

Survey review

Science and metaphysics in Aristotle's philosophy

Lennox J. G. & Bolton R. (eds): *Being, nature, and life in Aristotle: Essays in honor of Allan Gotthelf*. Cambridge: Cambridge University Press, 2010, 306pp, £60 HB

Leunissen M.: *Explanation and teleology in Aristotle's science of nature*. Cambridge: Cambridge University Press, 2010, 264pp, £53 HB

Roark T.: *Aristotle on time: A study of the Physics*. Cambridge: Cambridge University Press, 2011, 248pp, £50 HB

Michail Peramatzis

1. The transition from the *Analytics* to the *Metaphysics*

In the first two chapters of the second book of the *Posterior Analytics* (=A_{PO}.) Aristotle distinguishes between four types of question which are of interest for scientific inquiry: whether x exists; whether x is F ; what x is; and why x is F . He links our inquiry into whether x exists with that into whether x is F . Similarly, our knowledge of definition –what x is– is connected to our causal-explanatory knowledge –why x is F . This last point, it should be noted, is not merely a claim of epistemic or pragmatic interdependence between the practices of defining and explaining (or proving/demonstrating from explanatory premises). Rather, it also aims to track a deeper metaphysical interdependence between essence (a thing's what it is) and the cause-explanation for its being as it is but also for its having the necessary features it possesses.

In *APo.* II.8-10 Aristotle develops these twin interdependencies in his discussion of scientific inquiry into the essence and cause of process-types such as thunder or eclipse. His view is that in seeking to know the phenomenon that (e.g.) thunder is we are initially equipped with knowledge of the signification of the term ‘thunder’ as a certain type of noise or cloud-noise. To prove and explain the existence of this phenomenon is to prove that and to explain why this type of noise indeed belongs to the clouds:

Noise (of type *N?*) belongs to all cases of quenching of fire (of type *Q?*).

Quenching of fire (of type Q?) belongs to all clouds (of kind C?).

Hence, noise (of type *N?*) belongs to all clouds (of kind *C?*).

The middle term of this demonstrative syllogism (‘quenching of fire’) refers to the cause of the clouds’ possessing the feature of being noisy in the relevant manner. This is a sort of real-world causal relation, which in the present example is identified with efficient causation (cf. *APo.* II.11, 94a20ff.).

At the same time, though, Aristotle argues that in grasping this proof we are also in a position to read off from it the ‘real’ or causal definition of thunder, the account of its real-world essence which explains its being. In this definition the middle term, referring to the efficient cause, will play a central role:

Thunder _[TYPE] =_{def} noise in the clouds brought about by fire being cloudily quenched.

Again, this is not simply a position of epistemic match between our practice or our knowledge of explanation/demonstration and that of definition. It is also a thesis of metaphysical interdependence between essence and cause, one which grounds the epistemic interdependency position. (For more on this, see David Charles 2000; 2010, 268-328 and Peramatzis 2011, 180-188.) The basic element in thunder’s essence, its fundamental identity-fixer, is its efficient cause. Conversely, one of the crucial features of the thunder’s efficient

cause –one without which it could not operate as an efficient cause– is that it determines the kind's identity.

In his *Metaphysics* (mainly Z.17 and H.2-4) Aristotle seeks to extend this causal-explanatory model beyond process-kinds so as to include substance-kinds too, such as the type human. To do so, he initially uses examples of artefacts such as the kind house. In this example certain types of material (e.g., bricks, stones, etc.) are characterised by the relevant house-structure or arrangement, i.e. being a covering or shelter of a certain sort (*Met. Z.17*, 1041a20-27). Hence:

Being a covering/shelter of a certain sort belongs to the essence of a house.

The essence of a house belongs to these kinds of bricks, ...

Hence, being a covering/shelter of a certain sort belongs to these kinds of bricks, ...

Here the causal middle term, the essence of the house, is identified with the final cause: being for the sake of protecting humans and their belongings from wind, heat, and rain. Correspondingly, the definition of the house-kind would run as follows:

House [TYPE] =_{def} bricks and stones in the covering/shelter arrangement for the sake of protecting humans and their belongings from wind, heat, and rain.

On the basis of this sample definition it is not hard to see how the model applies to kinds of natural substance too (*Met. Z.17*, 1041a27-b9). Suppose the explanatory proof:

Arrangement in a certain (humanly) structure belongs to being a rational soul.

Being a rational soul belongs to this type of organic/functional body.

