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Colloquium 5

Plato's Theory of Sense Perception in the *Timaeus:* How it Works and What it Means'

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In (he *Timaeus,* two passages deal with sense perception: *Tim.* 42e-47e and 6lc-69a. The first passage describes the condition of the soul when newly incarnated (42e-44d), the structure of the human body: head and limbs (44d-45b), the eyes and the mechanism of vision (45b-46a), mirror images (46a-c) and the secondary causes contrasted with the purpose of sight and hearing (46c-47e), sight and hearing being the two senses which above all reveal the harmony of the universe. Thus this passage, included in the first part of the *Timaeus* which describes the "work of reason," is mainly ethical and teleological. The second passage, belonging to the second part of the *Timaeus* which describes "what comes about with necessity," explains the mechanism of sense perception (a) in the whole body (touch: pleasure and pain) and (b) in particular sense organs: eyes (colors), ears (sounds), tongue (tastes) and nostrils (odors).

I. The Mechanism of Sense Perception

In the second passage of the *Timaeus* (61c-69a), Plato's purpose is to demonstrate, as cosmologists had traditionally been attempting to do, that the principles of his physical philosophy are sufficient to account for the whole range of our experience of sensible phenomena. Therefore Plato's main purpose here is neither epistemological, as in

[1] To write this paper, I referred to two articles by Solmsen 1950 and 1961, and to a book by O'Brien 1984. The translation of passages from the *Timaeus* are from Comford 1937; but sometimes I have changed this translation taking into account my own translation (Brisson 1992).

the *Theaeletus,* nor ethical, as in the *Philebus,* but cosmological, physical, biological and physiological.

This task is not an easy one because, as Plato says in *Tim.* 61c-d, three explanations are involved, two of which Plato must defer: (1) the *pathemata,*[2] and (2) the origin of flesh and things associated with flesh *(Tim.* 73b-76e), and (3) the mortal parts of the soul *(Tim.* 69a-73b). In fact, sensation is involved in all these explanations, and this is why the three are inter-related. To refer to the *pathemata* involves reference to sensation, and reference to sensation involves referring to flesh and things associated with flesh and to the mortal parts of the soul. But the reverse is also true: an account of the mortal soul, and of flesh and things associated with flesh requires an account of sensation and therefore an account of the *pathemata.*

In fact, three elements must be taken into account for an explanation of sense perception: I) an object perceived, 2) a human being who perceives that object, 3) and the relation between an object and a human being.

A. Sense-objects

In our universe, every sense-object is ultimately made out of two and only two elemental triangles: the right-angle scalene triangle (a, a/2, a 3/2) and the right-angle isosceles triangle (a/ 2, a 2, a). To construct the equilateral triangles which form the faces of the three regular bodies: tetrahedron (four equilateral triangles), octahedron (eight equilateral triangles) and icosahedron (twenty equilateral triangles), which correspond respectively to fire, air and water, Plato uses six elemental right-angle scalene triangles (a, a/2, a 3/2); and to construct the square face of the cube (six squares), which is identified with earth, Plato uses four elemental right-angle isosceles triangles (a/2, a 2, a).

The three first elements are mutually transformable by being resolved into their component triangles. Earth falls outside the cycle of change as it is composed of cubes, each of whose faces is resoluble into half-squares, i.e., into right-angle isosceles triangles. A fifth primary solid, the dodecahedron also falls outside the cycle of change, in that its faces are made of pentagons. This figure is taken to represent the cosmos as a whole.

[2] There is no real equivalent for this term in English which will be defined on p. 150-151.

From these four primary bodies, or elements, and from these alone, Plato deduces the whole variety *(gene)* of sensible phenomena. Each of the regular solids exists in a limited number of different grades of size. There is, accordingly, (1) a corresponding number of grades of an element, each of them being composed of particles of uniform size. There are, besides, (2) non-uniform varieties of an element, consisting of particles of that element only, but of more than one grade; and (3) compounds of more than one primary body. Since all grades of all the primary bodies can enter into such compounds, there is a very large variety of possible combinations.

The secondary substances are listed (58c-61) according to their derivation from the primary kinds of each element. Even if some of the substances are formed from a combination of more than one element, Plato lists them according to the element which is dominant.

Sensible particulars are in the *Timaeus* made of four elements: fire, air, water and earth. Plato, it seems, borrowed this theory from Empedocles, but he proves to have been original in linking these elements to regular polyhedra: fire is linked to the tetrahedron, that is pyramid, air to the octahedron, water to the icosahedron and earth to the cube. Each of these regular solids exists in a limited number of different grades of size. While these details may be interesting for the history of sciences, only one thing is important for us now. In the sensible world, particulars and their mutual transformation, can always be translated into a mathematical formula.

In fact, what is being perceived by human beings are the *pathemata* of the secondary substances. The four primary bodies are too small to be visible or even perceptible:

> Now we must think of all these bodies as so small that a single body of only one of these kinds is invisible to us because of its smallness; though when a number of them are aggregated the masses of them can be seen. *(Tim.* 56b-c)

Thus even if fire explains why the body of the world is visible and earth why it is tangible *(Tim.* 31b ff.), and even if fire is said to be the lightest of primary bodies because it is composed of the smallest number of similar parts *(Tim.* 56a-b), these remarks seem to follow from reasoning rather than from real sensation.

B. Human Beings

A human being can be defined as the temporary association of a soul with a body (cf. *Tim.* 90e ff.). But what is a human body made of and what does a soul look like?

/. *The human body.* Like any sensible particular, the human body is made out of the same four elements: earth, water, air and even fire. Here is a description of its origin according to the *Timaeus.* Mixed in due proportion (ἀλληλοῖϊ *συμμΐτρα),* the unwarped and smooth triangles are used to produce the marrow *(Tim.* 73b-d). From earth soaked with marrow, plunged in the fire and dipped in water, bones and sinews are made. Then comes the making of flesh *(Tim.* 73e-74a), skin, hair and nails (Tim. 74a-76c).

The marrow, whose substance is identical with that of brain and semen *(Tim.* 73c6 ff., 91a4 ff.), is the *arche,* the principle or rather the first and basic tissue. All other tissues in the body either have their origin in the marrow or are understood by reference to it, because the soul is anchored in brain and marrow, and also because, in the *Timaeus,* Plato does view the organs not in relation to the physical safety and efficiency of the organism but in relation to soul. The bones protect the brain, the marrow and the semen, while flesh and sinews are devised to protect the bones, exactly as skin, hair and nails are devised to protect the flesh. Moreover, holding that flesh dulls human sensitivity, Plato points out that the gods who made human beings applied a very small amount of it to those parts which should be most sensitive and responsive. Hence longevity is a less worthy end than sensitivity *(Tim.* 74e1 ff., 75a7 ff., b7 ff.). By relating the first tissue, the marrow, to soul, and the other tissues to the first, Plato has oriented his account of the tissues towards teleology.

2. 77ie *human soul.* Human soul, that is the immortal part of human soul *(nous),* is composed of what is left of the original ingredient used to make the world-soul *(Tim.* 41d-e), namely the intermediate kinds of Being, Sameness, and Difference (cf. *Tim.* 35a-b). Consequently, the immortal part of the human soul is endowed *(Tim.* 43a-44c) with the same circles, those of the Same and the Different *(Tim.* 36b-d), and with the same mathematical proportions *(Tim.* 35b-36b) as the world soul.

When it is linked to a body, the immortal part of the human soul is attached to two mortal parts: spirit *(thumos)* and desire *(epithumia).* Within the body, the head is the seat of the immortal part of the soul, the spirited element is established in the region of the heart, and the appetitive part is situated in the belly under the diaphragm near the liver. These three parts of the soul are anchored in the marrow: the spinal marrow for the mortal parts, and the brain, for the immortal part.

The head contains the two circles cf the immortal part of the soul, which are similar to those of the world-soul. These circles are not material, but their effects can be perceived. Here are two examples:

> The sutures (of the skull) are of very various patterns due to the action of the revolutions and of the nutriment, being more or fewer in number according as the struggle between those powers is more or less intense. *(Tim.* 76a6-bl)

> Land animals came from men who had no use for philosophy and paid no heed to heaven because they had lost the use of the circuits in the head and followed the guidance of those parts of the soul that are in the breast. By reason of these practices, they let their forelimbs and heads be drawn down to earth by natural affinity and there supported, and their heads were lengthened out and took any sort of shape into which their circles were crushed together through inactivity. *(Tim.* 91 e2-92a2)

Therefore the distortion of these circles under the assault of food and sensation can be readily observed.

According to these postulates, sense perception appears to be a Janus-like phenomenon with both a physical and a psychological face, which will now be described.

II. The Perception of an Object by a Human Being

Two passages in the Timaeus give a general account of what sensation is: *Tim.* 42e-43c and *Tim.* 64a-b.

