PERSPECTIVES ON SCIENCE AND CHRISTIAN FAITH VOLUME 61, NUMBER 3 SEPTEMBER 2009

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In this issue …

*"The fear of the Lord
is the beginning of Wisdom."*
Psalm 111:10

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Perspectives on Science and Christian Faith

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Guest Editorial

The ASA in 2109: How We Got There

Edward B. Davis

Edward B. Davis

One of the benefits of being a historian is that you get to encounter the past in the present, through the perceptions and experiences of our predecessors. I have yet to figure out how to encounter the future, yet historians are often asked to prognosticate: considering the history of this or that, what do you think will happen in the next quarter century? Usually I decline the opportunity to consult my crystal ball, but let us pretend for the moment that I have used it to peer into the future of the ASA, looking forward to a century from now, when no one reading this editorial will be able to tell me how badly I was misled by that transparent little sphere.

The premise behind this thought experiment is, of course, that the ASA will still exist in 2109, when there will be 168 candles on its birthday cake. Plenty of organizations and institutions have been around far longer, but more than a few have not made it even to our present age, a modest sixty-eight. If we are still here in 2109, what will have made it possible? What might some future historian say then about how we got there?

First, he or she might say, we were clear about who we are and why we exist. The ASA is currently defined as "a fellowship of men and women of science and disciplines that can relate to science who share a common fidelity to the Word of God and a commitment to integrity in the practice of science." This has the advantage of being specific, without being too specific—Christians from a variety of backgrounds, who hold a variety of theological perspectives, are invited to become members, as long as they affirm the importance of the Bible as an authentic divine revelation and do not misrepresent scientific knowledge.

Our purpose is even clearer: "to investigate any area relating Christian faith and science" and "to make known the results of such investigations for comment and criticism by the Christian community and by the scientific community." Again, we find just the right amount of specificity, with enough breadth to ensure that many interesting topics will get plenty of attention, while leaving some controversial topics on the outside, for example, those related to more purely political or theological disputes—though both politics and theology can certainly influence one's views about science and Christianity.

The other part of our purpose reflects the two worlds in which our members live and work: first, in the body of Christ, of which we are only a very small part, with millions more no less valuable than ourselves; second, in the professional communities to which we belong and to whom we can be salt and light. In short, the ASA exists to advance the activity of science—including the social sciences and technology, along with the natural sciences—as a proper Christian vocation. If we are still here in 2109, it will be because we remained faithful to this vision.

Our future historian might identify a second, equally important, factor; he or she might find that our members were strongly committed to the future of the ASA, indeed, to its very existence as an organization dedicated to advancing the kingdom of God through our scientific vocations. This is where I come in, as your current president, and this is also where you come in, as the members who entrusted me with that job. My proposal to ensure that the ASA will be here for future generations of Christians in science is simple. I call it, "1 and 1 and 1."

Guest Editorial

The ASA in 2109: How We Got There

Here is what each of us can do, and if we do, then I have no doubt that our future historian will have something good to say about us. Let each member commit to doing three things for the ASA:

1. Persuade 1 person to become a permanent member of the ASA in the next five years;

2. Attend 1 annual meeting in the next five years, and keep this pattern as long as you can;

3. Give 1 percent of your estate, at the time of your death, to the ASA endowment fund.

Speaking now in the present rather than in the future, our greatest single need is to grow the ASA by another few hundred members—a goal that lies in our collective hands to achieve in the next decade, long before the next century. This can and should follow naturally from our calling to mentor younger colleagues in their development as scientists and in their walk in Christ. If one-third of our members follow through with this part of my proposal, then very soon the ASA will be able to do new things that will benefit both the body of Christ and the scientific community. If one-fifth of our members follow through with the second part, we will all make wonderful new friends, and our annual meetings will be even better than they already are. If even one-tenth of our members follow through with the third part, the ASA will be less dependent on annual giving; if one-fourth follow through with the third part, we could start to plan major new initiatives in a couple of decades, or even sooner, if more members participate. Let us go forth with courage and faith, trusting in him who holds the future in his hands!

Edward (Ted) B. Davis, *ASA President*
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In This Issue

This September issue of *PSCF* may lack the symmetry of the previous issue, but not its timeliness. This issue is cast in the shadow of contemporary challenges. It begins with a guest editorial "The ASA in 2109: How We Got There" written by the newly-minted president of ASA, Edward (Ted) Davis, and carries a challenge to ASA members to endeavor to make the ASA better equipped to realize its mission, and stretch its collective vision and prospective reach to the year 2109.

Besides this "state of the ASA" piece, we have a diversity of articles ranging from modern cosmology, the evolution of human cognitive capacities, part II of a series on Arthur Compton, to a detailed book review with a response by the book's author. Robert Mann (University of Waterloo) explores (once again) an ancient conundrum—the puzzle of existence—by framing the puzzle in a way that is cognizant of recent findings in cosmology and which poses a serious challenge to contemporary theological reflection. Ralph Stearley (Calvin College) assesses the evidence for the development of humanoid "soulish behaviors," and in so doing challenges previous scientific and theological interpretations. Ted Davis (Messiah College) continues his historical reading of the influential scientific and religious life of Arthur Compton.

This issue ends with a new category: a book review by Scott Rae (Biola University) of a recently published book by Joel B. Green (Fuller Seminary) en- titled *Body, Soul, and Human Life: The Nature of Humanity in the Bible* (Baker Academic, 2008) and Green's response. These scholars clearly differ in their interpretation of Scripture and how best to allow the natural sciences to influence their reading. The challenge of faithfully reading and interpreting Scripture is one we all share.

A final word about book reviews: As book review editors, we have attempted to provide a diversity of challenging book reviews. While still utilizing the "master-list" of ASA reviewers which has been generated, we have tried to broaden the base by inviting other reviewers to speak to the relevance and quality of recently published books.

Tolle lege: take up this issue and read.

Arie Leegwater, *Editor*
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Article

Robert Mann

The Puzzle of Existence

Robert B. Mann

Grappling with the problem of existence is one of the central tasks of theology, one that is both challenged and illuminated by scientific inquiry. The traditional form of the problem has been that of understanding why anything exists at all. While science and theology are harmoniously complementary in addressing certain aspects of this problem, a key point of tension between them has been in evaluating the role of Mind relative to matter. This is theology's oldest challenge.

I contend that theology's newest challenge is that of understanding the particularity of existence: why it is that some things exist instead of everything. This new form of the problem of existence is motivated by findings from modern cosmology, which have been interpreted as suggesting that our universe is part of a multiverse in which all things exist. The key problem—for both science and theology—is in understanding how to distinguish what exists from what is possible.

The key problem—for both science and theology—is in understanding how to distinguish what exists from what is possible.

The puzzle of existence is a question having multiple layers of meaning, and it can be asked at a variety of levels. Most people concerned with it begin with the self. Why do I exist? Where did I come from? What does my existence mean relative to my community? What will my existence mean, if anything, in the overall context of reality? At a broader level, many people extend the question beyond themselves. Why does my community exist? Why does my environment exist, and where did it come from? Is the form of existence of my community and/or environment optimal or can it be improved somehow? At the broadest level, these kinds of questions can be asked of all of reality. Why does anything exist at all? Why does this world exist? What is the origin of all that we observe and experience?

Providing a response to the puzzle of existence is theology's oldest challenge.[1] That there is something rather than nothing cannot be taken for granted if one wishes to obtain a fully coherent understanding of reality, one that incorporates both its objective and subjective features. In theological terms, such an understanding begins with the assertion that Mind is fundamentally the root of existence, the ground of being. While this claim is thematic in all religions, it perhaps reaches its pinnacle in the Gospel of John, which begins by stating that "In the beginning was the Word, and the Word was with God, and the Word was God."[2] Θεὸς ἦυ ὁ Λόγος—*Theos en o Logos*—encapsulates two coupled insights. One is that it is *Logos*—Word, Logic, Reason, Account, Meaning, Principle, Thought—that is the ultimate source of all things. The other is that this *Logos* is God, the great Other, the Mind that sources all matter.

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More succinctly, it is Intelligence that is the source of our intelligible existence.

Something instead of Nothing

Can we proceed the other way around? Can one reasonably say that a comprehensible universe has its origins in a Comprehender? To ask the question is to make certain assumptions about existence. First, the universe needs to have enough stable order so that intelligent agents can carry out investigations to discern its intelligibility. Second, the universe must not be too complicated for such agents to at least partially understand. Third, there needs to be some openness as to the possibility that a Mind might exist, along with criteria for deciding what makes such an inference reasonable.

The first two assumptions are foundational to the scientific process. From the earliest classifications that hunter-gatherer societies made about the flora and fauna of their environment to the most sophisticated theories and observations made by cosmologists of the cosmic microwave background, the whole endeavor of science presupposes the possibility of a stable order in which reason and observation can provide us with reliable knowledge. It simply would not be possible to do science otherwise.[3] One could imagine, for example, a universe (or planet for that matter) in which the environment underwent significant changes of such frequency that knowledge gathered at one time becomes nearly useless later on. For intelligent agents to survive in such an environment, it is only necessary that their physiology be able to adapt to such changing conditions and that the knowledge they have be sufficient for survival. Indeed, such conditions have been (and can be) replicated on earth in a cultural sense—unstable societies are generally not places where science flourishes.

The second assumption is of no less importance. It is quite possible for a stable universe to exist that is simply beyond the comprehension of any of its beings to understand. Consider the following example—with about 10^{58} particles per star, 10^{11} stars per galaxy and 10^{11} observed galaxies, it follows that our observable universe consists of approximately 10^{80} particles. One of the (indirect) discoveries of the past century is that all of these particles come in only a handful of types (electrons, up quarks, down quarks, neutrinos, photons, along with several other unstable particles), and that two particles of the same type are completely indistinguishable from one another. This is foundational to our understanding of particle physics.[4] Yet it is logically possible that each of these 10^{80} particles could have had distinct properties and features, in which case any comprehensive scientific formalism for describing them would be effectively impossible. Indeed, we are already aware of systems—the structure of the nucleus, weather systems, protein folding—whose enormous complexity pushes us to the limits of our ability to understand them scientifically. It is certainly conceivable that a full scientific description of them may forever elude us—though, of course, we will not know unless we try. What can be said with confidence is that the intelligibility of our universe has been of sufficient transparency to yield in large part to our scientific attempts to understand it.

The third assumption—openness to the possibility of Mind and a criterion for understanding it—has been and remains a point of considerable controversy. The comprehensibility of the universe produces a sense of awe and wonder in believer and unbeliever alike. Our comprehensible universe is perhaps best received as a gift, one to which our most profound response can only be that of deep gratitude to the One who made it possible.[5] Proceeding from wonder to gratitude is a response that comes naturally to those willing to place their faith in the Word, the *Logos* behind it all. The grand endeavor of science can be understood as a process of unwrapping this marvelous present we call the universe.

Yet this same response is deeply troubling to many. To assert the existence of Mind and furthermore to place one's faith in that Mind strikes them as a form of magical thinking, one in which rational thought has yielded to wishes and fairy tales. In contributing to our understanding of the puzzle of existence, science has proceeded by discarding magic in favor of mechanism, employing reason and observation to discern the details of this mechanism. Believers will be quick to point out that this process is not in contradiction with their perspective, and that theology is a not-dissimilar process involving reflection and revelation, which are then employed to discern the Meaning behind the mechanism.[6] Such Meaning receives its most coherent level of understanding in God, the *Logos* that empowers existence with *Telos* or Purpose. In this sense, science and theology make a joint contribution to the "why something instead of nothing" problem.

Nevertheless, most scientists do not regard the assumption of Mind as a productive scientific strategy.[7] They generally contend that there are apparently no sound criteria for making use of it, nor of its accompanying notions of meaning and purpose. It would be far better to put aside this concept entirely and proceed on the basis of what is called naturalism, an ecbatic[8] approach to understanding reality. Scientifically, this involves the assumption that explanations of observable effects are fruitful and constructive only when they hypothesize natural causes (in other words, specific mechanisms, not indeterminate miracles or magic). Going by the name of "methodological naturalism," this approach is technically agnostic and should be distinguished from the assertion that "nature is all there is and all basic truths are truths of nature," a view known as philosophical naturalism.[9] While this latter perspective is not logically implied by the former, it has been argued that the empirical success flowing from the vast body of scientific knowledge, combined with the lack of any sound criteria for discerning supernatural events or processes, makes it the only reasonable stance to adopt.[10]

This sets naturalism at odds with theism, which for many is an uncomfortable and unnecessary situation, but one that is all too common to ignore. Theists would like to understand existence rooted in Mind or *Logos*. This offers the advantage of understanding subjective experience in the same coherent framework as objective reality, speaking as much to the heart as to the mind.[11] Yet the emergence of matter from Mind is a problem that theology has not satisfactorily addressed. Naturalists prefer to understand existence in fully observable and measurable terms, with life and minds emerging from matter through fully undirected reductionist processes.[12] Proponents of this approach regard it as the most philosophically economical and empirically successful strategy to employ. Yet it ignores not only the problem of consciousness and its persistent resistance to yield to reductionism, but also does not really address the issue of what it is that puts "fire into the equations of physics and makes a universe for them to describe."[13]

Something instead of Everything

It is clear that the "something instead of nothing" problem, while old, is one that still provides interesting challenges for theology to deal with. Recently, a new theological challenge connected with the puzzle of existence has appeared on the scene, one driven by several different sources of scientific inquiry in the past few decades.

One can state the problem by means of a straightforward mathematical analogy. Any finite collection of objects can be counted as 1, simply by taking the number of objects in the set and dividing out by that number. Rather than counting all the objects in the set, we simply count the set as one object. Of course this approach will not work if there are no objects in the set—in that case, we employ the number 0, as a way of saying that there is nothing. In this simplified context, the puzzle of existence is the puzzle of why the set is not empty. Why is there 1 instead of 0?

With only slightly more sophistication we can go further with our mathematical analogy. What if we cannot count the objects in the collection because there are too many of them? No matter how large the count, there are always more to be counted. In mathematical terms, we say that the set is infinite in size, and we give it the symbol ∞. So, extending our simple analogy further, we can just as well ask the question, why is there 1 instead of ∞? Why is there something rather than everything?

This last question is one that has seldom been asked. If addressing the "something instead of nothing" question is theology's oldest challenge, the "something instead of everything" question is theology's newest challenge.[14] In principle, this question could have been asked a long time ago, since, in some sense, it is the converse of the old "something instead of nothing" question. It is clear that we inhabit a world in which something physically exists instead of nothing. It only takes a little more reflection to realize that some things do not physically exist, though they could have. This is typically trivial—that there are only ten flowers in a certain garden instead of fifteen, or that my height is 6 ft instead of an inch shorter or taller—but can entail both the fanciful (there are no unicorns) and the profound (I fortunately avoided cancer because of the timely removal of a tumor).

From this viewpoint, the "something instead of everything" question is really a puzzle of particularity. Why do certain things and events exist and not others? More generally, if something can exist—by whatever logically self-consistent criteria—why does it not exist? Most generally, why does everything not exist? Why is there not ∞ instead of 1?

This last form of the question might seem absurd, since it would appear to be obvious that everything does not exist. However, a growing body of evidence from cosmology and particle physics has suggested that perhaps this question is not so absurd. Intellectual honesty compels us to examine such evidence, from both scientific and theological perspectives, if we want to come to grips with the puzzle of existence.

Our Atypical Universe

We now have enough knowledge about our universe, at both macroscopic and microscopic scales, to ask whether it is a typical specimen out of all the possible kinds of universes one might imagine. What has emerged from the scientific body of knowledge is that the answer appears to be negative: our universe is atypical in a number of respects that are connected in unexpected and perhaps profound ways with our own existence. There are four main lines of thought pertinent to this assertion that I shall now briefly outline. Two of them—biophilic selection and cosmic fine-tuning—are "bottom-up," in that they proceed from assessment of a body of data. The other two—cosmic inflation and string theory—are "top-down," in that they originate from general scientific hypotheses concerning the structure of physical reality.

Biophilic Selection

Biophilic selection refers to the idea that the structure of our universe is constrained by the fact that it must be able to support life as we know it.[15] This seems to be a superfluous statement, since obviously there could be no scientists investigating a universe that is hostile to life. It was Brandon Carter who realized that this issue merited deeper investigation, and he wondered whether the existence of intelligent life on our planet could tell us something about the properties of the universe as a whole.[16] At the risk of oversimplification, the chain of reasoning goes like this:

1. Compare our universe—with its known constants of nature—to members of a set of possible universes that would result if these quantities had numerical values different from those we observe. One can extend this exercise to include types of particles, laws of physics, and initial conditions that are likewise modified relative to their known types and mathematical structure.

2. Ask the question: "Are the life-permitting features of our universe typical or special?" In other words, would life as we know it be common amongst other universes in the set?

The answer appears to be that life is not common.[17] Our universe appears to be very special in that it is finely tuned for the existence of many things that make it hospitable for life. This is neither obvious nor logically necessary. A simple example should suffice to make the point. Suppose we imagine a collection of universes that are alike in every respect except that the mass of the neutron differs in each one. In some universes, the neutron is heavier than the observed value of $1.674692712(13) \times 10^{-27}$ kg that it has in our universe,[18] whereas in others it is lighter. Superficially, it might seem that such universes would trivially differ from one another, but, in fact, the difference is quite striking. In those universes where the neutron is just 0.2% lighter (or less), protons preferentially decay into neutrons (and positrons and neutrinos). It would be energetically favorable for protons everywhere to decay, leading to the absence of hydrogen and all other known atoms, and therefore to the absence of life. In universes where the neutron is just 0.2% heavier (or more), all neutrons would decay, making any atoms other than hydrogen impossible to form.

We inhabit a universe in which the neutron is just heavy enough to ensure that, as the universe cooled following the Big Bang, just enough neutrons (one for every seven protons) became bound with protons to form a rich variety of stable nuclei for atoms to form and life to exist. The excess protons end up mainly as hydrogen that goes into making long-lived stable stars, water, and a host of biomolecules, all of which are necessary for life. There are many such examples of this type that follow from modifying the known laws and constants of physics. While mathematical solutions to the equations of physics are robust to such small modifications, life as we know it is not.

Cosmic Fine-Tuning

Cosmic fine-tuning refers to the set of observations which indicate that the large-scale properties of our universe are in an apparent state of very delicate balance.[19] Put another way, the standard model of cosmology will agree with observations only when its parameters are very precisely adjusted, meaning that small changes in these parameters result in significant disagreement with observation. There are several examples of this. One is the flatness problem, which refers to the observation that the current density of our universe is very close to its critical value at which space is perfectly flat (that is, in which parallel lines remain equidistant and never meet), as opposed to being positively curved like a sphere (where such lines ultimately converge) or negatively curved like a saddle (where such lines ultimately diverge). This is easily appreciated by inspection of a simple equation from general relativity[20]

$$\left(1-\frac{\rho_c}{\rho}\right)\rho a^2 = \frac{3kc^2}{8\pi G}$$

that indicates how the density of matter and energy ρ modify the curvature of space. Curvature is described by the parameter k, which takes on the values of –1, 0, or 1 for a negatively curved (saddle-like), flat, or positively curved (sphere-like) space, respectively, at a given scale factor a (which is a measure of the "size" of the universe, or rather the distance between any two spatial points at a given time). The point is that the right-hand side of this equation is constant (where c is the speed of light and G is Newton's gravitational constant), but the left-hand side contains quantities that change with time. Clearly, if $k = 0$, then $\rho = \rho_c$, meaning that the density must always have been constant at a value known as the critical density (the density needed to ensure $k = 0$), whose value is $\rho_c = 10^{-26} kg/m^3$. However, we observe our universe to be expanding: the scale factor a is increasing with time less rapidly than its density is decreasing, and so ρa^2 is decreasing with time. This means that $1 - \rho_c/\rho$ must increase with time to compensate. Extrapolating current observations back to the Big Bang, we find that ρa^2 has decreased by a factor of 10^{60} and so $1 - \rho_c/\rho$ must have increased by the same factor. But current observations also indicate that today $|1 - \rho_c/\rho| < 0.01$, which means that just after the Big Bang $|1 - \rho_c/\rho| < 10^{-62}$. This is the flatness problem: in order to get the current model to agree with observation, we must adjust the initial density of the universe to be nearly equal to its critical density, to 62-decimal-place precision.[21]

There are several other fine-tuning situations in cosmology, most notably the horizon problem[22] and the cosmological constant problem.[23] The horizon problem refers to the fact that the temperature of the cosmic microwave background is uniform everywhere to 1 part in 30,000, but there has been insufficient time for the different regions of the universe to come into thermal contact to make this possible. A rough estimate indicates that there were about 10^{88} communication zones (distinct causal regions) shortly after the Big Bang, which means there should be 10^{88} distinct temperate regions (somewhat analogous to the different climate zones on Earth), each of which has its own characteristic temperature. The puzzle is that these 10^{88} different "cosmological climate zones" all have almost exactly the same temperature. Is there some reason for this?

The cosmological constant problem refers to the observation that our universe is accelerating in its expansion. There are several ways of modeling such expansion, but the simplest is to use a constant vacuum energy density (unlike the mass-energy density ρ, which does change with time). The problem is that the vacuum energy required to generate the observed acceleration is almost but not exactly zero, and all known attempts to compute it from general theoretical principles get the required value wrong by a factor of 10^{120}—regarded by many as the most embarrassing disagreement between theory and observation in all of science![24]

The "bottom-up" perspectives of biophilic selection and cosmic fine-tuning give us good reason to regard our universe as atypical. It is obvious that we can only live in a universe whose laws, structures, and initial conditions permit life to exist—otherwise we would not be around to discuss it! What is not so obvious is that these laws, structures, and initial conditions are quite a special subset out of the collection of possibilities.

What might this mean? This is where the "top-down" approaches come in: they provide theoretical mechanisms whereby such atypicality might be realized.

Cosmic Inflation

The first of these, cosmic inflation, was developed in response to the flatness and horizon problems.[25] While there is nothing logically inconsistent about delicately balancing the initial conditions of our universe to achieve agreement in its observed flatness and uniformity of temperature, such an approach is regarded as an unsatisfactory contrivance. Inflation is an approach that replaces this contrivance with a mechanism. The basic idea is that very shortly—only about 10^{-35} seconds—after the Big Bang, a state of matter called a false vacuum existed. This kind of matter interacts with gravity in such a way as to generate an exponentially rapid expansion of the scale factor *a*. The universe can double in size every 10^{-34} seconds via this process, so if it only happens for 10^{-32} seconds, the universe increases in size by a factor of 2^{100} or 10^{30}. A single communication zone, of near-uniform temperature, can expand by this factor, stretching out to near-perfect flatness whatever wrinkles in curvature it might have originally had. In this picture, our observable universe is a small part of this communication zone, expanding to a grapefruit-sized region after the end of this inflationary era, and then expanding more slowly over the next 13.7 billion years to become the cosmos we see today. This is a possible mechanism by which (at least some of) the features of our cosmos become fine-tuned to their apparent particularity.

The false vacuum required for inflation to work is a very peculiar state of matter. Since there is nothing for it to depend on, its energy density must be constant everywhere at all times. Suppose someone were able to place some false vacuum inside a cylinder fitted with a piston. As the piston is pulled out, there is more empty space (more vacuum), which means that more energy has been created. This energy had to come from somewhere, namely from whatever it was that was pulling the piston. This means that the piston will experience a force (equal to the extra vacuum energy inside divided by the distance the piston moved) tending to pull it back in. In other words, the false vacuum exhibits tension as well as energy. Furthermore, to conserve energy this tension must be equal in magnitude to the energy contained in any given region. It is this last property that makes the false vacuum so unusual. When the gravitational effects of this kind of energy are taken into account, it causes space to expand exponentially rapidly. A false vacuum is equivalent to a cosmological constant, so during inflation the cosmological constant is presumed large enough to cause the rapid expansion, after which spacetime undergoes a transition to our true (or perhaps I should say, less false) vacuum with its observed small cosmological constant. While there are many mechanisms for generating the cosmological constant in both the false and true vacuums, it is presently unknown which one, if any, is correct. In this picture the birth of our universe is the nucleation of a region (or bubble) of true vacuum out of false, and our observable universe is a tiny region inside this bubble.

Of course there is no guarantee that the true vacuum that forms is the one that has the properties of our vacuum. Many different kinds of bubbles can form, within which each will have its own low-energy laws of physics. So perhaps, it is conjectured, inflation happens perpetually, with an endless variety of bubbles percolating out of some primordial false vacuum. This scenario, known as eternal inflation, endlessly generates a plethora of universes.[26] In this context, eternal inflation asserts that instead of just something, there, in fact, is everything!

String Theory

Another theoretical mechanism pertinent to cosmic atypicality is string theory. This theory posits that the fundamental particles of nature are line-like instead of point-like, and so are called strings. These strings can either be open like shoelaces or closed like rubber bands. The idea is that all observed elementary particles and forces are different excitations of one string-like object, a particularly attractive unifying principle. After a period of nearly fifteen years of dormancy, string theory exploded onto the scene in the mid-1980s, when a number of calculations showed that this approach made a very special set of predictions about the basic symmetries of nature.[27] This raised expectations that further study of string theory would yield a unique theory of everything, one that predicted all constants of nature and properties of elementary particles from a single grand equation.

However, as string theory was scrutinized by large numbers of theorists, more generalizations were found instead of more mathematical restrictions, making the unique theory of everything that much more elusive. Further calculations carried out a few years ago indicated that there could be as many as 10^{500} kinds of ground states to the theory, each with its own particular properties and features.[28] Our universe is presumably described by one of these kinds. What then selects it out of this enormous cornucopia of possibilities?

This question has caused many theorists to undergo a nearly complete reversal in their perspective on the subject. Perhaps all of these different kinds of ground states—in other words, different kinds of universes—actually exist, with ours being one amongst this vast set, now referred to as the "landscape."[29] The special features of our universe, then, are what they are because every possible variant of universe that can exist is somewhere realized.

The Multiverse Paradigm

These four perspectives on the special character of our universe have motivated many scientists to consider the possibility that our universe is a very tiny part of a much larger cosmos called a *multiverse*. Biophilic selection and cosmic fine-tuning are coming to be regarded as indirect evidence that we live in such a multiverse.[30] Cosmic inflation and string theory—at least in principle—provide mechanisms for generating different kinds of universes with differing laws, structures, and initial conditions. In the multiverse paradigm, these different universes are not hypothetical entities, but instead physically exist.[31]

Such an idea may seem outlandish, but it is motivated by some observational support of cosmic inflation. Inflation makes three rather generic predictions.[32] (1) The mass-energy density ρ of the universe is close to the critical density ρ_c, and thus the geometry of the universe is flat. (2) On average, there should be equal numbers of hot and cold spots in the cosmic microwave background as compared to the average cosmic microwave background temperature. (3) Fluctuations in the primordial density in the early universe have nearly the same amplitude on all physical scales. Cosmologists are currently scrutinizing the data being collected from the Wilkinson Microwave Anisotropy Probe (WMAP) satellite to test these ideas and to plan further similar projects in the future. While there have been a few surprises, such as the large amount of dark matter (a nonluminous gravitating substance whose composition does not comprise elements from the periodic table) and dark energy (an unknown form of energy—perhaps a cosmological constant—that is causing the universe to speed up in its expansion instead of to slow down, as was originally expected), the inflationary picture has so far passed these three tests at a basic level.[33] Recalling the false vacuum picture I discussed earlier, observational support for inflation can be regarded as indirectly indicative of a multiverse: our universe is a bubble of true vacuum inside a much larger false vacuum that endlessly generates other universe-type bubbles elsewhere within it.

So why is there something rather than everything? Increasing numbers of scientists are wondering if the question is ill posed. Leaning on the circumstantial evidence noted above for a multiverse, they would argue that perhaps everything does exist! In other words, the special features of our observable universe are an inevitable consequence of the generation of a staggeringly large number (perhaps the string theory estimate of 10^{500}?) of *kinds* of universes, each with their own distinct properties. Since the universe-generating mechanism realizes all possible variants of each kind arbitrarily, often with all possible logically allowed initial conditions, ours must be one of those in the generated set.

Can this really be a satisfactory answer to the "something instead of everything" puzzle? Is it credible to believe that everything actually exists, with our universe being in a tiny corner of reality that is shielded from it all? I have argued elsewhere that the multiverse approach is a conceptual Pandora's box: once you get started on the idea, it is not clear how or where to stop.[34] Scientifically it can run out of control, and it can be theologically lethal.

The key problem is in the demarcation of the possible.[35] It is clear that what exists is a larger set than what is observed, because we are still discovering new things. The question is whether all that exists is equivalent to all that is possible.

The situation is illustrated in Figure 1 (p. 146). The smallest circle represents our observable universe: the collection of all that is known to exist. At any given time, this is finite, insofar as the amount of matter and energy in our observable universe is finite. There is good reason to believe that our universe extends beyond what can be seen with telescopes, and it is clear that we have not exhausted within our universe all that can be detected (though it can be argued that we have bounded it in terms of energy), and so what exists is much larger than what we can detect. But what line should be drawn between the possible and the existent?

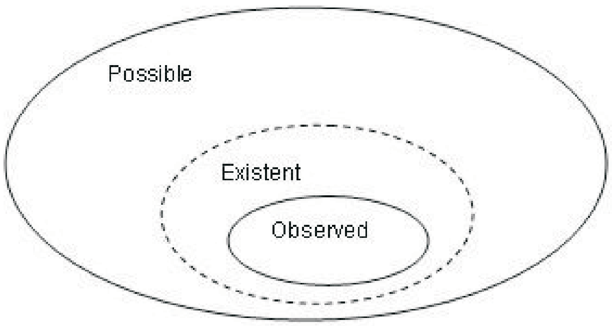

Figure 1. This diagram illustrates our observed universe within the existent universe and hints at the possible universe.

Scientifically, this is a serious challenge for multiverse theories. A given multiverse theory posits some kind of universe-generating mechanism, and then argues the case for the special features of our universe by contending that the mechanism *does* generate whatever it *can* generate. In this sense, a multiverse theory argues that the dashed line in the diagram above extends all the way to the limits of what is possible: whatever can exist, does exist. However, there is more than one way to generate universes,[36] and therefore different multiverse theories will make different claims about what is possible. This leads to a number of conundrums. What is possible in one theory might be contained within what is possible in another theory. Should we then opt for the theory in which possibility is minimized or for the theory in which possibility is maximized? Philosophical parsimony (i.e., the simplest explanation is best) would suggest the former, but the multiverse paradigm would suggest the latter. It is also conceivable that what is possible in one multiverse scenario contradicts what is possible in another, due, for example, to mutually exclusive premises. Again, by what criterion should we adopt one over the other?

It is important to recognize that these questions cannot be decided by observation and experiment, in that the multiverse paradigm—by definition—asserts that all that exists extends well beyond the capacity of observation. The special features of our universe can be explained only if our universe is one member of a very large set of existing companions whose properties are statistically spread across the spectrum of possibilities. It is also far from clear that these questions can be settled by mathematical self-consistency arguments, though there is much effort being expended in this direction.[37]

Theology's New Challenge

The relationship between the possible and the existent is theology's new question. Is it credible to believe that God created everything? Does God create (by whatever means) whatever can be created, or does the Creator make particular choices? Are there theological criteria for drawing a line, even tentatively, between the possible and the existent? If so, what are they? If not, can theology have anything useful to say about the multiverse? To probe the implications of the multiverse is to take up the challenge Zophar gave to Job, about probing the limits of the Almighty.[38]

It is a difficult challenge, one set in stark relief by the concept of the multiverse. The Bible describes God as being the source of all power,[39] having wisdom without limit,[40] and whose love is too vast to be grasped.[41] From these attributes come our concepts of an omnipotent, omniscient, and omnibenevolent God. In general—indeed, by definition—God's characteristics must be without bound. At the same time, we read that the creation is subordinate to God and is limited. The classic picture has been that of a finite creation whose origin, existence, and fulfillment depend on the limitless power of God.[42]

It is difficult to regard the multiverse as being anything other than a limitless creation. Adopting this viewpoint, the classic picture must be discarded, and a theological tension arises between the power of the Creator and the creation. Of course, tensions between different aspects of God's character are not new—the theodicy problem is the recognition of the tension between an omnipotent God and omnibenevolent God. However, in the multiverse context, new theological tensions can emerge between aspects of God's character that were previously thought to be in harmony, because in a situation where all possible outcomes are realized it is difficult to avoid a complete degeneration into absurdity. For example, the intelligibility of God reflected through a putatively elegant mathematical description of the multiverse is undermined by the imbecilic generation of all conceivable outcomes. The more pointless the universe seems the less comprehensible it becomes, to invert a well-known phrase of Weinberg.[43]

Perhaps, then, the multiverse is best eliminated from theological consideration. It is certainly tempting to regard the atypical features of our universe that are described in the framework of the anthropic principle as indicative of the selection of a Supermind, much in the same way that unusual structures such as Egyptian hieroglyphs or Ireland's Newgrange Megalithic Tomb are regarded as originating from purposeful minds instead of undirected natural processes. Yet this perspective is not without its own challenges. The first lies in how the multiverse is eliminated—how is the possible separated from the existent? There is also the question of how Mind instantiates matter, and what the link is between them.

