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TWO THINGS ARE OFTEN said about Aristotle's treatment of time in the *Physics*. First, that Aristotle's considered view of time is intrinsically tied to a language of temporal passage heavily dependent on the A-series.[1] As such Aristotle's understanding of time is plagued with the perplexities that the A-series generates.[2] Second, that the series of puzzles that Aristotle treats in IV. 10, leading to the conclusion that time is non-existent, are left unanswered by Aristotle.[3]

[1] J. M. E. McTaggart was the first to explicitly draw a distinction between the A and B-series. In his *The Nature of Existence*, Vol. 2 (Cambridge: Cambridge University Press, 1927), 10–11, McTaggart distinguishes two ways of ordering positions in time. First, "each position is earlier than some and later than some of the other positions." Insofar as this is the case positions in time constitute a B-series. Second, "each position is either past, present or future." This is the A-series. McTaggart notes that "the distinctions of the former class are permanent, while those of the latter are not. If M is ever earlier than N, it is always earlier. But an event, which is now present, was future and will be past."

[2] Such is the view of W. D. Ross, who notes that for Aristotle "as movement is the flux of a moving body, time is the flux of the now from the future through the present to the past" *Aristotle's Physics* (Oxford: Clarendon Press, 1936), 67. Cf. G. E. L. Owen, "Aristotle on Time" in Peter K. Machamer and Robert G. Turnbull, eds., *Motion and Time, Space and Matter* (Columbus: Ohio State University Press, 1976), 15–16; Sarah Waterlow, "Aristotle's Now," *The Philosophical Quarterly* 34 (1984): 104–128; Richard Sorabji, *Time, Creation, and the Continuum* (Ithaca: Cornell University Press, 1983), 46–51. There are, however, scholars who argue that Aristotle's understanding of time more closely corresponds to that of the B-theory, where time is understood in terms of static relations rather than in terms of temporal flow. See in particular Norman Kretzmann, "Aristotle on the Instant of Change," *PAS* 50 (1976): 91–114, as well as W. Wieland, *Die Aristotelische Physik* (Göttingen: Vandenhoeck u-Ruprecht, 1962), 327.

[3] In his book *L'espace et le Temps selon Aristote* (Padova: Editrice Antenore, 1965), Joseph Moreau notes "Où se situe le Temps par rapport à l'être et au non-être? Problème proprement métaphysique, qu'Aristote, nous le verrons, a peut-être en grande partie éludé; il l'a toutefois nettement posé" (92). Owen comments as well that "the paradoxes are not systematically and

Instead, after presenting the puzzles having to do with *whether* time is, Aristotle cannot move fast enough to his treatment of *what* time is, leaving the puzzles unresolved.[4] In this paper we would like to look at these two issues together. Our thesis is that the puzzles about the existence of time discussed by Aristotle at IV. 10 are generated by a particularly naïve version of the A-theory. Further, although Aristotle's answer to *what* time is incorporates elements of an A-theory of time, it manages to avoid just those particular puzzles discussed in IV. 10 leading to the conclusion of time's non-existence.

Our discussion is divided into three parts. First we provide an analysis of the puzzles raised by means of the commonplace ideas (ἐξωτερικοὶ λόγοι) mentioned by Aristotle at 217 b 31. This analysis will reveal that the puzzles are the consequence of a hypostatization of time, that is, the naïve notion that time has metaphysical status in its own right, in the way that a substance has, for instance. The hypostatization of time is what results when we ask questions concerning when the now exists and when the now ceases to be. We argue that these are questions that arise when the present is thought of as something that becomes, that is, that surges forward through history. Moreover, the problems brought to light by these puzzles are not left unresolved by Aristotle. Rather, Aristotle's considered view of time, piggybacking as it does on substances and their changes, would clearly avoid such a reification of time and hence the problems generated by it. In the second part of the paper we discuss Aristotle's view of the substrate of time, namely change, and show why Aristotle argues that change must be thought of as following a magnitude. Using our discussion in section 2 as our basis, in the third and final section we discuss the

directly answered in the sequel . . ." ("Aristotle on Time," op. cit., 27 n. 20). Kretzmann argues that Aristotle avoids the paradoxes through espousing what basically amounts to a B-theory of time. "Aristotle on the Instant of Change," op. cit., 107ff. Contra Kretzmann, we will argue that Aristotle's solution to the paradoxes does not depend on such a move.

[4] Recently, some commentators have attempted to find solutions to the puzzles in IV. 11–14. None of these commentators has been able to provide a single Aristotelian solution to the puzzles that would dissolve them all. For instance, while Michael Inwood suggests that there are hints that Aristotle might solve the problem of time's non-existence in terms of a persisting present, he only promises he will provide Aristotle's solution to the problem of when the now perishes (163, 165), but then never touches on that problem again. Michael Inwood, "Aristotle on the Reality of Time," in Lindsay Judson, ed., *Aristotle's Physics* (Oxford: Clarendon Press, 1991), 151–178. Richard Sorabji, on the other hand, attempts to provide an Aristotelian solution to the problem of when the now perishes, but only suggests his own (Sorabji's) solution to the problem of time's non-existence, and admits that "Aristotle does not get as far as discovering this solution to the paradox" (Sorabji, op. cit., 13). Our reading of Aristotle, on the other hand, is able to account for a dissolution of all the paradoxes through one single argument based on a holistic understanding of Aristotle's views on time. The particular solutions offered by Sorabji and Inwood, and why we feel they are inadequate, are discussed below in more detail.

significance of Aristotle's theory of time as that which results when we measure one change by another. Our discussion in sections 2 and 3 is geared towards an exploration of how Aristotle's own theory avoids a commitment to pure temporal becoming as real, that is, the idea that the now moves through a fixed continuum along which events are arranged in chronological order. The fact that this denial is an implication of his theory is closely linked to Aristotle's solution of the aporias in IV. 10.

1. THE ἐΞΩΤΕΡΙΚΟΙ ΛΌΓΟΙ

The arguments presented in IV. 10 concern difficulties arising from common sense views of time. We will argue that these puzzles are the result of a reification of time. Resulting from naïve conceptions of time, they dissolve once these have been replaced by Aristotle's ensuing demystified account of the nature of time. Two things stand out as important in this regard. First, Aristotle's definition of time involves number, and as Aristotle notes at 223 a 22 ff., number exists only insofar as there is a soul that counts. That Aristotle conceives of time as involving a soul that counts should alert to us to the fact that Aristotle does not conceive of time as something that, of itself, marches along a preexisting continuum, first privileging one moment and then another. Second, insofar as the substratum of time is that which is countable in the before and after in change, time is, as it were, a characteristic of substances undergoing change and is not an explanatory condition of their changing. Time is not a necessary condition of change; but rather, change is a necessary, but not a sufficient, condition of the existence of time. As such, time does not exist apart from change.

If time is dependent on change and on the soul that measures it, the question of the ontological status of time is resolved, since the substratum of time is simply the countable aspect of the change of substances and does not exist apart from these and their movements. On this view the question regarding time's existence and the puzzles attendant upon it have not been left unanswered, and the whole of Aristotle's discussion of time can be understood in the light of a more unitary and cohesive framework. The ontological status of time is derivative, dependent on substances and their changes. In demystifying time by reducing its substratum to an element of nature, that is, to a characteristic of substances that change, Aristotle has dissolved the very paradoxes that might lead one to deny the existence of time altogether.

