A Scientific Case for the Soul

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I. Introduction

Substance dualism, which I will hereafter call *entity dualism*, is the view that the seat of consciousness is an immaterial entity, often referred to as a soul. Perhaps the most common objection to entity dualism is that is it inherently antiscientific (e.g., see Dennett, 1991 pp. 35 – 37; Searle, p. 4). The locus of this objection is the so-called interaction problem – the problem of explaining how an immaterial soul could interact with the brain. This is illustrated by the prominence of the "causal closure objection" and the "energy conservation objection," both of which claim that the interaction between mind and body cannot be reconciled with science. (See chapters ___ and ___ for direct responses to these objections.) In this chapter, I will reverse the tables on the objection that entity dualism is inherently antiscientific: after carefully examining

the purported interaction problem, I will argue that the right version of entity dualism has the potential of fitting the fundamental values of science much better than its contenders; in the process I will develop an explicit model of how the immaterial soul could interact with the brain.

Arguably, the heart of the scientific approach to reality involves three criteria. Stated as preferences, these are: (i) a preference for views of reality that fit observational data over those based on prior philosophical commitments; (ii) a preference for simple and elegant laws over complex and messy laws; and (iii) a preference for potentially testable and fruitful theories. Focusing on contents of conscious experience and their correlation with brain states, I will first argue that *reductive materialism* – which states that conscious experiences are merely complex physical and chemical processes in the brain/body – fails to account for the data, the thus fails on the first criteria of good science. Then, I will consider the leading contender to reductive materialism, that of non-reductive materialism, a view which denies the existence of an immaterial soul but at the same time contends that conscious experience cannot be reduced to brain states. I will argue that standard versions of this view have major difficulties with the second criteria – specifically with regard to providing a relatively simple set of laws connecting brain states with states of conscious experience. Finally, I will show how the right sort of entity dualism has the potential of fulfilling all three criteria better than its contenders.

II. The Observational Data

Although in itself, reductive materialism is the simplest view of the relation of the mind to the brain (since it postulates no entities in addition to those given by the physical sciences), many philosophers claim it fails to account for human experience and other facets of our world. (See, for instance, the essays in this volume by Charles Taliaferro and Daniel Robinson). In this section, I will summarize the problem it has with consciousness and its contents, particularly what philosophers call *phenomenal qualia*, or *qualia* for short (with *quale* the singular form).[1]

Philosopher Michael Tye introduces the notion of phenomenal qualia as follows:

> Consider your visual experience as you stare at a bright turquoise color patch in a paint store. There is something it is like for you subjectively to undergo that experience. What it is like to undergo the experience is very different from what it is like for you to experience a dull brown color patch. This difference is a difference in what is often called "phenomenal character." The phenomenal character of an experience is what it is like subjectively to undergo the experience. If you are told to focus your attention upon the phenomenal character of your experience, you will find that in doing so you are aware of certain qualities. These qualities — ones that are accessible to you introspectively and

[1] There are other severe problems with reductive materialism which I will not discuss, such as the problem of how thoughts could be meaningful or how they could be *about* things. For example, since under materialism the only properties and relations in the world are physical, how could the thought "there are extraterrestrials somewhere in the universe" be about the universe, when there is no plausible material relation one has to the entire universe that could corresponds to this "aboutness"? (The relation could not be that of causality, for instance, since many parts of the universe are causally isolated from us.) In philosophy, this problem regarding "aboutness" goes under the name of the *problem of intentionality*.

> that together make up the phenomenal character of the experience are standardly called 'qualia'. (Tye, 2007, Section 1.)

To understand the problem that qualia present for reductive materialism, consider a person I will call Abaz. Suppose you simultaneously peered into his brain and his mind using both a "brain-scope" and a "soul-scope," the former completely mapping the pattern of physical interactions in the brain and the latter allowing one to map all of Abaz's experiences and thoughts. Further suppose Abaz looks at a green backdrop and you notice a certain pattern of the firing of neurons that always take place when Abaz sees green. One puzzle is why this pattern of firing causes the particular phenomenal quale it does (which I will call the "green quale") instead of any other quale – such as that corresponding to the color red, the taste of chocolate, and the like – or no experience at all. No matter how much you physically analyze the brain, you will only detect material fields and particles causally interacting with one another, not the corresponding green quale. Of course, by asking Abaz and other subjects what they experience when a certain set of neurons are activated, you could draw a correlation between the experienced qualia and the pattern of neuronal firings, but this is not the same thing as being able to describe the qualia in purely physical terms.

To put the argument another way, suppose scientists had a perfected physics and neuroscience that provided a complete map of all the material interactions in Abaz's brain along with a complete neurological account of the function of every system of Abaz's brain. It seems clear, at least to many who have pondered the issue, that a purely physical description of his brain will not include what it is like for him to have particular experience, such as tasting chocolate; further, it seems that his experiences cannot be deduced solely from such a description without knowing beforehand how brain states correlate with qualia. This is why, even after such a complete map of Abaz's and someone else's brain, it would make sense to wonder if the subjective quality of Abaz's experience is the same as the other person's. Further, as philosopher David Chalmers points out, these problems with reductive materialism will not go away with further developments in cognitive science and neurology. The reason is that these sciences can only explain the physical abilities and functions of systems in the brain; the problem that consciousness and qualia pose, however, is problem of why there is an inner experience at all in systems with certain physical abilities, functions, and physical structure. This problem – what he calls the *hard problem* – remains even after all physical abilities, functions, and structures have been explained, and therefore is beyond the explanatory scope of cognitive science and neurology.[2]

Given that qualia cannot be reduced to states of the brain/body described by physics and chemistry (states that hereafter I will simply refer to as "brain states"), reductive materialism fails on the most fundamental test of any theory, that of being compatible with the observational data. Two key consequences follow from this failure. First, one must hypothesize laws that link brain states with qualia, otherwise one cannot account for the observed correlation between neurological activity in certain regions of the brain and the occurrence of certain types of qualia. I will call these *linking laws*, though later I will use the term more generally to designate laws linking any set of non-subjective states with a set of subjective states. Since philosophers typically assume that laws imply or are undergirded by some sort of causal relation, I will

[2] Chalmers has developed this argument in detail in a major book on the subject (1997), along with a series of articles and responses to critics, many of which are available on the internet. Many others have presented similar arguments, such as Colin McGinn (2000) and Thomas Nagel (1974).

generally assume that where there is a linking law there is some corresponding causal relation – for example, if there is a linking law that correlates a material state with a quale, the material state either causally produces the quale or there is some common cause of both of them. This assumption, however, is not essential to my account.

Second, it seems to be a conceptual truth that an experience can only exist if there is an *experiencer*. For example, it seems that there cannot be an experience of pain without *something* experiencing the pain, whatever metaphysical category that "something" might fall under (such as a substance, a process, or an event).[3] In any case, even if this is logically possible, human experiences inseparably involve an experiencer: for example, it is not just that there is an experience of the sofa's being red, but that some particular person – such as Abaz – experiences the sofa as being red. It should be noted, though, that while I believe there is only one experiencer per human body, my argument will not depend on that assumption.