The following lines are quoted from the first passage on what is going to be experienced by the newly incarnate soul when the prescriptions of the demiurge are realized. The demiurge has retired and his sons build the human body putting in it the immortal part of the human soul, built by the demiurge, together with the mortal parts they have themselves built:

> And they (= the sons of the demiurge) confined the circuits of the immortal soul (rat *της αθανάτου ψυχής* **7Γ**«ριόδου?) within the flowing and ebbing tide of the body. These circuits, being thus confined in strong rivers, neither controlled it nor were controlled, but caused and suffered violent motions (. ..). For strong as was the tide that brought them nourishment, flooding them and ebbing away, a yet greater tumult was caused by the affections (παθήματα) of the things that assailed them, when some creature's body chanced to encounter (fire, air, water and earth] (. . .). For this reason these motions (at *κινησ(ΐς)*

were later called by the name they still bear "sensations" *(αΐσθήσας). (Tim.* 43a5-c7)

According to this passage, *aisthesis?* sensation which is ultimately a movement *(kinesis)* arises from the *pathemata,* that is affections, or to put it the other way round, the *pathemata* produce *aisthesis.*

The affections *(pathemata)* are therefore a necessary cause, or condition, of sensation *(aisthesis).* But they are not a sufficient condition. For Plato's account of pleasure makes it clear that the *pathemata* do not invariably give rise to sensation:

Now in seeking the explanation of any affection, whether perceptible or imperceptible, we must begin by recalling the distinction drawn earlier between what is mobile in structure and what is immobile (that is to say the passage on ihe natural mobilily of each of the four elements. *Tim.* 55e-56a); all the explanations we are bent upon discovering are to be sought along this line. When something that is naturally mobile is invaded by even a slight affection (πάβοϊ), it spreads it all round, one particle passing on the same effect to another (διαδίδωσιν κύκλω μόρια ἴτῖρα *(τίροις),* until they reach the rational part of the soul *(μΙχροπτ(ρ αν i-πΊ το φρόνιμου)* and report the quality of the agent *((ξαγγιΚτι τοϋ ποιήσαντος την δύναμιν). (Tim.* 64a6-b6)

The distinction between what is perceptible and what is imperceptible is determined not by a difference between the *pathemata,* but by a difference in what happens to the *pathemata* when they reach a sentient recipient.

A. The Physical Process

These two passages provide us with the necessary evidence to describe the physical process of sense-perception from the beginning to the end. From a purely physical side, a proper analysis of "sensation" or sense-perception depends on an understanding of three factors: the nature of the *pathemata* which enter the body, the nature of the recipient, that is "flesh and things associated with flesh," which are capable, or incapable as the case may be, of transmitting the various kinds of *pathemata* to the soul, and the nature of the transmitting agent, that is blood.

/. The pathemata. The *pathemata* are not therefore characteristics, for example "hot" or "cold," which would reside in an object independently of its effect upon a sensible percipient. This claim

[3] On the evolution of the meaning of *αΧσθησκ* in the Platonic corpus, cf. Frede 1987.

founders on Plato's repeated qualification (from 61c3 to 68d7) that the *pathemata* have to do with the human body, whether with the human body taken as a whole, or at least specified as "flesh," or with "individual parts" of the body.[4] Furthermore, the *pathemata* are not themselves quite the same as the *sensib'dia* of the *Theaetetus* (156a3-157c2, 182a3 ff.), qualities of "white" for example which exist only when, and for as long as they are being perceived. The *pathemata* or *pathe ate* simply the effects which one body has upon another and which, if the body affected is sufficiently receptive, will be transmitted to the *phronimon,* that is the rational part of the soul as we will see, these effects being thereby recognized as sensations.[5]

2. *The recipient.* As is clear from an analysis of pleasure, sensation or perception depends upon the confluence of two factors: the *pathos* which "falls upon" the body, and the nature of the body which receives the *pathos.*

2.1. Nature of the recipient. The nature of the recipient can be of two kinds: mobile or sluggish, according to the proportion of the elements of which it is made. As explained in *Timaeus* 55e-56a, earth is the most immobile or the least mobile elemental body, because it is related to the cube, which is made out of six squares. And because fire is related to the tetrahedron made out of four equilateral triangles, it is the most mobile elemental body; furthermore, air is less mobile than fire and more mobile than water.

A mobile recipient, where fire is prevailing, passes on the message, from one part of the body to another, until the particles that have been set in motion "reach the *phronimon* and there announce the nature and power of the body which has set them in motion" *(Tim.* 64b5-6). A sluggish recipient, in which earth is prevailing, is affected by the impulse from without, but it does not pass the impulse on to other parts of the body, so that in this case the body which received the *pathos (to pathon)* is left "without sensation" *(anaistheton) (Tim.* 75a-c).

Thus the *pathemata* or *pathe* will be recognized by the *phronimon* only if they strike upon an appropriately receptive part of the body. If

[4] *Tim.* 61d7. 62a6-7, 62b6-7, 64a2-3, 64a4-5, 65c2-3, 66dl-2, 67a7-c3, 67c4-68d7,67e6-68bl.

[5] More generally, the nature *(phusis)* of a thing, being *(ousia),* is revealed through property *(dunamis),* which is either an activity *(ergon),* that is the ability to produce such and such an affect or an affection *(pathos),* that is the capacity to be affected in such and such a way. As a matter of fact, *ergon* and *pathos* are the two sides of the same coin.

the *pathos* hits "bone or hair or any of the other parts in us that are made of earth" *(Tim.* 64c4-5), then the force of its impact will go no further. If, on the other hand, it hits our flesh, or other suitably sensitive parts of our body, then it will stand a chance of being transmitted to the seat of the *phronimon,* that is the brain, where it will be recognized as, and will therefore become, a sensation.

2.2. *Kinds of recipients.* In order to grasp fully all of this, one must remember that Plato makes a distinction between common perceptions of the body as a whole and the perceptions that occur in special organs of the body *(Tim.* 65b). Here is a list of these perceptions analysed in the *Timaeus:*

The body as a whole [touch, in relation to the four elements] (61d-65b)

- hot/cold (61d5-62a5)
- hard/soft (62b6-c3)
- heavy/light (62c3-63e8)
- smooth/rough (63e8-64al)
- pleasure/pain (64a2-65b3)

Special organ

Tongue [taste, in relation to water and juices *(-χυμοί)* (65b-66c)

- astringent/harsh (65c6-d4)
- acrid/agreeable (65d4-65e4)
- pungent(65e4-66a2)
- acid (66a2-b7)
- sweet (66b7-c7)

Nostrils [odors, in relation to water changing into air, or air changing into water] (66c-67a)

- pleasant/unpleasant (66dl-67a6)

Ears [sounds, in relation to air] (46c-47e, 67a-c, 80a)

- pitch [high/low] (67b6)
- smooth/harsh (67b6-7)
- loud/soft (67c 1)

Eyes [colors, in relation to fire] (45b-46c 67c-68d)

There is a specific problem with the sense of touch: it is common to the body as a whole, the parts of which can be more or less sensitive according to the thickness of flesh covering them. On the other hand, the special sense organs are built in order to transmit efficiently the *pathemata;* this is even the case for the tongue, which seems at first to be an exception, because it is made entirely of flesh:

> Those parts, on the contrary which are the seat of intelligence *(ἴμφρονα)* have less flesh, save where he (= the demiurge) formed a mass of flesh to be in itself **an** organ of sensation *(αἰσθήσεων)***, as** for instance the structure of the tongue. *(Tim.* 75a4-6)

Thus Timaeus saves himself from an apparent contradiction.

This being the case, a detailed study of the mechanism of every special sense perception leads to the conclusion: in the end, every sense perception is a kind of touch.

3. A measuring operation. What is really being transmitted in the process of sense perception? The only thing transmitted in this process seems to be the movement produced by a sense object on a body as a whole or on a sense organ. But as both the sense object and the sense organ are made out of varieties of the four elements which themselves are related to the four polyhedra, the type of movement which produces sense-perception depends on the structure, the number and the speed of these mathematical objects when they are in mutual contact.

One can therefore conclude that, for Plato in the *Timaeus,* sense-perception is really a measuring operation as indicated by the frequent use of the word *summetria,* which means proportion, that is ultimately the capacity for a thing to be compared to something else, namely by way of measuring.

Such a conclusion seems to be confirmed by a passage related to the description of sight:

> There remains yet a fourth kind of sensation which demands classification, since it embraces a great number of diversities. They are known by the general name of "colour," a flame which streams off from bodies of every sort and particles has it so proportioned to the visual ray (οψα *σύμμίτρα μόρια)* as to yield sensation. *(Tim.* 67c4-7)

This account of vision deals only with the visual ray whose fire coalesces with the daylight, and ultimately with the action of the particles which come from the objects to meet the visual ray emitted by the eyes. This action is qualified by the speed, the structure and the number of both sorts of particles.

Taste and smell are also described as a measuring operation. Here is the explanation of the mechanism of taste:

Again there are the panicles of substances reduced to a **fine** texture by decomposition before they make their way into the narrow veins (of the tongue)—particles which are duly proportioned *(συμμίτρίαν ἴχοντα)* to the earthy and with the airy particles which the veins contain, with the result that they set these in motion . ... *(Tim.* 66a2-5)

The mechanism of smell is much more difficult to explain:

An odour is always a half-formed *(ήμιγινίς)* thing, and no variety of substance has received the proportions [with the olfactory veins] *(tiiei oi ovbevi συμβιβηκ(ν)* to produce it. *(Tim.* 66d2-3)

Smell is occasioned only by vapor (water changing into air) and mist (air changing into water). According to G. Vlastos,[6] the changing mixture of air and water constitutes a fluid thinner than water, the thicker of the two ingredients of the mixture, which alone could not go into the olfactory veins, but firmer than air, which alone would not have sufficient viscosity to exert the requisite lateral pressure on the walls of the veins: the fact that this mixture is provisional and unsteady would explain the indefinite character of odors, which prevents us from giving their varieties distinctive names. Such an explanation makes unnecessary the hypothesis of particles of a third class, formed in the transitions between air and water, finer than the icosahedron of water and grosser than the octahedron of air.

