Hume's Colors and Newton's Colored Lights

The stated purpose of David Hume's *Treatise of Human Nature* is to establish a science of human nature on a foundation of experience and observation. And because, according to Hume, "there is no question of importance whose decision is not compriz'd in the science of man; and there is none, which can be decided with any certainty, before we become acquainted with that science,"[1] Hume expects his innovative researches to serve as a "compleat system of the sciences, built on a foundation almost entirely new." (T Intro 6)

Hume sometimes calls his field of inquiry "moral philosophy", and advertises the Treatise as an attempt to introduce "the experimental method of reasoning into moral subjects." But in what does this method consist? A long line of Hume's interpreters have discerned the influence of Isaac Newton on Hume's conception of experimental method in moral philosophy. However, there is an important contrary trend in Hume studies comprised of scholars expressing varying degrees of skepticism about the degree of Newton's influence on Hume, and about the extent to which Hume views Newton as a model worth emulating.[2]

One of these scholars is Eric Schliesser, who in a fascinating and provocative series of papers has developed a view of Hume's philosophy as constituting an "attack" on Newton and on the authority of Newton's natural philosophy. Schliesser's interpretation is bold and wide-ranging, and in this paper I would like to consider only one element of Schliesser's overall picture of Hume's complex relationship to Newton.[3] That element concerns the views of Hume and Newton on the nature of color.

In a 2004 paper, "Hume's Missing Shade of Blue Reconsidered from a Newtonian Perspective," Schliesser argues that Hume's well-known discussion of his missing shade of blue

example "reveals considerable ignorance of Newton's achievement in optics," and that Hume both fails to assimilate the lessons taught by Newton's optical experiments and makes assumptions about color shade gradations that flatly contradict the implications of these experiments.[4] I agree with Schliesser to this extent: there is little in Hume to indicate any direct application or assimilation of Newton's theory of color into the Humean science of human nature. However, I do not believe that there is sufficient evidence to conclude that Hume's own doctrines on color *contradict* Newton's optical results, or that they reveal ignorance of the lessons taught by Newton's optical researches. Rather, I would assert, Hume's views on color are logically and evidentially independent of Newton's results. In defense of my reading, I will argue that Schliesser (i) takes an overly broad interpretation of Newton's experimental results, and sees these results as teaching lessons about color experience and perceptual discrimination of colors that are in fact not warranted by the experiments themselves, and that Newton himself refrained from drawing; and (ii) takes inadequate account of Hume's disciplined methodological restrictions on the kinds of experiential evidence that are to be admitted in building the foundations of his science of human nature.

1. Newton on Light and Color

Isaac Newton's revolutionary theory of light and color was developed and refined in several stages throughout much of his adult life, and was finally set out in its most mature form in his *Opticks,* first published in 1704, over 30 years after Newton's first public presentation of the theory to the scientific community.[5] Newton's key discovery was that the white light of the sun can be decomposed via refraction into finer beams that are refracted at different angles, and that

display different colors according to the degree at which they are refracted. The recognition of the existence of this phenomenon mandated the modification of the Snell-Descartes law of refraction, and was developed by Newton in far-reaching and dazzling ways. On the basis of a series of ingenious and precise experiments with triangular glass prisms, Newton argues that the light of the sun "consists of rays differently refrangible."[6] So the degree to which a ray is refracted in passing from one transparent medium into another does not depend solely on the natures of the two media and the angle the incident ray makes with the line perpendicular to the surface at which the two media meet, but depends on further internal features of the ray itself. There are different *kinds* of light that are refracted by different amounts in experimental circumstances that are otherwise identical.[7]

Relying in part on what he had earlier called his "*experimentum crucis*", Newton argues that the refrangibility of a ray cannot be altered by successive refractions or reflections. Any beam of complex light can be decomposed via refraction into simpler kinds of light, but the simplest kinds of light consist of rays whose degree of refrangibility is preserved throughout subsequent refractions. Newton calls these fundamental kinds of light "Simple, Homogeneal and Similar."[8] The refrangibility of homogeneal light is, Newton held, an "original and connate property" of the light.[9]

Note that Newton's argument for these initial conclusions does not depend on any observations of the visible colors of the refracted lights. They rely solely on the observation of the geometrical properties of the images produced by passing light through prisms, and the geometrical relations these images bear to the shape and position of the prisms, as well as the location of the initial light source. These oblong images are more elongated than would be the case if the beams were composed of rays with a single, uniform degree of refrangibility.

However, Newton also investigated the spectrum of colors that are displayed by the different parts of the images generated by refracted sunlight. On the basis of additional experimental results and reasoning, he concludes that simple or homogeneal light has a unique color corresponding to its degree of refrangibility, so that if *homogeneal* lights differ in the color they display, they must differ also in degree of refrangibility. This conclusion is asserted very explicitly in Book I, Part I of the *Opticks*, as Proposition 1, Theorem 1, which we can re-formulate as follows:

> N1: For any homogeneal lights L_1 and L_2, if L_1 and L_2 have the same degree of refrangibility, they have the same color.

