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Aristotle's Theory of Colors

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This paper presents two Aristotelian explanations of color: a locational and a material. It presents both definitions, and then it focuses on his material explanation- specifically how to understand what black and white constitute and are constituted by. It argues that black and white are ontologically basic (not constituted by smaller particles). The amount of fire in the determinate body determines the amount of black and white particles, and a high degree of transparency decreases the proportion of black to white particles, and a low degree increases it. Considering the relationship between black and white and the basic qualities hot, cold, wet, and dry, the basic qualities determine which kind of determinate body is present, but they do not constitute the black and white upon that body.

Introduction

In this essay, I investigate Aristotle's theory of colors. I look at his locational definition; Aristotle defines it as the limit of the transparent in determinately-bounded bodies. Then I show his material explanation of what objectively constitutes color, in which Aristotle constructs color from ratios of white and black. I concentrate on Aristotle's material explanation of colors; specifically, how to understand what the primary colors black and white constitute and are constituted by. I argue that black and white are ontologically basic, and then I present a series of counterarguments and responses to help understand how black and white relate to the presence of fire and the degree of transparency, whether they are further reducible, and how the construction of the plurality of colors from black and white parallels Aristotle's construction of complex bodies from hot, cold, moist, and dry humors.

Color Qua Limit of Transparent in Determinate Bodies

To understand what the "transparent" is, Aristotle says in *De Sensu* 3 that the transparent is "not something peculiar to air, or water, or any other of the bodies usually called transparent, but is a common nature and power, capable of no separate existence of its own, but residing in these, and

subsisting likewise in all other bodies in a greater or less degree[1]" (439[a]22-25). The transparent is present in determinate bodies (those with surfaces) and indeterminate bodies (those without surfaces) and is itself bounded and unbounded. The transparent in indeterminate bodies has no bounding extreme or surface, while that in determinate bodies has one (439[a]27-29).

The locational definition of color in *D.S.* is that it is the limit of the transparent in a determinately-bounded body. Aristotle explains this definition of color from two perspectives; from that of the transparent and that of the determinate body. From the perspective of the transparent, Aristotle argues that "colour [is] actually either at the limit, or [is] itself that limit" of the bounded transparent in a determinate body (439[a]29-31). From the perspective of the body, because determinate bodies have bounding extremes, their own color is "definitely fixed" (439[b]5-7), and specifically at that extremity of the body (439[b]10-11).

This is in contrast to the unbounded transparent in indeterminate bodies. Aristotle says in *D.A.* 2.7 that the transparent is "what is visible, and yet not visible in itself, but rather owing its visibility to the colour of something else; of this character are air, water, and many solid bodies[2]" (418[b]4-6). It is also found "in the eternal upper body" (418[b]6-9). Here, the transparent is of the kind without its own determinate boundary, and it resides in bodies that are also boundless, such as water and air. Because it has no boundary, it has no color of its own, but owes its visibility to the color at the boundary of a nearby determinate body. This explains why (unlike the color of determinate bodies) the color of indeterminate bodies is "not the same when one approaches and views it close by as it is when one regards it from a distance" (439[b]3-5).

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[1] I use translations of *De Anima (D.A.)* by J.A. Smith*, De Generatione Animalium (G.A.)* by A. Platt, *De Generatione et Corruptione (G. et C.)* by H.H. Joachim, *De Partibus Animalium (P.A.)* by W. Ogle, *De Sensu (D.S.)* by J.I. Beare, *Metaphysica (Metaph.)* by W.D. Ross, *Meteorologica (Meteor.)* by E.W. Webster, and *Physica (Phys*.) by R.P. Hardie & R.K. Gaye in Aristotle, *The Complete Works of Aristotle.* Edited by Jonathan Barnes. Vol. One and Two. Princeton, N.J.: Princeton University Press, 1984. I cite pagination from Immanuel Bekker's 1831 Berlin edition.

[2] By 'solid bodies,' I think he means bodies without a determinate boundary, yet are solid. According to the presented interpretation, if it has a surface, then it must be visible in itself, or have its own color.