If sensation is a measuring operation, a major consequence follows; only that part of the universe ordered by the demiurge, and which is not without proportion or measure, can be perceived:

For the generation of this universe was a mixed result of the combination of Necessity and Reason. Reason overruled Necessity by persuading her to guide the greatest part of the things that become *(τών γιγνομίνων τα. πΚΰστα)* towards what is best. *(Tim.* 48al-3)

And parts of the universe remain now and always chaotic beyond any real sensation.[7]

[6] On that very difficult passage, cf. Vlastos 1967.

[7] What are these parts of the universe which have not been ordered by the demiurge? The Greek *των γιγνομίνων τα* πλίίστα need not mean that whole regions are unordered, but could just as well mean that some stuffs (within ordered regions) are more or less ordered. This could explain on the one hand why sense perception remains incomplete or imperfect, and on the other hand why the precosmic traces *(ίχνη)* of the four elements were perceptible before the ordering of the universe by the demiurge (cf. *Tim.* 52d-53c).

4. *Blood as the agent of transmission.* But what is the vehicle of the movement caused as a *pathema* or a *pathos* in a part of a sentient body, and transmitted through the body to the soul?

To answer that question, one must look again at these lines on the spirited impulse *(θυμός)* which has its place in the chest near the heart:

The heart, then, the knot of the veins (αμμα *των φΚ(βών)* and the fountain of the blood *(πηγή του α'ίματος)* which moves impetuously round throughout all the members, they (= the sons of the demiurge) established in the guardroom, in order that, when the spirit should boil with anger at a message from reason that some act of wrong is taking place in the members, whether coming from outside or, it may be, from the desires within, then every sentient part of the body should quickly, through all the narrow channels *(πάντων των στ(νωπων),* be made aware of the commands and threats and hearken, with entire obedience, and so suffer the noblest part (= the rational part of the soul) to be the leader among them all. *(Tim.* 70a7-cl)

So through every narrow channel all sentient parts of the body become aware of the commands and threats and are thus caused to obey the best and ruling part of the soul. These "narrow channels" must be the blood vessels whose physiological connection with the heart Plato specifies in the same sentence.

So it is easy to understand how blood is the agent of transmission of *pathemata* of the soul, both in common perceptions of the body as a whole and in the perceptions that occur in special organs of the body. Concerning the body as a whole one reads:

Next, they (= the sons of the demiurge) split these veins in the region of the head and plaited the ends and so as to pass across one another in opposite directions, slanting those from the right towards the left side of the body and those from the left towards the right side. This is partly to provide the head with a bond helping the skin to connect it with the body, since there were no sinews holding it all round at the crown, and further in order that the body as a whole *(άπαν* το σώμα) be informed of the effect of sense-perceptions (τό των *αισθήσιων πάθος)* coming from the parts of the body on either side. *(Tim.* 77d6-e6, cf. *Tim.* 42e5-43c7)

The same idea recurs in the sections devoted to the individual sense organs.

Sound is defined as a stroke which, being produced by air, "through ears, brain, and blood is passed on *(δίαδώομΐνην)* to the soul" *(Tim.* 67b2-4). The small blood vessels of the tongue are called the "testing instruments" of this organ and are described as "extending *(τιταμίνα)* to the heart" *(Tim.* 65c-d). Blood vessels serve also as carriers of smell

(Tim. 66d4 ff.). The section referring to vision never mentions blood vessels, but one reads:

> So the whole (fire from inside and fire from outside), because of its homogeneity, is similarly affected and passes on the motions of anything it comes into contact with or that comes into contact with it, throughout the whole body, to the soul, and thus causes the sensations we call seeing. *(Tim.* 45c7-d3)

Recalling the description of the heart as a "knot of the veins," we may readily surmise that *pathemata* affecting the blood in the veins are passed on to the heart.

Thus channels of one and the same kind would convey the commands of reason from the head to the rest of the body and carry sensations or sense impressions to the heart. Since the blood has its share of mobile air and fire units, the design which emerges would be physiologically as well as psychologically satisfactory, although we are still left to wonder whether sense perceptions should not reach the brain rather than the heart. It may seem strange to consider blood as the agent of transmission of the *pathemata.*

In fact, blood has these characteristics. It is nothing else than the food (plants) and drink cut up and melted by the hot or fiery substance within us, plus particles of this fiery substance whose presence accounts for its red hue *(Tim.* 77c-78b). Because it is made out of the four elements, it is able, according to the principle that the same is known by the same, to transmit information coming from any variety of sensible things made out of the same four elements. And because there is a lot of fire in it—fire being the most mobile element—, it has great mobility and consequently it is a very good agent of transmission. Besides, blood is moving all the time and everywhere in the body, so that it is always ready to carry information sent by any part of the body to the rational part of the soul. For Empedocles,[8] blood was the organ of thought *(νόημα);* however he did not make a sharp distinction between thought and sense perception. Hence there was no reason why his followers, including Plato, should not regard blood also as the instrument of sensory activity. Similar theories were advanced by Diogenes of Apollonia.

The best and newest theory concerning the system of blood vessels made the heart the center of this system. Plato accepts this view, but insists nevertheless, for philosophic and *a priori* reasons, on placing the organ of rational control in the head *(Tim.* 69c ff). This conviction was

[8] DK 31 B 98 = Simplicius, *In Phys.* 32.4 ff.

bound to land him in difficulties, because, not knowing the role of nerves discovered a century later by Herophilus,[9] a physician living in Alexandria, he cannot explain how perceptions arrive at the brain.

B. The Psychological Process

In the last pages, we have been describing the physical process of sense perception; let us now take into account the psychological process by raising these two questions. What is the final addressee of sensation? And what role do the mortal parts of the soul play in that psychological process?

Λ *The final addressee.* As we have seen, the final addressee of the *pathemata* is the part of the soul Plato calls the *phronimon:*

> When something that is naturally mobile is invaded by even a slight affection, it spreads it all round, one particle passing on the same effect to another, until it reaches the rational part of the soul and reports the quality of the agent. (77m. 64b3-6)

For example, when a cutting action is exerted upon a sentient body, and upon that part of a sentient body which is able to convey the movement of cutting to the *phronimon,* then we have the sensation of heat. The problem is to understand what Plato had in mind when he uses the word *phronimon* as a substantive here. Two arguments may give evidence that he had reason in mind. A textual argument: it appears that Plato uses the word *phronimon* to allude to the rational part of the soul, for example in the *Republic* (VI 530c1, IX 586d7, X 604e2) and in the *Laws* (VIII 837c7, X 897b8). And a technical argument: if the *pathemata* were not able to reach the rational part of the soul, how could the circuits of the immortal soul in the head suffer violent motions when assailed by sensations in a passage already quoted *(Tim.* 42e-43c)?

Such an interpretation of the meaning of *phronimon* is not usual, because it brings forward what is considered as Plato's metaphysical (or mythological according to some interpreters) epistemology. In fact, even if this passage does not allude explicitly to *anamnesis,* that is the remembrance of the Forms seen by the soul before its incarnation, one need no longer think that it remains the most probable solution. Why? Because when the *pathemata* have reached the rational part of the soul and have reported the quality of the agent, we are able not only to say

[9] Cf. vonStaden 1989.

"I feel hoi," but by a transference of terms we also say that "the fire is called hot;" and by a further transference of terms we say that "the fire heats and melts metal." The persistence of that linguistic activity related to the Forms in the *Timaeus* proves that it is not accidental.[10]

At the sight of this long list (the contents of n. 10), it is not surprising to learn that before god's intervention in the world "there was nothing deserving to be called by the names we now use. . .." (Tim. 69b6-7). Clearly, the establishment of names is an important consequence of, if it is not, indeed, in a sense synonymous with god's organization of the universe *(Tim.* 53b5-6). In fact, god's organization provides the sense-objects, which in the universe are constantly changing, with the stability they require in order to be named. These sense-objects are named after their Models, the Forms, which do not undergo any change and which provide the stability of the sense-objects. Thus, sense perception has to be related to the rational part of the soul, which is the only part capable of remembering the corresponding Forms, which it saw before its embodiment. Consequently, the rational part of the soul is also the only part capable of naming, which it does by establishing a link between a signal transmitted to it by the body and a name which is, in the first instance, the name of a Form.

2. The role of the mortal parts of the soul. In his account of the sensations transmitted through special sense-organs (tastes, smells, sounds, colors), Plato gives the mortal parts of the soul, which are established in the region of the heart (the spirited element) and of the liver (the appetitive part), and related to a role in the sense process.

In his description of taste, Plato writes:

When earth particles, making their way in at the small veins which serve the tongue as a sort of testing-instrument and extend to the heart *(τπαμχνα όπ την καρδίαν)*, come into contact with the moist and soft flesh, as they are melted down they contract and dry up the veins. *(Tim.* 65c6-d3)

In his description of smell, he writes:

The only clear distinction to be drawn here is twofold: the pleasant and the unpleasant. The unpleasant roughens and does violence to the whole cavity lying between the head and the navel (uera£u *κορυφής τον* re *ομφαλοί);* the pleasant soothes this region and restores (άποδιδόι/) it with contentment to its natural state. *(Tim.* 67a2-6)

[10] Denis O'Brien (O'Brien 1984, pp. 147-149) has counted 29 relevant occurrences: 58d2, d3, e7, 59a6-8, b5, c5. d5-6, e5. 60a1, a2-3, a4, b2-3, b5, d2, 62a4-5, b5-6, 63a6, c4, d3, 65e1, 66a1-2, b4, c7, 67a1-3, e2, e5, 68a2, a6-b1,b4-5.

