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Aristotle's Model of Animal Motion

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Abstract

In this paper we argue that Aristotle operates with a particular theoretical model in his explanation of animal locomotion, what we call the 'centralized incoming and outgoing motions' (CIOM) model. We show how the model accommodates more complex cases of animal motion and how it allows Aristotle to preserve the intuition that animals are self-movers, without jeopardizing his arguments for the eternity of motion and the necessary existence of one eternal unmoved mover in *Physics* VIII. The CIOM model helps to elucidate Aristotle's two central yet problematic claims, namely that the soul is the efficient cause of animal motion and that it is the internal supporting-point necessary for animal motion. Moreover, the CIOM model helps us to explain the difference between voluntary, involuntary and non-voluntary motions, and to square Aristotle's cardiocentrism with his hylomorphism, but also, more generally, it provides an interesting way of thinking about the place of intentionality in the causal structure of the world.

Keywords

Aristotle, locomotion, soul, perception, imagination, desire, transformation, alteration, mechanics, pneuma

1. Introduction

It is clear from Aristotle's biological works that he thinks of animals as self-movers – they move themselves of their own accord, without being

carried, pushed or pulled by other things. It is also clear from Aristotle's works that he takes animals to move themselves because they have souls. Indeed, Aristotle believes that it is correct to say, as his predecessors have been saying, that the soul moves the animal. However, he is quick to dissociate himself from his predecessors by adding that the soul does not move the animal by itself being in motion, since the soul, according to Aristotle, is not the sort of thing that can undergo motion, except accidentally, insofar as the body housing the soul undergoes motion. But how can the soul plausibly be said to move the animal, if the soul is an unextended form of the animal's body? In this paper we hope to answer this difficult question by considering passages in Aristotle's works, some of them unduly neglected, in which we detect a particular theoretical model at work. We shall set out the model, clarify the role of the soul in that model, and point out that the soul, by assuming that role, can legitimately be said to be the efficient cause of animal motion.

The model we attribute to Aristotle will allow us to address another question, one which has been said to 'remain central for any evaluation of Aristotle's theory of self-motion'.¹ The question is this: Aristotle frequently claims that animals are self-movers, yet in two passages in *Physics* VIII he seems to qualify that claim quite drastically. First, they are self-movers only in the restricted sense that they move themselves *locally*, whereas they do not move or change themselves in other ways: 'There are other natural motions in animals, which they do not undergo through themselves, e.g. increase, decrease, and respiration: every animal undergoes these while it is at rest and not moving with its own inherent motion' (259b8-11). Second, animals do not move themselves 'even in that way in the strict sense' (καὶ ταύτην οὐ κυρίως, 259b7). Various explanations of this qualification have been proposed in recent scholarship, mostly in attempt to avoid the developmentalist conclusion and to show that Aristotle's position is consistent. For example, some scholars have argued that the qualification is needed because self-motion requires external objects which animals have to represent to themselves in a certain way (Nussbaum, Furley). Others have argued that the qualification is needed in order to indicate that it is not the whole animal which moves itself, but one part of the animal, its soul, which moves the other part of the animal, its body (Morison). We hope to show that the model we are about to present provides a convincing

¹) Gill and Lennox 1994, p. xv.

explanation of the aforementioned qualification which not only does justice to Aristotle's texts but also incorporates the merits of the other scholars' explanations while avoiding some objections to which they are open.

Apart from allowing us to settle these two scholarly questions, the model has wider philosophical implications. We shall suggest that it can help us understand, without recourse to the developmentalist thesis, how Aristotle could be a causal determinist and nonetheless believe that animals manifest various degrees of spontaneity relative to their cognitive abilities, or how he could advocate the hylomorphic view that the soul is the form of the whole body and nonetheless claim that the soul is located in the heart. Very generally, the model provides an interesting way of thinking about animal agency, one in which the animal is firmly set in the causal structure of the world by way of downsizing its irreducible intentional states to a bare minimum.

We proceed as follows. In Section 2, we introduce the model in its simplest form, gradually fill it with details, and also discuss some controversial points of interpretation. Section 3 deals with Aristotle's central yet problematic claim that the soul is the internal supporting point necessary for animal motion. In Section 4, we then argue that the model can be extended to more complex cases of animal behavior and human action. In section 5, we indicate further philosophical advantages of the model. The last two sections show how the model we identify in Aristotle helps us answer the two questions with which we started this paper: in Section 6, we consider the soul's role of efficient cause of animal motion, and in Section 7, we show why animals indeed are self-movers, and why they are self-movers only in a qualified sense. This provides us with an opportunity to review recent scholarly positions on that issue and to place our interpretation among them.

2. The Model

In *De Anima* I.4, 408a34-b30 Aristotle defends his view that the soul cannot be moved properly speaking. The defence is occasioned by a *prima facie* counter-example, namely the common way of speaking (408b1-4):

We say that the soul is pained or pleased, inspired with confidence or fear, that it is angry, perceiving, thinking. All these are regarded as motions, and hence one might infer that the soul is moved. This, however, does not necessarily follow.

Aristotle's reaction seems very lenient at first sight (408b5-18):

We may fully admit that being pained or pleased, or thinking, are motions, and that each of them consists in being moved, but this being moved occurs due to the soul, e.g. anger or fear consists in the heart being moved in such and such a way, and thinking consists perhaps in this being moved or something else; of these modifications some arise when certain parts are moved locally, others when certain parts are altered (what sort of parts and how, belongs to another discussion). Yet to say that the soul is angry is similar to saying that the soul weaves or builds. Perhaps it is better to avoid saying that the soul pities or learns or thinks, and rather to say that the man does all that with the soul. This does not imply that motion is in the soul, but rather that sometimes it proceeds to the soul and sometimes from it, e.g. perception proceeds from these peripheral sense organs to the soul, whereas recollection proceeds from the soul to the motions or traces in the sense organs.

Aristotle does not wish to deny that affections in question are *motions*. On the contrary, he accepts that they are. What he denies is that the *soul* is the proper subject of these motions. Thus he needs to show how these affections can be regarded as motions without attributing them to the soul. Aristotle accomplishes this by arguing that the soul is only the terminus and the origin of motions that take place inside the body, not something that itself undergoes these motions. Thus Aristotle is in a position to grant that what are commonly taken to be motions of the soul are indeed motions, and yet to deny that these are motions of the *soul*.

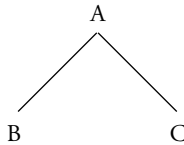
As we learn from this passage, affections arise when certain parts inside the body undergo local motion or alteration. Aristotle postpones a more detailed discussion of the relevant parts and the sort of their motion for another occasion, but we know that for Aristotle the crucial bodily part is the heart or its analogue; indeed, at the beginning of the quoted passages he says explicitly that anger and fear occur when the heart undergoes a certain kind of motion, and adds, more cautiously, that the same might be the case with thinking (*διανοεῖσθαι*), too. Given that the heart or its analogue is the central organ for Aristotle, and given his statement at 408b15-18 that motions proceed sometimes to and sometimes from the soul, we can infer that the heart or its analogue is the part of the body which, upon receiving certain motions from the periphery, transmits them somehow to the soul, and the part of the body which, upon receiving motions somehow from the soul, transmits them to the periphery. Of course, the big question is how this transmission of motions to the soul and their reception from the soul actually works. We shall leave this question aside for the

moment, and go along with Aristotle's suggestion that the soul is the point at which incoming motions end and outgoing motions start, without itself undergoing any of these motions. Let us call this the *centralized incoming and outgoing motions* (CIOM) model.

We find a schematic description of the CIOM model in *De Motu Animalium* 11 (703b26-35):

It is reasonable that motions run from the parts to the *archē* and from the *archē* to the parts and so reach one another. Let A be the *archē*. Then the motions from each letter in the diagram we have drawn arrive at the *archē*, and from the *archē*, as it moves and changes, being potentially many, the motion of B goes to B, that of C to C, that of both to both. But from B to C it goes by going first from B to A, as to an *archē*, then from A to C, as from an *archē*.²

Some manuscripts add the following illustration:³



This, we take it, is a schematic formulation of the same model we identified in *De Anima* I.4. Motions go from B to A and from A to C, which is to be understood in typical cases as perceptual changes going from the periphery to the centre and mechanical impulses going from the centre to the periphery. Aristotle allows the possibilities also that motions go from the centre to the perceptual periphery, as in the case of recollection (cf. *DA* I.4, 408b17-18 quoted above), as well as from the motor periphery

²) αἱ δὲ κινήσεις τῆ τε ἀρχῆ ἀπὸ τῶν μορίων καὶ τοῖς μορίοις ἀπὸ τῆς ἀρχῆς εὐλόγως συμβαίνουσι, καὶ πρὸς ἀλλήλας οὕτως ἀφικνοῦνται. δεῖ γὰρ νοῆσαι τὸ Α ἀρχήν. αἱ οὖν κινήσεις καθ' ἕκαστον στοιχείον τῶν ἐπιγεγραμμένων ἐπὶ τὴν ἀρχήν ἀφικνοῦνται, καὶ ἀπὸ τῆς ἀρχῆς κινουμένης καὶ μεταβαλλούσης, ἐπειδὴ πολλὰ δυνάμει ἐστίν, ἢ μὲν τοῦ Β ἐπὶ τὸ Β, ἢ δὲ τοῦ Γ ἐπὶ τὸ Γ, ἢ δ' ἀμφοῖν ἐπ' ἄμφω. ἀπὸ δὲ τοῦ Β ἐπὶ τὸ Γ τῷ ἀπὸ μὲν τοῦ Β ἐπὶ τὸ Α ἐλθεῖν ὡς ἐπ' ἀρχήν, ἀπὸ δὲ τοῦ Α ἐπὶ τὸ Γ ὡς ἀπ' ἀρχῆς. This is Nussbaum's text, with excised ἀρχή after ἢ μὲν τοῦ Β at 703b32, as proposed by Farquharson and followed by Kollesch. Although the mss. reading can, with some interpretative work, yield the same point, we follow Nussbaum's text for the sake of simplicity.

³) See Kollesch 1985 *ad loc.*

to the centre, which is less clear but might be plausibly interpreted as some sort of proprioceptive feedback.

In order to unpack the model, we shall address three questions: (1) How do motions go from B to A, explaining the simplest case of perception? (2) What happens at point A so that perceptions give rise to appetites? (3) How do motions go from A to C, explaining how appetites bring about movements of the limbs?

2.1. *Motions from B to A*

There are scholars who deny that perception, on Aristotle's account, involves motion or change which stands in relation to perceptual awareness as matter to form. If there is change involved in perception, they claim, it is only in the extended sense of transition from potentiality into actuality.⁴ This transition no doubt receives emphasis in the *De Anima* II.5, but this is only, in our view, because of the place of the *De Anima* in Aristotle's biology. Explanations of digestive processes, episodes of perception or occurrences of thoughts, we believe, is *not* on the agenda of that treatise. The agenda is, rather, to give an account of the formal principle of living beings which is going to be as general as possible and as specific as necessary, in order to be both applicable to all kinds of living beings and genuinely informative. Such an account consists of a treatment of the fundamental capacities of the soul – Aristotle calls them 'parts' of the soul – by explaining the objects in relation to which these capacities are exercised and the external conditions necessary for their production and mediation, as in the case of impacts that generate sounds or transparent substances which mediate colours.⁵ The perceptual part of the soul is one of the three fundamental capacities, and in the *De Anima* we hear little about the material structures and bodily organization an animal must have in order to possess a soul with the perceptual part, and still less about perceptual motions that take place inside the body. This, however, does not imply

⁴ Typical cases of change involve processes in which one quality, quantity or location gets replaced by another. Unlike such processes, which find their completion in a final state, transition from potentiality to actuality does not aim at a final state in which it terminates but is complete as long as it lasts. For an overview of the debate concerning Aristotle's theory of perception, see Caston 2004. For a recent position in this debate, see Lorenz 2007.