What is the nature of the experiencer? Leaving aside the question of the number of experiencers associated with a given human brain/body, the views on what an experiencer is can be divided into two camps: those who claim the experiencer is composed of other entities, and those who deny this. Those who advocate the composition view virtually always identify the experiencer of a given quale with the brain, some region of or set of processes in the brain, or some combination of the brain and the rest of the body. This view is commonly called *non-reductive materialism*, because while its proponents believe that the entity that experiences the qualia is a material thing or process, they also maintain that qualia themselves cannot be reduced to any features or states of the brain that can be described by the physical sciences. (Nonetheless, many non-reductive materialists consider qualia [and even being an experiencer] material properties; they just do not consider them properties that are reducible to those in physics, but rather as being so-called emergent properties. This issue will not affect my overall argument, however.) I will now argue that standard versions of non-reductive materialism seem to need enormously complex linking laws, and hence are likely to badly fail on the second scientific criteria mentioned previously: that of providing an account that invokes relatively simple laws.[4]

III. The Enormous Complexity Challenge

Terminology

The problem of the enormous complexity of the laws linking qualia with brain states has been recognized by many other philosophers. For example, this problem has led Thomas Nagel, one of the most influential critics of reductive materialism, to question his prior advocacy of non-reductive materialism (2002). To understand the complexity problem faced by non-reductive materialism, it will be helpful to introduce some terminology, beginning with some terms concerning qualia. Qualia are distinguished by what it is like to experience them: if two purportedly distinct qualia are experienced as identical, then they are identical. Now, qualia can be classified under very broad natural categories – e.g., as visual, auditory, tactile, and gustatory

[3] Given that this is a conceptual truth, it will be true even if, following the reductive materialist, experiences are merely brain states. Therefore, one must either deny that it is a conceptual truth or deny the existence of subjective experiences.

[4] A standard version of non-reductive materialism is one that does not invoke any additional physical entities or properties not found in the physical sciences. What a non-standard version would look like will become clear in the last subsection of section IV.

qualia. Some of these categories might have further natural subtypes, such as various types of visual qualia: e.g., the qualia associated with the subjective experience of seeing red. Presumably, at some point, there will be no further natural subcategories, with the qualia only differing by mathematically quantifiable features, such as their intensity, or in the case of visual qualia, their intensity and position within the visual field. Following biological classification schemes, I will call the lowest category of qualia *species*, with the category up one level a quale's *genu*s, the next level the quale's *family*, and so forth. Thus, presumably the qualia involved in experiencing pure redness (of a certain hue, saturation, etc.) is a species of quale containing many different individual qualia of various intensities, whereas the class of color qualia is a genus since particular species of color qualia fall under it. These groupings are to be determined by the inherent experienced nature of the qualia. The correct scheme of classification, however, is not important to my argument. Further, for the sake of exposition, in the rest of the paper I will only consider species of qualia and the various qualia they contain.

Presumably, there are laws that specify for each brain state whether or not it gives rise to qualia, and if so, what qualia it gives rise to. I will call these laws *linking laws*. In specifying the qualia a brain state gives rise to, the law will have to specify both the species of qualia and their respective intensities, and in the case of visual and certain other types of qualia, their apparent spatial location. Finally, since there cannot be qualia without an experiencer, non-reductive materialists must postulate a law or metaphysical principle that specifies which material systems constitute experiencers; this law constitutes a special linking law that will become relevant at the end of section IV when I consider possible non-standard forms of non-reductive materialism.

Laws of nature have two sorts of variables. One type of variable is called a *dependent* variable, which can be thought of as a quantity whose value the law specifies. The other set of variables are called the *independent* variables – these are the factors which determine the value of the dependent variable. For instance, Newton's law of gravity says that the force of gravity between any two masses is proportional to the product of their respective masses divided by the square of the distance between them.[5] In this case, the dependent variable is the force of gravity (since it is the quantity that the law determines) and the independent variables are the values of the two masses and the distance between them (since these are what determine the force).[6]

In the case of the qualia linking laws, there are two dependent variables: the species of the qualia and its intensity. (For simplicity of exposition, I will be neglecting the apparent spatial location of many types of qualia until near the end of section IV.) The independent variables will be the relevant features of the brain or other material systems that determine these aspects of the qualia. Now, in general, the more variables a law invokes, the more complex the law. Specifically, the more independent variables a law invokes that cannot be combined into a single variable, the more complex the law. This is nicely illustrated by laws enacted by human beings, though the same analysis applies to the laws of nature. Consider, for instance, sales taxes that many states have adopted in the US. A maximally simple sales tax would apply the same tax rate – say 6% -- to all items that are sold. Many states do not have maximally simple laws, but rather charge different rates for different items. For example, California charges an 8.5% sales tax on all items except unprepared food items. One could imagine even more complex tax laws, ones

[5] Mathematically, $F = Gm_1m_2/r^2$, where F represents the amount of force, m_1 and m_2 the mass of the first and second mass pair, r the distance between the center of gravity between the two masses, and G is the gravitational constant.
[6] Often by re-writing an equation expressing a law of physics one can change what are considered the independent variables and dependent variables, but this will not affect my overall argument.

that charged different tax rates for paper products, dairy products, crackers, honey, cereal, and so forth. Each of these items would constitute a different variable that could not be lumped together under a single variable, but would have to be considered independently. Clearly, the more such variables there are, the more complex the law. At some point, one could only imagine the difficulty a store clerk would have in calculating the sales tax without the use of a computer! An ideal of science is for the fundamental laws to invoke relatively few independent variables, an ideal which is largely fulfilled by the basic laws in the physical sciences. For instance, Newton's law of gravity only contains three independent variables – the values of the two masses and the distance between them.

The Challenge Explained

The challenge for non-reductive materialism is that the qualia linking laws appear to need a vast number of independent variables, hence making them enormously complex. The most general case of the laws linking material states with qualia will be a law that specifies which material states give rise to consciousness itself, since this is required for any qualia to exist. For simplicity of exposition, I will focus on this law, showing why it seems that it must be enormously complex, though the same sort of analysis will apply to the specific laws linking brain states with qualia.

To begin, imagine that one could see – using a fictitious "experience-scope" – whether or not a material system gives rise to conscious experience. Some systems, such as those associated with brains, will give rise to consciousness, and others will not. As one performed more and more experiments with different types of material systems, one could construct a list of those material configurations that are correlated with consciousness and those that are not. Eventually, one would have a vast listing of such conditions, far larger than any telephone book.

Now suppose one made each condition a law – for example, a law might state that when the condition given by the nth listing is met consciousness arises, whereas when the one given by the kth listing is met, there is no consciousness. Clearly, this would result in an enormously – in fact, infinitely -- complicated set of laws. A challenge for non-reductive materialists is to indicate how this enormous listing of correlations could be derived from a few simple laws.

To be simple, such laws must only invoke a few basic physical variables, upon which the existence of consciousness depends. This is where the difficulty lies. The existence of consciousness, let alone specific qualia, seems to depend on the right sort of complexity of arrangement of the parts of a physical system, along with the interactions between the parts. That is what appears to separate brains from other material systems, such as a rock in my garden, that presumably are unconscious. Further, there does not appear to be any set of a few basic physical variables (such as energy or the vibrational frequency of some material field) that can be used as part of a simple law to separate those material systems that give rise to consciousness from those that do not. This suggests that any law that directly connects material configurations with consciousness will itself have to invoke that complexity.

