Science in Context **28**(2), 171–193 (2015). © Cambridge University Press 2015
doi:10.1017/S0269889715000046

The Pythagorean Table of Opposites, Symbolic Classification, and Aristotle

Owen Goldin

Marquette University
E-mail: owen.goldin@marquette.edu

Argument

At *Metaphysics* A 5 986a22-b2, Aristotle refers to a Pythagorean table, with two columns of paired opposites. I argue that 1) although Burkert and Zhmud have argued otherwise, there is sufficient textual evidence to indicate that the table, or one much like it, is indeed of Pythagorean origin; 2) research in structural anthropology indicates that the tables are a formalization of arrays of "symbolic classification" which express a pre-scientific world view with social and ethical implications, according to which the presence of a principle on one column of the table will carry with it another principle within the same column; 3) a close analysis of Aristotle's arguments shows that he thought that the table expresses real causal relationships; and 4) Aristotle faults the table of opposites with positing its principles as having universal application and with not distinguishing between those principles that are causally prior and those that are posterior. Aristotle's account of scientific explanation and his own explanations that he developed in accordance with this account are in part the result of his critical encounter with this prescientific Pythagorean table.

At *Metaphysics* A 5 986a22-b2, Aristotle refers to a conceptual scheme in which certain Pythagoreans posited a table with two columns of paired opposites. The context is Aristotle's review of the sorts of causal principles to which his predecessors appealed. Aristotle distinguishes between two explanatory schemes offered by different Pythagoreans. Some take the principles of things to be numbers.[1] A second group posits contraries as the principles of things, and arranges them in two columns: "Others among them say there are ten principles, laying them out in columns – limit and unlimited, odd and even, one and plurality, right and left, male and female, resting and moving, straight and curved, light and darkness, good and bad, square and oblong" (986a22-6).

[1] Following Burkert 1972, most scholars today identify these Pythagoreans with Philolaus and those influenced by him; it is however controversial as to whether Aristotle got Philolaus right.

https://doi.org/10.1017/S0269889715000046 Published online by Cambridge University Press

Much concerning this table is unclear: 1) To what to extent is the table of opposites to which Aristotle refers, or one like it, of Pythagorean provenance? 2) What role did the table and the relationships it expresses play in Pythagorean life and thought? 3) Aristotle apparently takes the table to serve as a legitimate *endoxon*, from which metaphysical, scientific, and ethical inquiries are to begin, and by which such accounts are to be tested. For them to play this role, such *endoxa* get at least something right. What is it, in this case? 4) How does Aristotle think the relationships expressed in the tables are to be corrected or developed?

Aristotle says so little, and direct evidence is so scarce, that any attempt to answer these questions must be speculative. Nonetheless, answers can be given with a reasonable degree of plausibility. In the present paper I argue that 1) although Burkert and Zhmud have argued otherwise, there is sufficient textual evidence to indicate that the table, or one much like it, is indeed of Pythagorean origin; 2) research in structural anthropology indicates that the tables are a formalization of arrays of "symbolic classification" which express, however inchoately, a pre-scientific world view with social and ethical implications, according to which the presence of a principle on one column of the table will carry with it, or otherwise be associated with, another principle within the same column; 3) Aristotle thought that the table expresses real causal, conceptual, and metaphysical relationships; and 4) Aristotle faults the table of opposites with positing its principles as having universal application and with not distinguishing between those principles that are causally prior and those that are posterior.

Is the Pythagorean Table Pythagorean?

That the table of opposites, a version of which is mentioned in *Metaphysics* A 5, derives from the early Pythagoreans requires some defense, as the Pythagorean origin of the table has come under considerable suspicion in recent years.

Scholarly orthodoxy today minimizes the importance of Aristotle's testimony concerning the table of opposites for our understanding of Pythagorean thought. Thus, Burkert argues that important elements of the table derive from Speusippus or other figures in the early Academy and concludes:

> There is even more uncertainty latent in the possibilities of interpretation than in chronology. Is such a rigid scheme the result of true philosophical reflection, or of a primitive way of thinking? Or is it the expression of a strictly regimented way of life? We can see what the Platonists made of it, but it is not a helpful foundation for a reconstruction of Pythagorean philosophy. (Burkert 1972, 52)

Zhmud supports Burkert: "however much in its detail the table ultimately derives from the Pythagorean tradition, in its final form of the ten pairs of distinct kindred (or

https://doi.org/10.1017/S0269889715000046 Published online by Cambridge University Press

similar) opposites it is a product of the Academic systematisation, and exactly this form and not the opposites themselves were of interest to Aristotle" (Zhmud 1998, 266; see also Frank 1923, 254–255, and Zhmud 2012, 451–452). I argue that Aristotle's testimony can be regarded as having two components: 1) that the early Pythagoreans arrayed associated opposites in a table comprised of two columns, and 2) that these opposites were only the ten identified by Aristotle. Burkert's and Zhmud's arguments, which are not decisive, are directed to the second point, but leave Aristotle's testimony untouched in regard to the first. That alone, when considered in relation to other evidence, allows us to draw probable inferences concerning Pythagorean modes of explanation.

The main – and sole – piece of direct evidence in favor of a Pythagorean origin to the table is of course, Aristotle's own word, which is found both within *Metaphysics* A 5, and within his lost treatise on Pythagorean doctrines, for which Simplicius provides evidence.[2] It goes without saying that Aristotle had access to texts and testimony lost to us; his evidence is to be rejected only if (as is admittedly often the case with the Presocratics) his account is inconsistent with other reliable evidence.

Burkert points to circumstantial evidence that suggests that the opposites presented as principles derive from Speusippus or other members of the early Academy, who, in an attempt to give his own account the legitimacy of antiquity, ascribe it to the Pythagoreans (Burkert 1972, 51–2).[3] Zhmud points to how the table as reported by Aristotle has ten rows. Speusippus devoted a half of his *On Pythagorean Numbers* to the special properties of the number ten, while there is no evidence that it had such a role for earlier Pythagoreans. Further, the table as reported by Aristotle contains the theoretical oppositions of limit and unlimited and of rest and motion, which have special theoretical interest for Plato, and omits opposites like hot and cold, and wet and dry, which we know to have played crucial roles in the physical explanations of the early Pythagoreans and their contemporaries (Zhmud 1998, 259–66).

These arguments suggest that, as Burkert puts it, "'the table of opposites' is quite closely connected with Academic doctrines; we have here a continuous transition between Pythagorean and Platonic" doctrines (Burkert 1972, 51; quoted with approval by Zhmud 2012, 339). That said, Zhmud's argument that the Pythagoreans ascribed no special status to the number ten, which directly contradicts Aristotle's testimony

[2] See n. 28 below.

[3] The right-hand column is called a column of goods at *Nicomachean Ethics* 1. 6 1096b5-6 and 2.6 1106b29-30; at 1096b6-7 Aristotle tells us that "Speusippus seems to have followed them." The context of the discussion of the "column of goods" at *Metaphysics* N 6 1093b11-21 indicates that Aristotle's concern here is Academics and the way that they "separate" their principles. At *Physics* 3.2 201b24-6 (= *Metaphysics K 9* 1066a14) we are told that "the principles in the second column, because they are negative, are indefinite," Huffman rightly argues that Aristotle must have had in mind the compilers of "Pythagorean" table of *Metaphysics* A 5, but the passage is in a context which, according to Eudemus, applies to Platonic philosophy (Huffman 2005, 509).

https://doi.org/10.1017/S0269889715000046 Published online by Cambridge University Press

at 986a8-10,[4] is an argument from the silence of a very few sources, concerning a group that is at least reputed to hold many doctrines in secret.[5] (And could a group that ascribed some importance to number – the nature of which is admittedly unclear – have failed to be struck by how human beings have ten fingers and ten toes, and employ what we now refer to as a base ten number system?).[6] Further, although the table as Aristotle presents it does seem to include Platonic and post-Platonic theoretical principles, it also includes oppositions such as right and left, and male and female, drawn from common experience. As Kahn points out, "The way in which abstract and concrete, mathematical and moral-aesthetic opposites are jumbled together here may indicate an archaic origin. And the absence of the One-Dyad pair suggests that the list is independent of the main post-Speusippean tradition" (Kahn 2001, 65–66).[7]

In contrast to uncertain but important evidence suggesting that not all of the opposites identified derived from the Pythagoreans, there is no evidence at all suggesting that Aristotle is not to be taken at his word in taking the tabular presentation of opposed principles to be original to certain earlier Pythagoreans. There is no parallel in Plato, and no reason for arranging and presenting opposed principles in this way is suggested by the theoretical accounts of the early Academy. On the contrary, as we shall see, the table is consonant with anthropological evidence concerning ways in which features of the world are classified in ritualistic cultures, and with testimony concerning both Pythagorean science and the Pythagoreans' shared way of life.