Does Newton also say that if lights have the same color, they also have the same degree of refrangibility? That further conclusion does not follow logically from N1, and here we must be careful. By the time of the publication of the *Opticks*, Newton was quite clear in holding that a simple light can sometimes have the same color as a complex light. His recognition of this point had been signaled in an exchange with Huygens following an earlier presentation of the theory. There can be a green, he says, that is displayed both by a particular kind of homogeneal light with a fixed refrangibility, and also by a hetereogeneal or compound light consisting of an assortment of simple lights of differing refrangibilities, mixed in some proportion.[10] Newton also holds that some mixed colors might have an appearance unlike *any* homogeneal color, and that white light is one such example. So Newton is committed *at most* only to the following logically equivalent statements.

> N2a: For any *homogeneal* lights L_1 and L_2, if L_1 and L_2 have the same color, they have the same degree of refrangibility.

> N2b: For any *homogeneal* lights L_1 and L_2, if L_1 and L_2 have different degrees of refrangibility, they have different colors.[11]

We will return to the evaluation of these statements later. But what does it mean to say that a kind of light is red, or blue, or white? Newton is quite direct about this. To say that a *light* is red is ultimately to say that that light *appears* red or *displays* red. He develops that point as follows:

> The homogeneal Light and Rays which appear red, or rather make Objects appear so, I call Rubrifick or Red-making; those which make Objects appear yellow, green, blue, and violet, I call Yellow-making, Green-making, Blue-making, Violet-making, and so of the rest. And if at any time I speak of Light and Rays as coloured or endued with Colours, I would be understood to speak not philosophically and properly, but grossly, and accordingly to such Conceptions as vulgar People in seeing all these Experiments would be apt to frame. For the Rays to speak properly are not coloured. In them there is nothing else than a certain Power and Disposition to stir up a Sensation of this or that Colour. For as Sound in a Bell or musical String, or other sounding Body, is nothing but a trembling Motion, and in the Air nothing but that Motion propagated from the Object, and in the Sensorium 'tis a Sense of that Motion under the Form of Sound; so Colours in the Object are nothing but a Disposition to reflect this or that sort of Rays more copiously than the rest; in the Rays they are nothing but their Dispositions to propagate this or that Motion into the Sensorium, and in the Sensorium they are Sensations of those Motions under the Forms of Colours.[12]

Now there are obviously interpretive mysteries abounding here. But the general framework of Newton's conceptual scheme is clear. There is a primary and unexplained kind of redness that Newton calls the "sensation of red" or the "sensation under the form of red". Let's refer to that as 'red_1'. The other, related concepts of redness are then supposed to be derivative in something like the following manner:

N3: A motion in the sensorium is red_2 = df it is sensed under the form of red_1.

N4: A ray is red_3 =df it is disposed to propagate a red_2 motion into the sensorium.

N5: An object is red_4 =df it is disposed to reflect red_3 rays more copiously than rays of other colors.

There is one other feature of Newton's views on color worth noting at this point, because it gives us further insight into his thinking on the perception of color. Newton allows the possibility of colors that can only be *imagined*, but that are not displayed by any objects or lights found in nature. This point is brought out in these passages from Book I Part II of the *Opticks*:

> All the Colours in the Universe which are made by Light, and depend not on the Power of Imagination, are either the Colours of homogeneal Lights, or compounded of these, and that either accurately or very nearly, according to the Rule of the foregoing Problem.
> …..
> I speak here of Colours so far as they arise from Light. For they appear sometimes by other causes, as when by the power of phantasy we see Colours in a Dream, or a mad Man sees things before him which are not there; or when we see Fire by striking the Eye, or see Colours like the Eye of a Peacock's Feather, by pressing our Eyes in either corner whilst we look the other way. Where these and such like causes interpose not, the Colour always answers to the sort or sorts of the rays whereof the Light consists, as I have constantly found in what-ever Phænomena of Colours I have hitherto been able to examine. I shall in the following Propositions give instances of this in the Phænomena of chiefest note.

2. Hume on Color in Perceptions

Color plays a very significant role in Hume's account of the understanding in Book I of the *Treatise of Human Nature*, figuring centrally in his account of our visual ideas of extension and contributing prominently to his critique of what he calls "the modern philosophy", and of the characteristic distinction made by that philosophy between primary and secondary qualities. And yet there is no account in the *Treatise* of the natural philosophy of color and its origin in either the physical world or human physiology. One thing is clear: Hume approaches color

almost exclusively as a quality of our *perceptions* – the mental phenomena populating the "universe of the imagination." The study of perceptions and the more complex mental phenomena that involve them is the central – and perhaps we could say exclusive - object of study in Book I of the *Treatise*.

Hume's science of the understanding is developed in the context of both a principled methodological constraint on the kinds of observational evidence that will be admitted in developing that science, and a skeptical orientation toward what can actually be observed in any case, regardless of such methodological restrictions. After introducing his seemingly all-encompassing distinction of perceptions into impressions and ideas, Hume makes it clear that he is doubtful about our ability to know the origins of our sensory impressions in causes external to those impressions. He also makes it clear that, apart from the question of whether knowledge of that kind is ultimately attainable, any such investigations lie outside the scope of his own chosen investigation, since his subject is moral philosophy, not natural philosophy. This skeptical and restrictive methodological orientation comes through in several passages:

> Impressions may be divided into two kinds, those of Sensation and those of Reflexion. The first kind arises in the soul originally, from unknown causes. (T 1.1.1.12)