The description of the journey of the *pathemata* related to sound is curious:

Sound may be defined in general terms as the stroke inflicted by air on the brain and blood through the ears and passed on to the soul *(μίχρι ψυχής πΚηγήν ίαναδώομίνην);* while the motion it causes, starting in the head and ending in the region of the liver *(irepl την του ήπατος 'ihpav)* is the hearing. *(Tun.* 67b2-5)

As vision takes place in the head, no other seat is mentioned for visual perception.

Therefore the mortal parts of the soul (the spirited element and the appetitive part) seem to be tightly linked in one way or another to the process of hearing, smelling and tasting.

These mortal parts are also involved in common perceptions of the body as a whole, namely in pleasure and pain:

They (= the sons of the demiurge) imitating him (= the demiurge) when they had taken over an immortal principle of soul, went on to fashion for it a mortal body englobing it round (= the head). For a vehicle they gave it the body as whole, and therein they built on another form of soul, the mortal, having in itself dread and necessary affections; first pleasure, the strongest lure of evil; next, pains that take flight from good; temerity moreover and fear, a pair of unwise counsellors; passion hard to entreat, and hope too easily led astray. These they combined with irrational sensation *(αΊσθήσα* άλόνω) and desire that shrinks from no venture, so of necessity compounded the mortal element. *(Tim.* 69c5-d6)

The expression *αΐσθησα άλόγω* is not easy to understand if we consider that the rational part of the soul remains the final addressee of the *pathemata.* In fact, the mortal parts of the soul seem to perceive the *pathemata,* but appear to be unable to think about them or to give them a name. So as long as the *pathemata* have not reached the rational part of the soul, their perception remains irrational, insofar as they cannot be named properly.

If irrationality is understood that way, it becomes easy to explain how plants, which are enlivened by the third part of the soul only, the part called *επιθυμία,* which have nothing to do with reason, may be said to be endowed with sensations:

Now that all the parts and limbs of the mortal creature (= man) were united in a living whole, which, as the result of necessity, must spend his life surrounded by fire and air and be consequently dissolved and depleted by them and soon waste away, the gods devised succour for him. They gave birth to a substance of a kindred nature to man's, but combined with other shapes and senses *(ά'λλαΐι ίδί'αΐι καΐ αΐσθήσ(σιν),* so as to be a living creature of a different sort.

These arc trees, plants, and seeds, (. . .). Anything that has life has every right to be called a living creature in the proper sense; and the kind of which we are now speaking has the third form of soul, which, we said, is seated between midriff and navel; this has nothing to do with belief or with reasoning and understanding (λο/ισμοῦ τ« *και νοϋ),* but only with sensation, pleasant or painful, and appetites *(αϊσθήσιων; hi ήδ(ία<; κα'ι akytivrp μ(τα (πιθυμιών).* For it is always suffering all affections *(πάσχον γαρ* διατ{λ<ϊ *-πάντα),* but its formation has not endowed il with any power to observe the nature of its own affections and to reflect *(λογίσασθαι)* thereon by revolving within and about itself, rejecting motion from without and exercising motion of its own. Therefore it lives, indeed, and is no other than a living creature, but it stands still, fixed and rooted, because it is denied self-motion. *(Tim.* 76e7-77c6)

Plants are sensitive to the "common affections of the whole body" and attended by pleasure and by pain. They feel heat and cold, and some at least shrink from contact with hard or heavy or rough objects. The pleasurable or painful character of such contacts is supposed to be accompanied with some faint degree of desire to seek or shun. But plants have no perceptions such as we receive through the special organs of sense, enumerated with the corresponding qualities. Nor have they anything corresponding to the rational revolutions of the immortal soul seated in the brain of man. It seems to be the reason why they are excluded from Plato's scheme of transmigration, though they were admitted, it seems, to that of Empedocles.

Because they are enlivened by the third part of the soul, plants are sensitive, but only to the common affections of the whole body, even if they are devoid of reason. Therefore their sensation can be said to be "non-rational." But, as such, sensation is not non-rational; it remains so, until the *pathemata* have reached the rational part of the soul situated in the humain brain, or if they cannot do so, because plants have no brain.

I will now state the conclusions. But first I would like to give a brief summary of what has been said. Particles coming from outside hit a part of a human body. If this collision gives rise to a *pathema* or a *pathos* depending on the structure, the number and the speed of the colliding particles, the movement then initiated is transmitted by the blood through the body as a whole to the mortal parts of the soul first, and after to the rational part called *phronimon.* There, it triggers the process called *anamnesis,* which is the remembrance of a Form already seen when the soul was separate from the body, a remembrance which allows the activities of thinking and naming to take place. Sensation means the process as a whole, and that is why, in the case of plants, sensation is said to remain non-rational *(alogos),* remaining as such an incomplete process.

In other words, a signal is emitted by a thing from outside, received by a part of the body, and then transmitted to the mortal parts of the soul first and to the immortal part after, where it triggers the remembrance of corresponding Forms which makes language possible.

III. Conclusions

Though it is mathematically and physically very economical, this explanation of sense perception remains problematic on two points. The link between body and soul, and within the soul, the one between the mortal parts and reason are not well-defined. As well, the refusal to verify experimentally and the recourse to teleology weaken the scientific interest of the theory.

A. An Economical Explanation

This explanation of the mechanism of sense perception is very economical, not only because everything is based on the four elements, related to the polyhedra, which are made out of only two right-angle triangles, but also for these three additional reasons.

1) Some particular explanations are linked to a more general explanation. For example, weight is explained within the account of the elemental triangles *(Tim.* 55d ff.) or within the account of the four elements' place in the sphere of the world *(Tim.* 62c3-63e8).

2) Many phenomena are linked under the same explanation. For example, the mechanism involved in the transmission of sound through air *(Tim.* 80a-b) is a circular thrust, the same as the one involved in respiration *(Tim.* 79a-c), and in all the following phenomena:

> To this principle, moreover, we may look for the explanation of what happens in the case of medical instruments for cupping, of the process of swallowing, and of projectiles which keep moving after their discharge through the air or along the ground. *(Tim.* 79el0-80a2)

3) The same explanation is used for vision, touch and taste:

> The particles that come from other bodies and enter the visual ray when they encounter it, are sometimes smaller, sometimes larger than those of the visual ray itself; or they may be of the same size. Those of the same size are imperceptible—"transparent," as we call them. The larger, which compress the

/

ray, and the smaller, which divide it, are analogous to what is cold or hot to the flesh, and again to what is astringent or burning ("pungent" as we call it) to the tongue. These are black and white, affections which are due to those particles and are similar in character, though occurring in a different field and for that reason presenting themselves in a different guise. *(Tim.* 67d2-e4)

So the mechanism of vision, of touch and of taste is always the same, even if these perceptions occur in different sense organs.

It is clear here that Plato's purpose is to demonstrate, as cosmologists had traditionally been attempting to do, that the principles of his physics are sufficient to account for the whole range of our experience of sensible phenomena.

B. Relations between Body and Soul, and between the Mortal Parts of the Soul and Reason.

But, in any case, Plato fails to explain how sense perceptions centralized in the heart by the blood are transmitted to the soul. A Platonic physiology had to respect the dualism of body and soul, mind and sense; yet it also had to provide for a *αΰναψι,ς αισθησΐως προς* ***biavotav*** *(Theaet.* 195dl-2). It had to conform to the epistemological tenets that sense perceptions "reach" the soul and "report" to the soul, submitting their findings to its arbitration.[11] Certainly, Plato's soul is invisible and non material. It would be too much to expect that the physiology of his time be able to bridge the gulf between the material and the non material. Aristotle, the Stoics and the Epicureans will try to solve the problem each in their own way.

Plato also fails to explain what the links are between the mortal parts of the soul and reason. In fact, sense perception seems to remain non-rational until it has reached the immortal part of the soul situated in the brain. If it reaches that part of the soul, sense perception may trigger the remembrance of a corresponding Form and by doing so should

[11] Forexample, *Rep.* IV 423a ff., VII 524 a ff.; *Theaet.* 184d, 186c. In *Tht.* 186c 1-2, the grammatical object of *α'ισθάνίσθαι* is *οσα* δια τοΰ *σώματος παθήματα Ιπ\ την ψυχην Tilvti;* one should note that *τυνυν* and *παράγγελλαν,* the latter of which is found at *Rep.* VII 524a recur in the *Timaeus. Phil.* 33d-34b embodies thoughts remarkably similar to what we find in the *Timaeus.* More passages could be cited and more could be said about the epistemological presuppositions of Plato's physiology, but for the very well known subjects indicated in the text, a few references should suffice. Passages like *Phd.* 79c and *Phdr.* 249b suggest additional aspects of the relationship between the αισβησίΐί and the soul.

provide the opportunity of naming the quality perceived and of talking about it.

The over-all impression is that Plato has imposed his own psychological design of the soul upon the physiological theories of earlier thinkers. In dealing with these theories, he is selective as well as synthetic. It is in the synthesis that new conclusions emerge. The passing on of sense impressions from particle to particle had probably been described by Democritus. The important role of the blood vessel system had been established by Diogenes of Apollonia[12] and others, and the blood itself had been chosen as carrier by the "Sicilian" school." Plato, having committed himself to Empedocles' four elements and given them geometrically defined shapes, is in a position to select two elements whose units qualify them as mobile and sensitive. Regarding the travelling of sound from ear to brain, Diogenes of Apollonia knew as much or more than what we read in the *Timaeus:* what Plato adds is that at the end of this process the soul is reached. This may have been a relatively novel doctrine but is not likely to have been Plato's own discovery.

