ κατάφα-*
σις τοῦ ὑπάρχειν, ἡ ἀπόφασις τοῦ μὴ ὑπάρχειν. (78[b]17–21)

[*Version 1*] [3a] i.e. if animal's being denied of walls *were* the cause of breathing's not being attributed to walls, then animal's being asserted of walls

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[19] In favour of taking [3a] as a generalization is the fact that [3a′] introduces a different but equivalent example, as if Aristotle were concerned with saying: 'Don't get stuck on the particularity of my single example; I have generalized my point, and have another concrete example so that you may better understand me.' The fact that ἀσύμμετρα has the negation transposed into the predicate is irrelevant. Aristotle relies on the translatability of 'hot and cold being *in*commensurate' into 'hot and cold *not* being commensurate'. For discussion see M. Ferejohn, *The Origins of Aristotelian Science* [*Origins*] (New Haven, 1991), 136–7.

would be the cause of breathing's being attributed to walls . . . [3b] and, similarly, if animal's being asserted of walls *were* the cause of breathing's being attributed to walls, then animal's being denied of walls *would be* the cause of breathing's not being attributed to walls. (my translation)

According to the second option for taking step [3], its translation (let it be called 'Version 2') will be something like this:

[*Version 2*] [3a] that is, if *B*'s being denied of *C is* the cause of *A's* not being attributed to *C*, then *B*'s being asserted of *C would be* the cause of *A* being attributed to *C* . . . [3b] and, similarly, if *B*'s being asserted of *C is* the cause of *A's* being attributed to *C*, then *B*'s being denied of *C would be* the cause of *A not* being attributed to *C*. (my translation)[20]

According to Version 2, steps [3a] and [3b] describe some *logical* features of the general notion of a primary cause. In Version 2, only the consequents of the conditionals advanced in [3a] and [3b] must be taken in the counterfactual mode, whereas the antecedent must be formulated in the indicative. I shall explain later why there is such a difference between the antecedent and the consequent. For the time being, I remark that in Version 1, in its turn, explicit reference to the attempted demonstration of why walls do not breathe requires the antecedent of the conditionals to be in the counterfactual mode too. Cases explained in this way—namely, following the pattern of the logical relations between the concrete terms of the Camestres syllogism implied in [2]—illustrate the requirement by presenting a situation in which it is not satisfied. On the other hand, Version 2 attains more generality in expressing the requirement itself by avoiding concrete terms. In what follows I shall argue that Version 2 should be adopted.

Let me spell out the requirement. Take the Camestres schema, which is presupposed by Aristotle in step [2] and actually used in step [5] of [T1]:

> Every *A* is *B*.
> No *C* is *B*
> ∴ No *C* is *A*.

'Its negation' (in step [3a]) might be taken to refer to the minor premiss of the Camestres schema: this premiss denies that *B* is

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[20] I thank an anonymous referee for improving my formulation here.

attributed to *C*. And 'not being attributed' (78^{b}17–18) is shorthand
for '*A's not being attributed to C*', which is what the conclusion ex-
presses. Thus, when Aristotle says (in the antecedent of [3a]) that
'its negation is an *aitia* for not being attributed', he thereby de-
scribes a logical property of the primary cause as it can be displayed
in a Camestres schema:[21] if *B* is the primary cause of *A*, then the
fact that *B* is denied of something (as it is of *C* in the minor premiss
of the Camestres) entails the denial of the attribute it primarily ex-
plains; *A* is not attributed to *C* either. Let me provisionally call
this logical property the *first formal* condition for being a primary
cause.

But this, of course, is not the end of the story. The *first formal*
condition, as depicted in the previous paragraph, is incomplete in
itself: it is only a logical property shared by many other middle
terms which deliver sound Camestres syllogisms but *are not*
primary causes. This is why the second part of [3a] is strictly
needed. It works as a second half of the requirement for primary
causes: 'its affirmation is an *aitia* for being attributed'. Now, this
second half of the requiment is precisely what fails in our Camestres
case about walls' not breathing. If things were contrary to what
is stated in its minor premiss—that is, if walls were animals—this
would not entail that walls would breathe, for, in Aristotle's view,
there are some species of animals that do not breathe. The inference
from walls' being animals to walls' breathing would be a 'fallacy
of the consequent' (cf. *SE* 167^b 1–3) in the second figure. In order
to get a sound inference, the major premiss should be convertible:
'all animals breathe' should also be true. But this sentence is false
in Aristotle's view.[22]

Thus, the conjunction of the first and the second halves of the
requirement implies that a primary cause reciprocates with the
attribute it is meant to explain.[23] What one gets from picking up
together the antecedent and the consequent of the conditional
expressed in [3a] is a schema stating that *B* and *A* are convertible.

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[21] The Camestres schema is useful for displaying the logical property Aristotle is
highlighting, but this does not imply that Aristotle's point is restricted to second-
figure syllogisms. More on this later.

