Chronos in Aristotle's *Physics*: On the Nature of Time (Springer, 2015)
Chelsea C. Harry
Southern CT State University

Chapter 3: Taking Time

As a consequence of Aristotle's account of the nature of natural beings—their principles, that they undergo *kinêsis*, and that there are terms of this *kinêsis*—in the first half of the *Physics*, and in particular Aristotle's emphasis on potentiality as a modality of being, he defines the last term of *kinêsis*, time (*chronos*), in terms of *kinêsis*. What is more, insofar as he defines time in terms of *kinêsis*, he defines time likewise in terms of existing self-sufficient natural beings. This is implicitly so by the fact that *kinêsis* is a function of these natural beings, by their very nature, but explicitly because Aristotle defines time outright as the number (*arithmos*) of motion (*kinêsis*) with respect to before and after (219b1-2). "Before" and "After," anteriority and posteriority, is a non-temporal relation between relata, i.e. they describe a relation (*pros ti*) between actual beings. We saw this in the previous chapter. We also saw that time for Aristotle, in the sense that it is "taken" (λαμβανόμενος), requires some sort of "taker," or more precisely, since time is an *arithmos* of *kinêsis* for Aristotle, it requires someone or something to perceive the before and after and thus to ascertain the number of the *kinêsis*; depending on the case, the number might be apprehended by one or more faculties of cognition, e.g. perception, phantasia, intellection. This is not to say that time cannot exist potentially insofar as *kinêsis* can exist independently of its

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apprehension, but only that time requires additional conditions in order to be actualized.

Despite the language we saw in the previous chapter, which allowed for time apprehension by perception and marking, in *Physics* iv 14, Aristotle famously argues that time is dependent on *nous* (See 223a25-26, ἢ ψυχὴ καὶ ψυχῆς νοῦς). In what sense could the number of motion with respect to before and after be dependent on *nous*? Because Aristotle famously discusses the relationship between time and the soul, and only once qualifies soul as *nous*, it has been common for readers to underdetermine *nous*, as simply "soul" across the treatise. This is problematic because, for Aristotle, there are five main potencies of soul: intellective, locomotive, desiring, sensitive, and nutritive. While he argues that human beings have all five, he also tells us that nonhuman animals have at least desiring, sensitive and nutritive potencies—usually they also have locomotive— and still plants have the nutritive potency (see *De anima* ii 3). If *nous* can be collapsed into meaning simply, soul, the implication is that time is in every case dependent on ensouled being generally. The term *nous*, often translated "mind" and not "soul," is problematic without the added confusion that comes from conflating it with "soul." Namely, it is both the term Aristotle uses to single out the intellective faculty of soul, which as noted is reserved for human beings, and the term often understood by Aristotle's readers as that which names God/the first principle and the celestial bodies. In order to follow Aristotle's definition of *chrónos*, it is necessary to understand how he is using *nous* in *Physics* iv 14.

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In this chapter, therefore, I consider the meaning of *nous* in Aristotle's account of time as well as the necessity of a body by which to sense-perceive that which can be counted (recall 219a4-6, we perceive, αἰσθανόμεθα, time with *kinêsis*, and, by extrapolation, we perceive *kinêsis* through bodily senses, σώματος πάσχωμεν, and in the soul, ἐν τῇ ψυχῇ). As a result of my considerations, I argue for the possibility for limited time apprehension of nonhuman animals, and for the possibility for full time apprehension in human beings. This final task is buttressed both by discussions of sensation, memory, and animal behavior in the *Parva Naturalia* and in Aristotle's biological treatises and the bringing together the language of "marking time" and "counting/measuring time" to suggest that even while big-scale change requires the latter, the former is sufficient for small-scale change.[1] This is all in service to showing internal consistency in Aristotle's account of time apprehension in the physical works. In the case where Aristotle's examples of animal behavior limit the search for supporting evidence, I turn to results from contemporary experimental science to show that the position I attribute Aristotle is consistent *otherwise*, with demonstrated animal—both human and nonhuman—behavior and function. I will proceed with these tasks in sections II "Readiness for Thinking: from Marking to Counting" and III "Perceiving Time Revisited." But, first, in section I "Conditions for Actualized Time," I will provide a negative account and say more about what I think Aristotle does not mean when he uses *nous* in *Physics* iv 14.

[1] For a complete treatment of *chrónos* in the *History of Animals* (HA), see de Moor 2012, III.3.

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I. Conditions for Actualized Time

In Greek, there is a way in which *nous* means not only "mind," but also "perception." It is dubious that Aristotle intends a generally unconventional use of "*nous*" in *Physics* iv 14, i.e. meaning "perception" and not "mind," as he seems to do elsewhere (see *Nic. Ethics* vi); rather, "*nous*" here means broadly the working together of sense and intellection in that, as we see in *De anima*, the faculties of intellect require sensation. This is important to Aristotle's definition of time in particular because actualizing time, in the majority of cases, requires not only perception of *kinêsis*, but also counting *kinêsis*. The being undergoing *kinêsis* does so irrespective of the apprehension. But, only a being that can both perceive and count can interact with the being undergoing *kinêsis* in such a way so as to actualize time. Super human beings have neither a faculty (*dunamis*) by which to apprehend *kinêsis*, nor the type of intellect with the potential for counting. Sub-human beings do not have a rational soul with which to count. Aristotle thus could not have meant either that actualized time depends on, on the one hand, a super human being like God or the celestial bodies, or, on the other hand, a sub-human being like nonhuman animals or plants.

The unmoved mover/God is neither in time, nor does God have the potential for change. Thus, some have refuted the traditional reading of *Metaphysics* xii 7 where *nous* is thought to refer to God. Instead, a distinction has been made between *nous*, which is a readiness for thinking (see *De anima* iii 4) and *noesis*, or, thinking itself. It

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has been argued, thus, that God is not *nous* for Aristotle, as that contradicts the idea that God is pure actuality outside of time, but *noesis* (see Polansky 2011). Further, it has been claimed that God cannot be *noesis* either for Aristotle, since even the act of thinking seems to suppose an element of potentiality in that it requires an object (*noeta*) (see Gabriel 2009). Both have important implications for understanding Aristotle's account of time, and I agree with the general thrust of both. On the first account, *nous* cannot mean God in *Physics* iv 14 because that would require God, or pure activity, to have the potentiality to number, or count, the "before" and "after" in a being undergoing *kinêsis*. Ironically, this would render God impotent, since he would share the same lack of knowledge that humans, nonhuman animals, and plants have. On the second account, there is even more to find objectionable, i.e., not only is God's mind reduced to mere readiness for counting, but also it has an object of its activity, i.e. the *arithmos* of the *kinêsis*.