> The examination of our sensations belongs more to anatomists and natural philosophers than to moral; and therefore shall not at present be enter'd upon. (T 1.1.2.1)

> As to those impressions, which arise from the senses, their ultimate cause is, in my opinion, perfectly inexplicable by human reason, and 'twill always be impossible to decide with certainty, whether they arise immediately from the object, or are produc'd by the creative power of the mind, or are deriv'd from the author of our being. Nor is such a question any way material to our present purpose. We may draw inferences from the coherence of our perceptions, whether they be true or false; whether they represent nature justly, or be mere illusions of the senses. (T 1.3.5.2)

> 'Tis certain, that the mind, in its perceptions, must begin somewhere; and that since the impressions precede their correspondent ideas, there must be some impressions, which without any introduction make their appearance in the soul. As these depend upon natural and physical causes, the examination of them wou'd lead me too far from my present subject, into the sciences of anatomy and natural philosophy. (T 2.1.1.2)

On the basis of texts like these, then, I will say that Hume practices *methodological phenomenalism*. His central purpose in Book I of the *Treatise* is to study perceptions, and the patterns of causal dependency of some kinds of perceptions on other kinds of perceptions, as well as the factors that are responsible for enlivening some ideas to the status of a belief, for associating secondary impressions, for fusing distinct secondary impressions into one, and other such related mechanisms. Hume thoroughly eschews any investigation of the physical and physiological causes of impressions. His subject is only the mental causation that occurs in the world of perceptions, by which some sensory impressions cause ideas, ideas cause other ideas, and both of these cause passions and ideas of passions.

To recognise that Hume practices methodological phenomenalism in the Treatise is not to say that Hume has no personal views at all about the physical and physiological origins of impressions of sensation – or even possibly about their constitution. That Hume entertains such views is apparent from several passages in which he takes brief notice of them. But the study of such causes is manifestly and declaredly not the subject of the Treatise. What we can surmise about Hume's views on these matters comes almost entirely from casual references and sidelong expository glances, not from any dedicated inquiry that Hume himself conducts. [13]

Now let us turn to the famous missing shade of blue example which Hume presents very early in Book I of the Treatise. I will quote the passage in its entirety.

> There is however one contradictory phaenomenon, which may prove, that 'tis not absolutely impossible for ideas to go before their correspondent impressions. I believe it

> will readily be allow'd, that the several distinct ideas of colours, which enter by the eyes, or those of sounds, which are convey'd by the hearing, are really different from each other, tho' at the same time resembling. Now if this be true of different colours, it must be no less so of the different shades of the same colour, that each of them produces a distinct idea, independent of the rest. For if this shou'd be deny'd, 'tis possible, by the continual gradation of shades, to run a colour insensibly into what is most remote from it; and if you will not allow any of the means to be different, you cannot without absurdity deny the extremes to be the same. Suppose therefore a person to have enjoyed his sight for thirty years, and to have become perfectly well acquainted with colours of all kinds, excepting one particular shade of blue, for instance, which it never has been his fortune to meet with. Let all the different shades of that colour, except that single one, be placed before him, descending gradually from the deepest to the lightest; 'tis plain, that he will perceive a blank, where that shade is wanting, and will be sensible, that there is a greater distance in that place betwixt the contiguous colours, than in any other. Now I ask, whether 'tis possible for him, from his own imagination, to supply this deficiency, and raise up to himself the idea of that particular shade, tho' it had never been conveyed to him by his senses? I believe there are few but will be of opinion that he can; and this may serve as a proof, that the simple ideas are not always derived from the correspondent impressions; tho' the instance is so particular and singular, that 'tis scarce worth our observing, and does not merit that for it alone we should alter our general maxim. (T 1.1.1.10)

Note that the passage contains two main components. The second and more famous part of the passage, beginning with the words "suppose therefore", contains the presentation of the missing shade of blue counterexample. This will not be my main focus. Instead, I want to focus on the first part of the passage. It contains an argument that so far as I know contains no standard name in the secondary literature. I will call it the "means and extremes argument". It is a very problematic argument in itself, and there are several plausible ways of reconstructing it. What is Hume's point here? Why, after introducing the distinction between impressions and ideas, is there no mention of impressions in this passage, but only of ideas on the one hand, and "colours" that "enter by the eyes" on the other?[14] Are these colors physical or mental entities? Is Hume considering - and apparently rejecting - the possibility of distinct physical colors –

presumably lights of some kind - producing the same impression? Or is he considering and rejecting the possibility of different impressions producing the same idea? And how is the means and extremes argument related to the missing shade of blue counterexample, which it is apparently designed to set up in some way?