Aristotle defines color as "the limit of the transparent in determinately bounded bodies[3]" ($439^{b}11$-12). We can now go back and understand *De Anima* 2.7, where Aristotle says that "whatever is visible is colour" ($418^{a}28$-29) and that color is "what lies upon what is in itself visible; 'in itself' here means not that visibility is involved in the definition of what thus underlies colour, but that that substratum contains in itself the cause of visibility" ($418^{a}29$-31). It seems like he says that two things are what is visible: the color and what color lies upon. Alan Code explains that "a color is a feature of a surface, and since color is the cause of visibility, it follows that the cause of visibility is a *per se* attribute of surface."[4] Adding the premise that color is at the limit of the transparent, Code says: "On this theory, the color of the body is a feature that its surface possesses insofar as that surface is the limit of something transparent[5]."

Black and White in Determinate Bodies

We have found that color is at the limit of the transparent in determinate bodies. We can now look at different interpretations of what objectively constitutes color. When fire or a fire-like substance is present in the transparent in an indeterminate body, it produces light (and its absence produces darkness) ($418^{b}11$-14, 19-21). However, when fire is present in the transparent in a determinate body, it produces the primary color white, and its absence produces black ($439^{b}15$-19). The ancient Greek term 'λευκός,' which I have translated as the primary color, white, has also been used in extant literature as 'pale,' 'shining,' and 'colourless.'[6] However, here it is used only to refer to the primary color whose

[3] Code, Alan. "Aristotelian Colors as Causes." In *Festschrift for Julius Moravcsik* , edited by J. Woods D. Follesdall, London: College Publications, 2008. (I cite page numbers from the pdf version on Code's webpage on the Rutger's Department of Philosophy website: pg. 10, n. 21.). I am taking Code's proposed translation of $439^{b}11$-14 (instead of J.I. Beare's in the Barnes edition), which maintains Aristotle's premise that indeterminate bodies do not exhibit their own color.
[4] Code, op. cit. 11.
[5] Ibid. 12.
[6] Platnauer, Maurice. "Greek Colour-Perception." *The Classical Quarterly* (Cambridge University Press) 15, no. 3/4 (Jul.-Oct. 1921): 155-6.

opposite is black. So Aristotle defines white and black to be what is produced on the surface of a determinate body when fire is present in or absent from the transparent therein.

Plurality of Colors From Ratios of Black and White

Aristotle argues that the plurality of colors are formed from mixtures of the primary colors. He explains that "when bodies are mixed their colours also are necessarily mixed at the same time; and that this is the real cause determining the existence of a plurality of colours…" (440^{b}14-16). Specific ratios of white and black form the different colors. There are many colors because "the ingredients may be combined with one another in a multitude of ratios" (440^{b}18-20).

There are two categories of colors: those "based on determinate numerical ratios," and those that "have as their basis a relation of quantitative excess" (440^{b}20-21). The first category is those colors composed of numerical ratios of black and white. He says: "those involving numerical ratios (ἐν ἀριθμοῖς εὐλογίστοις), like the concords in music, may be those generally regarded as most agreeable; as, for example, purple, crimson, and some few such colours" (439^{b}32-440^{a}2). Specifically, some may be mixed "in the ratio of 3 to 2, or of 3 to 4, or in ratios expressible by other numbers" (439^{b}28-29). Richard Sorabji interprets this category to only include colors composed of very simple ratios[7] (such as 3/2 or 3/4).

The second category is those that "may be juxtaposed according to no numerically expressible ratio, but according to some incommensurable relation of excess or defect" (439^{b}29-31). "The other compound colours may be those which are not based on numbers" (440^{a}3-4).[8] Sorabji supposes this category to only include colors not expressed in rational numbers at all. It is for this reason that he

[7] Sorabji, Richard. "Aristotle, Mathematics, and Colour." *The Classical Quarterly, New Series* (Cambridge University Press) 22, no. 2 (Nov 1972): 299.

[8] Aristotle puts forward an alternative that "while *all* colours whatever are based on numbers, some are regular in this respect, others irregular" (440^{a}4-5). Sorabji argues that there are too few simple ratios to think that all colors could be based on simple ratios. Therefore, when Aristotle says that the other colors are "not based on numbers," he does not mean "not based on simple ratios," but instead "not based on rational numbers" ibid. 299, n 2.

thinks a major oversight in Aristotle's theory is that there is no middle ground for ratios that are non-simple, but composed of rational numbers, such as "256:243."[9]

Sorabji interprets three groups of colors in *D.S.* 4.[10] He interprets the first group to be the primary colors white and black and either grey or yellow "if, as is reasonable, we regard grey as a variety of black (for the alternative is that yellow should be classed with white, as rich with sweet)" (442a21-23). The second group is according to Sorabji those colors from the direct mixture of black and white. Aristotle says: "crimson, violet, leek-green, and deep-blue, come between white and black" (442a23-25). The last group is the colors that are mixed out of the secondary colors rather than out of black and white. Aristotle says: "and from these all others are derived by mixture" (442a23-25).