Aristotle begins *Metaphysics* xii 7 recounting his conclusions from *Physics* viii, that there are eternal heavens set into motion by what must be an unmoved mover. He likens the unmoved mover to objects of thought and desire; they too move without being moved (1072a26-27). Aristotle then demonstrates that whatever cannot be moved also cannot be that which is moved by an object of thought (1072a26-1072b1).[2]

[2] κινεῖ δὲ ὧδε τὸ ὀρεκτὸν καὶ τὸ νοητόν: κινεῖ οὐ κινούμενα. τούτων τὰ πρῶτα τὰ αὐτά. ἐπιθυμητὸν μὲν γὰρ τὸ φαινόμενον καλόν, βουλητὸν δὲ πρῶτον τὸ ὂν καλόν: ὀρεγόμεθα δὲ διότι δοκεῖ μᾶλλον ἢ δοκεῖ διότι ὀρεγόμεθα: ἀρχὴ γὰρ ἡ νόησις. νοῦς δὲ ὑπὸ τοῦ νοητοῦ κινεῖται, νοητὴ δὲ ἡ ἑτέρα συστοιχία καθ᾽ αὑτήν: καὶ ταύτης ἡ οὐσία πρώτη, καὶ ταύτης ἡ ἁπλῆ καὶ κατ᾽ ἐνέργειαν (ἔστι δὲ τὸ ἓν καὶ τὸ ἁπλοῦν οὐ τὸ αὐτό: τὸ μὲν γὰρ ἓν μέτρον σημαίνει, τὸ δὲ ἁπλοῦν πῶς ἔχον

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This passage differentiates *noesis* (thinking), *nous* (readiness, i.e. a potentiality, for thinking) and *noeta* (object of thought). The term in question is *nous*, which according to this passage has the capacity to receive objects of thought—a capacity that the unmoved mover could not have—not least of all because that which only "exists actually" has no capacity, i.e. potentiality at all. Consider, for example, that the unmoved mover, as the first mover, is not only the first in its class, but by virtue of this, the best. If the unmoved mover is the best object of thought, it is clearly an object of thought. Objects of thought move thought. Yet, it is impossible that the unmoved mover move itself. The unmoved mover does not have motion. If the unmoved mover is an object of thought, it is thus not also moved by thought.

Further, Aristotle explains, since thought shares the nature of the object of thought, readiness for thinking can think itself. Thought and object of thought can be the same thing (αὐτὸν δὲ νοεῖ ὁ νοῦς κατὰ μετάληψιν τοῦ νοητοῦ) (1072b20-21). But, again, thought (νοῦς) here cannot be reference to the unmoved mover/God. God has no capacity to think itself. Thinking for Aristotle, when human thinking, is not an isolated activity of an intellective capacity; rather, it occurs as a relation between a rational soul (*nous*) who has the capacity for receiving an object of thought, i.e., perception, and the readiness to think about it, i.e., intellection. In order to be both that which is thinking and that which is the object of thought, something must have the potential for actual thinking. *Nous* here refers instead to the intellective faculty of

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αὐτό). ἀλλὰ μὴν καὶ τὸ καλὸν καὶ τὸ δι᾽ αὐτὸ αἱρετὸν ἐν τῇ αὐτῇ συστοιχίᾳ: καὶ ἔστιν ἄριστον ἀεὶ ἢ ἀνάλογον τὸ πρῶτον.

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the soul. That the rational soul can make an object of itself shows that the rational soul is a potentiality of an existing self-subsistent being, who is itself a natural being. While the actuality of the divine is something toward which *nous* always strives, it is the potentiality of *nous* and of all natural objects, which characterizes them as existing self-sufficient natural beings.

For Aristotle, actual rational thought depends on the potentiality (*dunamis*) for thought, and this is consequent on the capacity (*dunamis*) to receive the object of thought (1072b21-22). The thinking is actual, which is to say it is in the process of thinking, when it possesses the object (1072b22). It is this active element, which Aristotle calls, God-like (δοκεῖ ὁ νοῦς θεῖον ἔχειν). Aristotle next argues that God's nature is essentially different from the nature of existing self-subsistent natural beings (1072b24-30).[3] Some natural beings are "God-like" in that they have a rational soul; for Aristotle, these are human beings. God is eternal, whereas humans are mortal, God is superlative, whereas humans share in a piece of God's goodness, God is actuality and life, whereas substantial beings are by nature ever potentially other than what they are now; their nature is the potential for *kinêsis*. Aristotle turns to the nature of divine thought in *Metaphysics* xii 9, concluding there that God or "God's thinking" is "thinking on thinking" (ἔστιν ἡ νόησις νοήσεως νόησις) (1074b34). In other words, God is pure actuality (*energeia*). Recall that the inherent potentiality for *kinêsis* (and

[3] εἰ οὖν οὕτως εὖ ἔχει, ὡς ἡμεῖς ποτέ, ὁ θεὸς ἀεί, θαυμαστόν: εἰ δὲ μᾶλλον, ἔτι θαυμασιώτερον. ἔχει δὲ ὧδε. καὶ ζωὴ δέ γε ὑπάρχει: ἡ γὰρ νοῦ ἐνέργεια ζωή, ἐκεῖνος δὲ ἡ ἐνέργεια: ἐνέργεια δὲ ἡ καθ᾽ αὑτὴν ἐκείνου ζωὴ ἀρίστη καὶ ἀΐδιος. φαμὲν δὴ τὸν θεὸν εἶναι ζῷον ἀΐδιον ἄριστον, ὥστε ζωὴ καὶ αἰὼν συνεχὴς καὶ ἀΐδιος ὑπάρχει τῷ θεῷ: τοῦτο γὰρ ὁ θεός

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likewise, rest) is the nature of natural beings. The first mover/God is pure actuality and cannot be otherwise; hence, it is not capable of *kinêsis*. Since pure actuality has no readiness to receive perceptibles, and in fact no potentiality whatsoever in its being, it cannot carry out the functions requisite to apprehend or take time.

A reading of *De memoria et reminiscentia* indicates that nonhuman animals experience time. Aristotle begins the treatise announcing that he will now treat memory and remembering. He will consider not only its nature and its cause, but also the part of the soul to which these functions, along with recollecting, belong (449b4-6). The distinction made here between memory and recollecting is important for Aristotle; for example, he goes on to clarify that the former is generally sharper in slow people, while the latter is generally sharper in clever people (449b7-8). The objects of memory, he argues, are relegated completely to things that are past (449b14). The future is not remembered, but expected, and the present is sense perceived (449b10-13). Aristotle demonstrates this to be the case with an example. When one is sensing a white object before him, he would say he is perceiving it, not remembering it. Likewise, when one is contemplating an object of science in a given moment, he would say that he knows it, not that he is remembering it.