C. Experimental Verification

In his explanation of smell, Timaeus describes a very simple experiment:

All odours are vapour or mist, mist being that which is on the way from air to water, vapour what is on the way from water to air; consequently, all odours are finer than water, grosser than air. Their nature is plainly seen when a man forcibly inhales the air through something that obstructs the passage of the breath: then no odour filters through with; nothing comes but the air robbed of all scent. *(Tim.* 66d8-e5)

The result of that experiment is used to ascertain the choice of that explanation of smelling.

But, at the end of his explanation of vision, Timaeus denies in general the possibility of experiment, arguing that a man carrying out experimental verification would be the equivalent of the demiurge:

But any attempt to put these matters to a practical test (ei δί' **TIS** *τούτων tpyoi σκοπούμίνος βάσανου λαμβάνοι)* would argue ignorance of the difference

[12] DK 64 B 6 = Aristotle, *Historia animatium* III 2, 511 b30 ff.

[13] Empedocles for example, DK 31 A 86 & B 107 = Theophrastus, *De Sensu* 9, 10; DK 31 B 105 = Porphyrius, *ap.* Stobaeus, *Anth.* I, 49, 53=377F Smith; DK 31 B 109 = Aristotle, *Metaph.* B4, 1000b6.

between nature and divine, namely that divinity has knowledge and power sufficient to blend the many into one and to resolve the one into many, but no man is now, or ever will be, equal to either task. (68d2-7)[14]

Besides, at the time, Greeks lacked instruments to realize such experiments: they also had only local standards to measure length, weight, volume and even time. Numbers were represented by letters, so the easiest computation was extremely complicated; moreover zero was still unknown.

This refusal to verify experimentally makes these coherent and economical explanations mere hypotheses. But for Plato, it doesn't really matter. Ultimately, vision and hearing give the human being the capacity to contemplate the harmony and the beauty of the universe and to reproduce it in him and in the city he is living in.

This concern is clearly formulated in these lines belonging to the first passage dealing with sense perception in the *Timaeus:*

> For our part, rather let us speak of eyesight as the cause of this benefit, for these ends: the god invented and gave us vision in order that we might observe the circuits of intelligence in the heaven and profit by them for the revolutions of our own thought, which are akin to them, though ours be troubled and they are unperturbed: and that, by learning to know them and acquiring the power to compute them rightly according to nature, we might reproduce the perfectly unerring revolutions of the god and reduce to settled order the wandering motions in ourselves. **(Tim.** 47b5-c4)

Vision and hearing reveal the rationality of the universe in order to show the contrast between "secondary causes" and true reason or purpose.

At the end of the *Timaeus,* the ethical aim of cosmology is reasserted *(Tim.* 89d-90d). The contemplation of the universe and, above all, of the celestial movements is supposed to preserve the excellence of the soul. Otherwise sensation may transform the soul into something bad. And because sense perception can change the behaviour of a soul, and thereby determine its destiny, in this way the "material" world acts upon the "non material soul." As well, since sense perception is ultimately a measuring operation, mathematics in the *Timaeus* does have ethical consequences.

[14] Greek terminology for evidence and its examination draws heavily upon words with primary meaning in the legal sphere. Here we find *βάσανος,* the regular term for procedure whereby slave witnesses were tortured in trials in Ancient Greece. On evidence and examination, cf. Lloyd 1979, chap. 4 and particularly, p. 252-254.

APPENDIX: Colors in *Timaeus* 67c-68d

These few pages on *Timaeus* 67c-68d must be read as a specific application of the general mechanism behind sensory perception (described in the main article), as it relates to colors.

A. Translation

[67c] We still have left a fourth kind of sensation, a kind which requires classification, since it includes within itself a host of different varieties, all of which, lumped together, we call colors, a flame pouring forth from each and every body, and which has particles so proportioned to the visual ray as to cause sensation. In what precedes, there was explained the point about the causes of the origin of the visual ray [67d]. Hence therefore it is most natural and would be convenient to go through a likely account of colors, as follows.

The particles that come off other bodies and which hit upon the visual ray are some of them smaller than, some of them larger than, and some of them the same size as, the particles of the visual ray itself. The ones therefore which are the same size are imperceptible—"transparent" as we call them. The others are larger and smaller: the former compress the visual ray, the latter divide it. They are analogous to hot and cold in the domain of flesh, and to pungent in the domain of the tongue, and to all such things, because they bring heat, we call "acrid." [67e] Black and white are the affections therefrom, which, while occurring in a different field, are the same, but appear different for the reason given.

This then is the way they should be spoken of. What is divisive of the visual ray is "white." The opposite is "black." The more piercing motion and one which belongs to a different kind of fire falls upon and divides the visual ray right up to the eyes. It forcibly pushes apart and melts the very passages of the eyes, and makes there pour forth from them a mass of fire and water that [68a] we call a tear. Being itself fire and meeting fire which comes towards it from the opposite direction, what with the fire leaping out as from a flash of lightening and the incoming fire being quenched as it enters the domain of what is moist, and what with colors of every kind being produced in the resultant confusion,—this effect we speak of as "dazzling," while the agent which produces it we christen "bright" and "flashing."

Then there is the kind of fire intermediate between these two [68b], which does reach the moisture of the eyes and mixes with it, but is not dazzling. To the radiance of the fire appearing through the moisture with which it is mingled and which produces a blood-colour, we give the name of "red."

Bright, mixed with red and white, becomes golden. What is the measure of the one with the others, it would make no sense to state, even if one could know; for of these matters there is no necessity nor a plausible account that one might be able to give even in an approximate sort of way.

Red blended with black and white is [68c] purple, or dark violet, when these ingredients are burnt to a further point and more black is added to the mixture. Tawny is formed by blending golden and grey, grey being a mixture of white and black; white yellow is a combination of white with golden. White combined with bright and plunged in intense black results in a dark blue color; dark blue, mixed with white, in pale blue-green; tawny and black, in green.

From these items, it will be sufficiently clear by what combinations the remaining colors should be represented so as to preserve the probability of our myth. [68d] But if anyone attemps to put these matters to a practical test he would be ignorant of the difference between human nature and divine, namely that god has knowledge and power sufficient to blend the many into one and again to resolve the one into many, but no man is now, or will be, equal to either task. (Cornford's translation here as later slightly revised. Denis O'Brien kindly pointed out to me both the excellences and the deficiencies in Cornford's rendering of the text.)

B. Running Commentary

The act of naming is central to this part of *Timaeus.* Clearly, the establishment of names is extremely important, if it is not indeed synonymous with the organization of the universe *(Tim.* 53b5). Vision functions in a manner analogous to the other senses (touch, taste, smell, and hearing). Colors are distinguished and classified by means of signals, which are first received by the eyes, and then transmitted to the rational part of the soul. The various colors are then given names, as is described in the main paper.

In his explanation of the mechanism of vision, Plato is following Empedocles, who compares the eye to a horn-plated lantern DK 31 B 84 = Aristotle, *De Sensu* 2, 437b23; see also DK 31 A 92 = Plato, *Meno* 76c). Theophrastus' more elaborate account (DK 31 A 86 = *De Sensu 1* ff.) of Empedocles' theory of vision falls into three parts. First, he outlines Empedocles' general theory of perception by means of different sizes of pores in the eyes and effluences in the objects seen. Then, he depicts the composition and the structure of the eye which is made of the four elements, but mainly of fire. Finally, he describes the act of vision in terms of pores and of effluences from the object seen.

Like Empedocles, Plato links vision to fire, or more precisely to various types of fire. We learn more about Plato's views on fire from the following passage: "There are kinds of fire: flame (<ρλό£), the effluence from flame which does not burn but gives light to the eyes; and what is left of fire in glowing embers when flame is quenched." (58c) More generally, the mechanism of vision as explained by Plato in the passage quoted, involves three kinds of fire. 1) The visual current, a pure fire contained in the eye. 2) A fire streaming off from every body, having particles proportionate to those of the visual ray. 3) Daylight, a body of pure fire diffused by the sun. More specifically, in daylight, a physical link is created between subject and object, when the fiery particles emitted by the object encounter the fiery particles emitted by the eye.

Ultimately, sight, as well as taste, smell and hearing, can be considered as a sort of touch which uses a special organ (the eye) and deals with a specific element (fire). The contact between the visual ray and an external fire produces a signal in the eye, which as such is a movement later on transmitted through the body by the blood up to rational part of the soul which inhabits the brain.

The particles of fire which stream off from each object must be proportionate to the visual ray. The word *σύμμιτρα* describes the relationship *(συμ-)* between two sets of measures *(μίτρα):* the measures of the particles coming from outside and those of the particles in the visual ray. In the final analysis, this etymology becomes crucial, because it demonstrates how, for Plato, who seems to follow Empedocles in these matters, vision is understood as a comparison between measures, or a measuring operation. The description which follows (67e-68b) will take into account the shape (tetrahedron or pyramid) of the fire particles, their size (bigger, smaller or the same), and probably also their speed (high or low). Here again Plato seems to be under the influence of Empedocles' theory of sensation (DK A 86 = Theophrastus, *de Sensu* 7). Both Empedocles and Plato make

συμμετρία a requirement of successful vision. But while for Plato what is required is *συμμετρία,* between the effluence and the visual ray, for Empedocles it is *συμμετρία* between the effluence and the eye. Moreover Plato's explanation is mathematical, as we will see.