Sorabji gives no definitive statement on whether he thinks the second group is entirely those colors composed of very simple ratios of black and white. However, for the last group, he suggests they are composed of irrational ratios of black and white[11]. He cites this as an oversight in Aristotle's theory because if two secondary colors mix, which are each composed of simple ratios, such as red (e.g. 1 to 2) and blue (e.g. 3 to 4), then mathematics suggests that the resultant color will also be composed of a simple ratio.[12] Overall, Sorabji argues that Aristotle thinks that black and white in "very simple ratios" produces agreeable colors including purple and crimson, and black and white in ratios that are not expressible in rational numbers produces the other colors. Sorabji's analysis will come up again when I look at the parallel between this theory and Aristotle's theory in *Generatione et Corruptione* 2 of the composition of bodies from hot, cold, wet, and dry.

Black and White Ontologically Basic

[9] Plato says this is in rational numbers in *Timaeus* 36B (ἄριθμος πρὸς ἄριθμον).
[10] Sorabji, op. cit. 296-7.
[11] Ibid. 297.
[12] Ibid. 299.

I argue that white and black are ontologically basic (nothing constitutes them). The main passage in support of the non-reduction is at 439[b]15-19, where Aristotle says that white and black are generated in determinate bodies "in the same way" as light is produced in air from the presence of fire. Light is not reduced to anything; at its most basic status, it is what is produced when fire is present in the transparent in an indeterminate body.

Any interpretation against mine that reduces the primary colors to further basic things has to take into account how the primary colors relate to both the transparency in the determinate body and the presence of fire (i.e. the passage at 439[b]15-19). One major passage cited in support of a reduction is in *D.S.* 3, where Aristotle says: "it is therefore the transparent, according to the degree to which it subsists in bodies (and it does so in all more or less), that causes them to partake of colour" (439[b]8-10).[13]

According to the theory that I have presented, which is also how I interpret Alan Code,[14] the presence of fire and the degree of transparency both do not constitute color. Instead, the presence of fire and the transparency are necessary causes of color. The transparent must be in the limit of the determinate body, but the degree of transparency does not affect the shade. It is as simple as this: the presence of fire causes white, and the absence causes black at the surface of the determinate body. This still leaves unexplained 439[b]8-10; specifically how to interpret the statement that the degree of present transparency affects the body's partaking of color. I will offer an interpretation in my section 'First Reply, Part B.'

First Counterargument - *Degree of Transparency Constitutes Bodies*

[13] In an unpublished draft, Eric Butler argues that Alexander of Aphrodisias thinks that this passage says that the possession of color is directly proportional to the maintenance of transparency (degree to which it remains rather than escapes from the body). However, this conflicts with my view that color is a feature of a surface. It is because the indeterminate body has no surface that it does not have its own color, not (as Butler suggests) because the transparency does not remain in the indeterminate body. (By his request, I will not cite page numbers.)
[14] Code, op. cit. 8.

In contrast to my claim that white and black are ontologically basic, Justin Broackes argues that only the degree of transparency constitutes the primary colors. He argues that "the white or light *is* the highly transparent and the black or dark *is* the non-transparent."[15] He says that "colour in bodies involves only one [element] (*colour* in the bounded). Transparency may be the essence of colour both in unbounded things and in bodies…."[16] On his view, the presence of fire in the transparent of a determinate body does not cause white (and its absence black), but instead just the degree of transparency causes them.