When the objects are not being perceived or thought readily, then they are being remembered. Remembering, for Aristotle, reconstitutes previously learned knowledge or previous sense perception in one's mind (449b15-24). It brings to mind an activity that has since ceased. He concludes that, "memory is, therefore, neither

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perception nor conception (υπόληψις), but a habit or state of one of these, whenever time has become (ἕξις ἢ πάθος, ὅταν γένηται χρόνος)" (449b25).[4]

The consequence of Aristotle's definition of memory is that, "only those animals which perceive time remember, and the organ whereby they perceive time is also that whereby they remember" (ὥσθ΄ ὅσα χρόνου αἰσθάνεται, ταῦτα μόνα τῶν ζῴων μνημονεύει, καὶ τούτῳ ᾧ αἰσθάνεται) (449b29-30). Thus, on Aristotle's account, time perception (κρόνου αἰσθάνεται), which implies the ability either for sense perception or intellection, or for both, is the necessary and sufficient condition for memory. We must determine the organ by or through which time perception happens, then, in order that we understand the types of animals that perceive time. Deciding the organ by or through which time perception happens may also be additional evidence that we can rule out God as a sufficient condition for the actuality of time, since as we have seen, God does not have parts, thus cannot have organs for time perception.

Aristotle appeals to his argument from *De anima* regarding the necessity of images for thinking (449b31-450a8).[5] Aristotle posits subsequently that, "we cannot think of anything without a continuum or think of non-temporal things without time" (450a9-10), a fascinating admission to which he does not return. It is possible that

[4] Beare translates ἕξις, "affection," seemingly missing the ambiguity of the term, i.e., that it might mean habit or potentiality/disposition. He renders ὅταν γένηται κρόνος, "conditioned by a lapse of time" in the ROT.

[5] νοεῖν οὐκ ἔστιν ἄνευ φαντάσματος· συμβαίνει γὰρ τὸ αὐτὸ πάθος ἐν τῷ νοεῖν ὅπερ καὶ ἐν τῷ διαγράφειν· ἐκεῖ τε γὰρ οὐθὲν προσχρώμενοι τῷ τὸ ποσὸν ὡρισμένον εἶναι τοῦ τριγώνου, ὅμως γράφομεν ὡρισμένον κατὰ τὸ ποσόν, καὶ ὁ νοῶν ὡσαύτως, κἂν μὴ ποσὸν νοῇ, τίθεται πρὸ ὀμμάτων ποσόν, νοεῖ δ΄ οὐχ ᾗ ποσόν· ἂν δ΄ ἡ φύσις ᾖ τῶν ποσῶν, ἀορίστων δέ, τίθεται μὲν ποσὸν ὡρισμένον, νοεῖ δ΄ ᾗ ποσὸν μόνον.

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Aristotle is referencing his claim from *Physics* iv 12 that things not measured are not necessarily "in time," but only accidentally in time (221b25). Even if non-temporal, which I imagine entails not undergoing *kinêsis*, Aristotle imagines that something can be accidentally "in time" insofar as it exists in concert with things that are undergoing *kinêsis* and being measured. Next, Aristotle builds on his previous argument, now showing that thought and thinking are only incidental to memory (450a9-14).[6] The sense in which intellection is only incidental to sense perception in the case of memory is that intellection depends on sense perception, even remotely in the case of intellectual objects since it is impossible to think without having had any experience at all with sense perception. Thus, Aristotle is saying here that there is the possibility for memory, which requires only the faculty of sense perception. Whereas, memory can be aided by intellection derived from sense experience, this is not a necessary condition for memory. This reasoning allows Aristotle then to conclude that, "Hence not only human beings and the beings which possess opinion or intelligence, but also certain other animals, possess memory" (διὸ καὶ ἑτέροις τισὶν ὑπάρχει τῶν ζῴων, καὶ οὐ μόνον ἀνθρώποις καὶ τοῖς ἔχουσι δόξαν ἢ φρόνησιν) (450a14-15). When we connect this conclusion with the prior claim that animals that sense time also have memory, we are tempted to conclude that nonhuman animals, insofar as they have the faculty of sense perception, perceive time. When we consider *Physics* iv 14, we see that this can not be

[6] μέγεθος δ' ἀναγκαῖον γνωρίζειν καὶ κίνησιν ᾧ καὶ χρόνον· [καὶ τὸ φάντασμα τῆς κοινῆς αἰσθήσεως πάθος ἐστίν] ὥστε φανερὸν ὅτι τῷ πρώτῳ αἰσθητικῷ τούτων ἡ γνῶσίς ἐστιν· ἡ δὲ μνήμη, καὶ ἡ τῶν νοητῶν, οὐκ ἄνευ φαντάσματός ἐστιν, <καὶ τὸ φάντασμα τῆς κοινῆς αἰσθήσεως πάθος ἐστίν>· ὥστε τοῦ νοῦ μὲν κατὰ συμβεβηκὸς ἂν εἴη, καθ' αὑτὸ δὲ τοῦ πρώτου αἰσθητικοῦ.

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the whole story. Though it is clear that Aristotle intends that, in some sense, time is perceived, there must be a limit to this kind of time apprehension in order that *Physics* iv 14 be consistent with Aristotle's remarks elsewhere.

Aristotle next clarifies that memory entails apprehension of before and after (450a19-20), which one assumes if memory entails time sense and if time sense entails apprehension of before and after. He then gets specific when he writes, "if asked, of which among the parts of the soul memory is a function, we reply: manifestly of that part to which imagination also pertains" (τίνος μὲν οὖν τῶν τῆς ψυχῆς ἐστι μνήμη, φανερόν, ὅτι οὗπερ καὶ ἡ φαντασία) (450a21-22). Aquinas, in his commentary on *De memoria et reminiscentia*, explains that apprehension of before and after entails imagination (*phantasia*): "For some animals perceive nothing save at the presence of sense objects, such as certain immobile animals, which on this account have an indeterminate imagination, as *De anima* iii says. And on this account they cannot have cognition of prior and posterior, and consequently nor time. Hence they do not have memory." It is not simply animals with sense perception that have memory, but animals with the ability to determine that "this" perceptible is being perceived "before" or "after" "this" perceptible. This determination requires an ability to mark (*orizei*) *kinêsis* in some sense. Here we find an indication that even if some or many nonhuman animals perceive time, not all can—owing to a lack of determinate imagination.

Aristotle ends the first chapter writing, "it has been shown that it [memory] is a function of the primary faculty of sense perception, i.e. of that faculty whereby we

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perceive time (ὅτι τοῦ πρώτου αἰσθητικοῦ, καὶ ᾧ χρόνου αἰσθανόμεθα)" (451a16-17). That time is *perceived* (ᾧ χρόνου αἰσθανόμεθα) by the faculty of *sense perception*, for Aristotle this is a faculty of the sensitive soul, and thus perceived by any being endowed with sense, seems unproblematic. In fact, this language is perfectly consistent with what Aristotle tells us about time perception in *Physics* iv 11. The problem is with Aristotle's argument at *Physics* iv 14, to which we will now turn.

