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Contrariety and Change: Problems Plato Set for Aristotle

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i

Plato and Aristotle each believe that contrariety is fundamental to the analysis of change. At *Phaedo* 70e4–71a10, for example, Socrates says that all things that have an origin (ἔχει γένεσιν) and that have contraries (ἐναντία¹) come to be (γίγνεται) out of (ἐκ) contraries. Thus if something comes to be greater, it must previously have been smaller, and vice versa. Other illustrations include coming to be weaker, faster, better, and more just from the contrary conditions. “Everything,” Socrates says, “comes to be in this way: contrary things from contraries” (*Phaedo* 71a9–10). Aristotle expresses a remarkably similar view at *Physics* I.5, 188b21–26:

[A]ll things that come to be, come to be out of contraries (ἐξ ἐναντίων), and all things that pass away, pass away into their contraries or intermediates between (εἰς ἐναντία καὶ τὰ τούτων μεταξύ). And the intermediates are out of contraries. For example, colors come to be out of pale and dark (ἐκ λευκοῦ καὶ μέλανος). And so all of the things that come to be by nature are either contraries or things that come to be out of contraries.²

Although the *Phaedo* offers different examples and says nothing about intermediates,³ there are enough similarities between the passages from the *Phaedo* and the *Physics* to commit both Plato and Aristotle to the idea that all things have their origins in contraries.

If we wish to understand Plato’s and Aristotle’s accounts of change, then, we must first understand their accounts of contrariety. Their accounts differ on a number of points. They disagree profoundly on the ontology of contrary features. Aristotle formulates a definition of contrariety; Plato never does.⁴ They even disagree about what features count as contraries: largeness and smallness, for example, are star examples of contraries for Plato, but Aristotle denies that these features are contraries at all (see *Categories* 6, 5b14–29). We believe that the story of how Plato and Aristotle came to hold the views they do on contrariety is a fascinating one, and one well worth telling. In this paper we tell the first part of the story, Plato’s.

¹ Although “contraries” is a standard translation of ἐναντία in Aristotle, “opposites” is often used as a translation in Plato. There is something to be said for this practice: Plato and Aristotle have different ideas about ἐναντίωσις. However, in the belief that it is a single thing they have different ideas about, we use “contraries” for both. Where required, we will use the terms “Platonic contraries” and “Aristotelian contraries” to distinguish between them.

² See also *Metaphysics* X.4, 1055b16–17; *De Caelo* I.3, 270a14–17; *Generation and Corruption* I.7, 323b28–324a9.

³ Arguably *Phaedrus* 262a anticipates the notion of intermediates in speaking of a thing’s changing from a feature to its contrary “bit by bit” (κατὰ σμίκρον).

⁴ Arguably *Philebus* 12d–13a anticipates Aristotle’s definition of contrariety as maximum difference within a genus (*Metaphysics* X.4, 1055a5–6).

ii

Before we begin to look at any details of Plato's view a consumer's warning is in order to alert the reader to a peculiarity of our interpretation: we believe the forms do considerably less work in Plato's theorizing about contrariety and change than the literature might suggest. The best way to illustrate the idiosyncrasy of our reading is to contrast it with a more familiar picture of the role of the forms in Plato's explanation of change.

According to Vlastos, Socrates is wise just in case Socrates participates in the form of wisdom, and in general, for any subject, S, and any feature, F, there is a form, the F itself, such that S has F just in case S has a share in the F itself (Vlastos 1981, 270-271). According to the *Phaedo* theory of explanation (which we will consider in more detail below), if something is F (beautiful, or large, or hot, for example), its having a share in the F explains why it is F (*Phaedo* 100d). According to Vlastos if we explained, say, the coldness of a dish of borsch in this way, the explanation would tell that the borsch is cold in virtue of its 'satisfying... [a] definition' whose 'logical content' is what '...marks off the Form [the cold itself]... from all... other forms...' (Vlastos, 92)⁵ These are 'safe but stupid'—hereafter, 'plain'—explanations (105c1). If Vlastos is right they are informative in roughly the same way as Aristotelian formal cause explanations (Vlastos, 91-2; see *Physics* II.3). We ask why something has such and such a feature. The explanation tells us what it is to have that feature. That answers our question once we see that the object has whatever the explanation tells us is necessary and sufficient for possessing the feature in question.²

This paper is concerned with changes consisting in the replacement of some feature F by some feature G, where F and G are mutually exclusive. If we cooled some borsch by putting snow in it, the borsch's ceasing to be hot and coming to be cold would be a change of this kind. According to Vlastos's story, one form (the hot itself) would determine what it is—and hence, what is necessary and sufficient—for the soup to be hot, and another form (the cold itself) would determine what it is—and hence what is necessary and sufficient—for the soup to be cold.

In our example, the snow is an explanation—a 'more elegant' (105c2)—hereafter, 'fancy'—as opposed to a plain explanation—of the change in temperature. Such explanations resemble Aristotelian efficient causes (Vlastos, 91-2; see *Physics* II.3). Vlastos thinks fancy explanations depend for their explanatory value upon further facts about the forms. For the snow to cool the soup, it must be cold and must make things that contain it cold by virtue of a 'physical law' or a 'law of nature'. What makes the coldness of and the cooling capacity of snow a matter of physical law rather than mere, brute fact regularity⁶ is the obtaining of what Vlastos calls a 'relation of entailment' between the forms of cold and snow (Vlastos, 105) that guarantees that snow will introduce cold into whatever we put it in. Presumably the cold that the snow brings to the borsch lowers its temperature because of some sort of exclusionary relation between the hot itself and the cold itself.

Vlastos's view exemplifies the common assumption that the theory of forms is a major component of Plato's understanding of change. But we think the forms are next to irrelevant to features that figure in a wide variety of changes—some of which are discussed in the *Phaedo* itself. To see why, suppose the borsch we cooled was hot relative to a knish we wanted to serve it with (H_k for short), but not as hot, e.g., as burning charcoal or molten lava. Suppose the snow made it cold relative to the same knish (C_k), but not as cold as frozen water or dry ice. According to the terminology we introduce in §iii and §iv below, to possess H_k is to be *qualifiedly* hot, and to possess C_k is

⁵ This is not Vlastos's example, but he intends his account of fancy explanations to be quite general, and thus to apply to temperatures.

⁶ Cp. Demos 1966, 176ff. and 186-7.

to be *qualifiedly* cold. On our interpretations (developed in the next two sections) even if a share in the cold itself is necessary for being cool relative to the knish, it is not sufficient. Furthermore, a full description of the nature of the cold itself would not serve—even if combined with descriptions of other forms—to provide a specification of exactly what it is to be C_k . The same holds for H_k .⁷ This means not only that the forms cannot be plain explanations for the temperature of the borsch before or after the change, but also, that they cannot ground fancy explanations in the way Vlastos thought. Suppose an ‘entailment relation’ does hold between the form of snow and the cold itself. Suppose an exclusion relation holds between the hot itself and the cold itself. Suppose that because of “entailment relations” between the relevant forms, snow must bring shares of the cold itself into anything that contains it. Even so, the soup can have a share in the hot itself without being H_k , the soup can have a share in the cold itself without being C_k , and neither form can show us what it is to have either of those temperatures. This is enough to render the basic story utterly inapplicable. The same holds, we think, for changes involving many different sorts of features. But where the basic story doesn’t apply, the forms can have little work to do in explaining change.

