

# Aristotle and Code

## Abstract

This paper argues that Aristotle was the first scientist to tackle the question of “nature’s codes”. Although his understanding of encoding is relatively primitive and rudimentary, he clearly sees the need for it, and gropes toward an understanding of it. It crops up in three areas. Semantics, being a system of artificial encoding, is a relatively straightforward case. More difficult is the case of cognition: perceptions are encoded as *kinêseis*, and this allows them to continue to exist subconsciously, appearing later in memory or dreams. And most difficult is the case of genetic theory: traits are encoded in male and female semen and so passed on to offspring; part of the story of the genetic code also does duty as the code that permits flesh – the undifferentiated product of digestion – to be differentiated into the various body parts.

Aristotle has many firsts to his name; one that has not really been explored, though, is that in a certain range of his scientific work, he brings into play the device of *encoding*. To be sure, he has no term for this device, no general theory of it, and his use of it is inchoate and rudimentary. He hasn't thought it through, but he has begun to make use of it, and there are some very striking subtleties in what he says, as well as some vexatious lacunae. In this paper I try to map out this matter, at least in a preliminary way.

Aristotle has recourse to encoding in at least three broad scientific areas. One, of course, is semantics. Another is cognition: perception, memory and dreaming. And a third is genetic theory and its concomitant theory of nutrition. Before I turn to Aristotle's work on those subjects, however, I should briefly say what I mean by encoding.

I take encoding to be a process by which a form that cannot be directly transmitted, *tel quel*, from one place and time to another place and time, is transmitted indirectly, through being converted into a transmissible format. In our culture the example that likely comes first to mind is the telephone: voice cannot travel long distances, but it can be converted into electrical pulses which *can* travel long distances through wires, and those electrical pulses can then be converted back into voice. The process requires two moments of conversion: the conversion of the initial or input form into the code, and the conversion of the code back into the final or output form; the output form is (formally!) identical to the input form. The code must be able to represent every relevant feature of the input form. In cases like speech and writing, to say nothing of telephony, the devising of code is artificial, that is, a product of human art; in many other cases it is natural, that is, part of the way that nature works. Large tracts of science are devoted to figuring out nature's codes. And Aristotle was, I think, the first scientist to step along the path of seeing that nature must work by codes, and of enquiring what those codes might be.

## 1. Semantics

In the immensely compact first chapters of *de Interpretatione* we learn, first of all, that spoken sounds are symbols of affections in the soul; these affections in the soul are the same for everyone, as are the things in the world that these affections resemble. Because there are different languages the spoken sounds are not the same for everyone in the world, but presumably they are the same within a linguistic group. Within a linguistic group, then, we encode our sentiments in spoken sounds, and our hearers decode those sounds into the corresponding sentiments. I cannot directly transmit my sentiment to you; but I can do so indirectly through this operation of encoding by me into speech, and decoding of that speech by you.<sup>1</sup>

However crude and simplistic this entire picture of semantics may now seem to be, it was of course foundational for the discipline, and it prevailed for centuries. And it exhibits all the essential features of the operation of encoding as I presented it above: the transmission of a form indirectly, by translating it into, and eventually out of, a code. The input form is an affection of the soul; the code does not resemble this form in any way (unless accidentally, as in cases of onomatopoeia), but once transmitted it is decodable by the hearer into an output form that exactly replicates the input form.

## 2. Cognition

In the discussions of common sense, memory and dreaming, in the *Parva Naturalia*, the device of encoding is very present. The term of art introduced by Aristotle for a code, or rather an element of a code, is *kinêsis*; usually the term occurs in the plural: we are constantly hearing about what happens to the *kinêseis* in such situations as perceiving several objects at once, in recollecting by stream of consciousness, in dreaming, in having after-images, and so forth. It is hard to know how to translate the term *kinêsis* here; Beare standardly renders it as "stimulus", but a stimulus is surely an external event that brings about perception, rather than part of the internal functioning of cognition; perhaps something like "disturbance" would catch it better; "movement" is a common translation, but one needs to sheer off its suggestion of locomotion. Let me now set forth a few observations about Aristotle's understanding of these *kinêseis*.