⁵ We explain Aristotle's notion of a part of the soul in Corcilius and Gregoric 2010.

that the perceptual part of the soul requires no definite material structure and organization, or indeed that no perceptual motion or change takes place inside the body. Aristotle's views on these issues are found in other biological writings, notably *De Partibus Animalium* and parts of the *Parva Naturalia*. For the purpose of presenting the CIOM model, we can suspend judgment on the question crucial for the 'literalism vs. spiritualism' debate, namely whether or not there are material processes that stand in relation to perceptual awareness as matter to form. In what follows we will describe motions from B to A leaving out an account of the precise relation of acts of perception to their proximate matter.

The picture that we find there can be summarized, very briefly, as follows. The peripheral sense organs of distance senses are homoiomerous parts made of a single element, such as water or air. Such parts have the requisite characteristic that enables the reception of sensible qualities, e.g. transparency of water in the eye is essential to receiving colours. This very same characteristic in external substances, such as air or water, enables mediation of sensible qualities, so that the peripheral sense organs have to be in contact with them. The peripheral sense organ of the contact senses is the flesh, which is also a homoiomerous part made of a mixture of all four elements.⁶ The peripheral sense organs are all connected with blood vessels, either directly or via structures which Aristotle called 'channels', some of which we would identify as the optical nerve or the auditory channel.⁷ Blood vessels are homoiomerous parts which form an elaborate network with the heart as its *archē* and centre. The heart is said to be a homoiomerous part on account of being 'receptive of all sensibles' (*PA* II.1, 647a28). The heart is the place in which another all-important homoiomerous part is produced, and that is blood. Freshly produced blood goes from the heart through the blood vessels to the entire periphery of the body, where it sediments. The rest subsides back into the heart where it gets replenished in the course of the digestive process. Blood has

⁶ For the sake of simplicity, we shall disregard the distinction between the senses of touch and taste, as well as Aristotle's refinement that the flesh and tongue are in fact connate media of the senses whereas the heart is their proper sense organ. Also, bloodless animals do not have flesh, tongue and the heart, but some analogous organs.

⁷ Some of the channels are said to be filled with connate *pneuma* (cf. *GA* II.6, 743b35-744a5), from which some interpreters conclude that *pneuma* has an important role in transmitting perceptual motions from the periphery to the heart.

different properties in different parts of the body, e.g. blood in the head is said to be thin, pure and cold, whereas in the extremities it is said to be thicker, more turbid and warmer. This is because thin, pure and cold blood is more conducive to transmitting the perceptual motions from the peripheral sense organs located in the head, whereas the blood of opposite qualities is more conducive to transmitting the perceptual motions from the connate medium of touch, the flesh, which covers extremities and the rest of the body more amply than the head.⁸

So the body of an animal, insofar as it is a living being capable of perceiving, contains a continuous system of homoimerous parts which stretches from the periphery to the central sense organ. The homoimerous parts on the periphery are either in direct contact with sensible objects, or else they are in contact with the external media in which sensible objects are located. So there is a continuous series of intermediaries, outside and inside the animal, between the sensible object and the central sense organ. The part of this continuous series which belongs to the animal – the sensorium – in the paradigmatic case of blooded animals consists of the peripheral sense organs, the heart, and the connecting structures, channels and blood vessels. The heart is said to be ‘the sense organ common to all peripheral sense organs’ (*Juv.* 1, 467b28), and ‘the master sense organ to which all sense organs lead’ (*Somn.* 2, 455a33-4). Admittedly, one reason why the heart is called ‘the master sense organ’ is that unless a motion from the peripheral sense organ reaches the heart, perception will not take place. This can be illustrated with Aristotle’s observation that soldiers go blind when the channels behind their eyes are severed by a blow to the temple (*Sens.* 2, 438b12-16). So the continuity of the sensorium is a necessary condition of the transmission of perceptual motions from the periphery to the heart; without it no perception can occur. Aristotle explains the transmission of perceptual motion as a standard case of transmission of motion in a physical medium (*Insom.* 2, 459b1-7):

This we must likewise assume to happen in the case of alteration; for that part which has been heated by something hot, heats the part next to it, and this propagates the affection onwards to the *archē*. This must therefore happen in perceiving, since an actual perception is a kind of alteration (*ἀλλοίωσις τις ἢ κατ’ ἐνέργειαν αἴσθησις*). This explains why the affection continues in the sensory organs, both in their deeper

⁸⁾ Cf. *PA* II.2, 647b29-648a13; II.4, 650b22-4, 651a15-19.

and in their more superficial parts, not merely while they are actually engaged in perceiving, but even after they have ceased to do so.

This explanation of transmission enables Aristotle to account for various other phenomena, such as after-images, appearances and images in dreams. Aristotle also takes due notice of the quickness of the transmission of perceptual alterations and even finds evidence of causal interaction between the perceiver and the perceived object (*Insom.* 459b23-460a32), as required by his theory of *poiein* and *paschein* in material things, elaborated in *De Generatione et Corruptione* I.7.

Without going into further details, we conclude that Aristotle took the view that sensible objects, through an external medium or by contact, set up motions – more precisely qualitative changes or alterations (ἀλλοιώσεις) – in the peripheral sense organs, and these alterations are transmitted to the central sense organ where perception takes place. Perceptions are or involve in this sense qualitative changes.⁹ This is how we would spell out ‘motions from B to A’ in describing Aristotle’s schematic description of the CIOM model.

2.2. *What Happens at Point A?*

What we have at this stage is a qualitative change in the central sense organ such that perception takes place. What happens next? How are perceptions transformed into motor processes that result in animal motion? To be able to address this question, we need to set out some preliminaries. Unfortunately, not all of these preliminaries can receive adequate treatment here, but we trust that the reader will find them plausible, consistent, and compatible with Aristotle’s texts.

First, and uncontroversially, Aristotle operates with a particular notion of nature. Animal nature is the soul as the internal principle of change. Second, Aristotle believes that there is such a thing as a bodily state in accordance with nature (κατὰ φύσιν). This is the state of the body conducive to the preservation and proper functioning of the animal. Third, there

⁹ Cf. *MA* 6, 701a5-6; 7, 701b17-18; 9, 702b21-2; *PA* I.1, 641b6. For more details, see Gregoric 2007, 40-51. Here we leave out the details that enter the explanation of episodes of sense-perception, especially the relation between qualitative changes and acts of perception. For the purposes of presenting the CIOM model it suffices to know that perception is *in one way or another* accompanied by qualitative changes.

is a mechanism of maintaining the body in the natural state, and this mechanism essentially relies on perception, feelings of pleasure and pain, and appetite. This requires some explanation.

‘That which is in accordance with nature,’ Aristotle writes in *Historia Animalium* IX.1, 589a8-9, ‘is pleasant. And all animals pursue pleasure which is in accordance with nature.’ Animals are constructed in such a way that they find things conducive to their nature pleasant, and things detrimental to their nature painful.¹⁰ That is to say, animals are built so as to go for those things which keep their bodies in the state which is in accordance with their nature, and they do so because the perception of such things is pleasant. Likewise, animals avoid those things which bring their bodies into states contrary to nature, and they do so because the perception of such things is painful. For example, Aristotle tells us that ‘all animals have the perception of pleasure that comes from food,’ which is why they all ‘have appetite for food’ (*PA* II.17, 661a6-8).¹¹ Since food is necessary for the preservation of animal, eating food is pleasurable. This conception of pleasure and pain Aristotle seems to have inherited from Plato.¹²

By feeling pleasure in perceiving some things and feeling pain in perceiving others, the animal distinguishes between things which are good for it and things which are bad for it, i.e. things which are conducive and things which are detrimental to the bodily state in accordance with the

¹⁰ This is the basic story in Aristotle’s account of ‘pleasures *kata sumbebēkos*’ in *NE* VII and X.

¹¹ See also *Sens.* 436b15-17 and *Rhet.* 1370a3-9.

¹² This is the replenishment model of pleasure of the *Philebus* 31a ff.; cf. *Republic* 585d, *Tim.* 64a ff., 81e1-2. True, Aristotle criticizes Plato’s account of pleasure in *NE* VII and X. However, it is not necessary to suppose that he rejects the replenishment model *tout court*; he only rejects it as a viable candidate for a *general* definition of pleasure, since such a general definition of pleasure would entail both pleasures *kata sumbebēkos* and simple pleasures. Aristotle thinks that simple pleasures, unlike pleasures *kata sumbebēkos*, do not follow on the replenishment of a previously impaired *phusis*, but on the exercise and actuality of an unimpaired *phusis*. He therefore refuses Plato’s account of pleasure as replenishment only as a definitional claim about what pleasure as such *is* (since he believes in the existence of pleasures which are not replenishments, but effects of the activities of natures). None of this implies that Aristotle would not accept Plato’s observation that animals and humans do experience pleasure while replenishing. On the contrary, Aristotle’s critique of Plato in *NE* VII and X presupposes his acceptance of the replenishment account as an observation concerning the pleasures *kata sumbebēkos* (see e.g. *NE* VII.12, 1153a2-7 and *EE* VII.5, 1239b37; cf. Corcilius 2008, 69 ff. and below).

animal's nature. Simultaneously, the animal is drawn to the things which are good for it and repelled by those which are bad for it. So there is an intimate connection between the feelings of pleasure and pain in perceiving things and appetite as the most basic case of desire. Aristotle says: 'To what perception belongs, to that pleasure and pain and the pleasant and the painful belong, and to what these belong, appetite also belongs; for appetite is desire for the pleasant' (*DA* II.3, 414b4-6). So to be an animal is to be a living being capable of perceiving, and to be a living being capable of perceiving is to be capable of feeling pleasure or pain – typically in encounter with things that are conducive or detrimental to the preservation and well-being of the animal – and to be capable of feeling pleasure and pain is in turn to be capable of having appetite for pleasant things and revulsion towards painful ones.

We find evidence for this in the *De Anima* (III.7, 431a8-14):¹³

(i) To be perceiving, then, is like bare saying or thinking; but whenever it is pleasant or painful, the soul, as if it were affirming or denying, pursues or avoids, and (ii) to feel pleasure and pain is to act with the perceptual mean in relation to what is good or bad insofar as they are such; and (iii) avoidance and pursuit when actual are the same. And what is capable of pursuing and what is capable of avoiding are not different, either from one another or from what is capable of perception; but their being is different.

In section (i) of this paragraph we find a three-stage analogy. Aristotle compares the activity of perceiving an object with bare saying or thinking of simple terms outside of propositions. Then perceiving is said to be either pleasant or painful. With this, we take it, Aristotle enters the second stage of the analogy, which he does not spell out. Presumably, having pleasurable or painful perceptions is comparable to combining simple terms into a proposition. Finally, in the third stage, pursuing or avoiding the object are compared to affirming or denying the proposition.

¹³ Most recent scholars agree that this passage is crucial for Aristotle's account of non-rational desire, e.g. Ricken 1975, 35 ff.; Richardson 1992, 394 ff.; Sorabji 1993, 19, 58; Tuozzo 1994, 535-6; Achtenberg 2002, 165 ff.; Whiting 2002, 173-4; Charles 2006, 27-9; Morel 2007, 132. For earlier commentators of this passage, see Hicks 1907, 527-8 (*ad* 431a8 ff.). For a full analysis of the passage see Corcilius 2011. The passage is difficult for a number of reasons, one of them being that it does not seem to stand in its original context (cf. Ross 1961 *ad loc.*).