In order to see how Aristotle's subsequent treatment of the nature of time escapes the problems that he discusses in Book IV. 10, we must first clarify what these problems are. Characteristically, at the beginning of his analysis Aristotle inquires "whether it [time] is among the things that are or the things that are

not . . ." (217 b 31).[5] The strange nature of such an inquiry is immediately made evident by the paradoxes that it generates. These are discussed in more depth below. First, however, a few general remarks having some bearing on the more technical analysis of Aristotle's ensuing discussion are in order. In the course of our ordinary talk about things, when we ask of something whether or not it exists, we usually assume that the kind of thing of whose existence we inquire is that sort of thing capable of enduring through time. Ordinarily, we assume that anything that exists (or has existed or will exist) exists at some time. We say of things that no longer exist that they "existed in the past," those things that continue to exist are "in the present," while given the normal course of events, we assume that certain things will "exist in the future." Thus to ask the question whether time exists in the ordinary way that *things*, such as dinosaurs, exist is to ask a rather awkward question, for things exist at particular times and places. Hence when pressed, our answer to the question about time would eventually involve us in the paradox of having to specify whether there was or is or will be a time when time is. The paradoxes seeming to indicate that time does not exist stem from the very nature of the question, particularly when taken in its most naïve and natural sense. Such a question easily misleads us into making the category mistake of thinking of time as if it were itself something that must be in time, as if time were a kind of substance. It is when we are misled into attempting to determine the *when* of time (as if there could be some moment in which time might become present to us) that the paradoxes that Aristotle discusses in his opening section on time arise. In what follows we will show that these paradoxes result precisely when time is hypostatized.

At 217 b 32 ff. Aristotle tells us that it would seem that time is not, for "some of it has been and is not, some of it is to be and is not yet." The argument here would seem to be that since time can be divided into the past, which is no longer, and the future, which is yet to be, then it does not exist. The next step in Aristotle's argument moves to counter the obvious objection that this argument ignores the present, which does exist now. But what is the nature of the present? Does the present constitute a part of time? Aristotle first notes that for any divisible thing, "if it is, either all the parts or some of them should be when it is." The "when" in this sentence is crucial, since it shows that for any divisible thing to exist, either all or at least one part of it must exist at some specifiable *when*. Since any part of it must itself be divisible, these parts should exist simultaneously. If the present moment were divisible, then the successive instants marking the divisions of the present would have to co-exist simultaneously, which is impossible. Hence no divisible part of time exists now. If, on the other

[5] Unless otherwise stated, all citations from Aristotle are from *Aristotle's Physics III and IV*, translated by Edward Hussey (Oxford: Clarendon Press, 1983).

hand, the present were like an indivisible point, it could not serve to constitute a *part* of time—no sum of indivisible instants will yield a divisible length of time.

The assumption that the now is like an indivisible point also yields further difficulties, since it would seem that either all or part of an existing thing must endure for more than a single now. No thing that is in merely one now is in time, for the now divides time but does not constitute it. However, it would seem that the now is merely in itself, and thus not in time. It would seem, then, that the now does not exist since there is no part of time at which it is present. The problem with this argument is that it assumes that there must be a time in which the now becomes present. However, the now is never present. It is, rather, that through which things become present to us.

That time is never present can be seen from Aristotle's ensuing discussion. "But of time, while it is resoluble into parts, some [parts] have been, some are to be, and none is. The now is not a part, for a part measures [the whole], and the whole must be composed of parts, but time is not thought to be composed of nows." This passage requires some elucidation. Let us take an arbitrary segment of time, for instance sixty minutes. Consider the moment that divides the segment in half; at this point thirty minutes will have passed, while thirty minutes are still to come. Were we to consider this moment as a divisible segment of time, let us say, a minute, at any given point during this minute some of it will be in the past, while the rest of it will be in the future. The fleeting instant that divides a segment of time is the now, and the now is not a part of time. For given a spatial analogy, any part has two limits and an intervening magnitude. (This is what Aristotle means when he tells us that a part measures the whole; in order for a part to be a unit capable of measuring the whole it must possess a non-zero magnitude and two limits that define it. In multiplying such a magnitude x number of times we should get a length equal in magnitude to the whole). However, this is certainly not true of the now; the now can possess no magnitude.[6] Were we to say that the present minute is a now possess-

[6] Sarah Waterlow (Broadie) questions what she believes may be Aristotle's too hasty conclusion that the now is indivisible in "Aristotle's Now," *op cit.*, 106 ff. The same matter is discussed in her earlier article, "Instants of Motion in Aristotle's Physics VI," *Archiv für Geschichte der Philosophie* 65 (1983): 129–46, where she ultimately defends Aristotle's doctrine that the present is instantaneous. This defense has to do with the fact that the moment of something's actually becoming F must be instantaneous and cannot involve a process. If it did involve a process, it would imply an endless regress in which we would never arrive at the moment at which a thing actually becomes F, since if moments were not instantaneous each moment could itself be thought of as implying a process through which the thing is becoming and has not yet become F. So Broadie, "When the terminus is reached the process is simultaneously complete and over; and this 'when' of completion is an indivisible moment. For if something is reached at all it cannot go on being reached and then perhaps cease being reached, as if reaching were a condition that begins and ceases. Thus, as completion is without beginning and without end (yet not eternal) it is complete as soon

ing a magnitude, we would have to think of it as having taken place all at once. Yet because of the successive nature of time this cannot be the case, and the now cannot be thought of as a part of time which is itself divisible. Insofar as any part of time, no matter how small, has two limits and an intervening magnitude, the now does not encompass it. The now is rather like a point without extension, and it is that through which time is divided. If the now is like an extensionless point, time cannot be composed of nows, just as a line cannot be composed of points.[7] This is because any continuum or magnitude having extension cannot be derived from the addition of elements without extension.

The gist of this argument is that no part of time can be said to exist, for no divisible part of time, no matter how small, can ever exist simultaneously with itself. In other words, there is no *when* in which a part of time exists all at once. On the other hand, that which does exist in itself in a given instant, namely, the now, is not a part of time. This inquiry into the existence of time fails precisely at the point where the argument inquires into the existence of time as if it were a substance that must itself be in time. The argument arrives at the false conclusion that time does not exist because it presumes that an inquiry into the existence of time can be carried out in the same way as any inquiry into the existence of natural substances which must themselves be in time in order to be. This argument seems to show that time does not exist because there is no *when* in which a part of it exists. But to say that time does not exist because it is not in time is to require that the categories of substances apply to time. It is to hypostatize time as if it were itself a substance.[8]

The next section of chapter 10 presents paradoxes stemming from a similar hypostatization of time, although these paradoxes will also reveal deeper issues which Aristotle will grapple with in the technical arguments at 219 b 9 ff. The puzzles presented here continue the earlier arguments designed to show that time does not exist and are intrinsically connected with them. Aristotle had first presented the argument that time does not exist because it can be divided into two parts, past and future, which strictly speaking are not. His

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as the subject has become F, and that, in turn, is only as soon as the subject is F, since it cannot have become what as yet it is not" (138).

[7] Kretzmann offers the following instructive analogy: "If we think of today as a salami sausage, then the present instant is a cut dividing the sausage in two. While the salami can be reconstructed out of slices, no matter how thin, it cannot be reconstructed out of cuts, no matter how many. As a salami is not composed of cuts, so a day (or infinite time itself) is not composed of instants" (Kretzmann, op.cit., 97).