The Duplication Dilemma

If the central challenge the multiverse presents to science and theology is that of understanding the boundary between the possible and the existent, it is not the only one. There are a number of subordinate interrelated problems that science and theology must both contend with in the context of a multiverse paradigm. There is not the space to discuss them all here, so I shall deal with one: the Duplication Dilemma.

Ellis and Bundrit first noted the Duplication Dilemma (as I call it) in the context of investigating the simplest kind of multiverse, though they did not use that term.[44] Consider a universe that is infinite in spatial extent and in which there is an unbounded amount of energy, everywhere obeying the laws of physics in our observable patch. Suppose now that these laws are valid everywhere. A simple kind of multiverse can be obtained here by simply allowing matter and energy to realize all possible configurations that are permitted by the known laws of physics. No quantum mechanics is required to do this—one is simply exploring the possibility that there is enough time, space, and matter to realize all possible known configurations of every allowed physical system. One can regard the universe-generating mechanism as being a random generation of initial conditions, spread out over spatial regions that are typically larger than the 10^{26} meters in size of our observable horizon.

One such physical system is the human body—your own, for example. Since human DNA has a finite number of configurations, your body will have a duplicate in this infinite universe. It is possible to estimate how far away this body-double is—about $10^{10^{29}}$ meters away from here.[45] Of course, this is but the nearest of many duplicates—infinitely many, since we have allowed the universe to have unbounded matter and energy. Most of these will be only physically identical, with presumably different personalities due to differing environments and circumstances. However, some will be nearly the same because the local environments and circumstances will also be nearly the same. In fact, our planet, our solar system, and our galaxy will also have complete duplicates. The nearest region of space that is identical to ours (one hundred light years across) can be estimated to be about $10^{10^{91}}$ meters away, and our nearest duplicate observable universe, about $10^{10^{118}}$ meters away.

Vast numbers, to be sure—but nonetheless finite. Such duplicates will occur infinitely many times since there are no bounds to the physical resources at the disposal of even this simple multiverse. Moreover, there will be proportionately even more duplicates that are imperfect copies. Taking this to its extreme, it means that any given physical system, individual, or society will experience everything it can experience. Furthermore, at any given instant in which you made an apparent choice, there is an equivalent situation somewhere out there in which your duplicate made a different choice. If you have ever wondered what life might be like if you had not met your spouse, taken that job, or passed that test, you can be confident that somewhere else in the multiverse your duplicates have had these experiences.

This might seem like a quaint and benign inference, more science-fiction than fact. Quaint it may be, but benign it is not. The reason for this is that all possible social, psychological, and physical outcomes occur from any given set of near-indistinguishable initial conditions. Specifically, all possible experimental outcomes occur for a given physical system somewhere in the multiverse. Two sets of near-identical observers could measure wildly different outcomes from the same set of conditions, with one set of observers inferring quite distinct forms of scientific regularity.[46] In what sense can we then say science is left with any predictive power? If we decide to restrict science only to our observable patch, then what is the point of introducing the multiverse in the first place? One is also left with the question of how one rules out unlikely outcomes on the basis of chance. Any phenomenon contradicting known science within a patch might just as well be attributed to being in a quirky location in the multiverse. Indeed, since everything that can occur does occur, one is ultimately left with a reasonless explanation for any given phenomenon.

Duplication poses interesting theological challenges as well. These have been discussed elsewhere, and have primarily concentrated on a loss of uniqueness.[47] If I am replicated many times in the multiverse, in what sense can I be understood to be a child of God, being worth more than many sparrows? To be sure, loss of uniqueness is a theological issue, one too easily dismissed by its critics. But it is not the only issue. Duplication presents a serious challenge to Christology.

If there are many duplicate worlds, then presumably there are many duplicate Christs. Pursuing the line of reasoning that follows from allowing all initial conditions, in some parts of the multiverse Jesus dies on the cross and in others he does not. What then do we make of the concepts of atonement and salvation? Do they only apply to those "lucky" parts of the multiverse where Jesus chose the path of sacrifice? Is Christ to be identified with God only in those sacrificial sectors? Does God so love only certain parts of this multiverse?

Note that these problems can be avoided (or at least ameliorated) if one imposes the theological constraint that all the duplicate Christs choose the path of sacrifice. This is fine, but it undermines the motivation behind this simple multiverse in the first place, which was to generate universes by random initial conditions. To impose such a constraint is to eliminate this randomness. But why stop there? Why not constrain such randomness so as to eliminate as many theologically uncomfortable duplicates as possible?

In fact, why not eliminate the multiverse entirely? This can be done by getting rid of infinite space, replacing it with finite spatial sections, or by revisiting the homogeneity principle in cosmology, so that the universe is not on average the same everywhere and so that not all initial conditions are realized.[48] Of course, one then needs to provide some kind of scientific/philosophical rationale that induces one (or both) of these possibilities.

Summary

I have outlined here what I believe is at stake in coming to grips with the puzzle of existence in view of modern science. The problem of *creatio ex nihilo*—why something instead of nothing—is one that continues to have an ongoing fruitful interaction in the science/theology dialogue. The key challenge is in understanding the role of Mind relative to that of matter. Though far from universally accepted, it does seem that a more coherently satisfying picture of reality is one in which the intelligibility of the universe is taken to be indicative of an Intelligence behind it. From a Christian stance, the challenge is both to understand in what way this Mind can be identified with the God of the Bible (since they clearly cannot be distinct) and to understand the relationship between this Mind and matter—how God both instantiates and interacts with the universe.

The other problem—why something instead of everything, or *creatio ex omnia*—is a new problem of considerably greater challenge, both scientifically and theologically. The central problem is that of the boundary between the possible and the existent. Asserting that there is no boundary—that everything that can exist, does exist—appears to undermine the basic foundations of scientific and theological reasoning.[48] Yet the rationale for how such a boundary should be delineated is far from clear. Even if one accepts provisionally that some boundary can be drawn, there are a considerable number of other difficulties a multiverse presents in both science and theology. The Duplication Dilemma is one example that I sketched out above. Further examples include problems with scientific elegance, empirical testability, spontaneous creation, unbounded evil, purpose, and free will.

It might be argued that these difficulties are being exaggerated. After all, there is an active body of scientific researchers examining models of the multiverse, with a number of cosmologists arguing that it provides the best explanation for the atypicality of our universe. It has further been argued that the multiverse is not incompatible with a theistic perspective, as it essentially pushes arguments from design and intelligibility up to a meta-level.[49] Perhaps we simply need to relax our demands of science and broaden our concept of God.

In my view, such arguments are too sanguine. It is not at all clear that the multiverse paradigm is scientifically beneficial. It is even less clear that this paradigm can be reconciled with any reasonable form of Christian theology. A far more critical analysis from scientific, philosophical, and theological perspectives needs to be applied in examining the multiverse paradigm. What ought we to expect from science in terms of providing a description of reality? What ought we to expect from theology in terms of providing an explanation for existence?

Is *creatio ex omnia* a meaningful concept?

Notes

1For a discussion in the context of modern cosmology, see William Lane Craig, "Philosophical and Scientific Pointers to Creation *ex Nihilo*," in *Contemporary Perspectives on Religious Epistemology*, ed. R. Douglas Geivett and Brendan Sweetman (New York: Oxford University Press, 1992), 191.

2John 1:1; Bible quotations are from the New International Version.

3For a discussion of this point, see J. Polkinghorne, *The Faith of a Physicist* (Princeton, NJ: Princeton University Press, 1994).

4For a nontechnical introduction, see L. M. Lederman and D. Teresi, *The God Particle: If the Universe Is the Answer, What Is the Question?* (Boston, MA: Houghton Mifflin Harcourt, 2006).

5Of course awe and gratitude are not just the prerogative of theists—the universe is so spectacular that even nontheists can appreciate its grandeur. However, gratitude has an intrinsically relational character—we are not only thankful *for*, we also offer thanks *to*. To be grateful for our understanding of the universe raises the question as to what entity our gratitude should be directed toward.

6J. Polkinghorne, *Reason and Reality* (Harrisburg, PA: Trinity Press International, 1991).

7See, for example, F. Wilczek, "A Model of Anthropic Reasoning: The Dark to Ordinary Matter Ratio," *Universe or Multiverse?* ed. B. Carr (New York: Cambridge University Press, 2007), 151.

8For a more complete description of the meaning of this term, see R. Mann, "Inconstant Multiverse," *PSCF* 57, no. 4 (2005): 302.

9*The Encyclopedia of Philosophy*, 1996 Supplement, s.v. "Naturalism."

10B. Forrest, "Methodological Naturalism and Philosophical Naturalism: Clarifying the Connection," *Philo* 3, no. 2 (Fall–Winter 2000): 7–29.

11For a full discussion of this kind of broad integration, see N. Murphy and G. F. R. Ellis, *On the Moral Nature of the Universe* (Minneapolis, MN: Augsburg Fortress Publishers, 1996).

12F. Crick, *The Astonishing Hypothesis* (New York: Scribner, 1994).

13K. Ferguson, *The Fire in the Equations: Science, Religion, and the Search for God* (Grand Rapids, MI: Eerdmans, 1995).

14I have stated this in "Inconstant Multiverse."

15For the first comprehensive discussion of this, see J. D. Barrow and F. Tipler, *The Anthropic Cosmological Principle* (New York: Oxford University Press, 1988).

16B. Carter, "Large Number Coincidences and the Anthropic Principle in Cosmology," *IAU Symposium 63: Confrontation of Cosmological Theories with Observational Data* (Dordrecht: Reidel, 1974), 291–8.

17For an early discussion of this, see J. Leslie, *Universes* (New York: Routledge, 1989).

18Brackets around numbers denote errors in the final digits of an expression. For example, 1.54378(12) means 1.54378 +/– 0.00012.

19B. J. Carr and M. J. Rees, "The Anthropic Cosmological Principle and the Structure of the Physical World," *Nature* 278 (1979): 605–12.

20For a derivation of this equation, see S. Weinberg, *Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity* (New York: John Wiley and Sons, 1972).

21W. J. Kaufmann III, *Universe*, 4th ed. (New York: W. H. Freeman and Co., 1993).

22For a discussion, see J. Barrow, *Theories of Everything* (New York: Ballantine Books, 1992).

23S. Weinberg, "The Cosmological Constant Problems" in *Marina del Rey 2000, Sources and Detection of Dark Matter and Dark Energy in the Universe,* ed. D. B. Cline (New York: Springer-Verlag, 2001), 18–26.

24L. Susskind, *The Cosmic Landscape: String Theory and the Illusion of Intelligent Design* (New York: Little, Brown and Company, 2005).

25A. H. Guth, "The Inflationary Universe: A Possible Solution to the Horizon and Flatness Problems," *Physical Review* D23 (1981): 347; A. Linde, "A New Inflationary Universe Scenario: A Possible Solution of the Horizon, Flatness, Homogeneity, Isotropy and Primordial Monopole Problems," *Physics Letters* B108 (1982): 389; see also A. H. Guth, *The Inflationary Universe* (New York: Basic Books, 1998).

26For a nontechnical description of this and other aspects of inflation, see A. Vilenkin, *Many Worlds in One* (New York: Hill and Wang, 2006).

27M. B. Green and J. Schwarz, "Anomaly Cancellation in Supersymmetric D=10 Gauge Theory and Superstring Theory," *Physics Letters* B149 (1984): 117; for some readable introductions to string theory pro and con, see respectively Brian Green, *The Fabric of the Cosmos: Space, Time, and the Texture of Reality* (New York: Vintage, 2005) and Lee Smolin, *The Trouble with Physics: The Rise of String Theory, the Fall of a Science, and What Comes Next* (Boston, MA: Houghton Mifflin Harcourt, 2006).

[28] For a readable introduction, see R. Bousso and J. Polchinski, "The String Theory Landscape," *Scientific American* 291 (2004): 60.

[29] See Susskind, *The Cosmic Landscape* for further details.

[30] Ibid.

[31] For a collection of articles that address this subject from a variety of perspectives, see Carr, *Universe or Multiverse?*

[32] See Vilenkin, *Many Worlds in One* for further discussion.

[33] The most recent cosmological results and their interpretation appear in E. Komatsu et al., "Five-Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Cosmological Interpretation," *Astrophysical Journal Supplement* 180 (2009): 330.

[34] See Wilczek in Carr, *Universe or Multiverse?*

[35] Here the term "possible" refers to everything that can self-consistently exist based on the premises of a given theory. For further discussion, see P. Davies, *Cosmic Jackpot* (Boston, MA: Houghton Mifflin Harcourt, 2007).

[36] For examples, see Leslie, *Universes*.

[37] See D. Page, "Cosmological Measures without Volume Weighting," *Journal of Cosmology and Astroparticle Physics* 0810:025 (2008) for a recent discussion and references therein.

[38] Job 11:7.

[39] Deuteronomy 3:23–25.

[40] Psalm 147:5.

[41] Romans 8:39.

[42] Job 38: 4–11.

[43] S. Weinberg, *The First Three Minutes,* 2d ed. (New York: Basic Books, 1993).

[44] G. F. R. Ellis and G. B. Bundrit, "Life in the Infinite Universe," *Journal of the Astronomical Society* 20 (1979): 37.

[45] For a more detailed discussion of these estimates, see Kaufmann, *Universe*.

[46] Strictly speaking, quantum mechanics is needed to infer these kinds of distinctions, but in practical terms this does not matter. Most experiments are well beyond quantum limits in determining their sources of error, and so conditions that appear identical to experimentalists can lead to vastly different results, at least in principle. The point is that even the most unlikely outcomes can appear in situations that appear identical to our own at any point in time, as long as it is logically possible, given the initial conditions.

[47] For example, see D. Page, "Does God So Love the Multiverse?" to appear in *Science and Religion in Dialogue*, ed. M. Y. Stewart (Oxford: Blackwell Publishing Inc., in press).

[48] Job 11:7.

[49] It is generally thought that science deals with what is "probable" based on our knowledge to date, rather than with what is possible, and for most scientific disciplines this pragmatic approach is satisfactory. However, what is probable depends on what is possible, and in dealing with the subject of cosmology, considerations of the boundary of the possible necessarily come into consideration.

[50] For further discussion, see Page, "Does God So Love the Multiverse?" and R. Collins, "The Multiverse Hypothesis: A Theistic Perspective," in Carr, *Universe or Multiverse?* 459.

Ralph F. Stearley

Article

Assessing Evidences for the Evolution of a Human Cognitive Platform for "Soulish Behaviors"

Ralph F. Stearley

During the past one hundred fifty years, a great number of fossil hominid specimens have been unearthed, providing an outline of hominid history extending back five million years. Associated with these hominid fossils are artifacts. Christians and others who have attempted to assess the humanity of these long-dead individuals have focused on evidences of cognition such as cave art, evidences of care given to injured or ill individuals, or burial. However, many more types of evidences as to cognitive abilities in these creatures are available.

Warren Brown has proposed that a cluster of interlinked cognitive capacities were elaborated over the past few million years of hominid history during an "evolutionary trajectory" which, in turn, undergird human "soulish behaviors."[1] These include language, a theory of mind, episodic memory, top-down agency, future orientation, and emotional modulation. This article is an attempt to put traction on Brown's proposal, through detailed examination of the paleoanthropological record. The ability to teach, and thus symbolically and rapidly transmit culture, is suggested as an additional capacity which is part of this cognitive platform. Primary data (anatomy, artifacts) and reliable inferences (based on comparative studies) support a notion of a stage-wise erection of a cognitive platform for soulish behaviors. A few significant, less-understood gaps remain in the cognitive trajectory.

Through the course of the past five hundred years, voyages of exploration, the development of a science of comparative biology, and revelations provided by the unearthing of fossil hominids have combined to establish that humans occupy a position in a genetic continuum of life on Earth. In addition, natural and human experiments on brain function have demonstrated that the human mind is, in turn, founded on this biological history. Many theologians, scientists, and lay Christians have pondered these discoveries during this interval. How should this historical continuity be juxtaposed to the Christian concept of the unique creation and calling of humanity? As cynically phrased by the paleontologist Stephen J. Gould, are humans "… only an afterthought, a kind of cosmic accident, just one bauble on the Christmas tree of evolution"?[2]

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In the fifteenth and sixteenth centuries, contact with hitherto unknown human groups posed some vexing theological questions for many Christian theologians, historians, and natural philosophers.[3] While most orthodox theologians agreed that these "new" human groups were descended from Adam, many realized that the (post-Noachic Flood) Table of Nations in Genesis 11 did not include the ancestors of the residents of the New World. Thomas Burnet (1681), for example, responded by suggesting "the Almighty, we may reasonably suppose, made provision for a saving remnant in every continent."[4] However, some Christians questioned whether these new peoples were indeed descended from Adam. Could there exist New World and other humans, patently bearing God's image, who yet did not descend from Adam and Eve? Could such beings as "Preadamites" have existed in the distant past?[5]

During the seventeenth and eighteenth centuries, well-executed anatomical studies of apes by Nicolas Tulp, Edward Tyson, and Petrus Camper confirmed their strong similarities to human beings.[6] Carolus Linnaeus, pious Lutheran and astute biological organizer, in his first edition of the *Systema Naturae* (1735), included humans with baboons, other monkeys, and apes under Class Quadrupedia and Order Anthropomorpha.[7] In his tenth edition, he erected the Order Primates for monkeys, apes, humans, and bats; in his notes to the twelfth edition, he commented, "It is remarkable that the stupidest ape differs so little from the wisest man, that the surveyor of nature has yet to be found who can draw the line between them."[8] Many of Linnaeus's contemporary natural historians, including the Compte du Buffon, objected to Linnaeus's placement. Operating under a Cartesian concept of the mind as a separate substance added to the body, they suggested humans were a distinct biological category.

In the third quarter of the nineteenth century, T. H. Huxley, Ernest Haeckel, and Charles Darwin reframed the comparative anatomy of apes and humans in a phylogenetic context.[9] Although finds of hominid fossils were then very rare, these authors made predictions regarding the locations and types of discoveries which would eventually be made. The "preadamite" controversy had thus been amplified to include potential human biological ancestry from an anthropoid primate stock. Since that time, a plethora of fossil hominid remains and artifacts have been unearthed and analyzed. The fossils and artifacts testify to a protracted history to the hominid lineage.

Furthermore, during the past two centuries, evidences have accumulated which link aspects of human responsible decision-making and socialization to specific brain activities. These evidences include case studies of patients with physical damage to the brain; neuroimaging studies of subjects undergoing tasks; and experiments which play one aspect of cognition against another, often by combining two or more demanding tasks simultaneously.[10] Many Christian neuroscientists, cognitive psychologists, and philosophers, deeply impressed by the evidences for the psychosomatic unity of the individual, now advocate a reversal of the Cartesian stance: the mind is not a separate substance from the body.[11] Many biblical texts describing human nature also treat humans as psychosomatic unities. Such lines of evidence provide a rationale for viewing the human soul as a set of emergent qualities or capabilities, and not a separate entity from the body; this viewpoint is sometimes referred to as "nonreductive physicalism."[12] In this article, I do not attempt to take a position on the human soul as emergent, although the observations presented here are relevant to the discussion.

Warren S. Brown feels compelled to adopt a view of the human soul as emergent. In his account, distinctly human capacities to *relate*—to oneself, to other humans, and to God—are the (evolved) earmarks of human uniqueness. Brown identifies six specific cognitive requisites for what he terms "soulish" existence. These are (1) language; (2) metacognitive skills, including a theory of mind; (3) episodic memory; (4) conscious top-down agency; (5) future orientation; and (6) emotional modulation.[13] Brown's proposal actually provides reasonable and approachable targets for detection in ancient hominids, regardless of one's viewpoint on the soul. These six cognitive capacities are phenomena needing explanation in any evolutionary scenario for the emergence of truly *human* existence. I suggest that the capacity to teach should be added to this list.

This article attempts to clarify some issues surrounding the nature of ancient hominids, specifically by addressing evidences or clues for cognition in these forms. Brown's categories of cognition, related to "soulish" existence are employed both for their real utility as targets for evaluation and for their theological significance. I will attempt to *intersect* data from relevant disciplines to derive a well-reasoned set of proposals regarding a human "cognitive trajectory." To do this, I will (1) briefly review the paleoanthropological record, (2) examine cognitive implications of artifacts associated with fossil hominids, (3) review trends in primate brain size and architecture and their implications for hominid fossils and the history of human cognition, (4) address proposals regarding theory of mind and language capacity in ancient hominids, and (5) summarize some strong and weak inferences for a cognitive history of soulish behaviors.

The Paleoanthropological Background

The fossil evidence for a long time-depth for human or human-like upright anthropoid primates is now considerable.[14] Figure 1, adapted from several sources, provides a graph of fossil hominid presence through the past 6.5 million years; the figure suggests possible ancestor-descendant relationships for these taxa. Artifacts, which have implications for motor cognition and social organization, in many cases, accompany these fossil occurrences.

A major group of early hominids are the australopithecines, known only from the African continent, and including several species subsumed under three to five genera; *Australopithecus*, *Paranthropus*, *Ardipithecus*, and *Kenyanthropus* are probably stable.[15] While australopithecine pelvises and limbs clearly indicate bipedality, particular features such as curved phalanges are interpreted as evidence for some arboreality, or alternatively, as evolutionary holdovers from arboreal ancestors. Australopithecines have a cranial capacity of around 400–450 cc. They are markedly sexually dimorphic. Australopithecines have been dated back to approximately 5.5 million years before the present (MYBP); incomplete and poorly understood remains occupy time horizons before that benchmark.[16]

Stratigraphic horizons younger than 2.6 MYBP, which contain australopithecines, often include worked stone implements. These are simple flaked cores, often termed "choppers"; many sites also contain the flakes struck from the cores.[17] The tools were originally termed "Oldowan" after the site of Olduvai Gorge in east-central Africa; but workers are increasingly terming this technology "Mode I." There is some uncertainty concerning which taxon was responsible for the production of Oldowan-style tools. Cut marks on associated mammalian bones indicate that animals were being scavenged or hunted by the Oldowan tool-makers.[18] The Oldowan technology remains unchanged stylistically up until 1.6 MYBP. There is no good evidence for use of fire by those individuals practicing Oldowan technology.

Hominids assigned to the genus *Homo* are known from stratigraphic horizons dating to about 2.5 MYBP.[19] The earliest forms, like the australopithecines, are known from Africa only and, at present, are assigned to *H. habilis* and *H. rudolfensis*. These earliest representatives of *Homo* are much shorter than modern *Homo sapiens* but possess a somewhat larger mean cranial capacity than that of the australopithecines, averaging 640 cc (range 590 to about 700 cc). *H. habilis*, while bipedal, possess feet which are rotated inward, such that locomotion on the hind limbs would have been extremely "pigeon-toed" and, in fact, not well suited for striding. These earliest representatives of the genus *Homo* may have been the sole creators of the Oldowan tools; at present, direct associative evidence is ambiguous.[20]

Larger-statured representatives of the genus *Homo*, assigned to *H. erectus* (Asia) and *H. ergaster* (Africa) appear in the stratigraphic record about 2 MYBP.[21] These forms approximate the height of modern humans, have body proportions (e.g., shape of pelvis, rib cage, projecting nose) which approximate those of modern humans, and have cranial capacities of between 900 and 1150 cc. The labyrinth of the inner ear attests to identical balancing ability while striding as that of modern humans.[22] Females become relatively larger; sexual dimorphism is greatly reduced. Fossil hominid remains from Dmanisi in Georgia, associated with Oldowan tools and dating to around 1.7 MYBP, resemble *H. ergaster* and document an early presence of *Homo* in south-eastern Europe.

After 1.5 MYBP, the African forms, and succeeding near-Eastern and European forms, are associated with a long-lived stone tool industry termed the "Acheulean," named for the French site of St. Acheul, originally excavated in 1853. This industry is typified by well-known bifacially-modified

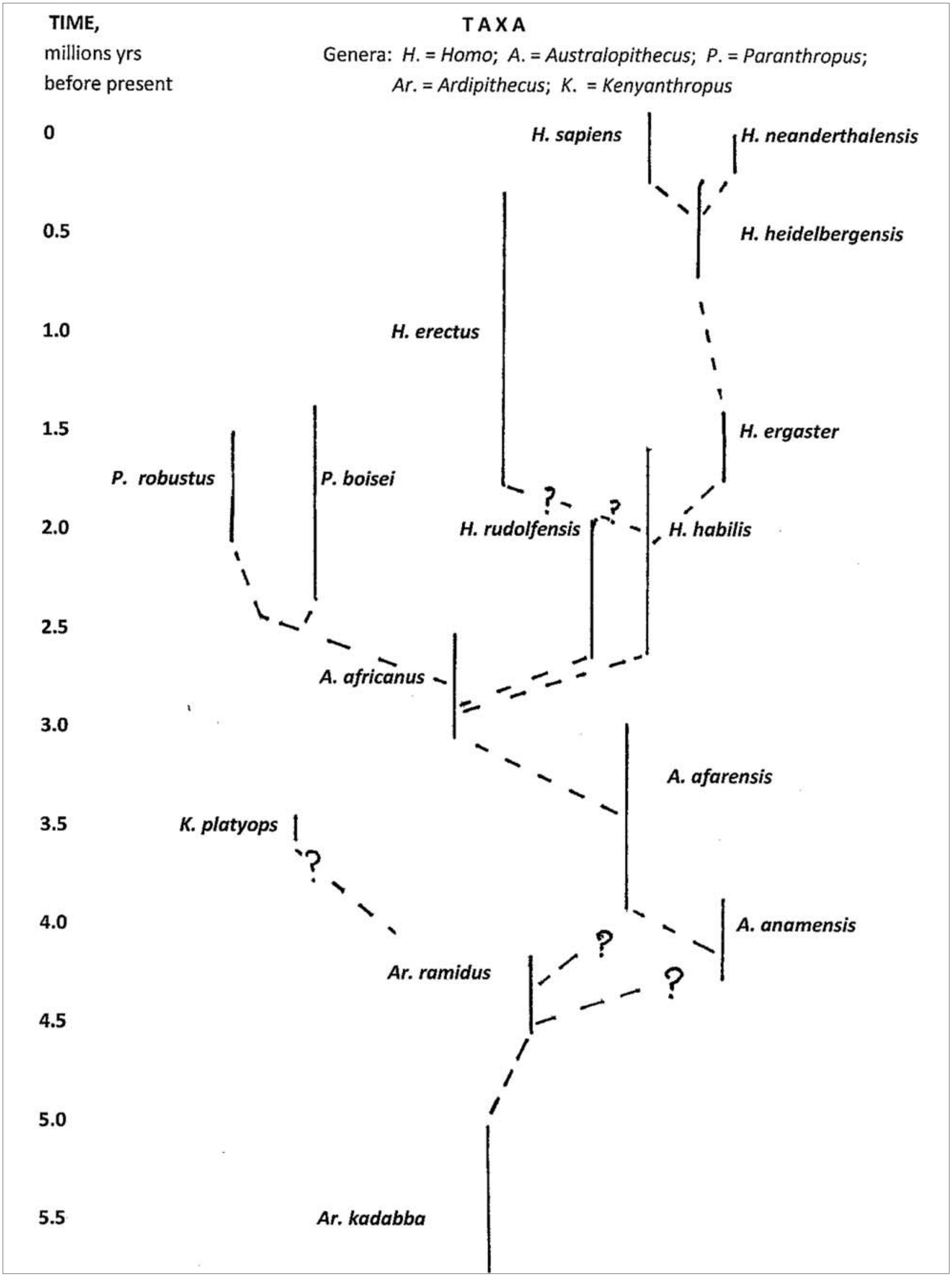

Figure 1. Phylogenetic emplacement of hominid taxa through time.

"handaxes."[23] Acheulean-style tools ("Mode II") persist for over one million years in Africa. East Asian sites from this time period contain few or no handaxes, and the smaller tools are different stylistically from their west Asian/African counterparts.[24]

Hominid skeletal remains dating from 500,000 to 200,000 before the present (BP) are as yet poorly understood. In east Asia, *H. erectus* is the dominant form during this time period. Southern Europe and sub-Saharan Africa exhibit distinct racial varieties with larger cranial capacities than standard *H. erectus*. Very few hominid fossils have been located in Europe prior to 500,000 BP, despite abundant paleontological sites dating from before this time.[25] After that point, early hominids assigned to *H. heidelbergensis*, utilizing Acheulean technology, appear in Europe and rapidly colonize regions north of the Alps and Pyrenees. *H. heidelbergensis* grades through time into the morph *H. neanderthalensis*.[26] Analyses of Neanderthal DNA appear to support the contention that this lineage did not interbreed with the modern-aspect humans which later replaced it in the Middle East and Europe.[27]

The Middle Paleolithic period, defined by technology emergent about 300,000–250,000 BP, is marked by a discontinuance of the production of classic Acheulean handaxes, and the introduction of a more diversified and aesthetic toolkit.[28] Flaking strategies at this point typically involve five to six clearly separable and planned phases; different techniques are applied to different lithic categories. These new tools include blunted, truncated, thinned, or snapped points which were almost certainly modified so as to be hafted; thus these provide the first evidence of "composite tools." They are sometimes found in contexts which provide evidence of mastery of fire. In Europe and the Near East, these stone tools collectively are termed the "Mousterian Industrial Complex," and in sub-Saharan Africa, they are assigned to the "Middle Stone Age." Middle Paleolithic sites are often located in rock shelters or caves; however, evidence for the construction of protective structures is absent. There is little or no real evidence for art or ornamentation.

Neanderthals are interpreted as being "cold-adapted" on the basis of limb proportions and robustness. Their skeletons exhibit much evidence of malnutrition, degenerative joint disease, and repaired bone breakages.[29] They evidently led a rough life. Neanderthal crania, while shaped differently from those of modern humans, actually possessed slightly higher brain volumes than those of modern humans. Neanderthal populations are often associated with the Mousterian tradition, but early *H. sapiens sapiens* populations also participated in this same tradition. Some Neanderthal burials were deliberate interments.

Humans of modern anatomical aspect, *H. sapiens sapiens*, with modern stature, body proportions, cranial capacities typically in excess of 1300 cc, and reduced faces, appear in the African record around 150,000+ BP, and moved into the Near East around 130,000 BP.[30] Beginning about 110,000 BP, they shared the terrain of the Near East with Neanderthal populations, which were probably migrating southeast from Europe. The two populations coexisted for the next sixty thousand years, both groups employing a similar Mousterian technology. After that time, modern-aspect humans totally replaced the Neanderthals in the Near East. During this interval, the modern-aspect humans developed a distinctive Upper Paleolithic variant technology termed the Aurignacian.[31] After about 60,000 BP, anatomically modern humans with Aurignacian technology moved into Europe and displaced the Neanderthals there. Modern-aspect humans also moved eastward, replacing perhaps a small surviving *H. erectus* population in China and southeastern Asia. Modern humans arrived in Australia prior to 40,000 BP (requiring several boat crossings in open seas of 30 to 90 km), and in North America sometime after 20,000 BP.[32] Demographic profiles of these modern *H. sapiens* demonstrate a clear extension in lifespan to beyond fifty years. Their artifacts exhibit highly aesthetic paintings, carvings, and objects for personal adornment, as well as "luxury" items, such as seashells, which were transported up to hundreds of kilometers from their site of origin.

A "First Pass": Artifact-Based Evidence for Cognitive Abilities

The earliest (Oldowan) stone tools are seemingly simple and are definitely monotonous, exhibiting no variability for over one million years. Kimura feels "the Oldowan makers did not seem to have a mental template for a final product, and the other factors such as availability, size, and shape of raw materials would have contributed to the final form of stone artefacts."[33] On the other hand, their manufacturers possessed a sense for obtaining materials with good fracturing ability, and were able to master techniques which successfully struck off sharp-edged flakes for cutting. The materials, furthermore, were often transported long distances, implying to Semaw "greater mobility, long-term planning, and foresight not recognized earlier."[34] While the choppers or cores do not exhibit a planned ultimate form (template), the blades struck from these may have actually been the goal. These sharpened flakes work well as butchery or plant processing tools.