A related peculiarity of our interpretation concerns Plato’s idea that the successful practice of medicine, shoemaking, and every other practical art or craft (τέχνη) depends upon bringing about change in which sizes and other quantities are brought from excess and defect to an ideal or desirable magnitude. At *Statesman* 283d-284b Plato observes that the determination of the desirable magnitudes, the excesses, and the deficiencies presupposes fixed standards against which the relevant quantities can be measured. It has been suggested that the forms are the ‘the absolute standards’ the craftsman must rely upon for this purpose (Demos 1966, 175ff). We believe the forms are so far from being able to perform this function that Aristotle had no reason even to consider them as alternatives to his own views about change in quantity, and about changes from excess or deficiency to desirable magnitudes or proportions.

iii

We begin with the *Phaedo* version of the theory of forms:

I’m going to try to explain to you the kind of cause I have been concerned with. I go back to those oft-mentioned things and proceed from them, laying it down that there is something beautiful itself by itself itself (τι καλὸν αὐτὸ καθ’ αὐτό), and good, and tall, and all the rest. If you grant me them and agree that they exist, I hope from them to explain *cause* to you, and to show you in what way the soul is immortal. ... Consider, then, whether you agree with me on what comes next. For it seems to me that, if anything is beautiful other than the beautiful itself αὐτὸ τὸ καλόν), then it is beautiful for no other reason than because (διότι) it shares in (μετέχει) that beautiful. And I say this about everything. (100b3-c6)

Thus Socrates begins by positing the existence of forms corresponding to the features beauty, goodness, tallness, and “all the rest.” Then he appeals to these forms in explaining why certain objects have the features in question. Suppose, for example, that Helen is beautiful. Then according to the *Phaedo*, what makes her beautiful is her sharing in the beautiful itself: she is beautiful precisely *because* she “shares in the beautiful itself.” Moreover, her sharing in the beautiful itself is the *only* thing that, according to the theory, can make her beautiful: she is beautiful *for no other reason than* that. According to the theory, then, Helen’s sharing in the beautiful itself is both necessary and sufficient for her being beautiful.

⁷ We assume of course that there are no such forms as the cold (hot) relative to the knish itself.

Since Plato seems clearly to say so here,⁸ it is commonly supposed that he believes that for any object and any feature, the object's sharing in the form corresponding to the feature is both necessary and sufficient for the object's having the feature. There are, however, good reasons for thinking that *Phaedo* 100b-c overstates Plato's real view, at least in the *Phaedo*. First, a case can be made for the claim that the *Phaedo* restricts the scope of its theory to forms for *contrary* features. Only forms for contraries are mentioned in Socrates' initial list at 100b6, and no forms for features other than contraries are mentioned elsewhere in the dialogue.⁹ In any event, since we are interested here simply in contraries, we will consider the theory only in its application to contrary features, and leave open the question of its applicability to other features.

More importantly, at least for our purposes in this paper, there is reason to think that the *Phaedo* does not in fact accept the claim that sharing in a form is sufficient for having the corresponding feature. Consider the discussion of comparatives 102a-103a. Here what is taken to be in need of explanation is the fact that Simmias is both larger than Socrates and smaller than Phaedo (102b4-5). At 102c10-11, Socrates tells us that in such a case—"when he is between the two of them" (102c11)—"Simmias has the name of being both small and large" (ὁ Σιμμίας ἐπωνυμίαν ἔχει μικρὸς τε καὶ εἶναι). We take it that "having the name of being small and large" here is periphrastic for "is small and large." If so, Socrates is telling us that if Simmias is larger than Socrates and smaller than Phaedo, then Simmias is large and small. In this case, then, Simmias has the feature largeness in virtue of being larger than Socrates. And although, as we shall see, mention is made of Simmias's sharing in the large itself in the explanation of his being larger to Socrates, other things must be mentioned as well. So in this case, sharing in a form is not sufficient, by itself, for having the corresponding feature.¹⁰

In cases in which an object's sharing in a form is sufficient for its having the corresponding feature, we will say that the object has the feature *unqualifiedly*, or that it has the feature *without qualification*, or that the feature is predicated *unqualifiedly*. So, for example, since sharing in sickness was sufficient to make Plato sick on the day of the *Phaedo* (59b10), he was unqualifiedly sick on that day. In other cases, where a more complicated situation—like Simmias's being larger

⁸ And elsewhere: see, e.g., *Phaedo* 78e, 100e-101a, 103e; *Parmenides* 130e-131a; and *Republic* 596a6-7. Aristotle attributes the view to Plato at *Metaphysics* I.6, 987b3-10.

⁹ Arguably the forms for unity and duality mentioned at 101c are exceptions to this claim. However, Plato has no clear conception of what features are and are not contraries, and he may be treating unity and duality as contraries here. Alternatively, they may simply be bad examples. (*Parmenides* 128e-130b is happy to treat unity and plurality as contraries.)

¹⁰ There is also reason to believe that the *Phaedo* does not accept the claim that sharing in a form is necessary for having the corresponding feature. Consider fire, for example. *Phaedo* 103e clearly implies that fire is hot, and 105bc says that we can adequately explain why, e.g., a stove is hot by citing the presence in it of fire. But the *Phaedo* does not bring the hotness of fire within the scope of the explanatory pattern of 100bc; it does not say that fire is hot because it shares in the hot itself. (In fact the *Phaedo* offers no explanation at all of why fire is hot. *Timaeus* 61d-62a does, explaining why fire is hot in terms of structural features of fire itself, and not, or not obviously, in terms of sharing.) According to the *Phaedo*, then, fire is hot, but it does not share in the hot itself. The same is true of the rest of the *Phaedo*'s fancy explanatory factors. The dialogue assumes that three, five, etc., are odd while two, four, etc., are even, that snow is cold, that soul is alive, etc., but it does not explain why these things have the features they do, and, in particular, it does not say that they have them in virtue of sharing in forms.

than Socrates—is required in order for a subject to have a feature, we will say that the object has the feature *qualifiedly* or *with qualification*. Simmias’s being large is an example of one, but not the only, variety of qualified predication in Plato. In the next section we will look at just enough of the details of *Phaedo* 102c-d to explain how this kind of qualified predication—being large relative to something else—differs on Plato’s account from being unqualifiedly large. After that, we will briefly describe some other varieties of qualified predication in Plato.

iv

Plato explains what makes Simmias larger than Socrates in two different ways whose connection with one another, and with the earlier discussion of sharing in forms, is unfortunately not obvious. According to the first explanation,

[Simmias] surpasses Socrates ... because Socrates has smallness relative to (πρός) his [Simmias’s] largeness.¹¹

According to the second explanation, when Simmias is compared to Phaedo, who is larger, and Socrates, who is smaller than he,

Simmias has the name of being small and large when he is between the two of them: submitting his smallness for the largeness of the one [Phaedo] to surpass, and presenting his largeness to the other [Socrates] as something surpassing his smallness.¹²

These two explanations raise a number of questions that Plato does not answer.¹³ Plato does not tell us how Simmias’s largeness is related to his sharing in the large itself; we assume that it is a feature he has, in part, because he shares in the large itself. Both explanations use the language of “surpassing,” the first in stating the fact to be explained, the second in explaining the fact; we assume that “[Simmias] surpasses Socrates” is a stylistic variant of “[Simmias] is larger than Socrates” in the first explanation.¹⁴ The second explanation has it that the fact in need of explanation is Simmias’s having the name of being large. As before, we assume that “having the name of being large” is periphrastic for “being large”; we also assume that “being large” here is elliptical for “being large relative to Socrates.”