In support of his identity claim, Broackes appeals to the previously quoted $439^{b}8$-10 in *D.S.* 3, and he cites *Meteor.* 3.4, in which Aristotle argues that "when there is a cloud near the sun and we look at it it does not look coloured at all but white, but when we look at the same cloud in water it shows a trace of rainbow colouring" ($374^{b}25$-29).[17] Broackes seems to be interpreting this passage to say that when we see the cloud in the sky, the cloud is highly-transparent, and so it appears white, but when it is in the water, it is less transparent, and so it appears darker.[18] Broackes also cites *De Generatione Animalium* 5.1, where Aristotle says: "black is not transparent, for that is just what is meant by 'black', what is not shone through" ($780^{a}33$-35).[19]

First Reply - *Mixing of black and white- preliminaries (from D.S. 3)*

Against Broackes, he himself acknowledges that his theory seems to contradict $439^{b}15$-19, because on his view, white and black are not generated in determinate bodies "in the same way" as light

[15] Broackes, Justin, "Aristotle, Objectivity, and Perception." Edited by David Sedley. *Oxford Studies in Ancient Philosophy* (Oxford University Press) XVII (1999): 62.
[16] Ibid. 62-3, n. 13.
[17] Ibid. 62-3, n. 13.
[18] There are problems with this interpretation fitting within its context. Before the passage, Aristotle argues that "an object appears black because sight fails; so everything at a distance becomes blacker, because sight does not reach it" ($374^{b}14$-15). Because "reflection diminishes the sight that reaches them" ($374^{b}21$-23), objects seen through reflection should be darker than when seen through the air. Thus, a better interpretation may be that the cloud in the water appears darker, not because it is less transparent than the cloud in the sky, but because it is seen through the reflection in the water.
[19] Broackes, op. cit. 63.

is produced in air from the presence of fire.[20] According to him, white and black are generated only by the degree of transparency, but light is caused by the transparency *and* the presence of fire.

I will look at both *D.S.* 3 and *G. et C.* 1.10, in order to suggest a much more detailed mechanism for how Aristotle's primary colors combine in specific ratios to form other colors. Aristotle discusses in *De Sensu 3* how to understand the mixing process, and that section reveals necessary conditions for black and white to mix. My interpretation may help understand why black and white are ontologically basic and how to interpret the passage at 439^{b}8-10 that says that the degree of transparency is directly related to the body's the partaking of color.

In my interpretation, there are two agents involved before combination: two blobs of uniform color (of any color). And there are two requirements for these agents; each must be attached to a separate matter piece, and each must be not divisible into minima.

Aristotle requires that each color to-be-mixed be related to its own underlying matter. He says: "when bodies are mixed their colours also are necessarily mixed at the same time; and that this is the real cause determining the existence of a plurality of colours…" (440^{b}14-16). Bodies (matter) must be mixed at the same time as colors, and therefore each blob of color must be attached to a separate matter piece.[21] This rules out the possibility that the blobs of color are divided and combined on one piece of undivided matter.

For the second requirement of my model, each to-be-mixed blob of color must be undivided into minimal particles. In 440^{b}4-10, Aristotle says that "mankind as a whole" can be divided into minimal parts, namely individual men, but an individual man is himself a "least part," and so he cannot be divided into minima. When he discusses the mixture of those things "not divisible into minima," he says that it is by "complete interpenetration must we conceive of those things to be mixed" (440^{b}10-13). He

[20] Ibid. 62-3, n. 13.
[21] I will argue later from looking at *G. et C.* 1.10 that Aristotle thinks that this matter must be the same for both agents.

argues that the bodies to which colors are attached are "not divisible into minima," and so mix in this way. Therefore in my model the blobs of color and the separate piece of matter attached to each must be themselves "least parts" or undivided into minima[22]. In summary, two blobs of uniform color must each be attached to their own pieces of matter, and they must be undivided into minima before mixture occurs.

Mixing of black and white- process (from G. et C. 1.10)

When Aristotle presents his theory in *D.S.* 3 of the mixing of colors from the interpenetration of the bodies, he refers to a previous discourse on mixture (440^{b}13-14), which I interpret to be *G. et C.* 1.10.[23] If we go back to the requirements from before, we have two blobs, each of any uniform color, each attached to a piece of matter, and each not divisible into minima. He requires in *De Generatione et Corruptione* that the underlying matter of the two agents must be the same in kind so that the agents can "reciprocate, i.e. are such as to act upon one another and to suffer action from one another" (328^{a}19-21). From the added information, each blob must have the same kind of matter.