An analogy will help illustrate this last point. Suppose that the members of a primitive tribe were trained to identify basic elements and chemical compounds, but were not given the concepts of an electron or that of an electromagnetic wave, such as a radio wave. (For example, they would be able to identify iron, but would not know that atoms of iron contained electrons.) Further, suppose that they were given the means of analyzing the arrangements of elements and compounds of various types of radios along with that of the radio station. Finally, suppose they were given the means of manipulating the material structure of the radios.

The tribe could then go about recording those material configurations which resulted in functioning radios (that is, ones that emitted the same sounds as produced in the studio) and those that did not. Once again, this would involve an enormous listing of conditions. Without invoking electrons and radio waves (or some functional equivalent of these), it is unlikely that there would be any way of deriving this listing from a few simple laws containing a few independent variables. Specifically, they could not distinguish functioning radios from non-functioning radios via simple laws that invoked the basic physical parameters available to them, such as color, density, energy, or the like. The problem is that the kind of complexity that makes a radio function is not reducible to a simple set of laws invoking these factors. However, once electrons and radio waves were postulated, along with the relatively simple fundamental laws governing them, the reasons for these correlations between material configurations and functioning radios would become clear; the tribe would no longer be stuck with simply postulating a law for each correlation. (See Fig. 1).

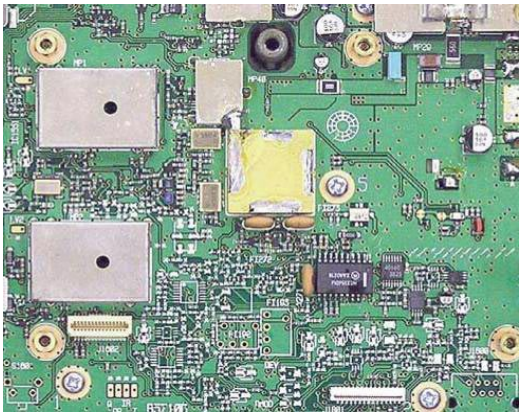

Fig. 1. A photograph of the inside of a modern day radio. Just as the postulate of electrons and radio waves (with their own fundamental laws) allows us to understand why certain material configurations result in a functioning radio, it is argued in the next section that the postulate of the right kind of soul with the right sort of linking laws could help us understand how brain states are connected with conscious experiences.

The lesson here is that by invoking a few new entities that cannot be directly observed, with a few new variables describing these entities (e.g., electric charge and the value of the electric and magnetic field), one can derive a highly complex set of correlations via a few simple laws. In fact, historically this is exactly what happened with the introduction of atoms. During the nineteenth century, more and more laws connecting observable features of physical systems – what philosophers call *phenomenological laws* -- were discovered. For example, scientists discovered the ideal gas law (which states that if one heats a particular type of gas in a box, its pressure will increase in proportion to its temperature), along with a host of laws that stated the results of combining chemical compounds in various proportions. As the nineteenth century progressed, more and more such laws were discovered. The number of such laws mushroomed, and without the introduction of some new entities (specifically, atoms), no one could find a way of deriving them from a few simple laws. As one instance of this, the relation between volume,

pressure, and temperature of many gases deviated slightly from the ideal gas law, but there was no simple way of accounting for the deviations.

One way of thinking about the situation is that phenomenological laws governing the observed features of the physical system – which could be thought of as its dependent variables – required that one take into account more and more independent variables (the particular type of gas, the particular chemicals being combined, and so forth) without being able to derive these laws from some small set of laws with a few independent variables. The hypothesis of invisible (and at the time undetectable) atoms allowed one to predict the mushrooming number of phenomenological regularities using the much simpler set of laws postulated to govern atoms. Essentially, this hypothesis introduced new fundamental entities and corresponding fundamental variables describing those entities (such as atomic weight and atomic number); the introduction of these new entities and fundamental variables allowed physicists to eliminate the enormous number of independent variables that the phenomenological laws had to invoke.

The above examples show that postulating new entities with their own fundamental properties can result in a great reduction of complexity of fundamental laws that more than compensates for the increase in ontological complexity entailed by the hypothesis of the new entities. In fact, this is the motivation for postulating new particles and other entities in physics, and so is standard practice in science. On the other hand, it is almost universally assumed that the introduction of the immaterial soul can only increase the complexity of one's ontology; thus, it is almost universally assumed that the scientific way of thinking is in conflict with entity dualism. The above examples indicate that the reverse might be the case. In fact, in the next section I will sketch how such a reduction in complexity of the laws linking subjective states with material states can be achieved by introducing a new metaphysical entity, the soul, with the right fundamental properties. This will constitute the core of my case for the scientific merits of the right sort of entity dualism.

I have no proof that non-reductive materialists cannot achieve such a reduction in complexity without invoking new entities and variables, but I do think that there is good reason to believe that they are in the same situation as the aforementioned tribe, and scientists n nineteenth century who belonged to the so-called "energist school," who attempted to provide a simple account of the various known phenomenological laws without appealing to atoms. The reason is that no simple relationship between the variables recognized by the physical sciences– such as energy, temperature, mass, and the like –seems to capture what differentiates those material systems that are conscious from those that are not. Rather, it is something about the complex configuration of components – as occurs in animal brains – that make the difference.

This last point is brought home by considering a simple thought experiment, that involving taking a group of neurons that constitute an experiencing brain and slowly changing the chemical and other interactions among them along with the shape, composition, and structural features of the neurons. With enough such changes, the brain will go from being conscious to being unconscious. Now, there are an enormous number of seemingly independent ways of making these changes – for example, one corresponding to a change in the strength of a particular type chemical reaction between some pair of neurons, along with all the possible combinations thereof. For every one of those seemingly different types of changes, the linking law will have to specify when the group of neurons goes from producing consciousness to not producing consciousness. Unless these changes can be reduced to changes in a few basic physical variables, the linking law will end up involving a vast, if not infinite number, of independent variables, one for each type of change. Yet, as mentioned above, it does not seem

there are any such variables to do the trick: certainly variables such as energy, temperature, mass density will not work to distinguish conscious material systems from unconscious systems.[7] This problem is greatly compounded when one considers that such parameters will also have to be found for the linking laws for qualia – for example, there would need to be a few basic parameters that determined when a material state produces green qualia, yellow qualia, the smell of roses, and the like.

The problem is nicely illustrated by considering a concrete proposal (based on experimental evidence) that some neurologists have given for material conditions of conscious experience. As explained by neurologists R. Llinás, U. Ribary, D. Contreras, and C. Pedroarena (1998, p. 1847), the proposal is that conscious awareness occurs when there are resonant vibrations between the thalamic and cortical structures of the brain that are in the frequency range of 20 to 50 hertz. Based on their proposal, one could postulate a linking law according to which consciousness comes into existence if and only if the amplitude of such resonance vibrations is above a certain threshold. Although this proposal might seem to only involve a simple law, a problem will arise regarding precisely specifying which neurological structures constitute a thalamic structure and which constitute a cortical structure; without such precise specification, the law will not be able to specify precisely when consciousness occurs. Although general descriptions can be clearly be given (otherwise scientists could not distinguish such structures), the law will have to separate out all the borderline cases. One can therefore engage in the same thought experiment as above, in which one changes the interactions, compositions, and various other features of the neurons composing each of these structures. Thus, for instance, the linking law will have to specify precisely when a group of neurons constituting a thalamic structure goes from being a thalamic structure to a non-thalamic structure for every possible set of changes. Consequently, the problem of seeming to need an enormous number of independent variables in one's linking law will return.