The three-stage analogy is cashed out in section (ii), in which Aristotle explains feelings of pleasure and pain as the activity of the perceptual mean (αἰσθητικὴ μεσότης) with reference to what is good or bad for the animal. We learn that to feel pleasure and pain just *is* to perceive things which are good or bad for the perceiver. Although Aristotle does not say so, we propose to understand ‘the good’ and ‘the bad’ here in line with what we have said earlier, namely with reference to animal nature: good – and hence pleasurable – are those objects which are conducive to the bodily state in accordance with the animal’s nature; bad – and hence painful – are those objects which are disruptive of the bodily state in accordance with the animal’s nature.¹⁴ So the relation of the object to the present bodily state of the animal, which either is or is not in accordance with the animal’s nature, is what accounts for pleasure and pain. For instance, if the animal lacks food, it will experience pleasure when perceptually confronted with eatable objects, say a carrot in the case of a hungry rabbit, whereas it will not experience pleasure, but possibly even feel pain, when it is perceptually confronted with the very same object while in another bodily state, e.g. the state a rabbit finds itself immediately after having eaten many carrots. Observe, by the way, that this is an explanation not only of why the rabbit approaches a pile of carrots and eats them, but also why at one point he stops eating.

In section (i) of the above text Aristotle says that whenever the perception of an object is pleasant or painful, the soul of the animal engages in pursuit or avoidance. The ‘whenever’ (ὅταν) indicates regularity, i.e. it signifies that pleasant or painful perception is necessary and sufficient for the occurrence of the corresponding desire. And given that the animal has pleasant or painful perception depending on its bodily state, it is reasonable to suppose that what we get here is a mechanism of maintaining the body in the natural state – a homeostatic regulation mechanism, to put it in modern terms.

¹⁴ The view that the expression ‘what is good or bad insofar as they are such’ refers to perceptible things useful, preserving or beneficial for the animal can be found in the commentaries of Simplicius and Philoponus (*ad loc.*). Note that this does not imply an especially ambitious interpretation of the activity of the αἰσθητικὴ μεσότης. The activity of the perceptual mean is a technical expression for the activity of sense-perception (cf. *DA* II.11, 424a1-10; II.12, 424a32-b2; III.7, 431a19; III.13, 435a21-3).

In section (iii) it is said that ‘actual avoidance and pursuit’ are not different from each other, that their respective capacities are not different from each other, and that both of them are in some sense identical with the capacity of perception, yet different in being. Surely what it is to desire is different from what it is to perceive. To perceive, i.e. to be active with the perceptual mean, is to take on sensible forms of external objects. Depending on the state of the animal’s body, the animal will find some of these objects pleasant and others painful (and still others neither). To desire, in a non-rational way, is to be drawn and repelled by pleasant and painful objects respectively, and thus to be *preserving* the natural state of the animal. However, both perceiving and desiring are the work of the same thing, the ‘perceptual mean’. All of this, we claim, boils down to a convoluted expression of the mechanism of maintaining the body in the natural state. According to the interpretation proposed here, animals are built in such a way that their bodies react to perception of objects which typically contribute or disrupt their bodies’ natural state, and the way they react is by being drawn to or repelled by these objects.

Given this account of non-rational desire in Aristotle, we are in position to answer the question posed at the beginning of this section. As we have seen in the preceding section of our paper, perceptions are themselves alterations (in one way or another). These alterations can affect the body in different ways, depending on the objects that caused them and on the current state of the animal’s body. Namely, if the perceived object is conducive or detrimental to the bodily state which is in accordance with the animal’s nature, perceptual alterations will produce heatings or chillings. These bodily reactions to what is perceived are in fact feelings of pleasure and pain with the appetite for the pleasant and revulsion for the painful (*MA* 8, 701b33-702a2):¹⁵

Now the origin of motion is, as we have said, the object of pursuit and avoidance in the sphere of things that can be done. Of necessity the thought and *phantasia* of these are accompanied by heating and chilling – although we do not notice this when it happens in a small part – for the painful is avoided and pleasant pursued, and painful and pleasant things are almost all accompanied by some chilling and heating.

¹⁵⁾ In the immediate sequel of the text Aristotle will give examples for this: emotions, feelings and the experience of all bodily pleasurable and painful things, he says, are accompanied by heatings and chillings of the body.

In short, perception causes appetite and revulsion whenever the object perceived is either good or bad for the animal. To be something good or bad for the animal, in the simplest case, means to be conducive or detrimental to the bodily state in accordance with the animal's nature. An object which is good for the animal will in this way cause an appetite when perceived, and an object which is bad for the animal will cause a revulsion when perceived. Perceptual alteration brought about by the object, depending on the state of the animal's body, will react in such a way as to undergo heating or chilling. This heating and chilling is a means of preserving the body in the natural state, since they make the animal drawn to the pleasurable object and repelled from the painful object. The point here is that desire, in its simplest form, is a motion – that is a thermic alteration – in the animal body, and it comes about whenever the animal perceives an object which is conducive or detrimental to the bodily state in accordance with the animal's nature.¹⁶ Such a desire has no intentional content distinct from what is available to the animal through the senses. As we have seen, the appetite and revulsion are said to be identical with perception, though different in being, insofar as the appetite and revulsion involve an impulse towards or away from the perceived object.

We have the following causal chain:

object → perception (alteration) → pleasure and pain / desire (thermic alteration).

The object causes perception, which is itself an alteration, and this in turn causes thermic alteration, heating or chilling, which corresponds to the feeling of pleasure or pain as well as to the appetite or revulsion. On our account, there is only one irreducible event in this chain, and that is the perception of the object; this member of the chain can only be explained with reference to the soul of the animal, i.e. a soul that comprises a perceptual part. Beyond the fact that an animal has such a soul there is no further explanation one can give to the question what makes the alteration produced by the object a *perceptual* alteration, an alteration such that the

¹⁶ One might object that this commits Aristotle to thinking that each and every instance of pleasure and pain is intrinsically connected to what is objectively good or objectively bad for the animal, and that this cannot be correct, since there are many cases of animals going wrong as to which objects they desire and which they do not. What we say in Section 4 below explains why this objection is unfounded.

animal in fact perceives the object. The other members of the chain, by contrast, can be adequately explained with reference to the states and processes in the body of the animal. The animal feels pleasure upon perceiving the object and desires that object because, first, the object sets up a perceptual alteration in the animal's body, and second, its body is in such a state that certain thermic alterations naturally follow.¹⁷

Finally, it is important to mention that the thermic alterations caused by perception take place in the heart. Aristotle writes in the *De Partibus Animalium*: 'Motions of pleasures and pains and in general of all perception evidently originate there [in the heart] and proceed to it' (III.4, 666a11-12). The most plausible interpretation of this sentence is that it is the perceptual motions that go to the heart, whereas the motions of pleasures and pains go from the heart (although we have seen that Aristotle allows for the possibility of perceptual motions from the heart to the periphery too).¹⁸ The same point is made in *De Motu Animalium* 9 (702b20-5):

We say that the perceptual capacity is also there [viz. in the middle of the body where the *archē* of the moving soul is], so that when the place around the *archē* is altered because of perception and thus changed, the adjacent parts change with it, expanding or contracting, so that by these means motion necessarily comes about to animals.

We shall presently say more about the 'adjacent parts' and how they are changed by motions that go from the heart. Here we would like to conclude by formulating an answer to the question in the heading of this section. What happens at point A is that perception of some objects – namely, those objects which are conducive to the bodily state in accordance with nature and hence pleasant, or detrimental to the bodily state in accordance with nature and hence painful – causes thermic alterations which correspond to the feelings of pleasure and pain as well as to the appetite for what is pleasant and revulsion to what is painful. So feelings of pleasure and pain, together with non-rational desire, are bodily reactions to perceptual input in the form of heating and chilling in or around the heart.

¹⁷) As for the phenomenal character of the feelings of pleasure or pain which accompany the perception of objects that are good or bad for the animal, Aristotle could say that the animal is sensitive to thermic alterations that take place in the heart, given that the heart, in his view, is the proper sense organ of touch.

¹⁸) From point A to point B in the diagram on page 56 (above).

With this account of pleasure and pain and non-rational desire as a self-preservation (or 'nature-preservation') mechanism on the level of perceivers Aristotle accomplishes two things. First, he manages to introduce finality into the behaviour of animals: animals are naturally drawn towards their natural goals.¹⁹ Among the perceived objects, some are good and some bad for animals, and animals pursue the former and avoid the latter. Second, Aristotle causally accounts for the motor-processes involved in animal motion, since desire, on the simplest account, is nothing other than the natural tendency of the animal body to preserve itself in the natural state. The ultimate principle behind this tendency is, presumably, the nature of the animal as a source of motion, i.e. the soul of the animal, which is in fact defined as an unmoved source of motion (*DA* I.3, 406a2; II.4, 415b10-12); desire, by contrast, unlike the soul itself, is not only a source of motion, but is itself a motion, namely a thermic change in the body, which is capable of initiating a further chain of inner bodily motions that can ultimately lead to the dislocation of the animal as a whole. Thus Aristotle calls desire a *moved* mover (*DA* III.10, 433b16-18; *MA* 6, 700b35-701a1; 10, 703a4-5) – something he never does with reference to the soul.

2.3. *Motions from A to C*

We have argued that pleasure and pain and non-rational desire are thermic alterations in the animal body caused by perception of objects which are good or bad for the animal.²⁰ How do these thermic alterations cause the limbs of the animal to move? Thermic alteration, heating and chilling, is a type of qualitative change. What is needed for the motion of limbs to occur is transformation of qualitative change into mechanical impulse.

¹⁹ Without necessarily having to attribute to them especially 'practical' representations which make the perceived objects also appear to them 'as good' (as opposed to appear without qualification, as suggested e.g. by Nussbaum 1978, Essay 5, esp. 230-4; Furley 1978, 174 ff.; Labarrière 1984; Richardson 1992, 385, 395-6; Morel 2004, 173, 182). For a more detailed discussion on this point, see Corcilius 2011, 124 ff.

²⁰ See *MA* 7, 701b16-23: 'Alteration is caused by *phantasiai* and sense-perceptions and thoughts. For sense-perceptions are at once a kind of alteration and *phantasia* and thinking have the power of the actual things. For it turns out that the form conceived of the warm or cold or pleasant or fearful is like the actual thing itself. That is why we shudder and are frightened just thinking of something. All these are affections and alterations' (transl. Nussbaum, slightly modified).

Aristotle thinks that there is a special substance in the animate body whose function it is to provide precisely this transformation.²¹ This is the notorious ‘connate air’ (σύμφυτον πνεῦμα).

Before introducing it properly, in Chapter 10 of the *De Motu Animalium*, Aristotle mentions the connate air almost *en passant* several pages earlier (*MA* 7, 701b2-16):

The movement of animals is like that of automatic puppets, which are set moving when a small motion occurs: the cables are released and the pegs strike against one another; and like that of the little cart (for the child riding in it pushes it straight forward, and yet it moves in a circle because it has wheels of unequal size: for the smaller acts like a center, as it happens in the case of the cylinders). For they have functioning parts that are of the same kind: the sinews and bones. The latter are like the pegs and the iron in our example, the sinews like the cables. When these are released and slackened the creature moves. Now in the puppets and carts no qualitative change takes place, since if the inner wheels were to become smaller and again larger, the movement would still be circular. But in the animal the same part has the capacity to become both larger and smaller and to change its shape, as the parts expand because of heat and contract again because of cold when they change qualitatively.