Aristotle also argues that the agents that mix with one another must "involve a contrariety," because, he says: "these are such as to suffer action reciprocally" (328^{a}33-34). With respect to our model, 'agents' refers to each blob of color, and black and white are the contraries. To understand the relationship between the agents and the contraries, Aristotle also says that the agents combine "more freely" if they are first divided into smaller bits, and then these bits are juxtaposed with one another (328^{a}34-^{b}3). From this information, I now nuance that model by claiming that when mixture begins, the

[22] This does not rule out that during the mixing process each blob can divide into black and white particles. We can look at Aristotle's example of the individual man (440^{b}4-10). An individual man is a unity in so far as he is the "least part" of mankind, but he is himself composed of different parts (i.e. hand, arm), and when mixing occurs, he would be split up into these parts to allow for interpenetration. Likewise, the color blob can be a least part and also be split up into black and white contraries.

[23] W.S. Hett also makes this inference, "Loeb Classical Library No. 288," (1957).

two agents (blobs of color) divide into smaller black and white contraries.[24] These new contraries are each a black or white particle attached to a piece of matter that is itself same in kind to that of the other particles. These contraries are then juxtaposed with one another, and during this middle phase they suffer action reciprocally.

Finally, Aristotle says that when there is not an extreme amount of one agent in comparison to the other, the agents both become "an intermediate with properties common to both" (328^a29-32). The mechanism that I propose is as follows: after the contraries are juxtaposed with one another, they come together in groups. The ratio of black to white particles within each group accords with the ratio of total black to white particles. The contrary particles suffer action reciprocally in these groups, and in doing so, all the particles in each group turn into new particles of the color specified by the ratio. These new particles, or "intermediates" together compose a new large blob that is the color of them. The new blob of color, although it is divisible into the new particles, it is indivisible into its most basic *explanatory* level: that of the black and white contraries.[25]

For example, if a red blob combines with a blue blob, then each blob first divides into black and white particles. If the overall ratio of black to white particles is 2:3, then in each group, 2 black particles comes together with 3 white particles, and that group forms five particles of, say, the color purple.[26] This new purple blob is composed of these purple particles or "intermediates."

[24] It is not the case that the blobs of color divide into particles of neutral color that themselves change in shade from black to grey to white. This is because of Aristotle's premise that only contraries suffer action reciprocally; therefore, the contraries must be on the most basic level during the mixture process.

[25] Aristotle gives an alternate scenario when an extreme quantity of one agent is brought together with a much smaller amount of another. In this case, he says the effect is "not combination, but increase of the dominant" (328^a24-27). He gives the example of a drop of wine and ten thousand gallons of water, where the form of the drop of wine dissolves, and "is changed so as to merge in the total volume of water" (328^a27-29). To explain this in my model, we can say that when one agent is much larger, it supplies an extreme amount of particles in its specific ratio, so that the overall ratio of black to white particles will be very similar to that of it.

[26] For example assume each blob supplies five particles. If the red blob supplies them in the (B:W) ratio 1:4 and the blue blob supplies them in the ratio 3:2, there would result a total ratio of 4:6, which would result in two groups, each with the ratio 2:3.

It is important to note that after the mixture process, the new color blob is composed of the new particles and not black and white particles. Thus the mixture process is indeed combination rather than juxtaposition[27], and so the color blob is indivisible into minima. I think that black and white are explanatorily basic (i.e. necessary) for the new color, but they are not sufficient. If they were sufficient, the new color could be reduced to only black and white particles. Instead, the new intermediate color must have properties that the combination of black and white together does not.

How does my reconstruction match with the passage at 439^{b}15-19, which says that black and white are generated in determinate bodies in the same way as light is generated in the transparent medium? I think that the amount of fire creates the amount of black and white particles in a body, and then color is determined by this ratio. If we accept that black and white are ontologically basic, how does this reconstruction of the mixing process help us understand how to interpret 439^{b}8-10 that says that the degree of transparency is directly related to the body's the partaking of color? The most intuitive interpretation seems to be that a low degree of transparency in the determinate body increases the proportion of black to white, and a high degree of transparency decreases the proportion of black to white particles in a determinate body.[28] Thus the degree of transparency is a variable that changes the color, but it is not the only thing required for color in a determinate body- fire is required as well (contra Broackes). This interpretation is also counter to that of Code, who does not argue for color to be affected by how much transparent is in the body. With my interpretation, however, white and black remain as ontologically basic units that are not constituted by smaller particles.

Second Counterargument - ***Reduction to Hot, Cold, Wet, Dry***

[27] In juxtaposition, Aristotle says the constituents are combined only relatively to perception i.e. if you are far enough away (or have weak vision) it looks like the two distinct constituents are one (328a13-16). In contrast, both agents in combination become intermediates with properties common to both agents (328a29-32, b20-24).