[8] Michael Inwood suggests that Aristotle solves the problem of time's non-existence since "Aristotle held that the now persists" ("Aristotle on the Reality of Time," op.cit., 178). It is unclear how this idea would solve the problem, particularly since to say that the now persists is to treat the now as a substance. As a persisting entity, the now would be thought to travel through history. Yet as we make clear below, it is this very understanding of the now that gives rise to the problems Aristotle discusses.

second argument, discussed above, is aimed at showing that the present instant does not constitute a *part* of time either, since it is indivisible. Aristotle's next argument, begun at 218 a 3 ff., illuminates further difficulties with the existence of the present instant. For if the now exists, it must remain either always the same or become always "different and different" (ἄλλο καὶ ἄλλο).[9] Both options, Aristotle shows, lead to unacceptable conclusions. At this point it is significant that Aristotle notes that the now seems to be the boundary between the past and the future.

> And (3) it is not clear whether the now which divides the past and the future is always the same or always changing. (a) If it is always different, and no two *parts* of time exist together (unless one includes the other), and that which now is not and previously was must have ceased to be, the nows also cannot exist together, but the earlier now must have ceased to be. Now (i) it cannot have ceased-to-be in itself (for then it was), nor (ii) can it have ceased-to-be in another now. For let us lay it down that nows cannot be next to each other, any more than points. If then it has ceased-to-be not in the next now but in some other, it would exist in the intermediate nows (infinite in number), simultaneous with them, which is impossible.[10]

The now marks the difference between past and future, not as a stationary point, but in such a way that each now recedes into the past. That the present now always perishes into the past is an indication that the now must always be 'different and different' (if the now were not 'different and different,' past, present, and future would be indistinguishable). But if this is so the problem arises that since we think of each now as a distinct entity, there must be some point in between successive nows that allows us to distinguish each now from every other now. Given that the now is always 'different and different,' that only some alternative like this is left to us is made evident by the fact that the now cannot cease to be in itself, just as a point cannot cease to be its own delimitation. For were the now to cease to be in itself, we would have to say that it *was* at the very moment of its ceasing to be, which is a contradiction.

On the other hand, an indivisible now cannot cease to be in a next now. The reasoning behind this involves some technical problems that Aristotle discusses at VI. 1. Insofar as the now is analogous to a point, the same reasoning that applies to a point also applies to the now. A point can be said to be together (ἐχόμενα) with another point only if either a) one of its extremities touches the second point or b) through the first point's touching of the second point the two form a unity. The former alone is a case of contiguity, the latter

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[9] As it will become clearer through the discussion that follows, by the idea that the now becomes "different and different," Aristotle has in mind the notion that each present instant is different from all other moments that will be or have been at some time present.

[10] This passage is taken from Ross's translation of the *Physics* (op.cit., 384–385), which is clearer at this point than the Hussey.

of continuity. Two things are contiguous when their extremities touch but they are different in kind from one another; points cannot be contiguous since they are not different in kind. Moreover, as Aristotle shows in VI. 1, since a point has no extension, it can be neither one nor together with another point. Since a point has no extremities, no part of it can be in contact with part of another point. On the other hand, if the points were in contact as whole with whole, they would still not be together or form a continuum. This is because any continuum must be divisible into parts such that the parts occupy different regions of space. However, in the case of a point that is together with another as a whole (point) with a whole (point), that is, as completely overlapping, the two points must be at the same point of space, which is to say that these two points must be identical. Since the two points would be a single point, and a point is indivisible, such an addition of points would yield no divisible magnitude or continuum. To put the matter another way, the addition of any number of extensionless points cannot yield a magnitude with extension. Thus, given that the now is analogous to a point, no now is next to another now.

There is a hidden assumption behind the reasoning at 218 a 11 ff. In order for a now to cease to be in another now there must be some contact between the two nows such that the now that ceases to be does so at the very point where the new now begins. For surely if time were composed of nows it could not look like this:

A B C D E F
• • • • • •

Here each now is represented by the successive points labeled A, B, C, D, etc. The moments A, B, C, and so on are punctuated by stretches of something of a fundamentally different nature than the moments themselves. Were time to look like this, each now would cease to be in something else than a now. But since of the whole of time, no single one of its moments was not or will not be at some time present, the perishing of a now cannot occur in something other than a now, that is, the perishing of a now must at some time be present. If this were not the case, the passing of a now would have to occur in something other than time (represented by the empty spaces in between each successive point). Surely, however, this is impossible.

The next part of Aristotle's argument is difficult, since it is not clear what can be meant by the phrase "since the now has not ceased to be in the next now but in some other one." This "other now" cannot mean "the now after the next," for if there are no next nows, there is also no now after the next. On the other hand, the now cannot perish in a successive now, for as Aristotle clearly states at 231 b 6 ff., things are in succession only if there is nothing of their own kind between them. However, moments cannot be in succession, because

that which lies between two moments is always a period of time with other moments in it. Thus this other now cannot be a successive now. Moreover, given the instant t1 and any arbitrary later instant t2, there will be an infinite number of instants between the two. Therefore t1 cannot perish at t2, for if it did it would have to coexist with the infinite number of instants in the interval bounded by t1 and t2.[11]

Given the difficulties concerning a common sense attempt to define the now as always different and different, Aristotle shows that the now cannot always be the same, either. For things are in time as before and after when they are in different nows. On the other hand, were the now always the same, there would be only one now and no way to distinguish moments such that they can be placed in a relation of before and after. If there is no way to distinguish the before from the after, but everything is said to take place in one now, then the absurd conclusion would follow that "events of a thousand years ago will be simultaneous with those of today and none will be either previous or subsequent to one another."

The paradoxes connected with the question of whether the now is the same

[11] Sorabji argues that Aristotle has the means to solve this puzzle, although he does not explicitly do so. Hence he claims that a solution to the puzzle comes in two steps: "The first point is that we must distinguish between the present and the perfect tense: we can never say, using the present tense, that the present instant *is* ceasing to exist. But we can say of what we once called the present instant that it *has* ceased to exist. When? The second part of Aristotle's answer would be: at any subsequent instant you like, however close—a millionth of a second later, or a two millionth. There will be no first subsequent instant" (*Time, Creation, and the Continuum*, op.cit., 10). Given the fact that Aristotle frames his problem in terms of the perfect tense, asking when the present instant *has ceased* to exist, (a fact that Sorabji admits) the first part of Sorabji's solution seems beside the point. The second step Sorabji envisions is, however, closely tied up with the first: there is no moment in which the present instant *ceases*; there is only the fact that it has ceased to exist. On Sorabji's reading of Aristotle, this is true because the passing of the now is not a process and cannot involve any duration; it is instantaneous; hence the now never *ceases*, since this would seem to involve duration. Sorabji notes that for Aristotle indivisible entities are never in the process of coming into existence or ceasing to exist (instants are, of course, indivisible entities); hence it is not the case that "if a thing has come into existence, it must previously have been in process of coming into existence" (12). This point, however, does not really solve Aristotle's problem, since we might still ask "which is the first instant in which indivisible entity x has ceased to exist?" To say that there is no first instant in which x has ceased to exist is not to solve the problem at all. According to Sorabji, that there is no such moment is proved by the fact that since time is a continuum, there are an infinite number of instants between any two instants. If at one instant it is two o'clock, to name an instant at which it ceases to be two o'clock is to be saddled with the burden of what sense to make of the infinite number of instants between two o'clock and the time in which it ceases to be two 'o clock. The textual evidence for Sorabji's reconstruction of Aristotle's solution is merely the fact that Aristotle recognized this fact, i.e., "that a given instant has no immediate successor, and that you can forever choose closer ones" (10). But this does not support his conclusion that Aristotle believed there is no first moment at which an instant ceases; it is merely to restate the puzzle and to infer that Aristotle solved it by refusing to provide an answer to it. Cf. Richard Sorabji, "Aristotle on the Instant of Change," *Proceedings of the Aristotelian Society* 50 (1976): 69–89.