Hence, a certain structure belongs to this type of organic/functional body.

From this we can formulate the definition of the kind as follows:

Human [TYPE] =_{def} a certain type of organic/functional body arranged in a certain structure for the sake of being a rational soul (or: for the sake of realising a specific type of life proper to this sort of rational soul).

Let me just point out that the demonstrations and definitions just offered as examples are schematic, and need to be filled in. Presumably, their fully worked out versions would avoid (amongst other pitfalls) the use of ‘gappy’ terms such as ‘covering/shelter of a certain sort’ or ‘a certain (humanly) structure’. For present purposes, however, these details can be put to the side.

2. Definition and explanation: Generality versus specificity

Commentators raise doubts about several points inherent in the picture just outlined. The first question is, roughly, whether Aristotle extends the model of the *Analytics* to cover related concerns in the *Metaphysics*. The simplest version of this objection states that, while the interest in explanation and proof is present in the *Metaphysics* too, Aristotle does not find useful the definitional aspect of the *Analytics* for his inquiry into substance. Hence, it is argued that *Metaphysics* Z.17 pursues only ‘why?’ questions as crucial for discovering the nature of substance. It does not, however, link these explanation-seeking questions with definitional ‘what is it?’ questions.

It is not difficult to provide a text-based reply to this line of objection. Aristotle himself not only in *Metaphysics* Z.17 but also in *H.2-4* suggests that definition remains important in the investigation into substance. Thus, at *Met.* Z.17, 1041b1ff., the question of why a certain structure belongs to the human body is clearly connected with the definitional question of what (the type) human is. Similarly, Aristotle has obvious interests in the essence –the what-it-is-to-be something (*to ti ên einai*)– and the form (*eidos*), which are the ontological counterparts to the definitions of substance-kinds (1041a27-28; b7-8). Put conversely, definitions are conceived as linguistic formulae or accounts (*logoi*) of essences or forms. If *Metaphysics* Z.17 gives a prominent place to the latter, as it obviously seems to be doing, it follows that it accepts the significance of the former too.

There is, however, a more nuanced form of this sort of objection raised, most notably, by Robert Bolton in his chapter in the Lennox & Bolton collection. Bolton (30-55) argues that *Metaphysics* Z.17 addresses the question of what primary substance is. In this context, as in the rest of the *Metaphysics*, primary substance is the *substance of* something, its essence or form. The ingenuity of this chapter is that it closely relates this notion to the concept of a certain sort of principle or cause. So far nothing controversial is at stake (see, for example, 1041a6-10). Bolton's distinctive claim is that Aristotle operates with an extremely strong assumption about the demarcation between metaphysics, on the one hand, and the special sciences such as mathematics, physics, or biology, on the other. Not only does he maintain that specific scientific disciplines are mutually separate as they deal with separate specific subject-matters. He also claims that metaphysics is distinct from any and every special science in that metaphysics is a general or abstract discipline, far removed from the level of specificity of, say, biology. Thus, for instance, while biology asks and seeks to answer questions such as 'what is (the type) human?' or 'why does this sort of arrangement belong to flesh, bones, tissues, etc. of this (humanly) type?', metaphysics is concerned with more general questions such 'what is (primary) substance?', 'what makes things substances?'. To mark off the difference between the generality of metaphysics and the specificity of (e.g.) biology, Bolton contrasts the question of what makes things substances with that of what makes things members of a specific kind (e.g., the human kind). This view encapsulates what Bolton calls the 'autonomy' of metaphysics from the special sciences.

If Bolton's view is correct, the picture adumbrated in section 1 is not accurate. In *Metaphysics* Z.17 and *H.2-4* Aristotle does not, in Bolton's view, seek to extend the *Analytics* model from process-types to substance-types. Rather, Aristotle's aim is to set out the nature of (primary) substance as such in terms of a general type of principle or cause. The relevant sort of principle or cause is to be spelt out as the form or the essence of a (type of) thing –

what makes something what it is or, more precisely, what makes something a (member of a) substance (-kind). Aristotle suggests that the question of what (primary) substance is should be understood as the question of why certain general metaphysical features, such as being a 'this' (*tode ti*), belong to a thing (such as Socrates) or to that thing's matter (such as Socrates' body). *Metaphysics* Z.17 argues, then, that the answer to this question is simply 'because the relevant form or essence belongs to Socrates, or to his body'. Bolton's contention is that the articulation of the 'what is it?' question in specific terms referring to determinate substance-kinds is not helpful in general, metaphysical inquiries. Hence, it is not useful to ask 'why does this structure belong to this sort of (humanly) body?' if one's primary goal is to answer the 'what is (primary) substance?' question.