Here Aristotle draws an analogy of the process of movement-causation in animals with the series of events, or a causal chain, at play in the seeming self-motion of automatic puppets. But what is of interest in our present context are the gaps in the analogy that Aristotle identifies. Unlike automatic puppets, animals undergo alterations, and additionally they have a part of their body which becomes larger and smaller due to these alterations (cf. 702b21-5). This part of the body, as we learn from Chapter 10, is connate air (*MA* 10, 703a6-10):

Now that which is moved but does not by nature impart motion can be affected by an external power, whereas that which imparts motion necessarily has some power and force. It is clear that all animals have connate *pneuma* and exert force with it.

Here, the ‘force’ provided by connate air is the mechanical force exerted by the expansion and contraction of connate air, not some new force miraculously created and injected into the physical world. Hence, connate air plays the role of a *converter* in the causation of animal motion, since it converts thermic alteration (heatings and chillings of pleasure and pain

²¹ So Berryman 2002, 93-7.

and desire) into pushing and pulling by way of contraction and expansion. For Aristotle, pushing and pulling (ὠσις καὶ ἔλξις) are the principles of all locomotion in the sublunary sphere.²² Hence the importance that Aristotle attaches to the function of connate air in his *De Motu Animalium* (10, 703a18-28):²³

And it [i.e. connate *pneuma*] is obviously well disposed by nature to impart motion and supply force. Now the functions of motion are pushing and pulling, so the instrument [of animal motion] has to be capable of expanding and contracting. And this is just the nature of the *pneuma*. For it is unforced when contracting, as well as force-exerting and capable of pushing for the same reason;²⁴ and it has both weight in contrast with the fiery stuffs and lightness in contrast with the opposite stuffs. That which is supposed to impart motion has to be such [viz. motion-imparting] without undergoing alteration. For the natural bodies overcome one another according to their predominance: the light is overcome and kept down by the heavier, and the heavy kept up by the lighter.

Connate air is the kind of body capable of transforming thermic alterations of desire into mechanical pushing and pulling. This is the decisive step towards the locomotion of the animal, since at this stage we find motions inside the body which are of the right sort to set limbs in motion. Thus another link is added to the causal chain:

²² *IA* 1, 704b22; *Phys.* VII.2, 243b12-244b22; cf. *DA* III.10, 433b25-6.

²³ In the *MA* Aristotle devotes almost an entire chapter to connate air (Chapter 10). Its importance, we take it, is not due to some special and immediate hylomorphic relation between the soul's intentional states (perception, pleasure and pain and desire) on the one hand, and connate air as the privileged instrumental body of the soul on the other, as argued for by Bos 2003. That this is not the right way to think about connate air is indicated by Aristotle's claim in the *MA* that the immediate causal antecedent of the expansions and contractions of connate air is neither 'perception' nor the alteration constitutive of perception, but thermic alterations which we identify with pleasure or pain and desire.

²⁴ We follow the mss. reading of 703a22-3 (καὶ γὰρ ἀβίαστος συστελλομένη καὶ βιαστική καὶ ὠστική), instead of Nussbaum's heavily emended text (καὶ γὰρ ἀβίαστος συστελλομένη <τε καὶ ἐκτεινομένη>, καὶ ἐλκτική καὶ ὠστική) which largely relies on Farquharson's conjectures based on slack manuscript evidence. One point of the received reading, we take it, is that *pneuma* is unforced when it contracts, i.e. its contraction is not a result of the pressure exerted on it by the adjacent parts, but of its being chilled; otherwise, *pneuma* would be pushed without performing any pulling. The other point is that *pneuma* exerts force by pressuring the adjacent parts on account of its expansion due to being heated.

object → perception (alteration) → pleasure and pain/desire (thermic alteration)
 → connate air's contraction and expansion (quantitative change)/pulling and pushing
 (mechanical impulse).

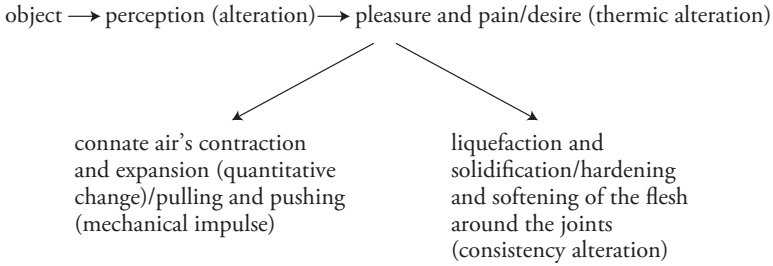
It is important to observe that desire's thermic alterations have other effects as well. Although not as dramatic as the expansion and contraction of connate air, these effects are of equal importance for animal motion. Desire's thermic alterations cause other kinds of alterations in the bodily parts surrounding the joints, presumably the flesh. These are alterations in the consistency of the flesh around the joints (8, 702a7-10):

Hence it is reasonable that the inner parts and those around the origins of the instrumental parts [i.e. the flesh around the joints] are constructed so as to change from solid to supple and from supple to solid, from soft to hard and *vice versa*.

The flesh around the joints must be able to become solid and hard in order to provide joints with the stable parts against which the mobile parts will move. 'For if one of the parts moves, there must be some part at rest,' Aristotle writes, 'and it is for that reason that animals have joints' (*MA* 1, 698a16-17).²⁵

With this bifurcation of the causal effect of desire's thermic alterations into connate air's pushing and pulling on the one hand, and the flesh's going liquid and soft or solid and hard on the other, all the necessary conditions for the mechanical motion of the limbs are met. Thus we get the following causal chain:

²⁵ Aristotle thinks that all bodies, insofar as they are bodies, must have some quality on the scale hot-cold, some quality on the scale hard-soft, and some quality on the scale dry-wet. So a body *qua* body can undergo three kinds of qualitative change or alteration. Interestingly, all three kinds are present in Aristotle's model: the heart undergoes thermic alteration, the flesh around the joints undergoes the remaining two kinds of alteration (liquefaction-solidification, softening-hardening). And apart from the qualitative changes, the other kinds of change are also present in the model: connate air undergoes quantitative change (expansion and contraction) and the limbs undergo change of place.



Aristotle does not say much about further steps in the causal chain leading to the motion of limbs and displacement of the animal. However, we can easily conjecture that, once the region around the joints is appropriately solidified and hardened, such that the limbs of the animal can be successfully supported against them, connate air operates on the sinews and other bodily parts by pushing and pulling so that the animal as a whole can move from one place to the other. This is hinted at *De Motu Animalium* 7 (701b2-10):

The motion of animals is like that of automatic puppets, which are set moving when a small motion occurs: the cables are released and the pegs strike against one another . . . For they [viz. animals] have functioning parts that are of the same kind: the sinews and bones. The latter are like the pegs and the iron in our example, the sinews like the cables. When these are released and slackened the creature moves.

In order to tighten and relax the sinews that operate on the bones, the animal needs to develop mechanical force. This is achieved by the pushing and pulling of the connate air in cooperation with the hardening or softening of the flesh around the joints such that a stable supporting point is either formed or dissolved.

Aristotle mentions that 'a small change occurring in an origin sets up great and numerous differences at a distance, just as, if the rudder shifts a hair's breadth, the shift in the prow is considerable'.²⁶ Clearly, Aristotle is committed to the view that the mechanical impulses generated in the

²⁶ *MA* 7, 701b24-28 (tr. Nussbaum); cf. 701b2.

heart somehow get amplified at the periphery. The tiny sinews in the heart may get pulled and relaxed in a certain combination, thus generating a mechanical impulse, but this could hardly suffice to move the entire leg. Aristotle does not explain how the amplification of the mechanical impulse is achieved, but he must have thought that some sort of leverage mechanism was at work. This is suggested in *Physics* VIII.6, where Aristotle says that the soul moves the body by leverage: ‘The cause of moving oneself is moved by itself, albeit only accidentally. For the body changes place, so that what is in the body also changes place, moving itself by leverage’ (259b17-20). A lever is what enables ‘great weight to be moved by a small force’²⁷ and it was exploited widely, in various forms, by ancient engineers. No doubt it was used in automatic puppets to which animals are compared in the quoted passage, and this analogy probably contributed to Aristotle’s belief that animal bodies contain parts that exploit the lever principle, so that the small mechanical impulse in the heart can produce large movements of the limbs.

Much more can be said about the physiological details of Aristotle’s account of animal motion,²⁸ but for our present purpose it is important to note that the whole process of animal motion consists of a continuous causal chain of events in which perception has a central role. If the right sort of object is perceived and the animal’s body is in a certain sort of state, nothing further is needed for the animal to displace itself:

For the affections [i.e. the hardening and softenings of the flesh around the joints] suitably prepare the instrumental parts [i.e. the limbs], desire the affections, and *phantasia* the desire; and *phantasia* comes about either through thought or through perception. (*MA* 8, 702a17-19)

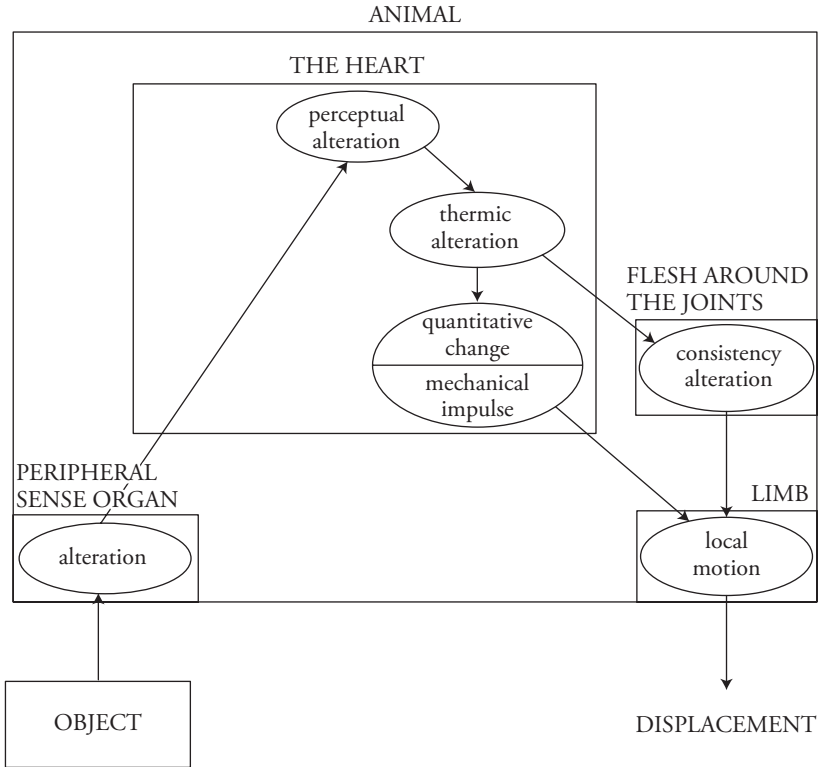
In short, the animal body is set up in such a way as to respond to objects that are typically good or bad for the animal, and this response triggers a chain reaction which crucially includes the conversion of thermic alterations into mechanical impulse.

* * *

²⁷⁾ Ps.-Aristotle, *Mechanica* 847b2, 850a30-2, 853a38.

²⁸⁾ This is the subject of Gregoric and Kuhar *forthcoming*.