One could attempt to evade this by introducing emergent properties or structures -- that is, properties or structures that arise in complex systems but cannot be specified by a simple equation based on the configuration of the underlying particles. The introduction of emergent properties or structures, however, simply pushes the problem back to the laws specifying when those emergent properties or structures arise. This can be seen in the above concrete proposal, where the proposed emergent structures consist of the thalamic and cortical structures of the brain: specifying these structures just pushes the problem of enormous complexity to another location.

As mentioned above, I have no proof that non-reductive materialists cannot find a simple linking law – one that only appeals to a few basic physical variables – that specifies those material states that give rise to consciousness. On the other hand, no one ever proved that the complexity of chemical and other laws could not be greatly reduced without the introduction of atoms; because atoms could be shown to do the trick, however, the burden was shifted to the other side to show how they could achieve such a reduction without such unseen entities. This chapter therefore, should be seen as showing that entity dualism has the promise of providing such a simplification, and thus as presenting a challenge to non-reductive materialists to find a way of doing the same.

[7] Even if one thought consciousness came in degrees, the problem would still remain of finding a simple equation that linked the degree, D, of consciousness with the enormous number of seemingly relevant physical parameters that specify the state of the brain.

IV. The Dual Aspect Soul Model

Entity dualism can be defined as the claim that the experiencer is an immaterial entity. Further, entity dualists almost universally claim the experiencer is a non-composite bearer of properties – that is, a *metaphysical simple*. This hypothesis avoids one problem related to the complex linking law problem for qualia, but only hinted at above: the need for a complex linking law to say which material composite is the experiencer. The reason is that since the metaphysical simple itself is the experiencer, no special linking law is needed to specify which of its states do, and do not, result an experiencer. Further, postulating a metaphysical simple does not invoke a new metaphysical category or principle, since physics itself seems to need metaphysical simples: for instance, if one adopts a fundamental particle ontology, then the fundamental particles (such as electrons) are the non-composite bearers of properties; on the other hand, if one thinks fields are primary, then space-time points are considered metaphysical simples. So, at least with regard to its hypothesis that the experiencer is a metaphysical simple, this immaterial experiencer account does not add any new metaphysical category; arguably, however, non-reductive materialists must add some new metaphysical principles or laws that have no precedent elsewhere: namely, those that specify that certain material systems are experiencers and others are not.

Merely hypothesizing such a metaphysical simple, however, does not itself solve the problem of linking brain states with the occurrence of conscious experience, or of specific qualia. For example, there would still need to be laws that linked states of the brain with the qualia experienced by the postulated metaphysical simple, with the same sort of thought experiment applying in this case as above: for any given quale, the laws will have to specify all the possible configurations of particles that give rise to that quale and those that do not, thus once again seeming to require an enormous number of variables.

A potential solution to this problem is to postulate that this new metaphysical simple has two kinds of properties, what I will call *subjective* properties and *non-subjective* properties. Subjective properties are defined as those that explicitly or implicitly involve consciousness or awareness and *non-subjective properties* are defined as those that do not: for example, qualia are subjective properties whereas the various features of my desk -- e.g., its weight, size, and shape – are non-subjective properties since they can be described without explicit reference to consciousness or awareness. Specifically, I will postulate that there are linking laws that link these non-subjective properties with particular quale or species of qualia. I will then explicate how these non-subjective properties could serve as intermediaries that can account for the regularities linking states of the brain with qualia states using relatively few simple laws. I will call this model of the soul the *dual-aspect soul model*, since it ascribes two different sorts of properties to the soul.

This model further postulates that these non-subjective properties can be represented mathematically. This means that if one ignored the soul's subjective properties, the hypothesis of such a soul would be equivalent to hypothesizing a new physical entity. The reason is that in modern physics, a physical entity can be defined as any entity that meets the following three criteria: (i) its states can be specified without reference to consciousness or awareness; (ii) its states can be described by some mathematical function; and (iii) the evolution of its states and their interaction with other material systems can be specified by a set of mathematical equations.

The non-subjective properties of the soul are stipulated to meet all these conditions. *Thus the primary way in which these dual-aspect souls differ from the commonly postulated material simples of physics (e.g., electrons) is that they have subjective properties in addition to non-subjective properties.* Further, since the soul's non-subjective properties can be represented mathematically, an equation can be constructed that specifies how they are affected by the physical properties of other entities. *This means that in principle, there is no more difficulty in specifying the equations governing the evolution of a soul's non-subjective states and their interaction with other fields -- e.g., standard material fields such as those that occur in the brain or even the non-subjective states of other souls -- than there would be with that of specifying the evolution and interaction of a newly hypothesized physical entity.*

The primary motivation for such an account is to simplify the laws linking states of the brain with qualia and other subjective states. As explained above, the difficulty for non-reductive materialism is that there are good reasons to believe that there are an enormous number of irreducible independent variables in the linking law, thus making the linking laws themselves enormously complex. This problem can be eliminated for qualia by requiring that there be relatively few, simply specifiable independent variables in the linking laws. Maximum simplicity will be achieved if there is one variable to determine the species of qualia, and another to determine the intensity of the qualia. Given that species of qualia are discrete (that is, they do not form a continuous spectrum), the specification of this variable would be maximally simple if it were also discrete – that is, come in integer multiples of some fundamental unit. The reason is that specifying an integer – for example, the number "3" – takes much less information than specifying a real number, which typically requires an infinite number of digits.

To see how such simplicity could be realized, I will begin by considering a fictional "guitar-string soul" whose non-subjective states consist of the vibrational pattern on a guitar-string and whose subjective qualia are linked with the states of this guitar string by a postulated set of linking laws. This will help provide the basis for presenting a more realistic model of the soul.

The "Guitar-string" Model

Consider an idealized guitar string (i.e., one with absolutely uniform density, tension, and shape and no damping) fastened between two points a distance L apart. When plucked, the string will vibrate. The standing wave vibrations on the string form what is known as a *harmonic series* of wavelengths and corresponding frequencies. The lowest frequency wave is called the fundamental. The frequency of the k^{th} harmonic is k times the frequency of the fundamental. So, for instance, the frequency of the third harmonic will be three times the frequency of the first. Each of these waves has two further attributes besides frequency: that of *amplitude* and *phase*.[8] Once these three attributes are specified, the exact waveform will be completely specified. (See Fig. 2.)

[8] The amplitude of the wave is given by the maximum displacement of the string from its resting position for a complete cycle of oscillation. To understand the idea of phase, first note that since all the waves falling under the k^{th} harmonic will be vibrating with a frequency f_k, all points on the string except the nodal points will move from being maximum positive displacement, to zero displacement, to maximum negative displacement, and then back again to maximum positive displacement with frequency f_k. The phase of the wave specifies where it is in this cycle relative to some reference time – say at time t = 0. Mathematically, the waveform of the k^{th} harmonic is given by the equation $h_k(x, t) = A_k\sin(kx\pi/L)\cos(2\pi f_k t + \theta_k)$, where x is the position along the length of the string (with one end fixed at 0 and the other end fixed at L), t is the time, A_k is the amplitude, θ_k is the phase, and *sin* and *cos* are the sine and cosine functions, respectively.

