PERSPECTIVES on Science and Christian Faith

JOURNAL OF THE AMERICAN SCIENTIFIC AFFILIATION

In This Issue …

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

VOLUME 67, NUMBER 1 **MARCH 2015**

(US ISSN 0892-2675) (CPM #40927506)

Perspectives on Science and Christian Faith

Perspectives on Science and Christian Faith (USPS 28-3740, ISSN 0892-2675) is published quarterly by American Scientific Affiliation, 218 Boston Street Suite 208, Topsfield, MA 01983. Periodicals postage paid at Topsfield, MA, and additional mailing office. POSTMASTER: Send address changes to: Perspectives on Science and Christian Faith, 218 Boston Street Suite 208, Topsfield, MA 01983.

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Qwerty, Time, and Risk

James C. Peterson

Our keyboards still have "qwerty" across the top line. This layout of keys is not the most efficient for typing, but it avoided hammer conflict in the first mechanical typewriters. The people who learned how to type on those first typewriters preferred not to learn a new layout, so the next typewriter iterations carried on the pattern, gathering even more typists invested in the "qwerty" line-up of keys. Continuity has a significant benefit in minimizing the time required to retrain.

Continuity also facilitates cooperation. This journal asks for submissions in one of the Word formats, not because it is the best word-processing program, but rather, because it is the one most widely used and enables all the reviewers, editors, checkers, and printers involved in developing and printing each article, to work together. The original author and the many people who shape a successful article at some point in the publishing process, dispersed across state and national borders, can be counted on to be able to handle that software. They can focus on the content and formatting rather than compatibility issues. Converting everyone from one common platform to another, even to a word processor that is better in some sense, would be disruptive and demanding over an extended period of time. This always leaves open the question as to when such a change will be worth the effort. There will no doubt be a point eventually, when the change will offer a net benefit.

Paradigm shifts—those in which one comes to understand something in a substantially different way—are even more complicated and demanding, and yet each of our authors in this issue is proposing some sort of paradigm shift. Karl-Dieter Crisman advocates open source software replacing much of our routine dependence on proprietary software. Janet Warren argues that half the world's population should be more concerned about the sin of apathy than the more often-cited sin of pride. She writes that if that were to change, more women would contribute to the STEM disciplines. Gregg Davidson states that the evidence is so overwhelming for common descent, that it is time to understand Adam and Eve as a hominid couple chosen by God to be the first endowed with souls. In contrast, Denis Lamoureux sees Adam and Eve as an assumption of ancient science that Genesis uses to describe human sin and the need for forgiveness, not as a particular first human couple. Then Derek Schuurman tells how he found on site that his earlier work, that of sending refurbished computers and software to developing nations, had not been as successful as he had hoped. He offers a new paradigm: establishing open source software and solar-powered computers as a more effective alternative.

Paradigm shifts create new risks. Implications and complications that no one predicts are to be expected. Early adopters relish investing the needed time and expertise to explore and troubleshoot changing approaches. It is a judgment call, then, for the rest as to when the evidence, benefits, and reliability are sufficient to make the switch. The widespread adoption necessary to keep cooperating can take considerable time through an often awkward transition. It took a century and a half for the solar system proposed by Copernicus to be widely acknowledged as more likely than the geocentrism that had prevailed for millennia. We often make such conversions more quickly these days, but not necessarily less painfully. Sometimes it takes a rising generation in a field to recognize the validity of the new approach, since they are not as invested in what had been previously taught.

Acknowlegment

At other times, a new approach is shown to be lacking before it spreads; thankfully, it dies out before more people fall under its misapprehension. Simply being new is, of course, not automatically superior. Eventually, if a new paradigm indeed makes better sense, the changeover can be worth the effort. We have seen that time and time again.

It has been said, in short, that if you think education is too expensive, remember the cost of ignorance. In parallel, it might be said that paradigm shifts are often jarring and disruptive. They can be uncomfortable, even disorienting. Yet a paradigm shift is not as costly as failing to change when change is warranted.

PSCF offers, in this issue, some proposed new approaches that are well worth the evaluation of our readers. ♦

James C. Peterson, *editor*

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Open Source Software and Christian Thought

Karl-Dieter Crisman

Karl-Dieter Crisman

This article introduces the distinction between proprietary and open source software, and discusses connections with Christian thought. It argues that this distinction is important for Christians to understand, and covers four main resonance points between Christian thought and open source software: stewardship, building community, helping the underprivileged, and promoting creativity. It also addresses how the approaches differ.

With ubiquitous computing power, the practice of science has changed dramatically—as has the range of ethical issues Christians must respond to concerning privacy, computing access, and whether to enhance human abilities.[1] This article surveys, and suggests, responses of the Christian faith tradition, in particular, to the idea of *open source software* (OSS). Open source refers to the way software is developed. It not only has implications for how we do science, but also has deep resonance with a number of core values in Christianity.

Especially with respect to creativity and freedom, the position taken here is that OSS better expresses a Christian approach. However, it is also not a panacea or a unique way to "write or use software Christianly," and such a survey cannot possibly be comprehensive. The intention here is to open the door to further discussion of the issues involved. As Redeemer University computer scientist Derek Schuurman says in his recent book, *Shaping a Digital World,* technology really is not value-neutral;[2] tools and methodologies Christians use in science have potential to reflect our beliefs as much as the questions we choose to address.

Open Source Software

The *source code* of a program is the original instructions to the computer, written by programmers. Usually this code is in a higher-level human-readable language such as C++, Java, and Python. By contrast, the software itself is usually a binary file—one only the computer can really read and interpret. This sets up a fundamental distinction:

> *Open source* software is software whose source code may be modified and redistributed. The source code of *proprietary* software may typically not be modified or redistributed without express consent.

We will delve later into further important distinctions, but the right to redistribute the source code is the most fundamental operating difference. One reason this is confusing is that, although nearly all OSS has no immediate acquisition cost, it is *not* the same as no-cost "freeware."

Consider the Firefox web browser or LibreOffice office suite;[3] these are OSS, but there are no-cost or loss-leader equivalents which are not. On the other end, many of us (whether we know it or not) use the Linux operating system kernel in embedded devices, in Android phones, or in company/university backends—in the latter case, with expensive service

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contracts. Similarly, the OSS Apache and nginx web servers, invisible to the end-user, dominate that market.[4] One may not even be aware that one's software is open source.

In science, the ideas of open access (for example, *PLOS*), open wikis, and open standards are more familiar, and we will spend some time on current technical science-related arguments regarding OSS shortly. But open source is only related to these, not identical to them, and to truly understand this (as well as the theology), a small amount of the history of OSS is necessary.

A Brief History

Many programmers of open source consider it (accurately) to be a movement, or even a philosophy. This view stems from a change in the role of programmers over the decades as software, not hardware, became the more marketable product. Political scientist Steven Weber characterizes this transition in his *Success of Open Source,* "The narrative of the programmer is … of the craftsperson from whom control and autonomy were taken away."[5]

Steven Levy's book *Hackers* tells this story (which is almost a mythology by now) in far more detail.[6] To oversimplify, it says that programmers from the 1950s to the 1970s, whether working in garages or on huge IBM mainframes, could be artisans who shared ideas and code, while today they are fungible resources. Whether this narrative is always true is less important than that it can feel true—that one may wish to see innovations built upon, not endlessly reinvented.

The mechanism asserting this control over a program is the *copyright license*. Standard intellectual property protocol for software grants the user a limited license to use copyrighted material. A free version may be restricted to nonprofit activities; some licenses restrict use outside the United States or prohibit use for certain activities, for example, creating weapons, and most explicitly require release from liability. Since the source code typically can be used to recreate the program, it is usually not included, and attempts at reverse-engineering are also usually prohibited by the license.

The key innovation by early open source developers—most famously in the case of Richard Stallman in the early 1980s—takes the idea of such licenses and inverts it, with a radical rethinking of intellectual property. *Open source licenses explicitly allow redistribution of source code.* There is no space to go into the full history of the various open source licenses, including the role that AT&T's phone monopoly played in it, but to really understand the motivations behind open source, any of the many books on this in the endnotes are well worth the read. Weber summarizes it well: "Property in open source is configured fundamentally around the right to distribute, not the right to exclude."[7]

It would take another article to examine properly why people write huge amounts of software under licenses that make it nearly impossible to charge for the software itself—not to mention how it often happens in a highly decentralized way, with corporate support coming after, not before, success. Some explanation will come up when we discuss community and creativity below, but for now we will follow open source guru Eric Raymond and others in stating that work on OSS, whether starting a project or working on a bug, comes from "scratching a developer's personal itch."[8]

One of the most pervasive licenses, originating with Stallman, does not even allow modifications to be distributed without allowing subsequent modification and distribution ("copyleft").[9] This means that not only can one modify the code (open source), but that it also can *never be directly used in a proprietary product.* Advocates of this stance often reject the term "open source," which dates to early 1998,[10] and use Stallman's original "free software,"[11] because copyleft licenses are to protect the freedom of the developer and all future users to do whatever they want with the software.

This is a controversial distinction. On the one hand, one might ask whether this sort of restrictive freedom is indeed free. On the other hand, one might ask whether allowing code that was initially open to become closed is in the spirit of freedom. There is a very healthy ongoing debate on this issue (including among the referees of this article!), and we have no intention of resolving it, on a Christian basis or otherwise. What is crucial for our purposes is that partisans of both perspectives are using the language of morality and freedom (in addition to other, more technical rationales) for at least some of their motivation for using such licenses; we will return to this several times.

Science and Open Source

Before considering theology and OSS, it is worth noting that there is a healthy discussion regarding OSS in scientific contexts, and it is not of purely academic interest. This will also help flesh out what OSS is.

First, OSS is everywhere in science. Well-used tools such as Biopython and Bioperl are sponsored by a foundation for open bioinformatics, while the R data analysis project is ubiquitous enough in biostatistics, psychology, and even finance that there are companies whose business model is entirely based on support or extensions for R.[12] The industry standard for technical document preparation in mathematics and physics continues to be programs based on LaTeX. In geography, the GRASS GIS has been under continuous development for decades, as has Octave in numerical calculation. In addition, there are hundreds of toolkits and files that researchers make freely available which run routines and scripts based upon standard proprietary tools such as MATLAB; such code is often OSS.

This illustrates a point commentators have made numerous times. In Weber's words, software is an "*antirival*" good.[13] Not only does the value of software not diminish if more people use it, including freeloaders (as opposed to the "tragedy of the commons"), but its value may also increase with additional users—for example, when they contribute bug reports or other suggestions. In domains with some programming expertise, OSS leverages this further with user-contributed fixes.

As science becomes more and more reliant upon computation (and scientists more knowledgeable in it), the value that most scientists receive from software is not the resale value of any software they use or develop, but the freedom to solve their own problems, whether in proteomics or optimization. Significant customizability and the ability to quickly fix problems in a program may even be a prime motivation behind starting a new project.

At the same time, because of the focus on use and not necessarily on development, the sciences will also ask hard questions about any new software. Questions of support arise—whether for support staff or for third-party/hardware support. Particularly in pedagogical contexts, the nature of the learning curve for the user interface and "sunk" investments in a program bear consideration.

We find that such questions accentuate the complexity of the issue; they do not provide a clear technical preference of one form. Some companies provide excellent support with their proprietary licenses and frequent updates; others may be sold to another firm which lets a product languish, or just go out of business with the customer at a loss. Similarly, some open source programs have robust ecosystems of online support and an easy transition from other programs, while others are known for challenging, developer-centered interfaces or lack of access to hardware.

However, scientific considerations, such as transparency and reproducibility of research, have gained in importance recently. Several editorials in scientific journals over the past five years, along with the explicit policies of some journals, have urged this. In particular, data and analytic code should be made available and usable for peer-reviewed work, while the analysis itself should be reproducible by "executing the code on the data provided and produc[ing] results matching those that the authors claim."[14]

Though this is possible using code built upon programs like MATLAB (as *PLOS*'s statement allows[15]), it does beg the question of whether to trust the results of programs whose source one cannot see, especially if the algorithm *is* the research, for instance, a new statistical test. On a more practical level, it is an incentive to release one's own code as OSS to enable further advances in science.

Those close to, or in, mathematics or computer science have additional issues to consider. For pedagogical reasons, students should often be able to verify and understand algorithms, and it is incredibly instructive to do so in the software they are actually using. Similarly, one might also want to know whether a correct algorithm has been correctly implemented.[16] Again, this is only possible with some way of viewing source, though not necessarily with rights to modify and redistribute.

Finally, considering how research has expanded beyond the domain of large universities in the West raises the question of who can afford to use certain types of software. Someone finishing doctoral work may move to an under-resourced college or return to a university in the developing world, where they may not be able to afford a license to use code developed for their dissertation. Differential pricing

schemes may be part of the solution; open source has this potential as well.

Christian Thought and Open Source

In all three of these latter examples (transparency, pedagogy, and access), one senses the ethical imperative coming through. Open source users and creators have a history of explicit moral value judgments in their self-perception and motivation. So it should be no surprise that there are explicit connections to Christian thought.

There are four major areas of resonance. It is worth noting that they are quite ecumenical and form natural connections to many secular value systems as well. We will return to freedom after considering each of the following in turn:

- Stewardship
- Building community
- Helping the underprivileged
- Promoting creativity

The claim of this article is that, although none of these are guaranteed simply by using OSS (and many proprietary programs have potential in each of these areas), open source has more potential to live up to these virtues, and hence, in general, gives more opportunity to connect with these Christian ideas.

Stewardship

The most obvious attribute of OSS is its low acquisition cost, and for many Christian commentators this question is best subsumed into that of direct stewardship of monetary resources for a given organization. We will leave aside for the moment whether this is all that stewardship is, and ask whether using OSS is like the servant who doubled the ten talents.

As a representative of many who say yes, consider erstwhile Charlotte, North Carolina, house church leader Donald Parris's detailed documents on switching church functions such as accounting and scheduling to computers using Linux. He asks,

> Cost is not the only factor in your [software] decision, and not even necessarily the most important. Yet, if you could reasonably manage your church for less money than you currently do, wouldn't you want to explore that option further? You might be able to … boost a missionary's efforts …[17]

The vision is compelling.

With *any* software, however, support and training costs, hosting, and other aspects of "total cost of ownership" (TCO) must be considered. In a recent microeconomic analysis, the software acquisition cost portion of (self-reported) TCO by firms in countries of all development levels was shown to be only one of the determining factors when considering whether to use OSS.[18] (This study would have been more valuable with far more specifics about the products acquired.)

As an example more familiar to many readers, although OSS learning management systems such as Moodle have partners offering paid support,[19] the lack of a sole institutional support point (as with rival Blackboard), can be a key deciding factor when the first priority is 100% uptime. Further, with extremely cheap internet access and free cloud-based solutions such as Google Docs, the dynamic has changed even further.

On the other hand, one blog post by a church solutions firm goes so far as to suggest that only churches with a lot of tech-savvy members need use OSS[20]—this is simply false.[21] There are OSS solutions needing no special training, and proprietary programs needing a great deal of it; this is not a specifically OSS versus proprietary argument. And certainly for many small organizations, acquisition cost *is* the largest part of TCO.

This brief stewardship discussion should make it clear that, although one may make a good argument for a specific open source product on price alone, this is only a part of a Christian reflection on OSS.

Community

It may be a surprise that for many open source users, fostering community plays a central role. One extremely popular content management system advertises itself with the tagline, "Come for the software, stay for the community."[22] Stallman, of "free software" fame, does not really disagree with the characterization that he "built up an entire political movement to address [the] issue of … crushing loneliness."[23]

Users and developers of OSS share and grow ideas intentionally together, including in person, and often speak of this aspect. One referee spoke quite eloquently of a "real Acts 2 vibe" and companionship. This resonates with Christian themes: Israel is to be a microcosm of true community; Jesus calls the disciples his true family; and the epistles are full of descriptions of how to live in community.

However, open source community is not identical to Christian community. Some OSS communities can be exclusive or even hostile to those new to it, to members with a different licensing philosophy, or to those who transgress unwritten norms.[24] Some projects can at least be perceived as uniting against the common foe of a particular computer company. Research does not suggest that this is a primary motive, but it is *a* motive.[25]

Finally, as a worldview (not necessarily in personal interaction), OSS communities value people for contributions. Extensive research bears out that in a "typical" project, reputation gained by meaningful contributions means something.[26]

In order to analyze this, we must compare it to an alternative model. Companies such as Google and Apple also welcome limited-user community, for example, in the form of help forums, but without the cultivation of "every user as a potential volunteer"[27] and the prototype of servant leadership. Training sessions in open source communities nearly always are about building one another up,[28] not about selling the features in the latest upgrade.

Larry Wall, an evangelical Christian, is the founder of a popular open source programming language, Perl.[29] He has often spoken explicitly about this connection: "[I modeled] the Perl movement on another movement … the founder [of which said], 'He who wishes to be greatest among you must become the servant of all.'"[30] Indeed, because developing OSS is typically voluntary, there is a real subversion of traditional hierarchies. Project founders cannot be autocrats, but they must convince developers of the technical superiority of their ideas. Wall says,

> I began by talking about the virtues of a programmer: laziness, impatience, and hubris. These are virtues of passion. They are also virtues of an individual. They are not, however, virtues of community. The virtues of community sound like their opposites: diligence, patience, and humility.[31]

Freed from making a sale, the open source model can relate to these spiritual gifts. Asking someone to use OSS means trying to win a contributor, not trying to acquire a customer; Schuurman mentions "the notion of common grace" to explain this.[32]

Raymond explains why this is true for developers: "authority follow[s] responsibility" for any piece of code.[33] However, any *user* has this potential as well, for example, by contributing to a help forum, suggesting better translations, or trying new versions. Proprietary systems usually pick exclusive groups with nondisclosure agreements; in the open source world, such groups must be as open as possible for success.

Philosopher Pekka Himanen compares social bonds in open source to a Plato-like academy of "companions in learning," rather than to an authoritarian monastery.[34] Jesuit spokesman and theologian Antonio Spadaro rightly calls this particular analogy *"molto riduttivo"*;[35] still, it seems very similar to Jesus's teaching his disciples to see him not only as master, but also as a friend who has given them power of their own.

There is a further reason for Christians to be involved with open source communities. The primary means of communication is electronic—one of the most powerful, fast, and nuance-free forms there is. Hence, there is rampant potential for misinterpretation and rash words. Becoming *charitable* contributors to such communities is one of the most powerful places Christians can be witnesses in the digital age; because of the distributed nature of OSS development, they can rise to positions of real influence and respect, and cause others to do likewise.

Helping Others

One of the most compelling moral arguments made in favor of OSS is that it allows sharing of one's resources with others. This is a prominent theme of Glyn Moody's *Rebel Code*, a major history of the GNU/Linux operating system.[36] Parris and Stallman are both extremely vocal on this. For Parris, it is partly because software piracy and "convenient" copying is so prevalent inside the church. Perhaps ironically, Stallman, a staunch atheist, asks Christians to call proprietary software demonic, since, in his view, a putative Satan would like nothing better than to hook people on things that are fun "on condition that they refuse to share it with anyone else."[37]

(Scriptures such as Luke 6:34–35 probably more than superficially support this view.[38])

In general, there is debate over whether new technology is good because it promotes efficiency, or bad because it creates dependence. Jacques Ellul's views are well known: "Everything in the technological world is a means and only a means, while the ends have practically disappeared."[39] Nonetheless, within the open source community (both from Christian and secular perspectives), there is a consensus that working on OSS can indeed help others, particularly the underprivileged.

Marco Fioretti, the founder of an Italian group of Catholics supporting OSS,[40] quotes liberally from papal encyclicals and scripture about repairing divides between rich and poor nations, and Baylor professor Alan Jacobs refers to the open source community as the "cyber-Amish."[41] In a personal communication, the founder of one open source program says,

> I think Sage is a form of contribution in a social sense. Open source is the way some nerdy types can best voluntarily contribute to society … I think the really good people that are a pleasure to work with see the social contribution as something they greatly value.

Himanen cites the same idea, "a desire to rid the network society of the survival mentality that so easily results from its logic."[42] Wall concurs, "People really do help people for the sake of helping people."[43] This motivates those of no faith as well as those of faith.

This argument also holds water empirically. To be concrete, OSS properly organized—which is not a given—has a number of important advantages in granting opportunity toward those not in the digital elite. We give some examples from a development point of view, though other ways of helping others can be analyzed similarly.

From the pure acquisition cost perspective for its graduates, the African Institute of Mathematical Sciences, for example, has a blanket policy to use OSS in all its dealings.[44] The original vision of One Laptop Per Child was to use Linux for this same reason. Bandwidth is also a cost issue in many circumstances.[45]

Similarly, especially in the developing world, low-end hardware or old operating systems is a real issue.[46] Typically, it is not worth the effort for a normal software developer to continue providing versions of their software for such situations. With open source, the potential exists to keep things operating far longer than typically viable, although it is not a guarantee that it will happen. As one example, MATLAB is currently dropping support for Windows XP, which still has significant market share worldwide, while GNU Octave maintains it.[47]

Two closely related points should be considered: learning from OSS, and localization. A number of studies (including some cited above) show that, outside a context where English is an expected knowledge base, using or writing software without the language or visual cues appropriate to a culture is unlikely; however, those with the language/cultural skills have many opportunities. Because the source is available, one can learn programming paradigms (as already happens with web pages because of Tim Berners-Lee's insistence that one must be able to "view the source"); for the same reason, localization is truly possible even for smaller firms in the OSS context. A good example is an Italian thesaurus contributed to OpenOffice by a school in Bologna.[48] But localization is not a guarantee, and requires infrastructure, as in the ANLoc African Locales Initiative.[49]

On the academic side, economists have done analyses of accelerating knowledge transfer to the developing world using OSS[50] and have published case studies of whether and how it is used.[51] Josh Lerner and Mark Schankerman's analysis examines current practice and draws mixed conclusions, but reinforces the idea that, even with large amounts of "comingling" of code, both small firms and large firms benefit from using OSS in varied cultural contexts.[52] Weber makes a lengthy related argument with respect to exclusion from the digital economy and dependency theory, though his argument also connects to freedom.[53]

It may thus be a little surprising that, despite many OSS Christian software projects, such as for church databases, there are few examples of institutional religious activity in the open source world.[54] Columnist Bruce Byfield suggests several interesting ideas on why this might be, in a 2006 article in Linux .com.[55] Catholic commentators such as Fioretti have tried to interest their coreligionists in this, but it was only in 2011 that Spadaro, in his flagship Jesuit journal *La Civiltà Cattolica*, wrote a longer article about

the "hacker ethic."[56] Because it bears upon the idea of helping others by giving, it is worth quoting one of his main observations about the "gifts" involved in open source activity: "*Non spinge a dare e ricevere, ma a prendere e lasciare che gli altri prendano,*" loosely translated, OSS is a "gift" that "does not incite to give or to receive, but to take and leave so that others may take."[57] This is not quite the same as the biblical idea of giving of oneself.

Spadaro makes compelling observations regarding the difference between the gift of God in salvation and the gift of contributions to software. This is important because it highlights the difficulty that nondevelopers might have to connect it to Christian practice. Namely, the personal and self-giving nature of such a relationship must slowly be acquired, and it is incumbent upon the user to activate it by becoming involved in a community. Why this might be truly important—and worth doing—brings our final connection to theology.