Even on these assumptions, the two explanations differ both in how they describe the fact to be explained and in how they explain that fact. The first has Simmias’s being larger than Socrates as the fact to be explained, the second has Simmias’s being large relative to Socrates as the fact to be explained.¹⁵ More importantly, the first description depicts Socrates’ smallness as something he has relative to someone else’s largeness, while the second may depict it as something that he has

¹¹ Σωκράτους ὑπερέχειν...ὅτι μικρότητα ἔχει ὁ Σωκράτης πρὸς τὸ ἐκείνου μέγεθος. (102c3-4)

¹² Οὕτως ἄρα ὁ Σιμμίας ἐπωνυμίαν ἔχει μικρός τε καὶ μέγας εἶναι, ἐν μέσῳ ὧν ἀμφοτέρων, τοῦ μὲν τῷ μεγέθει ὑπερέχειν τὴν μικρότητα ὑπέχων, τῷ δὲ τὸ μέγεθος τῆς μικρότητος τῆς μικρότητος παρέχων ὑπερέχων. (102c10-d2)

¹³ In what follows we ignore the comparison to Phaedo in the second explanation.

¹⁴ The surpassing relation mentioned in the second explanation is a more complicated matter. See n. 17 below.

¹⁵ In this context there may be no significant difference between the two ways of describing the fact. But in general “X is more F than Y” and “X is F relative to Y” will not be stylistic variants of one another.

independently of any comparison with what anyone else has and that may be compared to what others have. These two explanations of why Simmias is larger than Socrates¹⁶ are hard sayings whose interpretation is beset with difficulties we will not deal with in this paper.¹⁷ For our purposes, it is enough to note that on either explanation, Simmias's sharing in the large itself in not, by itself, sufficient for his being large. In addition, Socrates must share in the small itself, and Socrates' smallness must be appropriately related to Simmias's largeness.

According to the *Phaedo*, then, an object may be large in either of two ways. If a thing is large simply because it shares in the large itself, we say (following the conventions introduced in the previous section) that it is *unqualifiedly* large. If it is large because it is larger than something else, or large relative to something else, we say that it is *qualifiedly* large—qualified by a relation to or a comparison with something else. Although many features (e.g., beauty, hotness, and heaviness) admit of comparison, it not clear whether or to what extent Plato intends us to generalize from the cases of largeness and smallness that we just considered. Suppose, though, that we have a feature to which the *Phaedo* account applies. The conditions for having the feature unqualifiedly and having it relative to something else are different enough to allow one and the same individual to have the feature relative to with something else but to lack the feature unqualifiedly. Purple is lighter than indigo, for example, but both colors are dark. Although Claremont is cooler in the summer than Death Valley, it still gets pretty hot. For this reason, we take it that features that are predicated without qualification are different from features whose predication is qualified—not just for features predicated in comparison, but for all varieties of qualified predication.

¹⁶ Similar accounts can be given for Socrates' being smaller than Simmias, *Phaedo*'s being larger than Simmias, and Simmias's being smaller than *Phaedo*. But we are indebted to Vanessa DeHarven for pointing out that if Plato were to give exactly the same explanation, e.g., for Simmias's being larger than Socrates that he gives for Socrates' being smaller than Simmias, he would violate one of his own conditions for adequate explanations. At *Phaedo* 101ab, Socrates rejects such explanations as "Thelonus is larger than Bud, and Bud is smaller than Thelonus, by a head" because they appeal to the same thing in the explanation of contrary features. To avoid explaining being smaller and being larger by appeal to the same thing, Plato should say, e.g., that while the relation between the members of the ordered pair consisting of Socrates' smallness and Simmias's largeness explains why Socrates is smaller than Simmias, what explains why Simmias is larger than Socrates is be a relation between members of a different ordered pair—consisting of Simmias's largeness and Socrates' smallness—or a different relation between members of the same ordered pair.

¹⁷ For example, it is far from obvious what the formal properties of the "surpassing" relation mentioned in the second explanation would be, let alone which (if any) relation we are familiar with it might correspond to. Moreover, whatever surpassing turns out to be, the following would seem to be an obvious difficulty with the second explanation, at least as stated. Consider the smallness Simmias has in virtue of being smaller than *Phaedo* and the largeness he has in virtue of being larger than Socrates. We know that Simmias's largeness surpasses Socrates' smallness. Does it surpass his own smallness as well? If it does, then it would seem that he is both larger and smaller than himself. As for the first explanation: it is not clear what it is to say that Socrates' smallness is "something he has relative to the largeness of someone else," let alone whether this involves the surpassing relation mentioned in the second explanation. Finally, it is hard to say whether the two explanations tell two different stories or the same story in two different ways.

In addition to the predications discussed in the previous section, which involve Individual Comparison, there are several other kinds of qualified predication in Plato's writings. Qualified predication may also involve:

Sortal Comparison. According to the *Hippias Major*, the most beautiful ape is ugly relative to human beings, the most beautiful pot is ugly relative to maidens, and the most beautiful maiden is ugly relative to the gods (289b). Apes, pots, human beings, and maidens are accordingly "no more beautiful than ugly" (289c).¹⁸ We are familiar with many examples involving this sort of qualification. Someone can be large for a jockey, small for a football player; fast for a football player, slow for a sprinter; and so on.

Here we have a variety of qualified predication in which something is said to have a feature (e.g., beauty) relative to one kind of thing (e.g., maidens), and the contrary feature (ugliness) relative to things of another kind (e.g., gods). The difference between these qualified predications and predications involving comparatives is clear from the fact that if Socrates is five feet tall and Thelonus is an inch taller, Thelonus is tall relative to Socrates but short for a human being. Similarly, even if Claremont is large relative to La Verne, it is not large for a city in Southern California.¹⁹

Earlier in the *Hippias Major* it is affirmed that just people are just by justice (287c1-2), that wise people are wise by wisdom (c5), that good things are good by the good (c4-5), and that beautiful things are beautiful by the beautiful (c8-d1), in language close to that of the *Phaedo*.²⁰ So the *Hippias Major*, like the *Phaedo*, allows for the possibility that things can have features unqualifiedly.

Pure Relation. *Republic* 479b3-4 asks, "And again, do the many doubles appear any the less halves than doubles?" Apparently the idea is a group (e.g., six dice) may be called *double* in relation to one group (e.g., three dice) and *half* in relation to another group (e.g., twelve dice).²¹ Although there are obvious similarities between this case and the qualified predication of largeness and smallness,²² the predication of double and half involve no comparatives: although the group of six is half in relation to the group of twelve, it is not *more* half, and although it is double in relation to the group of three, it is not *more* double.

Respect. An object can enjoy a feature in one respect and the contrary feature in another respect. At *Republic* 436c-d, for example, Socrates says that we should describe a spinning top as at rest with respect to its axis but in motion with respect of its circumference (436d-e). And in the *Symposium* a man can be beautiful with respect to either or both of two parts of himself: his body and his soul (210b-c).

¹⁸ Regrettably Socrates does not raise the question whether there are beings relative to whom even the gods are ugly or—to put the issue sharply—whether there are limits to the series (presumably a partial ordering) his examples imply.

¹⁹ A useful discussion of individual and sortal comparison may be found in Wallace 1972.

²⁰ Note in particular 100e2-3: τῶ καλῶ τὰ καλὰ καλὰ.

²¹ See also *Theaetetus* 154cff.

²² Indeed, *Republic* 470b6-7 goes on to ask a question about largeness and smallness analogous to b3-4's question about double and half.