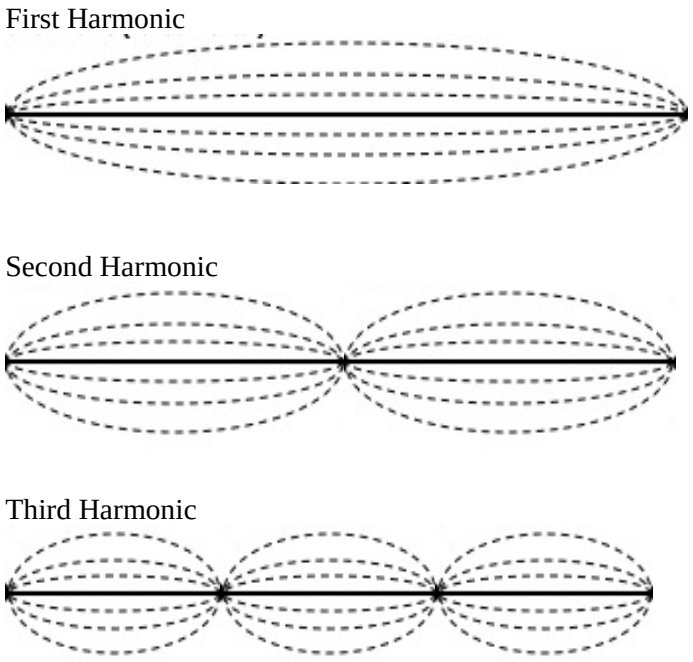

Fig. 2. Figure shows the vibration patterns for the first three harmonics; the second and third harmonics have correspondingly shorter wavelengths (as given by the distance between the nodal points) and vibrate with twice and three times the frequency of the first, respectively. In the guitar-string soul, the intensity of a given species of qualia is proportional to the amplitude of its corresponding harmonic – e.g., the intensity of the qualia of redness is proportional to the amplitude of the second harmonic. (The amplitude of a harmonic is just the amount by which the string deviates from its resting position as it vibrates -- as given by its height in the diagram.)

Now suppose that a linking law assigned each of the first three harmonics a certain species of qualia: for example, it assigned waves falling under the first harmonic the qualia of tasting bitterness; those under the second harmonic the qualia of seeing redness; and those under the third harmonic, the experience of a certain type of pain. (For now, I will neglect the fact that some of these qualia – such as color -- are typically experienced as having spatial location.) Further, suppose the law specified that the intensity of the qualia were directly proportional to the amplitude of the wave falling under the given harmonic. For instance, this would imply that if one doubled the intensity of a wave falling under the first harmonic, the guitar-string soul would experience twice the intensity of the taste of bitterness. Such a law would be particularly simple. For example, the equation specifying the relation between the first harmonic and its corresponding qualia could be expressed by the simple equation $I_1 = C_1A_1$, where I_1 is the intensity of the taste of bitterness, A_1 is the amplitude of the first harmonic, and C_1 is a constant

of proportionality.[9] This equation has only one independent variable – that of the amplitude of the first harmonic – which in turn can be specified by a simple description (namely, the amplitude of the first harmonic). The entire set of linking laws for our guitar string soul, therefore, would be given by the following three simple equations:

$$I_1 = C_1A_1$$
$$I_2 = C_2A_2$$
$$I_3 = C_3A_3$$

where I_1, I_2, and I_3 are the intensities of the taste of bitterness, the seeing of color, and the experience of a certain type of pain, respectively; A_1, A_2, A_3 are the amplitudes of the first, second, and third harmonic, respectively; and C_1, C_2, and C_3 are the respective constants of proportionality.

These linking laws are enough to determine the entire subjective experience of the soul. To see how, first note that any waveform on the string can be uniquely decomposed into its harmonics, by what is known as a Fourier series. Specifically, any waveform on the string can be decomposed into a combination of a wave of a certain amplitude and phase falling under the first harmonic, plus a wave of another amplitude and phase falling under the second harmonic, plus a wave of another amplitude and phase falling under the third harmonic, and so on. Further, the amplitude and phase corresponding to each harmonic is uniquely determined by the overall waveform on the string. Given any overall waveform, therefore, one can deduce the exact amplitude and phase of the wave falling under any of its harmonics, and hence the intensity of the qualia produced by that harmonic via the linking laws given above.[10] Consequently, this ability of waves to superpose and to be decomposable into a unique set of fundamental waveforms allows both the guitar-string soul to experience multiple qualia at the same time and for its qualia states to be determined by a few simple linking laws connecting the waveforms falling under each harmonic with its corresponding qualia.[11] Finally, since the wave pattern on the string is determined by the laws of physics, this means that once the above linking laws are specified, the combination of qualia experienced by the soul will be determined by the standard laws of physics.

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[9] Like all constants in physics, C_1 would be expressed in some chosen system of units. For example, if one used *bit* to denote some standard unit for the experienced intensity of bitterness and *amp* to denote some standard unit for amplitude, then C_1 would be expressed in terms of bit per amp. So, for instance, if C_1= 5.12 bit/amp, and the first harmonic had an amplitude of 2.1amp, then the intensity of experienced qualia of bitterness would be $I_1 = C_1A_1$ = 5.12bit/amp x 2.1amp = 10.752 bits. Notice the similarity between this law and some laws in science: for example, the distance that light travels in a vacuum is given by d = ct, where d is the distance, t is the time, and c is a constant of proportionality – namely, the speed of light (approximately 300,000,000 meters/second).

[10] Specifically, the mathematician Daniel Bernoulli (1700 – 1782) showed that a waveform on an ideal string of the type described above can be decomposed into a unique weighted sum of the waves falling under each individual harmonic: $W(t) = A_1(t)h_1(\theta_1) + A_2h_2(\theta_2) + A_3h_3(\theta_3) + \ldots$, where for any given time t, W(t) is the total waveform on the string, h_1, h_2, h_3, etc., are the waveforms of the first, second, third, etc, harmonics with phases θ_1, θ_2, θ_3, etc., and $A_1(t)$, $A_2(t)$, $A_3(t)$, etc., are the effective amplitudes of the first, second, and third harmonics, etc. Conversely, if one superposed a waveform of the first harmonic with amplitude A_1 and phase θ_1 with a waveform of the second harmonic with an amplitude A_2 and phase θ_2, and so on, one would obtain the total waveform W(t).

[11] This ability of states to superpose and be decomposed into more fundamental states is a feature of all attributes in quantum mechanics, and hence is pervasive underlying feature of the physical world. This opens up a much greater range of models for the soul other than those that specifically appeal to harmonic states.

Towards a More Realistic Model

Above, I presented a concrete illustration of how a dual-aspect model could greatly simplify the laws linking brain states with qualia. It is now time to turn to a more realistic version of the dual-aspect model based on ideas arising out of superstring theory. The model, however, should be only considered what physicists call a "toy" model – that is, a model presented for purposes of illustration and understanding -- and not necessarily as the way the soul actually is. The primary purpose of the model is to show that the dual-aspect view has the potential of providing a framework for constructing a viable model of the soul that enormously reduces the complexity of linking laws. In some ways, the model below should be considered analogous to John Dalton's original hypothesis of atoms in the early 1800's. Although it took over a century to fully articulate the nature of atoms (with some modifications of his original proposal being made along the way), his hypothesis showed that the hypothesis of such entities held the promise of greatly reducing the number of fundamental chemical laws, a promise that was eventually fulfilled.