Creativity

One of the highest essences of God is that he is "Creator of Heaven and Earth." God is *creative*, and even early in the biblical creation account he asks Adam to be creative, naming the beasts. Without the creative Word, "nothing was made that has been made"; this lies deep within the tradition of *imago dei*.[58]

Allowing full reign for creativity is deeply connected to open source development—all commentators agree—and is central to the "hacker ethic" Himanen expounds. Interestingly, Himanen places this creativity in contrast with Christian ideas about the purpose of life in ways that appear not fully thought through;[59] Spadaro's essay rightly ends with an extended paean to enabling of the creative element, connecting it to "the dynamic element in the Church … belonging to the Holy Spirit."[60] Samir Chopra and Scott Dexter's (partisan, but nonetheless scholarly) work on OSS and philosophy, *Decoding Liberation,* has an entire chapter on aesthetics and free software, with many pages devoted to creativity and collaboration.[61]

This connection may be surprising to those unfamiliar with coding, but it is vital. Computer and mathematics guru Donald Knuth says, "I think people who write programs do have at least a glimmer of extra insight into the nature of God."[62] Another prominent Christian in the field (both are Turing Award winners), Frederick Brooks, claims early in his best-known work, "I think this delight must be an image of God's delight in making things."[63]

Spadaro quotes Levy quoting Christian programmer Tom Pittman about this as well,[64] but a quote that they do not use is even more insightful: "… perhaps I had learned something about God. In this I have a definite advantage over the painter and the composer: I can create something that will interact with me, as man interacts with God."[65]

Larry Wall states explicitly that he believes that promoting healthy creativity is tantamount to helping achieve God's potential for humans: "In my little way, I'm sneakily helping people understand a bit more about the sort of people God likes."[66] Elsewhere he asserts that God's creative control is subtle, so ours should be as well.[67] Schuurman spends several pages on the cultural mandate and the uncovering possibilities inherent in creation as part of computer science.[68]

The broader point implicit in all of these assertions is that *anyone* can engage in this creativity.[69] OSS, in this view, gives anyone the potential to be creative without having to start from scratch; rather, he or she can modify or build on existing code. Even a small documentation fix, or the act of reliably reproducing the conditions under which a bug does and does not occur, is seen to be part of the creative scientific process. Software professional Ken Shafer places such maintenance firmly in the locus of biblical stewardship of God-given gifts.[70] By way of analogy, one might think of glass artist Dale Chihuly, who has been physically unable to work on his oeuvre for decades, yet shepherds a whole pool of workers who bring ideas to fruition; each is participating in the creative impulse, though under the hierarchy of the master.

Calvin College education professor Ron Sjoerdsma provides the biblical narrative of Bezalel and Oholiab (Exodus 35) as a paradigm.[71] These artisans were not just gifted to craft the beautiful ornaments for the tabernacle of the Lord, but they were inspired to teach others as well. This analogy of the need for skilled workers in technology to be mentors at the same time, to teach others to contribute in a community effort, is evident.

We suggest that with this point of view, OSS becomes a good place to start empowering others to use their God-given creative gifts to benefit the whole community and to redeem our digital world, with even tiny contributions being worthwhile.

Freedom

And ye shall know the truth, and the truth shall make you free (John 8:32, KJV).

Although freedom arose early in our discussion, we now raise it in a Christian context. Before discussing what Christians can affirm in OSS discussions of freedom, it is important to discuss what they cannot.

Many OSS enthusiasts explicitly connect the success of open source to so-called libertarian ideals—that is, to various economic and social freedoms, free from oversight or compulsion, whether from government, business, or religion. The idea is that code freedom works and is only the first step to wider freedoms—some even using language labeled by other observers as having "Messianic overtones." Raymond is probably the most vocal exponent of this, and he skewered Spadaro's essay because of the incompatibility of such a viewpoint with hierarchical ideas in Catholic thought (which indeed is a substantial part of the essay).[72] Weber is far more cautious but also outlines a set of conditions under which distributed production and this kind of freedom might be plausibly invoked in other disciplines or areas of life.[73]

Attractive as this may be to some Christians, this kind of freedom is not a Christian freedom. Christ's "yoke is easy," but there is still a yoke, and Paul still calls himself a servant or slave of Christ.[74] Freedom is not the same thing as total liberty: some changes in computer "code" will break the software. This is not a straw man; even the most passionate advocates for such liberty, such as Raymond, agree in their writing that there are limits. Chopra and Dexter spend considerable time interacting with moral philosophers from Mill to Popper and beyond to justify the copyleft licenses in terms of rejecting the fullest liberty.[75] One point raised is the danger that complete liberty perpetuates preexisting inequities in social structures—turn this on its head, and connecting open source to "libertarianism" seems far less germane.

To think about freedom more productively, consider Orwellian ideas, predicated on the very real fact that others using technology can control us or see our thoughts and actions. The recent furor over the scope of the National Security Agency's data collection and security bugs in both open source and proprietary software are in front of our consciousness. The same is true about companies, especially as they move their software—and hence our creative work—to the nebulous "cloud."

In our view, the ideas of reproducible research can help here. More important than the openness of the software is openness of the process and the data. In a word, *control of information is the key*. This kind of freedom is consonant with Christian thought; we do not want to be dependent on any human, but rather on Christ alone, to have freedom to worship, to spread the Gospel, and so forth.

Open source better enables this sort of freedom via *open standards,* a form of *commoditization*.[76] In a major anthology of open source musings from the mid-2000s,[77] article after article discussed how items from car tires to cement to toilet paper rolls are not locked in with proprietary formats,[78] but are standardized to enable more innovation building on those technologies. In this view, standardized protocols and file formats are necessary to enable flourishing in the digital realm. Even Lerner and Schankerman's advocacy "of neutrality between OSS and proprietary … [is] underpinned by a very strong commitment to … standards whose specifications can be used and implemented by all who desire to do so."[79] Work computations, home budgets, and homework should not be dependent on a proprietary format.

Whole countries and constituencies have adopted (or have threatened to adopt) requirements that documents be prepared in global standards for this very reason.[80] The web, as we know it, would not exist without the standards of HTML and CSS. Even now, archivists are finding that depending on any one company's existence for keeping file formats available risks losing part of our heritage.

Open standards allow for anyone to access their data with any appropriate tool, regardless of location or economic circumstance, as do tools available to all. Weber asserts that "certain bodies of code are essential … in the same way that pens and paper were."[81] Chopra and Dexter devote much space to human-technology interfaces,[82] and to whether we will have control of the code in use in such interfaces; perhaps

grandiosely, they view open source as allowing Ellul's prisoners of technology to unlock their own prison.

OSS cannot completely solve the issue of locking patrons into an ecosystem. But open source enables community-driven standards to be implemented and improved upon. This is a sense of freedom Christians can stand behind. It is not just freedom to distribute; it is freedom from potential cyber-bondage. This may sound dramatic, but we are still in the infancy of data defining us, and we little know what directions the future may take.

Epilogue

Many thanks are due. The Sage math software community introduced me to OSS, and Gordon College has been a hospitable place to try new things with it, including examining connections to faith. A Center for Faith and Inquiry fellowship enabled me to present these thoughts in workshops at the conference of the Association of Christians in the Mathematical Sciences and at the youth ministry conference of Open Boston. Finally, the two referees made many helpful comments from two very different viewpoints on the issue.

Our digital future is unclear; facial recognition technology and "big data" mining would have seemed completely futuristic just a decade or two ago, and likely will soon seem as commonplace as email. OSS is a big part of that future, and this is surely not the last Christian word on it.

This article restricts itself to connections between open source and Christian thought—not necessarily suggesting implications for theology, though an ill-defined "open source theology" has already appeared (type this phrase into your browser and see what you get). Likewise, the "software as a service" model represented most prominently by social networks and online applications "in the cloud" needs discussion from a Christian standpoint, as does the question of how open source is paid for.

What is already certain is that many Christians practicing in this sphere see a deep synergy with our faith. Open source is a fascinating and subversive paradigm; hopefully this article will help to spark the conversation at a higher and more visible level than before. ♦

Notes

[1]As an example, see controversy over Google glasses or Ray Kurzweil's embrace of "the Singularity" in Kurzweil, *The Singularity Is Near: When Humans Transcend Biology* (New York: Viking, 2005).

[2]Derek Schuurman, *Shaping a Digital World: Faith, Culture, and Computer Technology* (Downers Grove, IL: InterVarsity, 2013). His earlier article on the same topic, "Forming a Christian View of Computer Technology," *Journal of the Association of Christians in the Mathematical Sciences* (December 2007), is available freely at http://www.acmsonline.org/journal/2007/schuurman.pdf.

[3]It is hard to escape the irony of the fact that *PSCF* required use of a particular proprietary program for this article on open source software.

[4]One of the most respected surveys is Netcraft's, e.g., http://news.netcraft.com/archives/2014/08/27/august-2014-web-server-survey.html.

[5]Steven Weber, *The Success of Open Source* (Cambridge, MA: Harvard University Press, 2004), 25.

[6]Steven Levy, *Hackers: Heroes of the Computer Revolution,* 25th anniversary ed. (Sebastopol, CA: O'Reilly Media, 2010).

[7]Weber, *The Success of Open Source,* 1.

[8]Eric S. Raymond, *The Cathedral and the Bazaar: Musings on Linux and Open Source by an Accidental Revolutionary*, rev. ed. (Sebastopol, CA: O'Reilly Media, 2001), 19–64.

[9]The GNU General Public License, available at http://www.gnu.org/copyleft/gpl.html.

[10]And the decision by Netscape to license its browser under an open source license. See, e.g., Raymond, "Revenge of the Hackers" in *The Cathedral and the Bazaar*, 167–92.

[11]This inevitably requires the clarification that this means "free as in freedom, not free as in free beer." Sometimes the adjective "Libre" is used to maintain this distinction, and the acronym FLOSS is especially popular in Europe.

[12]Such as http://www.revolutionanalytics.com/ or http://www.mango-solutions.com.

[13]Weber, *The Success of Open Source,* 154.

[14]A recommendation from Roger Peng, "Reproducible Research and *Biostatistics*," *Biostatistics* 10, no. 3, (2009): 405–8. Similar editorials in *Science* and *British Medical Journal* have appeared in 2011 and 2012. Also related are David Joyner and William Stein, "Opinion: Open Source Mathematical Software," *Notices of the American Mathematical Society* 54, no. 10 (November 2007): 1279; and Darrel C. Ince, Leslie Hatton, and John Graham-Cumming, "The Case for Open Computer Programs," *Nature* 482, no. 7386 (2012): 485–88.

[15]"PLOS Editorial and Publishing Policies," section 7, http://www.plosone.org/static/policies#sharing.

[16]I am indebted to my colleague Russ Bjork for this point.

[17]Donald C. Parris, *Penguin in the Pew: Bringing GNU/Linux into the Church 2.0* (Raleigh, NC: Lulu Press, 2007), 43.

[18]Josh Lerner and Mark Schankerman, "The Demand Side: Assessing Trade-offs and Making Choices," in *The Comingled Code: Open Source and Economic Development* (Cambridge, MA: MIT Press, 2010), 103–56.

[19]See http://moodle.com/partners/.

[20]*Elexio Blog*, "Is Open Source Church Software a Good Cost-Saving Option?," blog entry by Ken Stewart, June 18, 2013, http://blog.elexio.com/blog/bid/305336/is-open-source-church-software-a-good-cost-saving.

[21]In personal communication, a colleague confirms that the Mormon (LDS) faith provides computers with OpenOffice

for standard congregational use. See also *Asay: Offline and Off-topic,* "It's Official: Open Source Is Righteous," blog entry by Matt Asay, December 7, 2005, http://asay.blogspot.com/2005/12/its-official-open-source-is-righteous.html.

[22]*Drupal – Open Source CMS*, https://drupal.org/.

[23]Sam Williams, *Free as in Freedom: Richard Stallman's Crusade for Free Software* (Sebastopol, CA: O'Reilly & Associates, 2002), 198.

[24]A very famous example of this in the Linux OS kernel is described in detail in Glyn Moody, "Low-Down in the Valley," in *Rebel Code: Inside Linux and the Open Source Revolution* (Cambridge, MA: Perseus, 2001), 162–81.

[25]Tux, the penguin mascot of Linux, can often be seen stomping on various Microsoft products and in posters on office doors of computer experts.

[26]In various venues, such as Andrea Bonaccorsi and Cristina Rossi Lamastra, "Comparing Motivations of Individual Programmers and Firms to Take Part in the Open Source Movement: From Community to Business," *Knowledge, Technology, and Policy* 18, no. 4 (2006): 40–64; and Sandeep Krishnamurthy, "On the Intrinsic and Extrinsic Motivation of Free/Libre/Open Source (FLOSS) Developers," *Knowledge, Technology, and Policy* 18, no. 4 (2006): 17–39. One good general source is Joseph Feller, Brian Fitzgerald, Scott A. Hissam, and Karim R. Lakhani, eds., *Perspectives on Free and Open Source Software* (Cambridge, MA: MIT Press, 2005).

[27]Karl Fogel, *Producing Open Source Software: How to Run a Successful Free Software Project* (Sebastopol, CA: O'Reilly, 2005), 132–33.

[28]This was a very common comment made in training sessions that I ran for the program I work with.

[29]Originally named for the "pearl of great price."

[30]Larry Wall, "2nd State of the Onion," talk given at the Perl Conference 2.0, August 1998, http://www.wall.org/~larry/onion/onion.html.

[31]Ibid.

[32]Schuurman, *Shaping a Digital World*, 98.

[33]Raymond, "Homesteading the Noosphere," in *The Cathedral and the Bazaar*, 19–64.

[34]Pekka Himanen, *The Hacker Ethic and the Spirit of the Information Age* (New York: Random House, 2001).

[35]Antonio Spadaro, S.J., "Etica hacker e visione Cristiana," *La Civiltà Cattolica* (March 2011).

[36]Moody, *Rebel Code*.

[37]Marco Fioretti, "Christian Endorsement of Free Software Increases," *website of linux.com*, April 16, 2006, http://archive09.linux.com/articles/53644.

[38]Thanks to Craig Story for this reference, one of many relevant ones.

[39]Jacques Ellul, *Perspectives on Our Age: Jacques Ellul Speaks on His Life and Work*, ed. Willem H. Vanderburg (Berkeley, CA: Publishers Group West, 1981), 50.

[40]Elèutheros, http://www.eleutheros.org/en/.

[41]Alan Jacobs, "Life Among the Cyber-Amish," *Books and Culture* (July/August 2002).

[42]Himanen, *The Hacker Ethic and the Spirit of the Information Age*, 141.

[43]Wall, "2nd State of the Onion."

[44]See http://www.aims.ac.za/en/apply/structured-masters-course-proposals.

[45]As of 2013, various sources report millions of American households still using dial-up services.

[46]A very interesting example of this is Caroline Hardin, "FOSS in School Communities: An Experience Report from Peace Corps Volunteers in Ghana," in *Free and Open Source Software and Technology for Sustainable Development,* ed. Sulayman K. Sowe, Govindan Parayil, and Atsushi Sunami (Tokyo: United Nations University Press, 2012), 286–312.

[47]See http://www.mathworks.com/support/sysreq/roadmap.html; they are dropping support for Windows XP and Mac OS X Lion, which is a full decade younger than XP, at the same time.

[48]Yu-Wei Lin and Enrico Zini, "Free/Libre Open Source Software Implementation in Schools: Evidence from the Field and Implications for the Future," *Computers and Education* 50, no. 3 (April 2008): 1092–102.

[49]Martin Benjamin, "Language Data as a Foundation for Developing Countries: The ANLoc 100 African Locales Initiative," in *Free and Open Source Software and Technology for Sustainable Development,* ed. Sowe, Parayil, and Sunami, 164–82.

[50]Jamil Alkhatib, Mohab Anis, and Hamid Noori, "Open Source: The Next Big Thing in Technology Transfer to Developing Nations," *International Association for Management of Technology Proceedings*, 2008.

[51]Such as Imed Hammouda, "The Open Source Ecosystem in Tunisia: An Empirical Study," in *Free and Open Source Software and Technology for Sustainable Development,* ed. Sowe, Parayil, and Sunami, 185–211.

[52]Lerner and Schankerman, *The Comingled Code,* 61–102.

[53]Weber, *The Success of Open Source,* 248–54.

[54]SIL (the parent of Wycliffe Bible Translators) enabled development of a universal typesetting program, and several sources report some activity in the LDS.

[55]Bruce Byfield, "Why FOSS Isn't on Activist Agendas," *website of linux.com*, December 13, 2006, http://archive09.linux.com/feature/58726.

[56]Spadaro, "Etica hacker e vision Cristiana."

[57]I am grateful to my colleague Damon DiMauro for assistance with an idiomatic translation.

[58]See Schuurman, *Shaping a Digital World,* 36–38.

[59]Himanen, *The Hacker Ethic and the Spirit of the Information Age*, 13–19.

[60]Spadaro, "Etica hacker e vision Cristiana."

[61]Samir Chopra and Scott D. Dexter, *Decoding Liberation: The Promise of Free and Open Source Software* (New York: Routledge, 2008).

[62]Donald E. Knuth, *Things a Computer Scientist Rarely Talks About* (Stanford, CA: Center for the Study of Language and Information, 2001).

[63]Frederick P. Brooks Jr., *The Mythical Man-Month: Essays on Software Engineering* (Boston: Addison-Wesley, 1995), 7. Interestingly, although Brooks's writing (technical and otherwise) is infused with scriptural references and his faith, his comments on open source and Eric S. Raymond's views in "What Are Better Design Process Models?," in *The Design of Design: Essays from a Computer Scientist* (Boston: Addison-Wesley, 2010), 51–60, do not seem to make any such connections.

[64]Spadaro, "Etica hacker e vision Cristiana."

[65]In his online essay, Tom Pittman, "Deus ex Machina, or the True Computerist," http://www.ittybittycomputers.com/Essays/DeusExMac.htm.

[66]"Larry Wall on Perl, Religion, and …," on the website *Slashdot,* September 6, 2002, http://interviews.slashdot.org/article.pl?sid=02/09/06/1343222.

[67]Wall, "2nd State of the Onion."

[68]Schuurman, *Shaping a Digital World,* 32–36.

[69]In one British study, teachers at schools who had opted to simply use open source experienced significant gains in self-perceived comfort with technology, compared to colleagues using nearly identical proprietary software. See "Open Source Software in Schools," technical report, British Educational Communications and Technology Agency, 2005.

[70]Ken Shafer, "Software Development and Maintenance as Stewardship," *Dynamic Link: Christian Perspectives on Software Development*, Issue 1 (2007–8): 6–7.

[71]Ron Sjoerdsma, "Teachers, New Technology—the Bezalel Principle," *Christian Educator's Journal* 38, no. 1 (October 1998): 4–5.

[72]Eric Raymond, "Imprimatur me!" *Armed and Dangerous* (blog), http://esr.ibiblio.org/?p=3094. Apparently Raymond replied before fully reading the original article, based on the very long set of comments on his post about it; the last comment has Raymond halfway through, and no indication of any further public dialogue between them.

[73]Weber, *The Success of Open Source,* 264–72.

[74]Matthew 11:30; Romans 1:1.

[75]Chopra and Dexter, *Decoding Liberation.*

[76]For a good historiographic perspective on this topic, including an interesting evaluation of modern open standards as a "consensus of critiques," see (esp. the conclusion of) Andrew L. Russell, *Open Standards and the Digital Age: History, Ideology, and Networks* (New York: Cambridge University Press, 2014).

[77]Chris Di Bona, Mark Stone, and Danese Cooper, eds., *Open Sources 2.0: The Continuing Evolution* (Sebastopol, CA: O'Reilly, 2005). See also the original influential Chris Di Bona, Sam Ockman, and Mark Stone, eds., *Open Sources: Voices from the Open Source Revolution* (Sebastopol, CA: O'Reilly Media, 1999).

[78]There certainly have been such incompatible standards in the past, and not just Beta versus VHS. The plethora of weights and measures in medieval Europe is an oft quoted example of how lack of standardization can impede innovation.

[79]Lerner and Schankerman, "The Demand Side: Assessing Trade-offs and Making Choices," in *The Comingled Code*, 210.

[80]As only a representative sample, see "Sharing or Collaborating with Government Documents: Proposal," January 28, 2014, http://standards.data.gov.uk/proposal/sharing-collaborating-government-documents; Martin LaMonica, "Massachusetts to Adopt 'Open' Desktop," *CNet News,* September 1, 2005, http://news.cnet.com/Massachusetts-to-adopt-open-desktop/2100-1012_3-5845451.html; Michael Reed, "Munich Linux Migration Project LiMux Reports Success," *Linux Journal* (January 2, 2012), http://www.linuxjournal.com/content/limux-munich-linux-migration-project-reports-success; Anita Chan, "Coding Free Software, Coding Free States: Free Software Legislation and the Politics of Code in Peru," *Anthropological Quarterly* 77, no. 3 (Summer 2004). A comprehensive list from 2010 is James Andrew Lewis, "Government Open Source Policies," Center for Strategic and International Studies, http://csis.org/publication/government-open-source-policies.

[81]Weber, *The Success of Open Source,* 246.

[82]"Cyborgism," but referring to everything from glasses to prosthetics and beyond.

E. Janet Warren

Article

Feminine Sin and Female Scientists

E. Janet Warren

The words sin and science are seldom mentioned in the same sentence. However, I suspect that sin, both individual and societal, is a contributing factor to the fact that male scientists outnumber female ones. This suggestion is not intended to produce the guilt and shame that is already so common in women, but intended rather to illuminate an issue and perhaps guide strategies to change. The gender gap in science has been addressed primarily in feminist and sociological literature; there has been little discussion from a Christian perspective. In this presentation, I first review the literature on the gender gap in Science, Technology, Engineering and Math (STEM), and then summarize the biblical/theological literature on gender equality. I next turn to the biblical/theological concept of sin (typically construed as pride and arrogance, which tend to be associated with men) and discuss how considering so-called "feminine" sin (neglecting responsible dominion and undervaluing oneself) can contribute to both our understanding of and our response to the gender gap in STEM.

My high school physics teacher told my parents during teacher interviews that I would never succeed in science. Perhaps a C– in a recent test had given rise to this judgment, although my grade was one of the highest in the class. I do not remember being too perturbed at the time, but now that I have a BSc and an MD, I think that he has been proved wrong.

Since the rise of feminist studies in the 1960s, there has been much discussion on the equal status of women in all areas of life. And, in most areas, there has been a concomitant reduction in gender inequality. Science, technology, engineering, and math (STEM), however, is one area in which there is still a gender gap. This issue has been addressed primarily in scientific and sociological literature; there has been little, if any, discussion from a Christian perspective, although gender equality in general has been much debated in biblical and theological literature.

In this article, I first review the general literature on the gender gap in STEM and then the biblical/theological literature on gender equality. I next turn to the Christian concept of sin in all its complexities and consider how an understanding of so-called "feminine" sin can contribute to both our understanding of and our response to the gender gap in STEM.