There are several, interrelated ways, both exegetical and conceptual, in which to undermine Bolton's argument. Perhaps the most promising starting-point would be to draw the distinction between two different sorts of 'what is it?' question, regardless of their level of generality. The first type of question is 'what is a particular substance (like Socrates)?', or 'what is a substance-kind (like human)?'. Aristotle thinks that in both cases we are asking a definitional question about compound items: the former is about particular compound substances, whereas the latter is about universal compounds, or compound types. These are particular or universal items which are analysable in terms of matter and form. It is precisely for this reason that Aristotle thinks that 'what is it?' questions of this sort can be articulated as 'why?' questions in which it is asked why a certain feature –a shape, an arrangement, a structure, etc.– belongs to an underlying material subject –a body, some bricks and stones, or some flesh, bones, and tissues, etc. It should be noted that this sort of 'what is it?' question could range not only over the general notions of particular substance and substance-kind but also over specific particular substances (such as Socrates) or determinate substance-kinds (such as the kind human).

The second sort of ‘what is it?’ question is ‘what is x ’s primary substance, essence, or form?’. To the general form of this question Aristotle would return the answer ‘it is to be the principle or cause of x ’s being what it is’. Again, however, the question can be put as ‘what is the primary substance of human?’, and so can be answered in terms of what it is to be a human, or being a human –the relevant (specific) essence or form. It seems that Bolton does not properly distinguish between these two kinds of question. Nor does he show whether or how *Metaphysics* Z.17 engage with either or both of them.

A plausible way in which to address this last question is to recall that this chapter signals a fresh start in the inquiry into primary substance as a certain sort of principle or cause (1041a6-10). This is our second type of ‘what is it?’ question. But, as is clear from the formulations just provided, this type of question presupposes that primary substance, as a principle or cause, is a principle or cause *of* some determinate (type of) thing (what I abbreviated as ‘ x ’ in the beginning of the previous paragraph). The relevant *explananda*, at this juncture, are either particular compound objects, such as Socrates, or determinate compound types, such as human. Because in *Metaphysics* Z.17 Aristotle seems to be focusing on substance-kinds, I shall limit my discussion to these cases in what follows. The *explanans*, the principle or cause that primary substance is, will be the ontological ground for such kinds. Aristotle, however, realises that the relevant *explanandum*, the kind human, is of no help in an investigation unless it can be articulated into its constituent matter—form aspects. Roughly put, whereas the question ‘why is human human?’ is opaque as a starting-point to be explained, the question ‘why does this sort of arrangement belong to this sort of flesh, bones, and tissues?’ is a properly formulated *explanandum*. It is precisely ‘why?’ questions of this last sort that primary substance, the form or essence, is the answer to. This is the sort of *explanans* sought for, the principle or cause that primary substance is.

The overall structure of Aristotle's argument, then, suggests that the initial 'what is primary substance?' question can be answered by first examining what the primary substance is the primary substance of. Because primary substance is mainly of substance-kinds, we have to tackle the question of what they, the relevant substance-kinds, are. But Aristotle has a useful line of reply to this last sort of definitional question, a reply which he has successfully applied to process-types (such as thunder and eclipse) in the *Analytics* (referred to at *Met. Z.17*, 1041a16 and 24-26). Because, as I noted, knowledge of definition depends on possessing the appropriate explanatory demonstration (and conversely), our definitional inquiries can be advanced on the basis of explanation-seeking questions. To tackle the question of what the type human is, we have first to know that such a type exists. This effectively is to know that certain features belong to the type of matter which is characteristic of the relevant kind: in the present example, that a certain arrangement belongs to flesh, bones, and tissues of this sort. Our definitional, 'what is it?' question, then, can be articulated into 'why does this arrangement belong to these flesh, bones, and tissues?'. The answer to this last question picks up the principle or cause that primary substance is: the essence or form being human.