I believe we must opt for the interpretation that by "colours" Hume means to be speaking here of a kind of visible impression – an impression of sensation. I base that reading on the fact that Hume elsewhere explicitly refers to impressions as "entering" by the senses to "strike" upon our mind or consciousness. Here are two passages in which Hume employs that language:

> … properly speaking, 'tis not our body we perceive, when we regard our limbs and members, but certain impressions, which enter by the senses; so that the ascribing a real and corporeal existence to these impressions, or to their objects, is an act of the mind as difficult to explain, as that which we examine at present. (T 1.4.2.9)

> Nor must we omit on this occasion our accustom'd method of examining ideas by considering those impressions, from which they are deriv'd. The impressions, which enter by the sight and hearing, the smell and taste, are affirm'd by modern philosophy to be without any resembling objects; and consequently the idea of solidity, which is suppos'd to be real, can never be deriv'd from any of these senses. (T 1.4.4.12)

So, the fact that Hume might talk of "colours" entering by the eyes does not give us any reason to think that Hume takes colors to be anything other than impressions themselves, rather than some other kind of physical cause of impressions. It is also very hard to see how the means and extremes argument sets up the missing shade of blue counterexample that follows it if we take Hume to be discussing the relationship between physical lights and impressions rather than the relationship between impressions and ideas, given that the manifest subject of this passage and section of the *Treatise* is the origin of our ideas. So I will assume that wherever Hume refers to *colors* he means the same thing as *sensations of color*, and is thus speaking of impressions.[15]

This interpretation becomes even more compelling when we ask about the *purpose* of the means and extremes argument. Interestingly enough, in light of the importance played by the Copy Principle in his philosophy, Hume seems to be offering the missing shade of blue as a counterexample that shows the *general rule* expressed by the Copy Principle is not some kind of exception-free *natural law*; and with the means and extremes argument he is moving to *block* a potential way out of the missing shade of blue counterexample he is about to offer us. That way out would consist in denying that the imaginary human subject in the missing shade of blue thought experiment is initially lacking the idea of the particular unexperienced shade of blue in question, before conjuring it up to "supply this deficiency." Hume imagines a critic of the missing shade of blue counterexample attempting this way out by claiming that the idea of the unexperienced intermediate shade of blue is in fact *identical* to the ideas of the shades of blue contiguous to that intermediate shade, and so there is no *new* idea that has to be raised up. But Hume rebuts this way of escaping from the missing shade of blue counterexample. He insists that the ideas that are produced by impressions of different shades of blue are "different from each other", and so one who has not enjoyed an impression of a particular shade of blue will initially lack the corresponding *idea* of that shade as well (before the "raising up" occurs). He argues that if one *denies* that the ideas of previously experienced adjoining shades of blue are different ideas, then one is committed to holding that the ideas of experienced shades of blue at the extreme ends of the spectrum of *all* the blue shades that have been experienced must not be different ideas either.[16]

Hume's seemingly blithe admission of a counterexample to his Copy Principle has often dismayed and bewildered his interpreters. Since Hume seems happy to admit that the principle stands as merely a non-exception less general rule of experience, rather than an exceptionless

empirical law, the interpreters have felt that Hume owes his readers a more careful investigation of the range of phenomena over which the exceptions can be expected to occur, so that he can move forward with confidently warranted applications of the Copy Principle in the important arguments to come. This is certainly an extremely important issue for the interpretation and evaluation of Hume's science of human nature, but it is not an issue for this paper. My aim here has only been to highlight Hume's commitment to methodological phenomenalism and to clarify the nature of the means and extremes argument, so that we can then evaluate Schliesser's assessment of Hume's relationship to Newton's optical theories.

Before turning to Schliesser's discussion and criticism of the means and extremes argument, note that Hume asks us in this passage to imagine *all* of the different shades of blue placed before us, except *one*. And he speaks freely of different shades of a color being *adjoining*. By all appearances, Hume is presupposing in his discussion of the missing shade of blue that there are only finitely many shades of blue, rather than either a dense or a continuous series of shades of blue. I am unable to pursue the full significance of these important presuppositions in this paper, but will only register my opinion that this finitist point of view in the realm of color shades is entirely in harmony with the finitist outlook Hume develops elsewhere in the Treatise in his repudiation in *Treatise* 1.2.1 and 1.2.2 of the infinite divisibility of both our ideas of extension and extension itself. And Hume's color finitism will turn out be relevant to my comments on Schliesser's argument.

3. Schliesser on the Means and Extremes Argument

We now turn to consider Eric Schliesser's criticism of Hume's reasoning in the means and extremes argument in "Hume's Missing Shade of Blue Reconsidered from a Newtonian Perspective". The core of the criticism in laid out in these passages from that paper:

> Hume then goes on to consider his much discussed missing shade of blue example as an exception to his general theory about the source of our ideas. It has been little remarked, however, that Hume's assumption in these last lines, that it is absurd to think that it is possible 'by the continual graduation of shades, to run a colour insensibly into what is remote from it', stands, in fact, in contradiction to the implications of Newton's optical researches. From Newton's earliest published optical writings onward it was known that there were an 'indefinite' or, as we now know, an infinite number of shades of colors. In the first letter to Oldenburg, published in the 1672 February issue of Philosophical Transactions, Newton wrote, 'The original or primary colours are, Red, Yellow, Green, Blew, and a Violet-purple together with Orange, Indigo, and an indefinite variety of Intermediate gradations'. (See also '…to all the intermediate colours in a continued series belong intermediate degrees of refrangability'; emphasis added in both quotes (Newton 1672: 3081–2)). It is very likely that Hume was exposed to this particular piece during his formal education (see Barfoot 1991: 153), but he could have also learned this from popular accounts of Newton's achievements. For example, Fontenelle remarks: 'This different Refrangibility of red, yellow, green, blue, violet and the vast variety of intermediate-colour'd Rays, a property which had never been suspected, and which no conjecture could have ever form'd, is the fundamental Discovery in Sir Is[aac] Newton's Treatise [i.e., Opticks]' (Fontenelle 1728: 14, emphasis added).
>
> Newton's experiments show, in fact, that the differences among different adjoining shades are imperceptible to the human eye. Note that what is important in this connection is that Newton, in exhibiting his new kinds of monochromatic light, had observed that these 'lights' formed a series in which closely neighboring elements were perceptually indistinguishable—i.e., indistinguishable in color. Thus, it is possible, with enough patience, theoretical knowledge and (admittedly) extraordinary experimental skill 'to run a colour insensibly into what is remote from it'. What Hume considers absurd is, in fact, the case! Hume's legislation from an armchair gets him into trouble.
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> So even if we grant Hume's claim that each shade of color produces a distinct and independent idea, then, Newton's experiments show, it turns out that it is impossible for us to distinguish otherwise independent ideas from each other when the different shades are near enough. In Hume's language: maintaining distinctness of ideas is problematic in adjoining shades. No such problem exists when comparing ideas that are far removed from each other; these do remain distinct.[17]