II. Readiness for Thinking: from Marking to Counting

Aristotle's discussion of the dependence of time on the soul is one of the more famous and debated passages in the time section of the *Physics*. Despite its relative brevity—spanning a mere paragraph of the overall argument—interpreters have disagreed about how to understand the crucial relationship Aristotle posits among time, *arithmos*, soul, and *nous*. The passage reads as follows (223a16-28)[7]:

> It is also worth considering how time can be related to the soul; and why time is thought to be in everything, both in earth and in sea and in heaven. Is because it is an attribute, or state, or movement (since it is the number of movement) and all these things are movable (for they are all in place), and time and movement are together, both in respect of potentiality and in respect of actuality? Whether if soul did not exist time would exist or not, is a question that may

[7] Ἄξιον δ' ἐπισκέψεως καὶ πῶς ποτε ἔχει ὁ χρόνος πρὸς τὴν ψυχήν, καὶ διὰ τί ἐν παντὶ δοκεῖ εἶναι ὁ χρόνος, καὶ ἐν γῇ καὶ ἐν θαλάττῃ καὶ ἐν οὐρανῷ. Ἢ ὅτι κινήσεώς τι πάθος ἢ ἕξις, ἀριθμός γε ὤν, ταῦτα δὲ κινητὰ πάντα (ἐν τόπῳ γὰρ πάντα), ὁ δὲ χρόνος καὶ ἡ κίνησις ἅμα κατά τε δύναμιν καὶ κατ' ἐνέργειαν; πότερον δὲ μὴ οὔσης ψυχῆς εἴη ἂν ὁ χρόνος ἢ οὔ, ἀπορήσειεν ἄν τις. Ἀδυνάτου γὰρ ὄντος εἶναι τοῦ ἀριθμήσοντος ἀδύνατον καὶ ἀριθμητόν τι εἶναι, ὥστε δῆλον ὅτι οὐδ' ἀριθμός. Ἀριθμὸς γὰρ ἢ τὸ ἠριθμημένον ἢ τὸ ἀριθμητόν. Εἰ δὲ μηδὲν ἄλλο πέφυκεν ἀριθμεῖν ἢ ψυχὴ καὶ ψυχῆς νοῦς, ἀδύνατον εἶναι χρόνον ψυχῆς μὴ οὔσης, ἀλλ' ἢ τοῦτο ὅ ποτε ὂν ἔστιν ὁ χρόνος, οἷον εἰ ἐνδέχεται κίνησιν εἶναι ἄνευ ψυχῆς. Τὸ δὲ πρότερον καὶ ὕστερον ἐν κινήσει ἐστίν· χρόνος δὲ ταῦτ' ἐστὶν ᾗ ἀριθμητά ἐστιν

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> fairly be asked; for if there cannot be some one to count there cannot be anything that can be counted, so that evidently there cannot be number; for number is either what has been, or what can be, counted. But if nothing but soul, or in soul reason, is qualified to count, there would not be time unless there were soul, but only that of which time is an attribute, i.e. if movement can exist without soul, and the before and after are attributes of movement, and time is these qua numerable.

Let us begin with a general observation. Notice here that Aristotle is recalling his actual definition of time from *Physics* iv 11, talking about time as a number, *arithmos*. And here, he takes a step further to define number. Number is something that has been or can be counted: Ἀριθμὸς γὰρ ἢ τὸ ἠριθμημένον ἢ τὸ ἀριθμητόν. Contrast this with his previous allusions to "marking" (*orizei*) *kinêsis*. Before moving on to discuss the relation of soul to time, then, I want first to say something about Aristotle's use both of *arithmos*, or number, and *metron*, or measure, in his various definitions and explanations of time leading up to this discussion.

In the Treatise on Time, Aristotle uses three different verbs to describe the apprehension of time and their corresponding nominal forms to refer to that which time is. He says that *kinêsis* is counted, *arithmêton*, measured, *metrêton*, and marked, *orizei* (see 219a22 "we have marked motion," 219a25 "we mark them," and 220b15, "time marks the movement"). But, as just mentioned, *orizei* is not synonymous with either *arithmêton* or *metrêton*. Because Aristotle uses both *arithmos* and *metron* in the time section, it has been argued that he uses them interchangeably (See Annas 1975 99). Since *metron*, literally "that by which anything is measured," seems to be a genus of various kinds of "thats," it has also been argued that Aristotle understands number in this case to be a kind of measure (see Coope 2005, 100). In *Metaphysics* x 6,

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Aristotle explains that, "Plurality is as it were the class to which number belongs; for number is plurality (*plêthos*) measurable (*metrêton*) by one" (1057a3). This passage has been used not only to defend each of the opposing views above, but also to say that for Aristotle, it is one, as opposed to number, which is under the genus of "measure" (see Klein 1969, 108). The potential for equivocation on "measure" runs parallel to the potential for the equivocation on "number"; for, as Aristotle himself points out about "*arithmos*," measure can mean both the unit of measure, i.e., the "that," or the measurement itself (see 219b where Aristotle says that number can mean both the number counted and the number with which we count). In the first case, we are talking about "one," and in the second place we are talking about a plurality measured by one. For Aristotle, time is number in so far as it is that which is counted—the plurality and not the one. The impulse to think that the analogous sense of *arithmos* and *metron* are not synonymous here has to do with the idea that Aristotle understands time to be an ordering and not a quantity (see Coope 2005, 104). While I would not have a problem acceding to the claim that there is a non-temporal ordering going on between anteriority and posteriority, it seems important to understand these positions as designating a relation. Yes, relations can connote an ordering, but the fact that such a relation exists does not automatically prohibit that the terms in relation, the relata, exist as a discrete plurality or quantity of things. I thus maintain the standard view that number and measure are synonymous in Aristotle's treatment, on the basis that order and quantity are not mutually exclusive designations, and I understand them both to refer to the plurality counted and not the unit, one, by which we count.