[22] Cf. *Resp.* 1, 470^{b}9–10; *PA* 4. 5, 678^{b}1; 4. 13, 697^{a}21.

[23] For a similar result see Philop. *In An. Post.* 175. 7–13 Wallies; McKirahan, *Prin-
ciples*, 214. On reciprocation of causal relations see *Post. An.* 2. 16–17 and *Cat.* 12
(where the causal priority of a cause over its effect is compatible with the reciproca-
tion in their mutual *implication of being the case*, 14^{b}10–24).

But this convertibility is meant as a condition for primary causes, not as a general rule about any sort of explanation whatsoever.[24]

Let me spell this out carefully. First, take the antecedent itself ('C's not being B is the *aitia* of C's not being A') as a conditional such as 'if C is not B, then C is not A' and translate it into predicate calculus:

[3a] (*Antecedent*) $\forall x\ (\neg Bx \rightarrow \neg Ax)$.

Take also the consequent ('C's being B is the *aitia* of C's being A') as a conditional ('if C is B, then C is A') and translate it into formal language:

[3a] (*Consequent*) $\forall x\ (Bx \rightarrow Ax)$.

Now, one should be very careful in employing such formalizations, for Aristotle is definitely not committed to a fallacy of conversion such as the following (let it be labelled [3a*] for future reference):

[3a*]: $\forall x\ ((\neg Bx \rightarrow \neg Ax) \rightarrow (Bx \rightarrow Ax))$.

Aristotle's point was never meant as an inference from the antecedent to the consequent of [3a*]. A reading of [3a] in terms of an intended inference would lead us to attribute a fallacy to Aristotle.[25] Now, it is clear that Aristotle did not mean [3a] as an inference valid for any proposition whatsoever in general, but something restricted to explanations. However, even with such a restriction, one might be tempted to see [3a] as stating an inferential rule about explanations *in general*: a rule that would permit the inference from 'not being B is an explanation of not being A' to 'being B is an explanation of being A'. This is what Barnes has proposed.[26] His paraphrase for [3a] is the following:

(1) If ($\forall x$) (if not-Fx, then not-Fx because not-Gx) then ($\forall x$) (if Fx, then Fx because Gx).

Barnes's idea seems to be that, according to this 'general principle about explanation', once one gets an explanation of not-Fx in terms of not-Gx, one will be permitted to infer that Gx explains Fx. Barnes is right in saying that the principle is false. What Barnes has

missed is that Aristotle has not meant [3a] as a general principle about *any sort of explanation whatsoever*. Aristotle is not interested in how one can infer new explanations from a previous one but is rather specifying criteria for *primary* explanations:[27] [3a] spells out a logical condition *for being a primary cause*—and a logical condition that is not sufficient for being a primary cause. Therefore, Aristotle's point should rather be expressed in the following way (let it be labelled [3a^{PC}], where the superscript 'PC' means that it is a condition for being a primary cause):

[3a^{PC}] *If B is the primary cause of A*, then $\forall x\,((\neg Bx \to \neg Ax)\,\&\,(Bx \to Ax))$.[28]

And the conjunction in the consequent of [3a^{PC}] can be packed into a biconditional:

[3a^{PC}]* *If B is the primary cause of A*, then $\forall x\,(Bx \leftrightarrow Ax)$.

The antecedent in [3a^{PC}], namely, '*if B is the primary cause of A*', is supplied from the context. Philoponus (*In An. Post.* 175. 7–13 Wallies) is on the right track in taking Aristotle to be proposing convertibility between the cause and what it causes. But Aristotle is more particularly concerned in [T1] with showing that 'cases explained in this way' (78^{b}21–2)—i.e. cases following the pattern of the logical relations between 'animal', 'wall', and 'breathing'—are not appropriate demonstrations because they fail to capture the primary cause.[29] He says that 'the [attempted] demonstration is of the *that* but not of the *why*' (78^{b}14). However, just a few lines earlier he made it clear that capturing the *primary cause* is the rationale that

[27] See McKirahan, *Principles*, 299, for a similar criticism of Barnes: Aristotle's point is about *demonstration* involving *immediate principles*, not about any sort of explanation. On the other hand, the amendment (2) which Barnes, *Posterior Analytics*, 158, advances might be true in itself—(='If not-*P* is among the conditions explanatory of not-*Q*, then *P* is among the conditions explanatory of *Q*')—but is not a correct exegesis of [3a].

[28] From [3b] one can get an equivalent formula matching Aristotle's phrasing, namely, [3b^{PC}]: '*If B is the primary cause of A*, then $\forall x\,((Bx \to Ax)\,\&\,(\neg Bx \to \neg Ax))$'. Now, since the order of the conjuncts does not matter, [3b^{PC}] can be taken as equivalent to [3a^{PC}]. But then, why has Aristotle explicitly expressed [3b]? I deal with this issue later.