or always different and different seem to stem, once again, from a reification of time implying a meta or hyper-time in which the now perishes, similar to the one discussed above. For to ask when the now perished is to treat the now in the same way that we treat things that are in time. Just as it makes little sense to ask the question whether there was a time in which time was, it makes little sense to ask whether there was a time in which the present moment ceased to be.[12]

These puzzles, motivated as they are by questions concerning when the now exists and when it ceases to be, relate in interesting ways to the contemporary discussion of the so-called A-theory of time.[13] On one form of the A-theory, events now past have the property of pastness, events now present have the property of presentness, and events that are yet to occur have the property of futurity. Thus on this form of the A-theory, a particular event will first have the property of futurity, next of presentness, and then finally, of pastness. This is a view on which the mere passage of time involves a kind of change, for on the A-theory events undergo change merely in virtue of the fact that they have progressed from the future, through the present, and into the past. The A-theory presupposes that events are arrayed along a continuum. Each event occupies the position that it does in the continuum in virtue of the relations of priority, posteriority, and simultaneity that it bears to other events. Presentness marches along the continuum of events, first privileging one moment, and then another, like a spotlight successively illuminating the members of a chorus line.

The fact that presentness works its way through the time-series constitutes a kind of movement. However, all movement is movement at a particular rate, and thus on the A-theory, presentness must have its own rate of movement. But we can't determine the rate of movement of the present if we know only the temporal distance that it has covered, just as we cannot determine the rate of spatial movement if we know only the spatial distance covered.[14] Hence, the

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[12] With regard to Aristotle's dilemma at 218 a 14–18, G. E. L. Owen makes a similar suggestion, noting that the dilemma is an artificial one, "depending on treating a moment as something with a career in time and not as itself an element of time" (op.cit., 17).

[13] McTaggart was the first to articulate this form of the A-theory, though he was no A-theorist. See his "The Unreality of Time," *Mind* 17 (1908): 457–474, and *The Nature of Existence*, op.cit., 33, § 305. Versions of the A-theory have been defended by A. N. Prior, Michael Dummett, and Roderick Chisholm among others. See, e.g., Dummett's *Frege: Philosophy of Language* (Cambridge: Harvard University Press, 1981), Chapter 11, Prior's *Past, Present and Future* (Oxford: Clarendon Press, 1967), and "The Notion of the Present," *Studium Generale* 23 (1979): 245–248, and Chisholm's *Person and Object* (London: G. Allen & Unwin, 1976). What unites the various forms of the A-theory is that, on them all, tensed language is necessary to the expression of temporal fact. Thus the A-theory stands opposed to that class of theories on which a tenseless language is sufficient for the expression of all temporal fact.

[14] Prior, in his "Changes in Events and Changes in Things," *Papers on Time and Tense* (Oxford: Clarendon Press, 1968), suggests that we could measure the rate of progress of the present if we

question of the rate of movement of the present would require us to introduce a hyper-time. Since rate is distance over time, if we wanted to clock the present's rate of movement from one point on the temporal continuum to a later point, we must know *when* in hyper-time it is at the first point and *when* in hyper-time it is at the second. But if we can ask the question when in hyper-time a particular event is present, we can also ask when in hyper-time a particular event ceases to be present, and this is just to ask when the now ceases to be.

2. THE SUBSTRATUM OF TIME

Aristotle's own theory of time is designed to avoid just these paradoxes. They are the result of an attempt to find the difference between two nows within the very continuum of time itself, as if a now could be marked off, or made individual, by another now. Aristotle's own account of what time is opens up an avenue through which these problems can be escaped. On this theory, time does not exist in its own right. It is, rather, an aspect of substances and their changes: the substratum of time is the numerable aspect of the before and after of substances undergoing change (or in the case of substantial change, of whatever underlies the change).[15] Since time does not exist in the way a substance does, we no longer need to place any part of time in time. In order to get his theory off the ground, however, Aristotle needs to show in precisely what way substances and their changes serve as the substratum of time.

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knew only the temporal distance that it covers. "[W]e have learned to talk of an acceleration of a foot per second per second without imagining that the second 'second' must somehow be a different kind of 'second' from the first—without imagining that if motion takes place in ordinary time, acceleration must take place in some super-time—[and thus we can] accustom ourselves equally to a change of 'a second per second' without any such imagining" (3). Thus, he suggests, we can understand the rate of progress of the present to be "a year per year, an hour per hour, a second per second." But just as an inch per inch, or a mile per mile, is not a rate of spatial passage (though of course if a thing moves a mile, it travels one inch per inch and one mile per mile), a second per second, or a year per year, is not a rate of temporal passage. The unit by which we measure distance traveled, regardless of whether the distance is spatial or temporal, must be different in kind from the unit by which we measure the time taken to travel that distance. Thus if we wish to measure the rate of progress of the present through time, we must introduce a hyper-time.

[15] At 219 b 1, Aristotle identifies time as "a number of change in respect of the before and after." It is clear that change, which according to Aristotle can be either substantial or accidental, always involves substance. In substantial change substances either come into existence or cease to be; in accidental change some property or relation of a substance changes. In both cases, however, there is always something that persists throughout the change, something that underlies. In accidental changes the substance persists; in substantial changes too, something must underlie the change. Hence in Book One of the *Physics* Aristotle notes that "But that substances too, and anything that can be said to be without qualification, come to be from some underlying thing, will appear on examination. For we find in every case something that underlies from which proceeds that which comes to be; for instance, animals and plants from seed" (190 b 1). Quoted from the R. P. Hardie and R .K. Gaye translation of Aristotle's *Physics* in *The Complete Works of Aristotle,* Jonathan Barnes, ed. (Princeton: Princeton University Press, 1984).

At 218 b 1 ff. Aristotle tells us that time is thought to be change. However, if time is change, then first, since there are many changing things, and the change is only in that which alters, there will be as many times as things which alter, which violates our intuition that there is only one time. Second, if time is change, since each change is itself faster or slower, then each time will itself be either faster or slower. However, time is not itself fast or slow, but that in respect of which we say that changes are faster or slower. Time, then, cannot be change. Yet, Aristotle argues, it is manifest that there can be no time if there is no change. At 218 b 21 ff. Aristotle presents a psychological argument, to the effect that the recognition of a lapse of time requires the recognition of change; where no alteration is marked off, no time can be said to have elapsed. Thus if time is not change, yet is not apart from change either, then it must be some aspect of change.