An initial question that has to be asked here is what, for Schliesser, are *contiguous* shades of color, and how is it they can turn out to be indistinguishable? It appears that Schliesser is reading Hume's use of the term "color" to refer to something like Newton's "colored lights" – the physical, optical stimuli which possess differing degrees of refrangibility and enter the eyes to stimulate the optical organs. Thus contiguous but indistinguishable colors would be lights of differing but nearby degrees of refrangibility that *appear* the same way to the observer with respect to their color.

But there are two points to make here. First, as has already been argued, Hume does not use "color" in that way. For Hume, colors are either impressions of a particular kind, or qualities of impressions and ideas. Colors are presented and discussed as mental, not physical phenomena. This does not mean that Hume is ignorant of Newton's views on the physical origins of color, but only that, whatever he might have known of these views, he would not have been concerned with them for the purposes of developing his science of the understanding.

But I think there is a further problem with Schliesser's reasoning: Despite Schliesser's suggestions to the contrary, Newton *himself* never says that distinct but nearby homogeneal rays in the spectrum of homogeneal rays might be indistinguishable as to their color. Instead, Newton appears to endorse the claim that homogeneal rays of different refrangibilities always display different colors. In Book I, Part II, Proposition II, Theorem II of the Opticks, Newton says that in his experiments separating rays into their different refrangibilities, "there appeared as many different Degrees of Colours, as there were sorts of Rays differing in Refrangibility." So, even a careful and ideally knowledgeable reader of Newton's Opticks might have concluded that rays of differing refrangibility always appear different in color.

One might argue that Newton *must* have believed rays that are sufficiently close in refrangibility are indistinguishable, because there are infinitely many degrees of refrangibility forming a continuous series, and it is implausible to think that the human sensorium generates an infinite palette of distinct color appearances to match each of these degrees one to one. But in the English version of the *Opticks*, Newton does not say there are infinitely many colors or colored rays, but only "indefinitely" many. And it would have been both theoretically presumptuous and empirically unwarranted for Newton to conclude that there are in fact infinitely many degrees of refrangibility detectable from experiments on the analysis of white light via prisms. The conclusion that there are *many* different degrees of refrangibility of light is a conclusion from the length of the oblong image projected by prisms, and however uniform and gap-free that image might appear, it is implausible to think we can distinguish infinitely many points of illumination when viewing such an image. Hooke, Molyneux and others had in Newton's time studied the limits on spatial distinguishability in vision, and Newton was certainly familiar with these results, as they were key points of interest in the contemporary debates about the reliability of naked eye versus telescopic sighting in astronomical observations.[18] Whatever leaps into the chromatic infinite some of Newton's enthusiastic admirers might have made on the basis of his results, it would seem odd for someone as famously scrupulous about empirical warrant as was Newton to make the same leap.

Of course, Newton might have believed on mathematical, purely theoretical grounds that one neither could nor should place *a priori* limits on the possible degrees of physical refrangibility among the light rays that might be found in nature between any two observed rays with degrees of refrangibility corresponding to two observed types of colored lights. But to decline to place a priori limits on the number of members in some family of related physical

quantities is not the same thing as concluding that family of quantities actually contains infinitely many members.

Schliesser later notes that Hume accepts that some people are able to make color distinctions that others miss, and that our ability to perceive distinct colors produced by distinct lights can improve over time. But this would only mean that some people experience the same visual impression of color in response to different stimuli, while others experience different impressions in response to those stimuli. It is not an implicit recognition that some lights of differing degrees of refrangibility are chromatically indistinguishable to all observers. In any case, even if Hume were convinced that there are different *lights* that cannot be distinguished by *any* observers, this acknowledgement by Hume would not be inconsistent with his view – as I have interpreted it – that distinct *impressions* of color always produce distinct *ideas* of color. What Hume would have said is that different stimuli might produce qualitatively identical impressions, but that the ideas of the colors of those impressions would then be the same idea.

4. Schliesser On Hume's Science and Methodology

Schliesser also argues that Hume is "much less than a naturalist than is commonly thought."[19] Accepting that there are different kinds of naturalism, he argues that "if naturalism is taken to be the doctrine that there is no first philosophy and that philosophy is continuous with and informed by the result of the sciences," then "attributing this view to Hume is problematic."[20] His basis for this claim is lies in the arguments we have already discussed. Schliesser believes that Hume has failed to appreciate and assimilate Newton's optical results, and incorporate them into his own

science of human nature in places where they are clearly relevant. But for the reasons I have already given, I do not believe Schliesser is correct here.