In the absence of independent evidence (which we do have for right and left) we lack full confidence in ascribing to the table the definite pairs of opposites that Aristotle ascribes to the table.[8] Yet, Burkert and Zhmud err on the other extreme by

[4] "Because the decad seems complete and to have comprehended the total nature of numbers, they said that there are ten things moving in the heavens."

[5] In personal correspondence, Carl Huffman has pointed out to me that Burkert, to whom Zhmud appeals, accepts as a genuine Pythagorean *acousma* Iamblichus, *Life of Pythagoras* 85, which identifies the oracle of Apolla with the tetraks, the numbers one through four, which total ten. Further, in correspondence (and now, in Huffman 2014) he pointed out how at 986a28-9 Aristotle confesses ignorance as to whether the table of ten opposites is earlier or later than Alcmaeon; if the table was Academic Aristotle would have known, as he was a member. This is significant evidence that the early Pythagoreans attributed special importance to the number ten. Huffman holds that in the absence of more decisive evidence, the table of ten opposites, as reported by Aristotle, ought to be accepted as authentically Pythagorean (see Huffman 2014).

[6] Zhmud denies that Pythagoreans prior to Philolaus attributed any special importance to number; Riedweg 2008, 80–3, trusts the Aristotelian evidence on this.

[7] It is significant that the "jumbled" nature of Aristotle's list includes the ethical opposites of good and bad. For at *Metaphysics* Λ 7 1072b31-2 Aristotle says that *neither* the Pythagoreans *nor* Speusippus posited the most beautiful and best as a primary principle. Burkert points to this passage as evidence that the table derives from Speusippus (Burkert 1972, 52 n. 118); presumably he is pointing to the contradiction between the presence of the good in the table and Aristotle's denial that the good is a Pythagorean principle. But the passage can also be used as evidence that the table does not derive from Speusippus! I speculate that Aristotle's point here is that the Pythagoreans did not appeal to the good as a *final* cause; consider how at *Metaphysics* I 5 986a4-6 he speculates that the good and the other opposites present in the table serve as *material* causes.

[8] The presence of limit and unlimited, or some variant of these, suggests followers of Philolaus or Plato as its origin, not the Pythagoreans whom Aristotle distinguishes from those taking a special interest in number.

https://doi.org/10.1017/S0269889715000046 Published online by Cambridge University Press

excluding the possibility that Aristotle relates valuable information concerning those opposites that the Pythagoreans employed as principles. I therefore proceed on the presumption that we are to respect Aristotle's report that a group of early Pythagoreans, distinguished from those who emphasized the importance of numbers, isolated certain pairs of opposites as having a privileged status as explanatory principles. The identity and perhaps the number of paired opposites may have been fluid,[9] but the tabular form in which Aristotle presents them is original to Pythagorean theorists. I shall argue that there is sufficient evidence to allow us to see the theoretical use to which this tabular presentation was put. I shall further argue that Aristotle himself grasped the structural features of the explanations based on the table, and that while he in part endorses the worth of the table as providing reputable opinions (*endoxa*) from which scientific explanation begins, he also explicitly points to the inadequacy of the table as an expression of the causal and explanatory arrangements.

Symbolic Associations

Beyond the testimony of Aristotle and other texts that derived from that, we lack direct evidence of the sort of thinking that may have given rise to the table of opposites. That is not to say that we are without resources that allow us to reconstruct what the Pythagoreans were up to in tabulating opposites as they did. Anthropologists have shown that within many pre-scientific cultures there are shared modes of conceptualizing oppositions that have in common the core features of the table of opposites. We can extrapolate from the meaning and structure found in the other cultures, to that given by the early Pythagoreans. These results are speculative, but are confirmed by other testimony concerning Pythagorian thought and way of life.

A fundamental principle of the tradition of anthropology initiated by Durkheim is that the geographical array of living quarters, social practices, myths,[10] and other varieties of lore share certain structural features, sometimes unique to a society, sometimes shared by a number of them, which result from underlying modes of association and conceptualization. For Durkheim, the most fundamental instance of how such structures are reflected in both ways of thought and ways of social life is the bifurcation between the spheres of the sacred and the profane, and the sacred itself is further divided into the beneficent and maleficent (Durkheim 1912, 412–414).

But even if the Pythagoreans responsible for the table are distinct from Philolaus, and, as Huffman 1993 has argued, Philolaus emphasized the distinction between limiters and unlimited as a result of reflection on Milesian explanations, it is likely that one Pythagorean group would have had an interest in the work of another.

[9] But see n. 5.

[10] Cornford [1912] 1991 is a Durkheimian attempt to show how early Greek philosophy emerged as a matter of rational speculation built on, and maintaining the basis of, Greek myth, which he interprets as a "collective representation" of the social structures underlying early Greek communities.

https://doi.org/10.1017/S0269889715000046 Published online by Cambridge University Press

Durkheim's student Hertz applied this strategy to culturally determined modes of conceptualizing opposites.

Hertz pointed out that there are many cultures whose beliefs and practices involve the arranging of opposites in two groups. Hertz studied the widespread association of the right and left hands with the polarity between the sacred and the profane, respectively. For those who belong to cultures with something like a table of opposites as a basic conceptual scheme, "the whole universe is divided into two contrasted spheres: things, beings, and powers attract or repel each other, implicate or exclude each other, according to whether they gravitate toward one or the other poles" (Hertz 1960, 96). According to this scheme, the whole sphere of the sacred is marked by a number of features that are associated with and accompany each other.[11] The pre-scientific cultures that are the focus of Hertz's study employ associations among opposites as a kind of sympathetic magic, by which one could bring about one opposite on the side of mana by virtue of another opposite that is associated with it in the same column.

Hertz's work foreshadows twentieth-century structural anthropology, and many of his insights have been validated.[12] But anthropologists and historians of religion came to abandon the thesis of a shared belief across pre-scientific cultures of a sacred force or mana (see, for example, Eliade 1958, 19–23). By the time the Pythagorean table of opposites was again considered from the standpoint of structural anthropology, the anthropological analyses were being given not in terms of the role that these opposites play in a presupposed underlying ontology, but in terms of the *symbolic meaning* of opposites.[13]

[11] Hertz thus writes: "Sacred power, source of life, truth, beauty, virtue, the rising sun, the male sex, and – I can add – the right side; all these terms are interchangeable, as are their contraries, they designate under many aspects the same category of things, a common nature, the same orientation towards one of the two poles of the mystical world" (Hertz 1960, 103). It is in a note to this passage that Hertz references the Pythagorean table of opposites as reflecting and deriving from this ontological scheme: "The correspondence with the table that I have set out is perfect: the Pythagoreans have simply defined and given shape to extremely ancient popular ideas" (ibid., 158, n. 50). For Hertz, social organization followed a shared understanding of the metaphysical structure of the cosmos. According to the account of Cornford [1912] 1991, the priority is the reverse of that posited by Hertz: social structures, specific to particular groups, determine modes of classifying the world and practices. He applies this analysis to the Pythagorean Table of Opposites in ibid., 68–70.

[12] For an account of work influenced by a reaction to Hertz's work on the anthropological significance of dualistic classification, see Parking 1996, 59–86. Parking's discussion, like the anthropological work he discusses, does not focus on the metaphysical commitments implicit in tables of opposites. It rather concerns the structural features of the oppositions and the relation between oppositions in ritual and in the social order.

[13] Thus, Vidal-Naquet writes that the Pythagorean tables express "collective representations" (Vidal-Naquet 1986, 64). Cf. Humphreys: "In my view the most important aspect of their [i.e. the structuralists'] approach is the idea that the aim of the analysis of myth and ritual is not to produce some kind of 'explanation' of each rite or myth, but to reconstruct a mental map of the concepts and symbols used in the whole body of Greek myth and ritual which represents the patterns of association and opposition which recur in the material, and does not depend on any advance preconceptions about the 'meaning' of symbols" (Humphreys 1978, 27). Cf. also how Burkert 1972, 468–479, employs the anthropological notion of symbolism to understand the importance of numbers in Pythagorean thought.

https://doi.org/10.1017/S0269889715000046 Published online by Cambridge University Press

G. E. R. Lloyd demonstrated the pervasive influence of fundamental polarities in Greek early science, including that of the Pythagorean table, in order to show that Greek science was determined by and dependent upon conceptual structures that pervaded Greek thought long before Greek theorizing concerning the natural world, and which persisted even as they shaped such theorizing (Lloyd 1991, 27–48, and 1966, 15–171). Among such conceptual structures are the prioritizing of right over left and the association of the right-hand side with other positively favored characteristics, in contrast with the negatively regarded characters associated with the left. Lloyd acknowledges and builds on Hertz's work and, like Hertz, prominently features the Pythagorean tables as an outstanding exemplification of these sorts of persistent cross-cultural structures. Lloyd, following anthropological developments, avoids Hertz's talk of a metaphysics of mana, and speaks instead of such a table as offering symbolic associations.