Having answered all three questions, we are now able to spell out the basic schematic description of the CIOM model, specifying all the links in the causal chain:



Obviously, the model crucially relies on the idea of transformation of motion: the external object causes alteration in the peripheral sense, this alteration is transduced to the heart via ‘channels’ and blood vessels. In the heart, this alteration becomes a *perceptual* alteration. If the perceptual alteration is caused by an external object which is good or bad for the animal, the perceptual alteration in the heart causes thermic alteration, and this thermic alteration has a double effect: contraction and expansion of *pneuma* (quantitative change), and solidification-hardening and liquefaction-softening of the flesh around joints (consistency alteration), which

combine to produce the mechanical effect of local motion of the limbs that allow the animal to displace itself.

This model seems quite intuitive. Perhaps it can be traced back, at least on the side of incoming motions, to Plato's *Timaeus*, in which perceptions are explained as motions that travel through the body and reach the circles of the soul in the head, or even to the Hippocratic *De Morbo Sacro*, where the breakdown of perceptual and motor functions in epileptic seizures is explained in terms of the inability of the air – which carries sensory and motor impulses – to access the central organ, the brain. More to the point, we find a similar model in contemporary neuroscience. Very briefly, the bodies of vertebrates include peripheral receptors sensitive to various kinds of stimuli from the environment, the system of sensory neurons which transduce the impulses by means of a chain of chemical and electromagnetic changes, and the brain as the central organ from which further chains of chemical and electromagnetic changes in the system of motor neurons bring about contraction or expansion of skeletal muscles in the limbs. We shall outline some further similarities between the two models in the following pages, but before that we should like to say something about the way Aristotle introduces the soul and intentionality into his model.

3. The Unextended Internal Supporting Point

We know from the beginning of the *De Motu Animalium* that animals, in order to move from one place to another, require two supporting points, one external, e.g. the ground on which they can stand and support themselves (in walking animals), and the other internal.²⁹ The external supporting point of animal motion is something that we can take for granted, since it is trivial that animals need to support their limbs against some external prop if they are to move at all. The internal supporting points are the joints, or more precisely the unmoved parts of the joints which occasionally form to serve as props for appropriate movements of the respective limbs. However, the unmoved parts of more peripheral joints may themselves be moved when larger portions of the body are moved, e.g. the unmoved part of the wrist, required for the motion of the hand, is moved when the whole forearm moves, the unmoved part of the elbow, required

²⁹ *MA* 1, 698b1-7 and 2, 699a8-10.

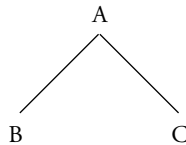
for the motion of the forearm, is moved when the whole arm moves, and so forth.

Aristotle proceeds on the assumption that the principle of animal motion must be in some internal supporting point. It cannot be in any of the joints, however, since none of the joints has an absolutely unmoved part, a part which could not be moved with a larger part of the body, or as Aristotle puts it, ‘an origin which is not the end of something else’ (*MA* 8, 702b6-7). Even the heart, located in the centre of the body, cannot be the sought internal supporting point (*MA* 9, 702b28-703a1, tr. Nussbaum):³⁰

Suppose, for example, that in the figure ABC B is moved, and A imparts movement. But there must, however, be something at rest, if one is to be moved and the other to impart motion. Then A, though potentially one, becomes two in actuality, so that it must be not a point but some magnitude. Again, C may be moved simultaneously with B, so that both of the origins in A must of necessity impart motion while being moved. Then there must be something else besides these that imparts motion but is not moved. Otherwise the extremities or origins in A would support themselves against each other when movement takes place, just like men who stand back to back and move their legs.

In this passage Aristotle invites us to imagine a case in which two sides of the body are simultaneously moved, say the left and the right shoulders and arms, corresponding to lines AB and AC in the diagram. The only way AB and AC could be moved simultaneously is if we imagine that they are moving in exactly the opposite ways with equal force, so that the motion of one could be used as the supporting point for the motion of the other (‘just like men who stand back to back and move their legs’).³¹ However, since we can clearly move left and right shoulders and arms simultaneously

³⁰⁾ For convenience we add the illustration from p. 56 above.



³¹⁾ Nussbaum thinks that this passage has a teleological dimension such that it can account for the ‘animal’s unified, coordinated pursuit of a goal’ (Nussbaum 1978, 372). We cannot see any hint at teleological concerns in the passage, though. To us it seems that the argument here is entirely ‘mechanical’.

in all sorts of ways, what is needed is an absolutely unmoved supporting point. Obviously, neither the heart nor any other extended part of the body can do the job. And since no extended magnitude can do the job in the case of simultaneous motion of two sides of the body, Aristotle thinks that the internal supporting point must be *unextended* (*MA* 9, 703a1-3):

But there must be some one thing³² that moves them both, and this is the soul, being distinct from a magnitude of this kind, yet being in it.

So Aristotle thinks, quite generally, that it is the *soul* which moves the animal, since only the soul can be the unextended and absolutely unmoved internal supporting point required for animal motion. Of course, there are many questions that might be raised in connection with this argument. Is an unextended supporting point really necessary for the simultaneous motion of the right and the left half of the animal body (or is the argument schemed in order to introduce the soul)? How can an unextended entity be located *in* any part of the body? How can an unextended entity be said to play the mechanical role of a supporting point?

We propose to make as much sense as possible of Aristotle's text by assuming that the unextended internal supporting point of animal motion is not the soul conceived as an organized set of capacities, but as the activity of perceiving (or having an appearance of) a pleasant or painful object. That is, the unextended and unmoved internal supporting point of animal motion is the inner representation of the goal of the animal's motion, what the animal 'has in mind', as it were, when moving towards a pleasant object it craves for, or moving away from a painful object it loathes. In other words, the intentional state of the animal, i.e. the activity of its soul – be it perception or appearance of a pleasant or painful object – provides a pivot upon which the mechanism 'hangs', or around which it 'turns'.

One may object that this is metaphorical speech, and that is – at least to the modern reader – partly correct. However, the metaphor points to one crucial point which can hardly be expressed otherwise within the Aristotelian framework. The alteration in the heart which is produced by an external object and which on its part brings about thermic alteration and its

³²⁾ We accept Nussbaum's reading (ἀναγκάϊον ἐν), supported by Moerbeke's Latin translation, although we have sympathies also for Jaeger's emendation ἀκίνητον ἀναγκάϊον ('that which moves them both must be of necessity immovable').

subsequent mechanical effects, is not a *mere* alteration, but an alteration with intentional dimension. This integration of the activity of the soul on the level of episodes is highlighted by Aristotle more than once in his *De Motu Animalium* when he says that the alteration which gives rise to the chain of inner motions described above must be of such a kind as to be produced *in virtue of perception*.³³ It is precisely this alteration with intentional dimension – be it perception or appearance – that makes a world of difference. Without it, the motion of an animal would be no different from the heliotropic motion of a sunflower; the incoming motions would be extended into outgoing motions in a more or less simple mechanical way. In cases of animal self-motion, however, the incoming motions rebound, as it were, at a point which marks their transformation into outgoing motions, and that point is the soul's activity of turning certain alterations in the body into alterations with intentional dimension. Could one not, then, describe this point from which the incoming motions 'rebound' to produce outgoing motions resulting with the animal's displacement – as an internal supporting point of animal motion?

This, we take it, is what Aristotle is getting at when he introduces the soul into the story of the mechanics of animal motion. That is what distinguishes a mechanism lit by intentionality from a blind mechanism that characterizes inanimate and insensitive entities. Although one can accuse Aristotle of introducing the light of intentionality in a miraculous or irreducible way, according to our interpretation it is introduced at one single point, namely at the point of perception.

Observe that the introduction of intentionality into the CIOM model again has a parallel in our contemporary model, to the chagrin of many reductivists. When the impulses from the peripheral receptors reach the relevant centres in the brain, they are interpreted in an appropriate way before the chemical and electromagnetic changes in motor neurons lead to contraction or expansion of skeletal muscles in the limbs. Today we know that there are electrochemical processes in definite parts of the brain which underlie this 'interpretation', but how this happens remains a mystery.

³³) κινεῖται γὰρ καὶ πορεύεται τὸ ζῷον ὁρέξει ἢ προαιρέσει, ἀλλοιωθέντος τινὸς κατὰ τὴν αἴσθησιν ἢ τὴν φαντασίαν (MA 6, 701a4-6); οὕτως μὲν οὖν ἐπὶ τὸ κινεῖσθαι καὶ πράττειν τὰ ζῷα ὁρμῶσι, τῆς μὲν ἐσχάτης αἰτίας τοῦ κινεῖσθαι ὁρέξεως οὔσης, ταύτης δὲ γινομένης ἢ δι' αἰσθήσεως ἢ διὰ φαντασίας καὶ νοήσεως (MA 7, 701a33-5); cf. *De Anima* III.10-11.

Somehow consciousness kicks in. However, consciousness introduced in the model operative in contemporary neuroscience is arguably a more global and diffuse phenomenon than perception introduced by Aristotle in his CIOM model. If one has to introduce magic, it is best to do so in as few and as simple strokes as possible. Even a reductivist will applaud this principle of economy and concede that Aristotle's theory, as we interpret it, performs very well on that score.

The idea that the soul plays a mechanical role may not be, after all, envisaged as a metaphor by Aristotle himself. Judging from his arguments in *De Motu Animalium* 2-4, the extension of the mechanical explanation to include intentionality is also fundamental on a large, cosmological scale: the unmoved mover of the rotation of the outmost celestial sphere seems to be the ultimate immaterial and unextended supporting point upon which the motion of the whole universe hinges, in a more or less literal way. And again it is crucial for Aristotle's cosmological account to establish, as he does in *Metaphysics* Λ.7, that the first unmoved mover is not a capacity, or a set of capacities, but a perfect and perduring activity. What follows from this is that Aristotle has a broader, more metaphysical conception of the 'mechanical' than we have, a conception which is not in every case coextensive with the 'materialist' or 'reductivist'.

4. More Complex Cases

As we have argued, animals are able to extend the existent causal chains because they have souls which allow them to perceive and thence to react to objects in their environment in accordance with their nature. Animals are not 'merely reacting' to their environment, as plants or inanimate objects do. Rather, perception enables animals to react to their environment discriminately, in an informed way. This is the crucial and, we have argued, the only point at which intentionality enters the picture. According to Aristotle, part of what it is to have perception is to be able to respond to objects which are good or bad for the animal. This is done in a bodily way, notably by heatings and chillings in the central organ, which we have identified with the feelings of pleasure and pain coupled with appetite and revulsion, respectively. The animal has to be able to respond in some such way, because it has a nature (soul) and a body with the tendency to keep itself in the state which is in accordance with the animal's nature. And this, as we have seen, introduces finality into the causal circuit, via

animal natures. Animal natures determine *objectively* the goals of animal motion – the preservation of the bodily state of the animal in accordance with the animal's nature – and with this also *subjectively* determine which things in the environment of the animal are pleasant or painful for it and hence to be pursued or avoided.³⁴

Nevertheless, it remains true that in the simplest cases of animal motion, animals are bound to react, upon perceiving food or threat, by pursuing one and avoiding the other. The fact that they identify food or threat by perception hardly makes them any less deterministic or predictable than sunflowers turning towards the sun or rocks rolling down a slope. Now should this observation be understood as a challenge to our account, we would say two things in response. First, there is no reason to suppose that self-motion applies only to systems which are indeterministic and unpredictable. Humble organisms have very simple and predictable patterns of behaviour, yet Aristotle would regard them as self-movers nonetheless. Second, the CIOM model is not restricted to the simplest cases of animal motion, but applies likewise in more complex cases with increasing degrees of indeterminism and unpredictability. This is what we would like to show, if only with unduly broad strokes, in the present section.