To understand and appreciate the nature and scope of Hume's naturalism, we must be willing to take seriously Hume's view that the natural world includes a coherent and partially autonomous sub-realm comprising an "intellectual world"[21] or "mental world"[22] consisting entirely of perceptions, and united by the causal principles relating them. Hume also calls this realm the "universe of the imagination."[23] The realm of the mental universe is only *partially* autonomous, because Hume does not deny that it also causally interacts with the physical world as studied in Natural Philosophy. However, because it turns out there is a great deal of internal regularity observable in the mental world itself, it holds together as a realm susceptible of independent study by a scientific specialist. Such a scientist can arrive at general principles of what appears to be purely mental causation involving impressions and ideas alone. So, whatever further connections these entities might turn out to have to the world of physical bodies, these connections do not undermine the internal integrity and relative autonomy of the Humean science of human nature. Hume also makes it clear that the conduct of his science of the mind does not require any decisions as to what the ultimate constituents of perceptions might turn out to be, if indeed that can ever be known. He says that the "essence of the mind" is "equally unknown to us with that of external bodies."[24]

Because Hume holds the above conception of the mental world of impressions and ideas, it makes sense for him to practice what I have called "methodological phenomenalism" in the study of the science of human nature. We might compare the methodological situation Hume thinks prevails in his own science with other sciences with which we are familiar. For example, a large amount of stellar gravitational astronomy can be conducted without making any

assumptions about what stars are made of, or where they ultimately came from. All we need to attribute to them are masses and their evolving positions which we observe over time. Similarly, evolutionary biology can be studied at one profitable level without making assumptions about the biochemical basis of biological inheritance. Also, we can recall that Albert Einstein developed his Special Theory of Relativity in "On the Electrodynamics of Moving Bodies"[25] as what he called a "theory of principle". The laws of the theory are formulated in a "space" of idealised measuring rods and clocks that determine an interrelated family of coordinate systems, but the theory makes no assumptions about the physical constitution of these rods and clocks, and the physical principles that might make them appropriate and applicable standards for the spatiotemporal measurement framework they determine.[26]

None of these analogies are perfect ones, but taken together they point to the ways in which a scientific field can be relatively autonomous with respect to other branches of science, and carried out independently of those other branches. Now since the relative autonomy Hume attributes to this "intellectual world" is *only* relative, and not absolute, it could well turn out that developments in optics or other sub-fields of natural philosophy might turn out to impinge on Hume's science in previously under-appreciated or unanticipated ways. As we have seen, Schilesser has argued that Newton's optical results are very much relevant to Hume's science, and that Hume would have understood this, and taken proper account of Newton's results by modifying his own conclusions, if he had fully understood those results in the first place. But I hope I have made a convincing case that this is a conclusion that we cannot draw, and that given Hume's understanding of the relative autonomy of the mental world of impressions and ideas, even a deep and comprehensive understanding of the extra-mental behavior of light and material bodies would not have required Hume to alter his conclusions.

Nor does Hume's mental science constitute a "first philosophy" in the sense of some set of a priori principles that place constraints on either the possible observations that science might gather or the possible general principles or empirical regularities that might be established by induction on the basis of those observations. Hume was perfectly willing to accept that the principles he thought he had established concerning perceptions were contingent and defeasible. But what he would have required is that arguments against any of these principles be themselves based on observations of impressions and ideas. Since observations and theories concerning prisms, light rays, reflective surfaces and "shining bodies" are not observations of these kinds of entities, he would have found them irrelevant to his concerns.

But Schliesser is on stronger ground, I believe, when he questions Hume's scientific methodology in comparison with Newton's four rules of reasoning. As I noted briefly earlier, Hume has struck many interpreters as disturbingly uninterested in establishing the limits of the kind of counterexample to the Copy Principle that he himself has adduced with his example of the missing shade of blue. Schliesser points out, in connection with Rule IV of Newton's four rules, that:

> Hume misses out on a perfectly respectable Newtonian methodological response, namely, that even minor empirical exceptions to general rules should be investigated because they open up the possibility of discovering interesting refinements to general rules or the possibility of formulating a more sophisticated new theory.

Here we are talking not about Hume's supposed lack of appreciation of Newton's optical results, but his lack of appreciation of Newton's methodological principles, or what we might these days call his *philosophy of science*. And I think there is much to be said for the claim that Newton possessed a sharper understanding of the requirements of rigorous scientific reasoning than Hume displays in the Treatise.

I have not tried to argue in this paper that Hume had a thorough knowledge, or even a modest degree of knowledge, of Newton's optical theories and achievements. I don't believe Hume's extant texts allow us to answer this question. I have only tried to show that contrary to Schliesser's characterization of Hume there is insufficient basis for concluding that Hume had "considerable ignorance" of these achievements. Hume and Newton approach color from two diametrically opposite directions on a very broad theoretical plain. Hume is concerned with perceptual phenomena and processes about which Newton had very little to say, and did not investigate experimentally – at least insofar as those investigations are revealed in the *Opticks*. And Newton is concerned with the properties of light and its transmission, matters which Hume decidedly places outside the scope of his ambitious new human science. One might suspect that these two realms of inquiry intersect over a common terrain, and that Hume reveals his ignorance of Newtonian optics in precisely that terrain. But I hope I have shown that this suspicion is incorrect.