Today, several West African chimpanzee populations employ stone hammers to crack nuts. The stone hammers, generally igneous rocks or lateritic soil crusts, are carried up to several hundred meters to suitable processing locations (e.g., those possessing a hard surface which can be employed as an anvil upon which to strike).[35] Through use, the hammers become broken; some of these broken flake accumulations mimic the debris associated with production of early hominid tools. Are modern chimpanzees cognitively close to the creators of the Oldowan tools?

In order to ascertain the cognitive implications of Oldowan tools vis-à-vis extant great apes, archaeologists Kathy Schick and Nicholas Toth teamed up with primate psychologists Susan Savage-Rumbaugh, Duane Rumbaugh, and Rose Sevcik to see what the pigmy chimpanzee Kanzi could accomplish when given the opportunity to construct rock tools.[36] In the first stage of the experiment, the use of sharp stone flakes in cutting cords which bound a box containing a food treat was demonstrated to Kanzi. Kanzi readily took up the use of such flakes for cutting, and rapidly learned how to select the sharpest flake out of a set of several presented to him. Next, the technique of breaking a flake off a rock (the "core") was demonstrated. Kanzi quickly took up the habit of splitting off flakes through this percussive technique. However, while his efficiency did improve, he never became adept at mastering the controlled blows at specific angles which the Oldowan tool-makers employed. Chimpanzee wrists and fingers cannot manage the spectrum of modern human grips (see below) and are ill-adapted for fine-scale manipulation. Kanzi eventually learned how to break stones by simply throwing them onto a hard tile floor; over a period of months, this became his technique of choice for creating sharpened stone implements, rather than direct percussion. Thus, the Oldowan tool-makers clearly evidence *greater spatial foresight*, in relation to manipulative motor cognition, than that possessed by extant apes.

The fact that Oldowan tool manufacture and use require more refined motor cognition than that possessed by pigmy chimpanzees suggests that the tool-makers possessed greater resources in those brain areas devoted to motor cognition: primary motor cortex (M1), supplementary motor cortex (SMA), and premotor cortex (PM).[37] One way to assess the cognitive implications of Mode I technology would be to perform a neuroimaging study of a modern human while the subject was undertaking the manufacture of an Oldowan-style tool. A pilot study of one subject, an experienced flintknapper who is right-handed, was conducted.[38] The pattern of brain activation observed was essentially that expected for a complex motor task requiring hand-eye coordination. Primary motor and somatosensory areas surrounding the central sulcus were strongly activated, including adjacent portions of the SMA. The cerebellum also was activated, as expected for a motor task. Right-handedness was evident in that the primary motor cortex of the left precentral gyrus, as well as the right cerebellum, was preferentially activated. The superior parietal lobes on both sides of the brain were also strongly activated. The superior parietal lobes are association areas involved in complex spatial integration of action and perception. All these areas, including the cerebellum, are greatly expanded in modern humans relative to hominids of two million years or so before the present. Interestingly, prefrontal activation was not noted.

Efficient and safe stone tool manufacture requires anatomical adaptations in the hand which parallel motor cognition investment by the brain. A sizeable body of research into the comparative functional morphology of the hand in fossil and modern humans was initiated by John Napier in the late 1950s and has culminated in classification schemes of various types of grips and associated features by Mary Marzke and co-workers.[39] Of particular note are a suite of special grips which enable the tool-maker to cradle the target stone and firmly pinch the hammerstone, such that tool-making does not expose the hand to damage. Chimpanzee hand morphology cannot sustain the gamut of finessed grips; australopithecine and *H. habilis* hands are intermediate in aspect between chimpanzees and modern humans.[40] Muscle attachment scars, relative digit proportions, and the presence of flattened pads in the hands of these early hominids indicate that anatomical reorganization of the hand, correlated to the demands of tool-making, was under way. These structures provide strong evidence that greater areas of somatosensory cortex were being required for manipulative tasks.

Oldowan technique exhibits little change for over one million years. This lack of experimentation and elaboration strongly correlates to the small cranial capacities of the hominids of this period. Several researchers have suggested that the activity of tool-making at the Mode I level, in turn, exerted some sort of Darwinian selective pressure for increased somatosensory cortical mass.[41] Beginning at 1.5 MYBP, the stone tool-makers at Olduvai demonstrate increasing command of percussive technique and more active transport of stone tools; Kimura suggests that this increased technological acumen accompanies the transition to *H. ergaster* in East Africa, with its increased energy needs and expanded foraging strategies.[42]

What of the next major industrial "tradition," the Acheulean, or "Mode II"? The characteristic form, the classic bifacial handaxe, represents a significant cognitive advance over the Oldowan simple core choppers and derived blades. Schick and Toth feel that "unlike the Oldowan artifacts, which show no definite preconceived shape that their makers were trying to produce, these Acheulean tools show unequivocally that these hominids had specific mental templates of the forms they wanted."[43] Experimental stone-working over the past century and a half has revealed the sequence of tasks required to form such objects.[44] The handaxe is formed from a prepared blank, chopped out of a larger boulder of brittle, fine-grained rock such as quartzite or flint. The blank is then carefully struck at many angles, symmetrically from both sides, to create the desired end-point object: a sharply pointed cutting instrument with one rounded end accommodating the palm of a human hand, and tapered toward the opposite end from all sides. Final trim to the edge is often accomplished with a hammer formed of softer bone or antler. Experimental usage of handaxes demonstrates that these tools are well suited for animal carcass processing; microscopic analyses of wear patterns on tool edges are also consistent with butchery. However, at Peninj, Tanzania, one of the oldest known Acheulean sites, blades have been recovered with embedded plant material and microwear patterns suggesting their use in woodworking.[45]

The level of cognition requisite to learn how to create Acheulean tools surely requires significant mental simulation of action, the ability to imitate, and a mental image of a final product (in fact, even contemporary flintknappers take months of apprenticeship to master the techniques of manufacturing Mode II stone tools).[46] Thus, some measure of Brown's *future orientation* and *top-down processing* criteria for soulish existence is present in archaic hominids of 1.5 million years or so before the present. On the other hand, Acheulean tools lack explicit symbolism or an aesthetic dimension, such as the rendering of animal or other natural features, or use for personal adornment.[47] Moreover, Acheulean tool forms blend into one another, in contrast to Upper Paleolithic tool forms, which are much more diversified and distinct.[48] Major changes in Acheulean technology were remarkably slow. And the straightforward adaption of stone-working techniques to Acheulian bone tools, rather than the development of techniques better suited to exploit natural bone mechanics, also suggests a lack of foresight.[49]

The Mode II tool-makers were *H. ergaster*/*H. erectus*, as well as earliest *H. sapiens*, with cranial capacities in excess of 1000 cc. Gibson and Jessee suggest that the conjunction of brain size and handaxe technology argues for a modest communicative ability, confined to events, objects, or actions in the immediate environment, which are known to both speaker and viewer.[50] Toth and Schick suggest a test of the language/technology connection: attempt to teach an apprentice or apprentices how to create an Acheulean tool without any verbal discussion (of course, this would take place in subjects with brains much larger than those of the original Acheulean tool-makers, and thus not be an exact re-creation).[51] To my knowledge, no one has yet undertaken such a test. My guess is that a modern human could fairly easily be taught how to manufacture a Mode II tool with little or no verbal instruction.

Middle Paleolithic tools (Mousterian tradition; Middle Stone Age) exhibit more regional variation than that of Lower Paleolithic tools; moreover these industries include multi-component tools, such as points clearly designed to be hafted to spear shafts, and crafted wooden spears. These cultures also utilized fire, created deliberately paved floors, and, in some sites, buried their dead.[52] All these traits attest to much greater levels of top-down mental processes and planning. Mental templates for design of such instruments are, at this stage, *hierarchical*.

Middle Paleolithic sites also show unequivocal evidence that pigments were applied to objects. However, to date no evidence has emerged that these pigments were used to create symbolic devices, such as paintings or geometric designs. The pigments are applied as smears on tools, and are described by Paul Mellars as "at best perhaps a rudimentary form of aesthetic appreciation."[53]

Upper Paleolithic industrial complexes include elaborate toolkits. New forms of blade technology appear. Demonstration that some lithic extraction sites were, in effect, economically specialized "quarries," is much more certain than for the Middle Paleolithic. New and highly significant tools include, for example, fat-burning lamps, as well as bone awls and needles which were used to construct tight fur/skin clothing essential for the colonization of high latitudes, making possible the immigration of humans into the New World across the Bering land bridge.[54] Other new tools include fishhooks and the spear-thrower.

Upper Paleolithic cultures also exhibit many aesthetic aspects. Dwellings such as skin tents exhibit preconceived forms. The archaeological record of the Upper Paleolithic is dense with objects designed for personal adornment; grave sites often include ornaments such as strings of bone or shell beads which are entirely lacking in Middle Paleolithic sites. Naturalistic art in the form of paintings and three-dimensional carved objects of many kinds appeared in profusion during this period. Notably, impossible or novel representations, such as a human carving with a lion's head, also are common. Such novel representations must have strong cognitive and symbolic implications.[55]

This proliferation of aesthetic objects has been termed the "creative explosion,"[56] the "big bang of human culture,"[57] or the "50,000-year problem."[58] The dramatic difference(s) between this culture and its predecessors has lured some archaeologists and cognitive scientists to postulate that, at this point, humans passed some sort of neural and/or social Rubicon, accompanied by significant expansion in the use of symbols, and, hence, perhaps the first true attainment of language.[59] Others see the emergence of art as a more gradual phenomenon, perhaps extending down into the Middle Paleolithic.[60]

Comparative Primate Neuroanatomy: Overview

Primates, in general, possess large brains with large neocortical regions, relative to other mammals of similar body size.[61] Furthermore, primates possess a unique and extra component to the prefrontal cortex, the lateral prefrontal cortex. The prefrontal cortex is involved in decision-making; the lateral prefrontal cortex appears to be devoted to the "rational" aspect of decision-making.

The brains of *H. sapiens* are absolutely and relatively larger than those of all extant primates; they are three times (absolutely) the size of the brains of extant great apes.[62] However, they are not simply "scaled-up" versions of ape brains; humans have a much smaller primary visual cortex than expected for anthropoids of this body size; human prefrontal regions and the temporal lobes are greatly expanded relative to those of great apes.[63]

With the advent of noninvasive neuroimaging techniques, volumetric and qualitative differences among extant primate taxa can be assessed while brains are intact and operating, as opposed to dead and preserved. A study of forty-four subjects from eleven primate taxa, including humans and all great ape species, has been conducted utilizing MRI.[64] Logarithmic plots of brain volume vs. body weights demonstrate that all nonhuman primate species sampled, including all great apes, fall close to a common regression line; humans are a distinct outlier. Similarly, logarithmic plots of neocortical grey matter volume vs. body weight reveal *H. sapiens* to be a distinct outlier. The human neocortex is 24% (or 115 cc) larger than that predicted by a regression line based on the other ten taxa. Human cerebral white matter is 22% (or 60 cc) larger than expected, based on a regression line for the other ten primate taxa. Human temporal lobes are quantitatively larger than expected for great ape brains scaled up to human size; in particular, temporal lobe white matter is greatly expanded relative to all nonhuman primates sampled.

Brain size expansion in *H. sapiens* dovetails with increases in the development of sulci and gyri relative to other extant primate taxa, a fact long appreciated by comparative neuroanatomists. "Gyrification indices" can be computed, based on a ratio of total length of outer cerebral cortex vs. total length of exposed cortex (only), across serial sections or averaged over the whole brain. In the same MRI study cited above, the squirrel monkey, *Saimiri sciureus*, for example, has a whole-brain gyrification index of 1.56; the orangutan, *Pongo pygmaeus*, the highest nonhuman primate, 2.29; humans, 2.57.[65] The MRI study of gyrification sampled all brains at ten equally spaced coronal "slices"; these revealed that the human prefrontal cortex and the parietal/posterior temporal cortex were more gyrified than expected based on the general whole-brain gyrification. The prefrontal cortex, as already noted, is well understood to be a major site of decision-making and task-management support via working memory. The parietal cortex is important for spatial representation and attention.[66] A similar study, conducted on twenty-nine different primate taxa, including twenty prosimians, eight Old World monkeys, and humans, again demonstrated large relative increases in gyrification in prefrontal cortical regions and in parietotemporal association cortical regions in humans (Figure 2).[67]

The large volume of human prefrontal cortex, relative to other primates, is paralleled by a significant expansion in human prefrontal cortical white matter. Human white matter anterior to the genu of the corpus callosum was 41% larger than that predicted by nonhuman primate regression of prefrontal white matter vs. nonprefrontal cerebral volume, while on the other hand, human prefrontal gray matter did not differ from predictions.[68] The expansion in white matter corresponds to an increase in intracortical connectivity.

Gross size differences between human and nonhuman brains are also reflected in differences in

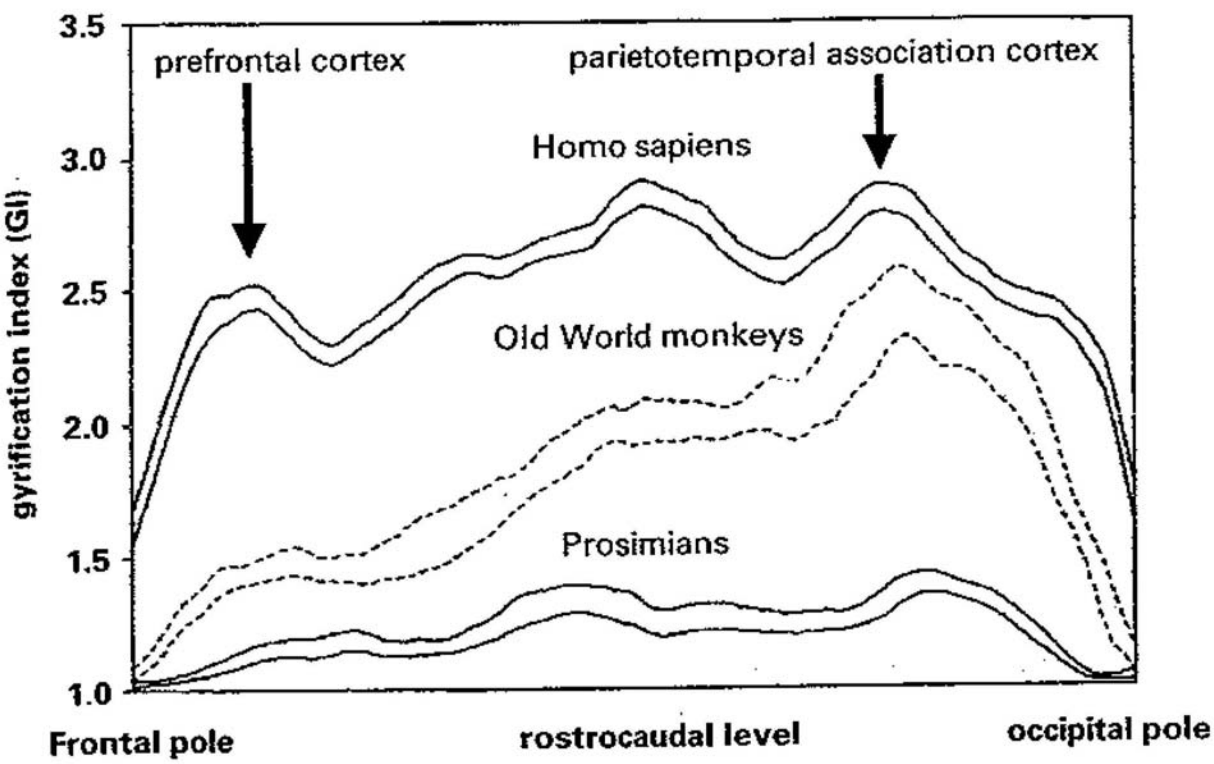

Figure 2. Gyrification indices in rostrocaudal sequence for 29 primate species. Gyrification index GI registered in a rostrocaudal sequence in brains of 29 different primate species. The primate species are classified as belonging to posimians (20 different species), Old World monkeys (8 different species) or *Homo sapiens* (61 individuals). The double curves indicate the 95 percent confidence limits in each group. (Modified after Zilles et al., 1988.) Used by permission from Karl Zilles, "Evolution of the Human Brain and Comparative Cyto- and Receptor Architecture" in *From Monkey Brain to Human Brain: A Fyssen Foundation Symposium*, edited by Stanislas Dehaene, Jean-René Duhamel, Marc D. Hauser, and Giacomo Rizzolatti (Cambridge, MA: The MIT Press, 2005).

noncortical areas of great significance. For example, human striatum volumes are four times those of baboons and twice those of chimpanzees; human hippocampus volumes are three times those of baboons and nearly three times those of chimpanzees.[69] Brain structures in modern humans are "off scale."

Learning: Comparative behavioral studies demonstrate that learning in primates is clearly related to brain size.[70] Functional implications of enlarged brains in humans include those related to procedural learning. Neuroimaging and studies of brain-damaged humans demonstrate that the basal ganglia, cerebellum, and premotor cortex are all implicated in such learning.[71] These structures, enlarged in humans relative to apes and in apes relative to monkeys, are essential for complicated motor activities such as dance, playing of musical instruments, use of complex tools, and so forth, and are also involved in automatic utterances and in writing. The hippocampus, as well as areas of the frontal and temporal lobes which connect to the limbic system, mediates declarative learning as well as emotional contexts for learning.

Social Play: The size of both the amygdala and hypothalamus is positively correlated to the percentage of total time spent in social play in nonhuman primates. A study of twelve primate taxa, including a loris (*Nycticebus*), several New World monkeys, several Old World monkeys, gibbons (*Hylobates*), gorilla, and chimpanzee, regressed percent time observed (by various research teams) in social play against the volumes of these two structures.[72] Social play frequencies and amygdala size were positively correlated and significant at the $p = 0.005$ level, $r^2 = 0.69$. Social play frequencies and hypothalamus size were positively correlated and significant at the $p = 0.01$ level, $r^2 = 0.67$. Nonsocial play frequencies (e.g., object play), on the other hand, were not correlated to amygdala or hypothalamus size. The amygdala is now understood to be a major functional unit in the recognition and generation of emotion. The hypothalamus is a key component of the limbic system, exerting a great control over autonomic function. It is also involved with basic emotions, such as aggression and frustration.

Language: Broca's area, a functional area of unique significance to humans, is an important brain region for the discussion of language and its possible evolution. This region, located on the posterior lateral portion of the frontal lobe, is important for syntactical organization of speech (as opposed to lexical).[73] Patients with the brain-damage syndrome "Broca's aphasia" understand the meanings of individual words, but have difficulty linking these into syntactic combinations which can readily communicate. However, Broca's aphasia is not always tied to damage in this region, and many other areas are highly important for speech production and for language comprehension. Nonetheless, for many years, Broca's area was highlighted in any discussion of the evolution of language, because a well-defined, enlarged (and hence modern-like) Broca's area can be relatively securely identified on the surface of a fossil brain endocast (see discussion below).

Motor Activities: Great apes and humans exhibit greatly expanded cerebellar volumes relative to other primates.[74] The greatly-expanded human cerebellum is often ignored in studies of comparative primate intelligence, because of the more blatant expansion of the cerebral hemispheres. The modern human cerebellum supports a larger and more finessed repertoire of motor activities, including those related to speech production.

A "Second Pass": Fossil Hominid Brain Size and Architecture and Cognition

Preserved endocasts of hominid brains are not uncommon. However, because the preservation is coarse-grained, an assessment of gyrification indices has not yet been attempted, and may never be possible. Patterns of gyri and sulci can be discerned but exact interpretation of these as landmarks has been debated (see below).[75] The endocast data have been discussed and argued for many decades, but today are being subjected to new interpretations based on better comparative studies and on neuroimaging data.

The volume of australopithecine brains, determined by endocasts, is about 30% larger than that expected based on a simple regression against body weight for extant apes.[76] Some expansion in cerebral volume relative to extant great apes is apparent. This volumetric increase may correlate to the ability to search out suitable raw materials and to manufacture Oldowan tools; this ability is apparently beyond the capability of extant great apes.

As noted in the previous section, humans differ from other primates in having a relatively reduced primary visual cortex. In extant primate brains, this is manifest by the position of the lunate sulcus, the anterior boundary of the primary visual striate cortex. The lunate sulcus, a relatively large structure, should be, in principle, visible in fossil hominid endocasts; however, this structure has proven to be highly controversial. Ralph Holloway and coworkers have long defended the notion that this landmark is positioned in australopithecines similarly to that of modern humans, indicating significant reduction of the primary visual cortex and the accompanying reorganization of the australopithecine brain architecture relative to apes, while Dean Falk and coworkers have argued that the position of the lunate sulcus in australopithecines is essentially ape-like.[77] In this article, I accept Glenn Conroy's adjudication, that Falk's diagnosis of the lunate sulcus in australopithecines is correct.[78]

Paleoneurologists agree that the brains of early *Homo* representatives exhibit similarities to those of modern humans. For example, the specimen KNM-ER 1470, a well-preserved early representative of *Homo* (disagreement exists as to species assignment) from East Africa, exhibits a probable Broca's area (unlike australopithecines), and a definite hemispheric asymmetry. While the overall endocast volume is in the 750–775 cc range, the organization is definitely more modern than that of australopithecines.[79]

The brain volumes of *H. ergaster*/*H. erectus*, as determined from endocast data, yet further diverge from those of australopithecines. Unquestionably, some of the brain size divergence is related to an absolute increase in body size, but the brain volume increases more than that predicted by body size alone.[80] Brain volume within *Homo* then increases over the time interval 1.8 MYBP until around 100,000 BP, from around 900 cc to the typical modern value. Neanderthal brain endocasts average slightly larger volumes than modern human brains; their brain architecture does not appear to differ significantly from those of modern humans.

While detailed mapping of fossil external brain structure can be problematic, general proportions and even gross size differences can grant information as to cognition in extinct hominids, when viewed in the light of comparative primate neurobiology.

Paleoneurology and Learning: Transfer-of-learning tests are designed to explore the ability of primates to reassess stimuli which previously had been associated with a reward; these are essentially measures of flexibility in learning. Beran and colleagues computed a Spearman rank-order correlation between cranial capacity and transfer index score for twelve extant nonhuman primates, with a value of 0.83.[81] An equation for the best-fit line was determined: Transfer index score = (0.05 x cranial capacity) – 7.2, based on numerical values of transfer index and cranial capacity, not their ranks. This regression equation was then applied to nine extinct hominids belonging to the genera *Australopithecus*, *Paranthropus*, and *Homo*, as well as modern *H. sapiens* (Figure 3).

If the results from application of this regression equation can be trusted, then they can be interpreted as follows: enhancement of transfer learning in *Australopithecus* and *Paranthropus*, two australopithecine genera, exceeded those for all extant primates but still lay close to those of present-day great apes. A jump in transfer of learning is evident in *H. habilis*; a greater jump in *H. rudolfensis*, a greater jump in *H. erectus*, and then an extensive jump up to the levels of *H. neanderthalensis* and *H. sapiens*, with *H. neanderthalensis* actually exhibiting slightly higher values than *H. sapiens*, due to their larger cranial volumes.

I do not believe these estimates of cognition for australopithecines based on brain size to be that far off the mark. They seem to approximate that cognitive level which I would grant based on the Oldowan technology demands.

Paleoneurology, Social Play and Emotional Modulation: Studies of the amygdala and hypothalamus, noted above, strongly suggest that fossil hominids with large brains would exhibit significant time spent in social play and greater capacity for Brown's category of "emotional modulation."

Language: The cognitive interpretations for early *Homo* (e.g., *H. habilis*, *H. rudolfensis*, *H. erectus*) based on brain size are intriguing and somewhat uncertain. Several paleoneurologists are willing to consider that *H. erectus*/*H. ergaster* possessed some language capability.[82] Some are willing to grant communicative and learning ability similar to those of modern humans to archaic *H. sapiens* and Neanderthals, extending back to perhaps 200,000 BP.[83] Language is discussed more fully later in this article.

Inferences as to a "Theory of Mind" in Ancient Hominids

Modern humans dialogue with one another; in the process, they obtain mental representations of the mind of the other individual. These mental representations are also formed on the basis of posture, gesture, facial expression, and other features. Brown claims that the internal representation of the "self" is correlated to this mental representation of another individual's mind.[84] The belief obtained from these representations, that one is actually interacting with another cognitive being and not a simulacrum or robot, is termed a "theory of mind," a phrase coined by Premack and Woodruff.[85] It has been argued that at least some measure of a theory of mind is requisite for real language.[86] Brown makes a strong case that this capacity is a prerequisite for relating to God. Can the kinds of evidences previously discussed provide clues as to a theory of mind in extinct hominids?

Neuroimaging studies have been employed to decompose the interrelated brain activities which undergird a theory of mind in humans. For example, neuroimaging studies demonstrate that, in modern humans, the cells of the posterior superior temporal sulcus (STS) exhibit marked activity when the subject is viewing motions. This region lies anterior and superior to visual area V5, which is activated during perception of motion. Significantly, the STS is also activated during imagination about motions, including goal-direction of actions, and thus the interpretation of actions in other individuals.[87] The anterior paracingulate cortex (ACC), part of the medial prefrontal cortex (MPFC), appears to be a later maturing region during human infant development. The ACC participates in performance

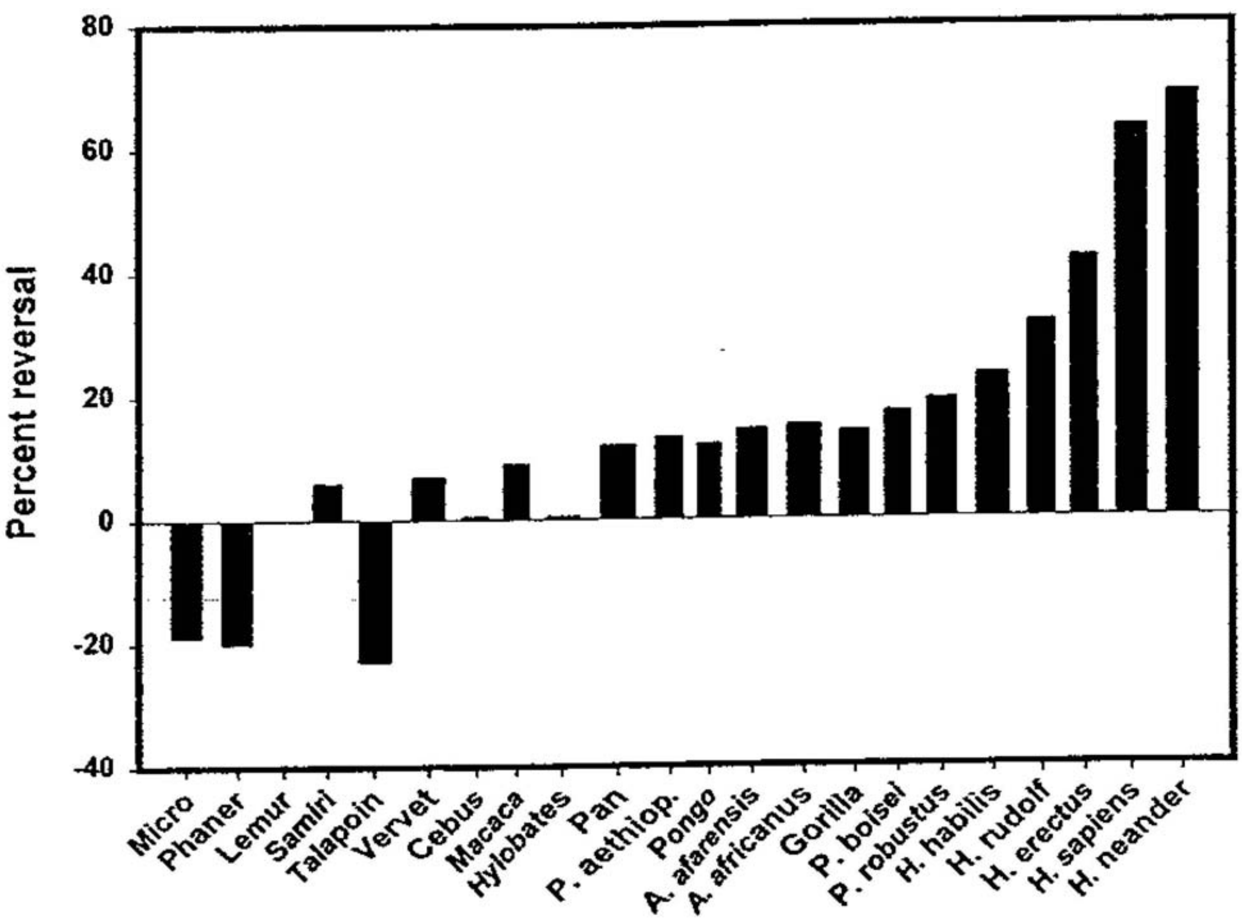

Figure 3. Transfer learning ability for thirteen extant primates, including humans; and inferred transfer learning ability for nine extinct hominids, based on brain size. Originally published as Fig.5.2 from chap. 5, "Predicting Hominid Intelligence from Brain Size" by Michael J. Beran, Kathlenn R. Gibson, and Duane M. Rumbaugh, in *Descent of Mind: Psychological Perspectives on Hominid Evolution*, ed. Michael C. Corballis and Stephen E. G. Lea (Oxford: Oxford University Press, 1999), 94. Reproduced with permission.

monitoring—detecting error and noting reward—and has been shown to be particularly involved in the interpretation of another individual's subjective internal emotional state.[88]

In an fMRI study of human/computer vs. human/human interactive game-playing, both protocols were accompanied by responses from the STS and ACC, but the human/human interactive version also elicited a strong response from the posterior cingulate and the hypothalamus, which are often associated with emotionally salient stimuli, and with the hippocampus, involved in episodic memory.[89] Thus, in humans, the theory of mind relies on a multiplex of interacting systems, connecting memory of past events and states, emotion, and the interpretation of postures, motions, facial expressions, and the like in other individuals.

fMRI studies on macaques demonstrate that both the STS and the frontal cortex area F5 are activated when motions are observed in other individuals.[90] These fMRI studies include motion-occlusion experiments in which an individual moves across the field of view, is temporarily occluded by an object, and then re-emerges on the other side. Thus, the same neurobiology is employed to follow and anticipate motion in macaques as in humans. But this is far from establishing that monkeys also follow another's subjective internal state.

Observations and experiments, in fact, have failed to demonstrate the presence of a theory of mind in monkeys. Tests for a theory of mind, often termed "Sally-Anne" tests, have been devised to ascertain expectations based on false beliefs concerning the state of another mind.[91] "Sally" and "Anne" are actor-researchers observed by an experimental subject. "Sally" places an object on one position in a room and then leaves the room for a time. During the time she is absent, "Anne" moves the object. When "Sally" returns, will the experimental subject expect "Sally" to go to the new position, or to the old? In humans, individuals with autism and children under four years of age will predict that "Sally" will search in the new position; these individuals are hypothesized to lack a theory of mind, because they do not realize that "Sally" would intend to return to the original site. Such tests, applied to macaques, utilize the gaze of the subject animal as the response, rather than a verbal prediction.[92] Thus far, these studies provide no evidence that the monkey understands the mental state of the observed individual. Years of behavioral observation on vervet monkeys and baboons in the wild also find no evidence for the presence of a theory of mind.[93]

Apes such as chimpanzees, in contrast to monkeys, exhibit at least a rudimentary theory of mind.[94] Chimpanzees not only follow another individual's gaze, but will do so past distractors. If chimps cannot perceive just what the other individual is staring at, they will double-check on the direction of gaze. Furthermore, chimpanzees will utilize information about another individual's gaze to conceal their approach to contested food items.[95] Chimpanzees also may quiet or suppress normal vocalizations in certain social situations, e.g., when hunting in a group. Apes demonstrate consolative behaviors such as comforting gestures by individuals uninvolved in a conflict. Apes, as opposed to monkeys, recognize their visage in a mirror and react to marks surreptitiously placed on their brow, indicating a degree of self-perception. Chimpanzees taught basic sign languages have, in turn, spontaneously taught other chimpanzees; this teaching activity included physically molding the novice chimp's hands to form signs.[96]

If extant apes, in general, possess a rudimentary theory of mind, then it is both phylogenetically parsimonious and neurobiologically sound to propose that the australopithecines, with their higher relative brain volumes, also possessed at least a rudimentary theory of mind. Therefore, some scenarios for hominid evolution explicitly begin with a theory of mind and some sort of attendant social grouping behaviors, which set the stage for a relatively early blossoming of language and culture.[97]

Simon Bar-Cohen, however, doubts whether hominids prior to the "creative explosion" circa 50,000 BP possessed a theory of mind. He lists eight classes of behaviors which require a theory of mind, including the following: intentionally communicating with others, repairing failed communication with others, teaching others, intentionally sharing a focus or topic of attention, and pretending. Bar-Cohen looks at autism in humans as a (devastating) lack of theory of mind.