The notion of a symbol in contemporary anthropology, however, is somewhat vague. "Symbols," in this sense, are not linguistic signs, by which one object refers to another. They are terms, concepts, social structures, practices, or aspects of human social life that, along with other such items form patterns of association within a society. These associations tend to reinforce themselves, so that a pattern in social life, for example, will be reflected by a similar pattern in myth, religious practice, medical lore, and the like. Some patterns may well have a kind of causal priority over others; that is to say, those embedded within social structures may be responsible for similar patterns in myth or in the physical layout of dwellings – indeed, anthropologists tend to focus on such linkages. But there is no reason in principle why those who subscribe to such associations might not think that an asymmetry in geographical layout is responsible for an asymmetry in political power. So understood, the structure of symbolic associations may constitute a world view by which explanations are offered or, as in the case of magical or medical practice, exploited to some practical end. But it need not; a structured array of such associations may exist in the absence of any such metaphysical account. Alternatively, such an account may exist, but only as partial, its components arising only as particular answers to particular "why" questions; indeed, such ad hoc answers may not have arisen at all except as a response to the "why" questions being asked by anthropologists trying to reconstruct an alien worldview.

Symbolism, as understood by anthropologists, is a bond between concepts or entities that are loosely associated with one another, such that, within a society for which the symbolic meaning holds, the presence of the symbolized will be thought to be fitting or appropriate given the presence of a symbol. Hence, symbolic correlations need not be thought of as indicating explicit belief in causal or logical necessitation. Nonetheless, if one lives in a society, or a world, in which things are thought to be ordered as they should be, given the symbol it is only to be expected that it will be accompanied by that with which it is associated, the symbolized. The two in some loose sense go together. What evidence is there that the table of opposites is an expression of patterns of symbolic association, so understood?

https://doi.org/10.1017/S0269889715000046 Published online by Cambridge University Press

Pythagorean *Symbola* of the Divine

It is a matter of controversy to what extent the early philosophers would have recognized a distinction between their activity as teachers, rendering the world intelligible, and their activity as leaders of religious communities, claiming special abilities, inculcating others in prescribed ways of life, and leading others to a kind of transformation. Within the community of Pythagoreans both activities seem to have been interrelated (see Riedweg 2008, 42–97).[14] Iamblichus, in passages that are generally accepted as derived from Aristotle's lost *On the Pythagoreans* (see Burkert 1972, 170),[15] tells us that among the Pythagoreans the right shoe was put on first, and the left foot was the first to be washed (*Protrepticus* 21, DK 58C6; see also *VP* 83,12). The favoring of the right is not here explicitly associated with other opposites, but it is at Plutarch, *De vitioso pudore* 532C 1–3: "the Pythagoreans were always careful to not place the left leg over the right or to choose an even number instead of the odd, all other things being equal" and Iamblichus, *de vita Pythagorica* 156, 5–9: "He ordered entering temples from the right, but departing from the left, postulating that the right is a principle of the numbers called 'odd,' and is divine, and that the left is a sign (*symbolon*) of the 'even' and of what is subject to dissolution" (Dillon and Hershbell 1991). We note that the right and the even are given positive evaluation, as they are in the table of opposites, and that the right and left are called principles, just as they are in the context of Aristotle's account of the Pythagorean columns. They too are called *symbola*. What sense can *symbolon* have in this context? The term is one often used in Neoplatonic thought to refer to a saying whose significance needs to be inferred through the working through of analogous relationships, and it is often so used in reference to gnomic Pythagorean sayings (on this, see Dillon 1976). But that cannot be the sense in which each opposite can be said to be a symbol, as the Pythagoreans would not have understood the principle as such to be a *saying*.[16] Two opposites that lie in the same column would have been called *symbola* in order to indicate that each opposite either brought with it, or led to the reception of, an opposite found within the same column. I suggest, then, that in referring to Pythagorean opposites as *symbola*, our sources are employing the term in its original sense, as a half of a whole, from which the presence, and nature of another half can be inferred, and that for this reason *symbola* was likely to have been the term used by Aristotle, if not by the Pythagoreans themselves.[17]

[14] Burkert writes "The question of what is scientific depends more upon form, method, and proof than upon the content or the practical function. May it not be that the conceptual and scientific impulse simply provides a new form for an ancient and pre-scientific lore or attitude?" (Burkert 1972, 206).

[15] The reliability of Iamblichus as evidence for an Aristotelian source here is bolstered by his use of *sumbolon* in a way atypical for him, on which see below.

[16] Conceivably the uttering of the name of an opposite could have been understood as a *sumbolon* in this sense, but there is no evidence to support this.

[17] The Suda provides evidence that as early as the fourth century the term *sumbolos* was already being used in its neoplatonic sense: "[Anaximander son of Anaximander], from Miletos, the Younger, a historian. His floruit

https://doi.org/10.1017/S0269889715000046 Published online by Cambridge University Press

So if this is the sense in which the right hand side is a *symbolon* of the divine, by entering the temple on the right, one is causing another divinity, or other positively evaluated opposites, to be present. To say that the right hand side and the good (or divine) are in the same column on the table of opposites would not only be a theoretical truth; but of practical use as well, via a precept of the Pythagorean code of life. Like other prescribed practices (such as the notorious prohibition against eating beans) those concerning appropriate use of right and left feet or hands would have been primarily understood as elements of a way of life, shared by fellow members of the community. This code of life is prescribed not only because it has inherent value, but also because of the positive consequences to which such a way of life is thought to lead.[18] And this code of life, like those of other many pre-scientific peoples, is both based on and perpetuates a system of "symbolic classification." The table of opposites is a way of presenting those conceptual associations that ground the Pythagorean way of life in a way that makes them available for theoretical inspection.[19]

The Pythagorean table is unique insofar as it is the result, not of anthropological studies of an alien culture (and is therefore not the artifact of an anthropological attempt to schematize associations made by those who likely had no interest at all in schematization), but of those whose beliefs and practices themselves display the associations in question. The Pythagorean table is a self-conscious formalization of symbolic associations that pervaded Pythagorean lore and practice. There are three aspects of this account that are of note. First, it involves recognition that conceptual or symbolic associations have been present in the world and in thought, and are available for formal systematization by virtue of which they can be made explicit. (As such, it is

is the reign of Artaxerxes who was called Mnemon [404-358 BC]. He wrote an *Explanation of Pythagorean Symbols*, including such sayings as 'do not step over the beam of a balance,' 'do not poke the fire with a knife,' 'do not eat from a loaf of bread before it is divided,' etc." (Węcowski 2014). Węcowski convincingly argues that "In principle, one might expect σύμβολα to be not so much a medium of Pythagorean teaching (such teaching would be duly called ἀκούσματα), but a secret code or token of identification of the sect and to consist of a 'sign' and an 'answer'. . . . Be that as it may, A.'s explanation must have looked similar to those that we find in Diogenes Laertios, Porphyry, or in Hippolytus. A. was most probably the first scholar to comment on the Pythagorean 'symbols' thus triggering the whole consecutive line of scholarship, including Aristotle." If Węcowski is right, Pythagorean utterances were called *sumbola* in the term's original sense, that which is accompanied by a counterpart, not in the sense of referring to an utterance that had an analogical meaning. This is evidence that Iamblichus' use of *sumbolon* in respect to the table of opposites directly or indirectly derives from early, genuinely Pythagorean material.

[18] Cf. Riedweg 2008, 65: "In general, a very extensive sacralization of all areas of life seems typical of the *vita Pythagorica*. The boundaries between profane-moralizing and religious-ritual admonitions therefore sometimes become fluid." As Bremmer points out, the Pythagorean way of life involved both Weber's *Wertrationalität* (the belief in the inherent superiority of a way of life) and *Zweckrationalität* (the belief that a way of life is superior because of the good things it brings) (Bremmer 1999, 76).