[28] Perhaps during the interaction with fire, the degree of transparency increases the relevant amount of black or white particles. Another possibility that is more undeveloped is that the degree of transparency does not affect the amount of black or white in the to-be-mixed color blobs, but it is necessary to create the intermediate during the mixing process, and so it affects the color of the intermediate then.

Some of Aristotle's higher-level qualities are derived from hot, cold, wet, and dry. In *Meteorology* 4.12, Aristotle explains that the qualities that differentiate the homogenous natural bodies are derived from "the hot and the cold and the mixtures of their motions" (390^{b}6-10).[29] While describing the composition of animals in *P.A.* 2.1, Aristotle says: "wet and dry, hot and cold, form the material of all composite bodies; and all other differences are secondary to these" (646^{a}16-18).[30] Here, he also derives higher-level qualities of bodies from hot, cold, wet, and dry. In this section I will first show why one may think that Aristotle would include the primary colors black and white as among the group of qualities that are derived from the hot, cold, wet, and dry. Then I will investigate what Aristotle means by "derived."

Some contemporary and medieval commentators support the reduction of the primary colors to the basic qualities. Sorabji thinks that the primary colors reduce to the elements; therefore, if he thinks the elements are derived from hot, cold, wet, and dry, then he would support the stronger reduction. Broackes is unsure of the reduction, but his best evidence for it is at *Phys.* 1.6, where Aristotle says: "some contraries are prior to others, and some arise from others- for example sweet and bitter, white and black…" (189^{a}17-19).[31] Broackes claims Aristotle says here that white and black arise from contraries. We have the reduction if we assume that by 'contraries' Aristotle means hot, cold, wet, and dry. The medieval commentators John Philoponus, Albert the Great, and Thomas Aquinas all concluded that color derives from hot, cold, wet, and dry. Philoponus says: "colours and tastes and all perceptible

[29] In 4.8, he says that mixed bodies are distinguished by two qualities: the first are capacities for acting on a sense, and the second "express [the body's] aptitude to be affected" (385^{a}1-11). He specifies that the second kind differentiate the homogenous natural bodies. Some examples of the eighteen that he lists include the aptitude or inaptitude "to solidify, [and] melt" (385^{a}14). The 4.12 passage says that the second kind are derived from hot, cold, wet, and dry (390^{b}6-10), but Aristotle does not explicitly rule out that the first kind (which includes white) are also so derived.

[30] Of the kind of differences he means, he gives the examples "heaviness or lightness, density or rarity, roughness or smoothness" (646^{a}18-20). These seem to be common sensibles (not specific to one sense organ), but he does not explicitly rule out sensibles like color.

[31] Broackes, op. cit. 84.

qualities are determined by the way in which hot and cold and dry and wet are mixed."[32] Albert the Great says: "sweet and bitter, and white and black, arise out of the four primary qualities."[33] Aquinas says: "tangible qualities are the causes of the other sensible qualities."[34]

If there is indeed a reduction of the primary colors to the basic qualities, like these early commentators thought, then we can ask what Aristotle means by "derived." T.K. Johansen, Victor Caston, and Justin Broackes all agree that Aristotle's higher-qualities in *G. et C*. 2.2 and *Meteor*. 4.8-9 cannot be stripped away to nothing else than hot, cold, wet, and dry. Johansen argues that the reduction of the tangible qualities such as "the viscous and the brittle" in *G. et C.* 2.2 ($329^{b}33$-34) to moist and dry is not a reduction such that the thing to-be-reduced is nothing else than what it is reduced to.[35] Appealing to Aristotle's doctrine that sense objects are causally active as such,[36] Johansen says that if viscosity is reduced away, then it is not the case that "it is viscosity as such that causes a perception of viscosity."[37]

Caston uses the *Meteor.* 4.8-9 example to show that higher-level qualities such as color can have their unique powers, which "depend crucially on the elemental powers that underlie them, while remaining distinct and efficacious in their own right"[38] These unique powers allow higher-level qualities to have explanatory primacy, at the same time as they are derived from lower-level qualities.

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[32] Philoponus, *Commentary on On Coming-to-Be and Perishing*, 232. 8-13 in *On Aristotle's On Coming-to-Be and Perishing 1.6-2.4*. Trans. C.J.F. Williams. Ithaca: Cornell University Press, 1999: 143.