The second challenge to Bolton's argument is to ask whether we can address what he calls the 'general metaphysical question' independently of the corresponding 'specific scientific' questions. It may be sufficient, at some abstract level of metaphysical analysis, to reply that primary substance (the essence or form) is a principle or cause for each thing's being what it (essentially) is. We may even deploy further notions drawn from Aristotle's conceptual apparatus, and reply that primary substance is the principle or cause that explains why objects or particular substances are 'thises' (*tode ti*), particular objects of a determinate type. But are we entitled, on the basis of these generic claims, to claim that we have any deeper understanding of what primary substance is, what its nature is as a principle or cause,

or how exactly it functions as an *explanans*? If we return an affirmative answer to this question, we seem to be rendering metaphysical knowledge too abstract or armchair-like, perhaps even too easy. One would expect that metaphysical knowledge is an epistemic achievement that requires grounding obtainable only by acquiring knowledge of specific essences or forms, of how they explain the natures and necessary features of determinate substance-kinds, and how they feature in the definitions of these substance-kinds.

This view also finds indirect textual support in Aristotle's own remarks at *Met. Z.17*, 1041a16-20. There he claims that tautological questions, such as 'why is human human?' are not the intended sort of *explanandum*. More importantly, answers to questions of this form given in terms of highly generic metaphysical notions such as self-identity (in Aristotle's jargon: 'indivisibility of each thing from itself', or 'oneness') are common to any and every kind of thing, and too brief. This suggests that he is primarily interested not in general or abstract metaphysical notions as such but in their specific, real-world grounds. Presumably, knowledge of the latter will also underwrite our grasp of the former. Without knowing specific essences or forms of determinate substance-kinds, then, or without knowing how the former ground the latter, we have only 'common and brief' grasp of the concepts of essence, principle, or cause, notions whose level of generality is not dissimilar to that of oneness or self-identity (the 'common and brief' notions mentioned at 1041a11-20).

Could Bolton defend his position by arguing that there is a distinctive source of our knowledge of general metaphysical *explananda* to be founded on a similarly general *explanans*? If so, what is this special source on the basis of which we know that (e.g.) being a this (*tode ti*) belongs to a substance-kind, or to its characteristic matter? It seems desperate to answer that thisness, and its belonging to substance-kinds or their matter are derived from logic alone, or logic plus dialectic, or any other similarly deflationary source. If thisness implies being a determinate kind (of thing), knowing that a type of object (or its matter) is a

this is not a matter of logic alone. Indeed, the grounds for the determinateness of a type of object seem to require a level of specificity which cannot be reached exclusively in terms of general concepts such as primary substance, essence, form, principle, or cause. Knowing that a certain type of matter has a determinate structure, one that is characteristic of a specific substance-kind, seems to presuppose knowledge of the particular sorts of matter, structure, and substance-kind in question. If this were not so, the relevant 'knowledge' could be deemed too shallow. How else could one grasp properly these items if one's knowledge involved only such highly generic terms as 'primary substance', 'essence', 'form', 'cause', etc.? Terms of this sort do not even accomplish the task of successfully referring to the *determinate* items at issue, let alone that of offering a firm metaphysical understanding of them.

Perhaps it would be useful, in this connection, to draw an analogy with the structure of determinate, determinable and determinant features. Thus, for example, being spherical is one of the determinates falling under the determinable being a solid shape, while the relevant determinant is having all points equidistant from the centre. Other determinates at the same level of specificity include being cylindrical, being conical, being pyramid-shaped, etc., each with its distinctive determinant. It is true that we could have some abstract grasp of the determinable being a solid shape without knowing a wide range of the determinates falling under it, or their determinants. Hence, for example, we may know that being a solid shape is to be a shape extended in the three dimensions of length, width, and depth. Would that sort of knowledge, however, entail that we have a solid understanding of the relevant determinable? It seems, by contrast, that a firm grasp of this determinable involves, minimally, knowing that being a solid shape is either being spherical, or being conical, or being pyramid-shaped, or being cylindrical, etc. Moreover, it requires our having an idea of what the corresponding determinant is for each case of determinate. Having an overview of this sort would enable us to understand fully what abstract feature is common to all determinates but also what makes

each determinate the type of feature it is. In short, we would have a firm grasp of the whole (or at least of the main parts) of the domain of the determinable being a solid shape.

More importantly, if we agree with Aristotle that metaphysical knowledge should be *primarily* of real-world objects or entities but not of abstractions, we would have further reason to ground our abstract conception of the determinable by reference to its concrete determinates and determinants: for there is no such thing in reality as being a mere solid shape. Reality (or perhaps stereometrical reality in the present case) consists of being spherical, or being cylindrical, or being conical, or being pyramid-shaped, etc.