> Children with autism also show us how useless a language capacity is without a theory of mind. Strip out a theory of mind from language use and you have an individual who might have

> some syntax, the ability to build a vocabulary, and a semantic system. Crucially, what would be missing from their language use and comprehension is "pragmatics"—being able to decipher the speaker's communicative intentions, decipher non-literal language, read "between the lines," understand jokes, and tailor one's speech to fit the listener's background mental states.[98]

I find Bar-Cohen's suggestions to be of mixed value. Certainly there is very limited evidence, if any, that primates in the wild purposively teach. Dorothy Cheney and Robert Seyfarth note, "Evidence for teaching by nonhuman primates, however, can be summarized by one word: scant."[99] However, chimpanzees taught how to use manual signs do intentionally communicate with humans. Bar-Cohen's use of autism as an example of language without a theory of mind puzzles me. While all view the phenomenon of autism as tragic, most of us would consider an autistic individual to be a damaged human being and not a nonhuman. On the other hand, perhaps this diminishment of cognitive ability gives us an insight into the cognitive world of past hominids with less-developed theories of mind. And, perhaps, communication (rudimentary language) over hominid history fostered a theory of mind.

In humans, teaching is, indeed, crucial. Teaching is necessary for cultural transmission and is certainly dependent on a theory of mind.[100] Teaching in modern humans, of course, includes the transmission of complex symbolic knowledge, including religious knowledge. I suggest that this ability, interlinked with language and a theory of mind, is a signal cognitive capacity characteristic of human soulish behavior.

The Emergence of Language

Teaching in humans involves rapid transmission of large quantities of cultural data, achieved through the medium of language. Human language is decomposable, cognitively, into three aspects or capacities: (1) lexical capacity; (2) morphological and syntactical processing, which organizes words into meaningful combinations; and (3) phonetic and phonological processes, which produce the sounds of speech.[101] Because these three aspects afford different types of clues in ancient hominids, I will examine each category separately.

Lexical Capacity: The dictionary or lexicon of the brain has been revealed by neuroimaging studies to be composed of distributed and overlapping neural networks. These networks are semantic in nature, that is, they call up various relationships between concepts when words are pronounced or imagined. Human brain areas activated during word recall include, for example, perception and motor areas associated with the object or action. The recall of the word "hammer," for instance, will cause activation of the primary sensorimotor cortex associated with gripping and using a hammer.[102] This phenomenon is also demonstrated in category-specific impairments, in which damage to specific brain regions affects entire categories of words (e.g., "animals"), because of semantic regionalization.[103] As most of the distributed neural lexical networks reside in cortical tissue, the lexicon can be tied, historically, to cortical size. If, for example, evidence could be provided that vervet monkey alarm calls, which are discreet for predator type, involved distributed neural networks, then these could be construed as "words."[104] However, because vervets possess much smaller cortical area than humans, their lexicon must have severe restrictions. Chimpanzees reared in human environments can be taught many dozens of signs. Because their employment of signs in combinations demonstrates semantic relationships, for example, the ability to respond to "who?" or "what?" questions, these signs are considered herein as lexical items.[105]

Thus, a preliminary working hypothesis might be that simple expansion of brain size, and particularly of the neocortex, during hominid history, gradually gave greater scope for lexicons. Cortical connections to the hippocampus would also be highly significant.

Speech production: Speech production per se is much more significant than many theorists have proposed, because of motor-cognitive skills which are interconnected to many brain circuits. An enormous number of modulated muscle combinations act to change the shape of lips, move the tongue, control inspiration/expiration, and change the shape of the vocal folds. Notably, these implicate the cerebellum. The cerebellum is expanded in apes relative to monkeys and exhibits expansion during hominid history. The primary motor cortex also includes large areas for the direction of facial muscles; notably, the laryngeal control cortex is adjacent to that for the lips and tongue.[106] Thus, expanded cortical regions, including supplementary motor cortex and premotor cortex, make available many more combinations of positions in the above subcomponents. These motor patterns take time to fully develop during growth. In fact, in modern humans, full motor ability for pronunciation is actually not reached until ten years of age.[107]

Because speech production by itself is very significant, it allows for a class of analyses which can actually be performed on fossil skeletons: comparative morphometric examinations of vocal tract shapes and sizes. The configuration of the neck relative to the skull base, the shape of the palate, and prognathism and mouth size can be scaled against those of chimpanzees and/or humans to judge whether the physical speech apparatus in a given taxon resembled those of apes or that of humans. Measurements of mandibular length and height, the height of the cervical spine, and the hyoid apparatus have been combined for samples which include chimpanzees; Neanderthals; a specimen of *H. ergaster*; Skhul V, which is an early anatomically modern *H. sapiens* from the Levant; other modern humans from the Upper Paleolithic; and contemporaneous humans.[108] Reconstructed proportions of the supralaryngeal vocal tract for the *H. ergaster* specimen were within the range of modern chimpanzees. The neck lengths for the Neanderthal skeletons were within the lower range of modern humans, but their oral cavities were longer. These features and some others indicate that Neanderthals could not create the full gamut of sounds which modern humans can, but this, by no means, rules out speech per se.

The human supralaryngeal vocal tract is constructed so as to favor speech, but at the cost of permitting choking. A Darwinian-style explanation for its persistence in hominid history, therefore, explains the origin of a *H. sapiens*-style vocal tract as an adaptation *following* the introduction of some sort of speech. The advantage provided by the communication outweighed the occasional death caused by choking.[109] On this scenario, perhaps tenuous, the case is made that *H. ergaster* possessed some sort of linguistic capability which in turn, over millennia, exerted a selective pressure for the development of the fully modern human supralaryngeal vocal tract.

Syntactical Thinking and Language: The phenomenon of hierarchical syntactical organization, such that language may generate nearly infinite meaningful combinations, is often claimed as the absolute distinguishing unit between human spoken communication and the verbalizations of other animals.[110] Chimpanzees taught nonvocal communicative techniques do exhibit extremely simple but real syntactical combinations.[111] However, a vast difference exists between these extremely short symbolic combinations and those of human syntax.

Philip Lieberman has championed the role which subcortical structures play in syntax.[112] In recent decades, CT scans and MRI have demonstrated that permanent loss of language involved in Broca's aphasia does not occur unless the damage extends to the subcortical areas. Subcortical structures such as the putamen and the thalamus have connections to the anterior cingulate cortex and dorsolateral prefrontal cortex. These subcortical structures perform important switching functions, and they mediate emotive significance to sentences.

Summary: Linguistic Capacity through Time

Intersected data from the fields of psycholinguistics, primate (including human) neuroanatomy and vocal tract anatomy, fossil hominid brain endocasts, and fossil cognates of vocal tract anatomy argue for the following historical propositions concerning the structural, neurological, and behavioral emergence of human language ability:

1. Australopithecines possessed lexicons similar to those of extant chimpanzees, but probably of slightly greater scope or finesse. However, like chimpanzees, their ability to communicate employing this lexical capacity was restricted by their vocalization abilities. They possessed a rudimentary theory of mind. Their brains, while relatively larger than chimpanzees, are small and lack a human-like Broca's area, indicating very limited syntactical ability; their technology also supports the notion that hierarchical thinking processes were minimal.

2. Broca's area is present in early *Homo*. Although it should not be presumed to confer modern-style speech, presumably it supported syntactic thinking, promoting syntactic communication.

3. *H. ergaster*/*H. erectus* possess a mid-range brain volume, around 1000 cc, with greatly expanded cortical regions. Assuming that connectivity follows cor-

tical volumes, these would certainly provide much greater lexical scope, and greater verbal motor control. Verbal communication would have been significant. Their technology, while supporting a thesis that these creatures planned, does not evidence much hierarchical thinking—a requisite for modern-style syntax.

4. The development of the suites of mimetic and social activity required for constructing and using Acheulean tools fostered greater flexibility in behavior patterns, including communicative patterns.[113]

5. The survival advantage granted by this more fluid and more specific vocal communication neurological-behavioral suite (larger lexicons, hierarchical-syntactic capability, mimetic behaviors), in terms of information transfer, would then permit greater applications. These would, of course, be interconnected with greater insight into other individuals' intentions and internal states (theory of mind) and greater environmental insight.[114]

6. Carried through to a logical end-point, this would result in the phenomenon of verbal instruction, with

7. the possibility of a complex symbolic culture.

A Cognitive Evolutionary Trajectory for Soulish Behaviors

Clues of diverse sorts testify to cognitive abilities of long-dead hominids. For example, biomechanical studies of small-scale structures in the hominid hand can, in turn, contribute to inferences as to the volume of somatosensory and motor cortex devoted to manipulation. Such clues may be blatant, but many are subtle. The revitalized field of cognitive psychology is today providing tools which enable reinterpretation of many of the "classic" symptoms of cognition, such as blade technology. Moreover, this new cognitive science provides us with a set of cognitive categories which are of much greater utility in the search for the human in these ancient hominids. These categories include those outlined by Brown and employed here.

I do not find inferences as to cognition in australopithecines to be problematic. These taxa were bipedal (but inefficiently so), which is surely significant for their ecology and lifeways. They possessed brains with volumes slightly larger than expected for their body size when compared to those of modern great apes. The brain volumes of australopithecines, however, suggest that they possessed little flexibility in learning. Interpretations of sulcul patterns on fossil brain endocasts of australopithecines are not resolved but may yet reveal that some modest architectural reorganization was occurring.

The creators of the Oldowan tools possessed an elevated motor cognition relative to that of extant apes, and also transported the requisite rock types much greater distances than do modern chimpanzees who employ rocks to crack open food items. This indicates a somewhat elevated ability to plan—what Brown termed "future orientation." The marked sexual dimorphism of australopithecines argues for a very different social organization than that of modern humans, possibly a polygynous one similar to that of modern gorilla troop organization.[115] This surely has implications for Brown's category of "emotional modulation." Parsimony suggests that australopithecines, like modern great apes, possessed a theory of mind, at least at a rudimentary level. However, evidence outlined above strongly argues that language was absent. The australopithecines possessed a small, yet real, kernel of the capacities which Brown proposed as the cognitive substrate for soulish behaviors, but from a psychological or cultural standpoint, the australopithecines were far removed from modern humanity.

It is possible that the manufacture and use of stone tools set in motion a recursive reinforcement for better motor control; individuals with greater motor resources (including those of the cerebellum) might have possessed some selective advantage. Because those same motor areas relate to speech production, this, in turn, would have fostered vocal control.[116] This notion circles back to that of an earlier generation of anthropologists, who put great stress on tool-making as the hallmark of humanity.[117]

Early *Homo*, presently classified as *H. habilis* and *H. rudolfensis*, while still short-statured, possessed brains up to 50% greater in volume than those of the australopithecines. Forebrain expansion is evident, including prefrontal cortex, and a plausible claim can be made that a Broca's area is present in early *Homo*. The mere presence of a Broca's area need not imply a speech system with the flexibility and open-endedness of modern language; brain volumetrics strongly suggest limited lexical ability in comparison to modern humans. However, if the extrapolation/interpolation method for estimating learning flexibility, as developed by Rumbaugh and colleagues, yields even somewhat accurate results, then we can assert that these creatures possessed much greater learning flexibility than that of extant apes.

With general brain expansion and expanded prefrontal cortex, early *Homo* would have possessed a much more nuanced theory of mind as compared to modern apes or australopithecines. Expansion in the sizes of the amygdala and hypothalamus would lead to greater emotional modulation of behavior and communication. Expansion of the hippocampus would lead to greater memory ability and better planning. We can infer that these capacities were interlinked; progressive efficiency in any one of these capacities would influence the others. However, it is doubtful that these abilities would as yet achieve levels which Brown's schema would classify as requisite for soulish behavior. These taxa will remain somewhat puzzling because we do not have good contemporary analogs for organisms at their level of cognition.

The forms *H. erectus* and *H. ergaster* are intriguing and problematic, partially through lack of some categories of evidence, and partially through the abundances of some kinds of evidence! The brains of these creatures range from 850 cc to 1150 cc; thus, the upper fringe of brain volumes overlaps that of the lower fringe of contemporary humans. Expanded brain temporal regions would provide greater association areas and, hence, greater lexical capacity.

The Acheulean toolkit, while monotonous and conservative for over a million years, exhibits a preference for symmetry and requires motor skills and hand functional morphology approaching those of modern humans. As Schick and Toth note, it takes weeks or months for a contemporary apprentice flintknapper to learn how to efficiently (and safely) create such superior cutting instruments. Assuming there were *H. ergaster* "apprentice flintknappers," these need not have been instructed primarily by spoken words; they could have learned their technique mainly through visual inspection, imitation, and experimentation. Brains of this size would even permit automation of tool-making behaviors. Perhaps *H. ergaster* tool-makers thought of lunch or planned to play with the children while they honed their Mode II tools.

H. erectus is the name given to this hominid grade in southeastern Europe, China, and southeastern Asia. Whether the hominids assigned to *H. erectus* are regional races of *H. ergaster* or not, some sort of migration out of Africa occurred. However, these creatures were not able to penetrate colder latitudes. They evidently lacked cultural resources to survive intense winters. This may or may not have cognitive implications; many contemporary hunter-gatherer groups in the tropics may lack cultural resources to survive intense winters.

Some scientists who have pondered the prehistory of the mind (e.g., Mithen, Deacon, Klein, Holloway) are willing to hypothesize that "mid-grade" hominids such as *H. ergaster* possessed a great deal of perishable or ephemeral culture and some degree of flexible vocal communication; others (Bar-Cohen, Walker and Shipman, Mellars, Davidson and Noble) believe these forms to be quite mentally and culturally deficient by our standards. The usual sticking points seem to be the absence of regional stylistic variation in Mode II technology and the absence of aesthetic objects. Significantly for Christian theorists, there is no evidence for religious practice. All workers, Christian and non-Christian, could make a better judgment call if they were permitted to resurrect a few *H. ergaster*, and watch them interact and live out their lives.

Hominids of the Middle Paleolithic have brains much closer in size and organization to those of modern humans. They moved into colder regions and their sites evidence the use of fire. Regional technological variations blossomed.

Hominids of modern anatomical aspect first appeared in Africa more than 150,000 BP. They subsequently migrated out and displaced contemporary hominids in southern Europe and in eastern Asia, transitioning into an Upper Paleolithic culture along the way. They continued their migrations into Northern Europe, to Australia, Northern Asia, and ultimately, into the Americas. Upper Paleolithic toolkits include many complex implements, which require hierarchical thinking and future orientation for their planning and production. Aesthetic objects, including objects of adornment, became common. Graves are accompanied by objects indicating respect for the departed or a sense of bereavement, or both. Some aesthetic objects are interpreted as evidence for shamanism. These hominids are judged by most workers to be as modern in their cognitive abilities.

Postscript: Antique Hominids and the Image of God

The notion that humans have been created in God's image is a significant item of faith for all Christians.[118] Theological evaluations of fossil hominids (whether or not the evaluators accept human evolution from nonhuman anthropoids) typically have been framed in a manner designed to present a criterion or criteria from which to assess the presence or absence of the *imago Dei*. The proposed test criteria usually include such items as cave art or other evidences of an aesthetic sense; evidences of care of injured or ill individuals; burial or other evidences of a belief in an afterlife. Such evidences certainly exist in the ancient record, but many other kinds of clues are present as well. The totality of the evidences, plus a set of search images informed by modern cognitive and neurobiological studies, provide a much more nuanced picture of the emergence of humanity and may even help us to understand the nature of the "image of God" in humans.

Classically, Christian theology holds that the image of God consists of various capacities, such as rationality or a moral sense, which are uniquely possessed by humanity. However, it is clear that such capacities underlie functions or roles which humans exercise. Vocational definitions of the *imago Dei* have been proposed by Verduin, Horton, and Middleton, among others.[119] For example, Richard Middleton's well-argued thesis that the "image" of God actually corresponds to an appointed office might offer some help in the resolution of difficulties with the hominid fossil record. This office is "a commission to extend God's royal administration of the world as authorized representatives on Earth."[120]

If the *imago Dei* represents an elective act by the Almighty God to a representational office, based on a cognitive platform designed over time, then may we be permitted to speculate when this appointment occurred?[121] I feel that the common tendency for Christians and non-Christians to focus on a few dramatic benchmarks, such as the eruption of cave art in southern Europe 40,000 BP (the "creative explosion"), misses some more basic, but humble, markers of a significant cognitive platform. For example, Middle Paleolithic culture is typified by the use of fire, multicomponent tools, regional variation in tool production, and human burial. Another potential benchmark might be the origination of anatomically modern humans. A third possibility would be the beginning of Upper Paleolithic culture. Perhaps it is not within our power to discern.

If the Christian accepts, as a working hypothesis, that humans are connected genealogically to other primates and that we understand something of the history of this connectivity by way of the fossil record, then many types of evidences become available to elucidate stages in the erection of a cognitive platform for both soulishness and the ultimate commission as God's regents on Earth. Brown's categories of cognition, which function here as targets for analysis, will continue to prove to be extremely useful, whatever one's perspective may be on the nature of the soul.

Human beings have been blessed with amazing cognitive abilities which enable us to relate to one another, to exercise stewardship over creation, and to seek our Creator. However, we still see dimly, as through a glass. We look forward to the New Creation, where God will dwell in our midst and no one will require instruction from a neighbor of God.

> ***"The signature on each soul may be a product of heredity and environment, but that only means that heredity and environment are among the instruments whereby God creates a soul."***
>
> —C. S. Lewis[122]

Acknowledgments

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Notes

[1]Warren S. Brown, "Cognitive Contributions to Soul," in *Whatever Happened to the Soul? Scientific and Theological Portraits of Human Nature* ed. W. S. Brown, N. Murphy, and H. N. Maloney (Minneapolis, MN: Fortress Press, 1998), 99–125; Warren S. Brown, "Evolution, Cognitive Neuroscience, and the Soul," in *Perspectives on an Evolving Creation* ed. Keith B. Miller (Grand Rapids, MI: Wm. B. Eerdmans, 2003), 502–23; Warren S. Brown, "Neurobiological Embodiment of Spirituality and Soul, " in *From Cells to Souls – and Beyond: Changing Portraits of Human Nature* ed. M. Jeeves (Grand Rapids, MI: W. B. Eerdmans, 2004), 58–76.

[2]Stephen J. Gould, *Wonderful Life: The Burgess Shale and the Nature of History* (New York: W. W. Norton, 1989), 44.

[3]Margaret T. Hodgen, *Early Anthropology in the Sixteenth and Seventeenth Centuries* (Philadelphia, PA: University of Pennsylvania Press, 1964); David N. Livingstone, *Adam's Ancestors: Race, Religion and the Politics of Human Origins* (Baltimore, MD: Johns Hopkins University Press, 2008).

[4]T. Burnet, *The Sacred Theory of the Earth: Containing an Account of the Origin of the Earth, and of All the General Changes Which It Hath Already Undergone, or Is to Undergo, till the Consummation of All Things* (London: R. Norton for Walter Kettilby, 1684–1690), 272.

[5]Livingstone, *Adam's Ancestors*.

[6]John C. Greene, *The Death of Adam* (Ames, IA: Iowa State University Press, 1959); Raymond Corbey, *The Metaphysics of Apes: Negotiating the Animal-Human Boundary* (Cambridge: Cambridge University Press, 2005); see also Thomas Henry Huxley, *Man's Place in Nature* (1863; reprint, Ann Arbor, MI: University of Michigan Press, 1959). During the 1980s as a member in an adult Sunday School class, I observed a guest lecturer firmly explain that "humans are *not* mammals."

[7]Carolus Linnaeus, *Systema Naturae, sive Regna Tria Naturae, Systematice Proposita per Classes, Ordines, Genera, et Species* (Leyden and London: Theodore Haak, 1735).

[8]Linneaus, *Systema Naturae*, 12th ed. (Stockholm, 1766). I owe the source of this quote to Greene, *The Death of Adam*.

[9]Cf. Huxley, *Man's Place in Nature*; Ernst Haeckel, *Naturliche Schopfungsgeschichte* (Berlin: Reimer, 1868), translated as *The History of Creation* (London: Kegan Paul, Trench, and Co., 1868); Charles Darwin, *The Descent of Man and Selection in Relation to Sex,* 2d rev. ed. (London: Murray, 1874); Donald K. Grayson, *The Establishment of Human Antiquity* (New York: Academic Press, 1983); Corbey, *The Metaphysics of Apes*; Livingstone, *Adam's Ancestors*.

[10]Cf. Rita Carter, *Mapping the Mind* (Berkeley, CA: University of California Press); Antonio Damasio, *The Feeling of What Happens* (New York: Harcourt Brace and Company, 1999); Carl Zimmer, *Soul Made Flesh: The Discovery of the Brain and How It Changed the World* (New York: Free Press, 2004); Edward E. Smith and Stephen M. Kosslyn, *Cognitive Psychology: Mind and Brain* (Upper Saddle River, NJ: Pearson Prentice Hall, 2007).

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[12]For excellent statements of contrasting views on the nature of the soul, I refer the reader to John Cooper, *Body, Soul, and Life Everlasting: Biblical Anthropology and the Monism-Dualism Debate* (Grand Rapids, MI: Eerdmans, 1989); Joel Green, "What Does It Mean to Be Human?" in *From Cells to Souls – and Beyond,* ed. Jeeves, 179–98; and Joel Green, *Body, Soul, and Human Life* (Grand Rapids, MI: Baker Academic, 2008), and the several position papers in Joel Green and Stuart L. Palmer, eds., *In Search of the Soul: Four Views of the Mind-Body Problem* (Downers Grove, IL: InterVarsity Press, 2005).

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Article


Edward B. Davis

Prophet of Science—Part Two: Arthur Holly Compton on Science, Freedom, Religion, and Morality

Edward B. Davis

The second part of this article discusses Arthur Holly Compton's religious activities and beliefs, especially his concept of God. Compton gave a prominent role to natural theology, stressing the need to postulate "an intelligence working through nature" and using this to ground religious faith. At the same time, this founder of quantum mechanics used Werner Heisenberg's uncertainty principle against the widespread view that humans are trapped in a mechanistic universe that permits no freedom of action.

> Whence then comes our world? Though science does not offer a positive answer to this question, it can point out that an intelligible world in which intelligent creatures appear seems reasonably to imply an intelligence working in the world, a basis on which most scientific men build their approach to religion. This implies that if our God is the God of Nature, we must recognize the laws of nature as describing the way in which God works, and a basis for a theology is found. We find that through the long, hard struggle of evolution men have come to the stage where they are partly responsible for the development of life, even their own life, on the earth. Thus science can lead to the conception of man as a co-worker with God toward making this world what he wants it to be.
>
> –A. H. Compton, 1938[1]

Arthur Compton's emergence as a public intellectual after winning the Nobel Prize followed directly from a visit to India he had made the previous year. His sister Mary and her husband, C. Herbert Rice, had been educational missionaries together in India since their October 1913 wedding. Rice was heavily involved with Forman Christian College in Lahore (now part of Pakistan), teaching psychology and serving as principal for several years. Supported by a Guggenheim Fellowship, Arthur spent the academic year of 1926–1927 in Lahore, at the University of the Punjab, where Rice would later become president after the partitioning of India and Pakistan.

Upon his arrival in Calcutta, Arthur learned that he was expected immediately to lead a cosmic ray expedition to Darjeeling in the foothills of the Himalayas—and that he was supposed to supply the experimental apparatus. Seeking out physicist C. V. Raman, who would win the Nobel Prize in 1930, he got the help he needed to rig an electroscope out of the bowl of a hookah—and it worked. Conversations with the

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scientists who accompanied him into the mountains, some of whom later held positions of responsibility in India and Pakistan, was something of an epiphany for Compton. "Years later," he recalled in his brief autobiography, "I told my friends that it was the beginning of my education." Seeing a foreign culture close up forced him to examine his own, and "the new values that I found unsuspectedly hidden in Oriental culture were balanced by a new depth of insight into the values of life in my own country." The "active interest in philosophy, especially ontology, as taught by my father," which "had lain dormant" since his student days, was awakening, spurred on by his "broadening culture interests" and by recent "developments of quantum theory that seemed to have interesting philosophical implications." He became particularly interested in determining "whether physical laws are sufficient to account for the actions of living organisms," and he began to consider "the relation of science to religion, a problem with which my father had wrestled, and which we had frequently discussed in my college days."[2]

Compton's View of God, Nature, and Humanity

Arthur Compton had always been a religious man, and some of his personal habits connected him with many conservative Protestants even if his increasingly liberal theological beliefs did not. He abstained from hard liquor and rarely smoked. Author Sherwood Eddy quoted an unnamed friend saying that "his home is a praying home. Above all his life is joyously, radiantly religious, minute by minute."[3] As a boy and during his undergraduate days at Wooster, he and his family attended Westminster Presbyterian Church, which was founded as the university church in 1874. While a graduate student, he taught Sunday School at the First Presbyterian Church (now Nassau Presbyterian Church) in Princeton, where his students included the two sons of the distinguished physicist Augustus Trowbridge, both of whom became Episcopalian priests.[4]

For the next four years, when he lived briefly in Minnesota, Pennsylvania, and England, his church activities are not known, but while at Washington University from 1920 to 1923, the Comptons joined Grace Methodist Episcopal Church (now Grace United Methodist Church), located not far from the university on the west side of St. Louis, where they sang in the choir. In December 1925, after Compton succeeded Robert Millikan in Chicago, they joined the Hyde Park Baptist Church (now Hyde Park Union Church), just down the block from their ample brick home at 5637 South Woodlawn Avenue in the leafy neighborhood bordering the university. He taught Sunday school for four years and served as deacon for three years. When the Comptons returned to St. Louis after the War, they joined the Second Presbyterian Church in March 1947. Arthur was an elder there from 1948 until his death in 1962; Betty became an elder at some point after the denomination in 1964 permitted women to hold that office. And each summer starting in 1935, the Comptons attended the First Congregational Church (now First Congregational United Church of Christ) of Gaylord, Michigan, close to the family cottage on Otsego Lake. They were drawn there, according to their son John J. Compton, by "a remarkable, Oberlin-educated pastor, Rev. [L. Mervin] Isaacs," who "inspired my grandparents and parents with his thinking and prophetic social gospel messages …"[5]

For understanding Compton's adult religious views, the Chicago congregation is by far the most important of these associations. It was a church of almost singular significance for its geographical and theological location at the center of the self-styled "modernist" movement in American Protestantism, some of whose leading representatives were connected with the University of Chicago and its widely influential Divinity School. The university's first president, Hebrew scholar William Rainey Harper, had been a member of Hyde Park Baptist for many years until his death in 1906, and his scholarly example helped to shape the church's identity. Harper's close friend Shailer Mathews, dean of the Divinity School for a quarter century, was probably the most prominent member when the Comptons arrived in Chicago; their colleague, the radical modernist theologian Gerald Birney Smith, was also an active member.[6] So was philosopher and intellectual historian Edwin Arthur Burtt, a secular humanist (he signed the "Humanist Manifesto" of 1933) whose book, *Religion in an Age of Science* (1930), contains a sharp critique of liberal Protestant efforts to accommodate modern scientific attitudes and conclusions that must be read partly as a highly unsympathetic commentary on his fellow members' ideas. Considering the historical "conflict" of religion and science, he wrote,

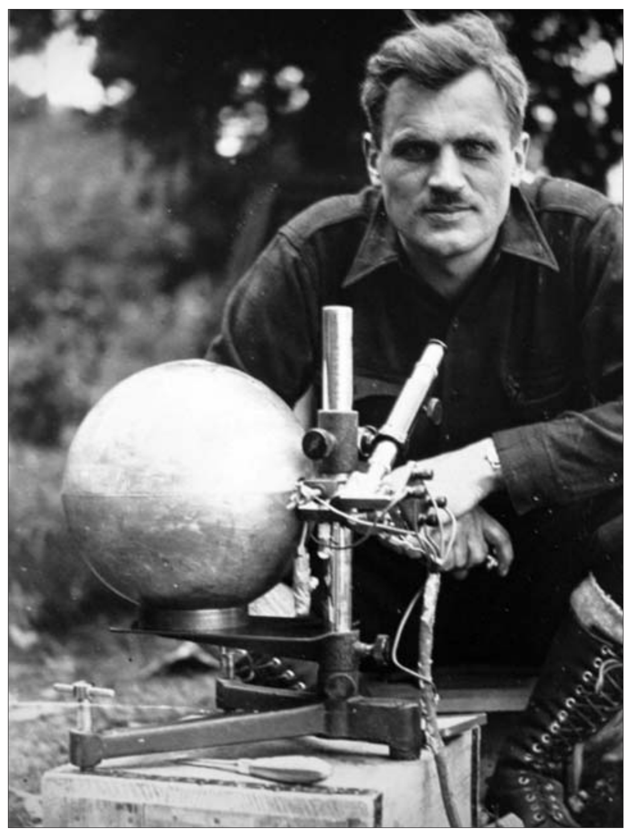
> "How much can I still believe?" is the question pathetically asked … Beginning with two score or more doctrinal articles there ensues a process of elimination and attenuation till today, in liberal circles, the minimum creed seems to have been reduced to three tenets: belief in God, confidence in immortality, and conviction of spiritual uniqueness in Jesus of Nazareth … Thus the pathetic game of give what must, hold what can, continues.[7]

At least a few members of Hyde Park Baptist Church probably doubted even these three tenets, but Compton did not. In short, the church was not only a hotbed of religious liberalism, but also a gathering place for leading intellectuals who did not necessarily share even a basic commitment to theism. Thus, Compton's views were developed and expressed within a friendly but theologically contentious environment that reflected the vigorous intellectual climate of a major university, with which probably a large majority of the membership were closely connected.[8]

When the Comptons joined Hyde Park Baptist in 1925, the pastor was Charles Whitney Gilkey (whose son, the late Langdon Gilkey, would become a leading theologian), an inclusive religious thinker who was already, at forty-three years of age, regarded by his peers as one of the twenty-five most influential Protestant ministers in the nation.[9] The following year he was named professor of preaching at the Divinity School, and his diverse congregation decided "to receive all serious Christians into membership without regard for mode of baptism or other tests of belief."[10] The Comptons and the Gilkeys soon became good friends, and when Gilkey stepped down from his pulpit three years later to assume similar duties as dean of the magnificent new chapel on campus (later named in memory of the donor, John David Rockefeller), Compton provided highly visible, ongoing support. As chair of a student-faculty committee that gave oversight to the chapel, he read the dedicatory service in October 1928; short addresses were given by John D. Rockefeller, Jr. and Haverford College historian Rufus Matthew Jones, an influential Quaker mystic who served as visiting university preacher at the time.[11]

In 1930, responding to student requests, Compton organized an Easter symposium on "Immortality," at which he and Mathews both spoke—a crucial event in his intellectual life that will be discussed in part three (in the next issue of this journal). We must not overlook the importance of this type of public witness in his own eyes. According to his son, "my father strongly felt the need to show students and his often suspicious colleagues that a man of science could also be a man of religious faith. So he arranged programs on the campus, wrote and lectured widely on science and religion," and helped plan the chapel programs.[12]

The decidedly ecumenical stance of Hyde Park Baptist epitomized the modernist religious attitude: what mattered most was Christian social action and moral conduct, not adherence to any specific set of doctrinal beliefs or even conversion experiences. The modernists also stressed divine immanence—the idea of God as dwelling and working "within" nature and the human heart, not "outside" of nature as the transcendent God of Christian tradition was believed to do. In their view, Jesus was not literally the second person of God become incarnate; rather, he was the supreme moral example who had trusted



Arthur on an expedition to study cosmic rays, ca. 1932–33, possibly on Mt. Evans in Colorado. The counting apparatus was designed to be carried on the back of a mule.
Courtesy of John J. Compton.

and obeyed his heavenly Father and loved his fellow human beings self-sacrificially. The immanent God was thus immanent in Jesus, and by following his example, God could also be immanent in us. Where classical Christian theology understood God in terms of *both* immanence *and* transcendence, the modernists of the 1920s typically stressed divine immanence much more than divine transcendence, often ignoring the question of transcendence and, in a few cases, perhaps even doing away with it entirely as an objective category.[13]

A number of leading American scientists of that decade were committed modernists, such as Caltech physicist Robert Millikan (whose Neighborhood Church in Pasadena was a near duplicate of Hyde Park Baptist), Harvard geologist Kirtley Mather, Chicago botanist John Merle Coulter, and Carnegie Institution eugenicist Charles Davenport. Compton fits into this group fairly well, although he had a more robust understanding of divine transcendence than Millikan or Shailer Mathews; certainly he was no longer an orthodox Christian.[14] According to his son, Arthur Compton's religious beliefs

> quite naturally evolved away from Elias' Christian orthodoxy and philosophical idealism, but kept their moral and ethical core. He knew the Bible thoroughly and quoted it often, but there was little of his parents' piety and I never heard any testimony of special religious experiences. There was nothing about sin and salvation or about having Jesus in your heart! He had little sympathy with theological doctrines, sacraments, or creeds. I was sitting next to him in the Second Presbyterian Church in St. Louis one Sunday morning when I noticed that he had fallen silent while everyone around us was reciting the Apostle's creed. So I asked him why. His answer was simply that "It's because I don't believe everything in it and I don't want people to think I do."[15]

With characteristic candor, Arthur Compton had answered his son's question directly. What then did he believe, if not this classic confession of Christian beliefs?