Women in Science

Historically, reason and rationality (assumed to be male attributes) were esteemed, and emotions and sensuality (assumed to be female attributes) were deemed inferior.[1] Because of this, and likely a multiplicity of other reasons, women were excluded from academic studies and universities in general, and

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from scientific enterprise specifically. Notable exceptions include Hypatia, a mathematician in ancient Greece; Hildegard of Bingen, distinguished natural scientist and theologian; physicist Laura Bassic, the first female professor; Florence Nightingale, a pioneer in public health and nursing education; and Marie Curie, a winner of the 1903 Nobel Prize in physics. There are many stories of women lecturing behind a curtain or disguising themselves as men in order to study science. By contrast, in nonacademic cultures, wise women were revered for their herbal medicine, and midwives were responsible for obstetrical care. The suffragette movement in the late-nineteenth century led to increasing university enrollment, and forty percent of university teaching posts were held by women in 1946. However, there appeared to be a re-masculization of science post-WWII. This changed again with the feminist movement of the 1960s, which led to an increased number of women in STEM.[2]

In the past few decades, research has shown a slow but steady decline in the gender gap, although men still far outnumber women in STEM academic fields. A recent article in *Nature* highlighted some discrepancies.[3] According to 2008 US government statistics, the median salary of male scientists was $84,000, and that of female scientists was $60,000; 1,794,000 men were employed in academia, versus 934,000 women. The US National Science Foundation reports that although women earn half the doctorates in science, they make up only 21% of full science professors and 5% of full engineering professors. On average, they earn 82% of the salary of male scientists. Interestingly, a survey of engineering programs (2003–2012) reveals that the number of female students in Christian colleges is about seven percent lower than the national average.[4]

Canadian statistics are similar. A 2010 report from the Natural Sciences and Engineering Research Council of Canada (NSERC) highlights a number of gender discrepancies in academic science.[5] Examining the so-called pipeline from 1985 to 2007 reveals that the odds of a first-grade girl receiving a PhD in STEM are approximately 1 in 286; the odds for a boy are 1 in 167. In 2007, 647 females and 1,198 males received doctoral degrees in science. Interestingly, the ratio of women to men in STEM at the bachelor's level is approximately 0.6 and has been stable over the past decade. This ratio drops to 0.48 at the doctoral level. The number of males and females enrolled in science studies has grown in absolute numbers in the past decade; in 2008–2009, women comprised 37% of Canada's undergraduate students in science and engineering. A survey of data from other countries reveals similar trends.

There are also stories and studies demonstrating discrimination against women in STEM. Francis Bacon described science as "masculine philosophy."[6] Rosalind Franklin's research on the structure of DNA is reported to have been stolen by Watson and Crick, who later received the Nobel Prize.[7] Pharmacologist Candace Pert details her career in science, including having her research stolen.[8] A recent study found that science professors, given identical CVs, would offer a student applicant identified as female $3,730 less per year than one identified as male.[9]

Not surprisingly, there has been much discussion regarding the reasons for the gender gap in science, and many theories have been proposed. The most obvious theory relates to biological differences between male and female brains. Although this theory is old, based on conjecture (for example, it was thought that mathematical ability was X-linked) and limited research, recent neuroimaging research has indeed demonstrated sex differences in both brain structure and function and in both architecture and activity.[10] Note that results represent averages.

- The male brain is about ten percent larger than the female one and has a higher percentage of white matter (tissue connecting the nerve cells, which constitute gray matter).
- Peak brain volume is attained earlier in girls (median age, 10.5) as compared with boys (median age, 14.5).
- Women have a larger caudate and hippocampus (associated with memory and emotions) and a smaller corpus callosum (connecting the two hemispheres of the brain).
- In terms of function, on average, women utilize approximately ten times more white matter than men (men use more gray matter).
- Women have better verbal skills, and men have better visuospatial abilities.
- Women excel in decoding emotional messages, or empathy, and interpersonal relationships, whereas men excel in spatial tasks and systematizing.

- Women tend to acquire knowledge through observation, experience, and intuition, whereas men are generally systematic, logical, and rational.
- Women also tend to use both hemispheres when performing a task, men only one.

A recent imaging study revealed connectivity differences between genders: male brains appear to facilitate connectivity between perception and coordinated action (primarily intrahemispheric); female brains show easier communication between analytical and intuitive processing (interhemispheric).[11] There are also differences in emotional processing, executive function, and spatial processing, although findings are not always consistent. Overall differences between male and female brains are small, and there is much variability.

This research has gained attention in the popular media,[12] but the interpretation of it, or how brain differences relate to behavioral differences, is unclear. For example, less activation of certain brain structures does not necessarily mean that those areas are less efficient. Some studies have also demonstrated a lack of correlation between brain and behavior; for example, there are gender differences in neural networks responsible for language, but no corresponding difference in language abilities. Gender differences in the brain are likely a result of the interplay of biological, psychological, and social factors. Given the brain's neuroplasticity, giving a boy construction toys to play with, for example, may lead to an increased development of spatial parts of the brain.[13] Ultimately the old nature/nurture issue remains unresolved, and, of course, we only have access to a "post-Fall" brain; therefore, we cannot know how much effect a corrupt world has had on neurological development. In sum, although there is a general male/spatial/analytic/logical and female/verbal/intuitive/emotional dichotomy, appealing to brain differences between men and women to explain the gender gap in STEM is inadequate. In fact, contemporary science is increasingly recognizing the value of nonanalytical processes in discovery, and there are many examples of revolutionary insights through intuition.[14] Indeed, "feminine" neurological attributes are no longer viewed as inferior.

Sociocultural theories have also been proposed to explain the gender gap in STEM. Historian Margaret Rossiter suggests two ideas: hierarchical segregation (fewer women participate at higher levels in academia) and territorial segregation (women's careers cluster in specific areas such as nursing and teaching). The hierarchy problem implies a top-down approach (women are prevented from attaining high ranks due to social barriers and discriminatory practices), but another approach looks at the problem from the bottom-up, as in the "leaky pipeline."[15] As mentioned, the gender gap increases during the transition from high school to university undergraduate programs to masters and doctoral programs. Reasons for this include educational inequality, effects of isolation, lack of role models, and difficulties balancing family and career. Jill Bystydzienski and Sharon Bird note that the pipeline model focuses on supply, not demand; it gives little insight into how institutions themselves need to change in order for women to join the ranks. Masculine values of hierarchy, independence, and competition, which dominate the field of science, are not welcoming for women who perhaps work more collaboratively.[16]

Sociocultural theories provide some explanations for the paucity of women in science, but they tend to focus primarily on men, and they consider the problem only at a societal level, not at an individual level. I now consider a Christian perspective for offering further insight into the gender gap in STEM.

Women and the Bible

The Bible's overarching views on men and women can be found in its opening few chapters.[17] First, both women and men are created in the image of God (Gen. 1:27). This declaration has been variously interpreted, but a primary aspect of it is our capacity and calling to be in relationship—to God, self, others, and creation. The Trinitarian God is intrinsically social; as relationships within the Godhead are mutual, so should ours be. (Note that relationality, typically a strength in women, not rationality, typically a strength in men, is stressed. Furthermore, it is increasingly being recognized in biblical and theological research that the Bible is primarily addressed to our nonrational faculties. It is filled with stories, parables, imagery, and other imaginative, intuitive, and emotional concepts—again generally female assets.[18])

Second, in another aspect of the *imago dei*, both women and men are commanded to care for creation, to "rule over … every living creature" (Gen. 1:28). This so-called cultural mandate includes being a responsible steward of God's creation, studying it (as scientists do), developing it, and caring for it and its creatures. This idea is reinforced in New Testament teaching: Peter encourages followers of Christ to use their gifts as faithful stewards (1 Pet. 4:10).

Third, men and women are called to be equal partners in marriage (Gen. 2:18–25). The Genesis 2 creation account describes Eve as a "helpmeet" (*ezer*) to Adam. Most other uses of this term refer to God; it is never used in a context implying subordination. Adam rejoices in her as "bone of my bones," suggesting similarity, not subordination. The creation of women leads to the completion of humanity (echoing Gen. 1:27, and reflected in Paul's description of woman as the glory or fullness of man, 1 Cor. 11:7). As Matthew Henry famously remarked,

> Eve was not taken from Adam's head—to top him. Not from his feet—to be trampled by him. Eve was taken from Adam's side—to be equal with him.[19]

Fourth, both women and men sin and share in the consequences of this sin (Genesis 3). It is clear that Adam was there with Eve when she ate the infamous apple; they are partners in the crime of disobedience. This will be discussed further in the next section.

Fifth, men and women are equally redeemed. Christ offers eternal life for all who believe (John 3:16) and a new creation for all (2 Cor. 5:17). In Christ, all are children of God; there is no male or female (Gal. 3:26–29). Jesus's earthly ministry demonstrated a respect for women (in keeping with his ministry to other marginalized persons) that clashed with a culture in which women were not even allowed to speak to a man in public. His birth was foretold directly to Mary (not through her father as would have been the custom) and was prophesied by a woman (Elizabeth, Luke 1:26–45). Jesus's followers included many women (Luke 8:1–3). He commended Mary for "sitting at his feet" (a phrase which suggested theological training, Luke 10:42), and his longest recorded conversation was with a Samaritan woman (John 4:1–40). Furthermore, the first witnesses to the resurrection were women, and they proclaimed this fact to male disciples (Matt. 28:1–10 and parallels).

Sixth, both men and women are commissioned to ministry, to go "forth and make disciples of all" (Matt. 28:18–20). They are also gifted with the Holy Spirit (Acts 2:17–18). Biblical examples of women ministers include the apostle Junia (Rom. 16:7; interestingly, her name was changed to the male version in a fourteenth-century translation), prophets (Philip's daughters, Acts 21:8, 9; women prophets in general, 1 Cor. 11:5), teachers (Priscilla, Acts 18:26; Lydia, Acts 16:14, 15; Phoebe, Rom. 16:1), and a host of women Paul describes as coworkers (Rom. 16:1–15, Phil. 4:2, 3). In addition, at Pentecost, inclusivity was emphasized since the sign of membership was changed from circumcision (exclusively male) to baptism.

Discussions on gender differences in the Bible often focus on a few Pauline passages which appear to subordinate women. However, these are filled with exegetical, linguistic, and contextual problems.[20] When God's revelation is considered within the entire Bible, it is clear that men and women are equally created, equally fallen, equally redeemed, and equally responsible. It is unfortunate that some Christian traditions use biblical texts inappropriately and discourage women from using their gifts both inside and outside the home, and from exercising responsible dominion and stewardship in all areas of life, including science. All things and *all people* hold together in Christ. However, this has not always been reflected in a world filled with sin.

Sin

"Sin," the word and the concept, is not popular. In contemporary media, it has often been trivialized or, indeed, celebrated. This prompted Karl Menninger to ask "whatever became of sin" in his eponymously titled book.[21] Perhaps in response to his challenge, the current literature on sin is large. Although most people have an intuitive knowledge of sin, understandings and definitions vary greatly. In fact, sin can be described using scientific metaphors: from chemistry, sin dilutes and disintegrates godly reality; from ecology, sin pollutes; and from medicine and psychology, sin can be viewed as sickness and psychopathology. Sin is a multifaceted and complex concept with various definitions, and can be considered from biblical and theological perspectives.

With respect to biblical studies, there is no exact Hebrew or Greek word for sin, but the words most commonly translated as such mean to miss the mark or to transgress a boundary.[22] Sin is a ubiquitous condition: all have fallen short of the glory of God (Rom. 3:23). It is both individual (for example, David, Ananias, Sapphira) and communal (for example, the apostate people of Israel). Indeed, the world is described as under the domain of sin (Rom. 5:12–14). There are many metaphors for sin: iniquity (Ps. 38:18), deceitfulness (Heb. 3:13), disobedience (2 Cor. 10:6), rebellion (Exod. 23:21), lawlessness (1 John 3:4), failure (James 4:17), wickedness (Gen. 6:5), impurity (Zech. 13:1) and idolatry (1 Sam. 15:23). It is often personified: sin is a "thing" that God can remove or put away (Mic. 7:19); it can be loaded onto a goat (Lev. 16:10); it is a snare (Prov. 5:22) and a crooked way (Prov. 2:12–15); it is like a weight (Isa. 1:4); it can enslave people (Rom. 7:14, 25) and is a superhuman power (James 1:15). The Bible contains frequent admonitions to repent and turn to God, as well as specific laws such as the Ten Commandments (Exod. 20:1–17; note that the first four involve behavior toward God; the last six, behavior toward others. Note also that Jesus emphasized loving God as the primary commandment [Matt. 22:37]). Ultimately, all sin is directed against God (for example, Psalm 51).

Although most people readily understand the teaching of the Ten Commandments, it is apparent from the multiple biblical metaphors that sin is both subtle and larger than life. It involves not only transgressing boundaries (disobedience, rebellion, idolatry, superhuman power) but also missing the mark (failure, a weight, a snare). It reflects an orientation away from God, a lack of love for him.

It is helpful to consider sin broadly, and theological studies can be helpful in this regard. Historically, the early church focused on categorizing individual sins. Evagrius identified eight generic sinful attitudes: gluttony, fornication, avarice, sadness, anger, sloth, vainglory, and pride. These were more famously reduced to seven by Gregory the Great in the Middle Ages who combined some and inverted the order because he viewed pride as the root of all sin.[23] Sin can also be categorized into inherent sinfulness—our innate tendency to sin, or being in a state of sin (perhaps the best understanding of what is termed original sin)—and sinful choices, or actual sin—when we willfully rebel against God and his laws.

Original sin was emphasized by Augustine, who has enormously influenced our theological understanding of sin.[24] He believed that it is impossible to not sin. Humans are helpless apart from God, but we put ourselves above God, and are plagued by concupiscence (lust of the flesh) and idolatry. Augustine thus viewed pride as the primary sin. Although concepts of sin were expanded and perhaps viewed more optimistically in the Middle Ages (Aquinas, for example, thought humans were capable of greatness through the grace of God), Augustine's theology was revived in the Reformation period and consequently is still influential today, especially in Protestant Evangelicalism.

Following Augustine, the twentieth-century theologian Reinhold Niebuhr has expanded on the view of pride as primary, the overvalued self.[25] He explains original sin as a consequence of existential anxiety due to the tension between the limitations of our creatureliness and our spiritual ability to transcend and reflect on this finitude. We are all born into conditions which provoke anxiety. We seek to find means to relieve our anxiety apart from reliance on God; therefore sin is inevitable, if not necessarily inherited (thus taking a softer, more nuanced view than Augustine). Niebuhr believes that pride involves both rebellion against God and a disregard for other people. It involves power, but pride can also be intellectual, spiritual, or moral (self-righteousness). Self-exaltation is universal. Pride is ultimately refusing to trust in God. Note that the emphasis on pride largely involves the biblical metaphors of transgressing a boundary, thinking and acting as greater than God. It neglects the metaphor of missing the mark or failing to live up to God's standard.

Augustine's legacy is large, but he has received much critique. Hugh Connolly thinks that Augustine's views are too limited, narrow, and legalistic; the moral life is best seen as a gradual process.[26] Biblical scholar Mark Biddle notes that the juridical/forensic metaphor has been prominent since Augustine and others, especially in Western evangelical theology. Sin becomes crime, a deliberate violation of God's law. Yet this does not fully reflect the biblical teaching on missing the mark, and it ignores other metaphors for sin such as failure and ignorance.[27]

Feminist theologians have also challenged the Augustinian/Niebuhrian emphasis on pride, noting

that most theology has been written by men. The sin of pride (arrogantly viewing oneself as all right), accompanied by domination and aggression, is typically a male problem. However, many women struggle with poor self-esteem, the opposite of an overvalued self. "Female" sin, refusing to recognize one's worth as a child of God, is less obvious. Valerie Saiving in 1960 was one of the first theologians to draw attention to this. She pointed out that women have often been treated as secondary citizens, and have appropriated the message that they are weak and incapable; they lack an organizing center, have difficulty respecting boundaries (for example, gossiping) and depend on others for self-definition.[28] Women's primary sin is self-abnegation and an undervalued self. They "miss the mark" in believing that they are not worthy of divine calling or human authenticity; they hide within a false self and fail to be the self that they are created to be.

Sin involves much more than breaking the law. As Serene Jones remarks,

> one could conceivably live a fully moral, upright life—avoiding many of the acts we call "sin"—and still be fundamentally in a state of sin because one has not accepted the fullness of grace that God has bestowed upon humanity.[29]

Feminist theologians point out that these sins are both individual and structural, and that women and men are equally responsible. It is important to recognize that these observations are generalities (some women overvalue themselves and some men undervalue themselves)—the issue is complex.[30]

Psychologist Mary Stewart Van Leeuwen describes gender differences in terms of the effects of the Genesis 3 curse.[31] Because men and women are equally created (and meant to be in equal relationship) and equally responsible for exercising dominion over creation (fulfilling the creation mandate), they have an equal predisposition for sin. However, the results of their sin differ. The man's sin involves an abuse of dominion (he ate the forbidden fruit) and sociability (he valued the woman over God), which results in pain in exercising dominion and domination over the woman (the dominion runs wild), with neglect of relationship (distorted sociability). He exercises dominion apart from God (pride). The woman's sin also involves a neglect of responsible dominion and sociability (she gave the fruit to the man); this leads to social enmeshment (her desire is for the dominating man) with a neglect of dominion. By partaking of the fruit, the woman transgressed the bounds of responsible dominion; the preservation of relationship becomes an excuse for failing to fulfill the creation mandate. Note the similarities between her views and the ideas of feminine/masculine sin, between domination and pride, and social enmeshment and a poor sense of self.

Biddle comes to similar conclusions. He recognizes that biblical texts contain ideas of both pride (typically masculine) and sloth (typically feminine). Sin can be viewed as both rebellion or arrogance and as underachievement or despondent passivity.[32] There is an overstepping of an upper boundary (trying to be God, not accepting the limits of humanity) and a failure to exceed a lower boundary (not being what God has created us to be, abdicating responsibility and hiding). Biddle believes that we need to embrace both poles of humanity: being made in God's image and being finite creatures. Sin occurs when these are out of balance. He suggests that pride and sloth can be reconciled through something more basic underlying both: mistrust of God. There is a violation of our relationship with God and a failure to embrace our authentic freedom. Against Augustine, Biddle claims that the primary sin is not pride and rebellion but underachievement, an unwillingness to place our ultimate trust in God as revealed in Christ.[33] We all miss the mark.

In a similar attempt to reconcile pride and sloth, Terry Cooper, drawing upon the work of psychoanalyst Karen Horney, argues that pride, if properly understood, underlies both the overvalued self and the undervalued self.[34] Pride and self-contempt, or the Niebuhrian and feminist perspectives, can be integrated. In fact, both perspectives are needed for a proper theological understanding of sin. People often are unconsciously proud of being humble, or of having low self-worth. There are differing forms of pride and differing responses to existential or ontological anxiety, which is a precondition for sin. These include moving against others (pride, arrogance), trying to be superior to others (narcissistic in its extreme form), and moving toward others in self-effacement. Cooper suggests that pride always involves a lack of trust in God; self-abnegation is one's own solution to a problem, not God's solution. We distrust God by trying to be either more or less than what we are meant to be. Life is ordered around one's own insecurities. Egoism, or self-preoccupation, underlies

both egotism (self-inflation) and self-deflation. Self-hate can be the flip side of pride; if we chronically feel guilty and insecure, we sometimes externalize it so that the problem becomes someone or everyone else's problem—paranoia manifests as pride. Pride is a defensive posture; lurking behind it is low self-esteem. Both the overvalued and undervalued forms of pride lack a healthy self-acceptance.

Feminist scholars provide an important corrective to the long-dominant view of sin as pride and arrogance. Sin needs to be considered in all its dimensions. It involves both overvaluing and undervaluing, both self-aggrandizement and self-effacement, both pride and passivity, both arrogance and acedia, both doing wrong and failing to do right, both being more and being less than God intends for us. Sin involves turning away from God, rejecting the one who creates, redeems, and sustains us.

Another important concept in our understanding of sin is its corporate/communal nature, which is emphasized in the Bible. Social structures (such as academic institutes) are tainted by sin; prevailing attitudes perpetuate sinful societies. Specific sins occur in the context of a sinful world. All have sinned and all are predisposed to sin. It is important to consider sin as neither exclusively individual nor exclusively social, but simultaneously both.[35] Biddle comments that the individualism and legalism of much contemporary Christianity overlook the systemic and dynamic nature of sin. In the biblical view, individual and corporate sin are intertwined, as are sin and its consequences (he describes it as one organic continuum).[36] It is easy to blame either other individuals or anonymous institutions, but it is important to recognize the symbiotic connection between individual sin and its structural embodiment.[37] It is possible that societal pressures on women have led to or have encouraged a collective sin of undervaluing the self. This does not preclude individual responsibility but adds another dimension to it.

Finally, it is essential to understand that sin cannot be understood apart from grace.[38] The world apart from God does not consider sin because it does not know grace. Sin and grace are intertwined. We are all born with a propensity to mistrust our Creator, to undervalue or overvalue ourselves in relationship to God. We can be honest about our sin because we have hope in grace. It is only through grace that we can restore relationships marred by alienation. Grace brings us out of hiding into the light.

The Way Forward

It is time to complete the circle and consider how a biblical/theological understanding of sin can inform the problem of the lack of women in STEM. There is now a large body of literature on the topic of women in science, although little from a Christian perspective.[39] As noted above, sociocultural explanations offer some helpful insights into the gender gap in STEM; Christian theology can add another perspective. The concept of feminine sin points to a tendency for women to neglect their responsible dominion over creation. With respect to science, failure to utilize one's God-given gifts and to accept one's worth in God's eyes is one possible factor explaining the paucity of women in science. This is true perhaps for the lack of women entering science fields as well as for the lack of advancement for women already in scientific careers. (I have encountered many Christian women who are insecure regarding their abilities, or who defer to men on certain issues, or who have inconsistent views regarding gender equality.)

From the research on women in science, suggestions have been made for decreasing the gender gap in STEM. A symposium in 2000 advised selecting science students using broad criteria, looking for single-mindedness and assertion, and being aware of unconscious discrimination.[40] In 2011, NSERC devised a policy statement on gender, science, and engineering which included the following proposed strategies:

- encourage female students in elementary and secondary schools to consider careers in science and engineering,
- increase the enrolment of women in undergraduate and graduate programs in science and engineering in all Canadian universities and colleges,
- increase the profile and retention rate of women in science and engineering positions,
- eliminate barriers for women who wish to pursue careers in science and engineering,
- promote the integration of female students and professionals both within and outside academia [and]
- provide female role models who are accomplished, successful, and recognized researchers in science and engineering.[41]

These are helpful strategies and are not necessarily incompatible with a Christian worldview. However,

these solutions focus on institutional and societal changes, and are thus primarily "top-down" approaches. It is also helpful to consider individual issues and a "bottom-up" approach. The above discussion on both the biblical equality of women and the "feminine" aspects of sin can provide insight in this regard. From the perspective of Christian theology, we also need to consider the neglect of responsible dominion as a factor in the gender gap in STEM. Whether women have been discouraged from fully participating by society or by the church, this is not what the Bible teaches.

Recall that men and women are created equal in God's image. Recall the creation mandate given to both men and women: to care for, cultivate, and study the divinely created order, science being one way in which this can be fulfilled. It is interesting to consider gender differences in brain function and how this may inform a response to the gender gap in STEM. The "male," "scientific" rationality once revered, and a likely explanatory factor in the subordination of women, is not prioritized in biblical teaching. Furthermore, "female" nonrational faculties, such as imagination and intuition, are valued not only in the Bible, but also in science. Christian women are perhaps uniquely gifted to study creation in obedience to God's calling by pursuing STEM careers.

Men and women are also equally commanded to Christian ministry, including teaching. Also recall the Fall, the "curse," and its results. The man can be viewed as abusing his dominion and dominating women; the woman can be seen as neglecting her responsible dominion and idolizing relationships. From a theological perspective, this "feminine" sin of missing the mark and not living up to one's potential is just as significant as the "masculine" sin of pride. Note that this is not an issue only for women, not another way of denigrating women. It is also a concern for the entire Christian community, and it applies to all areas of life, not just STEM. Sin is a problem and a product of both individuals and societies.