[19] For Kahn, the practices prescribed by the Pythagorean way of life serve primarily to distinguish the in-group from the out-group (Kahn 2001, 10). I am suggesting that many of the practices have the goal of bringing about positively valued attributes and things. See Iamblichus: "All of those [precepts] that determine what should or should not be done aim at conformity with the divine. This is a principle, and the whole way of life is ordered with a view to following God" (Dillon and Hershbell 1991, 15–17).

https://doi.org/10.1017/S0269889715000046 Published online by Cambridge University Press

analogous to the function of legislation as a codification of shared standards of conduct. In both cases, explicit formulation of modes of categorization are means by which society achieves a kind of self consciousness.) Second, it shows explicit awareness that things, and the way in which we are to think about things, involve binary oppositions.[20] Third, it shows explicit awareness that some of these oppositions have some kind of priority over others. The positing of the table is itself a kind of record of theorizing – the compilers wish to see the relationships among various kinds of associations at a glance. The Pythagoreans took a step beyond the Milesians, who were also engaged in theoretical study or philosophy, insofar as they identified associations and gave genetic accounts of the processes that lead to familiar entities and process. In Aristotle's terms (and, perhaps, their own) they explicitly identify principles *as principles*. Just as the visual schematization of social structures into a table of columns is an attempt by anthropologists to allow for theoretical reflection concerning them, so the setting out of opposed principles in tabular form by the Pythagoreans was an effort to allow for theoretical reflection concerning the theoretical grasp of principles.[21]

Anthropological evidence allows us to appreciate both the practical and the theoretical aspects of the Pythagorean table of opposites. The table has its roots in cultural associations that were the bases for rituals and practices of various kinds; it schematized these associations in a way that made them available for theoretical study. Aristotle's discussion, which focuses on the theoretical aspect alone, confirms this conclusion, and provides more evidence concerning the explanatory use to which the table of opposites was put.

How Were the Pythagorean Opposites Associated?

Aristotle often makes appeal to associated pairs of opposites that seem to be taken from the Pythagorean table, or from a table like it (with which he assumes familiarity).[22] He does not question certain commonly accepted associations, such as that between the

[20] See Hallpike: "Dualistic classification may therefore occur at any level of thought and is in any case as much an accommodation to the "two-ness" of reality as an expression of a binary propensity of the human mind. What *is* developmentally significant is the extent to which binary classifications are systematized, either into an integrated explanatory framework such as that of the Chinese or into exhaustive and hierarchically organized, goal-oriented, classificatory procedures" (Hallpike 1980, 234).

[21] The point is well made by Riedweg 2008, 35: "In passing let us note that these Pythagoreans . . . could in a certain sense be considered forerunners of modern structuralism, which is primarily concerned with hierarchical chains of binary oppositions in texts and other objects of analysis."

[22] When he does so, it is as part of his usual survey of the *endoxa*, the commonly held views that are to guide dialectical inquiry leading to the acquisition of first principles. Aristotle's appeal to *endoxa* is often followed by his own analysis, after which he returns to the *endoxa*, showing how they are erroneous or only partially true. But when Aristotle makes appeal to the associations given in a table of opposites, he never revisits that table itself, in order to indicate its deficiencies. This suggests that he himself, as well as his audience, accepts the table of opposites as a schematization of intelligible conceptual and causal relationships, safely embedded in everyday ways of understanding the world.

https://doi.org/10.1017/S0269889715000046 Published online by Cambridge University Press

good and the limited (*Nicomachean Ethics* 2 6 1106b29-30) or that between the good and the right side.[23] When reviewing the principles identified by his predecessors, Aristotle remarks that they all picked pairs of contraries (hot/cold, wet/dry, odd/even, love/strife, great/small, dense/rare?) that were all taken "from the same column" (*Physics* 1.5 189a1). What could this be referring to if not the Pythagorean table, or one derived from it (preserving its formal structure, but substituting alternative opposed pairs)?[24]

Metaphysics N 6 1093b7-18 mentions the table of opposites in the context of a discussion of those who make number the principle of all things:

> If mathematical objects be conceived as these thinkers conceive them, evidently goodness is predicable of them, and the odd, the straight, the equal-by-equal, and the powers of certain numbers, are in the column of the beautiful. For the seasons and a particular number go together; and the other agreements that they collect from the theorems of mathematics all have this meaning. Hence they are like coincidences. For they are accidents, but appropriate to one another, and one by analogy.

Here we have confirmation that the compilers of a table of opposites[25] are said to posit these opposites as regularly concurrent. Items in the same column are predicated of the same things, so that items in one column bring out the presence of other items in the same column.[26] This is the sort of association of opposites that we have seen to be a common structural feature of pre-scientific thought and practice.

Aristotle contrasts the Pythagorean table of contraries with a similar use of contraries by Alcmaeon in his medical and physiological accounts; the Pythagorean account has the advantage of determining exactly how many correlated contraries serve as

[23] See, for example, *On the Soul* 2.5 287b22-288a13, in which the motion of the heavens is said to be to the right, on the common assumption that motion to the right is better than motion to the left, and Aristotle's own teleological premise that the cosmos is set up in such a way that to the right is the best. On the argument, see Goldin 2010. To these examples there may be added the association of male with strong and female with weak, on which see, for example, *History of Animals* 9.1 608a35-b15 and *Politics* 1.13 1260a13. Aristotle is committed to this association, which is reflected in his report of the Pythagorean columns, but when he appeals to it he does not refer to the Pythagorean table.

[24] Granted, outside of odd and even, none of the opposites listed have a place on the Pythagorean table, as Aristotle himself reports to us. I suggest that in saying that the principles are "from" the same columns, Aristotle is not saying that they themselves are items included in these columns, but that they can be understood as deriving from them.

[25] From the context it is clear that Aristotle's immediate target is figures in the Academy, but, as I have argued above, however much Speusippus and others determine the number and identity of the table's paired opposites, its underlying logic persisted.

[26] Aristotle himself employs this principle at *Parts of Animals* 3.7 670b18-22, when explaining why the left side of the body is colder than the right: "Each of a pair of opposites is distinguished [from the other] by being in the column of its kind (*pros tēn suggenē sustoichian*). For example, right is opposite to left and hot is opposite to cold, and they are [respectively] in the same column with one another, in the manner described."

https://doi.org/10.1017/S0269889715000046 Published online by Cambridge University Press

principles, and which they are (*Metaphysics* A 5 986a31-b2).[27] According to Aristotle, the list of correlated opposites that Aristotle gives us are not merely examples of the *sorts* of opposites that the Pythagoreans took to serve as principles – it is these ten and not others that are said to uniquely have this role.

Within *On the Heavens* 2.2, Aristotle tells us of the zoological and cosmological use to which the Pythagoreans put the opposition of left and right (found in the table). He writes:

> Since there are some who say that there is for the heavens a right and a left, as do the so-called Pythagoreans – for this is their account – we must investigate whether, if we are obligated to apply these principles to the body of the universe, things are as they say, or are they rather otherwise. (284b6-9)

According to the Pythagoreans, a pair of opposites that has application to one domain, the human body, is thought to have application to another domain, the cosmos as a whole. Why? Simplicius, who had at least indirect access to Aristotle's more comprehensive account of Pythagorean doctrines in the lost *On the Pythagoreans*,[28] notes that the attribution of right and left to the cosmos follows from their presence in the table of opposites:

> Aristotle understands them to have said that right and left are found in all things. On account of the fact that they took right and left to be a single principle from the ten rows, which they said[29] were principles common to all things, since their study of these things was not exclusively concerned with the heavens. (386, 4–8)[30]

Simplicius reports that the directions right and left apply to the cosmos as a whole, because they are principles of every being.[31] In the presumption that Simplicius' account reflects his Aristotelian source, we can conclude that, according to Aristotle,

[27] See also Fr. B4: "Alcmaeon said that the equilibrium (*isonomia*) of the powers (wet, dry, cold, hot, bitter, sweet, etc.) maintains health but that monarchy among them leads to disease." The list of opposed powers is here explicitly given as indeterminate. It is not clear whether Alcmaeon's opposites were intended to be of universal application, as (I argue below) those of the Pythagorean table were thought to be (see Huffman 2013).

[28] Simplicius refers to the Aristotelian *Collection of Pythagorean Opinions* at *Commentary on On the Heavens* 386, 22–3. This is not in itself decisive proof of direct access, since it is possible that Simplicius could have access to the Aristotelian material second-hand, via Iamblichus' lost treatise, *On the Pythagorean Sects*, on which Simplicius wrote a commentary. (I owe this point to Hans Baltussen from personal communication.) See also *Commentary on On the Heaven* 392, 24–32 (on which see note 38 below), where Simplicius reports an emendation of the text of the *Collection* suggested by Alexander of Aphrodisias.

[29] An alternative translation is "which he said . . . "

[30] See also 383, 13–15: "The Pythagoreans posited right and left within the ten rows, which they said [included] the principles common to all things, which is why they are principles of heaven, as well."

[31] That is not to say that this inference is the only evidence Aristotle has for the Pythagoreans' attribution of right and left to the cosmos. As Huffman writes, "Aristotle must know of some oral or written assertion by the Pythagoreans that the cosmos as a whole has a right and a left, he cannot be deducing it himself from the universal applicability of the categories" (Huffman 1993, 225).

https://doi.org/10.1017/S0269889715000046 Published online by Cambridge University Press

the opposites arrayed in the table are not simply principles of certain kinds of things; each of them (whether in itself or as paired with its opposite is not clear) is a principle of anything.[32] Simplicius informs us that Aristotle is not attributing this inference to the Pythagoreans as one explicit in the text. Rather, the universal applicability of the opposites is inferred from other uses to which Aristotle saw the opposites of the table being put.