The main elements of Compton's religious beliefs are set down in his book, *Atomic Quest* (1956), which, though written near the end of his life, summarizes what he had probably believed for at least thirty years and perhaps longer. I begin with his understanding of God. "To me God appears in three aspects," he wrote, yet he did not mean the traditional doctrine of the Trinity even though his thoughts included the Father, Son, and Spirit. First, and "universally recognized," God "is simply the best one knows, to which he devotes his life," including love for others, truth for living, and "harmony of adjustment that brings beauty and graciousness and smooth cooperation in every aspect of human affairs." The Christian "finds his own soul" through commitment to this cause, which is "greater than himself." The "pre-eminent importance of what happens to persons," Compton observed, is the "central point" of agreement among world religions. With "its insistence on the inherent value of individual men and women," he emphasized, "Christianity has the key to survival and the good life in the modern world." Overall, he confessed that "making it possible for men and women to grow to their fullest worth as persons can be my highest form of worship."[16]

A second aspect was God's "conscious Power," possessing "a special concern for its conscious creatures who share the responsibility for shaping their part of the world." This goes beyond just "the forces of nature that science recognizes," to an awareness of other persons as being like ourselves. "More particularly," Compton said, "I follow Jesus' teaching that this Power that is the basis of existence holds toward me and all other persons the attitude of a wise and loving father." Thus, for Compton, we humans are co-creators with God, and "the opportunity to share with God the shaping of the conditions of life is a tremendous challenge and the great responsibility that comes with freedom." Our greatest task, therefore, "is to make it possible for others who are equally God's children to do their responsible share," and, in this way, we become "more worthy of God's companionship."[17]

"The third aspect of God that I recognize," Compton continued, "is that which shows itself in the lives of noble men," those "whose love of their fellows, whose unselfish devotion, and whose integrity of spirit have meant much to their community and have enriched their own lives." Such persons were for him "the embodiment of God" and were greatly to be emulated. The supreme example was Jesus. His life and teaching "form the most reliable guide that I have found for shaping my own actions." It is in following him "that I call myself a Christian." Jesus exemplified for Compton, in his own version of 1 Cor. 13:13, "love of neighbor as expressed in helpful service, hope for the future that inspires his followers, faith in God and fellowmen." "Based upon the records," Compton concluded, "I have so idealized Jesus that he has become for me the Son of God to a unique degree." Furthermore, Jesus' spirit "is an aspect of God, now alive in men and women," and it shapes the world through us. "This is what I mean when I say that Jesus is God," and, therefore, also "an aspect of the God I worship."[18]

Former Harvard President James Bryant Conant, a chemist who had worked closely with Compton on the Manhattan Project and knew him very well, understood this chapter as "a clear statement of the doctrine of Unitarianism (though you may not admit it)."[19] Conant had hit the mark. Though happily a lifelong Presbyterian, Compton understood Jesus as a unique human being, but not divine, essentially the Unitarian view. It is not insignificant that his pastor at Gaylord, Michigan, a very liberal Congregationalist trained at Oberlin, once closed a sermon by quoting this very part of Compton's book.[20]

Science fit into this picture in at least two ways. First, Compton quite literally saw divine providence at work in atomic energy. Given that supplies of fossil fuels are dwindling, "atomic energy is coming just in time to meet a fundamental human need." "Is it surprising," he asked more than rhetorically, "if we should see here working the hand of Providence?" We needed fossil fuels to reach our

The Compton family—all four siblings, their spouses, and their parents—at their summer home on Otsego Lake, near Gaylord, Michigan, ca. 1937.
Courtesy of Special Collections, The College of Wooster Libraries.

present level of scientific and technical accomplishment, and if they had been much less abundant, they would have run out before we were ready to use uranium. Likewise, "the fortunate fact" of half a century's experience with radium and x-rays "introduced us to the dangers as well as the possibilities of atomic radiation," without which we might face a "human tragedy" with nuclear energy. There was also a moral benefit, since "this gift of new power is forcing man toward a higher level of human development." We must "learn humanity" as "the condition for survival in the atomic age."[21] Specialists must cooperate more fully, educational opportunities must be enhanced, and "we must find objectives on which we agree." Compton's own objectives were unapologetically democratic—and for the most part, they probably fell on sympathetic ears during the Cold War. "In the development of the inherent value of every person," he concluded, "we thus find the fundamental and inspiring goal upon which we may hope that free men will agree." Love for others was the key to reaching this goal, bridging science and religion: "Life takes on meaning in a technological society if our hearts are in the human growth of those for whom we work." In other words, quoting his father, "Providence works through people, and we must do what we can to give Providence a chance."[22]

Compton also believed that science strongly supported the existence of an intelligence behind nature, a theme he was discussing in public talks by the late 1920s, including an address to the General Assembly of the Presbyterian Church in 1929.[23] At times, he made arguments that might fairly be seen to involve an early form of the anthropic principle, arguments that resemble some of those associated with the modern "intelligent design" movement—although he saw design as a philosophical and theological inference *from* science, not as an explanation *within* science to be employed when other explanations failed. He used the very term "intelligent design" in a lecture he gave in 1940 at the Church of our Father, Unitarian (now Unitarian Universalist Church) in Lancaster, Pennsylvania. "The chance of a world such as ours occurring without intelligent design," he said, "becomes more and more remote as we learn of its wonders." In one of the strongest endorsements of natural theology that any modern scientist has ever uttered, he added that "the study of natural science is the primary source of the raw material for building our idea of God." His talk inaugurated an annual series about immortality and modern concepts of God, established by the will of the retail merchant Milton T. Garvin, a founder of the Lancaster church.[24]

The two printed editions of Compton's lecture have some nicely worded passages—he was an articulate speaker. However, I will summarize instead the longer, more scholarly version of the same material, in chapters three and four of a book he dedicated to his father, *The Freedom of Man* (1935), an expanded version of the three Terry Lectures he delivered at Yale University in November 1931.[25] The ideas about God, nature, and humanity expressed there were crucially important to Compton. He repeated them (often verbatim) in several other lectures and publications over the next fifteen years, including (among others) his Garvin Lecture and an address he gave to the Jewish Theological Seminary of America in New York in November 1938—not to mention the prestigious John Calvin McNair Lectures at the University of North Carolina in November 1939, which were published the following year as *The Human Meaning of Science*.[26]

Preparing for the Terry Lectures only reinforced Compton's youthful confidence in a divine intelligence. As he told an interviewer four months later, "The study of physics has changed my conception of the kind of god, but has strengthened my confidence in the reality of God. I feel surer of a directive intelligence than I did at 20." Hydrogen atoms, carbon molecules, and living cells were "all built up out of simple units: electrons and protons. It seems to the n^{th} degree improbable that such an intricate and interesting world could have ordered itself out of particles with random character." The world revealed by modern physics "can only be the result of an intelligence working through nature."[27] Elaborating on this in *The Freedom of Man*, Compton began by observing that, while some scientists still felt "the need for a Creator to start the universe," the design argument "has never been adequately refuted," and "few indeed are the scientific men of today who will defend an atheistic attitude." Faith in God could even be "a thoroughly scientific attitude," if "based on the experience that the hypothesis of God gives a more reasonable interpretation of the world than any other," and if it enhances the life of the religious believer. Openness to new evidence would probably lead to some changes in one's conception of God, Compton commented, "but a man is a scientific or religious coward if he is unwilling to brave the storm in the hope of reaching the firmer ground on the other side."[28]

He went on to show how specific problems in physics, astronomy, and biology all illustrated the presence of intelligence in the universe. First, he considered the characteristics that protons, neutrons, and electrons needed to have "in order that they may be capable of massing themselves together to form a complex and interesting world such as ours." Employing various models in which the properties of these fundamental particles were allowed to vary, physicists had tried unsuccessfully to produce a hypothetical world capable of developing into one of comparable complexity. Compton wondered, could the formation of our world be just an accident? "If so," he suggested a bit sarcastically, then "chance can choose much more wisely than the best scientific minds of today."[29]

Turning to astronomy, Compton pointed out that scientific opinion on the age of the universe was "sharply divided," but that "the prevailing view at the moment seems to be that the universe as we know it had a beginning at a more or less definite time," anywhere from a few billion to a few quadrillion years ago.[30] This reflects early versions of what would later become known as the big bang theory. As for the ultimate fate of the universe, some astronomers agreed with the great Cambridge astrophysicist Arthur Eddington that the second law of thermodynamics ruled out a cyclical universe; others, such as Chicago astronomer William MacMillan, Caltech physicist Richard C. Tolman, and Yale philosopher F. S. C. Northrop, defended an eternally cyclical cosmos.[31] But "many of the defenders of both views," Compton noted, especially Eddington and Northrop, "have found it difficult to understand the world as other than the expression of the activity of a high Intelligence."[32]

Finally, echoing views he had held since college, Compton claimed that many biologists and paleontologists saw evolution not as a purely random Darwinian process, but rather as a directional process taking a direct course. On this particular point, his views were rapidly becoming passé—it was during the 1930s that the neo-Darwinian synthesis came together—but as he saw it, all three sciences supported the inference that there is an underlying intelligent power.

What sort of power could this be—friendly, or indifferent, to humanity? Where Einstein and others spoke of an impersonal creator, equivalent to rational order in the universe, Compton wanted his God to take special interest in human beings. We are quite special, he believed, and inhabited planets, like the earth, are of great rarity, even in an enormous and enormously old universe. Compton had recently taken such a position in the pages of *Science*, only to be challenged by Cincinnati astronomer Jermain G. Porter. Compton had replied by citing Eddington and James Jeans for support.[33] He repeated this claim in the Terry Lectures:

> There is reason to believe that we may occupy at present the highest position in the universe with respect to intelligent life. Does it seem then too bold to assume that the intelligent Creator, whose existence as we have seen is by far the most reasonable basis for accounting for our world, should take an active interest in the welfare of the uniquely intelligent beings he has created on our earth?[34]

Granted, the world "is a vast machine," characterized by "immutable" natural laws, and "the world plays [no] favorites by showing partiality toward man." Through evolution, however, we have acquired the ability to learn those laws and live accordingly—indeed, this is "the great contribution of science to humanity." Admittedly there has been "tragic, apparently ruthless, suffering" at each point in our evolutionary history, but Compton could not imagine a more effective way of "achieving adaptation to environment … than the one we see now working in nature." What is more, he saw this as a process of almost unlimited potential, in terms of human mental development. We are "clearly in the early stages of evolution. It would be a gross understatement," he added without blinking an eye, "to claim that with regard to such attributes as clarity of reason, appreciation of beauty, or consideration of our fellows, our remote descendants may be expected to excel us as greatly as we are in advance of the Java ape-man."[35]

There was nothing particularly unusual about Compton's evolutionary optimism. Scores of liberal Protestant scientists and clergy from that period believed that evolution would, with our active involvement, bring about moral improvement in one way or another. For more than a few, eugenics was part of that process, but I have found no evidence that Compton supported eugenics.[36] He did not hesitate, however, to find biblical support for his confidence in evolutionary progress, quoting what he erroneously referred to as "two Old Testament statements," when, in fact, both come from Paul's letter to the Romans. In his opinion, the friendliness of natural laws "to the well-adapted organism" finds an "exact parallel" in Romans 8:28 ("All things work together for good for him who serves the Lord"), while the opposite principle is well captured by Romans 6:23 ("The wages of sin is death"). With exegesis such as this, it is not hard to understand why Protestant fundamentalists found their liberal co-religionists so hard to tolerate.[37]

Compton's picture of our moral history and prospect was directly influenced by his colleague at Chicago, the famous Egyptologist James Henry Breasted, author of *The Dawn of Conscience* (1933), a work that also influenced Millikan. Breasted dated what he called the "Age of Character" to between four and five thousand years ago, and he believed that we still find ourselves only at the dawn of that era, with a bright noon yet to come in the distant future.[38] Up to that point, Compton asserted, "God held in his own hands the whole responsibility for evolution of life upon this planet. Gradually this responsibility is being shifted to our shoulders," leaving us with the challenge "of working with the God of the Universe in carrying through the final stages of making this a suitable world and ourselves a suitable race for what is perhaps the supreme position of intelligent life in His world!" This led Compton to conclude as follows:

> Science can thus have no quarrel with a religion which postulates a God to whom men are as His children. It is possible to see the whole great drama of evolution as moving toward the goal of the making of persons, with free, intelligent wills, capable of learning nature's laws, of seeing dimly God's purpose in nature, and of working with him to make that purpose effective.[39]

Such a broad vision is not without its difficulties, as Compton realized. Most of all, he was worried about theodicy, "God's undoubted responsibility for permitting evil to be present in the world, if our view is correct that the laws of nature represent His mode of action."[40] Here he was particularly impressed by the ideas of the English mathematical physicist Ernest William Barnes, author of *Scientific Theory and Religion* (1933). During his tenure as a Cambridge don, Barnes had been ordained an Anglican minister, and six years after being elected to the Royal Society, he left Cambridge for an equally distinguished career in the church, culminating in his appointment as Bishop of Birmingham in 1924.[41] Compton probably encountered Barnes' ideas during the academic year 1934–35, when he was George Eastman Visiting Professor at Oxford—he cited the 1934 edition of Barnes' book, he completed *The Freedom of Man* in May 1935, and he added passages borrowed from Barnes to the typescript on separate handwritten pages, after the text was all but finished.[42]

Barnes argued that we could not discern the reason why God used the struggle of evolution to produce our higher moral and intellectual faculties, but that is what God had done, and we are the unexpected result. As Compton put it, "such evils must be present in order that man's moral character shall develop." At this point, he simply waved his hands, gesturing at his final chapter (which will be discussed in part three in the next issue of this journal), in which he endorsed Barnes' conclusion that immortality would ultimately justify the goodness of God. What about God's mercy, given the suffering of all creatures inherent in evolution? Compton offered only a "very real" mercy that was limited to "the psychological rather than the physical realm." We know that we have done our best; God and our fellow humans also know this. This suffices to "protect us from the too keen cutting edge of conscience. Here it is that a sane well-balanced religion offers the solace for which men yearn."[43]

Prophet of Science: Human Freedom and Scientific Indeterminism

The Freedom of Man is manifestly about freedom, and, at that time, freedom was widely perceived to be under attack from science, especially from psychology and experimental biology. Jacques Loeb, a leading physiologist, epitomized this threat in *The Mechanistic Conception of Life* (1912). In his view, the ultimate goal of biology was to explain all aspects of life in terms of physics and chemistry.

We may wish to believe that we can act freely, Loeb argued, but in reality, even our higher feelings and ideals are nothing more than tropisms, involuntary responses to external stimuli. "Not only is the mechanistic conception of life compatible with ethics," he wrote, "it seems the only conception of life which can lead to an understanding of the source of ethics."[44] Loeb died in 1924, the same year in which attorney Clarence Darrow invoked psychological determinism to defend another Loeb, not related to the first. Richard Loeb and Nathan Leopold were gifted and privileged young college graduates who had kidnapped and viciously murdered a fourteen-year-old boy, simply for the thrill of trying to commit the perfect crime. The Leopold-Loeb trial was sensational, and the strategy Darrow employed was not only successful—he persuaded the judge not to impose death sentences—but it was also consistent with his personal beliefs.[45]

The following year, shortly before Darrow went to Tennessee to defend John Scopes in an equally famous trial, paleontologist Henry Fairfield Osborn blamed psychology for the irreligious image of science. Writing in *The Forum*, a prominent national magazine, he claimed that "psychologists have lost touch with the soul," an impression he confirmed through his friend James McKeen Cattell, the former Columbia psychologist who edited the journal *Science*. Osborn quoted Cattell as saying,

> I can talk more intelligently about any other subject than the soul. It is well known that psychology lost its soul long ago and is said now to be losing its mind. You should inquire of Descartes and the Catholic Church; it is a good subject for a paleontologist like yourself!"[46]

Compton had long rejected reductionist approaches to psychology. As a deeply religious man with a moral vision for science, the very possibility of religion and morality as he understood it depended crucially on the reality of human freedom: without freedom, we cannot choose to do what Jesus did. Even apart from religious considerations, he believed that freedom was the root of our meaning and worth as human beings.[47] But how could we be free, if scientific study since the time of Galileo and Newton has so completely established that nature is deterministic? This is how he saw the conundrum of religion in a scientific age, and he solved it to his satisfaction by challenging determinism itself. Compton knew quantum physics as well as anyone in the world—his own work on the particulate aspect of x-rays had been a key component of wave-particle duality, which in turn was central to the new physics—and he saw in the work of Werner Heisenberg a fissure in the deterministic wall of classical physics.

I do not know when Compton first met Heisenberg; it might have been at the International Conference on Physics at Lake Como in September 1927, which both men attended; they also attended the Fifth Solvay International Conference on Electrons and Photons in Brussels the following month. In any case, Compton invited him to give a series of lectures on quantum mechanics (in German) at the University of Chicago, and he came for several months in the spring and summer of 1929. At the same time, Paul Dirac was visiting the University of Wisconsin; the previous year, he had turned down Compton's offer to appoint him to a new chair at Chicago and also an invitation to visit Chicago. Dirac and Heisenberg probably met several times during this period, including at least once in Chicago, and they decided to sail together from San Francisco to Japan, where they had both been invited to speak.[48] (Heisenberg came back to Chicago in 1939 for a conference on cosmic rays. On that occasion he stayed with the Comptons and played classical music on the piano in their living room. Arthur urged Heisenberg to remain in America, but the German sensed war coming and felt that his nation would need him.[49])

Heisenberg's lectures were a model of clarity, notwithstanding the liberal use of advanced mathematics for which he was well known. What stuck out in Compton's mind, however, was not the elegant mathematics but a short prose section on Niels Bohr's concept of complementarity. As Heisenberg explained,

> the resolution of the paradoxes of atomic physics can be accomplished only by further renunciation of old and cherished ideas. Most important of these is the idea that natural phenomena obey exact laws—the principle of causality.[50]

Having shown the door to classical physics, Heisenberg advised those physicists still in the room "to review the fundamental discussions, so important for epistemology, of the difficulty of separating the subjective and objective aspects of the world."[51]

Compton quoted the first of these two passages in a talk about causality and science that he gave to the Physics Club of Chicago in early November 1930; his numerous subsequent lectures and writings on this general topic show that he took the second passage no less seriously.[52]

Looking more closely at this talk—delivered just as Compton was re-examining, at the height of his career, an issue that had interested him so much as a student—I am struck by his heavy reliance on *A History of Science and Its Relations with Philosophy and Religion* (1929), by William Cecil Dampier. Compton once told a theological educator that this book was "of great value" for its "appreciation of the relationships between science and philosophy and religion."[53] Like many other historians of science from that period, Dampier wrote about religion and science from the now-discredited "warfare" perspective, which consequently colors Compton's approach.

Following Dampier, Compton presented Socrates as an enemy of scientific thought, owing to his skepticism and his opposition to the mechanistic thinking of the ancient atomists, which "left no room for that freedom of choice which is the basis of morality …" When Socrates placed mind over

Physicists gather in front of the Ryerson Physical Laboratory in Chicago in 1929, probably in April or May in connection with Heisenberg's lectures.

Left to right (front row): Werner Heisenberg, Paul Dirac, Henry G. Gale, and Friedrich Hermann Hund; (back row): Compton, George S. Monk, Carl Eckart, Robert S. Mulliken, and Frank C. Hoyt. Eckart had earned the B.S. and M.S. degrees in engineering from Washington University in St. Louis, while Compton was chairing the physics department there. Eckart and Hoyt translated Heisenberg's Chicago lectures into English, with a foreword by Compton, as *The Physical Principles of the Quantum Theory* (1930). Mulliken had worked with all three European physicists, especially Hund, with whom he developed the Hund-Mulliken theory of molecular orbitals. At the time this photograph was taken, Compton was the only Nobel laureate in the group, but Heisenberg (1932) and Dirac (1933) would soon join him in winning the physics prize, and Mulliken was awarded the Nobel Prize for chemistry in 1966. Max-Planck-Institute, courtesy AIP Emilio Segre Visual Archives. (Gift of Max-Planck-Institute via David C. Cassidy.)

matter, he put morality against science. Plato's idealism did likewise; his followers only denigrated science and abandoned the idea of natural law, especially when they imbibed "Chaldean magic, miracles, and astrology," leading to "a superrational idealism known as Neoplatonism." In this analysis, ancient science failed because "its apparent denial of the effectiveness of purpose showed its uselessness. Science had failed to illuminate man's path of life."[54]

The rise of Newtonian science two thousand years later, according to Compton, forced us to accept a clockwork universe "over whose operation we have not the slightest control," raising once again the question of morality and freedom. This time, however, "it was no longer possible to laugh science out of court. Men had too much common sense to abandon again the great truths that science had given." The scientist was content to leave freedom to the philosopher, Compton commented, ignoring "the logical inconsistency of his position. He must have faith that his world is one of law," but "if his own actions are 'with a cause and by necessity' he cannot in truth 'make a search' at all."[55] In other words, freedom is indispensable to the actual practice of science—an important insight that Compton would keep repeating for the rest of his life.

The dilemma evaporated, however, with the coming of Heisenberg. Perhaps causality still holds for some unobserved properties of atomic particles, but for experimental purposes this does not matter: "it is as a *physical* principle that the law of causality must be abandoned," Compton proclaimed with evident glee. Einstein might not like it, but "the younger generation of physicists considers this principle an inescapable consequence of existing data …" To this the thirty-eight-year-old Compton added, "I myself should consider it more likely that the principle of the conservation of energy or the second law of thermodynamics would be found faulty than that we should return to a system of strict causality."[56]

At this point, extending physical uncertainty into biology, Compton appealed to a prescient article by the distinguished physiologist Ralph Stayner Lillie, his colleague at Chicago. Lillie's paper had appeared in *Science* just a few months after the publication of Heisenberg's derivation of the uncertainty relation for position and momentum—which Lillie did not cite, although he did cite a recent paper on quantum theory by German physicist Pascual Jordan. In a wide-ranging, philosophically oriented discussion of nervous activity, Brownian motion, genetics, and other "ultramicroscopic" phenomena in organisms, Lillie suggested that quantum indeterminism "would conceivably explain the indeterminism or inner freedom seen in voluntary action …"[57] For his part, Compton noted that indeterminacy at the quantum level would lead to unpredictable initial conditions for macroscopic events within organisms, as a nerve pulse at the molecular level is amplified many times. "Considering the complexity of the small-scale events associated with any of our deliberate acts," he wrote, "one may say with assurance that on a purely physical basis the end result must have a relatively great uncertainty." Compton did not believe that he had thereby solved "the old question of *how* mind acts on matter," but he did maintain that the new physics allows for it, "and suggests where the action may take effect."[58] What he really sought, we might say, was freedom to believe in freedom, not scientific proof of it—an attitude that he later clarified for his critics in *The Human Meaning of Science*.[59]

In the twelve months between his talk for the Physics Club of Chicago and his Terry Lectures at Yale, Compton's views on this topic became increasingly visible. In March 1931, he shared his ideas with what a reporter described as "a large audience" in New York. In August, in five short paragraphs on a single page in *Science*, he cited Lillie's paper against the determinist views of the noted physicist Charles Galton Darwin, grandson of the great naturalist. The following month, the *Yale Review* published a revised version of the talk he had given in Chicago the previous November, and a few months later Compton reiterated his thoughts in the third and final Terry Lecture.[60]

The version published four years later as the first two chapters of *The Freedom of Man* has the same overall argument as the others, but develops some points more fully. Most physicists just ignore the implications of classical physics, he noted, adding that "probably most of us have had an ill-defined idea that in our own actions some influences are effective which are not describable by physical laws." If nothing in our lives goes beyond electrodynamics, then "we are in truth merely complicated machines; whereas if other factors are significant, our laws of physics are incomplete descriptions of the world in that they do not describe our own actions." It has to be one or the other, and it is obviously important for the physicist to "know the realm within which his laws are applicable, and how far they are adequate to give a complete description of the world." To understand the actions of a living creature, he argued, psychological factors such as motives had to be taken into account; knowledge of the physical circumstances alone does not suffice to predict what a creature will do. Given the indeterminism inherent in quantum theory, however, "it is no longer justifiable to use physical law as evidence against human freedom."[61] What is more, although differences in states of consciousness are "not detectable by any known type of physical test," they must nevertheless exist. Natural selection has in higher animals "brought consciousness to an ever higher level of development," something that should not happen "if consciousness were of no value to the life of the animal," or if "the animal were incapable of affecting its course of action."[62]

A founder of quantum theory, Compton was convinced that the new physics was closely related to this, since quantum uncertainties affecting microscopic events "may result in an equal uncertainty in an event of great magnitude." For example, let a faint ray of light pass through a very narrow slit, and put a pair of amplifiers in the path of the diffracted beam coming out of the slit (fig. 1). Attach one amplifier to an explosive charge that would destroy the apparatus, and attach the other to a switch that turns off the apparatus. If a single photon comes through the slit, then the apparatus will either explode or turn itself off. Both events are equally probable, but the precise outcome is unpredictable. Suppose now that a physicist sets up a similar apparatus with two photocells attached to amplifiers, and then decides to go home for lunch when the next photon enters photocell A. "Here is a human action which is definitely subject to Heisenberg uncertainty," Compton concluded. Citing Lillie's paper, he added "that all deliberate actions of living organisms seem to be events of this kind." Nerve pulses are "presumably electrochemical reactions on a minute scale," and mental processes are probably similar, in which case the small number of molecules involved results in "an appreciable uncertainty."[63]

By combining uncertainty in quantum mechanics with causality in other aspects of nature, Compton believed that he had solved "the old dilemma of freedom in a world of law." In such a world, "man

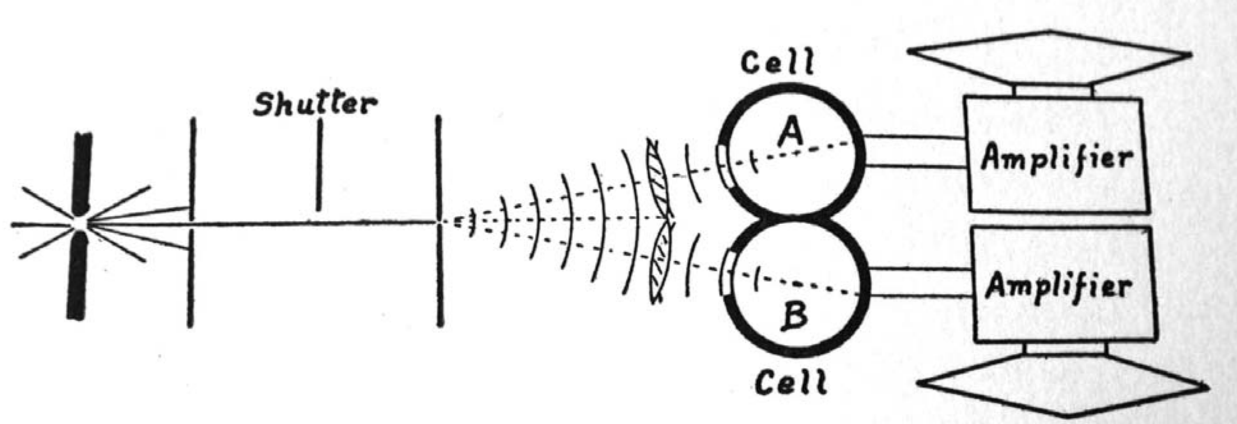


FIGURE 1

Nature does not obey exact laws. On successive trials, photons of light which traverse the slits do not always enter the same photoelectric cell.

Figure 1. Diagram of photon diffraction experiment from A. H. Compton, *The Freedom of Man* (New Haven, CT: Yale University Press, 1935), 39. Reproduced by permission of John J. Compton.

is left by science in control of his own actions within the bounds set by natural law," and "the powerful argument for morality … in a world governed by law," which Compton associated with Pythagoras, is "emphasized by every advance of science." Thus science, rather than overturning morality, "now presents new reasons why men should discipline their lives, and supplies new means whereby they can make their world more perfect." Furthermore, he stated, "our physical laws have acquired a new generality," since now "we may justifiably assume that these laws apply equally to living and non-living matter," whereas Newtonian physics lacked universal validity "unless human freedom was considered fictitious."[64]

Significantly, Compton did not, at that point in time, make a similar case for divine freedom. He did not argue explicitly that quantum uncertainties offer a possible locus for divine action in the universe. He touched on it only implicitly, when he was asked in May 1930 what the new physics "has to say about the old problems of free-will, immortality, and God?" Heisenberg's uncertainty principle, he answered, undermines mechanistic accounts of consciousness and "leaves room for an effective intelligence behind the phenomena of nature."[65] He went further than this only in an address he gave to the American Philosophical Society many years later in 1956, saying that the mechanistic universe "not only rules out the effectiveness of an assumed *Divine* Agent, but rules out also the effectiveness of the *human* will in determining the course of physical events." The demise of determinism changed all this:

> [T]he physical laws as they are now known, are not inconsistent with the effectiveness of purpose in shaping the events in nature. This … applies equally to one's own actions with reference to his responsibility for what he does, and to events occurring in the external world as related to other intelligences, either of men or of God. That is to say, we recognize now that we cannot call on physics and astronomy to give evidence for the effective action of free minds, either human or divine. But at the same time we recognize also that we cannot, on the basis of any kind of physical observation, deny that either human or divine minds may be effective in determining the course of certain types of events, in particular the actions of living organisms. Whether mind may participate in determining the course of events simply cannot be answered by physical observations.[66]

Even here, the possibility of God acting on nature at the quantum level is not stated openly, though Compton may have had it in mind.

Others did explicitly suggest this possibility in the 1950s, however, when theologians Karl Heim and Eric Mascall and physicist William Pollard all advanced versions of that idea. And in some ways, as Nicholas Saunders has noted, Compton's discussion of human agency in *The Freedom of Man* resonates with later efforts to understand divine agency—especially his point that unpredictable quantum events can have important macroscopic consequences.[67]

Compton understood that his ideas about the reality of free will and the limits of science would be controversial, but at least a few other leading physicists held similar views. Robert Millikan, for example, believed that the "philosophical determinism which has always been a presumptuous and a scientifically unwarranted generalization is now shown by experimental physics itself to be a false generalization." Like Compton, he held that a more limited "scientific determinism" was "merely a convenient working hypothesis, certainly no more difficult to reconcile with free will than are the wave properties of electrons and photons to reconcile with their corpuscular properties." Applied mathematician Warren Weaver of the Rockefeller Foundation, a friend of both Millikan and Compton, suggested that the conscience plays a role in our behavior "similar to that played by Schrödinger's ψ function relative to the behavior of electrons." As a devout Quaker, Arthur Eddington's commitment to human freedom was, if anything, even stronger than that of Compton, and he, too, stressed the role of consciousness in amplifying uncertainties at the microscopic level.[68] Indeed, Compton thought that "there is perhaps nothing better" than Eddington's book, *The Nature of the Physical World,* when it came to dealing with "the metaphysical implications of modern physics."[69]

Most philosophers, however, have not been very enthusiastic about Compton's defense of freedom. An outstanding exception is Karl Popper, who in 1965 gave the Compton memorial lecture at Washington University, published the next year as a booklet, *Of Clouds and Clocks* (1966). Popper's argument resonates with Compton's: consciousness evolved from the physical world, but it is not itself physical, and it can to some extent control things that are physical.[70] As for neurologists, Compton recognized the possibility, perhaps being realized in our own day, that "future psychological studies may inform us" whether a thought in the mind "may correspond to the formation of a particular pattern of paths of nerve currents … in the brain," which thus determines other currents. However, he always remained skeptical of deterministic conclusions that were "so contrary to the dictates of common sense." With Socrates, he felt "that the knowledge which comes to us intuitively through direct experience is of a more fundamental kind than that based upon intricate arguments concerned with delicate tests," so he might still affirm free will if he were living today, despite recent advances in neurology.[71]

Notes

1 Arthur Holly Compton, "The Natural Sciences," in *On Going to College: A Symposium* (New York: Oxford University Press, 1938), 141–68, on 159. For a similar passage of comparable eloquence, see Compton, *The Freedom of Man* (New Haven, CT: Yale University Press, 1935), 118–9.