What, therefore, is a Christian response? In general, I suggest that it needs to begin in our homes, in our Christian schools, and in our churches. We need increased awareness of the prevalence and sinfulness of underachievement and self-abnegation, and encouragement to not "miss the mark." Then we need teaching, counseling, and modeling about our value, worth, and responsibility through the eyes of Christ. As Jean Vanier notes,

> All humans are sacred, whatever their culture, race or religion, whatever their capacities or incapacities, and whatever their weakness or strengths may be. Each of us has an instrument to bring to the vast orchestra of humanity and each of us needs help to become all that we might be.[42]

Both men and women are beloved children of God who are called to shine as lights in the world, exercising faithful stewardship and leadership, as God works in us through our gifts (Phil. 2:12, 13). We need encouragement to reorient ourselves toward God. We need to accept his mysterious and magnificent love, accept the gifts he has given us (regardless of our gender) and use them responsibly, and surrender ourselves and our insecurities to our Lord. I suggest that change involves both internal and external processes; both individual and communal processes. We are one body in Christ (Rom. 12:5). Many Christian women have allowed their gifts to lie dormant, yet Paul teaches that all—men *and* women—are alive in Christ (1 Cor. 15:22) and have freedom through Christ to exercise our gifts (Gal. 5:1). In Christ there is no longer male and female (Gal. 3:28), and we need to stop acting as if there is.

With respect to Christian women in STEM, the challenges may be greater as a result of the long history of reverence of "male" rationality, as well as a historic antagonism between science and religion. However, Christian communities can help by teaching on scientific aspects of creation, including research and care for the environment, as well as teaching on the compatibility between science and faith. When young girls in homes, church, and school are given equal opportunities, they may be more inclined to choose a career in engineering, for example. Girls can be encouraged to help in building projects, not just kitchen ones. When girls see women scientists as role models, when children are valued and their gifts encouraged regardless of gender, we will be working toward fulfilling the creation mandate as well as the great commission. ♦

Notes

[1]Sarah Coakley, "Introduction," in *Faith, Rationality and the Passions,* ed. Coakley (Chichester, Suffolk: Wiley-Blackwell, 2012), 1–12; Charles Taylor, "Reason, Faith and Meaning," in *Faith, Rationality and Passions,* ed. Coakley,

13–27; Thomas Dixon, "Revolting Passions," in *Faith, Rationality and the Passions,* ed. Coakley, 181–95. A recent study in Europe demonstrated the persistence of beliefs that men are more rational and women more intuitive; Gerd Gigerenzer et al., "Stereotypes about Men's and Women's Intuitions," *Journal of Cross-Cultural Psychology* 45, no. 1 (2014): 62–81.

[2]Londa Schiebinger, *Has Feminism Changed Science?* (Cambridge, MA: Harvard University Press, 2001), 21–32.

[3]Helen Shen, "Inequality Quantified: Mind the Gender Gap," *Nature* 495 (2013): 22–24; see also Schiebinger, *Has Feminism Changed Science?,* for some older statistics.

[4]Gayle E. Ermer, "A Christian Response to Under-Representation of Women in Engineering Degree Programs" (paper presented at the Annual Meeting of the ASA/CSCA/CiS, McMaster University, Hamilton, Ontario, July 25–28, 2014). Information based on statistics from ASEE "Profiles of Engineering and Engineering Technology Programs."

[5]Women in Science and Engineering in Canada; Corporate Planning and Policy Directorate, Natural Sciences and Engineering Research Council of Canada, Ottawa, ON, 2010, http://www.nserc-crsng.gc.ca/_doc/Reports-Rapports/Women_Science_Engineering_e.pdf.

[6]See discussion in Schiebinger, *Has Feminism Changed Science?,* 67–91.

[7]Anne Sayre, *Rosalind Franklin and DNA* (New York: Norton, 1975).

[8]Candace B. Pert, *Molecules of Emotion: The Science behind Mind-Body Medicine* (New York: Scribner, 1997).

[9]The study involved 127 science professors at six US universities who were asked to evaluate two fictitious CVs of students applying for a job as a laboratory manager; C. A. Moss-Racusin et al., "Science Faculty's Subtle Gender Biases Favor Male Students," *Proceedings of the National Academy of Sciences* 109 (2012): 16474–79.

[10]For example, Simon Baron-Cohen, *The Essential Difference: The Truth about the Male and Female Brain* (New York: Basic Books, 2003); Melissa Hines, *Brain Gender* (Oxford: Oxford University Press, 2005); Donald W. Pfaff and Yves Christen, eds., *Multiple Origins of Sex Differences in Brain: Neuroendocrine Functions and Their Pathologies* (Heidelberg: Springer, 2013). For a critique on brain gender studies, see Rebecca M. Jordan-Young, *Brain Storm: The Flaws in the Science of Sex Differences* (Cambridge, MA: Harvard University Press, 2010).

[11]Madhura Ingalhalikar et al., "Sex Differences in the Structural Connectome of the Human Brain," *Proceedings of the National Academy of Sciences* 111 (2014): 823–28.

[12]For example, Daniel G. Amen, MD, *Unleash the Power of the Female Brain: Supercharging Yours for Better Health, Energy, Mood, Focus, and Sex* (New York: Harmony Books, 2013).

[13]A. M. Beltz, J. E. O. Blakemore, and S. A. Berenbaum, "Sex Differences in Brain and Behavioral Development," in *Neural Circuit Development and Function in the Brain,* ed. John Rubenstein and Pasko Rakic (San Diego, CA: Academic Press, 2013), 467–99; Jeffrey Derks and Lydia Krabbendam, "Is the Brain the Key to a Better Understanding of Gender Differences in the Classroom?," *International Journal of Gender, Science and Technology* 5, no. 3 (2013): 281–91; Schiebinger, *Has Feminism Changed Science?,* 159–79.

[14]The very small (particle physics) and the very large (astrophysics) both require imaginative access. A classic work on the nature of scientific discovery is Thomas Kuhn, *The Structure of Scientific Revolutions* (Chicago, IL: University of Chicago Press, 1967). Examples of discoveries include Newton's insights about gravity when watching an apple fall and Kekulé's dream of a serpent eating its tail, which helped him discover the structure of the benzene ring.

[15]Schiebinger, *Has Feminism Changed Science?,* 54–64.

[16]Jill M. Bystydzienski and Sharon R. Bird, "Introduction" in *Removing Barriers: Women in Academic Science, Technology, Engineering and Mathematics,* ed. Bystydzienski and Bird (Bloomington, IN: Indiana University Press, 2006), 1–19.

[17]For example, Aída Besançon Spencer, *Beyond the Curse: Women Called to Ministry* (New York: Thomas Nelson, 1985); Mary Stewart Van Leeuwen, *Gender and Grace: Love, Work and Parenting in a Changing World* (Downers Grove, IL: IVP Academic, 1990); Alan G. Padgett, *As Christ Submits to the Church: A Biblical Understanding of Leadership and Mutual Submission* (Grand Rapids, MI: Baker Academic, 2011).

[18]For example, Garrett Green, *Imagining God: Theology and the Religious Imagination* (San Francisco, CA: Harper & Row, 1989); Paul Avis, *God and the Creative Imagination: Metaphor, Symbol and Myth in Religion and Theology* (New York: Routledge, 1999). Sallie McFague suggests that previous views of God have been male dominant in *Metaphorical Theology: Models of God in Religious Language* (Philadelphia, PA: Fortress, 1982).

[19]Matthew Henry, *Commentary on Genesis*, public domain, http://biblehub.com/commentaries/mhcw/genesis/2.htm.

[20]For example, the word *kephalé* in 1 Cor. 11:2–16 is commonly translated "head" but can have multiple meanings, including "origin"; see Padgett, *As Christ Submits,* 70–71.

[21]Karl Menninger, *Whatever Became of Sin?* (Toronto: Bantam, 1973). He notes that sin has been reduced to either an illness or a crime, and that we tend to confuse the issue with semantic tricks or relativize it.

[22]Hebrew *ḥaṭṭāt* ; Greek, *hamartia*. As Mark E. Biddle notes, the multiplicity of terms is inadequately represented by the one English word (Biddle, *Missing the Mark: Sin and Its Consequences in Biblical Theology* [Nashville, TN: Abingdon, 2005], xiv).

[23]Based on Sirach 10:15; Evagrius of Pontus, *Eight Logismoi,* public domain, http://www.earlychurchtexts.com/public/evagrius_of_pontus_eight_logismoi.htm; see summaries in James Taylor, *Sin: A New Understanding of Virtue and Vice* (Kelowna, BC: Northstone, 1997), 25–31; Hugh Connolly, *Sin* (New York: Continuum, 2002), 41–61.

[24]Found mostly in *Confessions*, but also in *City of God*, book 14; both public domain. Augustine's theology was informed by his own guilt in relation to sinful past behaviors, as well as his arguments against Pelagius, who had a high view of the goodness of humanity. The concept of original sin is uniquely Pauline; it is not found in the Old Testament, although is hinted at (e.g., Psalm 51, Job 31:33; 1 Corinthians 15). This concept has been much criticized recently, e.g., Biddle, *Missing the Mark*, 3–8; Taylor, *Sin: A New Understanding,* 183–93.

[25]Reinhold Niebuhr, *The Nature and Destiny of Man*, vol. 1 (New York: Charles Scribner's, 1964), 178–240; see also discussion in Terry D. Cooper, *Sin, Pride and Self-Acceptance: The Problem of Identity in Psychology and Theology* (Downers Grove, IL: IVP Academic, 2003).

[26]Connolly, *Sin*, esp. 41–81.

[27]Biddle, *Missing the Mark,* e.g., viii.

[28]Valerie Saiving, "The Human Situation: A Feminine View," *Journal of Religion* 40 (1960): 100–12; See also Judith Plaskow, *Sex, Sin and Grace: Women's Experience and the Theologies of Reinhold Niebuhr and Paul Tillich* (Lanham,

MD: University Press of America, 1980). Interestingly, this concept has appeared in nonfeminist literature. Søren Kierkegaard thinks that the despair of weakness, or the need for external approval, is characteristic of women, whereas the despair of defiance, or self-reliance, is primarily a male tendency (*The Sickness unto Death*, trans. Walter Lowrie [Princeton, NJ: Princeton University Press, 1954], 195–208). Humanist psychologies (exemplified in Carl Rogers's well-known idea of unconditional positive regard) also claim that the undervalued self is the primary problem. Contemporary Catholic contemplative, Henri Nouwen, suggests that the greatest temptation common to humanity is not money, sex, or power but self-rejection, a fear of never being good enough; this contradicts the sacred voice that calls us God's beloved (Nouwen, *Discernment: Reading the Signs of Daily Life* [New York: HarperOne/Harper Collins, 2013], 30–37).

[29]Serene Jones, *Trauma and Grace: Theology in a Ruptured World* (Louisville, KY: Westminster John Knox Press, 2009), 102.

[30]Andrew Sung Park argues that so-called feminine sin is not really sin but what he calls *han*, suffering from being sinned against (Park, *From Hurt to Healing: A Theology of the Wounded* [Nashville, KY: Abingdon, 2004], 32). I agree that much low self-esteem results from being a victim rather than a perpetrator of sin, but I still think that the concept of sin as self-abnegation is helpful. Certainly helping women recover their sense of worth in God's eyes is part of the healing process for sufferers of abuse.

[31]Van Leeuwen, *Gender and Grace*, esp. 42–48.

[32]Biddle, *Missing the Mark*, 32–76, 136.

[33]David L. Smith in his biblical theology, *With Willful Intent: A Theology of Sin* (Wheaton, IL: Bridgepoint, 1994), comes to a similar conclusion. He concludes that sin transcends selfishness and idolatry, and has at its root the rejection of God as God, which includes rejection of Christ. Idolatry is a form of rejection of God, which seeks to replace him with an object of one's own choosing (pp. 301–26). Underlying both is an unwillingness to place one's ultimate trust in God as revealed in Christ.

[34]Cooper, *Sin, Pride and Self-Acceptance*.

[35]For example, Jones, *Trauma and Grace*, 102–25.

[36]Biddle, *Missing the Mark*, 115–19, 138–39.

[37]Connolly, *Sin*, 103–24.

[38]For a psychotherapeutic conception of this, see Mark McMinn, *Sin and Grace in Christian Counseling* (Downers Grove, IL: IVP Academic, 2008).

[39]The *International Journal of Gender, Science and Technology* began in 2009 and is peer reviewed; McMaster University (Hamilton, Ontario) has an organization called the Women in Science and Engineering Initiative (WISE) which includes mentoring and educational programs. The newly formed "Christian Women in Science" affiliate of the ASA also aims to mentor young women scholars and is a good start in this regard.

[40]National Research Council, *Who Will Do the Science of the Future? A Symposium on Careers of Women in Science* (Washington, DC: The National Academies Press, 2000).

[41]NSERC policy statement, Oct. 2011, http://www.nserc-crsng.gc.ca/Professors-Professeurs/CFS-PCP/Wcurrent-Factuelles_eng.asp.

[42]Jean Vanier, *Becoming Human* (Toronto, ON: Anansi Press, 1998), 14.

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Gregg Davidson

Article

Genetics, the Nephilim, and the Historicity of Adam

Gregg Davidson

Considerable controversy exists at present over the apparent inability to reconcile modern population genetics and the fossil record with a genuine first human couple and first act of disobedience against God. Genetic data argue strongly for not only shared ancestry between humanity and animals, but also that the effective human population never dropped below a few thousand. A unique model is proposed, along with a discussion of its strengths and weaknesses, for how a first human pair (Adam and Eve) could have existed without contradicting the findings of current genetics. The argument is not made in defense of any particular interpretation of the early chapters of Genesis, other than the existence of a first human couple and initial act of disobedience. In the proposed model, God chose an individual hominid pair to endow with souls, separating them spiritually, relationally, and cognitively from their otherwise biologically equivalent contemporaries. After being removed from Eden, limited (and forbidden) interbreeding took place between Adam and Eve's progeny and still-extant hominids, including more distantly related hominid species such as Neanderthals, resulting in offspring with unique characteristics referred to as Nephilim. *Such unions can potentially account for a present human population that derived from a genuine first human couple, while also carrying genetic evidence of contributions from a much larger hominid population. This model simultaneously offers a plausible explanation for Cain's fear at the time of his banishment, and the enigmatic identity of the "sons of God" in Genesis 6.*

Among discussions at the intersection of science and Christian faith, perhaps the most contentious subject in recent years is the historicity of Adam and Eve. On the scientific side, genetic and fossil evidence weigh heavily against humanity starting as a specially created, individual man and woman. Fossil hominid remains make a strong case for human lineage that derives from nonhuman ancestors, and genetic variability in the human genome appears to require that the earliest *Homo sapiens* population never dropped below several thousand members.

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On the theological side, there is no hint of metaphorical language in Romans 5, where the Apostle Paul writes that sin entered the world through one man, Adam.[1] Biblical scholars who have found ways of reconciling other scientific claims with an inspired, inerrant Bible—such as a sun-centered solar system, an ancient earth, or evolution of nonhuman life—have had greater difficulty finding ways in which genetic evidence can be reconciled with biblical characterizations of Adam and Eve. A growing number have simply decided that the creation story is entirely allegorical, and that Paul's description of sin entering through one (Adam) and salvation coming through one (Jesus) was a culturally expedient literary tool. For others, this view represents acquiescence to liberal theology,

in which science is elevated as a more trustworthy source of truth, and the Bible is viewed simply as a collection of human wisdom from which one must sort out the good and the bad.

In this article, I make a case for the possibility of a genuine first human couple and first act of disobedience that is consistent with current scientific understanding regarding the origin of humanity and population genetics. It is not an argument for any particular interpretation of the first chapters of Genesis, literal or otherwise, nor is it necessarily an expression of my own personal belief. Rather, it is offered as one possible scenario for how Adam and Eve could have existed as real individuals within the context of both human evolution and a particular reading of the biblical narrative. I would add a further note that no claim is made here of an airtight case. From a human perspective, no explanation for the origin of human beings—from the purely literalistic interpretation of the biblical creation story to the purely naturalistic belief in the undesigned flowering of self-aware life—is free from unresolved tensions. I will argue, however, that the proposed model has sufficient plausibility for serious consideration. A particular strength of the argument is that it simultaneously addresses two other long-standing theological conundrums: who Cain was afraid of in Genesis 4, and who the "sons of God" were in Genesis 6. We will start with a brief summary of the scientific data.

Fossil Hominids

There is a common misconception that the number of so-called hominid fossil discoveries is very small, with whole-organism reconstructions typically based on a stray tooth or fragment of a jaw.[2] In fact, remains from over 5,000 individual hominids have been discovered, ranging from single bones to nearly complete skeletons.[3] When dated and placed in chronological order, the exact relationship between species is not always apparent, but there is a clear progression of more ape-like to more human-like features through time.[4]

Genetic Evidence of Common Ancestry

Comparison of the DNA of disparate organisms allows rigorous testing of various origins models. In a special creation model, in which the first man was created *de novo*, similarities in DNA with other primates are expected because of a "common designer" rather than a common ancestor; God used similar genetic architecture for similar functions. Subsequent genetic drift beyond the creation event should have led to changes in the genetic coding that are unique in humans and in all other primates. One should not expect a series of random mutations, such as point changes (one "rung" on the DNA ladder), or duplication or inversion of gene sequences to be repeated in the same place and pattern in two separate specially created populations.

In an evolutionary creation model, humans should share some of the same mutations as other primates. If diverse organisms share a common ancestor, then comparisons of the DNA of any two species should contain examples of genetic mutations in the same place and pattern, with more shared mutations between organisms with a more recent common ancestor, and fewer between those with a more ancient shared ancestor.

When studying primates, duplicated and inverted gene sequences are found in substantial numbers between humans and other primates, consistent with an evolutionary creation model. The highest frequency of shared mutations occurs between humans and chimps, suggesting a more recent common ancestor than between humans and gorillas, orangutans, or other apes. Of some significance, the genetic distance between chimps and gorillas (the next most genetically similar ape) is greater than the difference between chimps and humans.[5]

Mitochondrial Eve, Y-Chromosome Adam, and Population Size

Using any particular sequence of DNA collected from a large sample of the human population, it is possible to link all humans back to a common ancestor. The estimated age of a common ancestor varies widely with different DNA sequences, which is fully expected as populations diverge and differentiate. As an example, one sequence of DNA might indicate a recent common ancestor shared only by Native Americans, reflecting a time after migration to North America that isolated these people from populations

still living in Eurasia. Another sequence might indicate an older common ancestor, one that predates the migration, that is shared by both Native American and Asian populations. Still other sequences may indicate more-ancient common ancestors shared between human and nonhuman organisms.

Most of the DNA in our cells shares its origin equally between our mothers and fathers. There are two exceptions. Y-chromosomes, found only in males, come exclusively from our fathers (females have no Y-chromosome to pass on). Mitochondrial DNA, referred to as *mtDNA*, is found outside the nucleus in energy-producing organelles called *mitochondria*. Mitochondria are found only in the egg, not in the sperm, with the result that mtDNA is passed on to both males and females exclusively from our mothers.[6] Population studies of mtDNA and Y-chromosomes are of interest for many reasons, one being that they do not undergo recombination during sexual reproduction. The only thing that changes their makeup from one generation to the next is mutation.[7] They are also uniquely suited for tracing ancestry back to a common *female* or to a common *male* ancestor. The most recent common human female ancestor, traced through mtDNA, is commonly referred to as *mitochondrial Eve*. The most recent common male ancestor, based on Y-chromosome studies, is less commonly referred to as *Y-chromosome Adam*.

Geneticists point out that mitochondrial Eve and Y-chromosome Adam are not synonyms for the biblical Adam and Eve for at least three reasons.

1. A common female ancestor is not fundamentally different from a common ancestor of unknown sex. Based on studies of nuclear DNA, additional older common ancestors can be identified (pushing the origins of humans back earlier than mitochondrial Eve).
2. The variability of DNA in the cell nucleus strongly argues that mitochondrial Eve was part of an effective population of at least several thousand individuals.[8] For nongeneticists, tracing our origins back to a single mother *and* to a larger contemporaneous population at the same time may seem contradictory, but it is actually quite plausible. The explanation is that mitochondrial Eve's offspring mated with members of the larger population present at the time, but within subsequent generations only mitochondrial Eve produced an unbroken line of *daughters*. Lineages from other females living at the time of mitochondrial Eve eventually passed through a generation of all male offspring (or did not reproduce). Males without lineage back to mitochondrial Eve continued to mate and contribute to the genetic pool, but once a generation was reached in which all the females traced their mtDNA to mitochondrial Eve, all future humans, male and female, would share the same common source of their mtDNA. The genetic makeup of modern humans thus reflects both a common single mother and ancestry from a larger population present at the same time. The same reasoning applies to a common Y-chromosome father. A common father does not mean that there were no other humans present and mating at the time. Rather, it simply means that in subsequent generations, only one male's lineage produced an unbroken line of sons leading up to the present.
3. The degree of genetic variability within the human population is not the same in mtDNA and Y-chromosomes, leading to different estimates of the time required to accumulate the observed variations. In other words, the most recent common mother and common father did not necessarily live at the same time. If mutations occur at roughly the same rate as observed today, mitochondrial Eve dates back roughly 200,000 years.[9] The common Y-chromosome father was thought to be more recent, dating back to about 140,000 years,[10] but several recent studies have argued for dates closer to or even predating mitochondrial Eve.[11]

Those attempting to reconcile the time offset with a genuine first human couple note that the published dates refer only to the *most recent* common mother or father, and do not preclude earlier common mothers or fathers. It is possible that a common *monogamous* mother and father existed at the same time, with a more recent common mother or father later in human history. On this subject, writers such as Fazale Rana and Hugh Ross have argued that a more recent common father is conceptually consistent with Noah's flood: Noah's three sons shared a common father, but their wives presumably each had different mothers.[12] Such an event requires that a severe bottleneck occurred in the human population since the time of mitochondrial Eve that does not appear to be

reflected in the diversity of human DNA.[13] It is worth noting here that the lack of evidence for a bottleneck only bears upon the question of the flood's extent. It does not address the question of whether Noah was a real person or if a flood of great size actually occurred. The only tension is that, at present, human genetic diversity does not appear reconcilable with a complete destruction of all humans from lands far distant from Noah.

Interbreeding

The most recent hominids thought to be distinct from *Homo sapiens* are the Neanderthals (and the more poorly known Denisovians).[14] Neanderthals had distinctive skulls and skeletal features that make these fossils easily identifiable. Their first appearance predates modern humans by over 100,000 years, but overlapped with *Homo sapiens* for thousands of years before their disappearance. Preservation of organic material from some Neanderthal remains has allowed genetic analyses, with the conclusion that they were indeed distinct from modern humans. However, comparisons of DNA from Neanderthal fossils, ancient *Homo sapiens* remains, and modern humans suggest that limited interbreeding took place between Neanderthals and some *Homo sapiens* populations, resulting in recognizable Neanderthal DNA in non-African human populations today.[15]

Summary of Scientific Claims

- Man shares a common ancestry with other life forms.
- Modern humans trace their ancestry both to a common mother and to a larger contemporaneous population (humanity was never limited to two individuals), roughly 200,000 years ago.
- Different varieties of hominids existed at the same time.
- Interbreeding occurred between *Homo sapiens* and hominids such as Neanderthals.

At first glance, the list above may seem utterly at odds with a historical Adam and Eve, but there is at least one possible scenario, summarized below, in which modern genetics and a genuine first human pair are not inherently in conflict.

- Adam and Eve were naturally born hominids selected by God.
- Selection included endowing with souls, making them spiritually, relationally, and cognitively distinct from their hominid relatives and neighbors.
- After being cast out of Eden, forbidden interbreeding occurred between their offspring and contemporaneous hominids.

Several criteria must be satisfied to reconcile this proposed history with scripture and modern genetics.