What does it mean to say that all opposites apply to *all things* (*pantōn*)? A strong reading would have it that both of a pair of opposites apply to every particular being that is, even those that would ordinarily be characterized by one opposite to the exclusion of the other. Although it would make sense to say that the right hand itself has both a right and a left side, it is hard to see what could have induced the Pythagoreans to say that both of the opposites straight and curved serve as principles of an entity that is straight. Accordingly, we are on safer ground in attributing to the Pythagoreans (as interpreted by Aristotle) the principle that each pair of opposites serves as a principle of every kind of thing. For example, every object has a right or left, straightness or curvedness, etc. The way in which these principles apply would be responsible for the distinctive characteristic of each thing. We note that such a reading still leads to apparently counterintuitive results. How is it that a number has a right or left side? How is it that an apple is either odd or even? It is not clear what answer the Pythagoreans would have given to these questions. Recall, however, the anthropological evidence we have reviewed concerning the sort of "symbolic associations" expressed in the table of opposites. That an opposite on one column carries with it other opposites in the same column suggests a kind of identity of all associated opposites. Thus, *Physics* 3.1 201b18-23 takes motion to have been said to be difference and the indefinite, insofar as all of these opposites were taken to be in the same column insofar as they are privation. Perhaps one can say that the oddness of the apple is found not only where there is an odd number of apples, but in the right hand side of the apple, or in any positive, determinate feature of the apple.

Aristotle confirms this interpretation, according to which the table of opposites is not simply to be read horizontally, by which a principle is paired with its proper opposite (as is apparently the case in the thought of Alcmaeon), but is also to be read vertically. Opposites in the same column are – somehow – to be associated with each other. This association is symmetrical.[33] In the case of some of these associations, Aristotle reports

[32] This is also the judgment of Huffman (1993, 225).

[33] This is apparently the interpretation of Simplicius, who, as we have seen, has at least indirect access to Aristotle's more substantive account of the table of opposites in the *Collection of Pythagorean Opinions*. He tells us that the Pythagoreans "took each of the ten opposites (*hekastēn antithesin tōn deka*) that are of the same kind (*suggeneias*) to be indications of each other (*sunemphainousan*)" (*In Cael.* 386, 12–4). The translation of Mueller 2004, 33, "they took each of their ten antitheses to indicate simultaneously all the antitheses akin to it," does not give the right sense. It is not one paired opposition that stands in a special relation with another opposition, but one of the opposites that stands in a special relation with another opposite, insofar as it is found in the same column. Though *antithesis* usually has the sense of "opposition" (LSJ s.v.) it can also have the sense of "opposite" as it does at Aristotle, *Eudemian Ethics* 1224a20.

https://doi.org/10.1017/S0269889715000046 Published online by Cambridge University Press

that one opposite *is* the other, but it is not at all clear that what is involved is the "is" of identity. Thus, for example, when reviewing the *endoxa* concerning what motion is, Aristotle considers some (presumably followers of Plato) to say that motion *is* the different or unequal or non-being (*heterotēta kai anisotēta kai to mē on phaskontes einai tēn kinēsin*, *Physics* 3.2 201b20-1).[34] Their reasoning is based on an appeal to the table of opposites: "the reason why they posit motion among these things is the fact that it seems to be something indefinite, and the principles that belong to the one column are indefinite because they are privative, for none of them is either a 'this' or a 'such' or any of the other [categories]" (201b24-7). Aristotle's response is that motion cannot be the different, indefinite, or unequal, as these sorts of things need not move. This remark makes clear that Aristotle takes those of his predecessors that made use of the table of opposites to take the items in the same column of the table to be mutually coextensive. In all cases in which an opposite A on one side of the table is associated with[35] an opposite B on the same side of the table, something is A if and only if it is B.[36]

Aristotle on the Asymmetry of Causation

On the basis of both direct and indirect evidence, we see that Aristotle reads the Pythagorean table as an account of metaphysical and physical principles, articulating

[34] The old Oxford Translation "they identify motion with 'difference' or 'inequality' or 'nonbeing'" is an overtranslation. (The same mistake is made in translating *Physics* 3.4 203a10-11, in which the Pythagoreans are said to hold *to apeiron einai to artion* as "the Pythagoreans are said to identify the infinite with the uneven." In accordance with what I have argued is Aristotle's understanding of the column of opposites, Aristotle is saying that according to the Pythagoreans that which is indefinite is also (in some sense) that which is even, that is, anything characterized by evenness is also somehow characterized by infinitude. Cf. Simplicius, who reports the testimony of Hermodoros, according to whom Plato classified the equal, the stationary, and that which is in tune, as in the class of the limited on account of how they, in contrast to their opposites, do not admit of the more and the less (*Commentary on the Physics* 247, 30–248, 30).

[35] Aristotle would likely grant that it is anachronistic to take such schemes as positing one opposite as *predicated* of another with the same column; he is well aware that the grammatical distinction between subject and predicate, and the correlative ontological distinction between substance and non-substance, awaits Plato's – and his own – insights. See Simplicius' explicit quotation of Aristotle's careful formulation, in his *Collection of Pythagorean Opinions*, of the relation between opposites in the same column: "they took each of the ten oppositions to at the same time indicate (*sunemphainousan*) all of the antitheses akin (*sungeneias*) to it. . . . It was therefore reasonable (*eikotōs*) for them to use right and left to refer to (*edēlōsan*) the other spatial antitheses" (*In Cael*. 386, 19–23). Aristotle here seems to be going out of his way to avoid saying that one opposite *is* or *is predicated of* an opposite in the same column.

[36] If one conjoins the thesis that all of the opposites are of universal application with the thesis that all of the opposites are mutually predicated with each other, we arrive at the conclusion that there are only two opposites; the columns systematically lay out not a multiplicity of principles, but a multiplicity of names for the same principles. This is apparently the understanding of Eudorus, as quoted in Simplicius, *Commentary on the Physics* 181, 22: "I say that the Pythagoreans isolate the one as the principle of all things, but in another respect they introduce two highest principles. They refer to these two principles by many names. One of them is called 'ordered,' 'definite,' 'known,' 'male,' 'odd,' 'right,' 'light,'" and Plutarch, *On the Pythagorean Life* 38, 7–8: "Of the opposed powers he calls the better one 'unit,' 'light,' 'right,' 'equal,' 'at rest' and 'straight' and the worse one 'dyad,' 'dark,' 'left,' 'unequal,' 'curved' and 'moving.'" Stobaeus attributes to the Pythagorean Eurusus the view that there are two opposed natures, but *phuseis* could either refer to a kind, or to any kind of characteristic or similarity shared by members of a kind.

https://doi.org/10.1017/S0269889715000046 Published online by Cambridge University Press

the ontological and causal structure of the world. On his account, the table isolates and explicates explanatory and metaphysical relationships that hold among various things and characteristics, explaining where and when they are present. As such, the Pythagorean table is a significant step forward in the project of rendering the world intelligible. However, the opposites that are identified as theoretical principles are not ranked in any systematic way. There is no causal priority between any two contraries found within the same column. If, for example, the right hand is associated with the male, and the left hand is associated with the female, it might be the case that gestation on the right hand side of the womb leads to male offspring, as it does according to the account of Parmenides (B 17). But on the Pythagorean account, the converse relation no doubt held as well. Thus, as Lloyd (1991, 27–48) has pointed out, the superior and comparative strength of the right hand was taken to be a given among the Greeks. The right hand would not be taken to be on the right because it is stronger; rather, the hand would be thought stronger because it is to the right. Symmetrical relations of entailment are posited among the explanatory principles.

Aristotle cannot accept this possibility. His general argument against the conversion of explanans and explanandum is offered in *Posterior Analytics* 1. 2–3. The argument in outline is as follows: The identification of a cause within an explanatory context is an explanation. One with the ability to give the relevant explanations concerning a genus has scientific knowledge, or *epistēmē*, concerning that genus. The optimal form in which such explanations are to be expressed is that of demonstration. The premises of such demonstrations must express ultimate causes. This is because any premise for which there are more fundamental explanatory causes would be subject to the question "why?" which would contaminate the intelligibility of the demonstrative conclusion; that demonstration would not ultimately answer the question as to why the conclusion is the case. If cause and effect had a symmetrical relationship, scientific explanations would be circular; Aristotle argues that demonstrations that were on the basis of such relationships would fail to show anything at all. Hence explanation, and the causal relationships that explanation makes clear, must rest on "principles" that stand in an asymmetrical relationship with that for which they are principles. Principles, for which there is nothing prior, must be first in the orders of explanation and causation.

In what follows I shall argue that Aristotle's main objection to the table of opposites, understood as an ontological and causal schema, is that it is oblivious to relations of causal and explanatory priority.