[33] Albert the Great, *Physica* 1.3.4 in *Opera Omnia*, ed. Borgnet (Paris, 1890), volume 3: pg. 56. Broackes's translation. op. cit. 85. Albert the Great is commenting on the *Phys*. 1.6 passage when he says this.

[34] Aquinas, Thomas. *Sentencia Libri De Anima*, 562 in *A Commentary on Aristotle's De Anima*. Trans. Robert Pasnau. New Haven: Yale University Press, 1999: 286.

[35] Johansen, T.K. "Aristotle on the Sense-Organs," 181, n. 8.

[36] Cf. Broadie, Sarah. "Aristotle's Perceptual Realism." *The Southern Journal of Philosophy* (University of Memphis) 31 (1993): 138. Broadie says that color is causally active as such. She cites as evidence the signet-on-wax passage in *D.A.* 2.12.

[37] Johansen, T.K. op. cit. 181, n. 8.

[38] Caston, Victor. "The Spirit and The Letter: Aristotle on Perception." In *Metaphysics, Soul, and Ethics: Themes from the work of Richard Sorabji*, edited by Ricardo Salles, Oxford: Oxford University Press, 2004: 273. He uses this point to support a material change during the process of perception, while maintaining color itself as the prime cause of the perception of color.

Broackes argues that in *Meteor*. 4.8-9, the four basic qualities provide what is necessary for the higher-order qualities, but they are not sufficient themselves. With the example of plastic, he says that "something with an appropriate mix of the four basic qualities might have all that was necessary to be plastic," however 'plastic' is not identical to whatever is a certain mixture of the four basic qualities.[39]

Overall, as a counterargument against my claim that black and white are ontologically basic, one could argue that the primary colors are derived from hot, cold, wet, and dry. And, by "derived," Aristotle means that the basic qualities provide the necessary material for black and white, but are not sufficient for black and white. Black and white still have unique properties and so cannot be reduced to only hot, cold, wet, and dry. This counterargument says that black and white themselves are *composed of* hot, cold, wet, and dry as part of their necessary ingredients.

Second Reply - *Only Parallel with Hot, Cold, Moist, Dry*

I think that the model of reduction that the counterargument presents explains how Aristotle constructs complex bodies from hot, cold, wet, and dry in *G. et C.* 2, and how he constructs the plurality of colors from black and white.[40] For these theories, the basic qualities themselves compose the higher-level qualities, but the higher-level qualities possess properties that cannot be reduced to the basic. However, I do *not* think that it explains the relationship between hot, cold, wet, and dry, and black and white, because although the basic qualities are necessary, they do not compose black and white. I will first show how the counterargument's model of reduction matches the first two theories, and then I will show how it does not match the third theory.

There are four levels in Aristotle's theory in *G. et C.* 2 of the composition of bodies from the basic qualities. Aristotle first posits a base substratum that serves as matter for the contraries. He says:

[39] Broackes, op. cit. 81-2.

[40] Butler argues that the status of black and white as ontologically basic units from which other colors are made parallels the relationship between the elements (earth, air, fire, water) and the composite bodies. Instead, I argue that it parallels the relationship between *the basic qualities* and the composite bodies. (By his request, I will not cite page numbers).

"We must reckon as a principle and as primary the matter which underlies, though it is inseparable from, the contrary qualities; for the hot is not matter for the cold nor the cold for the hot, but the *substratum* is matter for them both" (329[a]29-33). On the second level, Aristotle posits the contrary qualities hot, cold, wet, and dry. To understand what contraries are, he says in *Phys.* 1.5 that "everything, therefore, that comes to be by a natural process is either a contrary or a product of contraries" (188[b]25-26).[41] To see how this works in *G. et C.* 2, there are four simple bodies (Fire, Air, Water, and Earth) on the third level;[42] these simple bodies are each made up of two of the contraries. Aristotle explains: "For Fire is hot and dry, whereas Air is hot and moist (Air being a sort of vapour); and Water is cold and moist, while Earth is cold and dry" (330[b]3-6).