Analogously, then, to have the distinctive sort of Aristotelian, real-world-based understanding of the quasi-determinable concepts of primary substance, essence, form, principle, or cause, we would have to advance beyond the highly generic notion of being a cause for a thing's being what it is. We would have to underpin this abstract conception on the basis of grasping specific essences, forms, or causes of determinate substance-kinds. An essence, form, or cause of this sort would be the specific *explanans* which grounds the nature of the relevant substance-kinds but also their characteristic necessary features. Without knowing this *explanans*, or how it grounds the relevant *explananda*, it would be difficult to have a solid and overall grasp of the (whole or the main parts of the) domain of the quasi-determinable being a primary substance.

To diagnose the deeper problem with this aspect of Bolton's position, it is important to examine his notion of autonomy between metaphysics and the special sciences. No theorist would deny that metaphysics is a discipline distinct from any and every specific scientific branch. This is not to say, however, that there could be no interdependencies whatever between them. Hence, metaphysics may set theoretical constraints for the special sciences. For example, there are certain general principles, common to all special sciences, or at least to some of them, which metaphysics alone can thematise and theorise about. These are what

Aristotle calls ‘common axioms’, such as the logical principles of Non-Contradiction or Excluded Middle, shared by all the special sciences. Similarly, there are general principles such as ‘if equals be subtracted from equals, the remainders are equals’, which are common only to quantitative sciences such as number theory or geometry. Conversely, however, if we sought to grasp fully the explanatory value of such principles, the way they function as principles of things, we would have to see them at work, as it were, in specific cases in which they underwrite certain *explananda*. Presumably this sort of grasp can be achieved only within particular scientific disciplines which aim to explain, prove, and define determinate items. It may be that the principles of metaphysics are common in a comparable manner to all physical or biological sciences. This would not make metaphysics non-autonomous. Nor would it make the special sciences parasitic on metaphysics. Rather, this picture suggests an interdependence relation between the two domains: while metaphysics aims to understand the highly general, quasi-determinable principles of things –what is common to all sciences– the special sciences provide the determinate and determinant underpinning for each of these principles by employing them in specific explanatory tasks. Without metaphysical knowledge one cannot grasp the most abstract theoretical framework permeating reality as such, whereas without the special sciences one’s metaphysical knowledge is too ‘empty and dialectical’ or ‘common and too brief’.

Even irrespective of these last, rather speculative remarks about knowledge of determinables versus knowledge of determinates and determinants, however, Bolton’s argument does not establish that the *Analytics* model is not extendable to the *Metaphysics*. Nor does it undermine the claim of interdependence between definition and explanation/demonstration, a thesis which is grounded on the interdependence between essence and cause.

3. Essence and cause: what could play the role of a middle term in proofs?

This last interdependence relation is the focus of another central debate in modern Aristotelian studies. In the *Posterior Analytics* Aristotle already argues that the middle term of explanatory demonstrations such as the ones given in section 1 picks up a certain sort of cause of the process-type or the phenomenon being explained: either the formal, the grounding (a variant of the material cause), the efficient, or the final cause (*APo.* II.11, 94a20-24). Thus, for instance, in the thunder-related demonstration, ‘fire being quenched’ picks up the efficient cause of the relevant, ‘thunderous’ sort of noise belonging to the clouds. In *Posterior Analytics* II.1-2 and 8-10 Aristotle also maintains that this efficient cause is the crucial part of thunder’s essence, i.e. what makes thunder have the nature it has. His view seems to be that formal and efficient causation are inextricably linked: the (basic part of the) essence or formal cause of thunder is the efficient cause of thunder’s obtaining (i.e. of noise belonging to the clouds). Conversely, too, the efficient cause could not discharge its own role without also fixing the identity of thunder, or of the relevant cloud-noise.

In *Metaphysics* Z.17 Aristotle argues for this intimate link between the essence or form of substance-kinds, and the corresponding types of cause in the following passage:

It is clear, then, that what is sought is the cause –and this is the what-it-is-to-be [or: essence; *to ti ên einai*], to speak logically [*logikôs*]– which in some cases is that for the sake of which the thing is [as it is] (as presumably in the case of a house or a bed), while in some cases it is that which first began the change; for the latter too is a cause. [...] So what is sought is the cause of matter (and this [*sc.* cause] is the form) by which the matter is thus-and-so. And that is the substance [*Met.* Z.17, 1041a27-30; b7-9; Bostock’s trans. modified].