[29] Even if the expression 'cause of this sort' (τοιαύτης αἰτίας, 78^{b}23–4) refers particularly to *negative causes* to be expressed in second-figure syllogisms, the relevant point is that they instantiate the notion of an 'outside middle term' (μέσον ἔξω, 78^{b}13), i.e. causes that are not coextensive with their explananda ('animal', for example, is not coextensive with 'breathing'), and thereby fail to be primary ones.

makes a syllogism what he calls a demonstration of the *why*: 'and this syllogism is of the *why*, for the primary cause is captured' (78^b3–4).[30] He has explicated previously (in 78^a26–38) how an attempted demonstration can fail to capture the primary cause in the case of convertible or coextensive terms.[31] When he comes to 78^b13–28, he shows a similar failure involving terms that are not coextensive—but he does so in such a way that coextensiveness comes out as a formal requirement for primary causes. What he is trying to describe and characterize in [3a] is the logical behaviour of a primary cause. Therefore, [3a] must be understood strictly as [3a^{PC}], i.e. as something restricted to primary causes.

3. Is Aristotle's expression redundant in step [3b]?

Another important issue in [T1] is why Aristotle was not fully satisfied with step [3a], but added the seemingly redundant step [3b]. We can shed light on this by considering the syllogistic framework Aristotle employs. An important point is that the major premiss of the Camestres schema must be *convertible* in the case of primary causes: not only 'every A is B', but also 'every B is A' must be true. When the latter sentential schema also yields a true sentence, its truth allows us to construct a sound Barbara showing that the 'affirmation of the cause' (in the minor premiss) is an *aitia* for the major term A to be attributed to C:

> Every B is A.
> Every C is B.
> ∴ Every C is A.

Now, Aristotle could never be suggesting that both the Barbara schema and the Camestres schema should deliver sound syllogisms for the *same* minor term: the truth of 'every C is A' will be incompatible with the truth of 'no C is A' for any given interpretation of 'C'. What Aristotle means is that, B being convertible with A (given that B is assumed as the primary cause of A), then if a Camestres

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[30] See sect. 2.

[31] Aristotle is not explicit in 78^a28–30 about primary causes—he has just said αἴτιον with no adjective—but since the case in 78^a28–38 is complementary to the case in 78^a39–$^b4$ and since Aristotle says explicitly that the latter captures the primary cause, it is fair to infer that the first case (78^a28–38) is one in which the terms are coextensive but the primary cause was not captured.

syllogism captures the appropriate cause to explain why a given C is not A, then a correlated Barbara syllogism will correctly express the counterfactual situation confirming that C's being B would have caused C to have the feature A: this is what Aristotle expresses in [3a]; and, conversely, if a Barbara syllogism captures the appropriate cause for a given C's being A, then a correlated Camestres syllogism will correctly express the counterfactual situation confirming that, if C were not B, C would not be A: this is what is expressed in [3b]. This is why Aristotle spells out his requirement in a way that *might seem redundant, but is actually needed within his conceptual framework*—and we miss the point if we stick to our formal language with 'x' instead of 'C'.

Let us consider $[3a^{PC}]^S$, a syllogistic version of $[3a^{PC}]$ (the superscript 'S' indicates that the formula is meant only for syllogistic terms):[32]

> $[3a^{PC}]^S$ *If B is the primary cause of A, then* $\forall C\,((BeC \rightarrow AeC)\;\&\;(BaC \rightarrow AaC)^{\text{contrary-to-fact}})$.

There can also be obtained a syllogistic version for [3b]:

> $[3b^{PC}]^S$ *If B is the primary cause of A, then* $\forall C\,((BaC \rightarrow AaC)\;\&\;(BeC \rightarrow AeC)^{\text{contrary-to-fact}})$.

Consider $[3a^{PC}]^S$: no concrete instance of 'C' can satisfy both the antecedent of the first conditional ('$BeC \rightarrow AeC$') and the antecedent of the second conditional ('$BaC \rightarrow AaC$'). That is why the second conditional must be taken as contrary-to-fact, as expressing a situation that does not actually obtain.[33] And the same sort of claim holds for $[3b^{PC}]^S$. Thus, this syllogistic interpretation with the second conditional as contrary-to-fact depicts precisely what Aristotle means in [3a] and [3b]. If we continue to formulate the conditionals in our usual language—with 'x' referring to individuals of the universal class—[3b] will seem to be a redundant