Aristotle's Objections to the Logic of the Pythagorean Table

Aristotle's indictment of the Pythagoreans for not recognizing the symmetrical relation between principle and that of which a principle is a principle is found within *On the Heavens* 2.2. The passage is long, but, because of the complexity in the argument and the importance of Aristotle's wording, it needs to be quoted nearly in its entirety:

https://doi.org/10.1017/S0269889715000046 Published online by Cambridge University Press

> First, if right and left are present, we must grant that even prior principles are present in it. Now these principles have been distinguished in the lectures on the motion of animals, for the reason that they belong to their nature. For in some animals it is evident that all such parts (I mean, for example, right and left) are present – and in others some of them – but in plants only up and down. Now if we must apply to the heavens something like these distinctions, it is, as we have said, reasonable that those [orientations] that are present in animals are present in it, especially the primary one. There are three of them, and each is as it were a principle. The three I am speaking of are up and down, front and its opposite, and right and left – for it is reasonable that all of these dimensions apply to complete bodies. . . . Further, they can be . . . understood in regard to motions; I mean that the principles are those parts from which motions begin, for those that have them. Growth begins from what is up, motion in place from the right, and the senses from what is in front (for by "front" I mean that to which the senses are oriented). This is why we ought not look for above and below, right and left, and front and back, in every body, only those that, because they are alive, have a principle of movement within themselves. . . . This is why one might find it surprising that the Pythagoreans said that there are only these two principles, right and left, but omitted the other four, which are no less important. . . . While up and down are found in all living things alike, animals and plants, right and left are not present in plants. Further, insofar as length is prior to breadth, if up is the principle of length, and right of breadth, and if the principle of that which is prior is prior, then up is prior to right – in regard to [the order of] coming to be, since 'prior' has more than one sense. In addition to these points, if up is that out of which (*hothen*) motion proceeds, right the region from which (*aph' hou*) it proceeds, and front the region to which it is oriented, then for this reason too, up has a certain status of a principle (*tina dunamin arkhēs*) in relation to the other forms. On these two grounds, then, they deserve blame, because they omit the more important principles, and because they thought that they belonged to all things alike. (*On the Heavens* 2.2 284b10-285a27)[37]

The Pythagoreans are developing a theoretical account of the cosmos and the motions found within it. They do so by isolating a pair of opposites (right and left) as principles and applying them to the cosmos in a way that incorrectly posits Europe as up and to the right (285b25-7). We note that both the Pythagoreans and Aristotle pair the opposites right and left with another pair of opposites: up and down. Although up and down are not posited as principle opposites within the table of opposites, they are to be associated with the opposites light and dark, which are also present. Within the Pythagorean account, one pair of opposites is associated with another pair of opposites, and opposites are employed as explanatory principles in contexts where their applicability is immediately evident, indicating that certain oppositions are taken to be of extensive, if not universal, application.

Fundamental to Aristotle's critique is his insistence that principles of explanation be proper to a genus. We have seen evidence that the Pythagoreans took right and left to be principles of *universal* application. Aristotle, in contrast, takes right and left to be

[37] All translations are by the author.

https://doi.org/10.1017/S0269889715000046 Published online by Cambridge University Press

biological principles, applicable to only those living beings that are capable of motion. Since biology and cosmology are different disciplines, dealing with different kinds of things, it would seem as though right and left do not apply to the cosmos as a whole at all. Nevertheless, Aristotle does take them to apply, for the cosmos, as divine (1.9 279a18-30), is thought to be alive (2.2 285a29). Not only is it alive, it is in motion by virtue of an inner principle, and for this reason is thought to be an animal of sorts. As such, cosmology and terrestrial biology can be understood as branches of a more general biology, and the kinds studied by each will share key attributes, like the duality between right and left. Among animals, the right side has been empirically identified as the principle of motion (*Progression of Animals* 4 705b22-706a26); accordingly Aristotle identifies the right as the principle of motion of all living beings that have a left and a right side, including the cosmos as a whole. Since he understands right and left to be principles of motion, and the heavens rotate, there can be no determinate part of the heavens that can be identified as right or left, as there is for animals, which move linearly. Rather, in contrast to the Pythagoreans, Aristotle understands right and left as applicable to the cosmos as rotary *directions*. The rotary motion of the heavens, however, can be understood as either *to* the right or *to* the left, depending on one's orientation. But, on account of the general principle of physics that things are organized as they are for the sake of the good, the existent motion of the cosmos is identified as that which is "from the right." In conformity with everyday Greek, the motion that is to the right is counterclockwise, as it is when at a banquet one passes wine with one's right hand, to another seated at one's right (Braunlich 1936). Because this is so, the uppermost part of the cosmos, the tabletop, as it were, is the southern half.[38]

This is an odd argument, on which much can be said.[39] The problem with the Pythagorean explanation is not simply that it lacks an empirical basis;[40] after all, the Pythagoreans no doubt thought that many of the correlations among contraries in

[38] Aristotle reports that that the Pythagoreans made "us (i.e. the denizens of Europe) above and on the right side and those in the other hemisphere below and on the left side (the fact being the exact opposite)" (*DC* 2.2 285b25-7). Given that Aristotle comes to identify right and left, as applied to the cosmos not as determinate locations, but as rotary directions, what does he mean here in saying that although the Pythagoreans put Europe on the right, it is actually on the left? Simplicius provides the answer: "Is it rather the case that 'up and towards the right" is here said not according to his own preferred way of speaking, but according to that of the Pythagoreans? For they arrange (*sunetatton*) up and front with the right, and down and back with the left" (*Commentary on On the Heaven* 392, 21–24). Simplicius is telling us that Aristotle is thinking in terms of what we have argued is the logic of the table of opposites; up, front, and right are all coordinated, so that opposites found on the same column of the table are associated in a way that allows us to say that one opposite is the other. Thus, the upper is also said to be on the right. Because if we are on the lower half of the cosmos, Aristotle says, if we are to follow the logic of the table of opposites, we are also to be said to be to the left.

[39] I have elsewhere discussed it, in light of the tension between Aristotle's own skeptical remarks concerning the possibility of cosmological knowledge and the ideal of scientific explanation as revealing the intelligible structure of things (Goldin 2010).

[40] Lennox has argued that Aristotle broaches the issue in order to provide "an object lesson in empirical cosmology, countering the approach found in Plato's *Timaeus* and in Pythagorean doctrine," and that the account that he develops is intended to show what an adequate scientific account on the matter would look like

https://doi.org/10.1017/S0269889715000046 Published online by Cambridge University Press

the same column are verified by experience. Nor is it that it fails to make use of universal teleological principles. (For the Pythagoreans, to posit a right hand side is equivalent to positing a side that is good, and their answer to the question "why is this the right, and not that?" like that of Aristotle, would be "because that is for the good.")[41] Aristotle is rather making two points, both of which concern the logic of scientific explanations. The first can be extrapolated from Aristotle's insistence that right, left, and so forth do not apply to every body but only those that are alive – such principles *cannot* be universal, rather, they must be proper to the genus in question. No such distinction is made in the Pythagorean columns.[42] We have seen evidence from Simplicius to the effect that the reason why the Pythagoreans took right and left to apply to the cosmos as a whole is that they were present in the table of opposites, and as such were taken to be the principles of all things. Likewise, their use as modes of "symbolic classification" in ritual and action suggests that no such distinction can be made. Aristotle's criticism that, pace the Pythagoreans, right and left are to be applied to the cosmos only insofar as it is a certain kind of thing (an animal), is in effect a criticism of taking all opposites that are principles to have universal application. The

(Lennox 2009, 212). It needs to make the subject matter intelligible on the basis of both empirical observation and overarching teleological principles, applicable to more than one kind.

[41] Cf. Aristotle's discussion of the place occupied by the good in the Pythagorean Table of Opposites can be found in *Nicomachean Ethics* 1.6 1096b5-8. Aristotle had argued against those who take goodness to follow from being eternal, and proceeds to say that it is preferable to associate goodness and unity: "The Pythagoreans seem to give a more plausible account of the good, when they place the one in the column of goods; and it is they that Speusippus seems to have followed." Here the superordinate term is goodness, and unity is derivative from that. Aristotle has in mind the use of the column of opposites by Speusippus, who goes beyond his Pythagorean predecessors in laying out a metaphysical system that posits goodness as posterior to unity (see Taran 1981, 44, and Burkert 1972, 36, n. 38). The priority may well be reversed at *Nicomachean Ethcs* 2.6 1106b29-30: *to gar kakon tou apeirou, hōs hoi pythagoreioi eikazon, to d' agathon tou peparasmenou*. Nonetheless Simplicius, and perhaps his source, Aristotle in *On the Pythagorean Doctrines*, goes so far as to make sense of the Pythagorean table as structured by the opposition of the good and the bad. "The Pythagoreans placed all antitheses in two columns, one better, one worse – or one column of good and one of the bad" (*Commentary on On the Heaven* 386, 9–11). (Cf. *Metaphysics* N 6 1093b11-14, where Aristotle, apparently running together the two groups of Pythagoreans that he had distinguished in A 5, reports that those who posit numbers as causes of natural things say that the well (*to eu*) belongs to numbers, as they post odd, straight, square, and the powers of numbers – all but the last of which belong to the table of opposites of *Metaphysics* A 5; odd is a power of number as it is in the column of the *beautiful*.) Simplicius may be saying that the opposition of the good and the bad is the principle behind all of the other principles, in which case his source Aristotle may at one point have attributed to the Pythagoreans the very insight that in *On the Heavens* they are said to have failed to realize. If the Pythagoreans indeed had explicitly labeled one of the columns as good, then Aristotle's criticism of them would be even more pointed: they fail to show how it is the case that one side of the cosmos is the right hand side on account of what *they themselves* accept as the more primary principle, that of the good (cf. Plutarch *On Compliancy* 38, 7–8).