In order to identify this aspect of change, Aristotle introduces the idea of change following a magnitude. This view of change is crucial if we are to be able to measure changes by one another. At 219 a 10 ff. he tells us that "since what changes changes from something to something, and every magnitude is continuous, the change follows the magnitude: it is because the magnitude is continuous that the change is too. And it is because the change is that the time is." Just as a magnitude is continuous, a change must also be continuous. Now any spatial magnitude is continuous when its parts form a whole, such that its parts are not different from one another in kind but are distinguishable from one another spatially, i.e., by virtue of their being in different regions of space. For instance, a line is continuous by virtue of the fact that between any two points on a line there exists an infinite number of points, and no part of a line cannot be subdivided by points. Analogously, at least one of the conditions for the continuity of a change is that the substance that changes remain continuously identifiable throughout its changes. It is, moreover, because a change is continuous that time is continuous, and this means that it is insofar as some substance endures throughout its changes that a certain period of time can be said to be continuous.[16]

Aristotle's analogy between the continuity of a magnitude and the continuity of both change and time is a cornerstone of his theory of time. His linkage of the continuity of a magnitude with that of a change points to the logical priority of the idea of magnitude to that of change: in order to understand change at all we must make use of the concept of a spatial magnitude and think of the change as analogous with it. That Aristotle held this view is confirmed by his introduction of the technical phrase πρότερον καὶ ὕστερον

[16] This interpretation of the passage is supported by Aristotle's discussion at 219 b 9 ff., which we analyze more fully below.

(the "before and after"). These, Aristotle believes, are in place primarily, although they are there by position. He further notes that "since the before and after is in magnitude, it must also be in change, by analogy with what there is there" (219 a 16). However, as has been pointed out in the secondary literature, there are serious difficulties with Aristotle's attempted derivation of temporal order from that of spatial order.[17] Given the two points on a line A and B, the truth conditions of the proposition that A is prior to B will depend upon what one takes as the spatial point of origin. So why would Aristotle have thought of both kinetic and temporal order as deriving from spatial order?

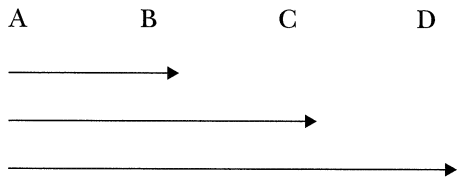
Perhaps one of the reasons Aristotle considers "the before and after" to be in *place* primarily (and thereby in a spatial magnitude) is because there they coexist in such a way that the conditions allowing them to be picked out *as* before and after are given simultaneously. Since the before and after in change (when considered individually) are not apprehended simultaneously, we can only represent them to ourselves as parts of the same continuous change through an analogy with the line. In other words, given that only one cross-section of a kinetic series is present at any given moment, in order to apprehend a kinetic series *as such*, at least two such cross sections must be kept in mind. They must, in other words, be held before consciousness simultaneously in order for a change to register. This, then, is the significance of the spatial analogy, for it is only through analogy with a line that two points of a kinetic trajectory can be re-presented simultaneously (so that the change can be registered) *and as belonging to the same series.*

An examination of Aristotle's concept of "the before and after" lends further support to this analysis. No doubt there are difficulties in attempting to pin down its exact meaning. The problem is that these words seem to embrace three concepts, all three of which are required if we are to make sense of "the before and after." First, it is *that* which remains the same both before and after. Second, it is that which allows us to distinguish the before from the after; and third, it is that which allows us to relate the before to the after. Hussey is at least correct to suggest that "we need something that can be said to run through the change in temporal order."[18] Anything that runs throughout the change is the same throughout different stages of the change. This would tempt us to think

[17] See for instance, Denis Corish, "Aristotle's Attempted Derivation of Temporal Order from that of Movement and Space," *Phronesis* XXI (1976): 241–251. There he notes that "the observation of distinct spatial positions in movement tells us nothing about time, precisely because information merely about spatial positions in movement does not tell us in what *spatial* direction the movement proceeds—or rather, does not tell us whether it proceeds in any one direction, rather than back and forth. If we wish to determine that there is only one single direction of movement, we must take time into consideration" (249). Sarah Waterlow (Broadie) also broaches the same problem in "Aristotle's Now," op.cit., 113 ff.

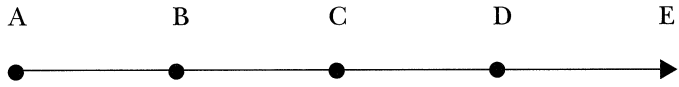
[18] Hussey, op.cit., 148.

that "the before and after" is the subject of a change in the sense of the first concept, but if it were *merely* this we would be unable to distinguish the before from the after in order to arrange them temporally. This is because the subject of the change, as *that* which undergoes change, is identical with itself throughout the change, and when considered *apart* from its relations to its stages of change, cannot be distinguished from itself. Thus the before and after must be in some sense the same and in some sense different. Hussey interprets "the before and after" as meaning "the leading edge of change: or "the permanent present." The "leading edge of change" means the lower boundary of the change so far. This meets the first and second requirements. As regards the first requirement, the leading edge of change can be said to have been both before and after, since at one point it marked the before, and at another point it marked the after. The "leading edge of change" also satisfies the second requirement, since at each point along the continuum of change through which it moves it marks a different stage up to which the change has progressed. According to Hussey, the leading edge of change could be represented by the following diagram:



where the point of the arrow represents the leading edge of change. Yet clearly this shows that Hussey's interpretation fails to encompass the third requirement. The leading edge of change alone (at any given moment) does not allow us to relate the different phases of the change to one another. In other words, the point of the arrow *taken by itself* does not stand in any intrinsic relation to the continuum through which it has passed, since I can easily imagine an arrow with no line attached. But in order for us to say of a point that it is either before or after, the relationship between the before to the after is presupposed, and thus the continuum between the before and after must also be contained in the concept of the before and after. For when we say that something is before, we also imply that something else is after it; there can be no concept of the before without our having an idea of the after. The only equivalent, then, of the term "the before and after" when applied specifically to change would seem to be *that* which is both before and after *through constituting* different stages in the process of the change. This would mean both a) that the "before and after" exists as the same subject before and after, and that b) this same subject is in different states in the before and after. For this reason the before and after can only be represented in terms of a spatially extended

continuum in which the before and the after can be apprehended simultaneously, for only in this way can we envisage a line of relationship between the two. In other words, in order for us to represent either the before or the after, we cannot think of either of these terms singly, but both must be re-presented simultaneously. This is to say that change, and therefore time, can only be adequately represented spatially. Thus the before and after cannot be the arrow as represented in Hussey's diagram, but must encompass the whole of the line, that is, it must encompass the whole of the change at *each* of its continuous stages of development. The before and after, then would more correctly be pictured thus:



where each point along the arrow marks a different stage of the change, and the entire line represents the whole motion thus far.

Now while Aristotle no doubt gives logical priority to the spatial continuum in the understanding of a kinetic series, this does not mean that what he has here is the beginnings of a development of a robust B-theory of time. No doubt a B-theory of time requires that events be arranged along a continuum where they can all be apprehended at a glance, allowing us to think of events as before, after, or simultaneous with one another. However, it is doubtful that Aristotle ever distinguished between static (B-series) and flowing (A-series) conceptions of time, or ever thought of the two as competing theories of time. In fact, he seems to run the two together: the now serves as both the idea of an instant marking a given point along the temporal continuum, as well as of the flowing present.[19] The reason why he does so has been suggested by Sarah Waterlow (Broadie): we *cannot* make sense of a B-series unless we implicitly assume the ideas of past, present, and future, concepts that belong to the A-series. Why this is so brings us back to the philosophical difficulties we noted above with Aristotle's prioritizing of the spatial continuum in the understanding of change and time. If all we have is a spatial continuum along which two points co-exist simultaneously, the truth conditions for the statement that one point is before another presupposes a point of reference indicating the direction in which I am to proceed. If A is to the left of B, A is before B only if I am proceeding from left to right. That I should proceed from left to right can only be indicated by another point to the left of A from which my traversal of the

[19] This is noted by Sorabji in *Time, Creation, and the Continuum*, op.cit., 48. Sorabji, however, later comments that Aristotle fails to give a satisfactory answer to the question of how the now is the same and how it is always different and different, and uses this to support his claim regarding Aristotle's ignorance of the differences between the A and B series. As we show in the body of the paper, however, Aristotle does in fact have a satisfactory answer regarding the different respects in which the now is the same and at the same time different and different.

continuum is to begin. Hence, while there is an important sense in which a spatial continuum must be presupposed in order to understand change (and hence temporal order), Aristotle seems equally to recognize the importance of the present moment as providing the point of reference from which we are to judge the *direction* in which we are to move in judging events as before or after one another. If event A occurred before event B in the past, the truth conditions for this judgment are given only through the fact that event B is closer to the present moment than event A.[20] This is the significance of Aristotle's understanding of the now as *both* a point in a kinetic series and as that which is present.