duplication of the point already made in [3a].[34] But a syllogistic version of [3a] with '*C*' standing for a syllogistic term requires [3b] as its counterpart—*if only to dispel the misleading appearance that Aristotle was exclusively focused on negative primary causes and second-figure syllogisms.* Aristotle's underlying concern is a general point about primary causes, not restricted to negative causes. My interpretation does not hang on how the expression 'cases in which the middle term has outside position' (ἐφ' ὧν τὸ μέσον ἔξω τίθεται, 78^{b}13) must be understood—whether as a sign that the ensuing discussion will focus exclusively on second-figure syllogisms or as pointing to middle terms failing the coextensiveness (or proximateness) requirement.[35] I believe that the sentence at 78^{b}13 should be paraphrased in the following way: 'furthermore, it happens the same [namely, one does not reach knowledge of the primary explanation] also in cases where the middle term has more extension than required'—and this is the way Philoponus, *In An. Post.* 174. 3–21 Wallies, takes the expression (following Alexander). However, if one insists that the expression 'cases in which the middle term has outside position' (ἐφ' ὧν τὸ μέσον ἔξω τίθεται) at 78^{b}13 must be taken as pointing to second-figure syllogisms, my answer is that, even so, Aristotle starts with second-figure syllogisms only as a useful tool for highlighting the coextensiveness requirement for primary causes in general.[36] But his point is a general one: if one starts with a given *C* that stands to *B* such that '*BeC*' is true—this is [3a]—then '*BaC*' must be counterfactual; but if one starts with a given *C* that stands to *B* such that '*BaC*' is true—this

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[34] Barnes, *Posterior Analytics*, 157, takes [3b] to be simply the contrapositive of [3a] without explaining why Aristotle has taken the trouble to express it. On the other hand, Barnes's formulation ('If (∀*x*) (if not-F*x*, then not-F*x* because not-G*x*) then (∀*x*) (if F*x*, then F*x* because G*x*)') cleverly grasps the generality of Aristotle's point with 'if not-F*x*' as the antecedent inside the antecedent of the conditional and 'if F*x*' as the antecedent inside the consequent of the conditional.

[35] Most intepretations favour the second option: Philop. *In An. Post.* 174. 3–21 Wallies; Ross, *Prior and Posterior Analytics*, 553; Barnes, *Posterior Analytlics*, 157; McKirahan, *Principles*, 215–16; Ferejohn, *Origins*, 136–7.

[36] In *Pr. An.* 26^{b}39 the expression points to second-figure syllogisms, but in 28^{a}14–15 it points to third-figure syllogisms, so it is not compelling to argue that Aristotle has used it in 78^{b}13 to restrict his remarks to second-figure syllogisms (see Ross, *Prior and Posterior Analytics*, 553). It is not possible to settle this issue by appealing to κατὰ τὴν τῶν μέσων θέσιν at 78^{b}32–3, since this expression can also be taken in different ways: as pointing to the syntactical difference in the position of the middle term in each figure, or as pointing to the choice of concrete middle terms that have different levels of explanatory relevance (I prefer the latter option).

is [3b]—then '*BeC*' must be counterfactual. Had Aristotle had a different language at his disposal—for instance, a language capable of expressing coextensiveness—he would not have needed to 'duplicate' his point with [3b].[37]

To sum up, Aristotle's underlying argument in steps [1]–[2] and [4] of [T1] might be taken as a *modus tollens* on the basis of [3a^{PC}]^S: the case depicted in the Camestres syllogism with the terms 'breathing', 'wall', and 'animal' falsifies the consequent of [3a^{PC}]^S, since it verifies only one of the conjuncts which constitute that consequent—even if all walls were animals (counterfactual), it would not be true that all walls would be breathing things. Aristotle thereby concludes (or suggests) that the middle term 'animal' cannot, then, be taken as the primary cause for explaining why walls do not breathe.[38] And [3b^{PC}]^S is in order where it is: [3b^{PC}]^S stresses that Aristotle's point is not restricted to negative causes formulated in the second figure, but ranges over primary causes in general.

4. The coextensiveness requirement for primary causes

Let me focus on the 'antecedent' or first half of [3a]—which is equivalent to the 'consequent' or second half of [3b]: 'its negation is *aitia* of not being attributed'. This phrase advances by itself a logical requirement for being a primary cause:

(R1) *B*'s being attributed to a given *C* must be a necessary (sine qua non) condition for *C*'s being *A*.

Similarly, the 'consequent' or second half of [3a]—which is equivalent to the 'antecedent' or first half of [3b]—expresses by itself

[37] Aristotle uses the verb ἀντικατηγορεῖσθαι to mean that two terms are coextensive with each other, but my point is that the four categorical forms available to express predicative sentences in his syllogistics do not enable him to *express coextensiveness* in any straightforward way. Aristotle has discussed what happens with the valid moods when terms are coextensive (in *Pr. An.* 2. 5–7), but this does not modify my point. I thank an anonymous referee for greater clarity on this matter.