Perceiving Subject. According to the theory of vision of the *Timaeus* and the “Heraclitean” theory of vision of the *Theaetetus*, what is white for one perceiver can be black for another. And what is beautiful for one perceiver or from one point of view, or under one set of circumstances can be ugly for (from, under) another.²³

vi

In dealing with the *Phaedo*, it is important to bear in mind that its limited agenda. Plato’s principal focus is on the issue of the immortality of the soul, and although Socrates claims that to allay the worries of Simmias and Cebes on this point requires a “complete investigation” of the causes of coming to be and ceasing to be (95e8-96a1), many issues arise that, because they do not directly affect the main point at issue, go unaddressed. So, for example, as we have seen, the *Phaedo* is not clear on the range of features for which there are corresponding forms. It is also silent on the question of the relation between the two modes of explanation (plain and fancy) it offers, and on the question of why some features (e.g., largeness and smallness) apparently lack fancy explanations. Other unanswered questions have to do with the *Phaedo*’s sketchy treatment of qualified and unqualified predication; we take up some of these in the next few sections.

vii

Plato’s acceptance of the varieties of qualified predication described in §v above introduces complications in understanding his claim that contraries come to be out of contraries.

Some Platonic contraries—e.g., life and death, odd and even—are mutually exclusive: no subject can exhibit both at the same time. Since no subject can exhibit both members of a pair of exclusive contraries at one and the same time, it follows that no subject can have one such contrary at one time and the other at a latter time without changing during the interval. For example, the number of members in a group cannot be even at one time and odd at the next, unless the membership increases or decreases in size. But many Platonic contraries are not exclusive in this way. Simmias is large relative to Socrates, and at the same time small relative to Phaedo; a maiden is beautiful relative to monkeys, and at the same time ugly relative to gods; a spinning top is in motion with respect

²³ See *Republic* 479aff., where anything that’s F will also appear G, and *Hippias Major*, where participation in the F itself makes something *appear to be F* (289de) or *to become F when put next to something else* (289a-b). Someone may object, e.g., that to be what we are calling beautiful by Perceiving Subject is not to be beautiful at all, but simply to *appear* to be beautiful. This seems to be Plato’s view at *Sophist* 235e-236a. Here, a sculpture produces a work that is so large that the lower parts will seem larger than they really are, and the upper parts, smaller than they really are from a normal viewing position. If the sculptor used ‘the true proportions of beautiful things’, the statue would look ugly, and so he uses ‘proportions that are not but will seem to be beautiful,’ (ὁὐ τὰς οὐσας συμμετρίας ἀλλὰ τὰς δοξούσας εἶναι καλὰς). But at *Republic* 479b, things that ‘appear’ to be beautiful will also ‘appear’ to be ugly, just as things that ‘appear’ to be doubles will also ‘appear’ to be halves—and similarly for great and small, light and heavy, etc. The verb φαίνομαι, here translated in the language of appearance, is sometimes used to talk about how things appear as opposed to how they really are. But it is sometimes used in connection with what is evidently the case. The example of doubles and halves indicates that in our passage Plato uses ‘appears’ in the second of these senses: 6 really is double relative to 3, and really is half relative to 12. Indeed, the whole point of his bringing in the language of appearance here is to introduce a realm of ‘what is and is not’ (477a6).

to its circumference, and at the same time at rest with respect to its axis.²⁴ This illustrates Plato's willingness to admit the possibility of compresence for contraries as well as for non-contrary features that anyone would expect subjects to be able to have at the same time. Whenever contraries can be predicated of one and the same subject at one and the same time, it is possible for something can have one of the contraries at one time and the other at a later time, without changing in the interval. Simmias will be large if we compare him to Socrates in the morning and small if we compare him to Phaedo in the afternoon, but his size does not change during the day. This raises questions about how to understand Plato's claim that contraries—as he conceives of them—come to be out of contraries, and about how much this claim can help us in understanding change and coming to be.

Republic IV includes a claim about incompatibility for contraries that seems to offer some help:

1. Exclusion: Nothing can either be in contrary states or do or suffer contraries at the same time, in the same respect, and in relation to the same thing. (*Republic* 436b8-c1; see also 436e8-437a2 and 439b5).

This principle tells us that whenever contraries are predicated, they must be predicated either of different subjects, or of the same subject at different times, in different respects, or in relation to different things.²⁵ For example, a man who is standing still and moving his arm requires a division in the subject: part of him is at rest, part in motion (436c). The number of Musketeers is odd and even: odd prior to D'Artagnan's joining them, even afterwards. A top can be at rest and in motion at the same time: at rest in respect of its circumference, in motion in respect of its axis (436d). And Simmias is both small and large: large in relation to Socrates, small in relation to Phaedo.

As far as we know Plato nowhere explicitly sets out conditions that distinguish contraries from non-contrary features, but Exclusion might be used for this purpose. We see no reason why Plato should not accept the following as a partial characterization of contrariety:

2. Contrariety: Two features are contraries just in case no single subject can be or do or suffer both features G at the same time, in the same respect, and in relation to the same thing.²⁶

This condition does partially characterize contrariety: it counts genuine contraries as contraries. But it seems inadequate in at least two respects. First, since no single subject can be both hot and warm at the same time, in the same respect, and in relation to the same thing, hotness and warmth count as contraries. This seems odd both in counting hotness and warmth as contraries²⁷ and in al-

²⁴ These examples all involve qualified predication. Whether compresence is possible for some cases of unqualified predication is a question on which the *Phaedo* is silent. As we shall see, the *Republic* implies a negative answer.

²⁵ Thus it tells us that the predication of contraries is always qualified predication, thus answering the question that the *Phaedo* left open.

²⁶ Notice that this does not give us a condition for contrary forms. To get such a condition from Contrariety, we would have to add conditions that appeal to the role of those forms in the qualified and unqualified predication of the features involved.

²⁷ *Republic* 438bc, however, gives some reason to think that Plato might swallow it. There he suggests that the greater is the contrary of the lesser, and the much greater is the contrary of the much

lowing that hotness has more than one contrary.²⁸ Second, since no act can be both unjust and virtuous, virtue and injustice count as contraries. This seems odd, too: injustice is a species of vice, the contrary of virtue, and virtue is the genus of justice, the contrary of injustice.²⁹ Furthermore, it is arguable that dead people cannot be either qualifiedly or unqualifiedly ill or well, honest or dishonest, graceful or clumsy, friendly or unfriendly, etc. If this is so, dead and honest (dishonest, graceful, etc.) would be contraries according to (2). This is a bad result if contrariety must be relied on for systematic characterizations of change. Going from life to death should qualify as a change, but going from life to lack of illness, honesty, etc. should not.

viii

Worse still, Plato's acceptance of qualified predications of contraries threatens to make change incoherent, as he himself seems to have realized. At *Theaetetus* 155a-d, Socrates introduces three general principles governing change:

3. If a thing has a feature (e.g., a certain size or number) at t_2 that it lacked at t_1 , then between t_1 and t_2 it came to have that feature. (155b)
4. If a thing remains the same with respect to a feature (e.g., if it remains the same in size or number) between t_1 and t_2 , then it does not come to have another, incompatible feature (e.g., it does not come to be greater or less in size or number) at t_2 than it was at t_1 . (155a)
5. If nothing is done or happens to a thing (e.g., if nothing is added to or subtracted from it) between t_1 and t_2 , then it remains the same (e.g., in size or number) between t_1 and t_2 . (155b)

These claims seem to be obvious truths about change generally or quantitative change in particular. According to 155b-c, however, when applied to everyday occurrences, the claims seem to imply a contradiction. Suppose that in January Socrates is large relative to Theaetetus, and that Socrates neither gains nor loses any of his substance during the course of the year, but that Theaetetus grows so much that by December Socrates is small relative to Theaetetus. Then Socrates has a feature in December that he lacked in January: smallness relative to Theaetetus. By (3), he must have come to have that feature between January and December. But by (4) and (5) he didn't. Since he neither gained nor lost any of his substance during the year, it follows from (5) he remained the same. And if he remained the same during the year, (4) tells us that he could not have come to be smaller than Theaetetus between January and December.