*i) kinêseis may both travel and stand still*

While it is true that *kinêseis* are often portrayed as moving around within the physiological apparatus of cognition – from special organ to common sense, or from common sense to memory – it is also true that they sometimes stand still. At 459b10, for example, Aristotle is considering after-images and he writes that the *kinêseis* remain in the eyes. So, however

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<sup>1</sup> We learn moreover that written marks are symbols of spoken sounds. If spoken sounds are code for affections in the soul, then written marks, are a kind of meta-code: code for a code. I cannot speak and be heard over long distances or long times: the speech code has these limitations on its utility. But I can convert my speech into writing; and writing can be sent to faraway places or can endure long times. Writing is meta-code. (And of course cryptography is meta-meta-code.)

exactly we are to conceive of a *kinêsis*, it is not an entity whose being consists in locomotion: a *kinêsis* can be, so to speak, at rest.

*ii) kinêseis are qualitative changes*

One might feel tempted to understand a *kinêsis*, then, as some sort of vibration or oscillation; such a disturbance can either travel or be at rest, all the while being, in another sense, in motion – quivering or pulsating motion.<sup>2</sup> But at 459a32 ff. Aristotle seems to commit himself to understanding these cognitive *kinêseis* as qualitative changes. The analogy he develops for their propagation, their travel, is that of heat: a hot body heats the body beside it, and then that one heats the next one in line, and so forth. Of course, this analogy is in one important way imperfect: with the transmission of heat there is no encoding; the heat that is transmitted to each body in turn is formally identical to the heat in the first of the bodies. Another passage at which we shall shortly look makes it quite clear that the *kinêseis* are not formally identical to the perceptions they encode.

*iii) kinêseis are physiological*

Chapter III of the *de Somniis* opens with this remark:

From this it is manifest that the stimulatory movements based upon sensory impressions, whether the latter are derived from external objects or from causes within the body, present themselves not only when persons are awake... (460b28 ff.)

This seems to make it quite unambiguous that Aristotle understands *kinêseis* as physiological; they can be provoked by external objects or just by internal physiology.

*iv) kinêseis may collide and conflict*

A few lines further on we come to see that these movements may have something of a life of their own before they emerge into consciousness.

We must suppose that, like the little eddies which are being ever formed in rivers, so the sensory movements are each a continuous process, often remaining like what they were when first started, but often, too, broken into other forms by collisions with obstacles. (461a8 ff.)

Or again, in *de Sensu*, we have a consideration of what happens if two movements conflict: if one is greater than the other, then the greater one prevails and expels the lesser, though the greater will appear less distinctly than if it were alone; on the other hand, if the two movements are equal in strength, they will either blend or cancel each other out. (447a20 ff.)

*v) kinêseis can be actual or potential*

In his discussion of dreaming, Aristotle has recourse to the idea that the residuary perceptual movements are in the soul potentially, but they may actualize themselves under certain conditions (461b15 ff.). It is not entirely clear whether the distinction between potential and actual here is simply that between conscious and unconscious: that is, whether an actualized

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<sup>2</sup> Devin Henry has explored some possibilities with respect to the physical realization of *kinêseis*, though his interest is in their role in genetics: Devin Henry. "Aristotle on the Mechanisms of Inheritance" *Journal of the History of Biology* (2006): 425-455.

movement is simply one that has entered consciousness.

*vi) logical isomorphism*

There is a fascinating but little-noticed passage of *de Sensu* in which Aristotle raises the question whether the same logical relation holds between *kinêseis* as that which holds between the forms they encode. The context is one of his discussions of the difficult question whether and how common sense can perceive contrary qualities at the same time.

Again, if the stimuli (*kinêseis*) of sense derived from contraries are themselves contrary, and if contraries cannot be conceived as subsisting together in the same individual subject...we must conclude that it is impossible to discern them coinstantaneously. (448a2 ff.)