Our analysis of the before and after is confirmed by Aristotle's discussion of it in relation to another concept, that of the ὅ ποτε ὄν, or substrate of the before and after. As that which makes the before and after what it is, this substrate (ὅ ποτε ὄν) is the whole of motion considered in its entirety.[21] In order for there to be a before, there must also be an after, and the two points of the trajectory mark a movement. Hence movement is a condition of the possibility of there being a before and after, although it is not by itself a sufficient condition of this being the case. On the other hand, any single before or after taken by *itself* is not the entire motion, but is itself defined differently, i.e., by the state of the change thus far.[22]

Aristotle's understanding of time as piggybacking on substances and their changes affords him a way of accounting for how the now is the same and always different and different. At 219 b 10 ff., Aristotle tells us that:

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[20] For a discussion of this point see Sarah Waterlow (Broadie), "Aristotle's Now," op.cit., 113 ff.

[21] At 219 a 20 the difficult sentence: "ἔστι δὲ το πρότερον καί ὕστερον ἔν τῇ κινήσει ὅ μεν ποτε ὃ κίνησις [ἐστιν] occurs. Ross interprets ὅ ποτε ὄν as an abbreviated form standing for "that, being in which the before and after in movement are before and after, i.e., the ὑποκσίμενον . . . menon or subject which is before and after." Ross concludes that the upshot of the sentence is: "The before and after in movement is, as regards its subject, movement; but its essence is not movement" (*Aristotle's Physics,* op.cit., 598). Hussey, on the other hand, translates the sentence as follows: "The before and after in change is, in respect of what makes it what it is, change; but its being is different and is not change" (Hussey, op.cit., 43–44). Hussey's translation of the ὅ ποτε ὄν brings out the meaning of the phrase more definitely and confirms our discussion above of some of the issues involved regarding the before and after.

[22] Our own analysis at this point is close to the one offered by Paul Conen in *Die Zeittheorie des Aristoteles,* (München: Beck, 1964). According to Conen, "Das Jetzt folgt dem Bewegten . . . d.h. das Jetzt is eine Folge des Bewegten. Denn *durch* das Bewegte haben wir Kenntnis von dem Vorher und Nachher in der Bewegung, und dieses als Zählbares ist das, was das Jetzt ist . . . . Das heißt aber doch, daß das Jetzt sowohl seinem Substrat als auch seinem Wesen nach dem Bewegten folgt" (79). Conen provides his own detailed analysis of the significance of the ὅ ποτε ὄν. According to him it is what is left of a subject when that which is essential to it *qua* its being that particular kind of subject is taken away. For example, insofar as being hot is essential to something's being hot water, when the hotness it removed what is left is simply water. So Conen, (219 a 19–21) "τὸ πρό τερον καὶ ὕστερον ἐν τῇ κινήσει ὃ μεν ποτε ist nicht das Vorher und Nachher in der Bewegung, sondern Bewegung schlechthin" (83).

the now is the same X, whatever X it may be which makes it what it is; but its being is not the same. It is the now that measures time, considered as before and after. The now is in a way the same, and in a way not the same: considered as being at different stages, it is different—that is what it is for it to be a now—but whatever it is that makes it a now is the same.

On the one hand, Aristotle defines any single before or after (which at some point was a now) in terms of a stage of change. In doing so, he has succeeded in enumerating conditions through which we can distinguish "nows" from one another without having to resort to the idea that a now is delimited by another now. On the other hand, the now is the same in virtue of some X which makes it what it is, the ὅ ποτε ὄν which functions as a kind of substratum. The ὅ ποτε ὄν is not the now *as* substratum, but is the substrate of the now.[23] This substratum is what is left of a subject once what is essential to it as a given *kind* of subject is removed. What is this substrate? It is that which is left once that which marks the now as countable, that is, as before and after, is abstracted. What is left as such a substrate is what underlies the difference and plurality of moments as countable, namely the change or movement itself,[24] or, if we want to be more precise, the changing thing *qua* changing thing. As we noted above, the changing thing is also the very condition of the possibility of there being a before and after.

A further clue can be garnered from the fact that Aristotle continues by discussing the *continuity* of the now throughout a change, which seems to be closely related to the ὅ ποτε ὄν, or substrate of the before and after. At 220 a 4 he tells us that time is continuous by virtue of the now, which follows the motion of the moving thing. It is through the *moving* thing that we become acquainted with change and the before and after in it, but the term "moving thing" comprises both the subject of a change (remaining continuously identifiable throughout the change), and the different stages of the change. At 219 b 18 Aristotle tells us:

The moving thing is, in respect of what makes it what it is, the same (as a point, so is a stone or something else of that sort); but in definition it is different, in the way in which

[23] Here we follow Conen's careful analysis of the Greek: "Dagegen scheint Aristoteles' Sprachgebrauch eindeutig zu ergeben, daß das Jetzt erst dann in *irgendeinem* (aktualen) Sinne ist, wenn Bewegungsphasen abgegrentz worden sind, und daß das ὅ ποτε ὄν τὸ νῦν ἐρτιν ™stin, welches vorgängig zu einer solcher Abgrenzung ist, weniger ist als Jetzt-Sein. Denn er sagt, daß das Vorher und Nachher in der Bewegung als *Zählbares* das Jetzt ist . . ." (83).

[24] A similar analysis was provided by Georg Wunderle in "Die Lehre Aristoteles von der Zeit," *Philosophisches Jahrbuch* 21 (1908): 33–55. Conen refines Wunderle's interpretation and shows that the best way to interpret the substrate of the now is as "the moving thing *qua* moving" (Conen, 88–89). This interpretation makes sense of all the uses in which we find mention of the ὅ ποτε ὄν and also helps us to make sense of the passage at 219 b 15ff regarding Corsicus at the Lyceum and Corsicus at the marketplace.

the sophists assume that being Corsicus in the Lyceum is different from being Corsicus in the market place. That then, is different by being in different places, and the now follows the moving thing as time does change. For it is by the moving thing that we become acquainted with the before and after in change, and the before and after, considered as countable, is the now.

Just as the substratum of the before and after is motion, so the continuity of the now is furnished by the moving thing. The continuity of the now is not furnished by the moving thing as defined by any particular stage of its change, but by the moving thing as moving through the entirety of its stages of change.[25] This means that in order to furnish continuity to the now the moving thing must simultaneously be thought of as standing in relation to different stages of its change. Only in this way can the moving thing furnish the requisite continuity between nows, for as Aristotle says, "the now follows the moving thing." It would thus seem that Aristotle's discussion of the *continuity* of the now is very similar to his discussion of the substratum of the before and after, and that indeed, both refer to the same thing.