Plato presents a similar puzzle for a case involving a group of six dice: that group is more by half relative to a group of four and less by half relative to a group of twelve without undergoing a change in number (154c). This puzzle is introduced by a general assumption—a close relative of (3) above—whose acceptance would generate similar puzzles for heat, color, and other features in addition to size (154b).

less. It is not a large step from this to the view that the much greater is also contrary to the greater.

²⁸ *Protagoras* 332a-333b uses the claim that each contrary has only a single contrary as a premise in arguing that wisdom and temperance are a single thing since each is the contrary of folly.

²⁹ Aristotle's characterization of contrariety as maximum difference within a genus (*Metaphysics* X.4, 1055a5-6) improves on Contrariety in not being subject to either of these criticisms.

Puzzles of this sort show that for some contraries that belong to things relative to something else, a subject that has one of the contraries at one time can have the other at another time, without having changed. Plato can appeal to Contrariety to avoid this result in some cases. For example, in the dice puzzle, the group of six dice is larger by half relative to one group and smaller by half relative to another, and according to Contrariety these two features are not contraries. But we can easily modify Plato's example to provide a case in which the group of six dice passes from contrary to contrary without changing. Suppose we compare the group of six to a group that increases in size from four members to twelve. Then the group of six is first larger by half and then smaller by half relative to one and the same group. According to Contrariety, being larger by half and being smaller by half relative to one and the same group *are* contraries. But even though these features count as contraries, the group of six, which was earlier larger by half than the second group, can be smaller by half later, without undergoing any change. And Contrariety does not help with the original growing boy puzzle at all: even though it was Theaetetus and not Socrates who changed, being large relative to Theaetetus and being small relative to Theaetetus qualify as contraries according to Contrariety, because Socrates cannot be both small and large relative to Theaetetus at one and the same time. Analogous cases can be constructed for relative and for comparative predications involving temperature, color, and other features.

ix

Problems of a different sort arise in connection with changes (e.g., from health to sickness) involving the *unqualified* possessions of contrary features. In the first place, the *Phaedo* is not clear on the question of the conditions under which features are predicated unqualifiedly. In the case of some of the features the *Phaedo* discusses, answers seem clear enough. All predications of oddness and evenness are unqualified, and a collection is even or odd unqualifiedly according as the number of its members is or is not divisible by two. Similarly, creatures that meet the definition of health will count as unqualifiedly healthy. In other cases, certain guesses seem more or less reasonable. Since, as we believe, the hotness of pure fire is as hot as it gets in Plato's cosmos, it seems reasonable for him to say, for example, that things within a certain range of the heat of pure fire count as unqualifiedly hot. In many cases, however, answers are increasingly problematic: e.g., is anything unqualifiedly beautiful, or unqualifiedly large or small, apart from the forms corresponding to these features?

Problems remain even if we assume that such questions have answers. To illustrate this, consider the features largeness and smallness. Recall that unqualified smallness is a feature Simmias has just in virtue of sharing in the form for smallness, quite apart from any comparison or relation to Socrates, to men in general, etc. Plato says contraries come to be out contraries (*Phaedo* 70e4-71a10). We suppose that if unqualified largeness and unqualified smallness are contraries, and if Simmias was unqualifiedly small at one time and unqualifiedly large at another, it should follow from an adequate account of contrariety that Simmias changed during the interval. But on the plainest reading of the text of *Phaedo* 102c10-d2, it would seem that this is false. At 102c10-d2, Simmias seems to have the largeness that makes him larger than Socrates and the smallness that makes him smaller than Phaedo independently of any comparisons to Socrates and Phaedo. Thus he seems to be both unqualifiedly large and unqualifiedly small at the same time. So if instead we compared him to Phaedo in the morning and to Socrates in the evening, he would pass from being unqualifiedly small in the morning to being unqualifiedly small in the evening, without having changed in between. It seems plausible to us, and we have no doubt that it seemed plausible to Plato, that nothing can be unqualifiedly large and small at the same time. And for some features like sickness and health, it seems not just plausible but obvious. But recognizing the plausibility of

such intuitions and accounting for their correctness are by no means the same thing; it is the latter that gives Plato trouble.

If Plato has anything definitive to say about the incompatibility of unqualified contraries, he says it at *Republic* 436b-d, which may be read as suggesting an extension of Exclusion (1) to cover them. Having said that nothing can do or suffer contraries at the same time, in the same respect, and in relation to the same thing, he says that if we ever find contraries being done or suffered at the same time we can be sure that the contraries belong to different items.³⁰ But if this passage does apply the principle of exclusion to unqualified contraries, all it tells us is that there are pairs of features such that no single subject can possess both members of any one of those pairs unqualifiedly at one and the same time. Presumably wellness and illness (and largeness and smallness) are pairs of this kind, while wellness and smallness (and illness and largeness) are not. If the relevant group were defined in such a way that unqualified largeness and smallness belong, and therefore that they fall under Exclusion, then Plato could say that being small at one time and large at another is sufficient for change. But Plato has no such account. Although it seems obvious that nothing can be unqualifiedly large and small (or well and ill) at the same time, Plato has no principled account of why Exclusion should apply to these. On the other hand, if Plato does not intend Exclusion to apply to the unqualified possession of contraries, he has no other way of ruling out the possibility that Simmias can be unqualifiedly large and small at the same time and thus that Simmias could be small at one time and large at another without undergoing a change in size.

Something like this can be said of qualified contrariety as well. Plato certainly does not provide any explicit account of why any given features should or should not fall under Contrariety. But his theory seems to have more resources here than it does for the case of unqualified contraries.³¹ That is because in at least some cases an appeal to the factors involved in the qualified possession of two features may provide a little help in understanding why Exclusion should apply to them. For example, it should be possible to explain why a given horse could not both ugly and beautiful with regard to the standards of beauty and ugliness to horses. And it might be possible for Plato to explain why Socrates could not be both large and small relative to Simmias.

x

Plato's problems in the *Phaedo* and the *Theaetetus* are not problems for us. To explain why Simmias is larger than Socrates and smaller than Phaedo, we introduce numerical measures of quantities: Simmias is larger than Socrates and smaller than Phaedo because his height is greater than Socrates' height and less than Phaedo's. So an obvious question to ask is why Plato didn't do what we would do in dealing with the issues raised in such passages as the *Phaedo*'s tortured discussions of qualified largeness, and the *Theaetetus*' puzzles of the dice and the growing boy? Why didn't he use numerical measures to analyze the fact that Simmias is smaller than Phaedo and taller than Socrates? Why did he worry about how even though Socrates did not change in size, he was at one time larger than Theaetetus and at another time larger without giving numerical measures of their height at the relevant times? Why did he attach so much importance to the fact that one group

³⁰ At 436b8-c1 (ὥστε ἂν που ἐυρίσκωμεν ἐν αὐτοῖς ταῦτα γινόμενα, εἰσόμεθα ὅτι οὐ ταῦτὸν ἦν ἀλλὰ πλείω), ταῦτα refers to parts of the soul mentioned earlier. But the doings and sufferings to which Plato refers are not limited to states of the soul; the principle is applied immediately to the motion and rest of a human body (436c) and then to the motion and rest of a top (436d).