The mechanism of sight is described mainly on the basis of the opposed processes of division and compression, which in turn are directly related to fire's essential characteristic: its tendency to penetrate and consequently divide its object. The explanation of white, black or transparent depends only on the size of the particles, which have the shape of a tetrahedron or a pyramid. According to *Tim.* 64d, affections which are neither painful nor pleasant function in much the same way. "Dividing" means spreading particles (of the visual ray) apart, and "compressing" means bringing them together. So when the particles coming from outside are smaller than those of the visual ray, they spread them apart, enlarging the space between them. When the particles coming from outside are bigger than those of the visual ray, they bring the latter together, reducing the space between them. When, however, the external particles are larger than those of the visual ray, no change takes place, and perception of color does not occur. For details, see Figure 1. That is why the transparent seems not to be a color, but an absence of color.

According to this explanation, the sense of sight (and more specifically black and white) is brought into relation to those of touch and of taste, using the verbs compressing and dividing. Hot and cold are explained in the following way:

> First, then, let us see how it is that we call fire "hot." We may study this question by observing the rending and cutting effect of fire upon our bodies. We are all aware that the sensation is a piercing one; and we may infer the fineness of the edges, the sharpness of the angles, the smallness of the particles, and the swiftness of the movement, all of which properties make fire energetic and trenchant, cleaving and piercing whatever it encounters. When we recall the formation of its figure we see that this substance, more than another, penetrates the body and divides it minutely and naturally gives the affection we call "hot" its quality and its names. The opposite quality is obvious enough, but it shall not go without an explanation. The particles of fluids in the neighbourhood of the body, when they enter it, thrust out the particles smaller than themselves, and not being able to insert themselves into their places they compress the moisture in us and solidify it by reducing what was not uniform and was therefore in motion to immobility, resulting from uniformity and compression. But a thing that is unnaturally contracted struggles, pushing itself apart again into its normal state. This struggling and shaking is called trembling and shivering; and the name "cold" is given to this affection as a whole and to the agent producing it. (61d5-62b6)

This passage is very interesting, because it elaborates on how dilation and contraction constitute tactile perceptions. In the case of sight, this opposition explains the colors, black and white (for details, see Figure I, p. 176).

Similarly, compressions and divisions explain taste as well, in a general sense, and then particularly the qualities of pungency (65e-66a) and acridness (65d):

> These (the affections peculiar to the tongue), like most of the others indeed, appear to be due to compressions and divisions of some sort; and further they have more to do than any of the rest with degrees of roughness and smoothness. (65c3-6)

In addition to their size, the swiftness of the particles is also taken into account to explain the bright and the red. The adjective *οξύς* means acute. It refers to the piercing and thus dividing quality of fire, because fire is related to the tetrahedron, or pyramid (55d-e, 56a) which looks like the point of an arrow. When said of motion however, *οξύς* means "quick, swift." Thus the meaning of *οξύς* in the phrase *την όξυτέραν φοράν* appears to be ambiguous, because the word can apply either to speed or to shape. That is why I think that the speed of the particles is taken into account here. Besides, one should note that when applied to things that affect the sight (the sun for example, //. 14, 345; 17, 372) and to colors (Aristophanes, *Peace* 1173), ó£ýí means "dazzling, bright."

This sharper fire divides the visual ray right up to the eyes. It pushes apart and melts the very passages of the eyes, and makes pour forth from them a mass of fire and water, called a "tear." This process is described in 83d7-e2:

> We call white phlegm all this decomposition of tender flesh in combination with air. Freshly forming phlegm, moreover, itself has a residue, namely sweat, tears, and all other such flowing substances that are daily purged away.

Flesh itself is constituted in the following way:

> With this intent, he who moulded us like wax composed flesh, soft and full of sap, by making a duly adjusted compound with water and fire and earth, which he suffused with a ferment composed of acid and saline. (74c5-dl)

Tears and flesh are naturally related, since they are composed of the same elements, fire and water, as we see in 74b7-c5:

While the flesh was to be a defence against burning heat and a shelter from wintry cold, and also a protection against falls, like our borrowed trappings of felt: it would yield to bodies softly and gently, and it contained in itself a warm moisture, which in summer it might sweat forth and so spread an active coolness all over the body by moistening it outside, while in winter, on the other hand, we should have this fire as a fair protection against the assaults of the beleaguering frost outside.

So when the fire contained in tears meets the fire which comes towards it from the opposite direction, the effect is "dazzling," while the agent which produces it is qualified as "bright" and "flashing."

"Bright" and "flashing" are classified as colors, which supports the belief that Greek terms for colors have more to do with differences of tone and brillance than with differences of shade. But the use of "bright" *(στίλβον)* and "flashing" *(λαμπρού)* remains puzzling. First, we are told that the dazzling effect gives rise to "colors of all sorts"; but in the last sentence (68a) "bright" or "flashing" is treated as if it were a simple color which, like other colors such as white and red, enters into compounds (for details, see Table 1). More generally, the word *στίλβον* may be said of lightning (Euripides, *Orestes* 480) and of metals, especially gold *(Tim.* 59b); and the word *λαμπρόν* may be said either of the rays of the sun *(Horn. Hymn to the Sun* [XXXI] #10) or of metallic bodies associated with the light of the sun (*//.* 13, 132; 17, 269).

When a kind of fire intermediate between the two reaches the moisture of the eyes (that is the water of the tears) and mixes with it, the result is not the bright or dazzling, but the color called "red." What does τούτων *μίταξύ* mean when qualifying a variety of fire? This kind of fire is relative to two others: the fire with a more piercing motion, which accounts for bright or flashing, and that with a less piercing motion, which accounts for black and white. If I am right, this third variety of fire is distinguished from the two others by its speed. Aristotle *(Mete.* 374a3) says that white light seen through a dark medium looks red. He regards water as dark, and this explains why the sun appears red through mist as well as through smoke. Thus, in this case, fire and water combine to produce the color red.

In my opinion, the crucial point in this passage is the link established between the color red and blood. Blood is described in the following way in 80d7-e4:

The particles, being freshly divided and coming from kindred substances - from fruits or herbs which the god caused to grow for this very purpose of feeding us - take on all manner of colors owing to their being mixed together;

but they are chiefly pervaded by a red hue, a character inwrought on moisture by fire that cuts and stains it.

Red is primarily the color of blood, which is a liquid where fire plays an important role.

Here ends Plato's description of what he considers the four primary colors. All other colors are seen as various combinations of the above (for details, see Table 1, p. 175).

In the *Timaeus* we find many examples of Plato's interest in manual skills, and not only in reference to the Demiurge. When it is said that red mixed with black and white makes purple, we must naturally think of a mixture of painters' pigments. And the use of the word "plunge," moreover refers directly to the work of dyers preparing their dye baths.

As in other languages, the names of colors are in Greek closely associated with natural realities or phenomena. Golden *(ξανθόν)* is the color of ripe corn, of gold, of honey and of hair. Purple *(άλουργόν)* is a darkened red. Dark violet *(ορφινον)* derive from *ορφρη* which indicates the color of sky at night. Tawny *(πυρρόν)* is used to speak of men or women with reddish hair. Grey *(φαιόν)* is naturally a mixture of white and black. White yellow *(ώχρόν)* is used to describe the complexion of "intellectuals" such as philosophers, or more specifically, Pythagoreans. Dark blue (κυανοί/) is the color of the enamel used to adorn armour (*//.* 11, 24; pseudo-Hesiod, *Scut.* 143), and of the stone called *lapis lazuli.* Pale blue green (γλαυκοί/) is the color of the sea and of olives. Finally, as Cornford notes, *πράσιον* is commonly used to designate the greenish color of the leek *(πρίσον).*

We have seen which of the four primary colors should be mixed together to obtain the nine other colors. Nothing however has been said so far about the mutual proportions of the mixture's ingredients. Plato gives the reason for this, adding an implicit criticism of Empedocles, when he says: "there is no necessity nor a plausible account . . .," criticizing Empedocles. According to Theophrastus *(De Sensu* 8 = DK 31 A 86), Empedocles explained the difference between the qualities of vision by the mutual proportion of elements within the eye. Moreover, in the fragments on blood, on flesh (DK 31 B 98 = Simplicius, *in Phys.* 32.6 ff.) and on bones (DK 31 B 96 = Simplicius, *in Phys.* 300.21 ff), numerical ratios between the four elements are indicated.

At the end of his explanation of vision, Plato warns against the arrogance of experimentation, arguing that a man carrying out experimental verification would be the equivalent of god. One may read in these words a condemnation of the boastful words with which

Empedocles opened his poems of *Purifications*. On this interpretation, Plato would not be criticizing Empedocles for carrying out experiments, but for claiming to be equal to a god in knowledge. If this hypotheses is the right one, the τι$- would refer to Empedocles.

More generally, this refusal of experimental verification makes Plato's coherent and economical explanations of colors mere hypotheses, equivalent to myths.

This explanation of colors, partly borrowed by Plato from Empedocles, is consistent with the mathematical explanations found elsewhere in *Timaeus* for both physics and physiology; thus sight can be defined as a measuring operation. It is an economical explanation because the processes of division and compression, enabling the perception of white and black, are in addition related to the senses of taste and of touch. It is a simple explanation because it corresponds to Plato's global ideas on sense perception. However, Plato's refusal to submit his theories to experimental verification deprives them of any scientific value.

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Table 1: Plato's palette of colors

Plato's explanation for colors is so simple and so coherent that it seems of interest to present it in table form.