Superstring theory is widely considered the most plausible candidate for a truly fundamental theory of all physical reality. Superstring models in physics postulate that the fundamental entities in the universe are miniature strings of energy that vibrate in a ten- or eleven-dimensional space, six of which are compactified; in this way, they are analogous to miniature guitar strings with various fundamental modes of vibration. Although superstrings are postulated to have a fundamental length (e.g., 10^{-33} centimeters), the superstrings themselves should not be thought of as composed of a set of spatial points; rather, they are typically considered as non-composite entities – that is, as metaphysical simples. As stated by physicist Lesal Randall, "according to string theory, the most basic *indivisible* objects underlying all matter are strings – vibrating, one-dimensional loops or segments of energy." (2005, p. 283, italics mine). She then goes on to stress that these strings are fundamental, not made of further parts. (p. 283) For example, they are not made of spatial parts. [12] In this way, they are like the quantum mechanical wavefunction associated with an electron or other non-composite particle: although as typically represented, the electron's quantum wavefunction is spread out in space, no interpretation of quantum mechanics considers the electron as being composed of its special parts; at most, the wavefunction could be thought of as representing some physical disposition that determines the degree to which the electron is present at each spatial location – as for example, in some versions of the so-called "Heinsenberg interpretation" of quantum mechanics.

Finally, these strings have various modes of vibration – such as rotational modes -- besides those given by their harmonic frequencies; an example of a different modes from everyday physics is a steal beam, which can undergo vibrations perpendicular to its length ("up and down" vibrations) along with vibrations consisting of compression waves along its length. Because of the way in which the ten- or eleven –dimensional space is thought to be compactified in string theory, strings can have a wide variety of modes of vibration. Each mode is then postulated to correspond to the various families of fundamental particles – such as the leptons, a family that includes the electron and some other particles. Brane theory extends this idea to

[12] Although a single string can divide into two strings (and two strings can interact to form one string), this does not mean the string is composed of two strings. As an analogy, a free neutron will decay into an electron, proton, and a neutrino, even though in the Standard Model of Particle Physics it is not composed of any of these entities, but rather of three quarks. Similarly, the muon – the heavy sister of the electron – is considered a non-composite particle, yet it decays into an electron and two neutrinos.

vibrating two- and higher-dimensional objects called *branes*, allowing for many additional modes of vibration. As with a guitar-string, each mode of vibration has well-defined harmonics, with each harmonic consisting of waves of definite frequency, but differing in amplitude and other features; further, the frequency of each harmonic is an integer multiple of some fundamental.

Taking inspiration from string theory, one could suppose that the soul itself is a miniature string (or brane) of energy, with its own dynamical equations. One could then postulate linking laws that link each mode of vibration with a particular genus of qualia (such as taste), with each species of qualia (such as a particular type of taste) under a given genus corresponding to a particular harmonic frequency of that mode; the intensity of the qualia falling under this species would in turn be linked by some simple function to the amplitude of the wave as in the guitar-string case. Hence, the linking laws should display the same descriptive simplicity as they did for the guitar-string model. Further, higher level groupings of vibrational modes could correspond to families of qualia, thereby providing a particularly elegant scheme of linking laws in which the structure of the higher-level groupings of the qualia corresponds to the structure of the different vibrational modes Finally, since the non-subjective states would be mathematically represented like any other newly hypothesized physical states, in principle their equations of motion and the way they interact with other physical systems are no more problematic than that of a newly hypothesized fundamental physical entity – such as a superstring. For example, one could require conservation of energy in the same way that it is typically done in all other places in physics except gravity (see chapter ____).

In the guitar-string soul, I developed the model for a soul that experienced three qualia and noted that I was ignoring the fact that some qualia – such as color qualia -- have coordinate positions. It would be useful, however, to see whether the above model might be able to account for coordinate positions. One way of obtaining coordinate positions is in a similar way to TV. For example, in a standard black and white TV, the information in the TV signal causes temporal variations in intensity of the electron beam hitting the back of the screen. Since the electron beam sweeps the entire screen every sixtieth of a second (the standard refresh rate), these temporal variations are transformed into variations in intensity of the beam hitting over the two-dimensional rear surface of the screen. If at some time the beam is at coordinate position in its sweep across the screen, the intensity of the beam hitting that coordinate position will be the intensity of the beam at that time. (The brightness of the screen at any point is proportional to the intensity of the beam at the point). Thus variations of intensity in time are translated to variations of intensity in the two-dimensional space of the screen.

Following the example of the TV, one could postulate a law that maps temporal variations in qualia to spatial variations in the visual field, with some "refresh rate." This additional law would allow the production of qualia over coordinate positions in the visual field. A similar account could be given of the auditory and tactile qualia field.[13]

[13] One might also wonder how the above model could account for different hues, saturations, and the like of color qualia. One way of accounting for these differences begins by distinguishing between qualitative versus quantitative differences in color qualia. Each kind of qualitative difference corresponds to a distinct species of qualia. For each of these species of qualia, a linking law links a harmonic with that species in the same way as in the guitar-string model; further, any quantitative differences in the qualia are then linked with quantitative differences (such as that of amplitude) in the waves falling under each harmonic. The brain is then postulated to process visual stimuli and interact with the soul in such a way that it only activates the harmonic corresponding to the perceived color qualia – in analogy to how a TV transmitter will only activate a TV tuner set to the same frequency. Finally, since normal individuals do not experience a superposition of colors – for example, when one looks at a surface that emits both

Finally, the dual aspect model understands the complex neurological processing that is required for perception as the processing necessary so the brain can activate the requisite non-subjective states of the soul so as to produce an accurate representation of the environment. An analogy might help: the linking laws between the non-subjective states of the soul and the qualia are analogous to the mechanisms that link electrical signals on the back of a visual display – such as a computer monitor – with the visual image on the display. The systems in the brain are analogous to the highly complex systems that must translate the visual information picked up by a camera into the proper electrical signals required by the display being used, such as a display at mission control viewing information coming from a satellite orbiting Jupiter.

The Primary Advantage of the Model

The primary advantage of the dual-aspect model is that it offers the potential of constructing a model of the soul in which there are relatively simple laws that link non-subjective states with qualia states. Although it is possible that such laws could be constructed under a non-reductive materialist account, it is difficult to see how this could be done. Further, as pointed out above, the individual laws linking these non-subjective states with other material systems need not be any more complex than the normal laws of physics. Consequently, the total set of fundamental laws in a dual-aspect model has the potential of being much less complex than those most likely required by non-reductive materialism. Finally, although the dual aspect soul theorist must hypothesize a new entity -- an immaterial simple that has subjective properties along with other non-subjective properties -- the non-reductive materialist also must hypothesize a new entity (a material composite) that has subjective properties. So, non-reductive materialist will have a hard time arguing that despite the complexity of linking laws, their view is to be preferred because it postulates fewer fundamental entities.