[38] For a different approach see Ferejohn, *Origins*, 136–7. On Ferejohn's view, Aristotle's worry is with causes that are too remote to explain (as if the 'Anacharsis case' at 78^{b}28–31 presented the central concern), whereas on my view Aristotle is *more specifically* saying that only coextensive causes can be *primarily* explanatory. It is important to stress that causes can be non-remote without being coextensive: Ferejohn's view will not cover them.

another logical requirement for being a primary cause: 'its affirmation is *aitia* of being attributed'. This implies the following:

(R2) *B*'s being attributed to a given *C* must be a sufficient condition for *C*'s being *A*.

And (R1) together with (R2) results in the requirement that *B* must be coextensive or convertible with *A*.[39]

[T1] is made harder to disentangle by all the circumlocutions used by Aristotle. He starts with a counterfactual mode to present his requirement by means of a foil that does not satisfy it (step [2]). But the expression of the requirement itself involves a counterfactual mode when interpreted with a triplet of syllogistic terms, since there could be no interpretation of '*C*' such that *B* would be asserted and denied of *C* at the same time. Such a tangled expression is due to the limits of his syllogistic language, which (besides other things) cannot capture coextensiveness as a single categorical form. When the two conjuncts encapsulated in the consequent of $[3a^{PC}]$ are interpreted in the syllogistic framework as $[3a^{PC}]^S$ (depicting relations between minor premises and conclusions), it is not possible to express both in syllogisms that are simultaneously sound. Thus, [3a] and [3b] are strictly needed to cover different triplets of terms for which either the *negation* or the *affirmation* will actually (i.e. not counterfactually) obtain. It was Aristotle's concern with a general point—not restricted to negative causes expressed in second-figure syllogisms—that led him to [3b], which is not a mere or redundant duplication of [3a].

Let me spell out again how the argument goes. Step [3a] starts with generalizing from cases such as the Camestres syllogism implied in step [2] and formulated in [5]. Requirement (R1) is satisfied: since walls are not animals and being an animal is a necessary condition for breathing (thus satisfying (R1)), it follows that walls do not breathe. However, requirement (R2) is not satisfied in that case, and this is a sign that the Camestres syllogism formulated in step [5] fails at stating the *primary* cause and thereby falls short of being an appropriate demonstration. However, there are

[39] Ross, *Prior and Posterior Analytics*, 553, saw that coextensiveness is at stake (as something involved in what is the 'precise ground' of the explanandum). See also McKirahan, *Principles*, 214, 299. But both scholars are far from explicating what is going on in each step of the text—nor do they explain why Aristotle needs [3b] after [3a]. Ferejohn, *Formal*, is very sympathetic to the coextensiveness requirement for primary causes, but he does not address 78^b13–28 directly.

still the cases in which the situation will be the reverse: requirement (R2) is satisfied, whereas requirement (R1) is not. Such cases can be depicted as sound Barbara syllogisms. For instance: since humans are mammals and being a mammal is a sufficient condition for being mortal (thus satisfying (R2)), it follows that humans are mortal. However, (R1) will not be satisfied, since humans could still be mortal even if they were not mammals—in short, being a mammal is not a necessary condition for being mortal and, consequently, being a mammal cannot be the primary cause of being mortal. Therefore, Aristotle's point in [3b], far from being a redundant repetition of the point made at [3a], is *welcome in context*: Aristotle thereby stresses that his requirement regarding the logical features of primary causes is a general one, not restricted to the negative causes as depicted in second-figure syllogisms.[40] Now, this also shows that steps [3a]–[3b] are not a mere rephrasing of the particular point made at step [2] about walls' not being animals, but are rather a generalization aimed at formulating universal requirements for primary causes. Therefore, Version 2 of step [3] is preferable to Version 1.

Once the reasons for the 'duplication' in [3b] become clear, the full logical requirement for being a primary cause can be expressed in the following way:

THESIS (=[3a^{PC}]*) If B is the primary cause of A, then $\forall x\,(Bx \leftrightarrow Ax)$.

Now, the entailment in the THESIS itself *does not convert*: this means that the convertibility between B (the cause) and A (that of which it is the cause) is only a necessary but not a sufficient condition for B to qualify as the primary cause of A. In order to be a primary cause, a given middle term B must also present an explanatory appropriateness which, for Aristotle, cannot be reduced to its convertibility with the effect.[41]

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[40] Other intepretations, such as those found in Ross, *Prior and Posterior Analytics*, 557, and McKirahan, *Principles*, 214, cannot account for [3b] in any interesting way and, furthermore, restrict Aristotle's point to negative causes. The same goes for Philop. *In An. Post*. 174–7 Wallies: although he understands Aristotle's point about convertibility between causes and effects (174. 34–175. 4), as he goes on (176. 8–177. 15, esp. 176. 24–6, 177. 1–4) he takes Aristotle as trying to establish that a cause for a negative fact must be expressed in the second figure.