³¹ This difference in resources may be due to the fact that for reasons sketched in the next section Plato had good reason to pay more attention to qualified than to unqualified contrariety.

of dice is smaller by half than a second group and larger by half than a third when he could have counted the dice in each group and compared the numbers?

It is easy to answer such questions unsympathetically. One unsympathetic answer is that Plato's apparent lack of interest in numerical measures in dealing with quantitative features like largeness and smallness betrays a remarkably inadequate and primitive notion of measurement. Another unsympathetic answer is that Plato was merely kicking up sand by presenting spurious puzzles he could easily have avoided. We certainly agree that ancient Greek measurement theory and practice was less sophisticated than our own. We also agree that Plato knew that some of these puzzles can be used to support sophisticated positions.³² But we also think that features like largeness raise genuinely important issues that must be resolved if numerical measures of length, temperature, weight, volume and other quantities are to be theoretically and practically useful.

In the *Statesman*, Plato says the importance of the art of measurement derives from its application to practical crafts like weaving and clothes making (*Statesman* 284a-b).³³ Plato typically describes the successful practice of any practical craft as depending upon the avoidance or correction of excesses and deficiencies of various items. Thus the musician must avoid tightening the strings of his lyre too tightly and too loosely. The physician must keep his patient from being hotter or colder than he should be. Like an athletic trainer, he must know whether the improvement of one man's condition requires him to eat more, less, or the same amount of food than another.³⁴ Disaster ensues if the craftsman disregards

due measure (τὸ μέτριον) by [applying] greater power to things that are too small [for it]—[too much] sail to a boat, [too much] food to a body, and [too many] principles (τὸ μέτριον) to a soul³⁵ ... (*Laws* III, 691c1-3)

If sufficiency, excess, and deficiency are crucial to the practice of the crafts, the usefulness of a measurement system will depend upon the help it provides in determining whether a given quantity is too much, too little, or exactly just enough of what is required for the purpose at hand. And no measuring system can help with this unless we can find out what is enough, and what is too much or too little for each given purpose. Thus Plato says the crafts, including statesmanship, depend upon the possibility of establishing standards (μέτρια) relative to which quantities can be called excessive or deficient (*Statesman* 284a-c). In order to determine whether, e.g., a given amount of food is sufficient for the physician's purposes, it will not do to find out whether it is greater (smaller) than just *any* smaller (greater) amount.

[T]he more and the less are to be measured relative (πρός) not only to one another, but also to the attainment of a due measure (πρὸς τὴν τοῦ μετρίου γένεσιν). (*Statesman* 284b1-c1)

The same holds, we suppose, for large and small amounts; a large amount of food would be large not just relative to *any* small amount. For the purposes of the physician, it would be large relative to the amount required to establish or restore the required bodily state. This makes it natural for

³² He says as much at *Theaetetus* 154c.

³³ In what follows we ignore a number of important complications.

³⁴ See, e.g., *Republic* 349a.

³⁵ We suppose that with the last phrase Plato has in mind, e.g., presenting a student with more principles of grammar than he can deal with.

Plato to think an adequate theory of the crafts³⁶ must explain what is to be larger and smaller, more and less, half, double, equal, etc., and what it is to be to be qualifiedly large, small, etc. But it must also account for the standard measures relative to which these comparatives and qualified predications of quantity can be used to characterize the excesses and defects that the various crafts must avoid, and the sufficient amounts they aim for.

It seems clear that the introduction of a system of numerical measures without an account of the due measures and of what it is to be large and small, etc., relative to them would have little to offer in answer to Plato's concerns about quantities in connection with the crafts. For example, it would not help a doctor to know how to measure temperature in degrees without knowing how the resulting numbers could be used to establish whether the patient's heat is medically deficient or excessive.

It is worth mentioning that a related point holds for theoretical crafts, though we don't know whether or in what form Plato would have subscribed to it. The point is nicely illustrated by an observation of the nineteenth century physicist, P. G. Tait. Tait says that because "there is no such thing as absolute size" there is no reason why an arbitrarily small object should not be "astoundingly complex in its structure."

However far we go [in examining smaller and small bits of matter] there will appear before us something further to be assailed. The small separate particles of a gas are each, no doubt less complex in structure than the whole visible universe, but the comparison is a comparison of *two infinities*.³⁷

A moral to be drawn from this is that the importance of numerical measurements does not require the "absolute" quantities whose existence Tait denies. In Tait's example, measurements can be of interest to a theoretician if they indicate whether an object has a size appropriate to the investigation of structure of a certain kind or at a certain level of complexity. More generally, just as practical crafts require measurements of excess and defect relative to a fixed standard, theoretical crafts require measurements of quantity in terms of units that are appropriate to the task of the theoretician.³⁸

If we are right about the importance of comparative and qualified quantities to Plato's conception of measure, we can see not only why he should have been concerned with problems like that of the growing boy, but also why he is not interested in a solution to the problem along more modern lines.

xi

Aristotle's discussions of contrariety—in *Metaphysics* Iota, for example—can be plausibly be read as a response to Plato's discussion of qualified predications. Aristotelian contraries are the fixed standards needed to ground descriptions and measurements of features with respect to which things change. Among these are the standards Plato had said the practical craftsman would need to measure excesses, deficiencies, and quantities involved in their correction (see the previous section). But Aristotle's account of contrariety also applies to standards that natural philosophers and

³⁶ In light of Plato's views on the centrality of crafts in human life, an adequate theory of the crafts would articulate what is foundational to the proper conduct of all practical affairs.

³⁷ From Tait 1876. The passage is quoted and usefully discussed in Bellone 1980, 40ff.

³⁸ We believe that a related consideration underlies the cryptic remarks on quantity at *Philebus* 16d-18d and 22c-25b. Reasons of space prevent us from pursuing the point here.

theoreticians need to describe and measure change. We think Aristotle's goal was to develop a foundational account of measurement that would apply to theoretical as well as practical crafts. We have no space in this paper to argue for this story, or to develop any of its details. But we will conclude with two brief suggestions about (what we take to be) Aristotle's response to some of the problems Plato set for him.

xii

First of all, consider the means at Aristotle's disposal for dealing with the growing boy and dice puzzles from the *Theaetetus* (see §viii above). According to *Categories* 7, 8a31 ff.,

6. A feature, F, is a relative (πρός τι) feature if what it is to be F—the being (τὸ εἶναι) of the feature—consists in its being related in some way to a feature, G, whose being consists in its being related to F.

For example, what it is to be double depends upon what it is to be half, while what it is to be half depends upon what it is to be double. Following Porphyry (*In Aristotelis categorias*, 125.25-29), we take the point of this to be to distinguish the relative features of a subject from features it possesses just in virtue of what belongs to it essentially or accidentally. To illustrate the distinction, recall Plato's groups of dice. One of them contained 6 dice. This quantity belongs to it non-relatively, just in virtue of its composition. By contrast, larger (larger by half) and smaller (smaller by half) are relative features. By itself, a group of 6 is neither larger nor smaller, larger by half nor smaller by half. But it is larger by half than a group of 4, and smaller by half than a group of 12. Recall Plato's observation that measurements in terms of relative greatness and smallness (πρὸς ἄλληλα μεγέθους καὶ μικρότητος καὶ μικρότητος) are worthless to the practical craftsman because what makes something greater is just its relation to what is smaller, while what makes something smaller is just its relation to what is greater (*Statesman* 283d). So characterized, relative greatness and smallness fit (6) above so well that Aristotle's characterization of relative features could easily serve as a generalization of Plato's observation.