One thing to say about this passage is that it makes it abundantly clear that Aristotle really does see a kind of encoding at work in these cognitive operations – in case there were any doubts about that point. We cannot even understand the question without supposing that there is a substantial formal difference between the code and what it encodes. And the question is simply whether the code and the encoded share certain logical properties. This, it seems to me, is a moment of remarkable subtlety in his groping towards the idea of code.

*vii) decoding?*

Aristotle's treatment of the *decoding* of cognitive movements is, to say the least, unsatisfactory. He alludes to it with such phrases as that the movements 'present themselves' (460b28); that they cause 'presentations' (464a18); that some are 'presentative' movements (462a10). But, of course, this is of a piece with the well-known fact that Aristotle, and antiquity more generally, seemed to have only the merest inklings of the problem that was to preoccupy philosophy from the Early Modern period on, namely the mind-body problem. Aristotle was, in a word, pre-Cartesian.<sup>3</sup>

### 3. Genetics

In genetic theory, Aristotle has recourse to encoding to explain the transmission of characteristics from parent to offspring. The *de Generatione animalium* is a work of evolving theory; in the early chapters Aristotle wants to say that all formal elements are contributed to an offspring by the male parent, the female parent supplying only matter. Such an idea, of course, makes it impossible to explain the inheritance of maternal characteristics. And so, later in the work, a subtler version of the theory emerges. But really at any stage in the development of this theory Aristotle has the following problem. A father's snub nose cannot be contributed directly, *tel quel*, to the offspring because semen doesn't have a nose; similarly a mother's elongated earlobes cannot be contributed to the offspring, because catamenial fluid does not have ears. So these features have to be contributed *indirectly*, through encoding. The semen, and the catamenial fluid, have to carry a code.

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<sup>3</sup> We must admit, of course, that exactly the same difficulty arises in our own science of cognition. Light is encoded as electrical impulses by the rods and cones of the retina; these impulses are conveyed by the neurons to the occipital lobe of the brain – but just how is it that they are then *decoded*?

And in fact the problem is even richer than this: Aristotle is well aware that some inherited characteristics emerge only in adulthood or later: they have somehow to lie latent for a time. The greying of hair, or a certain gait, or a timbre of voice are some of Aristotle's examples of later-onset inherited traits. (722a5 ff.)

It is striking that Aristotle here uses the same technical term for code as that which he used in the *Parva Naturalia*: *kinêseis*. And some, but not all, of the properties of *kinêseis* in the cognitive treatises appear also in the theory of generation.

*i) kinêseis both travel and stand still*

It is clear that, at the very least, the *kinêseis* in the male parent's semen travel to the womb of the female; and it is also clear that some, at least, of them have to wait quite a while before they can find expression in the offspring's traits. Body parts emerge only gradually during the embryo's development, and, as we have said, some inherited traits are not expressed until well into adult life. Some *kinêseis* have to stand still for a long time.

*ii) potential and actual existence of kinêseis*

In his attempt in Book IV of the *GA* to explain the fact that the father's traits do not always prevail, he has recourse to a complex – and not ultimately clear – theory according to which the *kinêseis* which correspond to the father's traits are present actually in the semen. These *kinêseis* may however be vanquished (*luesthai*), and if so then some *kinêseis* that were only potentially present may come to the fore: those representing remoter ancestors, or those representing the female. (768a12 ff.) Where the actuality/potentiality distinction in the code for cognition seems to be simply the distinction between what is or is not present to consciousness – what is or isn't decoded –, in the case of genetics it is more complex. Actual presence of a given *kinêsis* does not entail that that *kinêsis* will be expressed in a trait; just the opposite may be true, and this is the case that captures Aristotle's interest.