1. *Evolution and selection of a single hominid pair must be consistent with God's nature.*

This first criteria is a bold statement, because it implies that we can know and understand God's nature sufficiently to make such an assessment. On the one hand, we are presumptuous when we think we can define the parameters that must constrain the actions of God. Romans 11:33 proclaims that God's judgments are unsearchable and his ways unfathomable.[16] On the other hand, scripture also tells us that we can have the mind of Christ (1 Cor. 2:16), and gain understanding of God's nature and character through the study of both his revealed and natural world (Rom. 1:19).

The concept of nonliving earth materials giving rise to complex life is entirely consistent with what we are told of God's interaction with his creation. In the creation account, God spoke to the earth and commanded it to bring forth living creatures, and it obeyed (Gen. 1:24). This obedience is equally satisfied by the earth producing life in a single step, or through multiple generations (evolution) starting with nonliving earth materials. It is significant here that no distinction is made in the source material for Adam. Genesis 2:7 tells us that Adam was made from the same raw materials as the animals—from the dust of the earth. Whether created in one step or many, Adam was derived from the earth and owes his existence to God.

Selection of one individual from among many for a particular purpose is also consistent with God's nature. God chose Abraham over the rest of humankind, Isaac rather than Ishmael, Jacob over Esau, and Israel rather than other nations, typically without any explanation. Selection of one hominid pair over all others would be consistent with this pattern.

Lastly, creation over time through a series of stages is perhaps *more* consistent with God's nature than

instantaneous creation. Being made in the image of God arguably includes the desire to be creative. The sculptor pursuing this desire takes no delight in punching a button for a protrusion machine to spit out a statue, but rather spends countless hours working and shaping the material into the envisioned design. This reflection of God fits well with a mode of divine creativity that started with formless clay (earth materials) that was molded and fashioned over time through a series of generations toward a variety of end designs. But, being infinitely more creative than human beings, each step of God's handiwork—each successive generation—has been a marvelous end product on its own.

2. *To be evolved* and *to be the first true humans, Adam and Eve had to have nonhuman parents, yet they needed to be substantively distinct from their biological parents and relatives.*

In the proposed scenario, God worked his hominid creations through a long series of generations, culminating in a biological structure ready and suitable for housing a soul. If God selected two individual hominids to endow with souls, then this first pair would have been physically similar to their parents and neighbors, but spiritually, emotionally, and relationally on an entirely different plane.[17] Unpacking this idea requires some discussion of what it means to be in possession of a soul, and the difference between soul-bearing and "soulish" creatures.

The precise nature of the soul—and how an individual comes into possession of one—is a mystery. While there is no uniform consensus among Christian theologians, there is a general recognition that a human is both a physical and a spiritual organism.[18] Our physical form begins at conception with the recombination of our parents' genetic material and ends at death. (While scripture speaks of a bodily resurrection, it is a glorified version that does not require the reformulation of the same molecules dispersed at death.[19]) In order to exist beyond the grave, to have a continued relationship with God, and to experience eternal reward or punishment, there has to be a fundamental characteristic of each individual that is not bound by the laws of nature and continues when physical life ceases. If we define this characteristic as the *soul*, then its existence and its origin is not something that can be teased apart by the scientific method.[20]

This duality creates an inevitable tension. Awareness of a relationship with God that extends beyond physical death requires a sufficiently developed brain and physiology to carry out the appropriate neural transmissions to process that awareness. At the same time, the physiological structure that facilitates awareness cannot generate that awareness without the actual possession of a nonmaterially constrained soul. I would argue that the gift of a soul to a previously soulless, yet biologically equipped hominid, had the potential to impart a quantum, *bigger-than-biology* shift in the emotional and relational awareness of Adam and his bride that set them apart from their contemporaries.

A logical counter-argument might be made that hominids, such as Neanderthals that we do not think of as truly human (at least not in the modern sense), exhibited behaviors reminiscent of an understanding of life after death, such as ornamenting and burying their dead. Addressing this requires an understanding of what is meant by *soulish* behavior. The higher animals are often spoken of today as *soulish* creatures, meaning that they possess some degree of decision-making capacity and conscience experience that goes beyond simple instinct. Soulish characteristics may include loyalty, affection, pleasure, excitement, curiosity, sadness, or a measure of self-awareness. The reason we have such a word in our theological vocabulary is that we assume the behavior of the higher animals *resembles* that of a soul-bearing human, though lacking the spiritual identity that makes them subject to eternal reward or punishment after death.[21]

A soul-bearing creature—what we think of today as a *human*—has mental and relational capacities that go well beyond soulishness, such as a cognitive understanding of justice and mercy,[22] the ability to create and appreciate art, the desire to understand why things are the way they are, the ability to ponder and communicate abstract ideas, the desire to know truth, and the sense that there is a realm or existence that is beyond the physical. When the Bible speaks of creation in the image of God, it is not a physical appearance, but possession of such characteristics that allow human beings to be God's relational representatives on this earth.[23] As creatures lacking a soul, hominids living at the time of Adam and Eve may well have had behaviors that were much more

soulish than those of the most advanced primates of today, but still only soul-*ish*.

Selection and endowment of a soul at one point in time also avoids a logical conundrum inherent in arguments advocating an evolutionary development of the soul or spirit. In the evolution of *physical* forms, transitions from one function to another, such as bone structures transitioning to a more upright posture, can proceed in a stepwise fashion. There is no conundrum in a creature walking "partially upright." But if humans are uniquely in possession of a spiritual entity—a soul—that can abide with God in heaven or be cast into hell, stepwise transitions are much more problematic. How can a creature possess a transitional form of a soul that upon death gives it a *partial* eternal union with God in heaven, or a *partial* separation in hell?

Several additional questions logically arise from this discussion such as how the progeny of Adam and Eve came to have souls, whether the offspring of a soul-bearing human and a nonsoul-bearing hominid would have a soul, and how a sinful nature came to be inherent to the human condition. The proposed model is not dependent on a particular answer to any of these questions, other than the reminder that a soul that continues beyond the grave is not a biological entity that is constrained by genetic principles. We possess a soul and a relationship with our Maker, not by virtue of the DNA passed on by our ancestors, but by the divine agency of God. Given that much of humanity today is, in essence, "mixed" (at least considering Neanderthals), one may assume that God endowed all of Adam's progeny with souls. Rebellion from God is likewise a spiritual phenomenon, ungoverned by our biology—though certainly lived out in a bodily fashion. As such, the model is consistent with, but not dependent on any of the historical theological views of original or ancestral sin.[24]

3. *Adam and Eve had to live for a time in the midst of their hominid relatives.*

The presence of contemporaneous hominids offers a plausible explanation of who Cain was afraid of after becoming an outcast.[25] Genesis 4:14 relates Cain's concern that "whoever finds me will kill me." Every generation has pondered the question of who Cain feared if all of humanity at the time was Adam, Eve, and Cain (with Abel deceased). The standard response is that Adam and Eve had other children who quickly gave rise to a sizable population. But there are timing and location problems. Regarding timing, we are told explicitly in Gen. 4:25 that Adam and Eve's next son, Seth, was born *after* Cain killed Abel, and the absence of a genealogy for Abel indicates that he died childless. This requires that Cain was either afraid of people not yet born, or that his eviction occurred decades after his offense. Neither seems a reasonable option.

Regarding location, recall that Cain's punishment was *banishment*—sent to a land away from Adam and Eve. If there were other children of Adam and Eve in this land, it means they also committed terrible sins that resulted in their earlier banishment, yet without a hint of such events occurring in the biblical narrative. All these problems disappear if the land of Cain's banishment was inhabited by hominids. If so, it would have been quite natural to refer to these soulish, human-looking creatures using anthropomorphic pronouns such as *whoever*, and to fear them.[26]

4. *Hominids must have persisted and mated with Adam and Eve's offspring to produce the genetic variation we see today.*

Here we finally arrive at the *Nephilim* (found in the title of this article) as a means of addressing the genetic evidence that the effective human population never dropped below a few thousand.[27] Genesis 6 is the enigmatic story leading up to Noah's flood, in which the "sons of God" found the "daughters of men" to be beautiful and took them as wives. These unions were an anathema to God, and the offspring are identified with their own name, the *Nephilim*, of which some became known as "mighty men" or "men of renown." There are three common explanations offered: angels marrying human women, noblemen or tyrant rulers marrying commoners, or the righteous line of Seth intermarrying with the unrighteous line of Cain.[28] Substantive objections can be raised for each of these arguments. Angels intermarrying with humans fails because Christ explicitly stated that angels neither marry nor are given in marriage (Mark 12).[29] Noblemen intermarrying with commoners is a stretch because this would not have been objectionable to God, and would not have produced offspring with any unusual physical attributes. And the most commonly cited explanation, the righteous line of Seth intermarrying with the unrighteous line of Cain, falls short because *all* humanity, with

the sole exception of Noah, had become thoroughly unrighteous. If they were righteous, they would not have been engaging in forbidden unions and falling under God's judgment. Such unions likewise would have failed to produce offspring with any unusual physical attributes.[30] To further complicate matters, none explain why the Nephilim were still around *after* Noah, when the flood had supposedly wiped out all but Noah's family (Gen. 6:4; Num. 13:33).

It is conceivable that the "sons of God" were hominids, either those of the same biological stock as Adam and Eve, or more distantly related, coexisting hominids.[31] Hominids would have been "sons of God" in the sense that they were God's creations, and they would have been physically similar to soul-bearing humans, biologically capable of interbreeding, even if forbidden by God. The pervasiveness of this behavior indicated by Genesis 6 is consistent with the introduction of considerable genetic variability. Such intermixing could also potentially account for the persistence of the Nephilim after Noah's flood, even if one were to insist that the flood was universal in its coverage. It would require only one of the wives of Noah's sons to carry Nephilim DNA to ensure that it would manifest itself in some offspring after the flood (though it is again acknowledged that the genetic data does not currently support such an extreme bottleneck).

Interbreeding between the offspring of Adam and Eve with hominids from their ancestral population would not be expected to produce the unusual physical prowess associated with the Nephilim. However, if the timing of Genesis 6 coincides with the period of overlap between humans and Neanderthals, the heavier musculature of the Neanderthals could certainly have resulted in offspring with enhanced strength or unique physical characteristics that made it natural to refer to them by a special name.[32] (If farther back in time, then a similar argument can be made for an earlier variety of hominid.)

Figure 1 provides an example of how human-hominid interbreeding could produce the genetic makeup of modern humans.[33] In this simplified illustration,

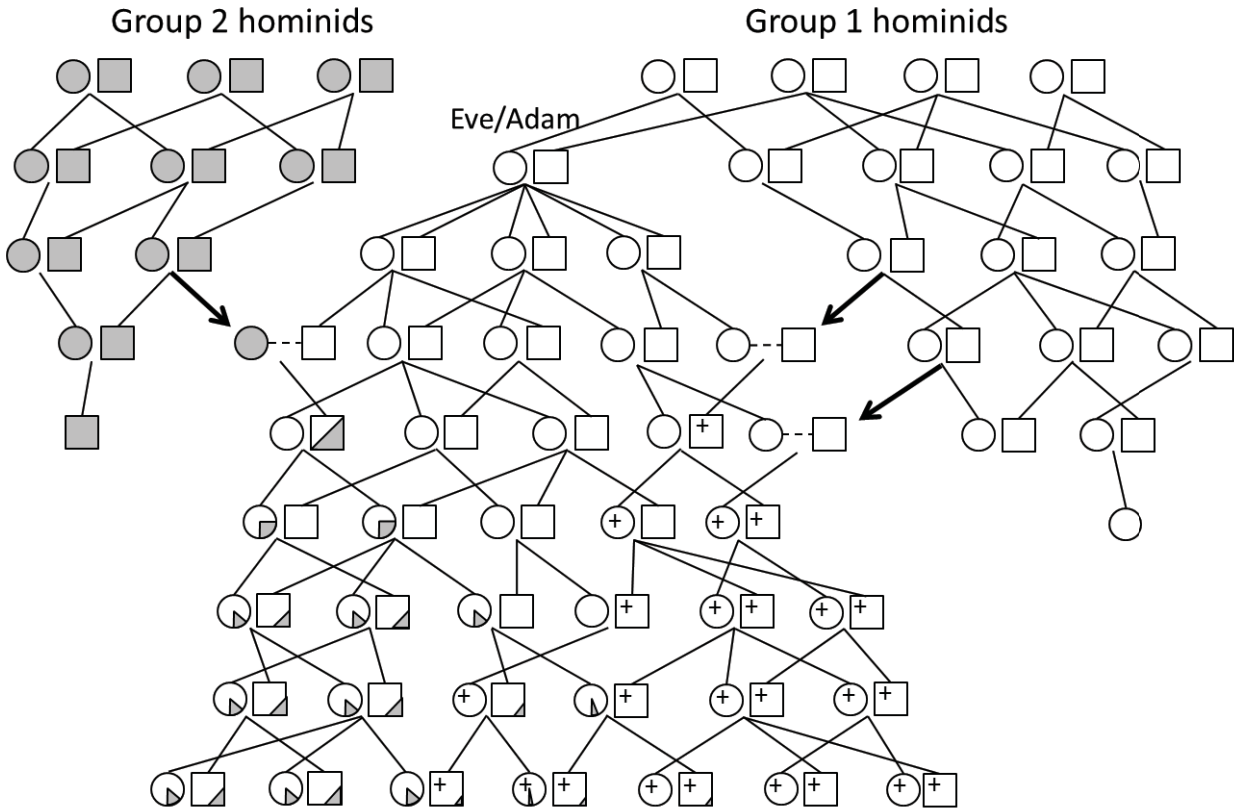

Figure 1. Lineage illustration for how similar and dissimilar hominid groups could have contributed to the genetic makeup of Adam and Eve's progeny. Squares represent males and circles represent females. Contribution to the human lineage (starting with Adam and Eve) from Group 1 hominids is indicated with a "+"; contribution from Group 2 hominids is indicated with proportional shading.[33]

an initial pair of hominids is selected from Group 1 and set apart as the first true humans—endowed with souls. In subsequent generations, forbidden interbreeding with contemporaneous hominids introduces greater genetic variation into the human gene pool. Group 1 represents the original stock from which Adam and Eve were selected. These individuals are not genetically distinct from soul-bearing humans, but do contribute to the genetic diversity of later humans. A plus sign in each symbol represents genetic variability introduced by interbreeding with Group 1 hominids. Group 2 represents a more distantly related hominid population, such as Neanderthals. In this case, the percentage of DNA introduced and passed along in later generations is tracked with proportional shading to show a final population of humans with varying retention of genetic material from these hominids (consistent with varying degrees of Neanderthal DNA in modern humans). Group 1 and Group 2 hominids eventually die out, with the exception of offspring produced via interbreeding with Adam and Eve's offspring. Figure 2 illustrates how this could be possible and still have all living humans trace their mtDNA lineage back to a common female, or their Y-chromosome lineage back to a common male.

Though this model equates the "sons of God" with hominids and the "daughters of men" with humans, it works equally well if these are reversed. Such a scenario perhaps fits better with the tendency for males to bring females back to their tribe. To preserve the ancestry of all living humans back to mitochondrial Eve, this simply requires that the progeny of all female-hominid/male-human unions eventually failed to produce daughters. Figure 1 is constructed intentionally to show insertion of hominid males from Group 1, and hominid females from Group 2, with modern mtDNA ancestry shown leading back to a common mother in Figure 2.[34]

5. *It must be possible for a first monogamous couple to produce a genetic lineage with different dates for the most recent common father and common mother.*

One mechanism for producing different dates for the most recent common mother and common father is by having multiple mates. If mitochondrial Eve produced offspring by more than one mate, the most recent *common* father of humanity would be traced to a different point in time. Different dates are also possible, however, beginning with a monogamous pair. Figure 1 is constructed to illustrate how a more recent common father is possible that still traces human ancestry back to a monogamous mate of mitochondrial Eve (traced out in fig. 2).

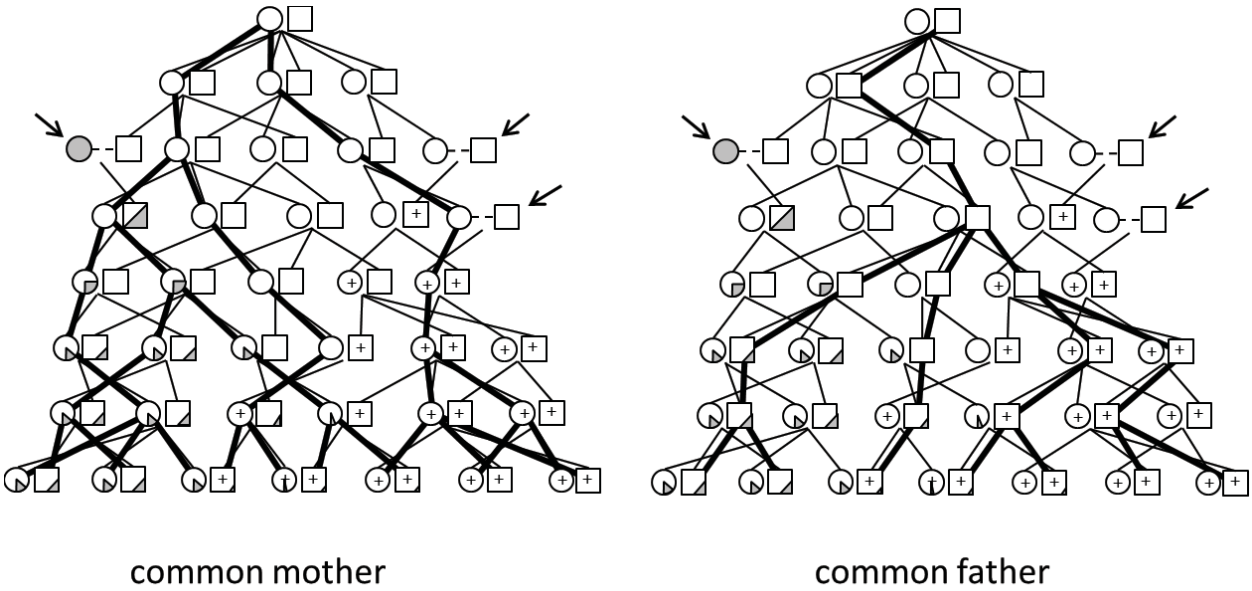

Figure 2. Maternal (mtDNA) and paternal (Y-chromosome) lineage traced for figure 1.

6. *The timing of mitochondrial Eve should correspond with the first appearance of agrarian society (tending livestock and gardens).*

Adam and Eve's first two sons were raising flocks and tending gardens (Gen. 4:2). Placing mitochondrial Eve at 200,000 years ago does not align well with the oldest evidence of animal husbandry and intentional gardening, which is an order of magnitude more recent.[35] Archaeologists recognize that the oldest evidence of any particular practice does not represent the date the practice was first applied—only the oldest date we have thus far discovered. Accumulation and preservation of materials related to a particular practice are not likely to be uncovered unless the practice had been in extended use and geographically dispersed. This means the very earliest application of agriculture, and the age of Adam and Eve, could be well over 20,000 years. Pushing this back to 200,000 years (by a very small, regionally isolated population) is a considerable stretch, though not categorically impossible.

A second possibility is that the biblical description is an anachronistic description of hunting (animal food sources) and gathering (vegetable food sources) practices, or some rudimentary form of tending flocks and gardens. This understanding, without the constraint that the timing must be within the last 20 to 30 millennia, does not depart from the fundamental mechanics of the story (Abel offered a blood sacrifice, Cain did not).

A final observation is worth noting concerning the accuracy and significance of genetically determined dates. Though nothing in the proposed model requires any date to be incorrect, there is some caution warranted against modifying one's theological understanding *solely* on the basis of genetically estimated dates. The dating methods employed are based on the assumption that mutation rates within specific segments of DNA are constant, such that variations within that segment in a population of organisms can be used to estimate how much time has passed since they shared a common ancestor. It is known, however, that mutation rates vary, in some cases by orders of magnitude, for DNA from different types of organisms,[36] for different segments of DNA within an organism,[37] for the same sequence of DNA over multiple generations,[38] and even for the same segment of DNA produced later in the life of an individual.[39] This means that mutation rates are dependent to some degree on the particular sequence of base pairs and the biochemical environment in which they are found. As mutations accumulate within a DNA segment, the subsequent rate of mutation for that sequence could conceivably change as well.[40] Additionally, there are studies noting mechanisms, such as duplication or replacement of a sequence of base pairs that can add unexpected heterogeneity and a potential overestimate of age.[41] Uncertainty can be reduced by comparing calculated ages based on a large number of different segments of DNA, and in some cases, by comparing those estimates with the radiometric ages of fossil transitional forms, though here also the dates do not always align as well as hoped.[42] None of this is suggested as an argument against employing genetic dating methods. It is only a word of caution against placing undue weight on the importance of these ages in attempts to reconcile science and scripture.

Conclusions

The existence of a genuine first human couple and a first act of disobedience against God have been challenged. In defense of both population genetics and a historical Adam and Eve, the described model illustrates how both the biblical and genetic records can be accounted for by interbreeding between hominids and the offspring of a genuine first human couple. The model preserves an understanding of a first sin (whether *original* or *ancestral*) as described both in Genesis and in the writings of Paul, and also potentially resolves the biblical conundrums of who Cain was afraid of in Genesis 3, and the enigmatic identity of the "sons of God" and the Nephilim in Genesis 6.

♦

Notes

[1]In this article, a "first sin" refers only to a first act of willful disobedience against God. No attempt is made to defend or describe the various theological views of how this first act affected subsequent generations.

[2]Technically speaking, *hominids* is a broad term that includes humans and African great apes. The subset of hominids giving rise to humans are identified as *hominins*. See B. Wood and P. Constantino, "Human Origins: Life at the Top of the Tree," in *Assembling the Tree of Life*, ed. J. Cracraft and M. J. Donoghue (Oxford: Oxford University Press, 2004), 517–35.

[3]Richard Potts, personal communication. Potts, director of the Human Origins Program at the Smithsonian Institution, has compiled a personal database of hominid fossil discoveries. At present, the database includes entries for over 5,000 separate individuals ranging from 20,000 to 6 million years in age. Note this is not 5,000 fossil frag-

ments, but fossil remains originating from over 5,000 different individual hominids.

[4]Ian Tattersall, *The Fossil Trail: How We Know What We Think We Know About Human Evolution*, 2nd ed. (New York: Oxford University Press, 2008). Contrary to the claims of young-earth advocates, fossils are not dated based on the assumption of evolution. The ages of layers in which fossil hominids are found are based on a variety of different methods: some that date the fossil material directly, and others that date the sediment or other artifacts found in the same layer.

[5]Excellent summaries of the evidence for common descent can be found in D. L. Theobald, "29+ Evidences for Macroevolution: The Scientific Case for Common Descent," *Talk Origins Archive*, ver. 2.89, March 12, 2012, http://www.talkorigins.org/faqs/comdesc; and D. R. Venema, "Genesis and the Genome: Genomics Evidence for Human-Ape Common Ancestry and Ancestral Hominid Population Sizes," *Perspectives on Science and Christian Faith* 62, no. 3 (2010): 166–78.

[6]R. E. Giles, H. Blanc, H. M. Cann, and D. C. Wallace, "Maternal Inheritance of Human Mitochondrial DNA," *Proceedings of the National Academy of Sciences* 77, no. 11 (1980): 6715–19.

[7]R. L. Cann, M. Stoneking, and A. C. Wilson, "Mitochondrial DNA and Human Evolution," *Nature* 325 (1987): 31–36; and P. A. Underhill et al., "Y Chromosome Sequence Variation and the History of Human Populations," *Nature Genetics* 26 (2000): 358–61.