Since one thing's possession of a relative feature (larger or smaller by half, in this case) depends upon the possession by something else of a correlative feature (smaller or larger by half), what has a relative feature can lose it, and what lacks a relative feature can come to have it by virtue of facts about other things. To bring it about that our group of dice is no longer larger by half, we need only add some dice to the group we were comparing it to, or compare it to another, larger group. If we'd like our group to become larger all we have to do is subtract dice from the group of 12, or compare it to another, smaller group. Thus, as Porphyry observed, relative features "come into and out of being without their subjects being affected" (Porphyry, 125.29). This is what we take Aristotle to mean when he says there is no change with regard to relatives (*Physics* V.2, 225b11).

This suggests a treatment of the puzzles of the growing boy and the dice. Aristotle can grant (3) (above) that for any feature, F, if something lacks F at one time and has F at a later time, it must have come to have F. He can also grant (4) that for any incompatible features, F and G, anything that has F continuously from one time to the next cannot have or come to have G during that span of time. But he can reject (5), according to which a subject that has a feature of *any kind whatsoever*, cannot cease to have that feature unless something is done to it or happens to it. Although (5) holds, e.g., for non-relative features, and to relatives possessed only by virtue of comparison to a fixed standards, a subject can lose a feature without undergoing any genuine change as long as that feature falls under (6) above (*Physics* V.2, 225b11-13). Therefore, contrary to (5), nothing needs to be done, and nothing needs to happen to a thing to make it lose or gain a relative

feature of this sort. And so it is with the features acquired by the dice and by Socrates in the growing boy example. They are features that fall within the scope of (6), not (5).³⁹

xiii

Our second and final suggestion has to do with features to which (5) applies. If all things come to be out of, and pass away into, contraries, there must be contraries in all of the categories with regard to whose properties things can change. Ignoring substantial change, these categories include Quantity, Quality, and Place (e.g., *Physics* V.2, 226a24ff. and *Metaphysics* XIV.1, 1088a31). The issues we are going to consider have to do with changes in quantity. Please note that what we have to say about them is by no means a complete account of Aristotle's treatment of quantitative contraries, let alone of the contraries involved in any of the other categories with respect to which things change.

Aristotle's general strategy for regimenting accounts of change requires the scientist to identify contraries he can use to locate the features with respect to which the subject of his investigation changes, and to orient his treatment of the change he investigates. For any given change, Aristotle supposes there should be a unique pair of contraries. Its members will be mutually exclusive features such that the change under investigation will consist of (a) the replacement of one contrary by the other, or (b) the replacement of one of the contraries by an intermediate falling somewhere in between it and its contrary, or (c) the replacement of one intermediate by another intermediate or (d) the replacement of an intermediate by a contrary. For example, Aristotle thinks dark and light are the contraries involved in changes of color; red, blue, and all of the other colors are intermediates ordered by their relations to them. Accordingly, any color change will consist of (a) a completely light subject turning completely dark (or vice versa), or (b) a completely light (or dark)

³⁹ This anticipates points that would become central to early 20th century discussions of what Peter Geach called 'Cambridge change' (Geach 1979, 90-91). In 1903 Russell (1964, 469) defined change as

...the difference, in respect of truth and falsehood, between a proposition concerning an entity and a time T and a proposition concerning the same entity and another time T', provided that the two propositions differ only in the fact that T occurs in the one where T' occurs in the other.

Of course this definition is inadequate; the change in the truth value of a proposition like 'Socrates is taller than Theaetetus' requires nothing more than a change in Theaetetus. We have seen that Aristotle is well aware of this. And it is remarkable that when one thing loses or gains a relative feature simply because of facts about what it is compared to, Aristotle says something comes (or ceases) to be true, instead of saying that any genuine (non-incidental) change (μεταβολή) has taken place.

... ἐνδέχεται γὰρ θατέρου μεταβάλλοντος ἀληθεύεσθαι καὶ μὴ ἀληθεύεσθαι θάτερον μηδὲν μεταβάλλον, ὥστε κατὰ συμβεβηκὸς ἢ κίνησις αὐτῶν. (*Physics* V.2, 225b11-13)

In this passage Aristotle uses the notion of change in truth value by means of which Russell tried and failed to define change as part of a characterization that *distinguishes* Cambridge from genuine changes.

subject turning one of the intermediate colors, or (c) the replacement one intermediate color by another, or (d) by light or dark.⁴⁰

This scheme imposes a uniqueness requirement on contraries:

7. If a feature has a contrary at all, it has no more than one. (*Metaphysics* X.5, 1055b30, 1056a11, 19-20)

One of Aristotle's problems with quantitative change is that things can change with respect to quantities that don't seem to satisfy this condition. For example, condition (7) is not satisfied by such features as being one or more feet long, weighing one or more pounds, etc. (*Categories* 6, 5b11ff.). That is because each of these magnitudes is opposed not to just one, but to an unlimited number of different magnitudes, no one of which has any better qualifications for being called its contrary than any other. Nevertheless, growing a foot and gaining a pound are certainly changes. To accommodate them to his general scheme, Aristotle must find a way of systematically identifying such quantities as contraries or intermediates.

A second problem arises in connection with quantities things have by virtue comparison, e.g., large relative to a millet seed or to a mountain (*Categories* 6, 5b17). Suppose the sizes of a particular seed or mountain are fixed. Then things can change with respect to these sizes: if something is large relative to a mountain at one time and small relative to the same mountain at a later time, it must have undergone a change in the interim. Like contraries, such quantities are mutually exclusive. Furthermore, they admit of intermediates.⁴¹ And (as required for all contraries in *Metaphysics* X.4 and *De Interpretatione* 7-10) a subject can lack both magnitudes, either because the subject is something like a soul that is incapable of having any sort of spatial magnitude, or because it has an intermediate, rather than one of the contrary magnitudes. But comparatives like these are not definite quantities. Things that are large relative to a millet seed (avocado seeds, watermelons, huts and mountains, for example) come in an enormous⁴² number of different sizes. This means that something whose size changes drastically need not change with respect to such comparative quantities: a sapling and the mighty oak it grows into are both large in comparative to a millet seed and small relative to a mountain. The indefiniteness that makes this possible also distinguishes quantities predicated by comparison to some actual object from the due measures Plato said were required for the successful pursuit of the crafts. For example, a nutritionally adequate amount of iron, an amount that is either small or large enough to cause blood abnormalities, and an amount that must be added to or subtracted from the diet to restore health will all be small relative to some objects of comparison (e.g., the amount of calcium in an oyster shell) and large relative to others (e.g., the amount of titanium contained in a thin slice of stewed morel). If quantitative contraries are to serve as or provide a basis for the determination of due measures, and if the magnitude of what has one of a pair of contrary quantities cannot change unless it is replaced by an incompatible quantity, contraries must satisfy a definiteness requirement:

⁴⁰ For some details, see Bogen 1991 and 1992.

⁴¹ At the very least, the size of a millet seed or a mountain must fall between the sizes of things that are large relative to it and things that are small relative to it. Intermediates are required by Aristotle to distinguish pairs of relatives that are contraries (according to *Categories* 6b15, some are and some are not) from pairs of relatives that are not (*Metaphysics* X.4, 1057a37 ff).

⁴² Only Aristotle's belief in a finite universe prevents the number from being infinitely large.

8. For any pair of contrary magnitudes, nothing that has either magnitude can be larger or smaller than anything else with the same magnitude.⁴³

Aristotle's second problem is to secure definiteness.