Lastly, I assert that on the fourth level, perceptible bodies are constructed from contraries present in excess amounts. Aristotle says that the simple body, Fire, is distinct from the perceptible body, fire: "the simple body corresponding to fire is fire-like, not fire…and so on with the rest of them" (330[b]23-25). Perceptible fire is "an excess of heat"; he explains this by saying that boiling is an excess of heat, and therefore fire is "a boiling of dry and hot" (330[b]25-29). I interpret this to mean that perceptible fire is like the simple body Fire, except with an excess of the contrary hot.[43] Aristotle summarizes his composition of bodies in *G. et C.* 2: "we have firstly that which is potentially perceptible body, secondly the contraries (e.g., heat and cold), and thirdly Fire, Water, and the like" (329[a]33-[b]1).[44]

This system parallels Aristotle's theory of the plurality of colors from the primary colors black and white. Recall that determinate bodies serve as underlying matter (first level), and the contraries are white and black (second level). Simple ratios of the contraries produce pleasant colors (third level) and excesses (I follow Sorabji here, and consider 'excesses' those not expressible in rational numbers)

[41] Aristotle names black and white as examples of these contraries, and says explicitly: "the intermediates are derived from the contraries- colours for instance, from black and white" (188[b]23-5).
[42] These simple bodies are what Sorabji calls 'elements,' and from which he derives black and white.
[43] Later, he says: "flame is par excellence Fire" (331[b]25).
[44] I think Aristotle includes the fourth level in the words "and the like."

produce the other colors (fourth level). Black and white are similar to hot, cold, wet, and dry in being irreducible basic qualities from which higher-level qualities are derived.

Both of these two theories match the counterargument's model of reduction because (1) the basic qualities *compose* the higher-level qualities, and (2) the higher-level properties in both theories have properties that can't be explained by the lower-level qualities. Regarding the first point, although one may think that Aristotle means that the contraries are only qualities of the simple bodies (i.e. they do not compose them), when he explains in *G. et C.* 2.4 the manner in which the simple bodies transform into one another, it is more intuitive to construct the simple bodies from the contraries. He says: "For Water is moist and cold while Earth is cold and dry- so that, if the moist be overcome, [and be replaced by dry] there will be Earth" (331^a34-36). If one contrary is replaced by another, then a new simple body is present. Because the contraries determine which simple body is present, they are more than just properties of the simple bodies. Instead, they are units of composition of the simple bodies. As for the second point, the simple bodies are *not* each another term for what is a certain combination of contraries. The higher-level qualities still have properties that cannot be explained only by the basic qualities. Although for these two theories the basic qualities do in fact compose the higher-level ones, the basic qualities are necessary but not sufficient.

As an example of how the counterargument's theory of reduction applies to both theories, if we have matter with the contrary fire and another matter of the same kind with the contrary dry, when they are combined in a simple ratio, they form matter of the same kind with the contraries fire and dry. The new combined body (Fire) has properties that the combination of fire and dry does not have. Similarly, if we construct a red particle from black and white particles, the intermediate has properties that the combination of black and white does not. However, in both cases, the basic qualities compose the intermediate.

However, this model of reduction does not work for the relationship between the qualities hot, cold, wet, and dry, and black and white. I think black and white are ontologically basic, at the same time as they are derived from hot, cold, wet, and dry. It is as simple as: hot, cold, wet, and dry together determine the kind of the determinate body that produces black and white from the presence of fire in the transparent in its limit. Hot, cold, wet, and dry are necessary for that specific determinate body to be present, but in contrast to the counterargument model, they do not compose black and white. Only in this sense are hot, cold, wet and dry necessary for black and white but not sufficient.[45] The matter underlying the hot, cold, wet, and dry is the same as that underlying the black and white.

Conclusion

Overall I have showed Aristotle's locational definition of color, and then I investigated how Aristotle reduces color to more basic qualities. Throughout the essay I tried to show how my choices of interpretation relate to those of other interpreters. The first major position that I argued for in this essay is that white and black are ontologically basic units that result from the presence and absence of fire in the limit of the transparent in a determinately bounded body. After presenting a model of how the plurality of colors results from black and white, I argued that the degree of transparency is a variable that changes the proportion of black to white particles. The second major position is that hot, wet, dry, and cold are necessary but do not compose the primary colors black and white, which is in contrast to how these basic qualities are related to the composite bodies and how black and white are related to the plurality of colors.

[45] Against the *Phys.* 1.6 passage, one could argue that when Aristotle says that white and black arise from contraries, he means not that they arise from hot, cold, wet, and dry, but from the specific contraries of the presence and absence of fire.

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