Notes

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1. All references to the *Treatise* are to Hume, David (2000), *A Treatise of Human Nature*, ed. David Fate Norton and Mary J. Norton, New York: Oxford University Press.

2. It is impossible to cite all of the many interpreters who have had something interesting to say on the subject of Hume's intellectual relationship to Newton, but writers whose discussions of the issue are particularly enlightening and important include Barfoot, Michael (1990) "Hume and the Culture of Science in the Early Eighteenth Century", in M.A. Stewart (ed.) *Studies in the Philosophy of the Scottish Enlightenment*, New York: Oxford University Press, pp. 151-90; Capaldi, Nicholas (1975), *David Hume: The Newtonian Philosopher*, Boston: Twayne; Force, James E. (1987) "Hume's Interest in Newton and Science", *Hume Studies* 13, pp. 166-216;

Jones, Peter (1982), *Hume's Sentiments: Their Ciceronian and French Contexts*, Edinburgh: Edinburgh University Press; Laird, John (1932), *Hume's Philosophy of Human Nature*, London, Methuen; McIntyre, Jane L. (1994), "Hume: Second Newton of the Moral Sciences", *Hume Studies* 20, pp. 3-18; Norton, David Fate (1982), *David Hume: Common-Sense Moralist, Sceptical Metaphysician*, Princeton: Princeton University Press; Noxon, James (1973), *Hume's Philosophical Development*, London: Oxford University Press; Passmore, John (1980), *Hume's Intentions*, 3rd ed., London: Duckworth; De Pierris, Graciela (2006), "Hume and Locke on Scientific Methodology: The Newtonian Legacy", *Hume Studies* 32, pp. 277-329; De Pierris, Graciela (2015), *Ideas, Evidence and Method*, Oxford University Press; Russell, Paul (2008), *The Riddle of Hume's Treatise*, New York: Oxford University Press; Sapadin, Eugene (1997), "A Note of Newton, Boyle and Hume's "Experimental Method"", *Hume Studies* 23, pp. 337-344; Stroud, Barry (1997), *Hume*, London: Routledge; and Wright, John P. (1983), *The Skeptical Realism of David Hume*, Minneapolis: University of Minnesota Press.

3. Schliesser's probing and very nuanced interpretation of the Hume-Newton nexus is developed in Schliesser, Eric (2004), "Hume's Missing Shade of Blue Reconsidered from a Newtonian Perspective", *The Journal of Scottish Philosophy* 2, pp. 164-75 (cited hereafter as "Missing"); Schliesser, Eric (2007) "Two definitions of 'cause,' Newton, and the significance of the Humean distinction between natural and philosophical relations", *The Journal of Scottish Philosophy* 5, pp. 83-101; Schliesser, Eric (2008), "Hume's Newtonianism and Anti-Newtonianism", The Stanford Encyclopedia of Philosophy (Winter 2008 Edition), Edward N. Zalta (ed.), URL = <http://plato.stanford.edu/archives/win2008/entries/hume-newton/> , and Schliesser, Eric (2009), "Hume's Attack on Newton's Philosophy" *Enlightenment & Dissent* 25, pp. 167-203.

4. Schliesser, "Missing", p. 164.

5. Newton, Isaac (1952), *Opticks: Or a Treatise of the Reflections, Refractions, Inflections and Colours of Light*, based on the 4th ed. London, 1730; New York: Dover Publications, 1952. Newton's theories of light and color developed throughout his adult life. The main writings in this course of development have been edited and made accessible online by The Newton Project, Sussex, UK. They include Newton, Isaac (1757), "An Hypothesis Explaining the Properties of Light", *The History of the Royal Society* 3, pp. 247-305; Newton, Isaac (1671-2) "A Letter of Mr. Isaac Newton … containing his New Theory about Light and Colors", *Philosophical Transactions of the Royal Society* 80, pp. 3075-87; Newton, Isaac (1672), "Mr. Isaac Newton's Answer to some Considerations upon his Doctrine of Light and Colors", *Philosophical Transactions of the Royal Society* 88, pp. 5084-5103; Newton, Isaac, "Of Colours", Additional Ms. 3975: pp. 1-22. Cambridge University Library, UK.

6. *Opticks*, Bk. I, Pt. I, Prop. II, Thm. II

7. I have relied on a substantial amount of expert secondary literature in developing my understanding of Newton's arguments. My primarily resources were Guerlac, Henry (1986), "Can There Be Colors in the Dark? Physical Color Theory before Newton", *Journal of the History of Ideas* 47, pp. 3-20; Hall, A. Rupert (1993), *All Was Light: An Introduction to Newton's Optics*, New York: Oxford University Press; Sabra, A.I. (1981), *Theories of Light from Descartes to Newton*, Cambridge: Cambridge University Press; Shapiro, Alan E. (1980) "The Evolving Structure of Newton's Theory of White Light and Color", *Isis* 71, pp. 211-35; Shapiro, Alan E. (1994), "Artist's Colors and Newton's Colors", *Isis* 85, pp. 600-30; Shapiro, Alan E.