[8]A good summary explanation of the genetics can be found in D. Venema and D. Falk, "Does Genetics Point to a Single Primal Couple?," The BioLogos Forum, April 5, 2010, http://biologos.org/blog/does-genetics-point-to-a-single-primal-couple.

[9]K. A. Cyran and M. Kimmel, "Alternatives to the Wright-Fisher Model: The Robustness of Mitochondrial Eve Dating," *Theoretical Population Biology* 78, no. 3 (2010): 165–72.

[10]F. Cruciani, B. Trombetta, A. Massaia, G. Destro-Bisol, D. Sellitto, and R. Scozzari, "A Revised Root for the Human Y Chromosomal Phylogenetic Tree: The Origin of Patrilineal Diversity in Africa," *American Journal of Human Genetics* 88, no. 6 (2011): 814–18.

[11]G. D. Poznik et al., "Sequencing Y Chromosomes Resolves Discrepancy in Time to Common Ancestor of Males versus Females," *Science* 341 (2013): 562–65; P. Francalacci et al., "Low-Pass DNA Sequencing of 1200 Sardinians Reconstructs European Y-Chromosome Phylogeny," *Science* 341 (2013): 565–69; and F. L. Mendez et al., "An African American Paternal Lineage Adds an Extremely Ancient Root to the Human Y Chromosome Phylogenetic Tree," *American Journal of Human Genetics* 92 (2013): 454–59.

[12]Fazale Rana with Hugh Ross, *Who Was Adam?* (Colorado Springs, CO: NavPress, 2005), 55–75.

[13]H. Li and R. Durbin, "Inference of Human Population History from Individual Whole-Genome Sequences," *Nature* 475 (2011): 493–97.

[14]J. Krause, Q. Fu, J. M. Good, B. Viola, M. V. Shunkov, A. P. Derevianko, and S. Pääbo, "The Complete Mitochondrial DNA Genome of an Unknown Hominin from Southern Siberia," *Nature* 464 (2010): 894–97.

[15]R. E. Green et al., "A Draft Sequence of the Neandertal Genome," *Science* 328 (2010): 710–22; K. Prüfer et al., "The Complete Genome Sequence of a Neanderthal from the Altai Mountains," *Nature* 505, no. 7481 (2014): 43–49.

[16]This is perhaps the least believed verse in all of scripture, for our tendency is to put God into neatly defined theological boxes, and to proclaim that "my God" would never do this or that.

[17]Such a possibility has been suggested by a number of other writers: for example, Rendle Short, *Modern Discovery and the Bible* (London: The Inter-Varsity Fellowship of Evangelical Unions, 1942), 81; Derek Kidner, *Genesis, Tyndale Old Testament Commentaries*, ed. D. J. Wiseman (Downers Grove, IL: InterVarsity Press, 1967), 26–31; Gavin Basil McGrath, "Soteriology: Adam and the Fall," *Perspectives on Science and Christian Faith* 49, no. 4 (1997): 252–63.

[18]C. Hodge, "Nature of Man" and "Origin of the Soul," in *Systematic Theology*, vol. 2 (New York: Charles Scribner, 1872), chapters 2 and 3; W. Grudem, "The Essential Nature of Man," in *Systematic Theology* (Grand Rapids, MI: Zondervan, 1994), chap. 23.

[19]Bodily resurrection cannot be a simple reformulation of our molecules at the time of death, for many have shared the same molecules over time as decomposition reintroduces atoms back into the ecosystem to be incorporated into a new organism.

[20]This is not an argument for any particular version of dualism. It simply recognizes that being made in the image of God includes a nature that does not cease to exist at biological death. See J. B. Green and S. L. Palmer, ed., *In Search of the Soul: Four Views of the Mind-Body Problem* (Downers Grove, IL: InterVarsity Press, 2005).

[21]This says nothing about whether there will be animals in heaven, only that their eternal destiny is not predicated on the spiritual condition of their souls or any conscious action on their part.

[22]Apes have been observed to demonstrate a sense of justice, such as whether they have been given their fair share of a treat, which is a good example of a "soulish" behavior that is a pale reflection of the human ability to contemplate the moral implications of choices made.

[23]Some insist that the "image of God" refers to one of three choices: resemblance to God, representation of God's authority on Earth, or being relational in nature. C. John Collins does an excellent job of arguing that scripture does not provide sufficient justification for limiting the "image of God" to one choice, and all three are likely true (Collins, *Did Adam and Eve Really Exist?* [Wheaton, IL: Crossway, 2011], 93–95).

[24]H. O. Wiley, "Original Sin or Inherited Depravity" in *Christian Theology* (Kansas City, MO: Beacon Hill Press, 1941), chap. 19.

[25]The possibility that Cain feared hominids (or "more primitive type of man") was suggested at least as early as 1942 by Short, *Modern Discovery and the Bible*, 81.

[26]Genesis 4:17 notes that Cain built a city, named after his son, in the land of his banishment. The proposed model fits with a city either built by Cain and his direct offspring, or built with participation to some degree by hominids.

[27]G. R. Davidson, *When Faith and Science Collide* (Oxford, MS: Malius Press, 2009), 73–79.

[28]John H. Sailhamer, *Genesis–Numbers*, ed. F. E. Gaebelein, vol. 2 of *The Expositor's Bible Commentary* (Grand Rapids, MI: Zondervan, 1990), 75–79; R. C. Sproul, ed., *The Reformation Study Bible* (Nashville, TN: Thomas Nelson Publishers, 1995), 18; and John H. Walton, *The NIV Application Commentary: Genesis*, ed. T. Muck, (Grand Rapids, MI: Zondervan, 2001), 290–96.

[29]The angelic interpretation gains strength from the use of "sons of God" to describe heavenly beings in three places

in Job (1:6; 2:1; 38:7), and it was likely the prevailing view of early theologians. The literary genre of Job is quite different from Genesis 6, however, and terms in scripture often carry more than one meaning. A declaration by Jesus that angels do not marry is part of the reason other explanations began gaining favor in the second century and thereafter (Walton, *The NIV Application Commentary*, 291, 295).

[30]An alternate minority view holds that this narrative is not an introduction to the flood, but simply a summary statement of the preceding chapter with man acting in a normal fashion of "marrying and giving in marriage" up until the flood (e.g., Sailhamer, *Genesis–Numbers*, 75–6). The discussion of the Nephilim, however, would suggest that something more out of the ordinary is being related, with direct bearing on God's decision to bring on the flood.

[31]Rendle Short came very close to suggesting this scenario in 1942 (Short, *Modern Discovery and the Bible*, 81).

[32]The only other reference to the Nephilim is in Numbers 13:33, many generations after Noah, where they are described as being much larger than the Hebrews. Neanderthals were not taller than contemporaneous humans. There are at least three possible explanations for large size: (1) genetic recombination between humans and Neanderthals produced offspring larger than their parents; (2) genetic drift in size-controlling gene expression in later generations carrying significant Neanderthal DNA resulted in larger stature; or (3) the interbreeding of Genesis 6 was with other, possibly earlier hominids. The degree of genetic diversity among African populations *lacking* contributions of Neanderthal DNA (or at least evidence of direct interbreeding) would appear to require that forbidden unions had been occurring between humans and genetically similar hominids for many generations before interbreeding began at a later time between Neanderthals and a subset of the human population.

[33]It was necessary to depart from normal convention in the creation of the pedigree chart in figure 1 in order to show the ancestry of *all* individuals in the lineage. Pedigree charts normally show lineages with mates brought in from unidentified parents. Kenneth Kemp proposed a similar model for mating with hominids of the same biological stock in K.W. Kemp, "Science, Theology, and Monogenesis," *American Catholic Philosophical Quarterly* 85 (2011): 217–36.

[34]It may eventually be possible to tell if Neanderthal contributions to human lineage were introduced predominantly from unions with male or female Neanderthals by studying Y and X chromosomes: see interview of David Reich by C. Zimmer, "Interbreeding with Neanderthals," *Discover Magazine* (March 4, 2013), http://discovermagazine.com/2013/march/14-interbreeding-neanderthals.

[35]M. A. Zeder, "Domestication and Early Agriculture in the Mediterranean Basin: Origins, Diffusion, and Impact," *Proceedings of the National Academy of Sciences* 105, no. 33 (2008): 11597–604.

[36]For example, J. F. Gillooly, A. P. Allen, G. B. West, and J. H. Brown, "The Rate of DNA Evolution: Effects of Body Size and Temperature on the Molecular Clock," *Proceedings of the National Academy of Sciences* 102 (2005): 140–45. The opening line reads, "Observations that rates of molecular evolution vary widely within and among lineages have cast doubts on the existence of a single 'molecular clock.'" They specifically note differences in mutation rates based on body size and metabolism.

[37]For example, M. Hasegawa and S. Horai, "Time of the Deepest Root for Polymorphism in Human Mitochondrial DNA," *Journal of Molecular Evolution* 32 (1991): 37–42. The evolutionary rate of the most rapidly evolving sites in mtDNA was estimated to be more than 100 times greater than that of a nuclear pseudogene.

[38]For example, N. Howell, J. L. Elson, D. M. Turnbull, and C. Herrnstadt, "African Haplogroup L mtDNA Sequences Show Violations of Clock-Like Evolution," *Molecular Biology and Evolution* 21, no. 10 (2004): 1843–54. This study identified several regions of mtDNA that have not mutated in a "clockwise" fashion, and advised caution against indiscriminate selection of mtDNA sequences for dating.

[39]For example, O. Venn, I. Turner, I. Mathieson, N. de Groot, R. Bontrop, and G. McVean, "Strong Male Bias Drives Germline Mutation in Chimpanzees," *Science* 344, no. 6189 (2014): 1272–75. Male humans and male chimps pass on genes with an increasing number of mutations as they get older.

[40]A similar caution was recently expressed by evolutionary biologist J. David Archibald of San Diego State University, reported in E. Wayman, "Ancestors of Today's Placental Mammals May Never Have Shared the Earth with Dinosaurs," *Science News* (March 9, 2013): 5–6.

[41]For example, C. M. Koehler, G. L. Lindberg, D. R. Brown, D. C. Beitz, A. E. Freeman, J. E. Mayfield, and A. M. Myers, "Replacement of Bovine Mitochondrial DNA by a Sequence Variant within One Generation," *Genetics* 129, no. 1 (1991): 247–55; and X. Gu, Z. Zhang, and W. Huang, "Rapid Evolution of Expression and Regulatory Divergences after Yeast Gene Duplication," *Proceedings of the National Academy of Sciences* 102, no. 3 (2005): 707–12.

[42]For example, fossil evidence suggests that chimpanzees and humans diverged from a common ancestor 6 to 8 million years ago, while recent estimates based on genetic mutation rates place the divergence closer to 13 million years. See summary article, T. H. Saey, "Human-Ape Split Gets an Earlier Date," *Science News* (July 12, 2014): 12.

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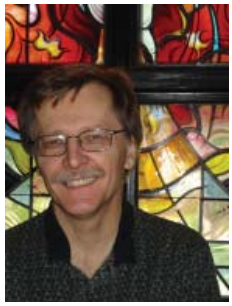

Denis O. Lamoureux

Beyond Original Sin: Is a Theological Paradigm Shift Inevitable?

Denis O. Lamoureux

Written from an evangelical Protestant perspective, this article examines the doctrine of original sin in the light of scripture, the Western Christian tradition, and human evolutionary science. It begins by examining biblical passages from the apostle Paul and classic creeds dealing with original sin in order that readers can feel the weight of questioning the truthfulness of this doctrine. Next, I challenge the concordist hermeneutic that undergirds both the Pauline passages and the traditional understanding of original sin as first formulated by St. Augustine. Finally, this article offers one possible approach for moving beyond the belief in original sin. I will assume an evolutionary creationist view of human origins and argue for a nonconcordist interpretation of biblical passages dealing with the creation of humanity. By embracing a biblically based approach to natural revelation, I then cast human sinfulness within the framework of a Christian evolutionary psychology.

The doctrine of original sin has been a foundational belief of the Christian faith throughout most of church history. It is a complex doctrine that is intimately connected to the fall of humans in Genesis 3 and later interpreted by the apostle Paul primarily in Romans 5:12–21. Original sin features at least ten different facets: fallenness, universal sin, first sinful act, original guilt, original sin as a disease, hereditary sinfulness, inclination toward sinning, propagation of sin through sexual desire, power of the flesh, and corporate sin.[1] This doctrine can be summarized in two basic concepts: (1) original sin is the very first sin committed by the very first man created, whom the Bible identifies as Adam; and (2) original sin includes the belief that all humans have descended from Adam, and that Adam's sin has been passed on to everyone as their own through natural reproduction.[2]

Recent scientific findings in genetics have called into question the historicity of Adam. Remarkably, this discussion is occurring even within evangelical Protestant circles.[3] For example, a landmark issue of *Christianity Today* in June 2011 featured a cover with a Neanderthal-looking male and the title "The Search for the Historical Adam: The State of the Debate." The cover commented, "Some scholars believe that genome science [i.e., genetics] casts doubt on the existence of the first man and first woman. Others say that the integrity of the faith requires it." This article not only assumed that biological evolution was a fact, but contended that the debate today is over whether there really was a human being who corresponds to the biblical figure Adam.[4]

To be sure, rejecting the historicity of Adam will have significant consequences

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for the doctrine of original sin. If Adam did not exist, then he could never have committed the first sin. And if there was no Adam, then all of humanity did not descend from him, and his sin could never have been passed on to every human being. Or to cast this issue in the form of a question: If Adam never existed, is it inevitable that Christian theology will experience a theological paradigm shift similar to those scientific paradigm shifts that have been seen in the history of science?

Scripture and Original Sin

The term "original sin" does not appear in the Bible. However, the basic concepts undergirding this doctrine—Adam as the first sinner and his sin passed on to all humans—appear within the Word of God. The notion of original sin is found in the writings of the apostle Paul, especially in his letter to the Romans.

Romans 5:12 is often seen as the primary biblical verse supporting original sin. As Paul states, "Therefore, just as sin entered the world through one man, and death through sin, and in this way death came to all people, because all sinned" (NIV).[5] There has been much debate regarding the translation of the final clause. Older Bibles have "in whom all sinned," with the relative pronoun referring to Adam. Modern renditions prefer "because all sinned," directing sinfulness more toward individuals instead of Adam. Both translations are grammatically possible and biblical commentators throughout history have suggested over a dozen different ways of translating this verse.[6]

Despite this difficulty with the translation of Romans 5:12, the fifth chapter of Romans offers five other statements that are consistent with the doctrine of original sin.

> [15a]the many [all humans] died by the trespass of the one man [Adam], …
>
> [16a]the result of one man's [Adam] sin: The [divine] judgment followed one sin and brought condemnation [to all humans], …
>
> [17a]by the trespass of the one man [Adam], death reigned [from the time of Adam to the time of Moses; v. 14] through that one man [Adam], …
>
> [18a]one trespass [by Adam] resulted in [divine] condemnation for all people, …
>
> [19a]through the disobedience of the one man [Adam] the many [all humans] were made sinners, …[7]

It is clear that Paul believed Adam was a real person because he identifies him as part of a historical period—"from the time of Adam to the time of Moses" (v. 14). These five statements are consistent with other Pauline assertions. For example, Romans 6:23 states, "the wages of sin is death," and 1 Corinthians 15:21–22 claims, "For since death came through a man [Adam] … in Adam all [humans] die."

In the light of these passages, there is little doubt that Paul accepted that (1) Adam was a historical person, (2) sin first entered the world through Adam, (3) Adam's sin resulted in all humans becoming sinners, (4) death entered the world as the divine condemnation for the sin of Adam, and (5) Adam's sin resulted in the divine condemnation and death of all humans.

In Romans 7, Paul expands his understanding of human sinfulness to include the natural propensity within all of us to act sinfully. This is another important feature in the traditional view of original sin.[8] In confessing his struggles, Paul writes,

> [15]I do not understand what I do. For what I want to do I do not do, but what I hate I do. [16]And if I do what I do not want to do, I agree that the law is good. [17]As it is, it is no longer I myself who do it, but it is sin living in me. [18]For I know that good itself does not dwell in me, that is, in my sinful nature [Greek, *sarx*, flesh]. For I have the desire to do what is good, but I cannot carry it out. [19]For I do not do the good I want to do, but the evil I do not want to do—this I keep on doing. [20]Now if I do what I do not want to do, it is no longer I who do it, but it is sin living in me that does it.
>
> [21]So I find this law at work: Although I want to do good, evil is right there with me. [22]For in my inner being I delight in God's law; [23]but I see another law at work in me [Greek, *melos*, parts of the human body; better translated as, "the members of my body"], waging war against the law of my mind and making me a prisoner of the law of sin at work within me [Greek, *melos*]. [24]What a wretched man I am! Who will rescue me from this body of death?[9]

In Galatians 5:17, Paul further explains this battle within each of us. "For the flesh desires what is contrary to the Spirit, and the Spirit what is contrary to the flesh. They are in conflict with each other, so that

you are not to do whatever you want." Paul refers to this human propensity to sin as "the flesh" five times in Galatians 5 and lists fifteen different sinful acts that gratify the flesh: "sexual immorality, impurity, and debauchery; idolatry and witchcraft; hatred, discord, jealousy, fits of rage, selfish ambition, dissensions, factions and envy; drunkenness, orgies" (vv. 19–21).[10]

To complete Paul's view of human sin and its powerful impact, we need to include Romans 8:20–22 and his belief in the cosmic fall. God's judgment of Adam in Genesis 3 led not only to physical death (v. 19), but it also extended to the entire creation and the cursing of the earth (v. 17). It is important to emphasize that this was not merely spiritual death because, in judging Adam, God states, "For dust you are and to dust you will return" (Gen. 3:19). In this way, Paul acknowledges,

> [20] … the creation was subjected to frustration, not by its own choice, but by the will of the one who subjected it, in hope [21]that the creation itself will be liberated from its bondage to decay and brought into the freedom and glory of the children of God. [22]We know that the whole creation has been groaning as in the pains of childbirth right up to the present time.

Note that Paul refers to "the *whole* creation" and not merely to a local region like the Garden of Eden. Divine judgment results in changes that are cosmic and to the entire natural world.[11] In pointing back to Romans 7:24 and his "body of death," Paul acknowledges in Romans 8:23 that we "groan inwardly" and await "the redemption of our bodies." For the apostle Paul, it is clear that decay, suffering, and death entered the world with Adam in Genesis 3.

In sum, the foundational concepts undergirding the traditional doctrine of original sin are within the Bible, especially in Paul's letter to the Romans. Anyone challenging this doctrine should feel the weight of these passages. And I certainly do. Yet it is worth noting that Paul's views are based on a concordist reading of Genesis 3. He understands the account of Adam as similar to a historical and scientific record of real events from the past. But the question must be asked, "Is a concordist interpretation of Genesis 3 correct?"

Christian Tradition and Original Sin

Christians throughout history have thought deeply about their beliefs, and the fruits of their scholarly labor have produced creeds and confessions of faith. Though the doctrine of original sin does not explicitly appear in the first creeds, the conceptual elements were present in the early church.[12] For example, Irenaeus the Bishop of Lyons (ca. 140–202) believed that humans became sinful and mortal because Adam sinned. Appealing to Paul in Romans 5, he writes,

> By the disobedience of the one man [Adam] who was originally moulded from virgin soil, the many were made sinners, and forfeited life … For we were debtors to none other but to him [God] whose commandment we had transgressed at the beginning.[13]

The doctrine of original sin as understood throughout most of history was shaped by the towering church father St. Augustine, the Bishop of Hippo (354–430). He coined the term "original sin" in 396, and Paul's letter to the Romans played a foundational role. Augustine writes,

> "To will," Paul says, "is close to me, but to do the good is not" (Rom. 7:18). For those who do not correctly understand these words, Paul seems to be eliminating free choice. But how does he eliminate it since he says, "To will is close to me"? For certainly willing itself is in our power, but what is not in our power is doing what is good. This [inability] is among the results of *original sin*. This comes not from our original human nature, but rather is the penalty for our guilt through which mortality itself has become a sort of second nature.[14]

Like many early church fathers, Augustine believed that Paul's comment in Romans 7:18 was a reference to the apostle before his conversion to Christianity. As Augustine qualifies, "But these words [of Paul] are the voice of a person who is under the law and not yet under grace."[15] However, late in life, he changed his position. Reinterpreting Romans 7, Augustine argued that "as the law of sin, in the body of death, wars against the law of mind, so that not only all the good and faithful *but also the great Apostle [Paul] fought against it*."[16]

In defending his view of original sin, Augustine repeatedly appealed to the Latin translation of Romans 5:12.[17] "Through one man sin entered the world and through sin death so that it passed on to all human beings, *in whom all have sinned*." For Augustine, the relative pronoun "in whom" (Latin, *in quo*) referred to Adam. Because of Augustine's powerful influence in the church, his understanding of original sin was incorporated into the Council of Carthage in 418.[18]

> Canon 1 … Anyone who said that Adam was made mortal in such a way that he would have died physically whether he had sinned or not, that is, he would have left the body not a punishment for sin, but from the necessity of nature, let him be anathema [Greek, "consigned to damnation"].
>
> Canon 2 … If anyone denies that infants newborn from their mothers' wombs should be baptized, or if anyone says that infants are baptized for the forgiveness of sins but contract nothing from Adam, no *original sin* expiated by the bath of rebirth, such that, as a result, the formula of baptism "for the forgiveness of sins" is understood not as true but as false, let him be anathema. What the Apostle said: "Through one man sin entered the world and through sin death so that it passed on to all human beings, in whom all have sinned" [Rom. 5:12].[19]

This council affirmed (1) the historicity of Adam, (2) the entrance of sin into the world through Adam, (3) physical death as a punishment for Adam's sin, and (4) that original sin is passed on from Adam to all humans, including newly born infants.

Despite differences between conservative Protestants and Roman Catholics, these traditions stand united with regard to the historicity of Adam and the doctrine of original sin.[20] For example, consider the *Augsburg Confession* (1530), which is foundational to the Lutheran Church. "Article II: Concerning Original Sin" states that

> since the fall of Adam, all human beings who are born in the natural way are conceived and born in sin. This means that from birth they are full of evil lust and inclination … this same innate disease and original sin is truly sin.[21]

In the *Thirty-Nine Articles* (1562) of the Anglican Church, the name "Adam" appears three times. "Article IX: Of Original or Birth-Sin" asserts,

> Original sin standeth not in the following of Adam … but it is the fault and corruption of the nature of every man, that naturally is engendered of the offspring of Adam; whereby man is very far gone from original righteousness, and is of his own nature inclined to evil, so that the flesh lusteth always contrary to the spirit; and therefore in every person born into this world, it deserveth God's wrath and damnation. And this infection of nature doth remain, yea in them that are regenerated.[22]

The name "Adam" also appears three times in the *Westminster Confession of Faith* (1646) held by Presbyterian churches. "Chapter VI: Of the Fall of Man, of Sin, and of Punishment thereof" states,

> Our first parents, being seduced by the subtilty and temptation of Satan, sinned in eating the forbidden fruit … They being the root of all mankind, the guilt of this sin was imputed, and the same death in sin and corrupted nature conveyed to all their posterity descending from them by ordinary generation. From this original corruption, whereby we are utterly indisposed, disabled, and made opposite to all good, and wholly inclined to all evil, do proceed all actual transgressions. This corruption of nature, during this lifetime, doth remain in those that are regenerated.[23]

To summarize, the doctrine of original sin is deeply entrenched within the Western Christian tradition. Once again, everyone should feel the weight of challenging this historic doctrine, as I do. Yet in examining these traditional documents, it is obvious that biblical interpretation plays a critical role. The formulators of creeds on original sin were concordists. They read Genesis 3 and Romans 5 as accounts referring to actual historical and scientific events. In particular, they accepted the historicity of Adam as the very first human and believed that every man and woman had descended from him. However, is a concordist interpretation of human origins in the Word of God correct?