[41] As I shall discuss in the next section, Aristotle's point about irreducibility was

5. Beyond the formal features of primary causes

It is of the utmost importance to stress my last remark. I claim that
Aristotle considers (R1) and (R2) as joint conditions for being a
primary cause. But I do *not* claim that Aristotle reduces the notion
of primary cause to the combination of (R1) and (R2). Conditions
(R1) and (R2) are just *formal or logical features* of a primary cause.
Now, the first half of *Posterior Analytics* 2. 13 (besides many other
texts) makes it clear that these two conditions cannot exhaust the re-
quirements for being a primary cause—since, for instance, not only
not twinkling but also *being near the Earth* as attributes of planets sa-
tisfy both conditions, although one of them is the cause of the other
but not vice versa (see also *Post. An.* 2. 16, especially 98^{b}16–19).[42]

   Aristotle surely has some additional criteria for sorting out
primary causes, besides these logical conditions. These additional
criteria rest on the notion of explanatory relevance and cannot be
cashed out in formal or logical features of their own. This is not
the place for a full discussion of these additional criteria, but I
shall sketch their main outlines. The first and main point is the
one that has already been implied in the previous paragraphs: the
explanatory appropriateness of a primary cause is not marked by
any logical asymmetry with its effect: as the effect can be soundly
deduced from the cause, in the same way the cause can be soundly
deduced from the effect (see 78^{a}26–^{b}11, 98^{b}4–24). This means
that explanatory appropriateness cannot be reduced to any logical
property of a cause. Second, the explanatory appropriateness of
a primary cause has a direct link with definitional priority: the
primary cause is an important factor in the definiens account of the
thing it is the cause of, but not the other way round (cf. 98^{b}21–4).[43]

established in 78^{a}26–^{b}11 and in *Post. An.* 2. 16, 98^{b}16–19. See R. J. Hankinson,
Cause and Explanation in Ancient Greek Thought (Oxford, 1998), 166–7; McKirahan,
Principles, 214–16; Ferejohn, *Formal*, 76–80. For a recent approach to the relation
between coextensiveness and causation see A. M. Leroi, *The Lagoon: How Aristotle
Invented Science* (London, 2014), 128–30.

[42] See M. Ferejohn, 'The Immediate Premises of Aristotelian Demonstration'
['Immediate'], *Ancient Philosophy*, 14 (1994), 79–97 at 84–6; Ferejohn, *Formal*, 77–
80; McKirahan, *Principles*, 214–16; Stein, 'Pluralism', 135–6; K. Koslicki 'Essence,
Necessity and Explanation', in T. Tahko (ed.), *Contemporary Aristotelian Metaphy-
sics* (Cambridge, 2012), 187–206 at 198–201; O. Goldin, 'Circular Justification and
Explanation in Aristotle', *Phronesis*, 58 (2013), 195–214 at 201–2.

[43] The word αἴτιον is not accompanied by any adjective in 98^{b}21–4, but τὸ αἴτιον

The definitional priority gives expression to the claim that the fully appropriate explanation of X is tantamount to understanding the essence of X (see 90^a14–23, 31–4, 93^a4). Third, the explanatory appropriateness of a primary cause is also marked by the fact that it makes a series of why questions come to an end: once the primary cause has been reached, there is no more sense in pursuing why questions about the explanandum at stake (cf. 85^b27–38). Fourth, although Aristotle never offers a conceptual analysis of the notion of primary cause or the notion of explanatory appropriateness, he relies on the intuitiveness of some uncontroversial examples to put us on the right track: it is because planets are near the Earth that they do not twinkle, but not the other way round (cf. 78^a36–8); it is because the Moon is spherical that it waxes and wanes in the way it does, but not the other way round (78^b8–10); the Earth's interposition causes the Moon to be deprived of light, but the Moon's privation of light does not make the Earth stay in the middle (98^b17–19).

Instead of substantiating these outlines, my main concern in the remainder of this paper is to highlight the fact that the notion of primary cause as depicted in 78^b13–28 fits very well with another feature of Aristotle's theory of scientific demonstration in the *Posterior Analytics*.

6. Primary cause, coextensiveness, and *katholou* predication

My interpretation allows us to gain a better understanding of Aristotle's insistence on coextensiveness between terms in a scientific explanation. Coextensiveness is the formal feature of the stricter notion of *katholou* introduced in *Post. An.* 1. 4, 73^b26 ff. Of course, this notion also has intensional features which are mostly relevant in Aristotle's theory, but all I need to say now is that coextensiveness between B- and A-terms is indeed an important requirement for scientific explanations.[44] Aristotle also insists on coextensiveness

in some contexts refers to what I am calling the primary cause, namely: the cause that delivers the appropriate explanation and thereby scientific understanding of its explanandum.