*iii) kinêseis may collide and conflict*

The story Aristotle tells about settling whether the offspring will be male or female, and which particular traits it will exhibit, is a story of conflict between *kinêseis*. In particular, Aristotle notices that a male child may have (many of) its mother's features, and a female child its father's. This seems very complex, but the explanation is given in terms of a conflict between generative movements; and it can only work if the movements are understood as richly multiform. That is, there cannot be just one movement that represents the father, and another that represents the mother, for then a male child would resemble its father in all respects, etc. So there has to be a movement for sex organs, of course, but also one for earlobes, and one for nose shape, and one for delicacy or coarseness of hand-bone structure, and one for colour of hair.... It is the rich and multifarious conflict between all these movements that brings about the complex observed phenomena of animal generation.

*iv) encoding?*

Where there was an issue about the *decoding* of cognitive movements – essentially the fact that Aristotle doesn't give it much attention and uses only the most allusive language about it – there is a problem about genetic *encoding*. Basically, it does not occur.

Let me explain. If Aristotle held to something like the theory of pangenesis, then we would have a pretty straightforward case of encoding here: the traits of the parent somehow pass,

encoded as movements, into the semen of the parents, and then, after a complex tussle between the corresponding pairs of movements from the two parents, the set of victorious movements would be decoded into a set of traits. But, of course, Aristotle does not accept pangenesis, and indeed he spends a good deal of intellectual energy in resisting it. He turns the tables on pangenesis and has an original theory of his own:

So we must say the opposite of what the ancients said. For whereas *they* said that semen is that which comes *from* all the body, *we* shall say it is that whose nature is to go *to* all of it.... (GA 725a21-23)<sup>4</sup>

So, in Aristotle's theory, the genetic story does not start with the traits of the parent; the traits of the parent are *themselves* the expression of a code, of a set of movements. And those movements do two things. On the one hand they govern the creation and maintenance of the parent's traits; and on the other they pass into the semen and so become (half of) the set of movements that will be decoded into the offspring's traits. There is a code for the parent's traits, but those traits come from it, not it from them. The code's the thing.

### 3 (a). Nutrition

This observation about Aristotle's theory of nutrition points to another instance of code in the body of his science. I number this instance 3(a) rather than 4, however, since nutrition and reproduction are, for Aristotle, essentially linked. They are the two distinctive powers of the vegetative soul, of course; but they are not ultimately distinct powers: they are parts of the same process.

Aristotle needs to explain how the undifferentiated flesh-matter that is produced by digestion comes to take on the shape required in order to build or sustain various parts of the body. How does some of this matter become fingernails, and some eyelids? In the GA and the GC, the following broad answer emerges. The undifferentiated flesh-matter is somehow imprinted with a *potential form* before it travels out to whatever part of the body it is destined for. A lump of flesh matter that will ultimately go to the fingernail is somehow refined and imprinted with a potential ungiformity before it goes to the finger; it doesn't acquire actual ungiformity: that happens only when it finally reaches the finger. But it acquires, we might say, the code for becoming ungiform.

All this flesh that is imprinted with particular potentialities to become part of this or that or the other organ accumulates somewhere in the gut, and the surfeit of it – that which is not needed for the nourishment and growth of the host body – is available to sculpt an offspring: it is semen. It contains a code, and whether that code is decoded in the host body by nutrition or decoded in an offspring body (or cast off as waste and so not decoded at all) is pretty much a matter of chance.

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<sup>4</sup> The Oxford translator Platt helpfully expands this picture in a footnote: "Because semen is derived from the nutriment which is conveyed by the blood-vessels *to* every part of the body. Though it does not itself go to every part it is a sort of quintessence of that which does."

In the discussion of nutrition in the *GA* and the *GC*, we do not find the language of *kinêseis*, but it seems clear that whatever is the physical realization of the code in semen must also be the physical realization of the code in nutrition.

### **Conclusion**

We have watched Aristotle begin to develop, in an entirely rudimentary and groping way, a notion of encoding. It's been striking to see this at work in three different sciences: artificial encoding in language, and natural encoding in cognition and in genetics and nutrition. And we have mapped some of the similarities and some of the differences in his understanding of encoding in these three areas.

This conceptual work is inchoate, perhaps, but it is a stunning new development in the history of science.

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