Scripture and Ancient Science

My answer to this question is "no." The best evidence against concordism is found *within scripture itself* in passages dealing with the structure of the world.[24] As figure 1 reveals, the Bible features a 3-tier universe. In other words, scripture has an ancient understanding of nature that could be termed "ancient science."[25] For example, we can appreciate

why ancient people believed the sun moved across the sky every day. As Ecclesiastes 1:5 states, "The sun rises and the sun sets, and hurries back to where it rises." From an *ancient* phenomenological perspective, that is exactly what it looks like to the naked eye.[26] Notably, belief in the daily movement of the sun lasted until the seventeenth century.

Ancient science is unmistakably present in the Genesis 1 account of creation. On the second day, God makes a firmament (Hebrew, *rāqîa'*) to separate the waters above from the waters below. When ancient people looked up, what did they did see? A huge blue dome. To suggest there was a sea of water in the heavens being held up by a solid structure was completely reasonable given their limited knowledge of astronomy. Regarding the fourth day of creation, God places the sun, moon, and stars in the firmament right in front of the heavenly sea. Is this heavenly arrangement not what it looks like without the aid of modern scientific instruments such as telescopes? In fact, the 3-tier universe was science-of-the-day in the ancient Near East.[26]

The apostle Paul also accepted an ancient understanding of the structure of the world. In Philippians 2:9–11, he concludes,

> Therefore God exalted him to the highest place and gave him the name that is above every name, that at the name of Jesus every knee should bow, [1] in heaven and [2] on earth and [3] in the underworld, and every tongue confess that Jesus Christ is Lord …

Modern translations render the phrase in [3] as "under the earth." However, the original Greek is *katachthoniōn*, and it is made up of the preposition *kata* meaning "down" and the noun *chthovios* referring to the "underworld" or "subterranean world." The apostle Paul believed in a 3-tier universe.[28]

In the light of this biblical evidence, it is obvious that concordism fails. The world is not made up of three tiers. Therefore, scripture does not offer an account of actual historical and scientific events in the creation of the universe.

It is also evident that the Holy Spirit, by inspiring the biblical writers, descended to their level and allowed the use of the science-of-the-day in order to reveal inerrant spiritual truths. In other words, the Lord *accommodated* in the same way he comes down to our level when he speaks to each of us in prayer. Figure 2 depicts the message-incident principle and my approach to statements in scripture dealing with the physical world. I suspect many Christians hold this interpretative principle in some implicit way. Most would agree that the primary purpose of the Bible is to reveal life-changing messages of faith. For example, whether birds were created before humans (Genesis 1) or after the man and before the woman (Genesis 2) is ultimately incidental and not essential to our personal relationship with the Lord.

Let us now deal directly with human origins in scripture. If the astronomy and geology/geography reflect an ancient science, then it is only logical that the Bible also has an ancient biology. In particular,

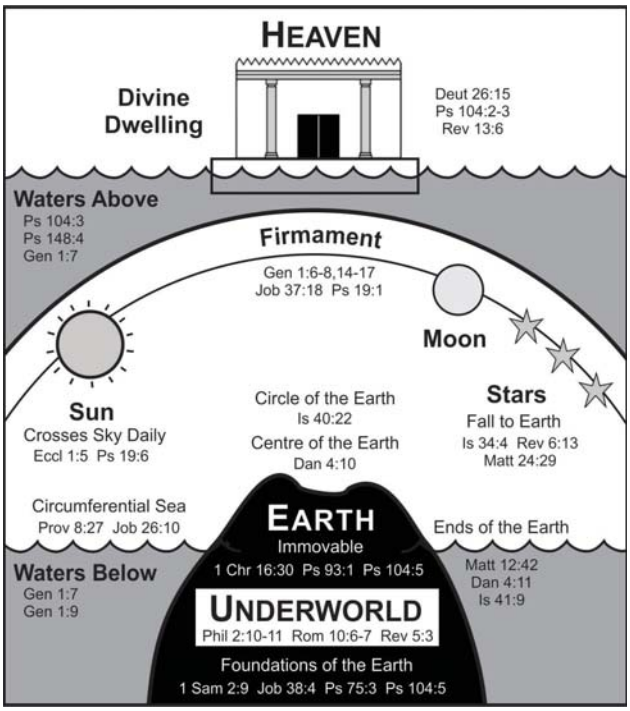

Figure 1. The 3-Tier Universe

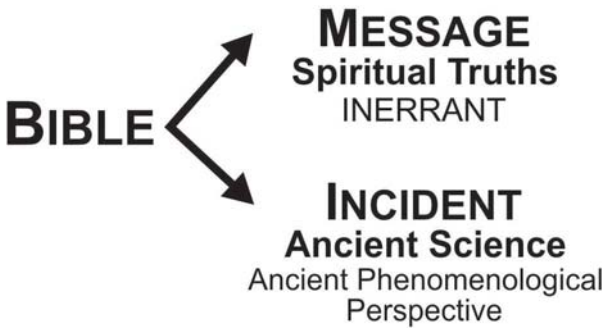

Figure 2. The Message-Incident Principle

consistency argues that scripture would have an ancient understanding of human origins. This is exactly what we find in the Word of God. Humans are created *de novo* in Genesis 1 and 2 (Latin, *de* means "from, of"; *novus,* "new"). That is, they are made quickly and fully formed. Ancient peoples were quite reasonable in conceptualizing the *de novo* creation of humanity. They would have seen that humans give birth to humans, who give birth to humans, et cetera. In thinking about the origin of humans, they would have reversed this data set of human births and worked backwards through time to come to the logical conclusion that there must have been an original human/s created *de novo* by God.[29]

In fact, *de novo* creation was the origins science-of-the-day in the ancient Near East. One approach viewed God as a craftsman using earth to fashion the first humans.[30] This appears in the *Epic of Gilgamesh* where a pinch of clay is used to create a man.[31] In the *Myth of Enki and Ninmah*, an intoxicated divine being makes seven imperfect humans employing some moist earth.[32] A goddess in the *Epic of Atrahasis* mixes clay with the blood from a slain god to fashion seven males and females.[33] And in the *Memphite Theology*, a god creates babies on a potter's wheel by shaping clay and then places them in their mother's womb.[34] These examples of the *de novo* creation of humans are similar to Genesis 2:7 where the Lord God is like a craftsman who forms Adam from the dust of the ground. Clearly, the creation of Adam is based on an ancient conceptualization of human origins.

Modern science complements this ancient evidence. Physical anthropology reveals an incontestable pattern of transitional fossils from pre-humans to humans. Genetics demonstrate that humans were not created *de novo*, but evolved from a population of about 10,000 pre-humans. And geology undermines the concept of a cosmic fall. If Adam is the reason suffering and death entered the world, then human bones should be at the bottom of the fossil record. But humans appear at the very top.[35] These are facts of science. All the lines of biblical and scientific evidence point to only one conclusion: *Adam never existed.*

How then are Christians to deal with biblical passages referring to Adam? My suggestion is that by applying the message-incident principle, we can draw these inerrant spiritual truths: God created humans, humans are created in the image of God, humans are sinful, and God judges humans for their sins. In order to deliver these life-changing messages during the inspiration process, the Holy Spirit accommodated and allowed the ancient origins science of the *de novo* creation of Adam to be used as a vessel. Therefore, when reading passages dealing with Adam, we need to separate and not conflate the incidental ancient science from the inerrant messages of faith.

In sum, concordist interpretations of the Bible fail to recognize and respect that the creation of Adam, and thus his very existence, is based on an ancient conceptualization of human origins. If Christians want to uphold the historicity of Adam through concordist readings of the biblical creation accounts and the writings of the apostle Paul, then to be consistent they should also accept the 3-tier universe in scripture. But I am doubtful that anyone today would choose to do so.

Christian Tradition and Ancient Science

As we noted earlier, Christian tradition, through the powerful influence of St. Augustine, formulated the doctrine of original sin. We also saw that the Bible has an ancient understanding of the physical world. A number of questions naturally arise. Does Christian tradition also include ancient science? Is it possible that an incidental ancient view of human origins has become an essential part of our faith? If so, was this ancient conceptualization integrated (or better, conflated) into the doctrine of original sin?

Let us first consider the astronomy held by some of the most important church leaders from the past. Augustine, at the beginning of the fifth century, reveals the deeply embedded concordism of his generation. He observes, "It is also frequently asked what our belief must be about the form and shape of heaven *according* to Sacred Scripture. Many scholars engage in lengthy discussions on these matters."[36] During Augustine's day, there was a debate over geocentricity and the 3-tier universe. Putting this discussion in perspective, he asks, "What concern is it of mine whether heaven is like a sphere and the earth is enclosed by it and suspended in the middle of the universe, or whether heaven like a disk above

the earth covers it over on one side?"[37] Yet Augustine had a definitive position regarding the structure of the heavens mentioned in Genesis 1:6–7.

> Bear in mind that the term "firmament" does not compel us to imagine a stationary heaven: we may understand this name as given to indicate not that it is motionless but that it is solid and that it constitutes an impassable boundary between the waters above and the waters below.[38]

Ancient views of astronomy also appear with the two leading Protestant reformers of the sixteenth century. Martin Luther accepted geocentricity as depicted in figure 3. This diagram appears in his 1534 Bible translation, across from Genesis 1. Luther's concordism is evident as he explains in his *Lectures on Genesis*,

> Scripture … simply says that the moon, the sun, and the stars were placed … in the firmament of the heaven … The bodies of the stars, like that of the sun, are round, and they are fastened to the firmament like globes of fire.[39]

Figure 3. Martin Luther's Geocentric Universe. Redrawn by Andrea Dmytrash from Martin Luther, *Luther Bible of 1534, Complete Facsimile* (Köln: Taschen, 2003), no page number.

John Calvin held another form of geocentricism. He believed that there was a series of spheres between the earth and a final sphere with each sphere carrying its respective heavenly body—sun, moon, or each planet. Calvin comments,

> We indeed are not ignorant, that the circuit of the heavens is finite, and that the earth, like a little globe, is placed in the center … The *primum mobile* [the final sphere] rolls all the celestial spheres along with it.[40]

The point of presenting these passages on astronomy is obvious. These three historic Christian theologians had an incorrect view of the structure of the universe. And since their astronomy does not align with physical reality, then is this also the case with their biology? Or to ask more incisively, did Augustine, Luther, and Calvin have a mistaken understanding of human origins? And was it conflated with their belief in original sin?

To answer these questions, let us focus on the biological views of Augustine, because he was the central figure in formulating the doctrine of original sin. Pivotal to his biology is the concept of seed or seminal principles (Latin, *rationes seminales*).[41] According to Augustine, God created the world in two stages. In the "first creation," he made everything simultaneously.[42] To support his position, he repeatedly used a concordist reading of the Latin translation of John 1:3a, "He [God] created all things together."[43] In this initial creative act, Augustine believed that God made the inanimate universe ("the firmament, and land and sea") instantaneously in their visible form.[44] However, with living organisms, the Creator formed them merely as seed principles, which he "scattered as seeds at the [initial] moment of creation."[45] In the second or "later creation," these seed principles "would later spring forth with the passage of time, plants and animals, each according to its kind."[46]

The theory of seed principles and the belief in two stages of creation are foundational to Augustine's understanding of the origin of Adam.

> For in that first creation of the world, when God created *all things simultaneously*, he created man in the sense that he made the man who was to be, that is, the causal [seed] principle of man to be created, not the actuality of man already created … And then creating all things *not together* but each in its own time [i.e., during the second creation],

> God formed man from the slime of the earth and the woman from a bone taken out of man.[47]

In explaining Adam's creation in Genesis 2:7, Augustine bluntly commented, "Now to think of God as forming man from the slime of the earth with bodily hands is childish."[48] Instead, he interpreted the fashioning of Adam as "a metaphor" to indicate "the power and might of God."[49] Being created from a seed principle, Adam "would be like the grass of the field, which was made before it sprang forth from the earth."[50]

The implications of Augustine's seed principles for original sin emerge in his interpretation of Hebrews 7:9–10. These verses state, "One might even say that Levi, who collects the tenth, paid the tenth through Abraham, because when Melchizedek met Abraham, Levi was still in the body [Greek, *osphus* means "loins, reproductive organs"] of his ancestor." Scripture records that Abraham fathered Isaac, who fathered Jacob, who fathered Levi. Augustine contended that "Levi was there [in Abraham's loins] according to the seminal [seed] principle by which he was destined to enter his mother on the occasion of carnal union"[51] (notably, *"Christ was there also"*![52]). Augustine then connected seed principles to original sin.

> For the same flesh not only of Abraham but also of the first and earthly man [Adam] [contained] the wound of sin in the law of the members at war with that of the mind [Rom. 7:23], a law transmitted thence by a seminal reason [seed principles] to all generations of descendants.[53]

In other words, Adam's original sin was passed on into every human being through seed principles.

Augustine's ancient biology of seed principles is also found in one of his most famous books, *City of God.*

> When the first couple [Adam and Eve] were punished by the judgment of God, the whole human race, which was to become Adam's posterity through the first woman, *was present in the first man* … God, the Author of all natures but not of their defects, created man good; but man, corrupted by choice and condemned by justice, has produced a progeny that is both corrupt and condemned. For, *we all existed in that one man*, since, taken together, we were the one man who fell into sin … our nature was already present in the seed [*seminales*] from which we were to spring.[54]

This ancient biology sheds light on Augustine's repeated use of the clause "in whom all have sinned" from the Latin translation of Romans 5:12. It would have made perfect sense to him that we all sinned "in Adam" because we were, in fact, all in Adam's body as individual seed principles. And we were all infected by Adam's sin.

To conclude, the traditional doctrine of original sin as formulated by Augustine is rooted in a concordist interpretation of scripture and steeped in an ancient understanding of biology. Augustine conflated inerrant biblical truths regarding human sinfulness with the ancient concept that humanity originated and descended through seed principles. If Christians today want to continue embracing original sin, then to be consistent, they should also believe in seed principles. But I am doubtful that anyone with a basic knowledge of modern genetics will do so.

Beyond Original Sin: Toward a Christian Evolutionary Psychology of Sinfulness

Evolutionary psychology is dominated by religious skeptics, giving the impression that this academic discipline is necessarily atheistic. However, I believe that every scholarly field can be viewed in the light of Jesus Christ and scripture. In order to move beyond the traditional belief in original sin, and in an attempt to understand human sinfulness through a Christian interpretation of evolutionary psychology, I begin with three assumptions.

First, I believe that the Father, Son, and Holy Spirit created the universe and life, including humans, through an ordained, sustained, and intelligent design-reflecting evolutionary process. This evangelical view of origins is often termed "evolutionary creation."[55] It is important to underline that I am not conflating my religious beliefs with evolutionary science. Evolution is incidental to my faith and only a vessel that delivers my belief that the world is the creation of the Holy Trinity. Should the theory of evolution be overturned, then without any difficulty, I will use the next model of origins as a platform to convey these same religious beliefs.

Second, I accept polygenism (Greek polus means "many"; genesis, "origin"). Humans descended from

a small population of pre-human creatures, and not from just one person. The variability in our genes rules out monogenism (monos, "single") and indicates that this group was about 10,000 individuals.[56] Moreover, by embracing a nonconcordist reading of the biblical creation accounts, it is clear to me that the traditional Christian belief in monogenism and the historicity of Adam is based on the ancient science of de novo creation. In using the modern sciences of evolutionary genetics and physical anthropology as an incidental vessel, I believe that the manifestation of the image of God and human sinfulness occurred roughly 50,000 years ago with the emergence of behaviorally modern humans. Once again, this is not a conflation. Rather, it is to acknowledge that science can be a vehicle for delivering inerrant truths about the human spiritual condition to a modern scientific generation. To make my position perfectly clear: sin did indeed enter the world … but not through Adam.

Third, I embrace natural revelation. God employed evolution to create the human brain with an ability to recognize intelligent design in nature (Ps. 19:1–4; Rom. 1:19–20).[57] He also equipped us with a capacity to distinguish the good from the bad, and he gave us the freedom to choose between them. In the classic biblical passage dealing with moral natural revelation, the apostle Paul in Romans 2:14–15 writes,

> [14]Indeed, when Gentiles, who do not have the law, do by nature things required by the law, they are a law for themselves, even though they do not have the law. [15]They show that the requirements of the law are written on their hearts, their consciences also bearing witness, and their thoughts sometimes accusing them and at other times even defending them.

Though the Gentiles did not have the scriptures, they still had God's moral standards within "their consciences." Paul affirms a natural morality since they "do by nature things required by the law" (NRSV translates, "do instinctively"). Applying this passage within an evolutionary creationist context, one can say that the Creator used evolution to "write" the moral "requirements of the law" within the human brain. I contend that this natural morality can be extended back in time to the emergence of the first behaviorally modern humans about 50,000 years ago. It was then that men and women became morally accountable before God.

In addition to my three assumptions, I need to comment on two disproportionate tendencies related to this discussion. The first deals with the excessive focus on sin at the expense of the reality that humans also act righteously. To be sure, sinfulness is humanity's greatest problem and this fact is emphasized repeatedly throughout the Bible. But scripture often uses hyperbole in dealing with sin. For example, in Romans 3:12b, Paul states, "There is no one who does good, not even one." To say that not even one person does good is clearly a hyperbole because, if this were literally true, it would contradict Paul's earlier statement in Romans 2:14–15 that the Gentiles do "things required by the law" and that their conscience at times defends them for righteous behavior. In other words, though we are without a doubt notoriously sinful, we also do acts of goodness.

Jewish tradition offers an insight that brings balance to this disproportionate focus on sinfulness. It recognizes that there are two natural propensities or desires within humans: *yētzer ha-tov* (the inclination to do good) and *yētzer ha-ra* (the inclination to do evil).[58] As a consequence, men and women experience an inner struggle between these two impulses. In Jewish tradition, *yētzer ha-tov* and *yētzer ha-ra* were seen as natural and as part of the human condition created by God. In contrast, within Christian tradition through the influence of Augustine, *yētzer ha-ra* took on a more sinister nuance and came to be termed as "concupiscence."[59] It was understood as an unnatural and disordered condition that arose because of original sin. I believe that moving away from Augustinian overemphasis on sin and returning to Jewish roots provides a healthier and more accurate description of our spiritual experience.

A second disproportionate tendency deals with the excessive emphasis on selfishness within evolutionary psychology. It is regrettable that Richard Dawkins's book *The Selfish Gene* has had such a widespread impact on this academic discipline. He believes that humans "are born selfish" and that we are merely "selfish machine[s], programmed to do whatever is best for its genes as a whole."[60] Despite being sharply criticized, his concept of so-called "selfish genes" continues to skew the discipline, in particular with the belief that even altruism and acts of goodness are ultimately selfish. However, Frans de Waal charges Dawkins with "coining a metaphor prone to be misunderstood."[61] He adds,

> Genes can't be any more "selfish" than a river can be "angry," or sun rays "loving." Genes are little chunks of DNA. At most, they are "self-promoting," because successful genes help their carriers spread more copies of themselves.[62]

De Waal introduces balance into evolutionary psychology and a welcomed alternative to Dawkins's excessive focus on selfishness. In *The Age of Empathy*, he argues for the reality of empathy and its evolutionary origins, beginning with mammals over 100 million years ago. Offering numerous examples of empathetic acts in chimpanzees, dolphins, elephants, and other mammals, de Waal contends that this behavior has "been selected over the ages, meaning it has been tested over and over with regard to its survival value."[63] In response to the criticism that empathy and the "warm glow" we experience for assisting others is ultimately selfish, he argues, "Yes, we certainly derive pleasure from helping others, but since this pleasure reaches us *via* the other, and only *via* the other, it is genuinely other-oriented."[64] In addition, de Waal believes that civilization would never have arisen had human evolution been rooted in selfishness only. He argues that empathy is "the glue that holds communities together."[65] De Waal then concludes that the human psychological state features a tension between evolutionarily selected empathetic/social behaviors and those which are selfish. He offers the metaphor, "We walk on two legs: a social one and a selfish one."[66]

Of course, it is evident that there is a problem with the terminology in this discussion.[67] To speak of mammals, other than humans, as being "selfish" or "empathetic" is anthropomorphic and dripping with moral overtones.[68] From my Christian perspective, only humans are morally accountable because we are the only creatures who truly understand the difference between good and evil. And only humans have the free will to choose between them. Therefore, I believe that *truly* selfish and *truly* empathetic acts appeared only about 50,000 years ago with behaviorally modern humans, because the natural revelation "written on hearts" would have made these first humans morally accountable before God.

Being evolved mammals, we certainly inherited through evolution deeply embedded behavioral propensities/proclivities within our brains. But it is more accurate to suggest that evolution gave us powerful "self-preserving inclinations," instead of calling these "selfish."[69] Similarly, the apparent "good" done by nonhuman mammals requires an understanding of the meaning of goodness in order to be categorized as "empathy" or "altruism." I have no reason to believe that such reflection occurs in animals other than humans. Terms free of moral nuances such as "pair or group bonding inclinations" between individuals or within groups seem more appropriate.[70]

Natural selection chose these self-preserving and bonding behavioral propensities since they contributed to the survival and evolution of mammals, including humans. With the appearance of the first morally accountable human beings, these proclivities deeply embedded in our brain became components of moral natural revelation. Therefore, our natural morality stems from an evolutionarily adaptive trait, and as a consequence, it is universal to humanity.[71] Evidence for the reality of a moral revelation within humans featuring self-preserving and bonding inclinations is that it transcends cultures and religious and philosophical beliefs. Here are a few examples.

Charles Darwin rejected Christianity in the late 1830s while formulating his theory of evolution. In *Descent of Man*, he acknowledged two evolutionary behavioral inclinations—"the social instincts" and "the lower impulses or desires." Darwin believed that the social instincts "no doubt were acquired by man as by the lower animals for the good of the community," and that they "served him at a very early period as a rude rule of right and wrong."[72] He then argued that the social instincts would "naturally lead to the golden rule, 'As ye would that men should do to you, do ye to them likewise' [Luke 6:31] and this lies at the foundation of morality."[73] Darwin also offered another significant insight into the human moral condition. Echoing the "war" within Paul (Rom. 7:23), he noted, "It is not surprising that there should be a *struggle* in man between his social instincts, with their derived virtues, and his lower, though momentarily stronger, impulses or desires."[74]

Evidence for the requirements of God's moral laws having been written on the hearts of Gentiles (Rom. 2:14–15) appears in the Cherokee legend of the "Two Wolves."

> An old Cherokee is teaching his grandson about life. "A fight is going on inside me," he said to the boy.

> "It is a terrible fight and it is between two wolves. One is evil—he is anger, envy, sorrow, regret, greed, arrogance, self-pity, guilt, resentment, inferiority, lies, false pride, superiority, and ego." He continued, "The other is good—he is joy, peace, love, hope, serenity, humility, kindness, benevolence, empathy, generosity, truth, compassion, and faith. The same fight is going on inside you—and inside every other person, too."
>
> The grandson thought about it for a minute and then asked his grandfather, "Which wolf will win?"
>
> The old Cherokee simply replied, "The one you feed."[75]

The metaphor of two wolves accurately depicts the turmoil we often experience between our evolutionary behavioral proclivities. The "terrible fight" within all of us again reflects the "war" within Paul in Romans 7, and the "conflict" he identifies between "the flesh" and "the Spirit" in Galatians 5. In the latter chapter, the deeds of the evil wolf are consistent with the "acts of the flesh" (vv. 19–21), and those of the good wolf are similar to the "fruits of the Spirit" (v. 22). And human free will undergirds the moral lesson in the Cherokee legend—which wolf will we feed?