[42] Aristotle makes the same general point in *Metaphysics* N 1093b14-21, where he questions certain theoretical associations made by the same thinkers that posited the table of opposites: these concerned not the association of items opposed to other items but the association between numbers and features of the world such as seasons. The cause of something must be in the same genus as the effects, for which reason numbers cannot cause seasons (see Annas 1976, 219): "Although Aristotle sounds less unsympathetic to them [the associations posited by his opponents] than one might expect, he cannot afford to allow that they are significant, for this would surely undermine the autonomy of different fields of inquiry, something which Aristotle is strongly committed to.

https://doi.org/10.1017/S0269889715000046 Published online by Cambridge University Press

second point is that the principles and derivative truths need to be clearly distinguished from one another. Even if they mutually entail each other, the ontological, causal, and hence epistemological relationships between them are not symmetrical. Aristotle emphasizes that explanation involves recognition of those principles that are *prior*, that is, that are more causally basic.

The discussion of cosmological direction offered in *On the Heavens* makes explicit reference to the discussion of biological morphological orientation given in *Progression of Animals* (*On the Heavens* 2.2 284b13-4). The principles of right and left are not of universal application; rather, they are biological notions, applicable to those living beings capable of locomotion, the animals. For this reason, scientific accounts of the regular and necessary features of parts of substances are likewise grounded on those indemonstrable principles pertaining to those kinds. Within the definition of an animal there is included not only that it has the potentiality for motion but also the organs by which it moves, for example, its two legs.[43] This is not quite the same as saying that the "right" (and, by way of privation, the "left") are included as definitional principles of animals, but it is close. For, given the existence of two legs, the existence of a side that is "right" follows, given the additional premise that a single substance possesses single origin of motion (*Progression of Animals* 4). According to Aristotle, the Pythagoreans are not incorrect in the assertion that right and left apply to the cosmos, but they are incorrect in not recognizing that there is a cause or reason *prior to* that of the opposition between right and left, which is the reason why right and left apply. This is why Aristotle begins his discussion of cosmic orientation by remarking: "First, if right and left are present, we must grant that even prior principles are present in it" (2.2 284b10-13).[44]

Aristotle has already indicated that the Pythagorean analysis in terms of opposites fails to take account of all relevant opposites and to have determined which of them have causal and explanatory priority.[45] He develops this point here: the Pythagoreans are oblivious to the pair of opposites that are primary. The directions front, back, up, down, left, and right have their primary reference in relation to the functional parts of

[43] See for example *Parts of Animals* 1.4 644b7-11.

[44] Evidence that Archytas was responsible for the insight that the table of opposites is deficient in not clarifying relationships of *causal* priority and posteriority is found in Simplicius *Commentary on the Physics* 431.4–16: "It is better to say that these <opposites> are causes, as does Archytas" (431.12) (Huffman 2005). Archytas is said to fault those who identify motion with what is uneven and principles that have the same bearing (*epi tauto pherei*) as these (such as the unequal). Huffman 2005, 508–15 convincingly argues that these are the Pythagoreans of the table of opposites; he thinks it likely that Simplicius' source Eudemus included a discussion of the Pythagorean table in his account relating the accounts of motion given by Archytas and Plato. "The Pythagoreans of the table of opposites similarly regard motion as being essentially indefinite and associate it with characteristics of the "indefinite" column in the table of opposites. Archytas' point of view is quite different. Motion is not in its nature disorderly. It does arise because of an inequality or an imbalance" (Huffman 2005, 521).

[45] As Carl Huffman has pointed out to me, Philolaus (who is presumably not among the Pythagoreans in question) would have identified one pair of opposites as causally prior to the other in the table: the pair limit/unlimited.

https://doi.org/10.1017/S0269889715000046 Published online by Cambridge University Press

living things. It is for this reason that Aristotle reminds us at 285a22-25 that because up is that out of which (*hothen*) motion comes, as distinguished from the right as that from which (*aph' hou*) it comes, the power (*dunamis*) of up is prior to that of the right.[46] Aristotle does not here explicitly tell us the sense of the distinction between from whence and from which. Elsewhere we are told that up is the source of nutrition, as the mouth of a human being is up (for which reason plants have their roots "up"; they, like the cosmos as a whole, are oriented up-side down) (*Progression of Animals* 3 705a27-b8). Down is by definition the contrary of up. Front is the origin of the senses (705b9-b14) – since the senses are oriented towards the object of desire, towards which an animal moves – and back is the contrary of front; since plants don't move – they lack front and back. As we have seen, right and left, too, are understood in terms of motion, although in a different manner from that of front and back. In one sense of "principle," the primary principle of up and down is "living thing," and the primary principle of right and left and up and down is "animal." Animals are distinguished from plants on the basis of their possession of a locomotive soul. But as Aristotle elsewhere makes clear, locomotion itself is to be understood teleologically in terms of the pursuit of the object of desire; animals are unlike plants, which are able to access what they need while remaining in one place (*On the Soul* 3.9; 12 434b22-7). Hence "up," the principle of nutrition, is primary, in the sense that nutrition, as the precondition of all living things, is also the precondition for certain living things, animals capable of sensation and motion. It is primary in another sense as well: animals move in order to eat. Right and left can only be understood functionally on the basis of motion, which in turn can only be understood on the basis of nutrition, the morphological orientation of which is up. I suggest that this is why Aristotle asserts that right and left have up and down as prior principles.[47] The Pythagoreans skip a step or two when they immediately apply the principles right and left to living things, without discussion of prior principles.

Aristotle objects that the Pythagoreans applied right and left *to the heaven*, without applying to it up and down which, in the case of living beings, are orientations that

[46] At *On the Heavens* 2.2 285a12-22, Aristotle again faults the Pythagoreans with neglecting up and down as principles prior to right and left. He reverts here to a nonfunctional, geometrical account of dimension, pointing out that up and down are principles of length, while right and left are principles of breadth, and that length is prior to breadth. It is not clear why Aristotle thinks that length is to be taken as prior to breadth.

[47] This is the interpretation of Simplicius as well: "<Aristotle's> fourth objection [at 285a22ff] in addition to these is that if up is the starting point of the motion which is characterised as growth, right that from which the motion starts, and forward that to which it proceeds, and the motion of growth is more important and more substantial (*ousiōdestera*) for an animal than local motion, it is clear that up will possess a more important power as a principle than the other differences. So their using right and left and leaving out up and down is absurd" (*Commentary on On the Heavens* 385a23-9; Mueller 2004, 32). For animal, the power of locomotion features in the essence just as much as the power of growth. So how is the latter more substantial? For a neoplatonist such as Simplicius, a species is part of its genus; accordingly, the whole is more of a substance than its part (see, for example, Proclus *Commentary on the Parmenides* 650, 26–34).

https://doi.org/10.1017/S0269889715000046 Published online by Cambridge University Press

are prior to right and left. But, if the heaven does not eat, which principle is prior to the orientation to the right?

I suggest that the principle that is prior to that of left and right is simply that of the good, or final cause, of the heavenly motions. Right and left are not to be identified without appeal to the notion that the cosmos is as it is because it, like all natural beings, has the basic features it has because that is to the good. In terms of the Pythagorean table of opposites, the principle good/bad must be posited as prior to the principle right/left, in order of causation and explanation. We have seen that there is some evidence that Aristotle himself is led to attribute to the Pythagoreans themselves such an organizing principle of the table of opposites. In an Aristotelian framework, one must say that prior to the identification of the counterclockwise motion of the heavens as "from the right" is the universal principle of physics that "nature does nothing in vain."[48] For Aristotle comes to identify the definitional principle by which one can make sense of the thesis that the heavenly rotation is from the right: the right is that from which a motion is to start. Without recourse to the principle that all things are set up for the good, it is impossible to make sense of why the celestial motions are in one direction rather than another.