Many animals, if not all, have the ability not only to perceive objects around them, but also to have things appear to them.³⁵ Things may appear to animals while the objects are present to their senses or after they are gone, shortly after, as in the case of after-images, or long after, as in the case of memory and dream-images. This is because alterations set up in the peripheral sense organs by external objects have causal powers. So much we have learnt from the earlier quoted passage from *De Insomniis* 2, 459b1-7. This is what Aristotle calls *phantasia*, or the capacity to have appearances which are direct or indirect causal descendants of perceptions.³⁶ An animal to which things can appear, including things which are not really there at the moment of appearing, can feel pleasure and pain and be drawn towards

³⁴ This is not to say that *pleasure* is the goal of an animal's desire. It is, as we have seen, the necessary and sufficient condition of desire, not necessarily its goal.

³⁵ It is controversial whether all animals, according to Aristotle, have *phantasia*; cf. Lorenz 2006, 138 ff. He attributes at least rudimentary *phantasia* to all animals capable of locomotion; cf. *DA* III.11, 433b31-434a5.

³⁶ How exactly Aristotle conceived of *phantasia*, its relation to perception, its operation and functions, are widely debated questions; see e.g. Schofield 1978; 2011; Nussbaum 1978, Essay 5; Labarrière 1984; Wedin 1988; Caston 1999; Lorenz 2006.

or repelled from any number of objects other than those which really are there and really are of the sort conducive or detrimental to the bodily state in accordance with the animal's nature. This is possible because appearances, *phantasmata*, borrow their causal powers from their causal ancestors, the perceptions to which they go back, directly or indirectly, with or without modifications of the content of original perceptions. These appearances are alterations as well, very much like the perceptual ones, and hence they can cause the same bodily reactions. When Aristotle writes at *MA* 7, 701b18-19, that *phantasia* 'has the power of objects' we take him to mean that *phantasia* can supply intentional content independently of, or in the absence of, actual objects available to perception.³⁷ And since this intentional content comes with alterations in the central sense organ, they can cause heatings or chillings and thus trigger animal locomotion as described above.

Thus *phantasia* brings with it a significant emancipation from causal determination by the animal's immediate environment available to perception. Animals in possession of *phantasia* are spontaneous in the sense that they can move even if the objects actually available to their senses are not really good or bad for them but only appear so, or even in the absence of any available object. Spontaneity of such animals arises from partial independence of what appears to an animal from what is perceived by it, as well as from the possibility of a delayed onset of appearances. However, the very same causal explanation applies to animal movements caused by appearances and by perceptions: both are initiated by the heatings and chillings caused by perceptions of good and bad objects, since even the appearances of good and bad objects trace their causal origin back to perceptions (*MA* 7, 701b17-23; *MA* 8, 702a5-6; *Phys.* VII.3, 247a8-9; *Mem.* 2, 452a1-2).

More developed animals are able not only to have things appear to them, but also to retrieve the residual appearances in a certain way or in a certain sequence. This ability, Aristotle calls it memory, enables an animal to recognize objects and situations, to associate what it currently perceives with what it has experienced in the past. In addition, more developed animals can associate what they currently perceive with a whole chain of things experienced in the past, which adds to the complexity of their behaviour. For example, a hungry dog can go behind the corner to the

³⁷ See also *MA* 8, 702a5-7; *Phys.* VII.3, 247a6-19.

butcher's shop because it remembers going there from its present location and being amply fed. This increases the degree of emancipation from causal determination by objects available to perception. Again, since memory operates by means of appearances, remembering something has the same causal powers as having something appear to one, and thus memory further expands the range of possible behaviours of an animal, again in full conformity with the CIOM model.

With the intellect (*νοῦς*) we reach the peak of emancipation from the world of perceptible objects. As is well-known, Aristotle maintains that thinking depends on *phantasmata*, i.e. on residual appearances.³⁸ It depends on *phantasmata* as the representational devices which enable thinking to take place in the human being, and it is through the *phantasmata* that the noetic content has causal powers. This mechanism is very much the same as the one that we have already mentioned in the case of appearances with delayed causal effects in animals which have the capacity of *phantasia*. For, since the residual appearances preserve not only the content but also the causal power of the perceptions which originally brought them about, the residual appearances which serve as representations of the noetic content can cause heatings and chillings in the animal in the same way as the residual appearances which represent perceptual content. The difference is, of course, that the former do not *represent* perceptual objects but objects of thought, e.g. universals, relations, possible states of affairs. Because the noetic content requires appearances, and appearances have their causal powers borrowed from the objects that engendered them, thoughts enter into the circuit of change in the physical world without themselves being a part of the physical world. This is, in a nutshell, why the problem of interaction does not arise for Aristotle, and that without making him a reductive materialist.

Aristotle thinks that humans are also able to manipulate residual appearances in all sorts of ways, e.g. to rearrange them, reconfigure them, or to fuse a plurality of appearances into a single appearance (*DA* III.11, 434a5-10). Moreover, humans are capable of assigning conventional and symbolic meaning to the residual appearances (*Int.* 1) which have little or nothing to do with the causal origin of these appearances. The ability to

³⁸) *Mem.* 1, 449b31-450a1; *DA* I.1, 403a8-10; III.3, 427b14-16; III.7, 431a16-17, b2; III.8, 432a8-10.

communicate and understand complex ideas is crucial for human dealings, just as the ability to discern causal relations is crucial for human action.

Of course, there is much more to be said about all this. The point we would like to make, however, does not require agreement on every detail. And the point is the following. Greater cognitive capacities introduce a greater degree of independence, as far as animal motion is concerned, from the immediate environment in which the animal finds itself. With this independence comes a greater degree of indeterminacy and unpredictability of animal behaviour. Human behaviour seems indeterminate and unpredictable to the highest degree, so much so that it has led some people to believe that human souls are radical self-movers in the sense of initiators of new causal forces into the natural world. Aristotle resists the temptation. If our interpretation is correct, he would explain a high degree of indeterminacy and unpredictability of human behaviour with reference to the rich cognitive abilities that humans possess, abilities which enable them to represent, for example, future actions and reactions of other human beings or possible states of affairs and – via their awareness of causal relations – the means of making them obtain, and to move themselves accordingly. Furthermore, rationality enables humans not only to set themselves goals which lie far in the future, but also to reassess their goals over time, that is, to rethink their conceptions of what is good or bad for them. Compared to the simplest cases of animal motion, this is an explosion of complexity of motion. However, the underlying causal mechanism in the case of the most humble as well as of the most developed animal is the same, namely the one embodied in the CIOM model.³⁹

5. Further Advantages of the Model

Apart from providing Aristotle with a single model of explanation for animals displaying a range of different cognitive abilities and modes of behavior, there are two further advantages of the CIOM model which we would like to mention. First, it is important to observe that rich cognitive abilities allow human beings only to modify causal chains in new and unpredictable ways, not to inject new causal chains in the world. Otherwise,

³⁹ In this we differ from Furley (1978), who thinks that there must be a qualitative difference between the account of the motions of simpler animals on the one hand and humans on the other. This is justly criticized by Freeland (1994, 38-9).

Aristotle's arguments in *Physics* VIII for eternity of motion and the existence of one eternal and unmoved mover would be undermined. Very briefly, Aristotle's worry is this: if animals were radically spontaneous self-movers that inject entirely new causal chains into the world – as Plato is likely to have thought – one might suggest that motion in the world was generated in the same way, with the implication that motion is not eternal. Moreover, since Aristotle's argument for the necessary existence of one, eternal unmoved mover seems to require that all causal chains ultimately go back to the unmoved mover, he is committed to discarding the idea that animals cause new causal chains. In other words, if there were some causal chains that can be traced back only to animals or their souls, the existence of one eternal unmoved mover would no longer be necessary.

On the other hand, Aristotle does not want to claim that animals merely react to causal chains in the world, because that would amount to a denial of self-motion. Although some philosophers might not oppose that idea, e.g. the atomists, Aristotle sides with the more intuitive view that animals are self-movers. So the challenge is to find a middle position, one in which animals are indeed self-movers, as most people tend to think, yet not such as to inject new causal chains. This challenge, we argue, is met by the CIOM model according to which animals are self-movers in the sense of being modifiers of causal chains on account of their cognitive abilities. Depending on the range of their cognitive abilities, animals transform incoming motions into a variety of outgoing motions, with or without delay, in relation to real or fictional things, things present to their senses or things imagined in the future, in predictable or surprising ways.

Apart from allowing Aristotle to explain animal motion without jeopardizing either his cosmological assumptions or the phenomenon that animals are self-movers, the CIOM model offers yet another advantage. It enables Aristotle to distinguish voluntary from non-voluntary and involuntary motions. Non-voluntary motions – such as breathing, growth or sleep – are explained in terms of ordinary physiological causality, i.e. without any intentional input or desire ('neither *phantasia* nor desire is in control of these', *MA* 11, 703b10-11). These are the processes which the body of an animal undergoes in interaction with its environment on account of the vegetative capacities of the soul. Involuntary motions – such as erections or leapings of the heart –⁴⁰ seem to be a reasonably small

⁴⁰ The expression ἡ [sc. κίνησις] τῆς καρδίας at 703b6 could refer to the regular heart-beat, but this does not seem to be the case here, as that would clearly belong among

but apparently problematic class of motions. Such motions are restricted only to a few bodily parts, namely the heart and the reproductive organs, and they seem to be problematic because such motions are caused by intentional input but against one's desire ('when something appears (φανέντος τινός), but without the command of thought', 703b7-8). There is little or nothing one can do about such motions. Following Plato, who introduced the problem of involuntary motions in the *Timaeus* (91a1-d6), Aristotle argues that involuntary motions happen in those parts of the body which resemble separate animals within an animal. It is as if these bodily parts have different tendencies or priorities from the animal's body as a whole, and hence they can occasionally react differently to a given intentional input from the rest of the body.

It is precisely in response to the problem of involuntary motions that Aristotle introduces the quoted description of the CIOM model in *De Motu Animalium* 11 (703b26-35) that we took as our starting point in Section 2 above. The sentence which immediately follows the passage we quoted there introduces a new element (703b35-704a2):

As for the fact that the same thoughts sometimes bring about motion against reason in the parts and sometimes not, the cause is that sometimes the passive matter is present in the right quantity and quality, and sometimes not.

Whether an intentional input gives rise to involuntary motion or not depends on the quantity or quality of 'the passive matter' (παθητικὴ ὕλη). This 'passive matter', we take it, refers primarily to the constituents of and around the heart that undergo chillings and heatings, but they may refer also to other bodily components involved in animal motion. If passive matter is not of the right quality or quantity, perceptual or representational alterations will bring about chilling or heating in or around the heart with ensuing motions of the relevant bodily parts, but this will be done in a more reactive fashion, passively, without a proper link to the content of perception or representation.⁴¹

non-voluntary motions in Aristotle's division. It is more likely that Aristotle has in mind something like Plato's 'pounding (πῆδησις) of the heart which occurs when one expects what one fears or when one's spirit is aroused' (*Timaeus* 70c1-2). See also *Juv.* 26 (20), 479b17-26; Nussbaum 1978, 383; Preus 1981, 99; Kollesch 1985, 62; Morel 2004, 170-1.