As we understand it, the leading idea of Aristotle's strategy for explaining how quantities can be opposed in such a way as to satisfy both (7) and (8) is that an ideal classification scheme would sort things into kinds such that—where K is one of these kinds—as large and as small as is possible for a K (or for a normal, or for a fully developed K, etc.) would be unique, definite magnitudes in relation to which intermediate sizes could be defined. Aristotle finds he must apply this idea in different ways to different sorts of quantities for different sorts of things. But here is one illustration of the general strategy.

Increase is a change in quantity that Aristotle characterizes increase as change 'toward complete magnitude' (εἰς τέλειον μέγεθος). By contrast, decrease is a change away from this complete magnitude (226a23-32). It is not clear just what (if anything) this can mean for all cases. But for an animal or plant that grows and shrinks (in size, weight, etc.) during the course of its life, Aristotle's talk of moving toward and away from complete magnitudes makes perfectly good sense if there is a definite maximum (or perhaps a unique, developmentally ideal) size that normal, healthy, mature organisms of a given kind can attain. These sizes will differ from kind to kind; horses can grow larger than wombats, and oak trees can grow larger than peonies. The magnitudes of maximal and minimal sizes are determined, according to Aristotelian biology, by the natural abilities for nutrition and growth possessed by normal organisms of various kinds. If for each kind there is also minimum size (beyond which no smaller organism of the kind can survive, or retain its normal functioning, or something of the kind), then there will be a maximum and a minimum size such that change in size for an organism will be increase toward the former, or decrease toward the latter for the kind to which the organism belongs.⁴⁴ We believe that when Aristotle characterized contrariety as

9a. extreme or complete difference (μεγίστη διαφορά at *Metaphysics* X.4, 1055a4; διαφορά τέλειος at 1055a16) between

9b. predicates of the same genus (1055a26ff.)⁴⁵

9c. that can belong to the same recipient (δεκτικόν) or matter (ύλη) (1055a29 ff.),⁴⁶

he was generalizing from this sort of account.⁴⁷ For growth or decrease in the size of an organism, the genus (9b) is size, the extremely or completely different predicates (9a) falling under the genus

⁴³ A similar condition is required for intermediates, and analogous conditions must be required for contraries and intermediates in other categories. We need not, and will not try to formulate any Aristotelian definiteness requirements here. Non-Aristotelian requirements of definiteness can be found in Ellis 1966, or any other standard treatise on measurement.

⁴⁴ See Bogen 1992, 17ff.

⁴⁵ This is the way people define contraries according to Aristotle in *Categories* 6, 6a17-18. (Cp. *Generation and Corruption* I.7, 323b29-324a1.)

⁴⁶ For further discussion see Bogen 1991 and 1992.

⁴⁷ According to *Metaphysics* X.4, 1055a10-22, both uniqueness (7) and definiteness (8) can be secured for any sorts of contraries for which 'modes of completeness' (...τὸ τελείως οὕτως ὡς ...) can be determined. On our reading, for any pair of contraries (quantitative, qualitative, or spatial)

of size are, e.g., maximally large (small) for a stoat. The recipients (9c) of which these contraries are predicated are organisms of a specified kind. The matters (9c) are their bodies. Change in size for a stoat is a process by which the animal's body comes to be closer to one of the extremes and farther from the other than it was at the beginning of the process. Once the contraries are fixed, numbers of convenient units can be assigned to them, and these can be used to characterize intermediates. Suppose that n ounces is the minimum weight for a stoat and that m is the maximum weight for two numbers, n and m . Neither n nor m has a contrary apart from its being the number of a minimum or maximum magnitude for some kind. But n and m are measures of contrary sizes. And for any $n' \geq n$ and any $m' \leq m$, such that $m' > n'$, what is n' at one time and m' at another will have changed in size, increasing toward or decreasing away from the complete weight for a stoat. Growing from one of the n' to one of the m' will be a change because the subject moves from one position relative to a complete magnitude to another—and similarly for shrinking from one of the m' to one of the n' . Growing larger will be a change because to grow larger will be to grow from one of the n' to one of the m' .

To see how this applies to due measures, imagine that you are an ancient Greek physical trainer who prescribes foods and exercises to maintain the fitness of a runner. You should know the maximal and minimal weights for normal human beings. You should know what intermediate weight range is healthy for humans, and appropriate for athletes, like the one you are training. This knowledge will allow you to decide whether she weighs too much or too little. If you also know how much pasta is required to maintain weight in the proper range, you will be able to find out whether her diet includes too much or too little, and if necessary, how her pasta intake should be changed to remedy an excess or defect in weight.

At *Categories* 5b24ff, Aristotle observes that what counts as many people in a village would not qualify as many people in Athens, and that what counts as many people in a house is less than what counts as many people in a theater. This illustrates an important difference between comparative measures of quantity (like small relative to a mountain) and the specifications of quantity by Sortal Comparison that Aristotle uses to explain contrariety and due measure in the examples we have just been considering. A group of people is not many or few relative to the number of people who were actually in the house, the theater, the village, or the city at any particular time. Instead, many and few are understood—depending on what is appropriate for the relevant context—as many for a house (or theater, or village or city to hold the capacities of the house, etc.) These magnitudes are determined, not by the populations, but by the capacities of the relevant places. Aristotle's use of Sortal Comparisons to explain quantitative contraries is analogous to this: magnitudes are fixed by appeal to the abilities (e.g., for growth) that are characteristic of kinds of individuals, rather than the magnitudes that have actually been attained by the members of the kinds.

The idea that natural kinds are distinguished from one another to an important extent by the abilities ($\delta\upsilon\nu\acute{\omicron}\mu\epsilon\iota\varsigma$) of their normal members is of course central to Aristotelian biology. Indeed, if what we have been suggesting in this section is correct, an important part of the work of an Aristotelian biologist (who studies natural differences between members of different kinds of organisms, or seeks to develop an adequate taxonomy of natural kinds) would be relevant to the identification of quantitative contraries. We believe an examination of Aristotle's treatments of other contraries (e.g., of contrary colors, tastes, directions and motions in space) would reveal equally strong con-

<F,G>, whose members can be possessed by things of some kind or kinds, K, the 'mode of completeness' that secures uniqueness and definiteness for the pair is constituted by the abilities of normal members of K to have features of the genus (e.g., colors, sizes, weights, etc.) to which F and G belong. For some discussion of this, see Bogen 1992.

nections between the identification of contraries and other departments of Aristotelian natural science. It would be nice if someone could find a text in which Aristotle said that his approach to the natural sciences had been shaped by his approach to the problems of change, contrariety, and due measure that Plato left him. It would be nice if someone could find a text in which Aristotle said that an advantage of his approach to natural science was the resources it provided for dealing with these problems. We don't suppose there ever were any such texts. But we don't need them to appreciate how important the Platonic problems of contrariety and change were to Aristotle's work in natural science and its philosophy.

Works Cited by Modern Authors

Bogen, J. 1991. "Aristotelian Contraries." *Topoi* 10, 53-66.

———. 1992. "Change and Contrariety in Aristotle." *Phronesis* 37, 1-21.

Demos, R. 1966. *The Philosophy of Plato*. New York: Octagon Books.

Ellis, B. 1966. *Basic Concepts of Measurement*. Cambridge: Cambridge University Press.

Geach, P. 1979. *Truth, Love, and Immortality*. Berkeley: University of California Press.

Russell, B. 1964. *Principles of Mathematics*. New York: Norton.

Tait, P. B. 1876. *Lectures on Some Recent Advances in Physical Science*. London: Macmillan.

Wallace, J. 1972. "Positive, Comparative, Superlative." *Journal of Philosophy* 69, 773-782.