Our analysis of this passage is very different from the one provided by Fred Miller in an oft-cited and influential article, "Aristotle on the Reality of Time." This same understanding of the passage has been put forward more recently by Michael Inwood. Both Miller and Inwood interpret the passage at 219 b 18 as providing evidence for the fact that Aristotle espoused the naïve version of the A-theory we discussed above. According to Miller:

> What persists through time is analogous to what persists through change. The now, insofar as it persists, corresponds to Corsicus, who is the persisting factor in the change of place. . . . Aristotle uses this model to explain temporal becoming, which involves the now as a persisting factor which received different accidental determinations.[26]

If we understand Aristotle in this way, then Aristotle's now is something that independently surges "through history like the crest of a wave along the ocean surface."[27] It is, then, something that moves. This understanding of the now would thereby give rise to the puzzles discussed in our first section. The difference between our own analysis, and Miller's and Inwood's, is crucial: our analysis is faithful to Aristotle's linkage of the now to the moving thing. Just as, for Aristotle, the existence of time is parasitic on the existence of substances

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[25] A similar analysis is provided by Conen, 88–89.

[26] Fred Miller, "Aristotle on the Reality of Time," *Archiv für Geschichte der Philosophie* 56 (1974): 132–155, especially 148. The same view is put forward by Michael Inwood in his article also entitled "Aristotle on the Reality of Time," op.cit., 164–165; so Inwood: "The now remains the same over time in the way Corsicus does, but differs in so far as it coincides with different stages of the movement of a body; the now is the same in so far as it is always simply a now, but differs in so far as it may be specified as, e.g., 6 o'clock" (165).

[27] Ibid., 150.

and their changes, so too the now is not a thing in its own right surging through history on the crest of a wave. Its existence, too, is parasitic on the moving thing: it is what it is in virtue of the moving thing. It follows the moving thing and has its continuity in virtue of it.

In defining the continuity of time and its identifiable moments in terms of a moving thing and the stages of its changes, respectively, Aristotle has avoided the paradoxes that the untechnical or common sense views of time generate. For if the substratum of time is the before and after in change, time is not a substance that needs to be "in" time. Moreover, we become aware of the substratum of time by virtue of the fact that the before and after in change can be represented simultaneously through a spatial analogy. Here the moving thing passes through the entirety of its stages of change as if moving through a magnitude, thereby allowing us to represent the stages of change to ourselves simultaneously. The importance of the spatial analogy cannot be stressed too much. It is only when I know at one and the same time that this thing which was once F, is now H, that I can apprehend change and hence time. If I cannot keep in mind and relate x-as-F to x-as-H, I would lose myself in the present and never know time to elapse. In this sense, at least, the first untechnical argument expounded by Aristotle at the beginning of Chapter 10 had a point. No single now constitutes time, and were I to know only the now I should not know time. By the same token, no single state of a change constitutes motion, but we perceive a motion when at least two states of the motion are noticed and kept in mind. However, in order to apprehend these two stages simultaneously and to relate them to one another, we must do so through a spatial analogy, which is to say that time can be known to have elapsed only when its substratum can be represented spatially. On the other hand, the second problem concerning the discreteness of each now is solved in virtue of the fact that each now is distinguishable from any other now by virtue of its being linked to different stages of a change.

3. TIME: SUBSTANCES AND THEIR CHANGES

Thus far we have discussed the preliminaries of Aristotle's theory of time, and shown how its substratum is linked to the changing thing. Aristotle's linkage of time to a substance and its changes goes a long way towards avoiding a view of time as something that proceeds independently of the measurement of events that take place within it.[28] If time were in fact something absolute,

[28] In her article, "Aristotle, Number, and Time" *Philosophical Quarterly* 25 (1975): 97–113, Julia Annas links the view that there is such a thing as pure temporal becoming with a Platonic view of time, and argues that Aristotle's account is designed to provide an alternative to such a view. This alternative is related to the ordinary unmysterious process of measuring in which one change measures another. So Annas: "To know how long a process took (or some other kind of motion

something that existed independently of substances and their changes, then the claim that the rate of everything's changing slowed down by the same amount every other year might be true. However, for such a claim to be true, there must be an absolute time that serves to define absolute rates of change. For if we say that the rate at which all changes take place has slowed, the rate to which we refer is an absolute rate of change. But on Aristotle's theory of time, there is no absolute time which might serve as a standard of absolute rates of change.

Although Aristotle avoids the paradoxes connected with pure temporal becoming by linking time with change, this leads him to another set of difficulties. These difficulties are already broached at the very end of Chapter 10, shortly after his discussion of the paradoxes connected with common sense views of time. Given that time must be connected with change, two things need to be considered. First, at 218 b 9 he tells us that "the alteration and change of anything is only in the thing that is altering, or wherever the thing that is being changed and altering may chance to be; but time is equally everywhere and with everything." Time cannot be *identified* with a change, for if it were there would be as many times as there were changes. It must be possible to say that the time of two simultaneous changes is identical. Second, time cannot be identical to change since changes are faster or slower, but time is not. Time is, rather, that through which we measure changes to determine whether they are faster or slower.

What alternative is left to us then, if time is *neither* something that exists apart from substances and their changes, nor is identical to a change itself? If time were something independent of change, we would be forced to adopt a view of time on which pure temporal becoming is real. On the other hand, if every motion were measured by its own time, no two motions could take the same time. Aristotle's solution to the problem has to do with an analysis of the concept of the number of motion, itself depending on his more general account of number.

This general account of number can be found in *Metaphysics* I, where Aristotle provides an alternative to a Platonic understanding of number. On the Platonic account, numbers are abstract objects having an existence independent of that which is counted. According to Aristotle in *Metaphysics* I, on the other hand, numbers have no such independent existence. Rather, their status

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broadly understood) is not a matter of comparing it with the passage of Time, as we might be tempted to think if we conceive of Time as a something objectively progressing against which we can compare processes as they occur. To know how long a process took is simply a matter of being able to count or measure its duration (just as to know how large a group is, is just a matter of being able to count its members). Doing this involves knowing what period is being taken as unit (just as counting a group involves knowing what type of thing is being taken as unit)" (103–104).

is tied to the activities of counting and measuring; in fact, the activity of counting is explained in terms of that of measuring. Just as measurement is always relative to the unit of measurement chosen, so too the activity of counting depends on the choice of a unit. As Julia Annas puts it, for Aristotle to count means "simply to fix on a type of thing to use as a unit, and then tell off those things using the numeral sequence.[29] Hence the activity of counting does not depend on relating what is counted to abstract objects; rather the unit through which we count functions like a unit of measure, and for this reason Aristotle tells us that one is the measure of number.

This more general discussion of measure and number serves as the backdrop against which we can make sense of the fact that Aristotle sometimes uses 'number' and 'measure' interchangeably in *Physics* Δ. Moreover, it helps us to make sense of Aristotle's assertion at 219 b 7 ff. that "time is that which is counted and not that by which we count." This idea fits well with Aristotle's anti-Platonist program: time is not an abstract entity but is composed of given durations. It is not the unit through which we measure the time that has elapsed, just as a measure of space such as a foot is not itself space. Time is, rather, *that* which is measured. But what is measured seems to be the change, and this would still leave us with the dilemma that no two motions could take the same time. However, at 220 b 7 ff. Aristotle notes that "time is not the number by which we count but the number which is counted, and this number turns out to be always different before and after, because the nows are different." The number which is counted is the number or duration of the change, and Aristotle wants to say that this number, for instance, 10 seconds, is the same for two changes occurring simultaneously, even if one change is faster than the other (223 a 32–b 10). *This* number is the same, according to Aristotle, since if "there are some dogs and some horses, seven of each; the number is the same" (223 b 5). There seems, however, to be a gap in Aristotle's account, since this argument only implies that it is the number by which we count that is the same, and not the number of things counted. However, Aristotle wants to argue, time is composed of *particular* durations; these durations are not measures of time, not, for instance, ten seconds, but *those* ten seconds that occurred at a given *when* (220 b 5). They have a hybrid status, one in between the particularity of a given change itself and the generality of a measure of time, which can be applied to any change whatsoever, no matter when it occurs. Time as the number of motion in respect of the before and after is not simply the number of motion of a *given* change, for then two simultaneous changes could not be said to take a single time. On the other hand, it is something less general than a measure of time.