⁴¹) Most commentators take the view that some sort of non-rational desire is involved in involuntary motions; e.g. Nussbaum 1978, 382; Charles 1984, 104; Morel 2004, 172, 182.

Whatever the details with involuntary motions may be, Aristotle clearly explains it with reference to the physiological concomitants of the CIOM model. Incoming perceptual motions go to the centre, and if the passive matter in and around the centre is not of the right quantity or quality, they will set up some outgoing motoric motions. However, in such cases, Aristotle seems to think, the motoric motions do not really originate in the centre (*MA* 11, 703b34-6):

But [motion] from B to C goes by going first from B to A, as to an origin (ὡς ἐπ' ἀρχήν), then from A to C, as from an origin (ὡς ἀπ' ἀρχήν).

Although the text is not as clear as one would wish, Aristotle seems to think that the heart is not really the origin of involuntary motions, but only a quasi-origin, or a centrally-located passing station.⁴²

If that is correct, we can state the following. In the case of voluntary motions, the flow of the incoming and outgoing motions is modified in the right way, namely by intentional input (the activity of the soul in perceiving or representing a given object) causing the right sort of bodily reaction (a desire for the object of perception or representation), which in turn causes further bodily processes, as outlined above. Only in such cases is Aristotle willing to grant that animal motion originates from the heart. Non-voluntary and involuntary motions, by contrast, do not originate in the heart, but only pass through it. Such motions, Aristotle seems to think, originate in the environment.

In that case, however, what would be the distinction between voluntary and involuntary motions? Should one reply that the distinction is to be sought in the cases in which non-rational desire is opposed to rational desire, we would be dealing with cases of *akrasia*. However, Aristotle denies that *akratic* behaviour is involuntary (*NE* VII.2-3, 1145b34-1146a4; VII.10, 1152a15-16). We would grant that the alterations causing involuntary motion of the heart and reproductive organs might be considered 'desires' of these bodily parts as 'separate animals', which might be sympathetic to one's Freudian intuitions, but we would insist that these alterations are *not* desires in the technical sense operative in Aristotle's theory of animal motion.

⁴² This quasi-origin role of the heart in the case of motions that go from B to C or from C to B *through* A as a passing station of motions that originate outside the animal is indicated by Aristotle's use of ὡς only in these cases (see 259b7-14). That Aristotle must be speaking about involuntary motions here is clear from the immediately following sentence, quoted above: 'As for the fact that the same thoughts sometimes bring about motion against reason (παρὰ τὸν λόγον) in the parts and sometimes not' (703b36-7).

This adds to the explanatory power of the CIOM model, since it can serve to show not only that the region of the heart is the centre of incoming perceptual motions and outgoing motoric impulses, but also allows Aristotle to distinguish voluntary from non-voluntary as well as involuntary motions by claiming that, in the case of voluntary motions, the *origin* and the principle of animal motion is in the centre. Or, to be as precise as possible, the unextended and absolutely unmoved soul-principle of animal locomotion is in the heart as the centre of incoming and outgoing motions.

6. How does the soul move the animal?

According to the model presented here, the activity of the soul in providing perceptual awareness, to stay with the simplest cases, is crucial in two respects. First, it is crucial because motions from B to A are perceptual motions only in virtue of the fact that they reach A and, secondly, because motions from A to C are desires that trigger voluntary motions only in virtue of the fact that they originate in A. Thus, A is the center of incoming and outgoing motions, that is a center of both receptivity and spontaneity of the animal.⁴³ We said that Aristotle conceives of this center as an unextended point, which we took to imply that the activity of the perceptual soul is not to be understood as a process in addition to the physical motions that the animal body undergoes. Rather, the activity of the soul is that point in this physical process at which perceptual awareness kicks in.⁴⁴ We claim, then, that the activity of the soul, understood as one or a series of episodes of awareness of perceptible qualities, is literally a part of the causal history of animal motion.

This claim is likely to provoke questions. How can the activity of the soul be a literal starting point of animal motion, if the soul is, as Aristotle emphasizes over and over again, immobile and unextended? We suggested a way of thinking about the role of the soul as an efficient cause according to

⁴³ As the heart, where the soul is said to be primarily located, is the part in which both perceptions and motor impulses (*kinēseis*) originate (*PA* II.1, 647a25 ff.).

⁴⁴ Aristotle makes no attempt at reducing perceptual awareness to mere *kinēsis*, i.e. it is not the case that for him the awareness of a perceptual quality is a process (*kinēsis*) separate from the qualitative change in the heart that is causally necessary (and perhaps sufficient) for the act of perception.

which it is not required for the soul to do any pushing or pulling. Rather, the soul is the unmoved point which turns certain motions in the body into perceptual motions that in turn spawn other motions in the animal's body and make the animal displace itself. Given that the animal's body is set up as a self-preserving mechanism, it is really the animal's *body* that reacts to perceptual input by heatings and chillings in the heart – if it stands in the right sort of relation to this input. This relation can be described objectively, as the input which informs the animal of things and events in its environment which are good or bad for it, or subjectively, as the input which is pleasant or painful and hence desired or abhorred.

In this picture, the soul's activity is related to the ensuing motor processes in the animal body analogously to the way in which the carpenter's knowledge of his art, when it is actualized, triggers his house-building motions. Without some such actualized piece of knowledge, the carpenter would not know which motions need to be undertaken in accordance with the art of carpentry, and hence he would either remain still or, if he were to move, he would not be moving *as a carpenter*. Similarly in our case: without an awareness of an object in its environment, either no motor processes would occur in the animal's body, or, if some motor processes were to occur, they would not amount to the *animal's* motions, but – as we have seen in the case of non-voluntary and involuntary motions – motions that go through the animal's body, but originate elsewhere, namely outside the animal's body.

We should add, however, that the whole process in fact involves a double function of the soul, as an efficient as well as a formal and final cause. Apart from being the efficient principle of the ensuing motor processes, the soul enters also as the structuring principle that defines the natural state at which the animal's self-preserving motions aim. In this role as a formal and final cause, the soul is not taken as an actuality, but as a set of *capacities* that formally defines the animal. In the role of the efficient cause, by contrast, the soul is taken as an *actuality*, in the most simple cases as episodes of perceptual awareness. Again, the comparison with the carpenter case may be useful here. The art of carpentry can be regarded, and is in fact regarded by Aristotle, as both a formal and an efficient cause of building a table, but surely it is the art of carpentry understood as a system of rules and procedures that is the formal cause of tables, and it is the art of carpentry understood as the episodes of awareness of the rules of the art and their application that is the efficient cause of tables.

This distinction allows us to tackle one large problem in Aristotle's theory. We have seen that the CIOM model is eminently cardiocentric. It sits well with a number of passages in Aristotle's biological writings which assign a special place to the heart. A notable example is *De Motu Animalium* 10, 703a29-b2, in which Aristotle compares the animal to a city well governed by law. There he suggests that the heart stands in a privileged relation to the soul, whereas the other parts of the body perform their functions on account of being attachments to, or literally 'outgrowths' from, the heart. One wonders how to reconcile Aristotle's cardiocentric claims with the more familiar view from *De Anima* II that the soul is the form of the living body as a whole ('holistic hylomorphism'). If the soul is in the heart and other parts do their vital activities by virtue of being attached to the heart, how can it also be true that the soul is the form of the whole body? That is, if the soul is the form of the *whole* body, does that not exclude the possibility that there is *no* soul in parts of the body other than the heart?

Some authors have thought that cardiocentrism and holistic hylomorphism are incompatible, so they resorted to the developmentalist thesis.⁴⁵ Others have convincingly argued that Aristotle took them to be compatible, showing that there are single passages in which Aristotle seems to advocate both views.⁴⁶ However, attempts to show precisely how they can both be true have been few and, in our view, not particularly successful.⁴⁷ We believe that our discussion of the CIOM model provides us with a means of showing how Aristotle can advocate both cardiocentrism and holistic hylomorphism.

We have seen that the cardiocentric CIOM model has to do with the soul's role of the efficient cause of animal motion. The crucial part of the story of transformation of incoming and outgoing motions is this: certain motions that arrive to the heart are turned into *perceptual* motions or alterations due to the soul's activity. It is only on account of that part of the story that the soul can be said to move the animal, rather than the external objects. However, all along the soul is also playing the role of the nature of the animal, that is its formal and final cause. The soul structures the animal

⁴⁵ Nuyens 1948, 55, 247; Mansion 1948, pp. ix-x; Ross 1957, 65-7; Louis 1973, pp. xvii-xviii.

⁴⁶ One excellent example is *Metaph.* Z.10, 1035b14-31 adduced by Block 1961, 57; see also Hardie 1964.

⁴⁷ Here we have in mind Tracy 1983 in particular.

body in such a way that it can support and exercise a set of capacities characteristic of that kind of animal. And the preservation of these capacities, at the level of the individual as well as the species, is the final cause of the animal. In this role of the formal and final cause of the animal, the soul is not taken in the sense of an episode of a certain sort of activity, but rather as a set of certain capacities. Hence, cardiocentrism and holistic hylomorphism belong to two different levels of analysis, each focusing on a different role of the soul in Aristotle's explanation of animals. Cardiocentric passages focus on episodes of psychic activities, some of which Aristotle takes to be the efficient cause of animal motion, whereas holistic hylomorphic passages focus on psychic capacities which Aristotle takes to be the formal and final cause of animals.

7. In which way is the animal a self-mover for Aristotle?

This brings us to the second question we raised at the beginning: in which way Aristotle regards animals to be self-movers, as opposed to being moved by something else external to them. According to the CIOM model, what makes animals self-movers is the right kind of causation of their motions, namely pleasure and pain and desire triggered by awareness of an object. It is only the motor processes caused in that particular way that Aristotle would count as motions that truly originate in the animal, and can thus be said to be the animal's own motions. According to the CIOM model, the animal is a *kinematic system* with an unmoved mover and a moved mover internal to it: (i) the unmoved mover is the soul's activity which provides the awareness of an object, whereas (ii) the series of ensuing motor processes (thermic changes, hardenings and softenings, contraction and expansion of the *pneuma*, and the ensuing mechanical pushings and pullings) are its internal moved movers; finally, (iii) the animal body as a whole is that which is moved without necessarily moving anything further.⁴⁸ (i) is the *prakton agathon* the awareness of which causes (ii), notably the corresponding desire and further motoric processes relative to the animal's bodily state, and (ii) in turn causes (iii), the displacement of the animal as a whole. Observe that no new forces are injected into the causal circuit

⁴⁸ This, we take it, is expressed somewhat schematically and without reference to the physiological details we find in the *MA* already in *De Anima* III.10; cf. 433b11-18.

during this process. Rather, the animal's spontaneity amounts to its ability to react to its environment in a special way. It is not reacting in a blind, mechanical way, but in an informed or conscious way, due to the activity of the soul. The animal does not react unselectively to all motions that impinge upon it from the environment, and to those motions to which it reacts, it does so insofar as these motions, upon reaching the heart, become motions with intentional dimension. In short, because of what happens at point A, motions from B to A and from A to C are not mere physical motions, but *psychophysical* motions.⁴⁹

In what follows we would like to situate the CIOM model we have presented within recent scholarly discussions of self-motion in Aristotle. The following conceptions of self-motion have been proposed.⁵⁰

(i) *Furley/Nussbaum: the intentionality thesis*. Furley and Nussbaum suggest that what makes the animal a self-mover is its intentionality, i.e. that the object of its desire relates to how things appear to the animal. Both Furley and Nussbaum thought that this requires a psychic capacity of 'seeing as' pleasant or desirable. Furley writes: 'Animals are clearly distinguished from inanimate natural bodies in that although both require external things to explain their movements, only animals require external things perceived (or otherwise apprehended) as having significance *for them*. Note that this is not just a difference in the complexity of the response to a stimulus, but a difference in kind. 'An animal is correctly described as a self-mover, because when it moves, its soul moves its body, and the external cause of its motion (the ὁρεκτόν) is a cause of motion only because it is "seen" as such by a faculty of the soul.'⁵¹ Nussbaum suggested that Aristotle's *phantasia* was such a psychic capacity.⁵²

⁴⁹⁾ We understand 'psychophysical motions' to be motions that cannot be adequately explained without reference to both certain bodily processes (alterations in the sense organs, heatings and chillings in the heart, etc.) and the psychic activities which introduce intentionality into these processes (perceptions, representations, feelings, etc.). Such motions, for Aristotle, are essentially both psychic and physical. This particular conception of 'psychophysicalism' is not identical with the current ones in Aristotelian scholarship, and it merits a separate discussion.