2 Compton, "Personal Reminiscences," in *The Cosmos of Arthur Holly Compton*, ed. Marjorie Johnston (New York: Alfred A. Knopf, 1967), 3–52, quoting 41–2; this anthology is cited henceforth simply as *Cosmos*.

3 "Cosmic Clearance," *Time* (January 13, 1936): 32; Sherwood Eddy, *Man Discovers God* (New York: Harper and Brothers, 1942), 177.

4 Compton, "Personal Reminiscences," 18.

5 John J. Compton to Edward B. Davis, June 27, 2007. For further information, see James R. Blackwood, "Arthur Compton's Atomic Venture," *American Presbyterians* 66, no. 3 (Fall 1988): 177–93; the records of Hyde Park Union Church; "About Westminster Presbyterian Church," www.wooster.edu/westminster/about.html; "History [of Grace United Methodist Church]," www.graceumc-stl.org/history.htm; and "A Brief History of Hyde Park Union Church," www.hpuc.org/History/Hist%20-%20History.htm (all accessed 28 May 2009).

6 Charles Harvey Arnold, *God Before You and Behind You: The Hyde Park Union Church through a Century, 1874–1974* (Chicago: The Hyde Park Union Church, 1974), includes lengthy discussions of the views of many prominent members from the 1920s. For a short summary of Mathews' theological views, see W. Creighton Peden, "Shailer Mathews," in *Makers of Christian Theology in America*, ed. Mark G. Toulouse and James O. Duke (Nashville, TN: Abingdon Press, 1997), 392–8.

7 Edwin Arthur Burtt, *Religion in an Age of Science* (London: Williams and Northgate, 1930), 122–3.

8 According to Arnold, *God Before You and Behind You*, 65, "perhaps seventy percent of the members were connected with the University" during the 1920s.

9 Charles Clayton Morrison, *The American Pulpit: A Volume of Sermons by Twenty-Five of the Foremost Living American Preachers, Chosen by a Poll of All the Protestant Ministers in the United States, Nearly Twenty-Five Thousand of Whom Cast Their Votes* (New York: The Macmillan Co., 1925).

10 This occurred at an unspecified date in 1926; see "A Brief History of Hyde Park Union Church," www.hpuc.org/History/Hist%20-%20History.htm (accessed 1 October 2007).

11 "The New University of Chicago Chapel," *Chicago Baptist News* 8, no. 2 (November 1928): 1; Arnold, *God Before You and Behind You*, 78. On Jones' thought, see Matthew Stanley, *Practical Mystic: Religion, Science, and A. S. Eddington* (Chicago: University of Chicago Press, 2007), 37–40.

12 John J. Compton, "Ariadne's Thread—or How It Helps to Have the Right Ancestors," unpublished and unpaginated typescript cited by permission of the author.

13 Gary Dorrien, *The Making of American Liberal Theology: Idealism, Realism, and Modernity: 1900–1950* (Louisville, KY: Westminster John Knox Press, 2003); Kenneth Cauthen, *The Impact of American Religious Liberalism*, 2d ed. (Lanham, MD: University Press of America, 1983); David Henry Koss, "The Development of Naturalism at the Divinity School of the University of Chicago with Special Emphasis on the Doctrine of God" (PhD diss., Northwestern University, 1972).

14 On Millikan's idea of God, see Edward B. Davis, "Robert Andrews Millikan: Religion, Science, and Modernity," in Nicolaas A. Rupke, ed., *Eminent Lives in Twentieth-Century Science and Religion*, rev. ed. (Frankfurt am Main: Peter Lang, 2009), 253–74.

15 Compton, "Ariadne's Thread"; cf. his similar comments in Blackwood, "Arthur Compton's Atomic Venture," 191.

16 Arthur Holly Compton, *Atomic Quest* (New York: Oxford University Press, 1956), 344–5.

17 Ibid., 345–6.

18 Ibid., 346–7.

19 Conant to Compton, January 14, 1957, Arthur Holly Compton Personal Papers, University Archives, Department of Special Collections, Washington University Libraries, series 6, box 17, folder "C." Further references to this collection are given as AHC Papers.

20 L. M. Isaacs to Compton, January 10, [1957?], AHC Papers, series 6, box 17, folder "I."

21 Compton, *Atomic Quest*, 324–5, 331.

22 Ibid., 341–2, 336, 352.

23 Compton to George Derby, July 29, 1930, AHC Papers, series 3, box 1, folder "1929–30." He told Derby that he had not yet published anything about this, but that he was then "writing for publication an article along this line …" It is not clear to which article he was referring.

24 This lecture was printed as a pamphlet, *The Idea of God as Affected by Modern Knowledge* (Boston: American Unitarian Association, 1940), and reprinted with talks by eight more Garvin lecturers as "A Modern Concept of God," in *Man's Destiny in Eternity: The Garvin Lectures* (Boston: Beacon Press, 1949), 3–20; quoting 13 and 5 in the pamphlet or 11 and 5 in the book (the wording of the second quotation is slightly different in the book). Identical passages appear in the fourth of five Norton Lectures he gave at Southern

Baptist Theological Seminary in March 1941, under the title "Some Religious Implications of Science," typescript archived at Southern Baptist Theological Seminary Library, Louisville, Kentucky.

25The three lectures became five chapters in the book. For reports on the second and third lectures, see "Compton Sees Life Beyond All Science," *New York Times*, November 13, 1931, p. 25, and "Compton Says Man Guides Own Destiny," November 14, 1931, p. 13.

26Compton, *The Human Meaning of Science* (Chapel Hill, NC: The University of North Carolina Press, 1940) consists almost entirely of material reprinted verbatim from *The Freedom of Man* and a related essay, "The Natural Sciences," in *On Going to College: A Symposium* (New York: Oxford University Press, 1938), 141–68; I will not discuss it further. He presented similar ideas as the Elliot Lectures at Western Theological Seminary (Pittsburgh, 1931), the Loud Foundation Lectures at the University of Michigan (1935), the Lowell Lectures (Boston, 1938), and the Norton Lectures at Southern Baptist Theological Seminary (Louisville, March 1941). Further published versions of these ideas include a pamphlet, *The Evolution of the Soul,* a lecture at Plymouth Congregational Church, Lansing, Michigan, November 10, 1938 (William F. Ayres Foundation, 1938); another pamphlet, *The Religion of a Scientist*, an address at the Jewish Theological Seminary of America on Monday, November 21, 1938 (New York: Jewish Theological Seminary of America, 1938) and subsequent printings; "The Religion of a Scientist," *Sermons in Brief* 1, no. 1 (January 1940): 88–95; "A Scientist's View of Religion," *The Chicago Theological Seminary Register* 30, no. 2 (March 1940): 5–8; and "Freedom," in *Rab Saadia Gaon: Studies in His Honor*, ed. Louis Finkelstein (New York: Jewish Theological Seminary of America, 1944), 107–16.

27George W. Gray, "Compton Sees a New Epoch in Science," *New York Times*, March 13, 1932, p. 20.

28Compton, *Freedom of Man*, 73–6.

29Ibid., 80–81.

30Ibid., 84.

31For valuable background on cosmology in the 1930s, see Helge Kragh, *Cosmology and Controversy: The Historical Development of Two Theories of the Universe* (Princeton: Princeton University Press, 2006), esp. 73–9; and Kragh, *Matter and Spirit in the Universe: Scientific and Religious Preludes to Modern Cosmology* (London: Imperial College Press, 2004), 88–103. Kragh's statement in the latter book (92) that Compton "paid less attention to natural theology" than Millikan accurately applies to their disagreement about cosmic rays, but would be incorrect as a broader generalization.

32Compton, *Freedom of Man*, 88–9.

33Porter, "Are Planets Rare?" *Science* 72, no. 1859 (August 15, 1929): 170; and Compton, "Are Planets Rare?" *Science* 72, no. 1861 (August 29, 1929): 219. Porter nevertheless agreed with Compton, "That a directive intelligence is evident in the universe is undoubtedly held by a great majority of scientists …"

34Compton, *Freedom of Man*, 109.

35Ibid., 110–3.

36For a wide-ranging account of religious views of eugenics in this period, see Christine Rosen, *Preaching Eugenics: Religious Leaders and the American Eugenics Movement* (New York: Oxford University Press, 2004). Edward B. Davis, "Samuel Christian Schmucker's Christian Vocation," *Seminary Ridge Review* 10, no. 2 (Spring 2008): 59–75, provides a detailed study of a scientist who was at the peak of his fame in the 1920s as a popularizer of eugenics and liberal religion.

37Compton, *Freedom of Man*, 113–4.

38James H. Breasted, *The Dawn of Conscience* (New York: Charles Scribner's Sons, 1933), esp. the introduction. Millikan, who belonged to the same church as Breasted, cites him in *The Autobiography of Robert A. Millikan* (New York: Prentice-Hall, 1950), 253, 280.

39Compton, *Freedom of Man*, 114–5. It is interesting to note that another scholar from Chicago, theologian Philip Hefner, has recently advanced a view of humanity that strongly resembles that of Compton, except for a strong ecological emphasis. Hefner sees humanity as "created by God to be a co-creator in the creation that God has brought into being and for which God has purposes." And, "The conditioning matrix that has produced the human being—the evolutionary process—is God's process of bringing into being a creature who represents the creation's zone of a new stage of freedom and who therefore is crucial for the emergence of a new creation." Hefner, *The Human Factor: Evolution, Culture, and Religion* (Minneapolis, MN: Fortress Press, 1993), 32.

40Compton, *Freedom of Man*, 116.

41On Barnes, see Peter J. Bowler, *Reconciling Science and Religion: The Debate in Early-Twentieth-Century Britain* (Chicago: University of Chicago Press, 2001), 260–70.

42Preliminary typescripts of chapters from *The Freedom of Man* are in AHC Papers, series 6, box 9, folders 6 and 15; those in folder 15 clearly supercede the others and probably date from 1932, except for handwritten additions from 1934–1935.

43Compton, *Freedom of Man*, 116–8.

44Jacques Loeb, *The Mechanistic Conception of Life: Biological Essays* (Chicago: The University of Chicago Press, 1912), 31. On Loeb's scientific work and the interpretation he gave it, see Garland Allen, *Life Science in the Twentieth Century* (New York: John Wiley and Sons, 1975), 73–81. The famous behavioral psychologist John B. Watson studied neurology with Loeb at Chicago.

45Edward J. Larson, *Summer for the Gods: The Scopes Trial and America's Continuing Debate over Science and Religion* (New York: Basic Books, 1997), 71 and note 26 on 278; Simon Baatz, "Criminal Minds," *Smithsonian* (August 2008): 70–9.

46Osborn, "Credo of a Naturalist," *The Forum* 73 (April 1925): 486–94, quoting 487.

47On this particular point, see Compton, "Science and Man's Freedom," *Atlantic Monthly* 200, no. 4 (October 1957): 71–4 (reprinted in *Cosmos*, 115–24).

48For details on the itineraries of Heisenberg and Dirac in America, see Helge S. Kragh, *Dirac: A Scientific Biography* (Cambridge: Cambridge University Press, 1990), 71–5, and Laurie M. Brown and Helmut Rechenberg, "Paul Dirac and Werner Heisenberg—A Partnership in Science," in *Reminiscences About a Great Physicist: Paul Adrien Maurice Dirac*, ed. Behram N. Kursunoglu and Eugene P. Wigner (Cambridge: Cambridge University Press, 1987), 117–62, on 132–7.

49Interview of Charles Weiner and Betty Compton, April 1968, cited by Blackwood, "Arthur Compton's Atomic Venture," 184; John J. Compton confirmed this story.

50Werner Heisenberg, *The Physical Principles of the Quantum Theory*, trans. Carl Eckart and Frank C. Hoyt with foreword by Compton (Chicago: University of Chicago Press, 1930), 62.

51Ibid., 65.

52Compton, "The Effect of Social Influences on Physical Science," in *Cosmos*, 81–100, on 83. The editorial introduction to this essay (81) underscores the influence of Heisenberg on Compton at this point in his life.

53Compton to Georgia L. Chamberlin, May 6, 1931, American Institute of Sacred Literature Records, Special Collections Research Center, University of Chicago Library, box 17, folder 2, henceforth cited as AISL Records.

54Compton, "The Effect of Social Influences on Physical Science," 88–90; Dampier, *A History of Science and Its Relations with Philosophy and Religion* (Cambridge: The University Press, 1929).

55Ibid., 94–5.

56Ibid., 96.

57Ralph S. Lillie, "Physical Indeterminism and Vital Action," *Science* 66, no. 1072 (August 12, 1927): 139–44, on 140. Lillie's article seems to have gone largely unnoticed, apart from Compton's writings. An exception would be Martín López Corredoira, "Quantum Mechanics and Free Will: Counter-Arguments," *The Journal of Non-Locality and Remote Mental Interactions* 1, no. 3 (October 2002), an online journal www.emergentmind.org/corredoiraI3.htm (accessed 29 January 2008), offering a heated, mainly a priori denial of all types of top-down causation.

58Compton, "The Effect of Social Influences on Physical Science," 97, 100, emphasis his.

59Compton, *The Human Meaning of Science*, viii–x, 49–50.

60"Sees Deity Ruling World of Chance," *New York Times*, March 27, 1931, p. 27; Compton, "The Uncertainty Principle and Free Will," *Science* 74, no. 1911 (August 14, 1931): 172; and Compton, "Do We Live in a World of Chance?" *Yale Review* 21 (September 1931): 86–94. The outline and pencil manuscript of this last item are in AHC Papers, series 6, box 9, folder 6.

61Compton, *Freedom of Man*, 26–9.

62Ibid., 41–4, 55–6.

63Ibid., 49–50.

64Ibid., 66–7.

65Philip Kinsley, "Antics of Atom Impel Science to Think of God: Compton Tugs at Veil of Mystery," *Chicago Tribune*, May 25, 1930, pp. 1, 20; cf. "Compton to Offer New View of Atom," *New York Times*, May 25, 1930, p. 25. He repeated those words to an audience in New York the following year; "Sees Deity Ruling World of Chance," *New York Times*, March 27, 1931, p. 27.

66Compton, "The World of Science in the Late Eighteenth Century and Today," *Proceedings of the American Philosophical Society* 100 (August 1956): 296–303, on 301, italics his. Cf. Compton, "Science and Man's Freedom." If he said something similar earlier, I am not aware of it.

67For details, see Nicholas Saunders, *Divine Action and Modern Science* (Cambridge: Cambridge University Press, 2002), 94–110.

68Millikan, *Time, Matter, and Values* (Chapel Hill: University of North Carolina Press, 1932), 30, 98–9; Warren Weaver, "Statistical Freedom of the Will," *Reviews of Modern Physics* 20, no. 1 (January 1948): 31–4, quoting 33; Eddington, *The Nature of the Physical World* (New York: Macmillan, 1928), esp. chaps. 10–15. Eddington spoke about this initially in his Gifford Lectures at Edinburgh in the winter of 1927, a few weeks before Heisenberg published his paper on the uncertainty relation. On Eddington's approach to religion and the limits of science, see Matthew Stanley, *Practical Mystic*, 153–68, 194–209, esp. 206–9; and Allen H. Batten, "A Most Rare Vision: Eddington's Thinking on the Relation Between Science and Religion," *Quarterly Journal of the Royal Astronomical Society* 35 (1994): 249–70. For a short history of efforts to relate quantum mechanics to human and divine action, see Daniel Patrick Thurs, "That Quantum Physics Demonstrated the Doctrine of Free Will," in *Galileo Goes to Jail and Other Myths about Science and Religion*, ed. Ronald L. Numbers (Cambridge: Harvard University Press, 2009), 196–205. Saunders, *Divine Action and Modern Science*, 94–172, provides a much more detailed account of several important efforts to relate quantum mechanics to divine action.

69Compton to Georgia L. Chamberlin, May 6, 1931, AISL Records, box 17, folder 2.

70Karl Popper, *Of Clouds and Clocks: An Approach to the Problem of Rationality and the Freedom of Man* (St. Louis: Washington University Press, 1966).

71Compton, *Freedom of Man*, note 9 on 58, 59–60.

BODY, SOUL, AND HUMAN LIFE: The Nature of Humanity in the Bible by Joel B. Green. Grand Rapids, MI: Baker Academic, 2008. 212 pages, index. Paperback; $19.99. ISBN: 0801035953.

Reviewed by Scott B. Rae, Talbot School of Theology, Biola University, La Mirada, CA 90639.

Joel Green, professor of New Testament studies at Fuller Theological Seminary, has produced what he calls a "progress report" on his years-long pursuit of the integration of biblical studies and the neurosciences. Though I commend him for taking up serious graduate study in an entirely different field (the neurosciences) in mid-career, the book is heavy on Green's first language of biblical studies. Readers who are looking for substantive discussion of the neurosciences will be disappointed, but Green's subtitle indicates his primary goal, which is to expound on human nature from the Bible. To be sure, his work is driven by his understanding of advances in the neurosciences, which, in his view, necessitates abandoning the traditional dualism that has been the consensus of biblical interpreters and theologians for centuries. The alternative that Green proposes—which fits with his reading of the Bible, and, in his view, does not require belief in anything immaterial in human nature, such as a soul—is that the functions attributed to the soul can be more plausibly explained by neuro-biological categories. Green's work, thus, could be viewed as a biblical defense of Christian monism, or nonreductive physicalism, seeing human persons as unified, embodied wholes consisting of nothing more than their material "stuff."

Green raises a number of important questions, which include the uniqueness of human beings, the grounding for human worth and morality, decision-making and free will, the focus of salvation, and views of life after death. In chapter one, he introduces his methodological approach which he admits draws heavily on the sciences, arguing that neuroscience should have a place in theological interpretation (pp. 22–8). Most chapters, except for the final one, begin with challenges to traditional theological views from the neurosciences, followed by lengthy, detailed, and well-documented explorations of biblical texts, attempting to demonstrate that his Christian monism is consistent with the Bible. Chapter two outlines his view of human nature, including the image of God. Chapter three addresses the notions of sin and freedom, affirming moral responsibility but admitting that free will as traditionally understood is "overrated" (p. 75). Chapter four addresses the concept of salvation, conversion, and change. He then applies this to the mission of the church and argues that the church's mission should reflect a holistic pursuit to minister to the whole person, not just his or her soul. The book concludes with an entirely biblical studies section on the resurrection of the body and the afterlife, wherein Green argues that the correct reading of the biblical text does not demand belief in a disembodied or intermediate state, in which the believer maintains existence and identity prior to the final resurrection of the body.

Green pointedly observes at the beginning, when establishing his hermeneutical methodology, that

> it is worth inquiring whether a substantive view of the soul in Christian thought is a consequence of unadulterated exegesis (i.e., read out of the text) or a philosophical-scientific assumption read into the text (i.e., eisegesis) (p. 26).

His point in the book is to demonstrate the latter. But later, he puts the question a bit differently, when he asks,

> If the "truth" about the human person were decisively determined by Scripture, what would happen were contravening evidence to surface from extrabiblical inquiry, particularly, scientific observation? … The better question is then, will we allow a particular scientific rendering of the voice of Scripture to masquerade as "timeless truth"? (p. 28).

Green is, in his words, *deliberately locating our interpretive work in relation to science* (p. 28). It seems that Green's charges against the traditional view apply just as readily to his own thesis. By locating his interpretive work in relation to neuroscience, does he not run the same risk of which he accuses the traditional view—namely, reading a philosophical-*scientific* (emphasis mine) assumption back into the text? He seems to be attempting precisely that which he is critical of—to show that *his* particular scientific rendering of the voice of Scripture (Christian monism informed by the neurosciences) is the "timeless truth" about human nature. The method he follows in the chapters that form the substance of the book seems to suggest this, as he points out challenges from the neurosciences, then attempts to show that the exegesis of Scripture harmonizes nicely with such a scientific worldview. At the least, if the concern is to get at an "unadulterated" view of the Bible, he should come at it without the overlay provided by the neurosciences.

Of course, the neurosciences do not settle the matter of what constitutes a human person, nor is it at all clear that considerations from the neurosciences should drive the reinterpretation of the Bible. The sciences are inept at deciding what are fundamentally philosophical issues, as evidenced by the fact that three different Nobel prize winning scientists (John Eccles, a substance dualist; Roger Sperry, a property dualist; and Francis Crick, a physicalist) all are quite aware of the neurosciences, yet that field cannot settle the debate. In fairness to Green, he is not claiming that the sciences settle the question, but it is clear that his exposure to the neurosciences is what is driving his re-reading of the Bible. As I note below, Scripture does not demand his nonreductive physicalism, and I would challenge Green to point out a single discovery in the neurosciences that the substance dualist cannot accommodate.

Green seems to downplay the fact that biblical writers had the worldview they did, not by accident, nor by uncritically adopting the philosophical consensus of the prevailing culture. Rather, the biblical authors espoused/assumed a particular worldview (though not systematically developed, analogous to their theology and ethics) as part of their message. They espoused a metaphysical view of the world, a view of epistemology, a view of ethics, a view of history, and, significantly, a view of the human person. The teaching of the biblical authors was embedded in a consistent worldview, of which their view of human nature was a part. This, of course, leaves room for literary conventions such as a wide variety of figures of speech, poetic literature, proverbial sayings, and so forth. But just because the neurosciences call the soul into question, it does not follow that the biblical writers were writing uncritically out of the allegedly (according to Green) mistaken dualism of their day. Similarly, just because the current philosophical consensus on ethics calls into question the biblical notion of objective, universal moral absolutes, it does not follow that the biblical authors were simply writing out of their own allegedly erroneous cultural assumptions about objective moral absolutes.

Even if one were to adopt Green's approach, it does not follow that if the neurosciences offer a plausible rendering of the functions traditionally attributed to the soul, then the "concept of soul as traditionally understood in theology as a person's authentic self, seems redundant" and, thus, can be rejected (p. 45). Perhaps an analogy from sociology or religion fits here. Just because sociologists can offer a plausible rendering of religious experience, it does not follow that religious experience is not genuinely what it claims to be. Simply because sociology can account for a religious experience, it does not follow that the religious experience can be *reduced* to that explanation. Likewise, it does not follow that the functions of the soul can be *reduced* to neurology, even though the neurosciences can provide a descriptive explanation of some of those functions.

Though Green is clearly aware of the many varieties of dualism, sometimes it seems that he is aiming his criticism at Cartesian dualism with its separation of the body and the soul. For example, the substance dualist can readily accommodate his view of conversion, that it involves neurological change (pp. 115–6), since for the substance dualist, it is no surprise that the soul impacts the body and vice versa. Surely the dualist can affirm that conversion is embodied, without affirming "somatic existence as the basis and means of human existence, *including the exercise of the mind"* (p. 122, emphasis mine). Interestingly, Green uses the notion of "mind," not the brain, to describe part of cognitive life, though for the physicalist, the notion of mind involves use of a category not available to him.

There are good biblical reasons why dualism has been the dominant view among theologians and the church for centuries. The commonsense reading of several key biblical passages seems unmistakably to point to dualism, in a way that precludes the monism that Green attempts to defend. In 2 Cor. 5:1–10, Paul affirms that one can be "absent from the body and at home with the Lord" (v. 8). Paul assumes here what he has already laid out in 1 Corinthians 15, which is a general resurrection of the dead (vs. 52–54), in which it is clear that for those who have died "in Christ," there is some time that elapses prior to inheriting a resurrection body. The only way to make biblical sense of Paul's teaching, that if he is "absent from the body, he is at home with the Lord," is to posit an "intermediate state" in which the believer lives "at home with the Lord" in a temporarily disembodied state. This strongly suggests that somatic (bodily) existence is *not* the basis of human existence, as Green insists (p. 122). Rather, it argues for the existence of a soul, which provides the essential continuity of identity. Of course, the reason why believers will live in eternity in embodied form is because bodies are necessary to actualize most of the capacities of the soul—though that is the norm, it does not follow that embodied existence renders the soul superfluous.

Green's insistence that "the dualism with which (Paul) is concerned is eschatological rather than anthropological" (p. 177) is a distinction without a difference. Though it is eschatological in focus, there is no reason why an anthropological truth about human beings cannot be bound up in an eschatological point. And the reason why Paul does not use the language of soul/spirit to describe the intermediate state (p. 177) is that Paul understood that even though he was absent from the body, *he was still himself*, and thus it was entirely appropriate to refer to himself with first person pronouns, since he grounds personal identity in the immaterial soul.

Paul's eschatology is best summarized by New Testament scholar and theologian N. T. Wright, who refers to the final destiny of the believer as "life after life after death." (N. T. Wright, *Surprised by Hope*, pp. 162, 168–9). This view best explains several other New Testament passages that suggest an intermediate state, such as Jesus' statement to the thief on the cross, "today you will be with me in paradise" (Luke 23:42–43; see also Darrell L. Bock, *Luke 9:51–24:53*, pp. 1857–8), and Paul's statement that he "longs to depart (from this life) and be with Christ" (Phil. 1:21–23). Both passages strongly parallel 2 Cor. 5:8. And Wright has clearly demonstrated that for those living during the writing of the Bible, including the writers themselves, the intermediate state was a mode of nonphysical, spiritual existence.

Green admits that the grounding of personal identity through time and change is a mystery (p. 180; though to be clear, Paul's "mystery" in 1 Cor. 15:51 concerns how the eternal transformation will take place, not how personal identity is grounded). It is only a mystery, however, for the monist—the dualist can provide an explanation that fits best with the biblical teaching. Green rightly concedes that it is problematic for the nondualist to sustain identity in material terms—what philosophers call a property-thing, or a bundle, view of a person.

This is a serious problem for the physicalist, one that the dualist can easily resolve by grounding personal identity in an immaterial soul. And it will not do for the monist to suggest that personal identity can be grounded in terms of relationality and one's narrative history (pp. 178–9), since those change as much if not more than our physical parts and properties. These disparate stands of our narrative history have nothing in themselves that remains the same through time and change. The unifying factor in the varied narrative strands of one's life is *presupposed*, not supplied by those factors, in the same way that continuity of identity is presumed, not supplied by the physical factors available to the physicalist. The dualist has an explanation for this presupposition in the existence of an immaterial, substantial soul. But physicalists must either adopt a weaker form of personal identity that is not strict and absolute or else simply assert that there is no problem for physicalism.

Unfortunately, this latter view is problematic for several reasons, not the least of which comes from the sciences themselves, if taken as the whole truth about us: We are aggregates of separable parts standing in an aggregate of relation-instances (causal, spatio-temporal, or otherwise). If the parts or the relation-instances change, there is a different object. It is incredible to believe that persons are atomic simples lodged somewhere in the brain! The simple fact is that the persistence conditions for people and their bodies (and the aggregated parts of their bodies such as their brains) are different, and the dualist knows why—persons are simple, immaterial substances; bodies are not.

One final note that I cannot ignore, as one trained in social ethics, is what I think of as a cheap shot at dualists regarding social ethics (p. 138). Green cites two newspaper headlines that advance a dichotomy between the mission of the church to "feed the soul" or "feed the hungry." Green then comments that "newspaper headlines like these make good sense in a world understood in dualistic terms." To presume that the majority of dualists hold these views is just flat wrong. Though a handful of dualists do buy into this outdated pietism about the world, most do not. Substance dualists maintain that in the Bible, there is just as much hope for the body as for the soul. Dualists affirm the importance of the body, the earth, and embodied human life on this earth—as critical components of faithfully following Christ. In fact, my students routinely tell me that in their churches, the social mission of the church is so much emphasized that they are concerned that the evangelistic mission of the church is underemphasized! Concern for the whole person, the earth and the culture is in no way inconsistent with substance dualism.

A Response, by author Joel B. Green, to Scott B. Rae's review of **BODY, SOUL, AND HUMAN LIFE: The Nature of Humanity in the Bible** (above)

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I am grateful for the opportunity to respond to Scott B. Rae's assessment of my book, *Body, Soul, and Human Life*. In part, this is because Rae and I differ significantly on both how to read Scripture and how the natural sciences might be brought to bear on our theological understanding of humanity; given the importance of these questions, more interaction is only to be welcomed. Moreover, since Rae has not represented well the argument of *Body, Soul, and Human Life*, I am all the more pleased to be able to address readers of *Perspectives in Science and Christian Faith*.

The reader of Rae's review may be forgiven for imagining that my agenda was to reread the Bible in the light of contemporary evidence from the neurosciences. This is the claim that Rae makes, but this is not the case. As I demonstrate in chapter one of *Body, Soul, and Human Life*, during the last century, biblical scholars who have examined Scripture's witness to the human person have shown over and over—quite apart from any influence from the neurosciences—that the witness of the Old and New Testaments supports what we generally name as a monist portrait of the human person. I go on to observe in chapter two that, were we to presume that the New Testament writers worked within a milieu that supported body-soul dualism, we might go on to imagine that the New Testament writers reflected this dualism in their books. Were we to do so, however, we would fail to take seriously either the degree to which even Greek influence in the first-century Roman world was monist in its view of the human person, or the degree to which the primary influence on New Testament writers was Israel's Scriptures rather than contemporary Greco-Roman philosophy. In short, from the perspective of the discipline of biblical studies, support for body-soul dualism is minimal. Accordingly, what I attempt in this book is not to reread the Bible through a neuroscientific lens. To the contrary, I demonstrate that those views of the human person which are consistent with what we are learning from the natural sciences present no fundamental challenge to biblical faith.

Numerous voices, both in and outside the church, urge that the findings of the natural sciences raise serious, even insurmountable, questions against traditional Christian theology. Taking seriously the witnesses of Scripture and natural science, I claim that "biblical studies and the neurosciences are paths characterized by convergence (in the sense that they reach similar conclusions, though coming at the issues in discrete ways), not competition or contrast" (p. 33). This is the essential burden of my study.

At the same time, Rae and I seem to have fundamentally different views with regard to the role of the natural sciences in theological discourse. Three issues surface here. The first is whether science has any voice. The view that I articulate in *Body, Soul, and Human Life* is that "theology" is a world-encompassing discipline; as such, nothing is outside its parameters, not even science. Because of our belief in God the Creator, we must take seriously the capacity of creation—and, thus, the study of creation via the natural sciences—to provide insight for theological inquiry. Given Rae's review of my book, I am unsure that he would agree—or, perhaps better, I am unsure what evidence could ever be counted as sufficient actually to influence theological thought. Some theologians (I refer to Jürgen Moltmann and Wolfhart Pannenberg, among others) have observed already that data from the natural sciences urge us to rethink body-soul dualism. The evidence I survey, from the beginnings of "neurology" in the seventeenth century to the early-twenty-first century, demonstrates the neural basis for all sorts of human capacities traditionally allocated to the "soul," with the result that, if there is an ontological entity we might call a "soul," it is difficult to know what purpose it might have other than an epiphenomenal one.

The other two issues are closely related—the one, hermeneutical; and the other, the nature of the Bible's witness on issues of science. Rae seems to miss my basic point, which is that the composition and interpretation of the Bible have never been and can never be absent considerations of science. I note, then, that "'what the Scriptures teach' about the human person is always in dialectical relationship to the presumptions brought by the interpreter to the enterprise of interpreting those texts" (p. 28). Thus, Rae's appeal to "the commonsense reading of several biblical passages" immediately raises the question, Whose sense gets to be "common"? Clearly, those who read the Bible from the perspective of body-soul dualism will agree with Rae's "commonsense," but this does not make such a reading congruent with the thought world of the Old and New Testaments.

Going further, Rae apparently wants to assert that biblical authors chose the correct viewpoints among the options of their day; does this mean that we should not question the science of the biblical writers? It is not difficult to show why this would be a fallacious position. Take, as one example, Jesus' claim in Luke 11:34–35: "Your eye is the lamp of your body. If your eye is healthy, your whole body is full of light; but if it is not healthy, your body is full of darkness. Therefore consider whether the light in you is not darkness." This saying depends on an erroneous ophthalmology, prevalent in the ancient world, which viewed the eyes as a conduit of light not into the body but from within the body out to the external world. Whether the eyes were healthy or diseased spoke to whether the body was full of darkness or of light. Jesus' saying makes perfect sense within ancient, flawed physiology. Similarly, Paul uses language for the resurrection body reminiscent of scientific speculation about the make-up of astral bodies. If earthly life recognized four elements (fire, wind, water, earth), heavenly life would require a fifth element, the *quintessence* comprising the stars. Paul's concerns are clear enough, even if they are grounded in an outdated periodic table; he wants to insist that our present bodies are outfitted for this world whereas our new bodies will be outfitted for the world to come.