Here it is worth bringing out two central points. First, Aristotle holds that there is an abstract, ‘logical’ as he calls it, level of metaphysical investigation at which the basic substance of a type of object is simply its essence, form or formal cause. To specify this abstract notion, however, it is necessary to invoke weightier causal notions of efficient or final causation. In Aristotle’s words, ‘this essence or form just is’—essentially, I take it—‘an efficient or final

cause' depending on the kind of case at issue. Hence, essence or form is intrinsically characterised by reference to real-world causal concepts. The second point, which is closely connected with the first, is that because efficient or final types of cause also function as identity-fixers of the relevant kind, they too are inextricably dependent upon the notion of essence, form or formal causation. The overall picture, then, is one in which the notions of essence and causation/explanation are intrinsically interdependent: they are not specifiable without each other.

To refer back to the example of explanatory proofs about substance-kinds provided in section 1, the middle term of the human-related demonstration, 'being a rational soul', picks up the final cause for the sake of which the type human is as it is, or why the characteristic human matter (this sort of flesh, bones, tissues, etc.) is structured in the way it is. This final cause would run along the lines of my schematic formula, being for the sake of realising a specific type of life proper to this sort of rational soul. Commentators, however, challenge the claim that the middle term of any properly explanatory proof could pick up something like the final cause. Most prominently, in *Explanation and teleology in Aristotle's science of nature*, Mariska Leunissen argues that the final cause should be separated from the form or essence. For example, while the form or essence of birds is to be flyers, a relevant final cause or function would be (e.g.) their wings' being for the sake of flying. Her idea is that final causes have only what she calls an 'explanatory' priority without any corresponding real-world causal priority. It is clear from this formulation that she takes explanatory priority in a merely epistemic fashion: final causes are prior in that they make it clear to us, or knowers such as ourselves, what features are there to be explained in terms of real-world causes. In the present example, it is observable at the outset that birds' wings are present for the sake of flying. Using this instance of final causation as a starting-point we can pursue its explanation

in terms of the proper, scientific cause, which (in Leunissen's view) is always a formal cause, or more fundamentally a material-efficient cause.

This sharp divide between final causation, on the one hand, and real-world causation in the form of either formal or material-efficient causation, on the other, is based on Leunissen's view that 'scientific demonstrations of natural phenomena [...] ought to reflect the chronological order of causation in the world, moving from the start or origin of the natural development to its end' (7-8; cf. also 13-15; 20-1; 135-6; 179-180; 183-9; 200-1; 211). It seems fair to point out that her view is founded on a conflation between temporal and causal priority. More fundamentally, I think, this conflation arises from a conception of causation which is heavily influenced by modern Humean views (or views developed in response, or in reaction to Humean views). In these views, it is an integral part of being x 's cause (at least in standard cases) to be temporally prior to x 's occurrence. It is unsurprising, then, that Leunissen concludes that ultimately only material-efficient causes can be real-world causes, picked up by the middle terms of syllogistic explanatory proofs: for they alone are also temporally prior to their 'effects', apparently confirming in this respect a tenet central to modern views of causation.

It is important to emphasise, though, that Aristotle's conception of causation is far wider than these views are. In calling final causes 'causes' Aristotle is serious about their real-world, causal role, and their explanatory priority in a manner which is not merely epistemic. In the example of birds' wings it is not simply the case that we find it epistemically easier or more useful to start our scientific investigation with the feature of being for the sake of flying. Rather, Aristotle thinks that being for the sake of flying explains why wings are as they are, and why they have the necessary features they possess. Intertwined with this causal operation is the final cause's identity-fixing role: being for the sake of flying is the basic part of what it is to be a bird's wing. If so, the final cause also

makes the relevant *explananda* what they are. This seems to be the sort of interdependency that Aristotle argues for not only in *Posterior Analytics* II, but also in the passage quoted from *Metaphysics* Z.17. In the case of substance-kinds, such as human or (a certain type of) bird, the essence or formal cause is (identical with) the final cause. Moreover, this final cause can be straightforwardly referred to by the middle term of the relevant explanatory proofs. This is because proofs of this sort are concerned not with what obtains chronologically first but with what grounds the nature of the kind, and its necessary features –what Aristotle calls the ‘cause of being’ in our passage (1041a32).