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With that said, we return to the passage on time and the soul. Recalling the first few lines from the passage above, Aristotle introduces the topic with a statement and a quasi-question, he thinks it "is worth considering how time can be related to the soul (ψυχή); and why time is thought to be in everything (ἐν παντὶ), both in earth and in sea and in heaven." Aristotle wants to consider how time is related to the soul, here not yet qualified as the rational soul. Time is thought to be in everything, meaning in things on earth, in the seas, and in the heavens. Though, since Aristotle has offered an unconventional definition of time here in the Treatise on Time, the idea commonly held that time is "in everything" is right, but now in a new sense. For Aristotle, time is in everything because, (1) "it is an attribute, or state (πάθος ἢ ἕξις), of movement (κινήσεώς) (since it is the number of movement)," and (2) "all these things [on earth, in the sea, and in the heavens] are movable (for they are all in place), and time and movement are together, both in respect of potentiality and in respect of actuality." If time is the number of *kinêsis*, it is not an intrinsic part of natural objects. Indeed, as I have argued, it has no existence for Aristotle qua itself and unless actualized remains a potentiality of *kinêsis*.[8] Yet, to the extent that natural beings on earth, in the sea, and in the heavens, undergo *kinêsis*, and *kinêsis* is an actualized potentiality because they are first of all actually in place, there is the potentiality for these natural beings to be in time.

[8] See Polansky (Polansky 2007, 463 n. 5) on interpretation of *hexis*. For Polansky, the examples of light and art in *De anima* iii as *hexis* provide support that *hexis* can mean potentiality or disposition. It seems that *chrónos* as *hexis* provides further evidence that *hexis* is a potentiality for possible actualization under certain conditions.

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Since at this point Aristotle has said only it is worth considering that time is related to the soul and clarified that time is an attribute of *kinêsis* because it is a number of *kinêsis*, the specific relationship of time to soul is not clear, but it does seem clear that it is going to have something to do with the sense in which time is a number, and number, as we saw previously, is something counted. A question thus could be raised as to whether this counting is done not by anyone in particular, but in accordance with some celestial standard, as it has been argued, or if it results from direct observations and then counting of *kinêsis*. This difference is parallel to the question raised in the previous chapter regarding whether Aristotle's analytic of time was an analytic of infinite time or time taken. It is worthwhile to address the analog to the previous question we find here. Understanding time as the number in accord with a celestial standard annihilates the possibility that time is actualized by the interaction between the observed and the observer and so too my previous claim that Aristotle is focused here in the *Physics* on the time taken. Instead, time becomes something *a priori*, namely, what we might take to be infinite time, unaffected by particular instances of existing self-subsistent natural beings undergoing *kinêsis*.

In addition, it seems suspicious that Aristotle would argue for the definition of time that he does, if he just meant to explain time as a pre-established standard—essentially predetermined before any *kinêsis* takes place and unalterable by particular *kinêsis* and observation. Certainly, given the context of his scope, access, method and goals in the *Physics*, it is unclear as to why, if time were really just a set number naming the perfect motion of the heavens, it appears in this context at all.

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Returning again to the text, Aristotle asks another question, which at this point seems redundant, namely: "whether if soul did not exist time would exist or not." But, now we get an explicit answer, "if there cannot be some one to count there cannot be anything that can be counted either." Whereas someone counting is not requisite so that "anything" exist, it is requisite in order that "anything" be counted. Aristotle here makes a general claim about the relationship between things existing, things being counted, and someone counting. Whereas, the claim that something counted, i.e. number, depends on someone counting may seem like a strange claim (one generally accepts that there can be eight planets in the solar system whether or not they are ever counted), the ideas of counting (by way of the counter) and the counted are intimately related in ancient Greek.

It has been argued that our modern concept of number, which comes from Descartes and Leibniz, is vastly different from the concept of number employed here by Aristotle (see Sachs 2008, 129). In Greek mathematics, numbers are names given to a discrete plurality of things (see *De interpretatione* ii on names as convention). They are "natural" and not symbolic expressions (see Sachs 2008 130 and Klein 1969 regarding fractions and negative expressions). Again, Ross (Ross 1936, 541) explains in reference to *Meta* 987b27 that "the Pythagoreans identified real things with numbers, it is not to be supposed that they reduced reality to an abstraction, but rather that they did not recognize the abstract nature of numbers" (see also fn 58). While the plurality of things to be counted exists outside of the fact of someone's counting them, the name given to the plurality is only potentially so. In order for number, as name, to

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arise, the plurality—the something to be counted—must be apprehended, thus named. In the case of time, as we know, the something to be counted is *kinêsis* to the extent that this is the mode of existence for natural beings. The sense in which *kinêsis* becomes numbered, and thus the sense in which time exists at all on this account, has to do with whether or not there is someone counting it. Indeed, since on Aristotle's definitions, time is a number, and "number is either what has been, or what can be, counted," number is arrived at by way of counting. It is thus implied that someone or something is doing the counting. Aristotle's claim here is that the number, i.e., time, necessarily depends on the counter.

It is the "some" of this someone counting—namely, who or what is it—that has caused so much debate over this passage in Aristotle's Treatise on Time. From the first section above, this someone could not be any ensouled being, i.e., plants, nonhuman animals, and humans alike. Unlike the act of simply marking (*orizei*), counting—really a type of naming—seems to be uniquely human. Looking back to the passage, Aristotle seems to say as much: "But if nothing else is of such a nature as to count but the soul and the intelligence (*nous*) in the soul. Then it is impossible that time be if soul is not, but only that of which time is an attribute." The actual existence of time, then, requires not simply soul, as it is often suggested and consequently misunderstood, but the intellective capacity of soul, or *nous*. It is the intellective faculty of the human soul that allows for a readiness for counting or naming, a potentiality, that is not present either in Aristotle's definition of God or in the souls of nonhuman beings (compare with *De anima* iii 4 "And indeed, they speak well who say

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that the soul is a place of forms, except that it is not the whole soul but the intellective soul, and this is not the forms as being-fully-itself, but in potential" 429a). Time is actualized when a human being with readiness for thinking brings this potentiality to bear on a being actually undergoing *kinêsis*.

Aristotle concludes the passage with a reminder about what is actually being counted: "The before and after are attributes of movement, and time is these *qua* countable." Whereas, I have emphasized before the notion of "marking" the difference from "before" to "after," thus not quite counting, here Aristotle uses the term *arithmêton* instead of *orizei*. One wonders how and/or why the "before" and "after" are sometimes marked, and marked by some nonhuman animals, and yet sometimes counted, seemingly only by human beings, i.e. those with *nous*.