[29] Ibid., 100.

Notwithstanding these difficulties, on the whole Aristotle provides a viable alternative to the idea of pure temporal becoming. Time is not absolute but is rather the product of an activity, that of using one change as the measure of another. As such, it does not exist apart from the soul that counts, measures and compares changes to one another (223 a 16 ff.). At this point, the importance of Aristotle's earlier careful discussion of change as following a magnitude should become apparent: in order to measure changes by one another you must be able to re-present them as following a magnitude and as continuous. Only through such a representation can you relate the two changes *qua* changes to one another. Furthermore, only if changes are represented as continuous is it possible to relate a given change to other changes occurring at different rates.[30]

At 220 b 14 Aristotle notes that:

> Not only do we measure change by time, but time by change also, because they are defined by one another. The time defines the change, being its number, and the change the time. We speak of 'much time' and 'little time', measuring it by change, just as we measure the number by what is countable: e.g., by the one horse we measure the number of the horses, for it is by number that we become acquainted with the multiplicity of horses and, conversely, by the one horse that we become acquainted with the number of horses itself. Similarly, in the case of time and change, we measure the change by the time and the time by the change.

Aristotle's claim that we measure the change by the time and the time by the change cannot be taken to mean that a particular kind of change provides the unit by which we measure the time taken by an instance of *that* kind of change. Rather it must mean that we choose a particular kind of change and make it the unit by which we measure the time taken by changes of *other* kinds. For instance, let us take as our unit the time needed for the moon to revolve once about the earth. We could not use this unit to measure the time taken for the moon to complete a particular revolution about the earth. If we did, we should have the trivial conclusion that the time taken for the moon to complete this particular revolution equals the time taken for the moon to complete a revolution about the earth. Hence, when Aristotle says that change and time are defined by one another, he means that that the activity of timing involves

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[30] Ross cites one of Aristotle's arguments (232 b 26 – 233 a 12) for the infinite divisibility of time and extension: "He supposes a faster moving body A and a slower moving body B, and supposes B to move distance TΔ in time ZH. Then A will move distance TD in a lesser time ZΘ. Then B will move in time ZΘ a distance less than TΔ, TK. Then A will move distance TK in a time less than ZΘ: and so on. The simple assumption of two bodies moving with uniform but different velocity establishes the infinite divisibility both of time and of distance" (Ross, op.cit., 70).

taking one change as a unit, and then measuring another change in terms of that unit. For instance, we call the full circular motion of the minute hand on a watch an hour, and the time it takes for the earth to revolve once around its axis a day. If we were to take the first as our unit of measurement, we should say that a day is twenty-four hours in length. On the other hand, if we were to take the second as our unit of measurement, we should say that an hour is 1/24th the length of a day. Time is what results when we measure changes by one another. A thing is thereby "in time" only if its duration can measured by some particular kind of change that we have made our unit of time (220 b 32 ff.). This unit needs to be uniform. Aristotle tells us that "uniform circular motion is most of all a measure because the number of this is most easily known" (223 b 19), and that "time is thought to be the motion of the celestial sphere because other changes are measured by this one" (223 b 22).

All of this provides us with a theory of time avoiding the notion that pure temporal becoming is real. However, the theory seems to be beset with a significant disadvantage. How do we know a given change that we use to measure the duration of other changes is uniform? What if, for instance, the amount of time it takes the earth to revolve once around its axis were variable? The key to the problem of determining uniformity lies in the fact that the duration of a change is never absolute, but is measured instead by some particular kind of change that we have made our unit of time. Hence, a given change is uniform only in relation to changes of other kinds. But what relation must one kind of change bear to others if it is to count as uniform? The ratio of the duration of that change to the duration of the others must remain a constant. Only in this way does its rate of change count as uniform. For instance, the motion of the earth about the sun counts as uniform relative to the motion of the earth on its axis, since regardless of the year in the time that the earth takes to revolve once about the sun the earth revolves about its axis 365 times. However, we can isolate many kinds of changes that are uniform relative to one another, but not all of them will serve as an adequate choice of units. If a bicycle has only one gear, then one turn of the pedal will always correspond to a some particular number of turns of the wheel; perhaps one turn of the pedal will always correspond to three turns of the wheel. Thus the rate at which the pedal turns and the rate at which the wheel turns are, relative to one another, uniform. But neither would make a good choice for a unit of time. Relative to almost all other kinds of changes they are not uniform, that is, the duration of one revolution of either the pedal or the wheel does not stand in a constant ratio to the duration of most all other changes. Hence, a given change will form the basis of a useful unit of time only if its duration is uniform relative to changes of many kinds, that is, many constant

ratios of the duration of this change to other changes can be formed.[31] The uniformity that makes a particular change the basis of a good choice of temporal unit is a *relative* uniformity, a uniformity that it has in relation to other kinds of changes. It is, in fact, a kind of *harmony* among changes of various kinds.

Let us conclude with a summary of our results. The paradoxes elaborated by Aristotle in Chapter 10 are closely connected to the view that pure temporal becoming is real. These paradoxes are not left unresolved by Aristotle, since they do not arise on his own theory of time. Aristotle is an A-theorist in the sense that time relations are always judged in relation to the present instant, but he does not hold a view of time in which the present instant surges through history like the crest of a wave on the ocean. There is no such thing as an absolute temporal flow, but rather, time is the product of the soul that counts and measures changes against one another. Time is therefore an aspect of substances and their changes, and not something that exists in its own right.

In this century, debate about the nature of time has been dominated by discussion of two issues, viz., the issue of the reality of absolute time and the issue of the reality of the A-series. However, discussion of these two issues have been carried on in relative independence of one another. One seldom encounters a discussion of the reality of absolute time that draws explicit connections to the A-theory, and vice versa. Aristotle's theory of time stands in contrast to this recent trend. We have argued that Aristotle adopts a form of the A-theory that is essentially united to a kind of relationalism about time. Moreover, Aristotle's theory of time is not vulnerable to a criticism that has crippled many recent attempts to construct a viable A-theory. Since the form of the A-theory that is adopted by Aristotle is essentially relationalist, it does not imply that the present "crawls up" the time-line of the world. If the present were to ascend the time-line of the world, the rate of its movement must be an absolute rate, i.e., a rate that makes reference to absolute temporal flow. However, as we have argued, for Aristotle there is no such thing as absolute temporal flow.[32]

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[31] There are, of course, other desiderata for useful units of time. For instance, the members of the community that make use of a given change to measure others should have easy access to it. Furthermore, the choice of unit of change used to measure other changes will in part be dictated by biological constraints. If a change is too quick for us to register its occurrence, it cannot serve as the basis for a good choice of unit.

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