[44] I disagree with R. Smith, 'Immediate Propositions and Aristotle's Proof Theory', *Ancient Philosophy*, 6 (1984), 47–68 at 63: 'we have no idea how he finally resolved the problem of fitting convertible terms into sciences: it is possible that he abandoned them in despair . . . or that he simply lost interest in the whole enterprise

between *C*- and *A*-terms at 74^{a}1 ff.—which implies coextensive-
ness between the *three* terms of the demonstration—but let me keep
this further complication out of my present case.[45] Some scholars
have said or implied that the notion of coextensive or commensur-
ate *katholou* introduced at *Post. An.* 1. 4, 73^{b}26 ff., is a peculiarity
confined to those specific passages with no important role to play
in Aristotle's theory. Ross says that 'this strict sense of *katholou* is,
perhaps, found nowhere else in Aristotle. Usually the word is used
in the sense of *kata pantos* simply'.[46] Barnes refers to it as a 'singu-
lar sense'.[47] As it stands, this is a remark about terminology, which
I take to be wrong on its own.[48] But the mistake is to assume or
infer that the notion of commensurate *katholou* has no major use in
Aristotle's theory of demonstration.

First, coextensiveness between the *A*- and the *B*-term is an im-
portant feature of the appropriate demonstrations depicted in *Post.
An.* 78^{a}39–^{b}10. One might be tempted to say that coextensiveness
should not be taken as the paradigmatic case. Aristotle has picked
up cases involving coextensive terms in order to stress that the ex-
planatory appropriateness of a cause is not reducible to being a
necessary and sufficient condition for deducing the explanandum.

when its difficulties became too great'. I agree rather with Ferejohn, 'Immediate',
85–6, McKirahan, *Principles*, 214, and Ferejohn, *Formal*, 83–90. Certainly, coex-
tensiveness is *not* the end of the story (more on this below), since there still might
be *intensional gaps* in an attempted demonstration with coextensive terms (see P. S.
Hasper, 'Sources of Delusion in *Analytica Posteriora* 1. 5', *Phronesis*, 51 (2006), 252–
84 at 280–1, and Angioni, 'Definition', 86–8). A difficulty stems from the fact that, in
Post. An. 1. 3, 73^{a}17–18, Aristotle has said that coextensive terms are rare in demon-
strations (ἐπειδὴ ὀλίγα τοιαῦτα ἐν ταῖς ἀποδείξεσι). I cannot address this difficulty
here, but I do not believe that 73^{a}17–18 jeopardizes my interpretation. Many things
depend on how ἀποδείξεις should be taken in 73^{a}18. I take Aristotle to be describing
what his adversaries would have to admit: for them, there is circular and reciprocal
demonstration, but at the same time they take demonstrations as ranging over any
sort of terms (as Aristotle has done with 'demonstrations' in his syllogistics), not
only over coextensive terms. I thank an anonymous referee for stressing the need to
mention 73^{a}17–18.

[45] Coextensiveness between the *three* terms seems to be the concern in *Post. An.*
1. 4–5, whereas in *Post. An.* 1. 7–8 Aristotle considers prominent cases where co-
extensiveness between the major and the middle is good enough: the subordinate
sciences (1. 7); application of theorems to particular instances (1. 8); and cases such
as the lunar eclipse (1. 8).   [46] *Prior and Posterior Analytics*, 523.
   [47] *Posterior Analytics*, 118.
   [48] *Katholou* has the 'strict sense' throughout chapters 1. 4–5, 1. 24, and 2. 16 of
the *Posterior Analytics* (as well as in 1. 33, 88^{b}31: see L. Angioni, 'Knowledge and
Opinion about the Same Thing in *APo* A-33', *Dois Pontos*, 10 (2013), 255–90). See
also 1. 8, 75^{b}21; 1. 31, 87^{b}30, 33, 39, 88^{a}2–6, 14; 2. 2, 90^{a}28, 30.

Once this thesis has been established, Aristotle might proceed with other examples in which the terms are not coextensive with each other. One might pursue this same line of argument concerning *Post. An.* 2. 16, a chapter in which, examining the logical relations between cause and effect, Aristotle concludes that 'also the middle term in these cases must be equal to that of which it is the cause, i.e. must convert' (98^{b}35–6). The expression 'in these cases' refers exactly to cases in which the explanandum at stake is a commensurate feature attributed to its proper subject. One might then argue that 'these cases' are peculiar cases and nothing guarantees that they must be taken as central cases.