There are four basic colors

White = A
Black = B
Red = C
Bright = D

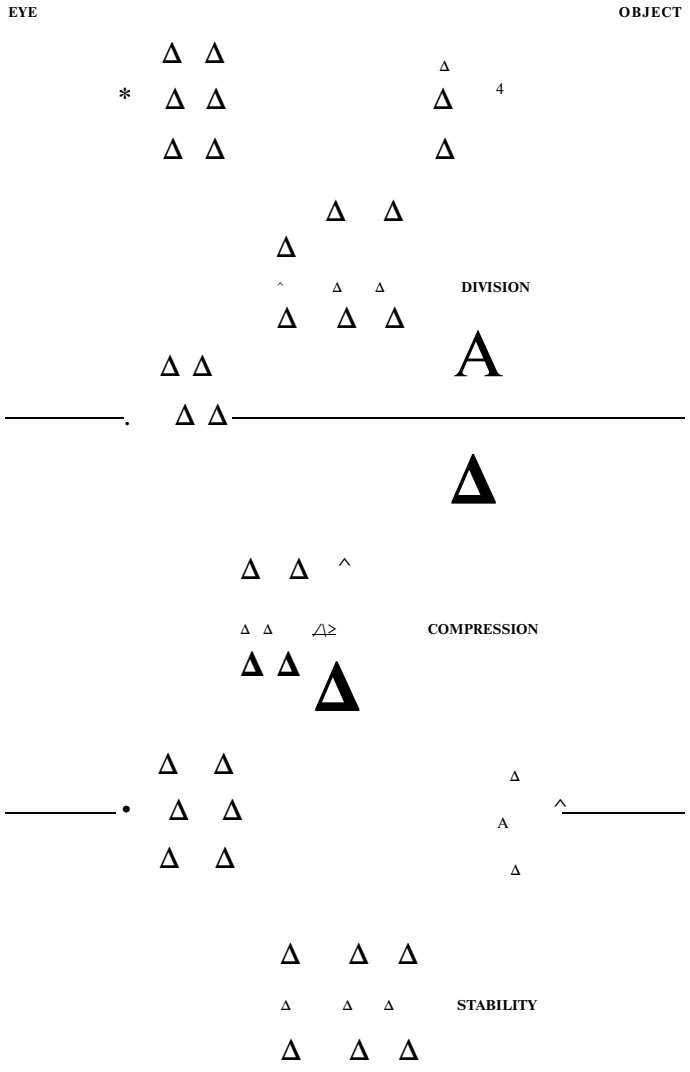
By mixing these basic colors, one can obtain all other colors

golden (E) =	A + C + D
purple (F) =	A + B + C
dark violet (G) =	(A + B + C) + B = A + 2B + C
tawny (H) =	E + I = (A + C + D) + (A + B) = 2A + B + C + D
grey (I) =	A + B
white yellow (J) =	E + A = (A + C + D) + A = 2A + C + D
dark blue (K) =	A + B + D
pale blue green (L) =	A + K = A + (A + B + D) = 2A + B + D
green (M) =	H + B = (2A + B + C + D) + B = 2A + 2B + C + D

That is

I	A	B			
F	A	B	C		
G	A	2B	C		
H	2A	B	C	D	
M	2A	2B	C	D	
E			C	D	A
J			C	D	2A
K				D	A	B
L				D	2A	B

Figure 1. The visual application of Plato's theory of compression and division



Commentary on Brisson

DANA R. MILLER

Professor Brisson presents an accurate and useful discussion of the account of the physical mechanics of sense perception in the *Timaeus*. Although his discussion is lucid, the following outline of the basic points might be helpful:

(1) the primary substances are the four elemental bodies;

(2) secondary substances are aggregates of the elemental bodies;

(3) secondary substances produce various effects or *pathemata* on sentient beings;

(4) the organs of sense receive the effects and transmit them as motions through channels;

(5) these channels are the blood vessels;

(6) blood vessels have the intermediary role of conveying these motions to the brain;

(7) the brain conveys these motions to the rational, immortal part of the soul.

Finally, one might add this to the list:

(8) the rational part may choose, once aware of motions originating from the sense organs, to direct the activities of the body and of the other parts of the soul.

Although Plato is reputed to have had less regard for the outside world than most humans, he has in the *Timaeus* troubled himself to give a more or less coherent account of sense perception. Sense perception provides the basis of our cognitive link to the world around us. Remaining with the "link" metaphor, the account of perception just outlined is a chain composed of several links. Now a chain is only as strong as its weakest link. Just how strong is Plato's chain? Prof. Brisson claims that it is a very weak chain indeed.

At the end of his paper Prof. Brisson argues as follows:

> Plato *fails* to explain how sense perceptions centralized in the heart by the blood are transmitted to the soul. A Platonic physiology had to respect the dualism of body and soul, mind and sense, yet . . . it had to conform to the epistemological tenets that sense perceptions "reach" the soul and "report" to the soul, submitting their findings to its arbitration. Certainly, Plato's soul is invisible and non-material. It would be too much to expect that the physiology of this time would be able to bridge the gulf between the material and non-material (this volume, p. 164).

It is *not* clear to me why Plato's account "fails." I take it that Plato's account "fails" either because (a) it does not do the explanatory work Plato should, and presumably did, require it to do or (b) it does not do the explanatory work that *we* require of a plausible, experimentally verifiable, account and, furthermore, it makes claims contrary to what we regard to be scientifically established truth.

If Prof. Brisson thinks that Plato's account fails in the sense of (b), I would agree. Still, this would be a rather insignificant failure, one hardly worth mentioning. No one would expect such an account from Plato nor, for that matter, from Descartes. I would think, then, that the claim is that Plato's account fails in the sense that his theory does not do the explanatory work he needs it to do.

To investigate whether Prof. Brisson is right, we must determine what work Plato's theory must do and whether the links in his chain of transmission are strong enough to accomplish this work for him.

For the sake of the argument, let us grant Prof. Brisson's assumption that the work that the perception theory must do is to give an account of how sense perceptions "reach and report" to the soul, or as Plato puts it in the *Theaetetus,* how sensations have a "connection with the mind" *(συνά-ψιι προος οιάνοιαν* [195d1], quoted by Brisson on p. 164).

Following the general framework of Prof. Brisson's exposition of Plato's theory of sense perception, which I have summarized, we need an account of how the senses inform the mind about the external objects that have an effect on them. To accomplish this task, the effects or *pathemata* produced by external objects must be transmitted to the mind in a language, so to speak, which it can understand. If Plato can give a coherent account of this, an account that would be plausible, given the other claims for which Plato argues in the *Timaeus,* then the theory has done the work required of it: it has succeeded.

Let us take a simple case. Heraclitus comes out of his cave to go swimming; it's unbearably hot. The only water nearby is a river.

Heraclitus goes to the river, but as he approaches, he hears a roar and observes to himself, "By Zeus, I bet the water in that river is moving so fast that if 1 went in, I would never be the same again, in fact, I would drown!" So Heraclitus decides not to enter the river.

What has happened here is that Heraclitus' eyes and ears were affected by the turbulence of the river. These organs transmitted the information to Heraclitus' mind, his thinking, which occurs in the rational part of his soul. His mind sizes up the situation based on what information it gets from the senses, and concludes that swimming would be risky.

Now we must examine the links of the chain. In the interest of brevity and clarity I will limit the number of links to three. (1) A sense organ's reception of data from objects of sensation and its transmission of this data inwards. (2) The blood's transmission of sense data to the brain. (3) The brain's transmission of sense data to the soul.

(1) According to Plato, as Prof. Brisson has explained to us, an audible sound is a "blow that is transmitted to the soul through the ears by the air of both the brain and the blood" (67b2-4), and "the motion" caused by this blow, a motion that starts in the head and ends up in the region of the liver, is "hearing." The river by its turbulence produces "blows" that are transmitted by the motion of the elemental air bodies that lie in between the river and Heraclitus' ear. So the sound of the river enters Heraclitus' ear as "blows" which are motions that are then transmitted inwards through the ear.

What about the sight of the swirling waters? According to Plato's account (45b-c, 67c), the dark churning of the waters cause the emission of pyramidal fire bodies. Pyramidal fire bodies emitted from the eyes, joining with similar fire bodies from sunlight, form a stream or ray that comes in contact with the fire bodies coming from the river. Because the waters are dark, these fire bodies are bigger in size than the fire bodies of the visual ray. Being bigger, they forcibly condense the visual ray. The visual ray, which extends from the eyes to the object of vision, has the "same affectivity" throughout (45c7) and is "a single body" (45c4). It therefore transmits the motion (45d1) of forced condensement "into the body until it reaches the soul" (d2).

So the sight of dark, churning waters enters Heraclitus' eyes as a kind of motion transmitted by the fire bodies of vision. As in the case of hearing, this motion is transmitted onwards to the brain.

To summarize: the first link is the transmission of motion originating from an external object into the body through an organ of

sense. The elemental bodies, in this case air and fire, do the transmitting, passing on the motion faithfully because each kind has the same basic shape and mobility. Within the conceptual framework of the *Timaeus,* this link seems adequ?te. (2) The second link is the blood's transmission of the "motion"—which originates from the sense object—to the brain. Blood is a composition of the four elemental bodies. Its channels, of course, go to all parts of the body. The blood transmits the received "motion" by the interaction of its elemental constituents. For example, a sensible motion transmitted by air outside the body is transmitted to the brain by the air particles in the blood. Granting that elemental air bodies can transmit a motion in this way—something that Plato would have no compelling reason to doubt—this part of the transmission theory is plausible. Prof. Brisson suggests that the blood will take the "motion" to the heart and that this poses a problem (p. 164). In the case of hearing and sight, obviously the blood's first stop will be the brain, so there is no problem. But even, say in the case of touch, the "motion" should pass through the heart on the way to the brain, I fail to see a problem. What is important for Plato is that the "motion" is transmitted to the brain, which does not seem to be in question.