Despite the potential simplification afforded by the dual-aspect model, the set of linking laws would involve an unavoidable complexity given by the number of distinct species of qualia that cannot be put on a common scale (or simply describable mathematical space), since effectively there will need to be a distinct linking law for each such species. In the guitar-string model, for instance, there were effectively three linking laws, one for each species of qualia. Further, there will be a minimal, unavoidable arbitrariness for each linking law: e.g., it will be arbitrary why the k^{th} harmonic is associated with the particular species that it is, instead of some other species or none at all. All fundamental laws of nature, however, involve some arbitrariness. For example, if the fact that charges always repel each other were a fundamental law, then it could not be explained by a further law. One could attempt to eliminate the metaphysical arbitrariness by appealing to some underlying necessity in nature to account for the law – like charges repel each other because they *must*; but the epistemic arbitrariness will remain, since one cannot see *why* that necessity must hold (unless one builds into the concept of charge that it repels other charges, in which case the law becomes a tautology and hence tells us nothing). In respect to epistemic arbitrariness, therefore, laws connecting the mental and physical states are no more problematic than laws connecting physical states. The respect in which they are more

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red and green light, one does not experience both a red quale and green quale but rather a new color – there needs to be some mechanism that keeps this from happening. This could simply be the result of the brain only significantly activating one harmonic, in which case the soul would only experience one color per coordinate patch. Or, there could a further law that requires that the soul experiences only one species of color qualia per coordinate patch. The former, but not the latter, would allow one in principle to modify someone's brain in such a way (such as by putting some device in the brain) that the person would experience a superposition of colors in one coordinate patch. This possibility is one way in which the dual-aspect model could be further developed via scientific experiments.

problematic is that that the effective number of such basic linking laws -- one for each species of qualia – will likely be much larger than the number of fundamental laws of physics. The best one can hope for, therefore, is to minimize the complexity, not to eliminate it. [14]

At this point, one might wonder why non-reductive materialists could not follow the lead of the above dual-aspect model and propose a non-standard form of their view, one which postulates new non-subjective states as intermediaries, but ascribes them to a material composite instead of an immaterial entity. Although they could do this, the disadvantage of this proposed account is that one will have to hypothesize an additional linking law to pick out which composite is the experiencer of the qualia.[15] When one experiences redness, for instance, what aggregate of particles is the experiencer? Some aggregate in the occipital lobe? The brain? The body? As Dean Zimmerman points out in chapter ___, these sorts of entities are vague entities whose boundaries standard science does not specify. Yet, the experiencer has to be some specific aggregate (or set of aggregates); thus the linking law will have to specify which of the many possibilities it is. In the case of the brain, for instance, the law will have to specify whether the experiencer includes the atoms in a particular highly deformed neuron at the edge of the skull, or in the case of the body, whether it includes the atoms at the edge of the calluses and toenails on ones feet.

Even if non-reductive materialists could find a way to make this law relatively simple via the use of the postulated additional non-subjective properties, their view would likely be worse off than the dual-aspect soul view. Although both views require types of laws and entities not found in science, non-reductive materialism requires a new unprecedented type of fundamental irreducible law: one that specifies that a specific aggregate (or set of aggregates) is the bearer of some postulated set of properties. In contrast, throughout the physical sciences, only metaphysical simples (such as electrons) are postulated to be fundamental bearers of properties, with the properties of aggregates being assumed to be reducible to the intrinsic and relational properties of these simples. (Even if one is believes in emergent entities, there are no fundamental laws in our current sciences that specify when they come into existence or their irreducible properties.) Thus, arguably, even in the best case scenario, non-reductive materialism cannot meet the scientific ideal of simplicity as well as the dual-aspect soul view. In any case, the above dual-aspect soul model presents a challenge for non-reductive materialists to sketch out a view that is as simple and elegant, especially if they want to claim the mantel of being more in accord with science.

Finally, the above model shows that even though one cannot offer a scientific account of the linking laws themselves – just as one cannot offer such an account of any fundamental laws of nature – the experiences of a dual-aspect soul could fall within the purview of science: once the linking laws are given, one can explain why the soul experiences the qualia it does, and predict its future qualia states using the standard laws of physics. This explicitly shows that entity-dualist accounts of the soul need not be antiscientific or merely appeal to mystery (or special acts of God), contrary to the claim made by many of its critics (e.g., Dennett, 1991 pp.

[14] Further, it seems that any metaphysical account of physical laws can be given for linking laws: e.g., if one claims that physical laws hold because of some underlying necessity or causal power, one could claim the same for the linking laws.

[15] For an outstanding treatment of the problem of specifying which material aggregate is the experiencer along with various metaphysical problems surrounding the existence of composite material entities, see Peter Van Inwagen (1990).

35 – 37; Searle, p. 4), and even many of those sympathetic to some form of dualism (e.g., Robert Adams, 1987).

V. The Soul's Interaction with the Brain

I have already discussed in general terms how the non-subjective states of the soul could interact with the brain. Here I will offer a physical analogy as to how this interaction could take place. The brain could be considered to provide energy to the soul, with specific brain systems – such as the occipital lobe -- providing energy primarily to those vibrational modes of the soul with the same frequency, a phenomena known as *resonance* that is pervasive throughout the world: resonance is the reason radio or TV tuners pick up specific stations and why energy can be easily transferred between two tuning forks with the same frequency. Each of the five senses could have their own vibrational modes, with each species of qualia falling under each of the senses having its own harmonic frequency; this means that the soul would experience a given species of qualia only if the brain emitted the right frequency of energy (in perhaps the right mode). Further, higher-level abstract thinking could require activation of its own type of mode, also attuned to its own mode and overall frequency. Like TV signals, the waveform of these vibrational energies emanating from the brain to the soul – say from the occipital lobe – might also carry sensory and other kinds of information.

The interaction between the brain and the soul, and within the soul itself, need not be one way, however. There might be linking laws between certain specified subjective states and non-subjective harmonic states of the soul. For example, a linking law could specify that when a particular type of subjective state occurs, the amplitude (or energy) of the corresponding harmonic frequency (of some specified vibrational mode) will increase by an amount proportional to the intensity of that state and the time over which it occurred. This would allow the subjective states of the soul to influence its non-subjective states. Since the connection between the non-subjective states and other material states are specified by some set of equations, these subjective states can then affect the brain.[16]

One could also postulate the existence of various damping "mechanisms" in the soul, causing the energy of the vibrational modes to slowly dissipate, unless continually fed energy by the brain or something else. Almost all physical systems in the universe have these damping mechanisms; the only known possible exceptions are certain systems that exhibit specifically quantum mechanical behavior, such as superconductors. (Dualists who believe in survival of bodily death could hypothesize either that the dampening mechanisms in the soul disappears at death, in analogy to how the resistance of a metal disappears when it goes into a superconducting state, or that some new energy source – such as a new body -- continues to power its various modes.)

Of course, many other models could be proposed regarding how the brain and non-subjective states of the soul interact. The point here is that the dual-aspect framework allows one to build and potentially test more specific models of this interaction, and hence potentially make scientific progress on the nature of the interaction of the soul and the brain. For example, if one hypothesized that the occipital lobe emitted such waves, one could then attempt to duplicate the material operation of the occipital lobe in some other material medium, place that material in its

[16] The above account does not include agency and the ability to choose. To do this, one must just hypothesize that the soul has the power to affect subjective states. How the soul—as a "metaphysical agent" -- is able to affect these states, however, remains a mystery, falling outside of any sort of lawlike account.

own sealed tiny container in the skull (where it did not significantly interact with other neurons), and see if it affected the person's visual sensations without significantly directly affecting the neurons in the visual areas of the brain. Such an experiment, even if it yielded negative results, would at least allow one to make progress on narrowing down the nature of the interaction between brain and non-subjective states of the soul. Thus, the dual-aspect framework could provide a fruitful scientific research program for understanding and explaining the relation between the mind and the brain.