In the cases of process-types, by contrast, which are instances of coming-to-be, and which are underwritten by efficient causes, it is clear that efficient causes will be explanatorily and causally prior, as well as the identity-fixers of the relevant process-types (1041a31-32). The essence of the thunder-type involves (basically) fire being quenched in the clouds, the efficient cause of the thunder’s occurrence. And this efficient cause is one which operates by making thunder the kind of process it is. It is true that in this case the basic cause identified with (the crucial part of) the essence is also temporally prior: quenching of fire does, after all, precede instances of thundery noise in the clouds. But Aristotle does not take this temporal priority as fundamental. Rather, he privileges the causal and identity-fixing role of fire being quenched in the clouds.

This, presumably, is why even in cases in which he seeks to explain natural *processes of coming-to-be* such as the generation of a human, he understands the relevant efficient and material causes of the processes by reference to formal and final causation. While the father’s seed and the menstrual fluids are the efficient-material causation pair of the coming-to-be of a human offspring, they are to be understood in terms of the end- or completion-stage of this process. The nature of entities present at this late stage is determined by, indeed is identical with, the final cause that being a human is. If so, what the relevant efficient-material causes

are is dependent on what the final cause is, while the converse does not hold good. For being the father's seed and being the menstrual fluids present at the initial stage(s) of this generation process are teleologically directed to the coming-to-be of a complete human being, an entity which possesses the human form in completeness, and which has the capacity successfully to perform the relevant human functions (the final cause of the kind human).

It should be clear that Leunissen's view cannot be sustained in the light of Aristotle's arguments in the *Analytics* and the *Metaphysics*. For he identifies the essence or form with the cause, including the final cause, and so sees no difficulty with demonstrations whose middle term picks up the final cause, or with definitions in which the fundamental identity-fixing task is accomplished by this sort of cause. What, however, is the philosophical significance of this doctrine (assuming that it is Aristotle's own)? The answer to this question falls outside the scope of the present study. It is worth, though, gesturing towards a reply along the following lines. Aristotle's distinctive sort of essentialism is not merely a view about linguistic or conceptual items which are supposed to encapsulate the signification of certain kind-terms, such as 'thunder', 'eclipse', 'house', or 'human'. Rather, it is a view which underpins linguistic or conceptual practices by reference to real-world essential features of the corresponding kinds. The 'real-worldliness' of these features is based on their being types of robust causal items, such as efficient or final causes, entities which carry through specific causal tasks. The 'essentiality' of these features is due to their operating as identity-fixers in virtue of which the relevant kinds are as they are, and possess the necessary (but non-essential) features that they have.

Aristotle's further move is to argue that the intimate relation between causation and essence—also reflected in the interdependence between our practices of explaining and defining— is neither a case of coincidental fluke nor a metaphysically brute relation of necessary co-occurrence. Rather, he thinks (if I am reading him correctly), that (part of) what

it is to be an essence or form is to act as a final or efficient cause (depending on the case at issue). Conversely, too, to be a final cause of a substance-kind, or an efficient cause of a process-type, is to be the basic entity that makes the relevant kinds what they essentially are, and also grounds their necessary (but non-essential) features. Causation and essence are, in Aristotle's view, intrinsically intertwined in an indissoluble fashion.

4. The limits of hylomorphism

As I observed already, Aristotle maintains that particular substances as well as universal substance-kinds are compound entities, consisting of matter and form. This central commitment of Aristotle's hylomorphism entails that token-objects such as Socrates or type-objects such as the kinds human or horse involve (essentially) material and formal aspects or features. Aristotle, however, seems to extend this hylomorphic picture beyond these basic cases in a way which suggests that the matter—form distinction is universally applicable. Thus, for example, he claims that the house-*form* includes both being made of bricks, stones, and mortar, and being a protective shelter (*De Anima* I.1, 403b1-9). Similarly, he argues that natural *forms* include (essentially or necessarily?) material parts (*Physics* II.2, 194a12-15; b9-13; *Met.* Z.11, 1036b21-32). Further, he holds that mathematical *forms* such as being circular or being triangular contain an 'intelligible' sort of matter (e.g., being made of lines, or being continuous) in addition to their formal aspects (*Met.* Z.10, 1036a9-12; Z.11, 1036a31-b20; b32-1037a5). And in his introductory account of psychic *functions* and *affections* he offers the example of anger which he takes as (essentially or necessarily?) a sort of boiling of the blood around the heart (material aspect) for the sake of revenge (formal aspect; *De Anima* I.1, 403a24-b2; b16-19).

A sceptical theorist, however, would treat the claim that (e.g.) the *essence* or *form* itself is essentially matter- or/and form-involving as being either ill-formed or nonsensical.