Again, returning to time's identity as *number*, it is something about the number, which allows for the disparity in Aristotle's language about time apprehension. But, what is it about numbers, which could allow for the lack of congruence we see in Aristotle's descriptions of their apprehension? Numbers, as referents for discrete quantities of real things, instead of self-subsistent beings themselves, do not have attributes (recall 204a8-29, number is not a substance). Thus, it must be the number itself, i.e., the quantity of things *it* names, which makes the difference for its potential cognition. When the being in question undergoes only smallscale *kinêsis*, here understood to mean a difference between the "nows,"—this one, "before," and this one, "after"—not separated either by an extended spatial continuum or by many intermediate "nows," the time or number of the *kinêsis* can be

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perceived. For example, if I walk across the room, the before and after of the locomotion is apprehended easily by another animal in the room. Here, perception of change seems to allow for a rudimentary or partial perception of time. The number of the change is so small that it does not seem to require counting. When the locomotion happens over a greater spatial magnitude, and thus apprehending it requires recognizing what becomes a continuum of change over the magnitude, e.g., I start in New Haven and end up in Thessaloniki, a more robust faculty for apprehension appears requisite. The change is too great to mark, and indeed I wager that no nonhuman animal (or small human child)[9] measures precisely such a change—they certainly detect a difference between places (something changed!), but not the change itself, thus not the numeral of the change.[10] This explains why Aristotle reintroduces the term *arithmêton* when he discusses the relationship between time and the soul and then clarifies *nous* as the additional faculty necessary to apprehend the time.

It seems appropriate then to distinguish between time perception based solely on sensation, which seems to be the course of perceiving and "marking" (*orizei*), as we saw in the previous chapter with our discussion of *Physics* iv 11, and time perception

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[9] See for example *HA* 588a24-588b6, where Aristotle equates the psychology of a child to that of a nonhuman animal.

[10] King, (2009, 62), also distinguishes between perceiving and measuring time. His argument is that, "representations are necessary to the perception of common perceptibles such as change and magnitude, and also for the cognition of time. Because representations are a function of perception, this means that time is perceived." He notes that Aristotle (echoing Irwin) does not mention memory in the *Physics*. He concludes, "representation is responsible for the perception of time." defended by 450a9-12, where Aristotle says, according to King, "it is necessary for change and magnitude to be perceived with the same thing that time is perceived."

made more precise by the capacity for enumeration (*arithmêton*). This is to say that the potential for time exists in all *kinêsis*, and it is in some sense recognized by the sensitive soul, but the rational faculty of the soul is required in order to bring time, at least in the case where the number that time names is a large quantity of discreet beings, from a hazy multiplicity to a known quantity. Counting sets humans apart from nonhuman animals. We can differentiate a multitude by counting. This allows us to move past sensing number, hence employing our souls' intellective potency to determine the discrete number of items that we sense to be a multitude. Thus, counting looks to require both a body as medium for obtaining sense data and a higher order intellect to discern number. Counting motion, which amounts to the coming into actuality of time, then, requires living beings capable of sensing the before and after in motion and, when we are not just dealing with short-term *kinêsis* or a small quantity of discrete existing beings, a readiness for intellection in order to number, or name, the plurality. Aristotle, then, leaves taking time, generally, to human being. But, he allows that nonhuman animals perceive small-scale change and time, without which they would not have the tools to serve necessary ends, e.g., the capture of prey and evasion of predators. In the next and final section, I will offer up evidence, from Aristotle's *Parva Naturalia* and biological treatises, supported by experimental results from conteporary science, in further defense of this position.

III. Perceiving Time Revisitied

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In *De sensu et sensibilibus*, Aristotle takes up discussions that would have been too specific for his general work on the soul, *De anima*. He refers to these as the "remaining part of our subject" where he means specifics about soul. Here, we are going to get into the details of soul functioning. Despite that we learn in *De anima* about certain faculties of soul, which do not require the body as medium, the soul never functions disembodied. In *De sensu et sensibilibus*, Aristotle's topic turns to a more focused discussion of what he names the most common and important faculties of soul, those that require both soul and body. He explains that these faculties—sensation, memory, passion, appetite, desire, pleasure, and pain—belong to all animals (436a8-10). Indeed, they can be tested to reveal that both soul and body are necessary for their proper operation. One does not see without an eye, but neither does a corpse or a brain-dead animal even with eyes. The brain in the vat does not feel pain, but neither do the disemboweled organs. Aristotle reasons that this is the case because these faculties "all either imply sensation as a concomitant, or have it as their medium" (πάντα γὰρ τὰ μὲν μετ΄ αἰσθήσεως συμβαίνει, τὰ δὲ δι΄ αἰσθήσεως); he then concludes that sensation is a faculty of soul inextricable from the body through which external stimuli are taken in (436b1-9).[11] He continues, explaining that while the senses are a natural attribute of the beings (Cf. *HA* 533a15-18), which we call "animal" (*zoon*); indeed, it is by the faculty of sensation that we distinguish between what is and what is

[11] ὅτι δὲ πάντα τὰ λεχθέντα κοινὰ τῆς τε ψυχῆς ἐστὶ καὶ τοῦ σώματος, οὐκ ἄδηλον. πάντα γὰρ τὰ μὲν μετ΄ αἰσθήσεως συμβαίνει, τὰ δὲ δι΄ αἰσθήσεως, ἔνια δὲ τὰ μὲν πάθη ταύτης ὄντα τυγχάνει, τὰ δ΄ ἕξεις, τὰ δὲ φυλακαὶ καὶ σωτηρίαι, τὰ δὲ φθοραὶ καὶ στερήσεις· ἡ δ΄ αἴσθησις ὅτι διὰ σώματος γίγνεται τῇ ψυχῇ, δῆλον καὶ διὰ τοῦ λόγου καὶ τοῦ λόγου χωρίς

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not animal" (ἀνάγκη ὑπάρχειν αἴσθησιν· τούτῳ γὰρ τὸ ζῷον εἶναι καὶ μὴ ζῷον διορίζομεν) (436b11-13); they operate for different functions in different animals.

For Aristotle, despite that sense perception is activity (*energeia*), which is an end in itself, the senses are also a means to an end, and the ends (*teloi*) differ in accordance with the varied potencies of souls for which he argued in *De anima*. This difference is seen first with regard to the senses requiring an external medium to operate: smelling, hearing, and seeing (436b18-19). We are told animals that move locally possess these senses, and for all of them these senses are means for basic survival. Animals can use smell, sound, and sight to find food and/or to be alerted to possible dangers. But, these senses can, "…serve for the attainment of a higher perfection. They bring in tidings of many distinctive qualities of things, from which knowledge of things both speculative and practical is generated in the soul" (τοῖς δὲ καὶ φρονήσεως τυγχάνουσι τοῦ εὖ ἕνεκα· πολλὰς γὰρ εἰσαγγέλλουσι διαφοράς, ἐξ ὧν ἥ τε τῶν νοητῶν ἐγγίνεται φρόνησις καὶ ἡ τῶν πρακτῶν) (437a1-4). These higher ends are restricted to animals that have intellect (τῶν νοητῶν), i.e. to humans.[12]

Yet, whereas the distance senses of seeing, hearing, and smelling allow animals to sense proper sensibles, i.e., that which can be sensed only by being seen, that which can be sensed only by being heard, and that which can be sensed only by being smelled, we learn also of common sensibles (see *De anima* ii 6 for a parallel account). When

[12] Cf. *GA* 731a30-731b7: sense perception is a kind of knowledge and *HA* 588a24-588b6 where Aristotle claims that there is an analogue for knowledge, wisdom, and sagacity in nonhumananimals and then admits that it is difficult to demarcate human animal from nonhuman animal potentiality.