VI. Evolution and the Soul

How might the dual-aspect model fit with the theory of evolution and the existence of animal minds? For theists, one possibility is that God creates just one type of generic soul for all animals, but the structure of an animal's brain determines which non-subjective states of the soul are activated. As animal brains get larger (in the right ways) and have more of the right neurological subsystems, they are able to power those non-subjective states that must be activated for higher levels of consciousness -- such as abstract thoughts -- to occur.[17] Another possibility is that major groupings of animals, such as families, orders, or genera each have their own type of soul, with the variation among lower level groupings – such as species within a genus -- being a result of the ability of their brains to activate and send appropriate signals to the various non-subjective modes.

Yet another possibility is to combine the dual-aspect model of the soul with some version of emergent entity dualism, such as that presented by William Hasker in chapter ____. One way to do this takes its inspiration from modern quantum field theory, which views particles as *quanta* of their respective fields: for example, electrons are considered quanta of the electron field and photons are considered quanta of the electromagnetic field. From a field point of view, the quanta are merely excitations of the field, whereas from a particle point of view, the quanta are individual metaphysical simples.

Given that one accepts that some quanta are individual entities (as many philosophers are inclined to do for some types of quanta, such as the electron), one has a situation in which metaphysical simples are somehow produced out of the energy of the field, with the type of simples that are produced being dependent on the type of field in question. Since the energy of the individual quantum comes in discrete units, this means the in order for any quanta to be produced, the energy of the field must have at least the energy of a single quanta. For example, an electron has a fixed rest mass, which corresponds to a fixed energy as given by Einstein's famous equation $E = mc^2$. Thus, to produce an electron, the electron field must have at least this amount of energy. Applying this idea to the dual-aspect soul theory, souls could be considered analogous to quanta of an overarching field which I will call a "soul field," for lack of a better name. Hence, individual souls would only come into existence when enough energy is pumped into this soul field to produce at least one soul quanta – e.g., a single "soul string" in the toy model presented in section IV. Just as only certain material structures can transmit and pump electromagnetic energy into a receiver (e.g., radio transmitters), it makes sense that only certain kinds of neurological structures are capable of pumping enough energy (of the right frequencies and of sufficient coherence) into the soul field to create a soul quanta. This implies that souls will

[17] One could even postulate that the modes corresponding to abstract thought have a certain minimum level of energy – that is, that they are quantized (as the various fields of physics are); thus they could only be activated by a brain that is large enough to generate the minimum level of energy.

only come into existence when animal brains reach sufficient size and complexity during the evolutionary process. Larger and appropriately structured brains could then be postulated not only to create souls, but to activate higher level modes of vibration of the soul-string, such as those required for abstract thought.

In one version of the above scenario, all souls would be the same type of entity, but with different modes of their souls being activated depending on brain structure and function. An alternative scenario is one in which there are distinct types of quanta of the soul field (just as in there are distinct types of quanta of material fields), some of which can only be created by sufficiently complex brains. Finally, one could hypothesize that the soul field obeys a rule that implies that normal brains have at most one soul quanta.[18] Whichever of the above views one adopts, the important thing to note is that they each allow the dual-aspect soul theory to provide a non-arbitrary dividing line between animals that have souls and those that do not (e.g., worms), along with non-arbitrarily accounting for the different levels of thought that various types of animals can achieve.[19] [20],

VII. Conclusion

Above I first argued that given that subjective states, such as what it is like to taste chocolate, cannot be reduced to purely physical states of the brain. Given this, one is left with the option of some form of non-reductive materialism (the view that the brain/body itself is the

[18] Similar rules, called "superselection rules" occur throughout quantum mechanics. An example is the Pauli-exclusion principle, which dictates that not more than one electron can occupy a quantum state; since each orbital in an atom has two possible quantum states corresponding to the two different directions of electron spin, this rule implies that each orbital can have at most two electrons.

[19] Some might wonder if the arbitrariness is just pushed to the conditions necessary to create soul-quanta. The answer is that there is an arbitrariness in the value of the parameter that determines the minimum energy of a soul quanta; this sort of arbitrariness, however, it is no greater than that of the parameters that determine the energy of individual quanta in standard physics – e.g., the value of the rest energy of the electron in the case of the electron field. Further, although the non-reductive materialist could hypothesize the existence of a quantized energy field such that the experiencer comes into being with the first quanta produced, it is still likely that complex linking laws would be required to determine which aggregate of particles compose the experiencer, as argued previously.

[20] Some might wonder how survival of bodily death could occur under the dual-aspect theory without invoking a new body for the soul to interact with. First, note that even if one thinks the soul is generated by the brain, there is no reason to think that it could not continue to exist after the brain dies; as an analogy, if photons of light are produced by shining one's flashlight into empty space, they will continue to exist even if one were to destroy the flashlight. Significant life after death, however, would require perceptions of the environment, memory, and the like. Something corresponding to vision might be able to occur by the sensory non-subjective modes of the soul being directly stimulated by the electromagnetic field that exists at every point in space; this would allow the soul to not only "see" using the normal visible spectrum, but also using other parts of the electromagnetic spectrum such as the infrared and x-rays. Another possibility is that the soul has the equivalent of radar, sending out its own vibrations which are reflected back from objects in its environment with corresponding information about them. As for memory, special non-subjective modes of the soul – or some associated field – could record all of one's experiences, in analogy to how many of today's computers come with a second hard drive that automatically backs up all one's programs and data. (Indeed, in modern field theory, all material structures– and hence all storage of memory – consist of fields that retain their basic form for a long period of time. For example, a stable arrangement of electrons, protons, and neutrons consists of particular stable states of the electron, proton, and neutron fields). This memory might be only accessible when the brain dies, much like rebooting a computer from the second hard drive. Another possibility is that the information regarding the past of the entire universe is stored somewhere, which after death each soul has partial access to, in analogy to how some computers backup their data to external mass storage sites.

subject of experience and other conscious states) or some form of entity dualism (the idea that an immaterial entity is the subject of mental states). I then argued that if standard forms of non-reductive materialism is true, it is very likely that the laws linking physical states with subjective states would be enormously, if not infinitely, complex. Next, I proposed that what I called the dual-aspect view of the immaterial soul could potentially solve this problem. According to this view, the soul is a metaphysical simple that has both subjective and non-subjective states, the latter of which make no reference to consciousness and are describable mathematically. These additional properties allow one to construct a set of simple laws linking the non-subjective states of the soul with its subjective states. Further, because the non-subjective states are mathematically describable, potentially there could be simple equations that specified how these states interact with physical systems such as the brain. I then suggested how my account could be extended to subjective states influencing the brain, and how it might account fit with the theory of biological evolution.

Finally, it should be stressed that although there are other motivations for entity dualism, the one pursued in this paper is based in the spirit of science itself: that of accounting for the known phenomena in the simplest possible way. Thus, reductive materialism was rejected because it could not account for the fact that we have subjective experiences. Second, non-reductive materialism was found wanting because it seemed to require enormously complex linking laws. Finally, the history of science suggests that to account for new phenomena in a simple way, often one must hypothesize new entities with new fundamental properties, as illustrated by the hypothesis of atoms. We then showed how introducing a new entity, the soul, that has both subjective and non-subjective properties could potentially provide a far simpler account of the observed correlations between brain states and subjective states. Along the way, we indicated how this hypothesis has the potential of leading to a fruitful new research program.

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