For, the sceptic would argue, the matter—form distinction is not intended to apply to the form itself, but only to the compounds (tokens or types) consisting of matter and form. This sceptic could concede that Aristotle deploys, without hesitation, a hylomorphic style of analysis in treating natural or artefact forms themselves, mathematical entities, or even more remote items such as what he calls the ‘functions and affections’ of the soul. It does not, however, follow from this (our sceptic would argue) that hylomorphism applies to such cases too in any fully-fledged fashion. Rather, such cases are (the sceptic would counter-propose) hylomorphic only by analogy; or this hylomorphic style of analysis is merely a heuristic device deployed solely as a starting-point for scientific inquiry. At any rate, the sceptic would conclude, the hylomorphic approach need not entail that anything other than compound token- or type-objects are literally hylomorphic in any weighty sense.

This form of objection would apply *a fortiori* to more abstract items such as the infinite, the void, location, or time. Thus, for instance, an interpretation of Aristotle’s account of time along the lines of Tony Roark’s view in *Aristotle on time: A study of the Physics* would be particularly vulnerable to this line of attack. Roark applies a strong, literal version of hylomorphism to everything, including the notion of time. In his view, Aristotle himself takes this approach as he understands everything, including things like syllables or arguments, as matter—form compounds. Even time, then, is a hylomorphic compound. In the Aristotelian definition

Time =_{def} the number of motion/change as to the before and after,

the determinate *definiendum* is analysed in terms of the determinable, material concept of change or motion, and (ultimately) certain determinant, formal items, the psychic activities of

perception accompanied with imagination and memory, which account for the fact that change or motion are numerable 'as to the before and after' (3, and 173ff).

Our sceptic would seek to undermine this ingenious interpretation by doubting whether the exercises of perception, imagination, and memory constitute actual formal parts of the nature of time. Perhaps, the activities of these psychic faculties are merely enabling conditions without which time could not exist, or could not exist in the physical world that is perceptible by us (or by percipients like ourselves). Or, in a more idealistic turn, these psychic, formal items are merely the ways in which we grasp or measure time, but are not parts of what time itself is (if it is anything).

Here is an analogy which could be invoked by our sceptic. In an innocuous formulation of Aristotle's view, the existence of (some or other) matter or physical objects is necessary for the existence of mathematical entities within the physical world. Further, the soul's perceiving physical objects, and its abstracting away from them perceptible matter are activities without which we could not grasp or study numbers or geometrical items. Perceptible matter, however, or acts of perception, abstraction, thought, and other psychic capacities are not parts of what it is to be a determinate number or geometrical shape. For, in Aristotle's view, every mathematical entity is essentially independent not only of all types of perceptible bodies (from some or other of which it is abstracted in the first place) but also of any psychic acts which abstract into, or somehow construct it. There simply is no place within the definition of any mathematical item for mentioning perceptible materials or activities of the soul.

It is certainly a legitimate question of Aristotle's philosophy of mathematics what the ontological status of numbers or geometrical entities is: whether and how they exist in the physical world, how they are metaphysically dependent upon material objects, or what their relation is to perceivers and/or thinkers. Answers to these questions, however, could be given

simply by holding that mathematical entities necessarily depend, for their existence within the physical world, or as subject-matters of mathematical study, on (respectively) the existence of perceptible matter or physical objects, and on the exercise of acts of perception, abstraction, thought, or/and other psychic faculties. Yet it hardly follows from this, indeed it seems implausible, that any specific type of mathematical entity essentially involves perceptible matter or psychic activities as its determinants.

Our sceptic would conclude, then, that the mention of number in Aristotle's account of time, and the dependence of number on psychic acts of perception, imagination, and memory may reasonably be viewed in a similar manner. Thus, time is, arguably, essentially independent of such formal, psychic items: for, after all, the latter are not explicitly mentioned in the definition of time. This may be so despite the fact that, without certain acts of the soul's faculties, time could not exist as numerable- or measurable-by-us, as an abstraction in thought, or as a central concept of natural philosophy. This line of objection attacks some of Roark's basic assumptions about the breadth and depth of Aristotelianhylomorphism. While his assumptions are extremely attractive and (I think) defensible, more needs to be said to establish them in satisfactory measure.

Worcester College

University of Oxford

Oxford OX1 2HB

UK

michail.peramatzis@philosophy.ox.ac.uk

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