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things can be perceived with more than one faculty of sense, they are sensed in common. Aristotle provides the following list: figure, magnitude, motion, rest, and number. Sight allows us the most variability in sensing, and it plays an especially big role in perceiving common sensibles.

Now, these passages leave us with a lot to think about regarding the way sense perception functions to allow animals—both human and nonhuman—to attain various ends. Both humans and nonhumans, in so far as they are capable of locomotion, can see, hear, and or smell. But, what can they see, hear, or smell? In Aristotle's biological works, we find myriad examples of nonhuman animal perception. Consider, for instance, these passages from the *Historia Animalium*: Fishes are repelled by loud noises (533b4-534a7), e.g., those that seek shelter in holes after hearing men rowing; dolphins beaching themselves as a response to loud splashing;[13] shoals of fish scurrying away at the slightest sound; sub-rock dwelling fish that emerge when stones are clashed against the rock. In these examples, Aristotle attributes animal action to the animal's sense of hearing. This explains his amazement that the fish hear without any clear instrument for apprehending sounds, and likewise that they seem to smell without an instrument for olfactory perception (533b1). In each of the cases given, however, the animals seem to be detecting motion, a common sensible. As a common sensible, they could be hearing the motion or sensing it by some other means, e.g., by touch—feeling the vibrations of the clanging rocks or the splashes in the water made by the oar. In any case, it is clear that in these examples, perception of motion functions to effect

[13] Aristotle infamously classified dolphins as fish, specifically "dualizers."

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consequent movement and action.[14] The resulting movement serves greater ends, such as attempt at preservation of life.

Aristotle provides other concrete examples of animal sense perception; he tells us that the octopus will relinquish its unusually firm grip on rocks at the first smell of fleabane (534b26-30), that the hyaena will await a passerby in order to prey upon him and—from another perspective, that the dog will fall prey to the hyaena when persuaded by its strange vocalizations mimicking a vomiting man (594a32-594b4). He tells us also of the enmity between the horse and the anthus. Aristotle states unequivocally that the bird sees poorly. It thus relies on its sense of hearing to, as Aristotle explains, mimic the horse's vocalization and fly at the horse to persuade it to leave—its only defense against the horse's nefarious intentions (609b15-19). Hereto, we see perception effecting movement and action in the service of other ends. In the second example, the end is attainment of nourishment, and in the third example, the end is self-preservation, most critical aims. That Aristotle claims sheep to be the least intelligent of the quadropeds because it leaves its herd and/or shelter for no reason—often to its own demise—is further confirmation that sensation for Aristotle is not only active in nonhuman animals, but that it is meant to be used in service to a purpose (610b21-25). When the animal moves locally without an aim, especially when such

[14] On the causes of movements and actions in animals, see *De motu* vii, especially 701a25-35 and viii, especially 701b34-702a6. According to Aristotle, regarding animal movement: "… the proximate reason for movement is desire, and this comes to be through sense-perception or through *phantasia* and thought (Τῆς μὲν ἐσχάτης αἰτίας τοῦ κινεῖσθαι ὀρέξεως οὔσης, ταύτης δὲ γινομένης ἢ δι᾽αἰσθήσεως ἢ διὰ φαντασίας καὶ νοήσεως)" (34-35).

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action goes against self-preservation, it is said to lack intelligence. We learn as well of the owl and the night-raven, who, opposite fish (602b5-9) see poorly in daylight (619b19) and at length of the highly intentional life of bees, who, as it were, are put off by malodours (623b5-627b23). We see in these examples that insofar as perception is often useful for animals, i.e., in service to important ends, we might then consider how perception of motion and number serve such higher ends. Could animal perception without intellection allow for some sort of time apprehension?

Number is also a common sensible, according to Aristotle. Insofar as number is typically perceived by way of enumeration, and not sense perception, one wonders what Aristotle is up to here. How are numbers perceived by the sensitive soul, and to what ends? In the context of our conversation of time, where time is classified as a number—but, a number *derived of* motion—it is likewise pertinent to ask about the possibility that time can be actualized, i.e. the number of motion can be apprehended, only by way of perception. Yet, while the answers to these queries are not directly answered in the Corpus Aristotelicum, the idea that at least some time can be perceived without enumeration is consistent not only with the examples given above, where nonhuman animals are perceiving motion, but also with Aristotle's language beginning in *Physics* iv 11, where he talks about time apprehension as perception and marking and with his arguments in the treatise on memory. Our final task, then, is to inquire as to how perceiving number and counting number differ in the service of time apprehension. In an effort to present Aristotle's claims, both that time requires *nous* and also that (1) nonhuman animals have a sense of time, (2) both motion and number

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are common sensibles, and (3) time can be perceived (and motion marked), as consistent, I will incorporate conclusions from contemporary science to support the claim that while in fact some numbers, i.e., small numbers typically less than four can be perceived even by infants and nonhuman animals, larger numbers must be enumerated. Such evidence lends hard proof to Aristotle's insights about the complexity of "taking time."

Given our common experiences with perception, we understand that even humans seem only to sense small numbers. When I see two apples on the table, for example, I can say without thinking that there are two there. When there is a bushel on the table, however, I can only immediately say that there are many. I would have to count them to know exactly how many are there. When I hear three notes strum on a guitar, I seem to hear them without enumerating them; but, when many notes are strum in quick succession, I can no longer discern how many there have been. Indeed, experimental programs in psychology and neuroscience know this to be the case. According to Kaufman et al.'s landmark study (1949), whose conclusion effectually synthesizes the two prevailing yet seemingly opposed conclusions at their time; there is no immediate and adequate perception of number,[15] but there is an activity whereby numbers six and under are rapidly and accurately discriminated. They name this activity, "*Subitizing*," from the Latin "subitus," sudden. Trick & Pylyshyn (1994) confirm that small and large numbers are enumerated differently; they accept Kaufman et. al's term and, further, conclude that subitizing relies on preattentive

[15] Cf. again Klein 1969 on the possible intuitive nature of *arithmos*.

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information, whereas counting requires spatial attention. In a recent study, Harvey et. al (2013) conclude that, "numerosity perception resembles primary sensory perception and, indeed, it has been called the number sense"; and, "the cortical surface area devoted to specific numerosities decreases with increasing numerosity."[16] But, even if human adults subitize quantities of about six and under, what evidence do we have that nonhuman animals and human children do the same?[17] Do nonhuman animals and human children have the information Trick and Pylyshyn consider preattentive?