To leave the biblical texts themselves and refer instead to its interpreters, the philosophy-science of the first centuries of the church, influenced by Neoplatonism (and its forerunners), led to the assumption that the word *soul* in the Bible should be invested with content reminiscent of Platonic dualism rather than Hebrew holism. And Cartesian mechanics has perpetuated a similar dualism among modern readers of the Bible. The questions I want to raise—Whose science? Which science?—thus seem crucial for interpreting the Bible and for engaging in theological reflection on the nature of the human person.

It is difficult to know what to make of some of the details of Rae's review. I am unsure why anyone seeking "a substantive discussion of the neurosciences" would pick up a book with the subtitle *The Nature of Humanity in the Bible*, for example. Another mystery: since neither in this book nor otherwise do I identify myself as a nonreductive physicalist, I wonder why Rae has chosen thus to label me and my position. My choice not to label my position in this way is not because I regard nonreductive physicalism as problematic on biblical grounds, but because I do not regard the biblical witness as fitting easily the precision employed by today's philosophers. Thus, I have preferred the more fuzzy term, "monism," and throughout steer clear of the eliminative physicalism that Rae attributes to my position. (Does Rae lump all nondualist positions together on principle?) Along the same lines, it almost goes without saying that Rae's representation of nonreductive physicalism with reference to humans as "consisting of nothing more than their material 'stuff'" is an egregious caricature that accounts in no way for the modifier "nonreductive"—regarding which I can do no better than to refer my reader to my colleague, Nancey Murphy (e.g., *Bodies and Souls, or Spirited Bodies* [Cambridge: Cambridge University Press, 2006]).

I find it puzzling that Rae (and other dualists) are attracted to the writings of N. T. Wright, even attempting to draw support for their dualism from Wright. This is baffling because Wright's anthropological monism is transparent in many of his writings, and this makes me wonder how carefully Wright is being read. For example, Rae urges that my claim that Paul's dualism is eschatological rather than anthropological "is a distinction without a difference," but my claim actually parallels Wright's study of the matter in *The New Testament and the People of God* ([Minneapolis: Fortress, 1992], 252–6). For Wright, this distinction is significant for how we understand the Jewish context of early Christian thought. He enumerates a range of possible dualisms—cosmological, moral, anthropological, psychological, and more—then rejects, for example, *anthropological* dualism and embraces *eschatological* dualism as normative for first-century Judaism. For Wright, first-century Judaism did not view humans as bipartite creatures. Rae claims that "Wright has clearly demonstrated that for those living during the time of the Bible, including the writers themselves, the intermediate state was a mode of nonphysical, spiritual existence." But Wright has demonstrated no such thing—and, indeed, is far too sophisticated a biblical scholar to flatten the evidence from the period of the Second Temple in this way. This is not even true of Wright's own reading of the New Testament evidence. Setting aside Wright's more thoroughgoing analysis in *The Resurrection of the Son of God* (Minneapolis: Fortress, 2003), we can turn to the popular-level book to which Rae refers: *Surprised by Hope* (New York: HarperOne, 2008). More generally, with regard to "immortal souls," Wright observes that

> much of the Christian and sub-Christian tradition has assumed that we all do indeed have souls that need saving and that the soul, if saved, will be the part of us that goes to heaven when we die. All this, however, finds minimal support in the New Testament, including the teaching of Jesus, where the word *soul*, though rare, reflects when it does occur underlying Hebrew or Aramaic words referring … to what we would call the whole person or personality, seen as being confronted by God (p. 28).

Over and over in *Surprised by Hope*, Wright draws a sharp line of demarcation between body-soul dualism and biblical faith. To cite another example, Wright observes, "We have been buying our mental furniture for so long in Plato's factory that we have come to take for granted a basic ontological contrast between 'spirit' in the sense of something immaterial and 'matter' in the sense of something material, solid, physical." But this is not the case with Paul, Wright notes, nor was it even the case with the "dominant cosmology" of Paul's day, which was Stoic; far less was it the case within "Jewish creation theology" (*Surprised by Hope*, pp. 153–4). Christian hope is not grounded in an "immortal soul," Wright says (e.g., *Surprised by Hope*, p. 160). Indeed, when answering the question of how God will accomplish that act of new creation by which we experience eternal life, Wright follows the well-known science-theologian, John Polkinghorne (himself a dual-aspect monist): "God will download our software onto his hardware until the time when he gives us new hardware to run the software again" (*Surprised by Hope*, p. 163). Wright's perspective here seems far removed from Rae's "intermediate state" experienced as "a mode of nonphysical, spiritual existence."

Of course, my point is not that Wright and I agree on all of the relevant exegetical details. However, on our respective affirmations of fully embodied, holistic human life in this life and the next, and the implications we draw regarding the nature and mission of the church, Wright and I find ourselves very much under the same theological roof. Rae's attempt to introduce dueling New Testament scholars at this point does not work.

Finally, I am nonplused that Rae thinks I have taken a cheap shot at dualists when I observe that distinguishing between feeding souls and feeding the hungry makes good sense in a world understood in dualistic terms. I am nonplused because I make no claim that this distinction is either necessary or inevitable. I am nonplused because, in Rae's defense of a social ethics grounded in dualism, he perpetuates this very distinction by observing that his students wonder if "the social mission of the church" has not led to an underemphasis on "the evangelistic mission of the church." Rae has made my point for me: dividing the church's mission in just this way finds a home in a world understood in dualistic terms. But if the human is understood in holistic terms—indeed, in the very terms for which I argue in *Body, Soul, and Human Life*—then the distinction between, say, biological or social or relational or spiritual needs is not so easily made. God's work of restoration, and so the church's mission, is oriented not to parts of a person but to human persons holistically understood, fully embodied, embedded relationally within the human family and in the cosmos God has created, and, indeed, in relation to God.

Health & Medicine

SPIRITUALITY AND AGING by Robert C. Atchley. Baltimore, MD: The Johns Hopkins University Press, 2009. xvi + 201 pages, index. Hardcover; $45.00. ISBN: 9780801891199.

Dedicated "To Awakened Being, with gratitude" and on its way to becoming a best seller, this book challenges readers "to engage the possibilities of spirituality and aging" by trying its ideas and framework to "see what happens" (p. 159). It aims to put "the jumble of concepts and empirical evidence in the field together into a meaningful mosaic" as a starting point for research, teaching, and service (pp. 146–7). Although it repeatedly claims to be nonreligious, its subtitle should be *An American Buddhist Interpretation*.

Robert Atchley, Distinguished Professor of Gerontology (emeritus) at Miami University, Oxford, Ohio, has published many articles and books, including the best-selling social gerontology text, *Social Forces and Aging,* now in its tenth edition. Renowned for developing continuity theory (challenging disengagement), he has lectured widely, conducted numerous workshops and seminars on aging, and has a three-decade interest in his subject.

Most of this book is oriented around the spiritual self-perceptions, existential experiences, and spiritual identities of people. An introduction and three chapters about spiritual experience, spiritual development, and related concepts are followed by two chapters about spiritual journeying (transpersonal psychology and sociology), then four chapters of examples "using an expanded view."

Spirituality is interpreted as "a holistic region of human experience" that "is rooted in our purest experience of existence, the 'I Am' without words, just awareness" (p. 6). According to Atchley, it is an inner subjective concept that sensitizes us to qualities and avenues of experience beyond concretely observable referents. Because it pertains to an experiential region of life as a quality that can be both immanent and transcendent, we should augment empirical and analytical analysis with "humanistic capacities such as contemplation, rumination, imagination, and intuition" (p. 6).

"Spiritual development is in essence an increasing connection with the non-personal ground of being that lies within each human being, whether he or she is religious or not" (p. 114). Self-actualization, achieved through the human potential movement's philosophy and methods, is at the core of Atchley's operating definition. Spirituality "gradually infuses more and more of life, until most experiences are at least partly a spiritual experience" (p. 114). That secular humanist perspective is close to the unacknowledged biblical teaching that people are created in the image of God. Because God is Spirit (John 4:24), the central core of each person is the spirit, so everything human is in some sense spiritual.

Most authorities will agree that "many people have spiritual experiences but deny them because of their *belief* that spirituality does not exist" (p. 49), that holistic gerontology education should include spirituality, that students will be more attracted to it if encouraged to work simultaneously on their own "spiritual process," that all who work with aging people should tune into the basic spirituality of those they serve, and that spirituality needs further study.

However, nearly all of the large and rapidly expanding corpus of existing research on spirituality and aging is neglected, so this book provides neither summaries nor direct comparisons. The references mention very few research-based studies, most of which are not cited in the text. The alleged reason is that most of the research commingles religious and spiritual variables, but the author's faith may be more important.

Atchley's goal is to treat spirituality in its own right as a topic distinct from religion. In fact, however, those concepts overlap so significantly that many research variables (behavior, beliefs, affiliations, and attitudes) can be used as admittedly imperfect indicators of either religion, spirituality, or both. Indeed, one of the very few empirical studies he does cite reveals that only 6.7% of a diverse sample thought that spirituality and religiousness do not overlap. He assumes that the current behavioral science tendency to refer to them collectively as Religion/Spirituality (overlapping but not synonymous concepts) has such serious flaws that all empirical studies mentioning religion should be ignored. He believes that looking at spirituality as separate from and not overlapping with religion will "provide a conceptual and theoretical picture of spirituality that is much broader, deeper, higher, more interrelated, symphonic, full-spectrum, and panoramic than the narrow views used in much of the current work on spirituality and aging" (p. 8).

Most of the data Atchley uses are drawn from his own reflections, interviews, and experiences as a spiritual elder or sage (one who manifests "cognitive, emotional, and contemplative wisdom" from doing "the inner work necessary to act in the world with pure being, transcendence of the personal self, and direct connection with the sacred," p. 76). He has studied with Sri Nisargadatta Maharaj in India, spent several years teaching at Buddhist-inspired Naropa University, and since 1996 "has found spiritual community in Quaker Meetings" (p. 201).

The frequently mentioned goal of separating spirituality from religion is belied by Atchley's advocacy of his own religious faith—a nontheistic Buddhism supported with contemplative methods from the Quaker tradition. The book has few, mostly casual, references to Christianity, Judaism, and Islam, but it is permeated with commendatory references to contemplative enlightenment that is only occasionally identified as Buddhist. It also shares the three jewels of Buddhism (p. 43), the Zen Buddhist depiction of the spiritual quest as the search for an elusive wild ox in the forest (pp. 57–62), the Buddhist practice of Tonglen (p. 84), the Buddhist eightfold path and wheel of the dharma (pp. 94–6), the Buddhist concept of nothingness (p. 127), and the Tibetan Buddhist preparation for death (pp. 137–8). Its most cited authorities are Ken Wilber, a Buddhist transpersonal psychologist, Ram

Dass, a Hindu guru, and the late Aldous Huxley, who was associated with the Vedanta Society.

Buddhist perspectives are blended with contemplative Quaker methods of spiritual journeying and growth through inner discovery, spiritual seeking in community, and transpersonal group process. Quakers are described as examplars of the "true self" with its "journey of reuniting soul and role" (p. 56). Their clearness committees, living-learning communities, and joyful "answering that of God in everyone" (pp. 156–7) are praised. The richness of Christian faith and the Bible for spirituality and for transpersonal sociology and psychology is completely ignored, presumably because they are religious, as if Buddhism and Quakerism are not.

This book is very well organized and smoothly written. Its self-oriented categories of qualities in spiritual experience and its linkage with selected psychological interpretations are innovative. Because a central focus is "the value of being on an intentional journey whose purpose is to find within oneself the nonpersonal consciousness needed to approach objectivity" (p. 158), it arouses self-reflection and stimulates contemplation about spiritual realities.

Appendix A is an excellent twenty-two-page "Spiritual Inventory." Its eighty-five questions, several with additional subsidiaries, are a useful tool for either discussion groups or personal assessment of spiritually-related experiences, desires, activities, feelings, and self-concepts. Appendix B similarly provides perceptive "Questions for Reflection and Spiritual Self-Assessment." Because the responses of most Americans will flow from their religious or anti-religious spiritual experiences, the questions can be adapted to fit the diverse viewpoints of other religious groups, not only those of contemplative meditators, secularists, and Buddhists.

By his veiled Buddhist faith and exclusion of the interactions of religion and spirituality, Atchley subtly pushes readers toward spiritual perspectives that fail to consider the faiths and philosophies of most Americans. He also ignores data that demonstrate how biblical teachings and Christian faith guide millions of people to personal fulfillment and spiritual wholeness, sometimes affirming and sometimes correcting or contradicting his goals and techniques for their attainment. Like him, for example, the Bible affirms the "danger of an overly individualistic approach" to spirituality and the need for a spiritual community that provides "support, checks and balances, and feedback along the spiritual journey" (p. 147).

The diversity of methods applicable to the study of spirituality, selected deficiencies of conventional research, and a critique of a prominent multidimensional study are overly concisely sketched on pages 152–4, yet Atchley refuses to acknowledge that empirical research has strengths despite its weaknesses. He scorns scientific studies of spirituality because every investigation touches only on fragments of the complex subject. His methodological preference is for intensive open-ended interviews instead of the "flawed questions" used in "large-scale structured sample surveys, with their relatively rigid protocols and mathematically abstracted analyses" (p. 190). He rightly emphasizes that "one-shot survey questions" about a person's spiritual identity are very deficient, but he apparently assumes that whatever good researchers interpret as, at best, imperfect reflectors of spirituality, invariably attempt to "measure" its entirety.

This innovative essay will stimulate theory development and research in spite of its disparagement of scientific research, its implicit disparagement of non-Buddhist religious faiths, its subtle contempt for theistic and biblical guidelines for spirituality and aging, and its weak index that omits dozens of subjects and nearly all authors cited in the text. It is based upon introspective convictions, New Age and Eastern philosophical speculations, and erudite opinions presented as facts while ignoring more firmly grounded empirical evidence. Therefore his conclusion is also mine, "Revise and improve. Junk this framework and make a better one of your own" (p. 159).

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History of Science

CHARLES DARWIN (Blackwell Great Minds Series) by Michael Ruse. Malden, MA: Blackwell Publishing, 2008. xii + 337 pages. Paperback; $24.95. ISBN: 9781405149136.

The cover blurb claims that this is "the definitive work on the philosophical nature and impact of Darwin's thought." In reality, it is an extensive informal introduction to the topic. This series focuses primarily on philosophers, and the overall point of the book is to look at the impact of Darwin's ideas (and later developments from them) on philosophy, though Ruse readily admits that Darwin was not much of a philosopher. Overall, Ruse does more to justify the idea that evolutionary philosophy is worth pursuing than to survey what sorts of concepts have emerged from evolutionary philosophy.

As many philosophers and much of the general audience do not have much background in evolutionary biology, Ruse starts with an extensive overview of Darwin's life and evolutionary biology, both as conceived by Darwin and in its more modern development. Some points are oversimplified, and what I think of as important caveats are not always present. Overall, it is a fairly good overview of the field of evolutionary biology (despite disparaging paleontology, which is more or less equated with Stephen Gould). Ruse also gives good coverage of the history, including intellectual history, influencing Darwin.

As many of the book's readers will not be scientists, the quality of the figures could be greatly improved for clarifying concepts. Many of the figures are not very helpful, especially for someone unfamiliar with the field. For example, Figure 4.2 showing the geographic link between sickle cell genes and malaria uses darker or lighter shading for malaria prevalence on one map, and percentages of sickle cell genes in different populations as numbers written on the other map, making them difficult to compare. Figure 5.4 shows *Archaeopteryx* and pigeon skeletons, but differences are not spelled out and teeth are not visible in the former. Several other figures would also benefit from more explanation. A couple of figures are taken directly from Darwin's work, providing a nice historical tie-in (and lack of copyright), but a more artistic modern rendition of the same topic would have been clearer. Figure 5.3, like many biologist-produced diagrams, retains 570 rather than 545 million for the Precambrian-Cambrian boundary, though the geologists made the change well over a decade ago. Also, due to a typo in the figure, it claims that in the upper Precambrian, "cranial sediment chiefly oxidized." Rusty cranial sediment might account for some of the philosophical claims in the book, but "cratonal" was the intent in the figure.

Ruse often presents arguments initially as a dichotomy, only later providing a more nuanced admission that one can hold intermediate or otherwise different positions. This approach tended to annoy me, but it could reflect an attempt to provide a simpler approach followed by complexities, as Ruse uses a colloquial style throughout. Still, there are many passing statements outside the main thrust of a passage that make unsupported philosophical assertions on highly debated topics. The nuanced treatment may come much later. For example, page 111 claims that accepting evolution entailed a change from "a worldview that allowed interventions by the Creator" to "a worldview that refused to allow the Creator any direct role." The next paragraph qualifies this a bit, stating that there is "some truth" to this, and noting that some (like Huxley) endorsed evolution because they already "endorsed the metaphysical shift they thought it embodied," but the following section seems to persist in equating evolution and naturalism. Likewise, chapter 7 begins by asserting that religion "cannot enter into the discussion of the origins and nature of humankind." The intent of the paragraph seems to exclude religious consideration from the scientific discussion (which, of course, is contentious), but it gives the impression of excluding religion from all discussion of origins and of human nature, a much more contentious claim. Later on, the detailed discussion of religion in chapter 10 concludes that Christianity and evolution are reasonably compatible. Thus, it would be easy to pick out quotes supporting a particular viewpoint on evolution and Christianity while misrepresenting Ruse's overall verdict.

Another occasional problem is the use of inaccurate religion-related statements, e.g., "Calvinistic mind cast—a self-deprecating belief that we must have been pathetic degenerates" (pp. 170–1); holding that evolution is not all that important in understanding modern human culture; claiming that character is attributed to lingering effects even in secular thinkers after more than 2,000 years of Judeo-Christian denial that we have any connection to animals (p. 171). On page 208, "Creationism" and "Creationist" are undefined examples of errors. Augustine's willingness to accept nonliteral interpretations of the Old Testament is cited as justification labeling "anti-supernatural explaining away" Augustinian (e.g., the resurrection of Jesus really just means we still feel him in our hearts). Likewise, a passing assertion that the Bible indicates that Jesus expected the end times within his lifetime is unsupported, as well as not seeming tenable to me.

On pages 209–10, Ruse deals very briefly with the suggestion (attributed to Christians generally and Polkinghorne specifically) that human brains have capabilities above and beyond what natural selection would be expected to produce. The response is merely that it is hard to say what evolution could not do and that alternative ideas (i.e., God) are hard to test scientifically. Thus, being hard to test is an advantage for evolution and a disadvantage for alternatives, not to mention the false dichotomy of God or evolution. (Gould's suggestion that human mental capacities could be a byproduct of evolution, rather than directly selected for, gets similar treatment—theistic arguments are not the only ones getting quickly dismissed.) The suggestion by Plantinga (also explicitly labeled as a Christian) that evolutionary explanations for the mind leave us with uncertainty about whether there is any ultimate reality behind them, receives a bit more treatment (pp. 210–4), but the answer is mainly that this places one in an implausible scenario.

On perceived implications of evolution for morality, Ruse surveys a variety of views, including those of Darwin himself. In particular, he highlights the tendency for people to claim evolutionary justification for a number of mutually conflicting moral claims. Ruse notes the problem of identifying evolution with progress, an assumption that underlies much popular invocation of evolution in moral contexts. Rather, Ruse prefers to treat moral norms as an established empirical fact and as a result of evolution, but does not provide a thorough defense of this position. Ruse likewise finds the attempts to provide an evolutionary explanation for religion far from satisfying, mainly because the numerous mutually conflicting models that he notes generally say much more about the author's views on religion than about evolution.

In summary, this book is a good introduction to biological evolution and the ideas that invoke it. Although it is not the definitive work on evolutionary philosophy, the notes will direct the interested reader to the literature. The style will annoy some readers, and Ruse's taste in examples would interest Freud, but it is a useful contribution to the field.

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Mathematics

THE MATHEMATICS OF THE HEAVENS AND THE EARTH by Glen Van Brummelen. Princeton, NJ: Princeton University Press, 2009. 352 pages. Hardcover; $39.50. IBSN: 9780691129730.

In the classic children's story, *A List*,[1] one morning the protagonist, a literal Toad, makes a list of things to do that day. A strong wind blows the list away. Toad is immobilized without it. With it, he could have accomplished many things. In desperation, he enlists the help of his friend Frog, and together they spend the day pursuing the list.

In many ways, Van Brummelen's exhaustive history of trigonometry parallels *A List*. The Frog and Toad protagonists are "obsessed scientists [who] are not very hard to find" (p. 203) and who generate extensive lists of triangle ratios versus an associated angle so as to answer more easily basic questions about the heavens and the earth. Like the wind, time and chance distribute this idea of the list up through the ages and across cultures from the first inklings of the idea with the Egyptians and their notion of slope, to the Greeks and their geometry axioms who in Hipparchus and Ptolemy render their lists using Babylonian sexagesimal form, to the Indians who use a hodgepodge of practical calculation tricks to improve their lists, to the Arabs and their algorithms and more lists, and then to the Europeans who render their lists in decimal form. After each list is compiled, a new generation or an adjoining culture finds a better way of constructing the tables, sometimes rediscovering old ways, yet all mimicking the reasoning and style of Ptolemy's *Almagest* and its recursive construction by way of versions of the half angle formulas and the addition formulas, whose modern day representatives are

$$\sin^2\left(\frac{\theta}{2}\right) = \frac{1-\cos(\theta)}{2} \text{ and}$$

$$\sin(\alpha \pm \beta) = \sin\alpha\ \cos\beta \pm \cos\ \beta \pm \cos\alpha\ \sin\beta.$$

At the end of the book, we the readers are at tea time: Van Brummelen promises a second book to tell the rest of the story, from the days of Copernicus up through today where the lists no longer clutter our bookshelves but instead are readily accessible in e-space, to any desired degree of accuracy.

Although Van Brummelen invites anyone to read his book, he clearly states that "my first loyalty is scholarly," (p. xiii) and that his book is the first updating of the subject "in a Western language" since the 1903 publishing of Anton von Braunmühl's work.[2] He documents the text with hundreds of footnotes, and his bibliography runs to thirty-five pages. To maximize a casual reading experience of Van Brummelen's encyclopedic book, I recommend first getting a broad overview by reading the first forty pages—*the history of mathematics in a large nutshell*—of Berlinghoff and Gouvêa.[3] Then read snatches of a history of math text such as Eves.[4] If after these two, the reader persists in wanting more on how modern society inherited the sine function and its relatives, read Van Brummelen.

Even though he says at the outset that "definitions are unwise in a historical account" (p. 10), Van Brummelen religiously knows his definition of trigonometry and rarely strays from his subject. Throughout his narrative, he features selections from the works of trigonometers written in a semblance of the original notation, followed by an explanation in modern terms. Here are a few snippets of what to expect. When Archimedes was inventing language to characterize very large numbers in his work *The Sand Reckoner*, he uses Aristarchus' model of a heliocentric universe (*and* trigonometric reasoning) because a geocentric model is too small to contain all of the sand particles being enumerated (pp. 27–30). The Indian astronomer Bhāskara (AD 600) used a rational function, whose modern representation is

$$\frac{4\theta(180-\theta)}{40500-\theta(180-\theta)},$$

to approximate the sine function on the interval $0° \leq \theta \leq 180°$; and Van Brummelen offers a clever re-creation of how Bhāskara may have discovered this amazingly good approximation (pp. 102–5). Furthermore, the medieval Indians basically had the equivalent of our eighteenth-century Taylor series for sine:

$$\sin(\chi) = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \ldots,$$

where x of course is in radians. Such discoveries are wondrous, especially if we remember that up until after the days of Galileo, mathematicians worked in prose rather than symbols. Thus ancient and medieval trigonometric algorithms were often a series of couplets. The Arabs used trigonometry for a number of religious purposes: finding the direction from any place to Mecca so that the faithful could kneel in the proper direction during prayer; finding the time of day with respect to the sun, for a true believer needs to pray five times a day at the proper times; and determining when the fasting month of Ramadan, with the appearance of a new crescent moon, begins. To compute such quantities, zealous astronomers compiled detailed trig tables; indeed, the thirteenth-century trigonometer Najm al-Dīn al-Misrī's table contained more than 400,000 entries. The west, too, had equally dedicated zealots; Rheticus, who was mentored by Copernicus, along with a team of four others, in a labor of twelve years, generated 388,800 entries of tables for the six standard trigonometric functions to fifteen significant digits in the last seven hundred pages of his *Opus Palatinum*. With a few corrections near the singularities of the tangent and secant and their co-functions, these tables were the standard until 1918 when Marie Henri Andoyer compiled tables to twenty significant digits.

Finally, a word about the etymology of *sin*. The Greek's basic trigonometric function was the ratio of a circle's chord subtending twice a given angle to the circle's radius. The Indians found the ratio of a right triangle's opposite side of a given angle to its hypotenuse to be a more useful ratio and called it the *jyā*, Sanskrit for *chord*. Islam transliterated the word to the Arabic *jiba*, an Arabic word which also meant *fold* or *inlet*. Translated into Latin as *sinus*, in English it became *sine*, which in practice is abbreviated as *sin*. As for Frog and Toad, like many of the lost trig lists of the past, they never find their original list, but as the sun is setting on their day, Toad remembers the last thing on the list, "Go to sleep," and that is what they do.

Notes

[1]Arnold Lobel, *Frog and Toad Together* (New York: Harper Collins, 1979).

[2]Anton von Braunmühl, *Vorlesungen über Geschichte der Trigonometrie*, 2 vols. (Leipzig: Teubner, 1900/1903).

[3]William P. Berlinghoff and Fernando Q. Gouvêa, *Math through the Ages* (Farmington, ME: Oxton House and The Mathematical Association of America, 2004).

[4]Howard Eves, *An Introduction to the History of Mathematics* (Saunders, 1953).

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ORIGINS & COSMOLOGY

MORE THAN A THEORY: Revealing a Testable Model for Creation by Hugh Ross. Grand Rapids, MI: Baker Books, 2009. 304 pages. Hardcover; $17.99. ISBN: 9780801013270.

The purpose of the book *More Than a Theory* as stated by its author, Hugh Ross, is to "present a creation explanation for the record of nature in a scientifically acceptable form" (p. 14). Ross, the founder and president of *Reasons to Believe* (RTB), goes on to say, "My hope is that by developing RTB's creation model and testing it against other explanations we may see significant scientific progress on the origins and history of the universe" (p. 21).

Ross, his books, and the work of his colleagues at RTB are well known for their advocacy of old-earth views of creation. With outstanding credentials in the field of astrophysics, Ross has done much to draw people into worship as they consider the majesty of the universe in the context of a deep appreciation for the authority of Scripture and a high degree of respect for the scientific findings of cosmology. Through his talks, his books, and his gentle demeanor, Ross has done much to illustrate how Christians ought to deal with contentious issues if they are to be faithful followers of the Christ we all follow.

This book, in particular, has an especially important purpose. Ross has embarked upon a project to develop a scientifically testable model of a biblically consistent view of creation. The model is all-encompassing. It includes both the origin of the components of the physical universe as well as the origin of life and its various forms. Since I am not a physical scientist, this review will focus on the book as it relates to my discipline, biology.

Ross proposes that God has created life through a series of epochs up to and including the creation of Adam and Eve. In the current epoch, God is no longer creating new life forms. We are currently, as Ross sees it, in the seventh day, the day of God's rest. No new species are being created and because of that, biodiversity is decreasing (p. 189). Ross divides life up into three categories: "first, purely physical; second, both physical and soulish (manifesting mind, will, and emotions); and finally, one species with body, soul, and spirit" (p. 170). His first category includes everything except birds and mammals. The second is birds and mammals which, as he sees it, have a special capacity to form emotional relationships not only with members of their own species but also with humans. In fact, God endowed these "soulish" species with special capacities to serve or please humans (p. 170). We humans are unique in that we have soul and spirit. As Ross sees it, the whole purpose of the first 3.8 billion years of life's history is to prepare a place that is ideally equipped for human civilization. Beginning especially with the Cambrian explosion though, God engaged in a *flurry* of activity:

> … the Creator worked efficiently to rapidly prepare a home for humanity. A huge array of highly diverse, complex plants and animals living in optimized ecological relationship and densely packing Earth for a little more than a half billion years perfectly suits humanity's needs. These life systems loaded Earth's crust with sufficient fossil fuels and other biodeposits to catapult humans toward a technologically advanced civilization" (p. 159).

The history of life on earth has one purpose, Ross believes, and that is to prepare the earth for the arrival of our current technologically adept civilization.[1] Our arrival time was planned in advance. We would be created when there were sufficient fossil fuels to enable civilization to thrive. The RTB model proposes that each species of advanced life (i.e., soulish animals) is a unique creation event. For example, the species on the pathway to whales and horses (documented extensively in the fossil record) are not part of an evolutionary trajectory; rather, each species reflects one new creation event. Large animals, as he sees it, are especially in need of new creation events. Because of their large bodies, long generation times, and small population size, they accumulate deleterious mutations, and they keep going extinct. Because of that they have to be created again. Each time, they are recreated a little differently, always becoming increasingly suited in some fashion for a world that would eventually be inhabited by humans. "Creatures such as cockroaches, with long extinction times, manifest either no transitions or very few. God seldom needed to intervene to preserve them" (p. 163). All of this is an interesting approach on how to harmonize one view of Scripture with scientific data. It relies heavily, as I see it, on the views of "genetic entropy" put forward by the young-earth creationist and former Cornell agricultural geneticist, John C. Sanford.[2] I think it would be helpful, though, if it addressed the views and referenced mainstream thought in evolutionary genetics, which is very different than the views espoused here.[3]

The RTB model of unique creation events of all "soulish" species from scratch is inconsistent with other extensive genetic data. The insertion of hundreds of thousands of repetitive DNA elements each at the exact same location really needs to be addressed. It is clear to biologists that by far the majority of these insertions have no functional significance. Hence they are simply passed from one generation to the next as ancient history, "scars" of old events from days gone by. Often when they are inserted at a particular site, they become truncated. When that happens, it is the exact same truncated version that is found at the exact same site in all ancestral species.

Ross attempts to address this question through a three-page discussion (pp. 196–8) of what he considers to be the demise of the "junk DNA" hypothesis. For example, he states that "After more than thirty years of referring to DNA that does not code for proteins as 'junk,' geneticists have discovered five kinds of nonprotein-coding DNA … that perform critical functions." Actually, throughout that thirty-year period, there were likely very few geneticists who would not cringe at the use of the term "junk" DNA. They knew that in the midst of that DNA of no apparent function, there would be portions that were important in regulating gene activity. Ross attributes the recognition, that there was regulatory DNA in the midst of nonfunctional regions, to observations of physicists in 1994. "This breakthrough and later analyses of genomes drew teams of geneticists worldwide into a veritable frenzy to uncover hidden designs …," he states on page 198. Actually the frenzy of activity had dominated the field of molecular biology for the preceding twenty years and continues to dominate it today. Geneticists continue to believe that most of the repeated DNA is not functional, although there are certainly "islands of functionality" surrounded by that which likely has little benefit or harm. The inheritance of these regions of nonfunctionality, including deletions and insertions within them in a lineage specific manner, remains inconsistent with the RTB model.

On page 69, Ross lays out the foundations for the RTB model: "God's dual revelation through the record of nature and through the words of the Bible must be trustworthy, free of contradiction and error." He then proceeds to point out that both the discipline of science and that of theology involve human interpretation. "In some instances these interpretations can be faulty and/or incomplete. Similarly Christian theology is not the same as the words of Scripture. Like science, theology involves human interpretation, which may be inaccurate." This is laudable. What he is saying here is that neither can be totally trusted since both involve human interpretation. Where they differ, one or the other must be wrong.

Given that statement, I am sure that Ross would be the first to admit that he brings his own interpretations to the table as he sits down to write the book. For example, interpreting the wonderful 104th creation-Psalm, Ross suggests that the Psalmist may be referring to extinctions, followed by re-creation events, when he says: "When you take away their breath, they die and return to dust. When you send your Spirit, they are created and you renew the face of the earth" (p. 81). Others would look at this as rich 3,000-year-old poetry in which the poet, like each of us today, celebrates God as the Creator and Sustainer of life in the here and now. They will feel that Scripture is not meant to be used as a scientific textbook, and that doing so leads to an inadequate biblical hermeneutic.