However, this line of argument overlooks the fact that *Post. An.* 2. 16 is a chapter *devoted* to examining the logical relations between the cause and that of which the cause is cause. The chapter *starts* by asking whether there is a relation of mutual entailment between cause and effect (98^{a}35–^{b}5) and, having established that there is such a relation (98^{b}5–16), *argues* that the asymmetry between cause and effect is compatible with that logical relation (98^{b}16–24). From this it clearly follows that the explanatory appropriateness of a primary cause cannot be reduced to this relation of mutual entailment. It is not a coincidence that this string of claims chimes with the argument developed at *Post. An.* 1. 13, 78^{a}28–^{b}11, which is another chapter mainly concerned with clarifying what being a cause delivering a proper demonstration amounts to. It does not seem reasonable to say that *central* examples and *central* arguments in *both official* treatments of causes and their logical relations to their effects in the *Posterior Analytics* should not be taken as the paradigmatic case for scientific demonstration—especially because further evidence is furnished by Aristotle's conspicuous insistence on coextensiveness and *katholou* predications in chapters 4–5 of book 1. And Aristotle coherently employs the terminology introduced in *Post. An.* 1. 4 when he characterizes the mutual entailment or the coextensiveness between causes and explananda at *Post. An.* 2. 16:

[T2] *ἢ εἰ ἀεὶ καθόλου τὸ πρόβλημά ἐστι, καὶ τὸ αἴτιον ὅλον τι, καὶ οὗ αἴτιον, καθόλου; οἷον τὸ φυλλορροεῖν ὅλῳ τινὶ ἀφωρισμένον, κἂν εἴδη αὐτοῦ ᾖ, καὶ τοισδὶ καθόλου, ἢ φυτοῖς ἢ τοιοισδὶ φυτοῖς· ὥστε καὶ τὸ μέσον ἴσον δεῖ εἶναι ἐπὶ τούτων καὶ οὗ αἴτιον, καὶ ἀντιστρέφειν.* (98^{b}32–6)

Whenever the explanandum [*problēma*] is a commensurate universal [*katholou*], then the cause is also a whole, and that of which it is the cause is a commensurate universal. For instance, leaf-shedding is

confined to a given whole, even if there are species of it, and it is a
commensurate universal [*katholou*] for those—be it plants or plants
of a specific sort. Consequently, also the middle term in these cases
must be equal to that of which it is the cause, i.e. must convert. (my
translation)

There are many controversial intricacies in this passage, but it is
clear that it confirms what Aristotle has established in [T1]: the
primary cause delivering the appropriate explanation for a given
explanandum must be (when put in the triadic framework of syllo-
gistic demonstration) a middle term coextensive with the *A*-term
(and, in most cases, coextensive with the *C*-term too). And this
means that: (i) the primary cause is a necessary and sufficient condi-
tion for its explanandum to obtain (and vice versa), although (ii) its
explanatory appropriateness cannot be reduced to its being a neces-
sary and sufficient condition for its explanandum to obtain. This is
the THESIS.[49]

Furthermore, my interpretation of the requirements for being a
primary cause is also suited to Aristotle's notion of causal priority
as described in *Cat*. 14^{b}10–22.[50] All I need do here is to remark that
the relevant sort of causal priority (which, of course, requires some
asymmetry between cause and effect) is perfectly compatible with
logical *convertibility* (or *reciprocability*) between cause and effect,
and such convertibility, when cashed out in the syllogistic frame-
work, amounts to coextensiveness between *B*- and *A*-terms and to
mutual entailment between the minor premiss and the conclusion
of Barbara and Camestres syllogisms. This is enough to strengthen
the case for the claim that the notion of a primary cause and its lo-
gical feature of being coextensive with that of which it is the cause
is not a *sui generis* peculiarity confined to a weird paragraph in *Post.
An.* 1. 13, but plays a central role in Aristotle's overall theory of
demonstration.

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[49] Furthermore, coextensiveness (besides other things) is also implied in *Post. An.*
1. 24, a chapter concerned with establishing that universal demonstrations are su-
perior to partial demonstrations. As a quick survey of the examples is enough to
settle, the contrast in *Post. An.* 1. 24 involves two kinds of Barbara demonstration,
one (the 'universal') in which the *A*-term (2R) is a commensurate universal of the *C*-
term (triangle), and another (the 'particular') in which the *C*-term (isosceles) does
not exhaust the extension of the *A*-term (2R).

[50] On this point see M. Peramatzis, *Priority in Aristotle's Metaphysics* (Oxford,
2011), 242.

7. Conclusion

I have shown that 78^{b}13–28, far from being a desperately convoluted passage committed to a false principle about explanation, is a coherent argument in which Aristotle presents logical requirements for being a primary cause. I have also shown that the seeming redundancy of Aristotle's expression is rather his way of making a general point about primary causes which is not restricted to either negative causes or second-figure syllogisms. The requirements are in accordance with another feature of Aristotle's theory of scientific demonstration, namely, the notion of a commensurate universal as developed in *Post. An.* 1. 4. I have not discussed the important intensional features of this notion, because it was enough for my point to focus on its extensional feature: being a commensurate universal *includes* (but does not collapse into) the satisfaction of requirements (R1) and (R2) for being the appropriate cause of a given explanandum. I hope to have shown that passage 78^{b}13–28, in expounding (R1) and (R2) as logical criteria for being a primary cause, makes an important contribution to Aristotle's overall project in the *Posterior Analytics*.

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