(2002), "Newton's Optics and Atomism", *The Cambridge Companion to Newton*, ed. I. Bernard Cohen and George E. Smith, Cambridge: Cambridge University Press; and Westfall, Richard S. (1962), "The Development of Newton's Theory of Color", *Isis* 53, pp. 339-58. The work of Alan E. Shapiro has been especially important in shaping my views. I would like to thank Professor Shapiro for clearing up some difficult issues for me via email correspondence.

8. *Opticks*, Bk. I, Pt. I, Def. VII.

9. Newton, "New Theory", p. 3081.

10. Isaac Newton "Answer [to Huygens]", p. 6089.

11. Newton held from the earliest presentations of his theory that white – that is, the white that is displayed by the white light of the sun – is "ever compounded". There is so simple or homogeneal version of white. If the color of some light is white, then that light must be a compound light. Newton and his contemporaries regarded this as one of the most striking and revolutionary aspects of his theory. A long-standing conviction, developed in different ways by Newton's predecessors, was that the white light of the sun was in some way the purest and simplest form of light, and that color resulted from a modification of this pure and fundamental light by contact with other objects. Newton demonstrated that the white light of the sun was compounded from other simpler forms of light, and argued further that there was *no* form of white light that was uncompounded.

12. *Opticks*, Bk. I, Pt. II, Prop. II, Thm. II, Definition.

13. One needs to emphasise right away that *methodological phenomenalism* does not entail *phenomenalism*. It is not any part of my interpretation of Hume that he believes perceptions and the processes that relate them exhaust the entities in the world, but only that an inquiry into the nature and existence of extra-mental objects lies outside the scope of the science of the understanding that is the subject of Book I of the Treatise. Hume often speaks in ways that seem to take the existence of external objects for granted. And he posits in the discussion of skepticism about the senses in T 1.4.2 that we cannot but believe in such objects, before going on to give an account of the mechanisms that generate such beliefs. He also argues that we cannot *conceive* of external objects as specifically different from perceptions. But he stops short, I hold, of offering an affirmative account of either the nature or existence of such objects.

We must also distinguish (i) what Hume believes from (ii) what the science of human nature as developed in the *Treatise* is designed to affirm. By analogy, a scientist such as Darwin might have personal beliefs about the physiological and biochemical basis of evolution that he refrains from incorporating into his official presentations of the theory of evolution. Similarly, Newton had views about the nature of gravitation that can be inferred or surmised from his informal or unpublished work, but that are not entailments of the mathematical principles of natural philosophy as set forth in the *Principia*.

14. We should consider the suggestion that when Hume refers to, "the several distinct ideas of colours, which enter by the eyes," the relative pronoun refers back to "ideas", and so he is speaking of *ideas* themselves entering the eyes. One might guess he has forgotten the distinction between ideas and impression he has just drawn within the Lockean category of ideas, and his re-labelling of Lockean ideas as "perceptions". But this reading seems strained and uncharitable, and it is much simpler to read the sentence with a different parsing. Rather than reading it as

referring to *ideas-of-colours which enter by the eyes*, we should read it as referring to *ideas of colours-that-enter-by-the-eyes.*

15. Hume argues in T 1.2.6 and T 1.4.6 that we cannot conceive of external objects as "specifically different" from our perceptions. In itself, this is a doctrine about the limits of our powers of conception or ideation. However, one interpretive possibility is that Hume regards external objects, or some superficial parts of them, as *intrinsically identical* to perceptions *in fact*. This would allow for an interpretation of light as something like the pointillistic type of sensible species proposed by some ancient and medieval thinkers, external entities that are emitted from the minimal parts of the surfaces of objects, propagated through space toward the perceiver, and literally "strike upon" and "enter" the perceptual organs and minds of perceivers. While I think this is a fascinating area for further investigation, I am not prepared to endorse this reading at this time.

16. It must be acknowledged that the reasoning is not very compelling. The critic might wish to hold that while *some* nearby distinct shades of a color like blue produce ideas that are not different, not every such pair does so, and so the extreme shades might be different while some pairs of adjoining shades are identical. Schliesser, focusing on adjoining light stimuli rather than nearby impressions, seems to suggest a more radical move for the critic of Hume's argument that denies the transitivity of identity in the case of "physical" continua. I will not address his suggestion directly in this paper, for reasons that will become clearer in what follows.

17. Schliesser, "Missing", pp. 164-65.

18. See, for discussion of this historical topic, Wade, Nicholas J. (2005), "Vision and the Dimension of Nerve Fibers", *Journal of the History of the Neurosciences*, 14(4), pp. 281-94.

19. Schliesser, "Missing", p. 164.

20. Schliesser, "Missing", p. 171.

21. T 1.1.7.15, SBN 23-24; T 1.4.5.1, SBN 232; and T App.10, SBN 633.

22. T 1.1.4.6, SBN 12-13.

23. T 1.2.6.8, SBN 67-68.

24. T Intro.8, SBN xvii.

25. Einstein, Albert (1905), "*Zur Elektrodynamik bewegter Körper*", *Annalen der Physik* 322 (10): pp. 891–921

26. An exceptionally interesting recent analysis and critique of Einstein's methodology can be found in Brown, Harvey R. (2005), *Physical Relativity*, Oxford University Press.

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