As Ross points out, the scientific data is also subject to interpretation. This means that he is aware that the science he presents to his reader has been filtered through his own perceptions. It is important to emphasize that he sees the science of biology much differently than mainstream biologists, not only in how biology is interpreted but also in how he presents the data itself. We all see data through tinted lenses. However, as scientists who color the lenses of the general public, we have a special obligation to be especially careful that we are presenting the science in a balanced and accurate manner. I am not sure that Ross always succeeds at this. For example, Ross states that the Cambrian explosion "occurred in a time window narrower than 2 to 3 million years (possibly much briefer)" (p. 158). Actually, a recent authoritative review states that "while the Cambrian radiation occurred quickly compared with the time between the Cambrian and the present, it still extended over some 20 million years of the earliest Cambrian."[4] Ross gives no references for his time span of about one order of magnitude less. It may still exist in the current scientific literature, but if so, I think it important to provide the citation, especially given that this is a book intended for non-experts. They will be taking him at his word.

Similarly readers, in being told about human uniqueness relative to the characteristics of chimpanzees, are told that

> New research … indicates that the widely advertised 98 to 99 percent similarity between the chimpanzee and the human DNA is greatly exaggerated … while comparisons between the complete human and chimpanzee genomes have *yet to be done*, the most complete analyses performed so far show that the similarity is closer to 85 to 90 percent (pp. 183–4, emphasis mine).

Ross does not mention (and seems to be unaware) that the chimpanzee genome was sequenced in 2005[5] and that the similarity of DNA sequence between the chimpanzee and human is indeed 99 percent in the portions of the genome that code for protein and 96 percent similar in the genome as a whole.[6] This is much different than his 85 to 90 percent figure.

There are other key statements in the book that are not cited. Here is one: "naturalistic models predict that examples of design convergence should prove nonexistent to extremely rare" (p. 166). I am not aware of any predictions of this sort in the scientific literature and believe it would have been good to cite the work to which he is referring. Also, on page 163, he states, "naturalistic models would predict transitional forms among tiny-bodied simple life-forms vastly outnumbering those among large-bodied complex life." There is no citation and I am unaware of any work that would lead to that conclusion. As another example, on page 162, Ross indicates

> biologists should be discovering new bacterial species (definitions of a species are difficult to apply at the bacterial level) at a rate that roughly exceeds one per year. Yet during the past 150 years biologists have failed to observe—in real time—the emergence of even one truly new bacterial species. (Parentheses are in the original.)

He fails to cite any microbiology data that would allow one to trace the basis for his prediction. Finally, as one last example, on page 147, the book states that "Evidence now shows … the simultaneous appearance of multiple distinct complex unicellular life-forms rather than a single ultra-simple organism." The basis of this evidence is not cited and I am personally unaware of such data.

The sincerity of the project, like the sincerity of Ross himself, is highly admirable. However, if this is going to be science, and not simply a model of how things work based on one interpretation of Scripture, a much more thoroughly cited and up-to-date analysis of the data will be of fundamental significance. Clearly, as Ross himself points out, there is much work still to be done.

Notes

1On page 70, Ross states that God created as he did so that (among other things) he could "supply physical resource for the rapid development of civilization and technology and the achievement of global human occupation."

2John C. Sanford, *Genetic Entropy*, 3d ed. (Waterloo, NY: FMS Publications, 2008).

3See, for example, Michael Lynch, *The Origins of Genome Architecture* (Sunderland, MA: Sinauer Associates, 2007).

[4]Charles R. Marshall, "Explaining the Cambrian 'Explosion' of Animals," *Annual Review of Earth and Planetary Sciences* 34 (2006): 356.
[5]Chimpanzee Sequencing and Analysis Consortium, "Initial Sequence of the Chimpanzee Genome and Comparison with the Human Genome," *Nature* 437 (2005): 69–87.
[6]For a compelling review of the comparison between the two species, see Ajit Varki and David L. Nelson, "Genomic Comparisons of Humans and Chimpanzees," *Annual Review of Anthropology* 36 (2007): 191–209.

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MORE THAN A THEORY: Revealing a Testable Model for Creation by Hugh Ross. Grand Rapids, MI: Baker Books, 2009. 256 pages + 5 pages of appendices, 30 pages of footnotes, index. Hardcover; $17.99. ISBN: 9780801013270.

Many readers of *PSCF* are probably familiar with ASA member Hugh Ross and his apologetics ministry Reasons to Believe (RtB, www.reasons.org). Ross earned a PhD in astrophysics and worked for a time as a research astronomer at a major university before founding this ministry. In recent years, the scientific staff of the ministry has grown to include expertise far beyond astronomy. *More Than a Theory* is the latest of several books from Ross and his team presenting solid arguments that not only is the Bible consistent with the data of modern science, but the data push one toward a belief in the God of the Bible. While this might be considered an intelligent design approach, Ross distances himself somewhat from the Intelligent Design movement per se by being very explicit that the designer is the God revealed in the Bible.

In the book *Creation as Science* a few years ago, Ross broke new ground in the interaction between science and Christianity by proposing that creation be tested as a scientific model. His (really his team's) Bible-based RtB creation model was used to make predictions of what would be found through scientific research in the coming years. *More Than a Theory* is an update of the RtB model approach. Anyone who has any interest in this subject, but did not get around to reading the previous book, should read the present book. Those who read the previous book and would like an update, can now read the latest.

The present book seems to be aimed at a broad audience of both Christians and nonbelievers who have at least a little interest in science, but not necessarily much knowledge of science. Beginning with a discussion of what science is and is not, there is an emphasis on the making and testing of predictions. Some may disagree with Ross' criticism of typical modern definitions of science that allow only natural processes, but he presents good arguments for a more open definition. Ross also discusses how scientists routinely use models, since this concept may not be familiar to readers with less background in science than most *PSCF* readers. Following these points, the book summarizes the various positions Christians have taken over the years when interacting with science.

The real meat of the book sets forth the RtB model, beginning with the biblical basis and proceeding to scientific data and tests in various areas of science. Ross emphasizes RtB's commitment to both biblical and scientific integrity, and a commitment to follow wherever the evidence leads. The tests begin with cosmology and other areas of astronomy, and are followed by the origin and history of life in general; then come advanced life forms, and finally humanity. While there is a good deal of scientific detail here, it is presented in ways that should be understandable to many nonscientists. The extensive footnotes can lead interested readers to more detailed presentations in other RtB books, as well as to the professional scientific literature and other sources. As an astronomer, this reviewer concentrated on the astronomical chapters (but also learned a lot from the biological material). In general, the astronomy is good, solid science. One might argue that while the "just-right" tuning is fundamentally correct, some of it is overplayed to a degree. For example, the temperature and luminosity of the Sun must be very close to what they are for the survival of humanity, but I suspect that these solar properties could be somewhat different *if* the Earth's distance from the Sun were adjusted appropriately to compensate. Large changes in any of these quantities would run afoul of other issues, but small variations may be allowed which could be larger than the book implies. Discussing such interactions between properties, however, could easily get into details beyond the intended scope of this book (or of this review, for that matter). The fundamental point that Ross makes is that a great deal of what astronomers observe broadly is fine-tuned for human life here. This is recognized today by many atheistic astronomers as well as by Christians.

Finally, Ross discusses how the model's predictions have fared to date, when compared to predictions based on naturalism, theistic evolution, and young-earth creationism. Since the other models do not all have predictions made by their adherents, the tests necessarily include predictions Ross constructs from the writings of various authors. To this reviewer, the predictions from the other models do not appear to simply be straw men set up to be easily knocked over. Furthermore, Ross encourages supporters of other positions to send him predictions that can be tested by further research. The RtB model fares very well—read the book to learn how well! It is said that the RtB website will include a list of predictions and how they fare, with periodic updates planned. I look forward to following the updates as they appear.

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Philosophy & Theology

THE REASON FOR GOD: Belief in an Age of Skepticism by Timothy Keller. New York: Dutton, 2008. 242 pages, endnotes, index. Hardcover; $24.95. ISBN: 9780525950493.

Tim Keller is not your typical apologist. Despite being in a quite conservative denomination, Keller has built a successful church in Manhattan by addressing, in a winsome and intellectually honest way, the concerns of his mostly young, urban audience. Keller brings this authenticity and gentle reasonableness to *The Reason for God*. While the book has some shortcomings, it is a positive contribution.

Unlike many today, Keller does not adopt an "us vs. them" culture-war stance. He aims for respectful, reasonable discussion, and usually succeeds. In the first half of the book, Keller considers common arguments against Christianity (including exclusivity, evil and suffering, injustice from the church, science, and the Bible). He urges skeptics to "doubt your doubts" and to see if their reasons for rejecting faith stand up to scrutiny or are based on some alternate, unjustified faith. In the second half, Keller presents positive reasons, moving from arguments for theism (such as cosmic fine-tuning and our sense of morality and longing for God) to Christian specifics like the claims of Jesus and the Resurrection. A final chapter tells readers what it means to commit to Christ.

Keller generally does well with both defensive apologetics and the positive chapters. His writing is accessible without being simplistic, relying on sources like Jonathan Edwards, N. T. Wright, and especially C. S. Lewis. He does not claim to offer proof by the standards of Enlightenment rationalism, but he builds a strong case for the credibility of Christian faith.

ASA members should appreciate chapter 6, refuting the "Science has disproved Christianity" objection. The circular argument against miracles is easily dealt with, but the best part comes as Keller debunks the "warfare" model of science and faith. He approvingly cites Francis Collins and Alister McGrath; warfare promoters like Henry Morris and Phil Johnson are nowhere in sight. He emphasizes the key distinction between evolution as a scientific theory that might describe how God works, and the philosophical naturalism that some (such as Richard Dawkins and, sadly, many Christians) inappropriately weld onto it. Without using the phrase, he tentatively endorses theistic evolution, while rejecting "evolution as All-encompassing Theory." It is encouraging to see a prominent evangelical like Keller avoid the warfare, the uninformed interpretations, the shoddy treatment of science, and the knee-jerk rejection of biological evolution that are common among his counterparts. If more followed Keller's lead, science would be much less of a stumbling block for the Gospel.

Despite this praise, I have two significant criticisms. First, in the chapters on arguments against Christianity, some important questions are addressed weakly or not at all. For example, Keller does a good job of defending the exclusivity of truth and hell as a logical destination for those who actively reject God, but he ignores the biggest issue for many, which is, "Is Gandhi (or my Buddhist friend, or the tribesman who never heard the Gospel) condemned to hell?" In the chapter on the Bible, the problematic inerrancy doctrine is not mentioned, despite its centrality in the author's own denomination. Theodicy is a difficult topic for any apologist, but much of that chapter amounts to "maybe God had a good reason for causing the Holocaust and the tsunami." He does eventually get to the cross and God's participation in suffering, but there is no mention of other concepts that many find helpful, such as Polkinghorne's "free process" defense and similar ideas in Lewis' *The Problem of Pain*.

An example illustrates my second criticism. In chapter 8, Keller shows that "evolution has wired us to seek a God who isn't there" is a weak argument. But then he says, "This is a huge Achilles' heel in the whole enterprise of evolutionary biology and theory." What a silly statement. It may be a flaw for evolutionary psychology, but that is hardly "the whole enterprise." His argument has no bearing on common descent and the other central features of evolutionary biology.

This is not an isolated incident. It is as though years of conditioning trained Keller to take potshots at "evolution" at every opportunity. On several occasions, he forgets the wisdom of chapter 6, failing to respect the important distinction between evolution as science and as an all-encompassing world view. Perhaps chapter 6 represents recent evolution (pun intended) in Keller's thinking, and while writing other chapters he could not resist slipping into old "warfare" habits. Whatever the reason, these vestiges of warfare undercut his previous helpful messages about science.

I am not a big fan of apologetics books. I think we are in a time when more people are moved by a holistic approach to the Christian story (as in N. T. Wright's *Simply Christian*), and when our primary apologetic should be the church as it loves and faithfully follows Jesus. But many people still want specific arguments and answers. For such people, *The Reason for God*, despite its flaws, is much better than most works in this genre, and is well worth reading.

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THE EVOLUTION OF EVIL by Gaymon Bennett, Martinez J. Hewlett, Ted Peters, and Robert John Russell, eds. Göttingen: Vandenhoeck & Ruprecht, 2008. 368 pages. Hardcover; $95.00. ISBN: 9783525569795.

The Evolution of Evil began with a graduate seminar at the Center for Theology and the Natural Sciences at the Graduate Theological Union in Berkeley, California. The participants agreed that through the process of evolution, countless animals have suffered greatly through predation, illness, and extinction over ages of time. In response, they asked two orienting questions. First, does it fit God's character and justice to create a world of such suffering and waste? This is a version of the classic question of theodicy with a deepened challenge from the numbers of harmed individuals over eons of evolution. Second, does the genetic selection of survival of the fittest account for recurring human evils such as genocide? The book's first five chapters orient the reader to theology, evolution, and sociobiology. The second five chapters follow on the first question, and the last five chapters on the second question. Established leaders in the field set the context, and the developing scholars push forward points of the discussion, much as one would expect in a lively doctoral seminar and research group.

Our own ASA Fellow George Murphy provides the book's concluding chapter entitled "Cross, Evolution, and Theodicy: Telling It Like It Is." There he argues that a theology of the cross includes a kenotic view of divine action in creation. God works through, yet is concealed by, the painful process of evolution. The world "must pay a price for its integrity and relative freedom, and that price becomes higher the further living things have advanced toward sensitivity, consciousness, and moral agency." As Ted Peters says, we are destined by our genes to be free. God has endowed us with a genetic system that founds a costly freedom that is worth its high price.

As in almost any anthology, the quality of the chapters is uneven from one to the next, but they are more integrated than in many such collections. One frequent assumption is that extinct species have been wasted. But are flowers that bloom resplendently for only a few days therefore a waste? That an individual or a species is temporally finite does not mean that it was not worth its while. A full chapter is devoted to Rene Girard's theory of scapegoats as repeatedly central to human experience, but the book does not specify whether the phenomenon his argument describes is included as an example of replicating human culture, or of culture repeatedly carrying out genetic tendency. In every chapter, there is the welcome presence of extensive footnotes to alert the reader to the wider discussion. In particular, several of the authors have recently published books to expand the themes of their chapters. Christopher Southgate's *The Groaning of Creation: God, Evolution, and the Problem of Evil* (Louisville, KY: Westminster John Knox Press, 2008) is a case in point.

Considering the book's erudite reflection on an increasingly felt challenge (and the book's price of $95.00), the anthology would probably best fit theological or university libraries.

Reviewed by James C. Peterson, R. A. Hope Professor of Theology, Ethics, and Worldview, McMaster University Divinity College and Faculty of Health Sciences, Hamilton, ON L8S 4K1.

KNOWLEDGE OF GOD by Alvin Plantinga and Michael Tooley. Malden, MA: Blackwell Publishing Ltd., 2008. 270 pages. Paperback; $34.95. ISBN: 0631193647.

THEISM AND ULTIMATE EXPLANATION: The Necessary Shape of Contingency by Timothy O'Connor. Malden, MA: Blackwell Publishing Ltd., 2008. 177 pages. Hardcover; $74.95. ISBN: 1405169691.

The first book is a debate between Alvin Plantinga and Michael Tooley on the existence of God. They discuss whether belief in an all-good, omniscient, omnipotent, God is warranted. While I cannot do justice to the nuances of the complex give-and-take of their arguments, I can suggest some salient lines of their positions. In the opening chapter, Plantinga is concerned to oppose the philosophy of materialism or naturalism. He poses the question of whether faith is warranted. He holds that faith "just *is* a certain kind of knowledge, and knowledge of truths of the greatest importance" (p. 9). Plantinga then defines warrant as "the quantity enough of which distinguishes knowledge from true belief" (p. 9). Warrant, says Plantinga, is related to the "proper function" of our cognitive faculties, "working in the way they are supposed to work" and in the "appropriate cognitive environment" (p. 11). Proper function seems to be related to the notion that our cognitive faculties have been designed for a certain purpose and that our using them for this purpose is how we know that our knowledge is warranted. Naturalism, the belief that matter is all there is, he says, cannot ground proper function and thus cannot provide the warrant for making our true beliefs into knowledge. The reason why it cannot ground proper function is that naturalism does not have any notion of things being designed in nature by "conscious, purposeful intelligent agents" (p. 20). In this way, naturalists have no reason to think that the beliefs with which their cognitive faculties supply them are reliable (p. 30). Thus, naturalism leads straight to an absolute skepticism, since none of our beliefs are warranted.

Plantinga asks what a belief would have to be, from the naturalist's perspective, and he responds that it would be nothing but an electro-chemical event in the brain. As such, he asserts that it could not have any sort of content or signification. In the absence of any reason or purpose behind such neuronal events, naturalists have no warrant for believing that any of their beliefs are true. Hence, materialists, who are true to their position, ought to be eliminative materialists, since under their philosophy, there cannot be any such thing as beliefs. At this point, Plantinga proceeds to give what appears to be an argument for substance dualism regarding human beings. Given that neuronal (material) events cannot be said to have propositional content, he goes on to argue that something immaterial must be at the source of how we get from neurons firing to beliefs: "… if a material object can't think, then whatever thinks must be an immaterial object. Hence a human being is really an immaterial object (or at least has an immaterial part or element)" (p. 56). Plantinga raises a very interesting question with regard to how material events can give rise to spiritual realities such as beliefs and consciousness. He does not consider, however, the possible benefits of the concept of emergence in his appeal to an apparent substance dualism.

For his part, Tooley denies that formulating a credible account of neuronal events with meaning (propositional content) entails an appeal to an immaterial mind (substance dualism) as Plantinga suggests. Instead, he proposes a kind of weak, property dualism. In this brand of dualism, one can account for the existence of qualitative states (e.g., "greenness"), or "syntactically structured sequences of experiential states and causal connections," by appeal to the complex circuitry of the brain. In this way, there is no need to appeal to an immaterial mind since the neurophysiology of the brain is sufficient to account for our experience and beliefs. Tooley develops his position along Darwinian lines by arguing that the beliefs produced by the neurophysiology of our brains can be trusted to produce reliable beliefs and states, because the very survival of our species has been and continues to be dependent upon it.

Turning to theodicy, Tooley's argument for atheism is not of the deductive sort that J. L. Mackie made famous. He does not claim that the existence of evil is logically impossible, given that God is an omniscient, omnipotent, and morally perfect being. His approach is, rather, inductive. He seeks to enumerate a number of reasons, taken from empirical facts about the world, and leading to the improbability of there being a God. He thinks that this approach to the issue is more promising because it is less abstract and more forceful than the deductive approach. He makes a list of many different things that have caused untold suffering, throughout the eons of time, for human and nonhuman animal life.

Having made this enormous catalogue of pain, Tooley focuses upon a single event in human history to make his case: the Lisbon earthquake of 1755, in which about 60,000 men, women, and children were killed. God is defined as a morally perfect, omniscient, and omnipotent person. It is, according to Tooley, terribly wrong that such a being would fail to prevent the Lisbon earthquake from happening. Furthermore, there is no possible good(s) that could have come about, during or in the aftermath of the earthquake, that might compensate for the horror of the catastrophe of this human slaughter. Given this state of affairs, it is, says Tooley, highly improbable that God exists.

Plantinga considers whether the kind of evil that Tooley mentions is a "defeater" for belief in God. He is unimpressed with Tooley's claim that God has no good reason for permitting such atrocities as the Lisbon earthquake. Plantinga asserts that if God exists and is a perfectly good person, then a believer is perfectly within his or her rights in believing that God had good reasons for allowing the Lisbon earthquake to happen. The "rightmaking property" needed to counterbalance this suffering is, according to Plantinga, that a perfectly good person, namely God, allowed it to happen (pp. 170–1). To the counter-argument that he is simply *assuming* that belief is justified in the face of such evil, Plantinga replies that Tooley is equally *assuming* simply that it is unjustified (p. 171).

Plantinga also considers Tooley's argument that the existence of really horrific evil is incompatible with the existence of God. His reply to this is interesting. He states,

> … an *argument* might be counterproductive, enabling the believer in God to turn his attention away from these evils, taking refuge in abstract discussion … It diverts attention from the phenomena that in fact constitute the defeaters for theistic belief (p. 180).

He states that for someone who believes in God "in a sort of weak and perfunctory way," such evils may be a defeater, but for someone whose faith is supported by what Aquinas called our natural knowledge of God or what Calvin called the *sensus divinitatis* or the Holy Spirit, such evils may challenge or trouble one's faith but will not, in the end, overwhelm one's faith (p. 180). Plantinga believes that belief in God is "non-inferentially justified—i.e., that there is powerful non-propositional evidence or grounds for the existence of God" (p. 164). Thus, if a person's "cognitive faculties are functioning properly … [and] she believes in God by way of *sensus divinitatis,*" then "the extent, duration, and distribution of suffering and evil" (p. 180) will not constitute a defeater for her belief because, according to Plantinga,

> She realizes that God has good reasons for permitting these things to happen—after all, being God, he would, wouldn't he? But she may nonetheless deeply resent what she sees God as doing, hate what he's doing, and resent him as well. She realizes that all of this is for some wonderful end, some end God has in mind, an end probably beyond her ken; this need not put her at ease and she may remain angry and resentful. But she needn't even entertain for a moment the belief that there is no such person as God (p. 180).

In *Theism and Ultimate Explanation,* O'Connor's project is to rejuvenate appreciation of the "rich realm of irreducible modal truth" (preface, x). By modal truth he means the way that possibility and necessity are part and parcel of our ability to furnish an explanation of states of affairs in the world. We talk about what *might have been* or what *must be so*. O'Connor is interested in this way of speaking and wants to explore, philosophically, how we know such modal truths:

> … how do I go about "verifying" that my dog *might* have been in the yard instead [of on the couch], or that my wife not only is not but *could not* have been simultaneously in this room and upstairs? These truths are not observable, or obviously inferable from what can be observed (preface, x).

O'Connor criticizes many contemporary denials of his modally realist position. Modal realism is a position that takes seriously the notion that possibility and necessity are part of the deep structure of reality. They are not projections of the human mind, remnants of the conceptual schemes of our language, or merely the contents of empirical generalizations about the world. In his criticism of these various contemporary positions regarding modal truth, O'Connor says, "A great many contemporary metaphysicians have been captivated by the modally denuded Humean picture of the physical world and our interactions with it …" (p. 31).

Having defended his notion of modal realism, O'Connor now attempts to employ it with respect to the nature of the world and the existence of God. His purpose amounts to a revival of Aquinas' "third way" for the existence of God, which is based upon "possibility and necessity." O'Connor takes seriously the perennial question, "Why is there something rather than nothing?" He believes that this question implies the notion that the things of this world are, in their ontological character, "contingent" or non-necessary. A continental philosopher might put it more poetically and say that this world is a "gift." Be that as it may, O'Connor claims that the contingent character of the things and events of the world are causally dependent upon and find their ultimate explanation in a transcendent, necessary being, who is God (p. 85).

Of particular interest to readers of this journal will be O'Connor's final chapter in which he discusses the relation of his philosophic findings on the divine nature to Christian revelation. He chides many contemporary Christian theologians for their "de-Hellenizing" tendencies in rejecting the results of philosophic theology. While he respects some healthy criticisms of the ways that such philosophic frameworks may modify, distort, or ignore the character of the God revealed in Scripture, O'Connor asserts that not all such suspicions are justified:

> … there is also bad news for the uncompromisingly "de-Hellenizing" theologians. Natural theological reflection cannot be neatly separated from unphilosophical religious belief. Specifically, the concept of God implicit in certain claims at the heart of the biblical revelation themselves *require* articulation in the metaphysical terms of necessary being (p. 132).

As O'Connor later argues, those who would deny God's ontological character as a "necessary being" attack God's sovereignty over created being since they are claiming, implicitly, that "… there *could* have been objects other than God who do not owe their existence to anything, who just 'happen' to exist" (p. 143). Such a state of affairs would be embarrassing for Christians to hold since God would no longer be the "Creator of all things, visible and invisible."

Both of these books offer nuanced and sophisticated reflections in philosophical theology. For that reason, it seems to me, they are recommended more for graduate school libraries in philosophy and theology than for undergraduates. Still, the precocious undergraduate may profit from them.

Reviewed by Jay Aultman-Moore, Professor of Philosophy, Waynesburg University, Waynesburg, PA 15370.

Religion & Science

THE HISTORICITY OF NATURE: Essays on Science and Theology by Wolfhart Pannenberg; ed. Niels Henrik Gregersen. West Conshohocken, PA: Templeton Foundation Press, 2008. xxiv + 242 pages. Paperback; $29.95. ISBN: 9781599471259.

Even those who do not or cannot agree with him on any number of points admit that the sheer breadth of Wolfhart Pannenberg's oeuvre places him in the top tier of twentieth-century theologians. Through his numerous published volumes and articles, Pannenberg proved himself to be a formidable theological thinker who was capable on multiple fronts. His keen intellect allowed him to see through to the problem areas in the thinking of theologians and philosophers as diverse as Kant and Barth, Bultmann and Cobb, Descartes and Schleiermacher. As this volume of essays shows, Pannenberg was equally adroit at engaging even the meteoric advances that so characterized science across the twentieth century in the fields of quantum physics, cosmology, evolutionary biology, and psychology. In short, these collected essays prove yet again that Pannenberg is an alarmingly learned individual.

This volume, edited by Pannenberg's former student Niels Henrik Gregersen, brings together sixteen essays, all of which traffic in topics somewhere in the vicinity of the border territory between theology and science. Two of the essays were previously unpublished, and seven others were translated from the original German by Linda Maloney specifically for this volume. A couple of the more recent pieces were published in other venues as recently as the year 2000, whereas most were published in the 1970s and 1980s in a variety of periodicals and edited volumes. This collection, published by the Templeton Foundation, is divided into four sections: Methodology, Creation and Nature's Historicity, Religion and Anthropology, and Meaning and Metaphysics.

Across the scope of my own theological education, my exposure to the thinking of Pannenberg was regrettably little. But even those pastors and theologians who know only a bit about the theological contributions of Pannenberg are probably aware that his work concerning the historical nature of Jesus Christ's resurrection is among his signature pieces of reflection. In fact, I have always found his writing on this subject to be profound and yet accessible enough that I have been able to weave it into more than a few Easter sermons. Although this review cannot capture the subtle nature of his thinking, it may suffice to say that in the face of those who mumbled about (if not outright denied) the historical nature of the resurrection, Pannenberg asserted that Jesus' rising again from the dead was at once a historical occurrence and yet an out-of-history event, in that Christ's emergence from his tomb represented not so much an event of past history as an in-breaking of the future into our collective past. Christians have the hope that they will one day rise again, not just because God says it *will* happen but because in Christ it already *has happened.* The future's promise already came true in the past. This is our hope.

In this volume of essays, Pannenberg's distinctive view of the future's influence on our present moment is on prominent display. For many Christians who try to engage theological and faith matters with reference to the teachings of contemporary science, it is the past, the beginning, the origin of the universe that becomes of paramount importance. What did God do to make the Big Bang possible? How did God order the cosmos in the beginning, and what does that tell us about our present moment and the nature of all that exists? In short, when it comes to faith and science, many Christians look to the past. Pannenberg, however, turns this on its head through his belief that it is *the future*, not the past, that is decisive for what is happening now.

Pannenberg believes that far too many theologians and ordinary Christians look to the distant past in order to see what God did, once and for all, in the creation of the universe. The idea seems to be that God finished his work of creation long ago and, having clapped the dust off his divine hands, walked away from that creative process with a de facto declaration along the lines of, "That's that." But Pannenberg is utterly convinced that the act of creation is ongoing, and that it is the realization of God's future vision for this universe (what believers would call the fullness of the Kingdom of God or of the New Creation) that not only draws the universe onward in a kind of evolutionary progression right now (and throughout our past) but that renders the whole of reality as utterly contingent and ever-new. As Pannenberg writes, "Contingency and novelty in natural processes can be interpreted theologically as evidences of God's continuing creative activity" (p. 47).

A striking insight that emerges in this volume is Pannenberg's conviction that the universe is not governed by fixed laws that determine what happens moment to moment so much as it is filled with contingency and novelty, as God retains divine freedom to make the universe into what he desires it to be in the future. Of course, a great many regular patterns emerge from God's orderly arrangements—patterns that we are able to codify into what we would regard as the rules that govern "the way things go" in this world. But for Pannenberg, those patterns (or what some might call "natural laws") are less about some fixed order established long ago and more about the regular ongoing work of a God who compels the universe forward, not from behind, but from up front, as he draws all things toward the future he has planned in Christ.

This fundamental orientation of thought informs a great many of the essays in this volume. Because these sixteen pieces were never planned to be incorporated into a single book, there exists across them a fair bit of repetition. If you read this volume from cover to cover, you will repeatedly run across sections that ponder how "field theory" may explain divine action in our physical universe, as well as other sections that discuss Pannenberg's views on evolution and the Bible, including his clever point that even biblical literalists should note that in Genesis 1, God commands *the earth* to bring forth a variety of plants and species (and so why would anyone be surprised to encounter the Darwin-esque discovery that over time, *the earth* did indeed evolve a wide variety of plants and species!?).

But despite some repetition of thought, these collected essays impress the reader with Pannenberg's breadth of learning. Included here are essays that smartly engage questions surrounding human consciousness and the nature of the soul, process theology (and why its teachings on the "initial aim" of each creature do not anchor our hope the way Pannenberg's own "anticipated" future work of God succeeds in doing), the *Logos* Christology of John Cobb (and Pannenberg's sharp insights into how Cobb deviates far more from his teacher, Alfred North Whitehead, than Cobb himself seems to sense), and several different reflections on the nature of time, space, and eternity, some of which, to be frank, go to places somewhere beyond this reviewer's ability fully to comprehend or grasp!

Although a few of the essays from the 1970s and 1980s seem a little dated in terms of not taking into account more recent scientific developments, this collection of essays from the last third of the twentieth century feels fresh and vibrant and deeply challenging. There were a number of passages that seemed overly ponderous, and there were a few occasions when I wished Pannenberg had been willing simply to grant that faith-based insights, as delivered to the heart of believers by the inner testimony of the Holy Spirit, count as reliable and epistemically defensible pieces of knowledge that need no further proof or elaboration. But those quibbles aside, reading these essays revealed not only the mind of a brilliant theologian, but also the heart of a true believer in the future God has prepared for his creation beyond the inevitable demise of this current cosmos and/or of the exceedingly brief existence of any one of us.

The editor no doubt knew what he was doing when he concluded this collection with a relatively short essay titled "A Modern Cosmology: God and the Resurrection of the Dead." In it, Pannenberg engages the thought of Frank Tipler, whose reflections on the anthropic principle and related matters may not indicate the replacement of theology with physics (as Tipler has suggested) so much as (in Pannenberg's term) the "approximation" of the two. But at the end of this short essay, Pannenberg is at his theological and lyric best as he notes that when pressed, Tipler claimed he was not a Christian, because he could not believe that anything like a resurrection from the dead could ever have happened. Science rules out such miracles, after all. Still, Tipler's own belief that the universe is headed toward some omega point of renewal led him once to admit that he could believe in a resurrection of a dead person in the past "if the appearance of such a person at a particular stage of human history were necessary for the omega point to be attained at the end." To that deeply intriguing musing, Pannenberg replies, "According to Christian teaching that is, in fact, the case" (p. 210).

Or to put it another way, "Risen indeed!"

Reviewed by Scott Hoezee, Director of the Center for Excellence in Preaching, Calvin Theological Seminary, Grand Rapids, MI 49546.

Book Notice

THE EXTRATERRESTRIAL LIFE DEBATE, ANTIQUITY TO 1915: A Source Book by Michael J. Crowe, ed. Notre Dame, IN: University of Notre Dame Press, 2008. xxi + 554 pages, appendix, selected bibliography, index. Paperback; $39.00. ISBN: 9780268023683.

This source book, in fact, a monumental anthology, presents key documents from the pre-1915 history of the extraterrestrial life debate. Michael Crowe, the Rev. John J. Cavanaugh Professor Emeritus in the Graduate Program in History and Philosophy of Science at the University of Notre Dame, provides an introduction and commentary for each of the source documents, some of which are published for the first time or in a new translation. The book is designed to shed light on the question of the existence of extraterrestrials, and on those who sought to tackle the question. The range of documents treated is extremely impressive: excerpts of primary sources from Aristotle and Lucretius, through Newton, Pope Voltaire, Kant, to Herschel, Darwin, Wallace and Lowell, among others.

Reviewed by Arie Leegwater, Calvin College, Grand Rapids, MI 49546.

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