⁵⁰⁾ We omit Waterlow 1982 and Gill 1994 because they are not concerned specifically with animal motion.

⁵¹⁾ Furley 1978, 175.

⁵²⁾ Nussbaum 1978, 221-69, endorsed by Furley 1978, 179 n. 13.

The model of animal motion suggested here partly overlaps with the intentionality thesis insofar as the awareness of an object is indeed a crucial step in the series of events that leads to animal motion. However, there are differences. (a) The CIOM model does not require a special psychic capacity for 'seeing as' in order to trigger desire. Consequently, it can operate with a minimal notion of intentionality as a basic form of awareness of perceptual qualities. In the CIOM model, 'seeing-as pleasant or desirable or good' is, at least in the simple cases, *reduced* to the relation of the bodily state of the animal to the perceived object. The awareness of the goodness, desirability or pleasantness of the object is a possible, but not a necessary requirement for desire, according to the CIOM model. (b) The intentionality thesis presents desire as a primitive psychic capacity, which is incompatible with Aristotle's repeated claims that desire is a moved mover (cf. *DA* III.10, 433b16-18; *MA* 6, 700b35-700a1; 10, 703a4-5). In the CIOM model, by contrast, desire is reduced to bodily processes relative to the animal's nature.

(ii) *Freeland: objective teleology*. Without denying an important role to intentionality in the causation of animal motion, Freeland suggests that the objective goal-directedness of animal motion is decisive for self-motion. 'Animals,' she writes, 'are self-movers only when they are caused by their own souls to act for the sake of something objectively good' (62). The objectivity of the good (relative to the animal's nature) is also a feature of the CIOM model. And since Freeland does not deny that intentionality has an important part to play in Aristotle's conception of the animal's self-motion, the general line of her argumentation to a large extent matches our suggestion. However, apart from this general claim, Freeland does not venture to say how the soul moves the body. She writes: 'How does its soul move the hummingbird? By an informed conception of the particular goal of food, in this case, flower nectar. There is, undoubtedly, an efficient causal chain like that traced in the *De Motu Animalium* between the flower, perception of the flower, desire, and action. Further, I acknowledge that intentionality is a factor in the relevant causal chain. Nevertheless... it is the animal's own soul that has the power to actualize its capacity to move' (51-2). Thus, Freeland acknowledges that there is a causal story to be told, and she even acknowledges that intentionality has an important role to play in this story, but she does not venture to spell out this causal story. However, the details of this causal story are crucial for an adequate

understanding of Aristotle's conception of animal locomotion and the animal's status as a self-mover. And this involves not only a description of the causal chain leading from the object in the animal's environment to the animal's displacement relative to the object, but also the role of the animal's nature in this process.

(iii) *Meyer: the hexis model.* Meyer contends that Aristotle's claim according to which animals are self-movers entails the denial of the proposition that their desires are moved by external objects (1994, 68 n. 4). She thus develops a model of self-motion according to which it is our character dispositions in relation to desire that play the role of the unmoved mover in animal action. The first mover of our actions, the *prakton agathon*, is not simply the external object of our pursuit, but the *goal* of our actions. This goal of our actions, she claims, is a future state of affairs (69) and the way that we see things as goals crucially depends on our moral character (79). Perceptual affections that trigger our desires ('the external antecedents of the self-mover's activity', 77), she suggests, are best understood as merely accidental causes of our movements. The proper (*per se*) cause of animal motion is the voluntary agent, i.e. the person that acts from his or her character dispositions.

Much of what has been suggested here is fully compatible with Meyer's line of argumentation. This holds especially for the pertinent and useful distinction between accidental and *per se* causes of motion, a distinction which seems easily applicable also to animal natures, the activity of their perceptual capacities on the one hand, and the external antecedents of their motions on the other. However, it seems that the *hexis* model, as presented by Meyer, only applies to the most complex cases of human beings who have some influence on what they desire, how they desire, with the ability of entertaining second-order attitudes towards their own desires. The CIOM model, by contrast, explains why all animals can legitimately be regarded as self-movers in the relevant sense. Moreover, it seems that Aristotle did not have a problem admitting that our desires are moved by our perceptions (or other forms of awareness) of external objects. For this reason, presumably, he calls desire a 'moved mover' (*DA* III.10, 433b16-18; *MA* 6, 700b35-701a1; 10, 703a4-5). This, as we have seen, is not a problem for his notion of self-motion, because the fact that external objects *appear* to the animal already involves the activity of the soul. The fact that desire is moved by perception therefore does not seem to present a threat

to the causal autonomy of living beings. Moreover, Meyer's move to describe the object of desire as a future state of affairs imagined by the animal, e.g. the rabbit's imagining of eating a carrot instead of imagining simply a carrot, is incomplete, because it does not explain why and at which point the rabbit stops eating.

(iv) *Berryman: the pneuma thesis.* According to Berryman, what Aristotle has in mind in talking about self-motion in *Physics* VIII.2 and 6 is self-locomotion only. Thus, on her proposal, the problem addressed in these chapters is not how animals can move from place to place without an antecedent cause, but only without an antecedent *locomotive* cause. Now, the causation of locomotion from non-locomotive antecedent motions as it occurs in mobile animals, she rightly argues, crucially requires the ability to convert qualitative into local change. Aristotle's solution to the problem, she claims, consists in the introduction of a special stuff, the notorious *sumphuton pneuma*. *Pneuma* is precisely the stuff that is capable of this crucially important transformation and thus the simple but satisfying solution to the problem of self-motion (2002, 93 ff.).

Again, we agree with much of what Berryman claims. We have also argued that the role of *pneuma* in the causation of animal motion is to convert qualitative change (namely the thermic changes concomitant with pleasure and pain and desire) into contraction and expansion, thus introducing mechanical force into the story. However, we do not think that *pneuma's* role as a converter of one type of motion into another addresses what seems to us to be the core issue of animal self-motion. The core issue is the antecedent one, that of some motions gaining intentional dimension upon reaching the heart. Unless the converting action of *pneuma* is caused by *perceptual* alterations, as we have seen, we cannot speak of voluntary self-motion, but of involuntary motion at best and of mere mechanical reaction at worst. Moreover, Berryman seems to overlook Aristotle's knowledge of the fact that transformation of qualitative change into mechanical impulse can be achieved by other substances, such as boiling water.⁵³ The reason for introducing the supposedly non-empirical *pneuma*, then, seems to be deeper. What makes *pneuma* suitable for the organ of

⁵³) See *Physics* IV.7, 214b1-4. Strangely, this passage is not noted by Berryman in her treatment of *Cael.* 301b20 ff. and an episodic discussion of a passage in the *Meteorology* at 2002, 92 n. 20.

animal locomotion, we believe, is rather its ability to both expand *and* contract, to do so repeatedly, and without losing its cohesion or position inside the heart.

(v) *Morison: the two parts thesis*. Morison has offered an interpretation of *Physics* VIII.2 and 6 that puts into doubt what seems to have been a consensus among recent interpreters (including Berryman). This is the thesis that Aristotle in these chapters questions the animals' status as self-movers. He writes (2004, 75): 'When an animal self-moves, there is an unmoved part which moves the rest of the animal – this much we know from the fact that an animal does not move itself properly speaking, since one part moves another. But in that case, the unmoved part (which moves the other part) ends up moving accidentally (κατὰ συμβεβηκός, 259b18) along with the organism as a whole. However, it is *just this* which is the crucial point for Aristotle's argument, and which defuses the threat posed by animals to his argument of *Physics* VIII.6. For Aristotle goes on to claim: "we may be sure that if a thing belong to the class of unmoved things which move themselves accidentally, it is impossible that it should cause continuous motion" (259b20-2).'

Essentially, Morison claims that the simple fact that the animal is a kinematic system consisting of an unmoved mover and a moved part is entirely sufficient for regarding it as a self-mover, which is all Aristotle needs to establish for the purpose of his argument in *Physics* VIII.2 and 6. Other than that, Morison is right to point out, Aristotle's interest in animal motion in *Physics* VIII is very limited.⁵⁴ Now since Morison has very little to say about the details of animal motion, and since we, on the other hand, are not in the business of providing a detailed interpretation of Aristotle's arguments in *Physics* VIII.2 and 6, we shall only state that Morison's minimal thesis about self-motion in *Physics* VIII poses no threat to anything we have said in this paper.

8. Conclusion

In this paper we have presented a theoretical model operative in Aristotle's theory of animal motion. The 'centralized incoming and outgoing motions' model (CIOM), as we have called it, situates intentional states, starting

⁵⁴) A point made also by Waterlow 1982, 216.

with perception, and motor processes of the animal in the causal context of its environment. The model is based on the assumption that the animal is firmly set in the causal structure of the world. The animal constantly reacts to its environment, but only the right kind of reaction qualifies for self-motion. In the most basic cases, self-motion occurs when the reaction is causally determined by a combination of two factors, the soul's cognitive activity and the particular state of the animal's body. The soul's cognitive activity at the centre of the animal's body makes certain alterations in the heart such that they have intentional dimension, and some of them, depending on the state of the animal's body, in turn cause thermic alterations which bring about the expansion and contraction of the *pneuma* and other changes which ultimately result with movements of the limbs that enable the animal to displace itself and to manipulate objects in its environment. Clearly, animals are agents of enrichment of the causal structure of the world, points at which multiple transformation of motions occurs, bringing about new and often unpredictable effects that otherwise would not occur in the world.

Apart from the two problems formulated in the opening two paragraphs of this paper, the CIOM model allows us to tackle some other long-standing Aristotelian problems in a relatively simple and unified way, such as the problem of involuntary motions of certain bodily parts, the problem of the relation between perception, feelings of pleasure and pain, desire and other motor processes, or the relation between Aristotle's cardiocentrism and hylomorphism. Moreover, the model makes us aware of an important methodological distinction between the study of animals on two different, but complementary levels, namely on the level of formal/final causality, focusing on the soul as an organized set of capacities, and on the level of efficient causality, focusing on episodes of the soul's activities, notably of the activity of perceiving whereby certain alterations in the sensorium become perceptual alterations.

And more generally, beyond the scope of Aristotelian scholarship, the CIOM model seems philosophically attractive because it presents an interesting way of thinking about intentionality and the way it enters the causal structure of the world. Having set out the scholarly details of the model in this paper, we hope to provide a more general discussion of its philosophical advantages in the future.⁵⁵

⁵⁵) This paper originates from our collaboration made possible by TOPOI – Cluster of Excellence 264 in Berlin. The stimulus came from a workshop on Aristotle's cardiocentrism

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