Let us return first to the examples of nonhuman animal perception of motion from Aristotle's biological works. It seems clear that nonhuman animals sense number, even if the exact quantity remains unknown. Thinking again about the hyaena, one would not say that if the hyaena should encounter twenty men or fifteen dogs, instead of one in each case, that she is somehow unaware that there are multiple. In order to catch one, she not only sees the many, but also devises a strategic plan for isolating her anticipated catch. Aristotle observes that when the lion is pursued by many men at once, his behavior is different than when he is either not being pursued or when he is himself pursuing other prey (629b14-20). These examples tell us that nonhuman animals, on Aristotle's account, do alter behavior when faced with multiple, as opposed to one, objects. Returning to my previous point that "*nous*" in

[16] Reas (2014) reports these results for laymen in her recent review of this study: "One side of this brain region responds to small numbers, the adjacent region to larger numbers, and so on, with numeric representations increasing to the far end."

[17] Kaufman et. al address this question, admitting that the conclusions in their study are based on a study of adult human number perception. To include children and nonhuman animals in such a study, they suggest that one consider that: Subitizing, Estimating, and counting are all learned behaviors (1949, 524).

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Physics iv.14 must mean the working *together* of sense and intellection in that the faculties of intellect require sensation, here we see the possibility for limited time apprehension insofar as the number is small enough to sense, even if the potency of intellect is not present to calculate or measure.

In fact, recent research in neuroscience, psychology, and animal cognition confirms Aristotle's observations, showing that many animals at various ages perceive number without counting (see for example J.J. Cooper et. al (2003, 236), dogs seemed to have "some concept of number of objects, though it would not be fair to infer anymore than simple subitising of number. It may therefore be that dogs only represent numbers of objects as 'one,' 'two,' and 'lots.'" Further, V. Dormal et al. (2006, 110) report:

> Animal data show that various species can discriminate numerosities in experimental as well as in natural conditions…There is also clear evidence that newborn babies and young children experience time and have a precocious temporal representation…These elementary numerical skills shared by animals, infants and adults would rely on a cerebral network located in the inferior parietal cortex.

Though, whereas these studies were conducted almost exclusively testing number perception with the sense of sight, Riggs et. al (2006) proved that subsitizing can happen even with what Aristotle calls the most distributed sense, touch (see Riggs et al. 2006). This opens up basic time perception to all animals, of all ages, on Aristotle's account.[18] Aristotle's vast experience with the natural world seemingly led him to these same general ideas about the possibilities for soul functioning in all animals.

[18] I am grateful to Lanei Rodemeyer and Heidi Lockwood, for sharing with me on

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But, of course, time for Aristotle is a number of *kinêsis*, not a static quantity. How do we see number when the numbers perceived are not all present at once? Specifically, how can perception of not only number, but the number of motion, allow for time apprehension in Aristotle? King (King 2009, 65) rightly points out that Aristotle does not discuss this point; King's explanation, which I think is correct, is the result of a contextual approach: Aristotle's "theory of change does not allow for change or rest at an instant, and also because his theory of time requires the cognition of change, rather than being itself a presupposition for the cognition of change." King answers this problem with a theory of representation, based on perception; namely, he suggests that we perceive representations (images) of the perceptibles and that the "now" perceived before is held in representation even as we experience it change to "now" perceived as after. He concludes that, "remaining representations make it possible to perceive time, which is one of the preconditions of memory" (66). Indeed, Wood et. al (2008) confirm that rhesus monkeys can differentiate between small numbers of non-solid portions of food, not poured simultaneously, up to the number four and Agrillo et. al (2008): mosquitofish are able to discriminate between small numbers of non static objects, notably as high as the difference between three and four. West and Young (2002) show that nonhuman animals can understand simple

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separate occasions that their infant children seem to experience time. And, indeed, we see here that scientific results confirm that they do. The question remains as to the extent and nature of their time apprehension; I propose that Aristotle was correct to group human children with animals insofar as they are using faculty of sense as opposed to thought to cognize temporality.

calculations, e.g., two treats are shown to a dog and one treat is taken away; the dog notices the difference between two and one.

Here, we see contemporary science providing experimental evidence for the conclusions Aristotle seemingly developed about time perception—especially, insofar as it is a type of number that, if perceived, must be perceived with motion or change, the possibility that it happens with nonhuman animals. Aristotle's observations about animal behavior, as presented in his biological works, demonstrates that there would have been a conflict between his conclusion at *Physics* iv 14, that readiness for thinking would be required for time apprehension, and his explicit claim in the *De sensu et sensibilibus* about nonhuman animal time apprehension. This tension is confirmed by his varied language in the Treatise on Time, switching among language indicating that time is apprehended by way of the perceiving, marking, counting, and measuring of motion. Certainly, extended change, e.g., the trip from Thessaloniki to Athens, or the growth from infancy to adulthood, is not going to be cognized by nonhuman animals. There is simply too much change to keep track of—in King's language, to represent—and for which to account, and, given Aristotle's understanding that time is a number, thus too great a number to perceive. When the number is a small quantity, corresponding to a small scale change, e.g., the lion runs across the field, time in Aristotle's understanding would be easily cognized without a readiness for thinking, the lion was at one end of the field, and now he is at the opposite end, so the number of the change is small enough to perceive without any further activity of soul. This conclusion is widely supported by Aristotle's examples of nonhuman animal behavior

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in his biological treatises, e.g., to give a negative account, if such changes were *not* cognized, intentional necessary ends, such as catching of prey and avoiding predation, would be impossible.

In so far as nonhuman animals perceive, and Aristotle allows for perception of time, it seems likely that, for Aristotle, sense perception is a necessary but not sufficient condition for full time sense. Time is a number for Aristotle; to the extent that many, if not all, animals can mark (*orizei*) before and after in *kinêsis*, sense-perceiving number, they must have a weak sense of time, i.e., perception of small-scale change. But, insofar as the number must be counted or measured, time actualization seems left to humans (see Ross 1936, 599 on *orizei*, that it is not the same thing as measuring time). It is the intellective faculty of the human soul that allows for a readiness for counting or naming, a potentiality, that is not present either in Aristotle's definition of God or in the souls of nonhuman beings (compare with *De anima* iii 4 "And indeed, they speak well who say that the soul is a place of forms, except that it is not the whole soul but the intellective soul, and this is not the forms as being-fully-itself, but in potential" 429a). Time in any case is actualized when a human being with readiness for thinking brings this potentiality to bear on a being actually undergoing *kinêsis*. Human beings, as beings with both sensitive and rational souls, are thus a sufficient but not necessary condition for partial time sense and, along with the natural being undergoing change, both the necessary and sufficient condition for full time actualization in Aristotle's account.

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