Aristotle's sole explicit treatment of the Pythagorean table of opposites is in the context of his program of reviewing of the *endoxa* in order to show that they reveal no variety of causation outside of the four he has identified (*Metaphysics* 1 10 993a11-16). Aristotle speculates that the elements posited by both groups of Pythagoreans serve as material causes (986a4-8).[49]

He has little to say about it in this regard. (Because they are more fully worked out and show greater theoretical sophistication, he is more interested in the accounts offered by Empedocles that similarly attempt to account for a wide variety of natural phenomena on the basis of a plurality of material principles. If they are unsuccessful, so, a fortiori, would be those of the Pythagoreans.) But in *On the Heavens* 2, Aristotle considers in greater depth an actual example of a physical explanation worked through by the Pythagoreans, on the basis of paired opposites, which shows a deeper appreciation of both the strength and weakness of logical structure of the sorts of explanations that

[48] On this principle, which features prominently in the discussion of biological directionality in *Progression of Animals* 2 704b11-705a2, see Lennox 2001, 205–22. The centrality of this principle to Aristotle's argument is emphasized in Lennox 2009.

[49] "Element" must here be synonymous with "principle" (see *Metaphysics* Δ 1 1013a20). No evidence is given for taking the opposites to have the status of material causes. We note however that from an Aristotelian point of view, the opposites fall into a number of the categories of being, for example, quality (light and dark), quantity (odd and even), and relation (right and left). Noticeably missing from the table are any terms that Aristotle would recognize as substantial. So if Aristotle is presuming that the Pythagoreans' *explananda* were material substances, which they acknowledged as coming to be and passing away through the conjunction and interplay of more basic principles, he may well have inferred that these Pythagoreans held that material substances are *constituted* out of the various basic opposed nonsubstantial characteristics which somehow served as preexisting matter. Whatever the grounds for his interpretation, it is patently speculative, for which reason it does not play an important role in the account of the Pythagorean table that is the focus of the present paper.

https://doi.org/10.1017/S0269889715000046 Published online by Cambridge University Press

the Pythagoreans were attempting. Aristotle comes to credit the Pythagoreans with the insight that explanations proceed by working through the entailments that hold among associated features. But he criticizes the Pythagoreans on the grounds that they failed to recognize the need to reveal the relations of causal priority and posteriority that hold among the principles that are identified. The *Posterior Analytics* can be understood as an attempt to systematically remedy the faults of the Pythagorean explanatory scheme.

Acknowledgments

Earlier versions of this paper were presented to the Sixth Annual Marquette Summer Seminar in Ancient and Medieval Philosophy, Marquette University, 2011, and the Society for Ancient Greek Philosophy, 2012. I am grateful for the questions and comments of those audiences, and comments from three anonymous reviewers of the present journal, Orna Harari, and especially Carl Huffman. Sameena Mulla helped me navigate initial forays into the anthropological literature. I benefited from the editorial assistance given by D. J. Hobbs and Drew Dumaine.

References

Annas, Julia. 1976. *Aristotle's Metaphysics Books M and N*. Oxford: Clarendon Press.

Braunlich, Alice F. 1936. "'To the Right' in Homer and Attic Greek." *American Journal of Philology* 57(3):245–260.

Bremmer, Jan. 1999. "Rationalization and Disenchantment in Ancient Greece: Max Weber among the Pythagoreans and Orphics?" In *From Myth to Reason: Studies in the Development of Greek Thought*, edited by Richard Buxton, 71–83. Oxford: Oxford University Press.

Burkert, Walter. 1972. *Lore and Science in Ancient Pythagoreanism*. Cambridge: Harvard University Press.

Burnet, John. 1948. *Early Greek Philosophy*, 4th ed. London: Adam and Charles Black.

Cornford, Frances McDonald. [1912] 1991. *From Religion to Philosophy: A Study in the Origins of Western Speculation*. Princeton: Princeton University Press.

Dillon, John. 1976. "Symbol and Analogy: Three Basic Concepts of Neoplatonic Allegorical Exegesis." In *The Significance of Neoplatonism*, edited by Ransom Baine Harris, 247–262. Norfolk VA: International Society for Neoplatonic Studies.

Dillon, John M., and Jackson P. Hershbell. 1991. *Iamblichus: On the Pythagorean Way of Life*. Atlanta: Scholars' Press.

Durkheim, Émile. 1912. *The Elementary Forms of the Religious Life*. Translated by Joseph Ward Swain. London: Allen & Unwin.

Eliade, Mircea. 1958. *Patterns in Comparative Religion*. Translated by Rosemary Sheed. New York: Sheed & Ward.

Frank, Erich. 1923. *Plato und die sogenannten Pythagoreer: Ein Kapitel aus der Geschichte des griechischen Geistes*. Halle: Niemeyer.

Goldin, Owen. 2010. "Cosmic Orientation in Aristotle's *De Caelo*." In *Proceedings of the Boston Area Colloquium in Ancient Philosophy* 26, edited by Gary Gurtler, 91–117. Leiden: Brill.

Hallpike, Christopher R. 1980. *The Foundations of Primitive Thought*. Oxford: Clarendon Press.

Hertz, Robert. 1960. *Death and the Right Hand*. Translated by Rodney and Claudia Needham. London: Cohen and West.

https://doi.org/10.1017/S0269889715000046 Published online by Cambridge University Press

Huffman, Carl. 1993. *Philolaus of Croton: Pythagorean and Presocratic*. Cambridge: Cambridge University Press.
Huffman, Carl. 2005. *Archytas of Tarentum: Pythagorean, Philosopher and Mathematician King*. Cambridge: Cambridge University Press.
Huffman, Carl. 2013. "Alcmaeon." In *The Stanford Encyclopedia of Philosophy* (Summer 2013 Edition), edited by Edward N. Zalta, http://plato.stanford.edu/archives/sum2013/ entries/alcmaeon. Last accessed Dec. 29, 2014.
Huffman, Carl. 2014. "Pythagoreanism." In *The Stanford Encyclopedia of Philosophy* (Winter 2014 Edition), edited by Edward N. Zalta, http://plato.stanford.edu/archives/win2014/entries/pythagoreanism. Last accessed Dec. 29, 2014.
Humphreys, Sarah C. 1978. *Anthropology and the Greeks*. London: Routeledge and Kegan Paul.
Kahn, Charles. 2001. *Pythagoras and the Pythagoreans: A Brief History*. Indianapolis: Hackett.
Lennox, James. 2001. *Aristotle's Philosophy of Biology: Studies in the Origin of Life Science*. Cambridge: Cambridge University Press.
Lennox, James. 2009. "*De caelo* II 2 and its Debt to *De Incessu Animalium*." In *New Perspectives on Aristotle's De Caelo* (*Philosophia Antiqua Vol. 117*), edited by Alan C. Bowen and Christian Wildberg, 147–214. Leiden and Boston: Brill.
Lloyd, Geoffrey E. R. 1964. "The Hot and the Cold, the Dry and the Wet in Greek Philosophy." *Journal of Hellenic Studies* 84:92–106.
Lloyd, Geoffrey E. R. 1966. *Polarity and Analogy: Two Types of Argumentation in Early Greek Thought*. Cambridge: Cambridge University Press.
Lloyd, Geoffrey E. R. 1991. *Methods and Problems in Greek Science*. Cambridge: Cambridge University Press.
Mueller, Ian. 2004. *Simplicius, On Aristotle's "On the Heavens" 2.1–9. The Ancient Commentators on Aristotle*. Ithaca: Cornell University Press.
Parking, Robert. 1996. *The Dark Side of Humanity: The Work of Robert Hertz and Its Legacy*. Amsterdam: Harwood Academic Publishers.
Riedweg, Christoph 2008. *Pythagoras: His Life, Teaching, and Influence*, 2nd. ed. Ithaca: Cornell University Press.
Taran, Leonardo. 1981. *Speusippus of Athens: A Critical Study with a Collection of the Related Texts and Commentary* (*Philosophia Antiqua* Vol. 39). Leiden: Brill.
Vidal-Naquet, Pierre. 1986. *The Black Hunter: Forms of Thought and Forms of Society in the Greek World*. Translated by Andrew Szegedy-Maszak. Baltimore: Johns Hopkins University Press.
Węcowski, Marek. 2014. "Anaximander the Younger (9)." *Brill's New Jacoby*. Editor in Chief: Ian Worthington. Brill Online, 2014. http://www.encquran.brill.nl/entries/brill-s-new-jacoby/anaximander-the-younger-9-a9. Last accessedDec 29, 2014.
Zhmud, Leonid. 1998. "Some Notes on Philolaus and the Pythagoreans." *Hyperboreus* 4 (Fasc. 2):243–70.
Zhmud, Leonid. 2012. *Pythagoras and the Early Pythagoreans*. Oxford: Oxford University Press.

https://doi.org/10.1017/S0269889715000046 Published online by Cambridge University Press