(3) The third, and most interesting, link in the chain of perception is between the brain and the soul. Plato claims that the "motion" is transmitted from the brain "to *(μέχοι)* the soul" (45d2). To understand how this might work we need to know what, in Plato's conception, the brain is and what the soul is. The latter requirement cannot be easily met. But I think the following definition might serve, at least, for the present argument. The soul is, for Plato, a self-moving something' not composed of the elemental bodies; furthermore, what goes on in the soul can be reduced to motions of some kind. As for the brain, it is formed marrow, as Prof. Brisson has explained to us (p. 150).

Plato pays special attention to the marrow. Why he does so will become immediately apparent. The marrow is formed of the very finest materials in exact proportion: it consists of the most perfectly shaped elemental bodies, made of the best "triangles." The marrow is the "origin" or "starting point" (αρχή 73b2) for the generation of all the other tissues of the body, and the organism is formed around it. Marrow constitutes a "universal seed-ground *(πανσπερμίαν)* for all

[1] See Plato's discussion of soul and self-motion in *Phdr.* 245c5ff, *Lg.* 896a Iff.

living beings" (73cl-2). It is such a seed-ground for living beings because "the three kinds of soul are *planted* and bound fast in the marrow" (73c3-4), and, of course, a thing cannot be alive unless it has soul. The three kinds of soul, rational, spirited, and appetitive, are "planted and bound fast" in differently shaped and located parts of the marrow. The round marrow located in the head is like a "plowland *(αρουραν)"* into which the "divine seed," that is, the most divine kind of soul, the rational soul, is "planted" (73c7-8).

The marrow serves as an "anchor" and "bond" (73d5-6) which binds the soul to the organism. How, exactly, does this work? The marrow is composed of the best materials because the best materials fit together in the strongest possible way. Thus fitted together they can *hold in* the soul, which is, according to the definition we have adopted, a self-moving something not composed of elemental bodies. So marrow holds in the soul's motions. According to Plato, when we get old or sick, what holds the triangles together, thus forming the elemental constituents of the marrow, is "loosened" (81c6). Once this happens, the bonds that hold in the soul-motions are broken, the soul escapes unharmed, and the body dies (81d5-e5).

The relation, then, between the marrow and the soul is one of container and contained. The circular motions of the divine part of the soul are happily contained in the round marrow of the brain. Thinking and self-awareness, Which is the primary activity of this part, consists of these motions.[2] In a discussion of the appetitive part of the soul, quoted by Prof. Brisson (p. 162), Plato mentions that this kind of soul lacks the capacity to be "self-aware and rationally to consider *(λογίσασθαι)* what pertains to itself while it revolves within and about itself, rejecting motion that comes from outside and exercising its own motion" (77b7-c3). I think it is rather clear that the rational soul does possess precisely this capacity. It resembles the world soul which, Plato tells us, likewise "revolves within itself," having an "intelligent" life (36e3-4).

Now to return to the account of perception. The motion originating ultimately from an external object, Heraclitus' river, reaches the brain through the blood. Transmitted through the high-quality elemental bodies of the marrow, this motion disturbs the motion of the rational soul (cf. 43d 1-2, 44a4-7). The circular motion of the rational soul is self-aware and therefore is aware of the appearance of a new motion.

[2] Cf. 37b6-c3,40a8-bl, 90c7-dl; *Lg* 898a8-b8; cf. also/in. 407al9-23.

The soul, possessing a superior kind of self-motion, quickly "rejects" the disturbing motion—lest it have longtcrm effect on its own motion—and, on the other hand, "rationally considers" what the new motion has "announced to it" (64b6) about the outside world. Heraclitus realizes that swimming is not an option.

This is the third link. It too, I think, holds. The chain of perception as a whole holds because Plato has carefully analyzed perception as a transmission of motion and reduced thinking to motion as well.-[1] Motions, he thinks, can have an effect on one another, and furthermore, he accepts the old principle that "like recognizes like."[4] Therefore it is at least plausible that external objects can impact on us through our sense organs such that we make rational choices based on the information received. Therefore, within the framework of the *Timaeus,* Plato's account of perception, I think, succeeds.

But Plato should not be released without a final challenge. Motion is the motion of something. It is not clear just what kind of thing the soul is, but it is, in Plato's view, something. The motions transmitted by the air and Fire bodies in Heraclitus' marrow are evidently motions of these bodies. But it is far from obvious just how the soul's motion is disturbed by the motion of the elemental bodies that are its container. If the soul is perfectly non-material, it is hard to conceive how the motion of whatever it is could be troubled by the motion of a material body. Prof. Brisson, in the passage I quoted at the beginning, says that "a Platonic physiology had to respect the dualism of body and soul." Dualism between the material and non-material is, in the view of Prof. Brisson, unbridgeable, at least for Plato. Therefore Plato's theory of sense perception was doomed to failure from the outset.

But is the soul perfectly non-material in the *Timaeus;* is soul a kind of Cartesian mind? I do not think so. It is clear that it is not composed of the elemental bodies or of the triangles. But it is nowhere stated that the soul is immaterial in every respect. Soul, in the *Timaeus,* is an intermediate kind of thing; in later Platonism this idea became very popular indeed. Soul is constructed out of the following constituents: "In between the indivisible substance *(ουσίας)* which is always the same and the divisible <substance> that comes to be with respect to *(ntpi)* bodies, he compounded *from both* a third kind of substance" (35al-4). Although we may not be able to say just what kind of

[3] See 43c4-7 where all sensations are defined as "motions."

[4] See, e.g., *Phd.* 66al-3, d8-e2; alsodn. 404bl7-18, 405bl5.

substance the third kind of substance, soul, is, it cannot be perfectly immaterial, inasmuch as one of its constituents is quite material. Insofar, therefore, as it has something in common with material substance,[5] Plato can reasonably claim that the soul can be influenced by motions from bodies and can be a cause of motions in them.

From our perspective Plato's account of sense perception may not be satisfying, but we should, at least, credit him with an account that is inwardly coherent and thoughtfully constructed.

We would probably like Plato to be a little more forthcoming; we would like him to tells us a bit more about just how he thought soul causes motion in bodies. To my knowledge Plato confronts this problem directly only once. In the *Laws* Plato offers three possible explanations of how soul can move a body, for example, the sun.

> (1) The <soul> abides within this visible round body <of the sun> and conveys it everywhere just as our soul carries us about everywhere;
>
> (2) or, as some hold, from somewhere outside <itself> the <soul> provides itself with a body of fire or air of some kind and pushes the body <of the sun> with a body;
>
> (3) or thirdly, the <soul> itself, though being bare *(ψιλή)* of body, has certain other most extraordinary powers <by which> it guides <lhe sun>. (898e8-899a4)

Plato does not commit himself to any of the options given here. But, keeping the *Timaeus* in view, I suggest that Plato may be proposing the following explanation of how soul moves body. In the *Timaeus* Plato offers a version of the first option: soul, within and throughout the body of the world, causes its motion. But option (1) does not tell us very much. Option (2) seems to tell us more: soul uses elemental bodies as instruments by causing them to move, and they, in turn "push" other, larger, bodies. Even if Plato does hold this view (which he attributes to others), it does not tells us all we want to know. How does soul move air and fire bodies? Option (3) is compatible with options (1) and (2) and tells us something new. Soul, according to (3), is "bare of body." In the framework of the *Timaeus* this would mean

[5] Because of this commonality with material substance Plato can claim that soul is *spread throughout* the body of the world and envelops it (36e2-3)—something against which Aristotle protests *(An.* 407a2-3)—and, as mentioned above, that its motions are *held in* by the marrow.

that soul is not formed of the triangles.[6] But further, soul, according to option 3, also possesses "powers ***(bvvaptis)."*** These powers are said to be "extraordinary ***(ύπ(ρ βάλλουσας*** *θαΰμαπι)"* but not transcendent. The powers of soul, Plato says, "guide" the sun. But what propels the sun, what actually causes it to move? Perhaps the answer is given in option 2. Perhaps Plato is suggesting, in a backhanded way not uncharacteristic of him, that the "extraordinary powers" of the sun's soul move its elemental bodies (i.e., fire bodies: see *Tim.* 39b4-5) which in turn propel the sun. In the *Timaeus* Plato claims that the transmission to soul of the sensations of hearing and sight occurs by the motions of air and fire bodies. In view of the passage in the *Laws,* he may have also thought that soul, by its powers or motions, transmits motion to air and fire bodies, which are the finest and most mobile of the elemental bodies. These bodies, in turn, initiate motion in the other less mobile elemental bodies and, in general, in the organism's various parts, "pushing" them, so to speak. If this is so, the passage in the *Laws* does not, in fact, state three alternative accounts, but three stages of a single account: by its special "powers" (option 3) soul moves certain elemental bodies (option 2) in a living organism (the sun, having soul, is alive) which then spread motion throughout the organism (option 1).

If we were to challenge Plato to explain to us just how the soul's "extraordinary powers"—which I take to be the "motions" discussed in the *Timaeus*—move the subtlest elemental bodies, he might reply that it is just obvious that the soul's powers do move these bodies, and that they can do it by virtue of the fact that soul is an intermediate substance.

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See the discussion of body at 53c4-7.

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