Modern Buddhism offers another example of the universality of moral natural revelation outside of the Judeo-Christian religious tradition. In the *Nghi Thuc Hang Tuan Chanting Book*, two behavioral propensities are understood to be deeply embedded within humans.

> Our heart's garden is sown with attachment,
> hatred, and pride.
>
> In us are seeds of killing, stealing,
> sexual misconduct, and lies …
>
> We know so well in our consciousness are buried
> all the wholesome seeds—
>
> seeds of love and understanding,
> and seeds of peace and joy.
>
> But if we do not know how to water them,
> how can they spring up fresh and green?[76]

Another chant reveals that humans can be "swept along by the seeds of unwholesome acts into paths of darkness."[77] The agricultural metaphor of two types of seeds in "our heart's garden" and "buried" within "our consciousness" is an effective description of our inherited evolutionary inclinations. This aligns with Romans 2:15 and Paul's view of a natural moral revelation within Gentiles that is "written on their hearts" and "their consciences." The Buddhist chants urge us to "water" the "wholesome seeds." Similarly in Galatians 5:16, Paul encourages, "Live by the Spirit and you will not gratify the desires of the flesh."

In proposing a Christian approach to human sinfulness and evolutionary psychology, I am certainly not advocating concordism whereby the Pauline biblical passages cited above are disclosing this modern science. Instead, under the inspiration of the Holy Spirit, Paul is revealing inerrant truths about our spiritual condition without having any idea of the evolutionary roots of our behavioral proclivities. What Christian has not cried out like Paul, "What a wretched man I am! Who will rescue me from this body that is subjected to death?" (Rom. 7:24). Or to cast this question within the context of evolutionary psychology, "Who will rescue me from my evolutionary self-preserving inclinations?" Paul gives the answer, "Thanks be to God, who delivers me through Jesus Christ our Lord!" (Rom. 7:25). The apostle then commands, "Be transformed by the remodeling of your mind" (Rom. 12:2) and "clothe yourselves with the Lord Jesus Christ, and do not think about how to gratify the desires of the flesh" (Rom. 13:14). Updated for our generation, let Jesus be the Lord over our evolutionary past, encouraging our pair- or group-bonding inclinations and denying our self-preserving inclinations.

Similarly, Augustine had no idea of evolutionary psychology, yet he too experienced the powerful inner workings of evolutionary self-preserving inclinations. Acknowledging the desires of the flesh, he confessed that "not to consent to them is a struggle, a conflict, a battle."[78] Troubled by our conflicted spiritual condition, Augustine asked, "For how is sin dead when it works many things in us while we struggle against it?"[79] Of course, Augustine's answer is original sin. He explains, "It is the result of the guilt of the first man [Adam] … it revives and reigns."[80] Even though Christians are forgiven for their sins and dead to sin (Rom. 6:2, 11), Augustine recognized the continuing presence of "foolish and harmful desires" within all of us and saw that "we must take care, as it were, of their burial … aided by the grace of God through Jesus Christ our Lord."[81] Self-preserving evolutionary proclivities are indeed

powerful, but they do not control us.[82] The gifts of God's grace and our own free will allow us to control our evolutionary past.

Final Reflections

Challenging the doctrine of original sin, the towering church father St. Augustine, and Western Christian tradition throughout most of history is not only daunting, but could be viewed as outright hubris. My justification begins by recognizing that scripture and tradition are intimately connected to the scientific paradigms-of-the-day. As this article reveals, both include ancient conceptualizations of astronomy, geology/geography, and biology. In particular, the Bible and Christian tradition feature an ancient understanding of human origins—the *de novo* creation of Adam. The implications are obvious. No one today believes in a firmament, a heavenly sea, a 3-tier universe, or a geocentric world. Nor should we then believe in the historicity of Adam, and as a consequence, the doctrine of original sin.

To be sure, the greatest problem in moving beyond Adam and original sin comes from the apostle Paul in Romans 5 and 7. But if we recognize and respect the incidental ancient biology of human origins embraced by Paul, then we can draw out these inerrant spiritual truths: we are all sinners, God judges us for our sins, and the Good News of the Gospel is that we are offered the hope of eternal life through the sacrificial death of Jesus on the cross. No doubt about it, separating these messages of faith from the incidental ancient science is a counterintuitive way to read scripture. However, I am convinced that once Christians discover the ancient astronomy and geology/geography throughout the Bible as well as Paul's 3-tier universe in Philippians 2:9–11, they will begin to reconsider the truthfulness of the biology in scripture, including the historicity of Adam and the doctrine of original sin.

In closing, most readers will have recognized that the subtitle of this article—Is a Theological Paradigm Shift Inevitable?—points back to Thomas S. Kuhn's famed *The Structure of Scientific Revolutions*.[83] Kuhn offered a theory of scientific progress that entailed extended periods of "normal science" punctuated by intense intervals of "revolutionary science" in which the foundational "paradigm" of a scientific discipline is completely overthrown. The classic example of a "paradigm shift" is the radical change from Ptolemaic (geocentric) to Copernican (heliocentric) astronomy.

A paradigm shift begins with the discovery of "scientific anomalies" that fail to fit within the reigning paradigm and that eventually lead to a "crisis." Kuhn noted that "battles over paradigm change" are "inevitable" and that "a generation is sometimes required to effect the change."[84] The conflict between paradigms arises because of their "incommensurability." They are not just incompatible; they are utterly different ways of looking at the very same scientific data. As Kuhn elaborates, a paradigm shift "cannot be made a step at a time, forced by logic and neutral experience. Like the gestalt switch, it must occur all at once (though not necessarily in an instant) or not at all."[85] To illustrate the massive perception change of a paradigm shift, Kuhn points to the well-known duck-rabbit diagram (figure 4). So too in science, a new paradigm offers another platform from which to view the very same scientific data in a radically different way.

Can Kuhn's understanding of scientific revolutions be applied to theology? For most of church history, normal theology has been steeped in concordism and ancient science, resulting in creedal statements that authorize the historicity of Adam and the doctrine of original sin. The first scientific anomalies challenging the paradigm of monogenism appeared with Charles Darwin's *Origin of Species*, and now they are intensifying since the publication of the *Human Genome Project*, once led by evangelical Christian Francis Collins.[86] Theological anomalies also arose in the nineteenth century with the birth of biblical criticism

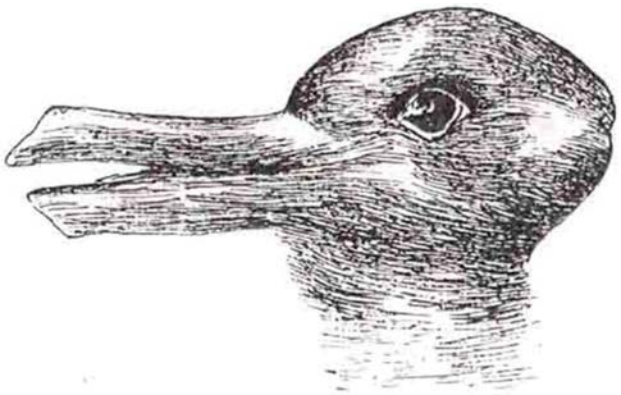

Figure 4. The Duck-Rabbit Diagram. Duck-rabbit illusion from J. Jastrow, "The Mind's Eye," *Popular Science Monthly* 54 (1899): 312.

and the questioning of concordist interpretations of Genesis 1–11. Within the evangelical theological academy today, there is growing acknowledgment that scripture features common ancient Near Eastern motifs, literary genres, and views of origins.[87] The appearance of influential evangelicals rejecting concordism and Adam indicates that these individuals have personally experienced a theological paradigm shift. And the June 2011 *Christianity Today* article reporting a debate within evangelicalism over the historicity of Adam might be a signpost of the start of a theological crisis.

Is a theological paradigm shift overthrowing the doctrine of original sin inevitable? Only history will tell. There is no doubt that concordist and nonconcordist interpretations of Genesis 3 and Romans 5 are incommensurable. Christians seeing the ancient science in scripture for the first time certainly experience a radical perception change in passages they had previously viewed only as scientifically and historically concordant. Personally, I think evangelicalism is in the initial stages of a theological crisis. My hope and prayer for my community is that the inevitable bloodshed of a paradigm shift be limited, and that we be united by the atoning blood shed on the cross for our sins. ♦

Acknowledgments

I thank Anna-Lisa Ptolemy, Lyn Berg, and Esther Martin for their splendid assistance in preparing this manuscript. I am also grateful for insights offered by Chris Barrigar, Paul Bruggink, Andrea Dmytrash, Keith Furman, Gary Crites, Nancy Rosenzweig, and Paul Seely.

Notes

[1]T. A. Noble, "Original Sin and the Fall," in *Darwin, Creation and the Fall,* ed. R. J. Berry and T. A. Noble (Nottingham, UK: Apollos, 2009), 101–12. This paper is written from an evangelical Protestant perspective. For an eastern approach to original sin, see Peter C. Bouteneff, *Beginnings: Ancient Christian Readings of the Biblical Creation Narratives* (Grand Rapids, MI: Baker Academic, 2008).

[2]This distinction reflects the Latin theological terms *peccatum originans* (the event of original of sin) and *peccatum originatum* (the condition of original sin) (Tatha Wiley, *Original Sin: Origins, Developments, Contemporary Meanings* [Mahwah, NJ: Paulist Press, 2002], 5, 56).

[3]Francis S. Collins, *The Language of God* (New York: Free Press, 2006); Dennis R. Venema, "Genesis and the Genome: Genomics Evidence for Human-Ape Common Ancestry and Ancestral Hominid Population Sizes," *Perspectives on Science and Christian Faith* 62, no. 3 (2010): 166–78; Daniel C. Harlow, "After Adam: Reading Genesis in an Age of Evolutionary Science," *Perspectives on Science and Christian Faith* 62, no. 3 (2010): 179–95.

[4]Richard N. Ostling, "The Search for the Historical Adam," *Christianity Today* 55, no. 6 (June 3, 2011): 23–31.

[5]Since this article is directed to an evangelical Protestant audience, I will use the *New International Version* (Grand Rapids, MI: Zondervan, 2011).

[6]Joseph A. Fitzmyer, "The Consecutive Meaning of *Eph' Hō* in Romans 5:12," *New Testament Studies* 39 (1993): 321–39.

[7]Ibid., 339. Fitzmyer notes, "Yet no matter how one understands 5:12d, the universal causality of Adam's sin is presupposed in 5:15a, 16a, 17a, 18a, 19a." In the block quote, I have removed the reference to Jesus juxtaposed at the end of each verse in order to magnify the concept of original sin.

[8]Christian tradition has often termed this inclination toward sinful behavior as "concupiscence." Today it is usually restricted to mean "sexual desire." However, the Latin *concupiscentia* carries a much wider meaning. For example, Augustine viewed all sinful acts as the result of "promptings of concupiscence" or "concupiscence of the flesh" (quoted in *Augustine in His Own Words,* ed. William Harmless [Washington, DC: Catholic University of America Press, 2010], 334, 387). Noble insightfully suggests that concupiscence is "the self-centered mind-set" (Noble, "Original Sin," 108).

[9]Instead of the 2011 NIV's "body that is subjected to death" in v. 24, I have returned to this Bible's original "body of death" (so too NASB, NRSV, KJV), since, in my estimation, it is the best translation of the Greek text.

[10]In the 2011 NIV Bible, most occurrences of the Greek word *sarx* have been translated as "flesh" instead of "sin nature" (Rom. 7:18 is a notable exception). See "Updating the New International Version of the Bible: Notes from the Committee on Bible Translation," https://www.biblegateway.com/niv/Translators-Notes.pdf (2010), 8. Of course, all translations of the Bible are interpretations, and use of the term "sinful nature" to translate *sarx* is loaded with theological nuances, especially from a Calvinist (Reformed) perspective with its imbalanced focus on sinfulness (e.g., the notion of total depravity). Douglas J. Moo identifies five basic meanings of *sarx* in Paul's letters: (1) the flesh covering bones, (2) the human body, (3) the human being, (4) the human state or condition, and (5) the human condition of fallenness. Moo terms the last "the ethical sense of *sarx*" and defines it as an "ingrained tendency toward sin" or a "compulsion, or force, namely, the bent toward sin that prevents the *egō* (Greek, first person personal pronoun; literally, 'I') from putting the will to do the law into practice" (Moo, "'Flesh' in Romans: A Challenge for the Translator," in *The Challenge of Bible Translation,* ed. G. Scorgie, M. Strauss, and S. Voth [Grand Rapids, MI: Zondervan, 2003], 366–67, 369, 371).

[11]F. F. Bruce expresses the traditional understanding of the cosmic fall in stating, "Like man, creation must be redeemed because, like man, creation has been subjected to a fall" (Bruce, *The Epistle of Paul to the Romans* [London: Tyndale Press, 1963], 169).

[12]Wiley, *Original Sin*, 37–55.

[13]Irenaeus, "Against Heresies," in *Ante-Nicene Fathers,* ed. A. Roberts and J. Donaldson (Grand Rapids, MI: Eerdmans, 1973), 1:448, 544.

[14]Augustine, quoted in Harmless, *Augustine*, 384; my italics.

[15]Ibid. This interpretation of Romans 7 by the early fathers is not surprising since many embraced asceticism.

[16]Ibid., 424; my italics.
[17]For example, ibid., 394, 404, 406, 411, 423.
[18]Ibid. As Harmless comments, "The hand of Augustine is clearly visible in their [the canons of the council] wording" (p. 414).
[19]Ibid.; my italics.
[20]See "Decree on Original Sin," in Council of Trent (1546), in Heinrich Denzinger, *A Compendium of Creeds, Definitions, and Declarations on Matters of Faith and Morals,* 43rd ed., ed. Peter Hünermann (San Francisco, CA: Ignatius Press, 2012), 371–74; Pope Pius XII, "*Humani Generis* (1950)," in *The Papal Encyclicals 1939–1958,* ed. Claudia Carlen (Wilmington, NC: McGrath, 1981), 181–82; *Catechism of the Catholic Church* (Ottawa, ON: Publication Services, Canadian Conference of Catholic Bishops, 1992), 89–93.
[21]"Augsburg Confession" (1580), in *The Book of Concord: The Confessions of the Evangelical Lutheran Church,* ed. Robert Kolb and Timothy J. Wengert (Minneapolis, MN: Augsburg Fortress Press, 2000), 36, 38.
[22]"Thirty-Nine Articles," in *The Creeds of Christendom*, ed. Philip Schaff, 3 vols. (Grand Rapids, MI: Baker, 1996), 3:492–93.
[23]"Westminster Confession of Faith," in Schaff, *The Creeds of Christendom*, 3:615–16. With these three Protestant creeds, we could also include the foundational documents of Christian Reformed churches which uphold the traditional belief in original sin: "Belgic Confession" (1561); "Heidelberg Confession" (1563) Question 7, Article XV; and "Canons of the Synod of Dort" (1619) Third and Fourth Heads of Doctrine, Articles II and III.
[24]Paul H. Seely, *Inerrant Wisdom* (Portland, OR: Evangelical Reformed, 1989); Denis O. Lamoureux, "Lessons from the Heavens: On Scripture, Science and Inerrancy," *Perspectives on Science and Christian Faith* 60, no. 1 (2008): 4–15.
[25]For a series of lectures on the ancient in the Bible, see http://www.ualberta.ca/~dlamoure/ancient_science.html.
[26]It is important not to confuse (and conflate) the *ancient* phenomenological perspective of the biblical writers with our *modern* phenomenological perspective. What ancient people saw with their eyes, they believed to be real, like the literal rising and literal setting of the sun. In contrast, when we see the sun "rising" and "setting," we know that it is only an appearance or visual effect caused by the rotation of the earth.
[27]For examples of Egyptian and Mesopotamian views on the structure of the world, see http://www.ualberta.ca/~dlamoure/h83.pdf.
[28]It is possible that Paul may have been a geocentrist. But if this is the case, it does not affect my argument that he accepts an ancient science of the structure of the universe.
[29]This thought process is known as "retrojection" (Latin *retro* means "backward"; *jacere,* "to cast, throw"). It is the very same type of thinking used today in crime scene investigations. Present evidence found at the scene is used to reconstruct criminal events in the past.
[30]The other mechanism was a natural plant-like sprouting of humans from the earth. For example, in *KAR 4* the gods plant the seeds of humans into the earth and people later "sprout from the ground like barley" (quote in Richard J. Clifford, *Creation Accounts in the Ancient Near East and in the Bible* [Washington, DC: Catholic Biblical Association, 1994], 30).
[31]Ibid., 48–49.
[32]Ibid., 39, 75.
[33]Ibid., 74.
[34]Ibid., 105, 107.
[35]By acknowledging scripture's ancient biology for the origin of life, it is only consistent that the Bible also has an ancient understanding of the origin of death. Moreover, a corollary of the *de novo* creation of life is that death can only occur after life has been created. That is, built into the definition of *de novo* creation is the fact that the entrance of death into the world only happens after living organisms have come into existence.
[36]St. Augustine, *The Literal Meaning of Genesis,* trans. John H. Taylor, 2 vols. (New York: Newman Press, 1982), 1:58–59; my italics.
[37]Ibid., 59.
[38]Ibid., 61.
[39]Martin Luther, *Luther's Works: Lectures on Genesis*, ed. J. Pelikan (1536; St. Louis, MO: Concordia, 1958), 42–43. Luther's concordism is further seen in that he was a young earth creationist. He asserts, "We know from Moses [the traditional author of Genesis] that the world was not in existence before 6,000 years ago … the world, with all its creatures, was created within six days, as the words [of Scripture] read" (pp. 3, 5).
[40]John Calvin, *Commentary on Genesis,* 2 vols. (Grand Rapids, MI: Christian Classics Ethereal Library, 2007), 1:24–25, 114. Calvin's concordism is evident in that he embraced young earth creationism. He argues, "Moses relates that the work of creation was accomplished not in one moment, but in six days." He also dismissed the notion of "infinite periods of time" and claimed the world has existed "in the period of six thousand years" (John Calvin, *The Institutes of the Christian Religion* [Grand Rapids, MI: Christian Classics Ethereal Library, 2005], 142–43). For an excellent examination of Calvin's ancient scientific beliefs, see Davis A. Young, *John Calvin and the Natural World* (Lanham, MD: University Press of America, 2007).
[41]Other terms Augustine used include *causales rationes* (causal principles), *rationes primordiales* (primordial principles), or simply *rationes* (principles). See Augustine, *The Literal Meaning of Genesis*, 1:253. The concept of seed principles comes from the Stoics. These ancient Greek philosophers were pantheists and viewed God as the seed principle (singular, Greek *logos spermatikos*). In sharp contrast, Augustine asserts that God created a variety of seed principles (in the plural). These were "invisible formative" forces, and not "visible corporeal" substances. In this way, the seed of a plant contains both components (1:153, 174, 185; 2:123–24). See also Maryanne Cline Horowitz, *Seeds of Virtue and Knowledge* (Princeton, NJ: Princeton University Press, 1997), 27–28, 49.
[42]Augustine, *The Literal Meaning of Genesis*, 1:184.
[43]For example, ibid., 1:142, 175, 177, 180, 199.
[44]Ibid., 1:177.
[45]Ibid., 1:141.
[46]Ibid., 1:178, 184.
[47]Ibid., 1:185, 189; my italics.
[48]Ibid., 1:192.
[49]Ibid.
[50]Ibid., 1:177. Augustine suggested that Adam "was made to grow through the stages of human development requiring the passage of years which we observe as necessary for man's growth" (1:194).
[51]Ibid., 2:123.
[52]Ibid., 2:122; my italics. Augustine even argued that Christ was in Adam. But to uphold his miraculous birth, Augustine suggests that only Jesus's "visible corporeal germ" was there, not his "invisible formative principle," which came through the Holy Spirit (2:123–24). Augustine

was adamant that Christ was not tainted by original sin (2:125–26).
[53]Ibid., 2:124.
[54]St. Augustine, *City of God*, ed. V. J. Bourke (426; New York: Image [Doubleday Books], 1958), 271, 278–79.
[55]Denis O. Lamoureux, *Evolutionary Creation: A Christian Approach to Evolution* (Eugene, OR: Wipf and Stock, 2008), 19, 29–35.
[56]Venema, "Genesis and the Genome," 173–74.
[57]Lamoureux, *Evolutionary Creation*, 53–104.
[58]James Gaffney, *Sin Reconsidered* (New York: Paulist Press, 1983), 32–34. Notable examples of the Hebrew noun *yĕtzer* appear in Gen. 6:5 and 8:21 with the *inclination* of the heart/mind on evil. The Greek noun *epithumia*, translated as "desire, longing, and craving," carries both good and bad nuances. Regarding the latter, James 1:15 states, "After *desire* has conceived, it gives birth to sin." I am grateful to Brian Glubish for introducing me to these concepts.
[59]See endnote 8 regarding the term "concupiscence."
[60]Richard Dawkins, *The Selfish Gene* (New York: Oxford University Press, 2006), 3, 66.
[61]Frans de Waal, *The Age of Empathy* (New York: Three Rivers Press, 2009), 40. I am forever grateful to Callee Soltys for introducing me to this book.
[62]Ibid., 39.
[63]Ibid., 225.
[64]Ibid., 116.
[65]Ibid., x.
[66]Ibid., 159.
[67]Workman and Reader recognize this problem with terms. In commenting on altruism, they observe,

> Social psychologists generally define altruism as selfless behavior conducted on behalf of other without regard for one's self-interest. Note that such definitions include intentionality on the part of the altruist. In contrast, evolutionists define altruism purely in terms of the act performed, not the intention behind it. In this way ethologists [those who study animal behavior] have no problem in discussing examples of *apparent* altruism in animals. (Lance Workman and Will Reader, *Evolutionary Psychology* [Cambridge, UK: Cambridge University Press, 2008], 183; my italics)

[68]This problem with terminology can be seen in the title of Daryl P. Domning's *Original Selfishness* (Aldershot, UK: Ashgate, 2006). He contends that selfishness extends back to "the very origin of life itself" (p. 140). I doubt that self-replicating molecules and the first cell were "selfish."
[69]This category reflects the biological notion of a "self-preservation instinct" with animals and would include self-propagating, self-protecting, etc.
[70]I am not committed to this proposed terminology and would certainly invite other suggestions.
[71]See Jesse Bering, *The Belief Instinct* (New York: Norton, 2011), 7, 195.
[72]Charles Darwin, *The Descent of Man*, 2nd ed. (London: John Murray, 1874), 124.
[73]Ibid., 126.
[74]Ibid., 125; my italics.
[75]http://www.firstpeople.us/FP-Html-Legends/TwoWolves-Cherooke.html. I am grateful to Nathan Barlow for this information.
[76]*Nghi Thuc Hang Tuan Chanting Book* (Edmonton, AB: Truc Lam Monastery, 2011), 10–11. I am grateful to Alexandra Zelazny for this citation.
[77]Ibid., 17.
[78]Harmless, *Augustine*, 425.
[79]Ibid.
[80]Ibid. Augustine attributes this admonition to Ambrose.
[81]Ibid.
[82]Interestingly, Dawkins in principle agrees: "We have the power to defy the selfish genes of our birth" (Dawkins, *The Selfish Gene*, 200).
[83]Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 3rd ed. (Chicago, IL: University of Chicago Press, 1996).
[84]Ibid., 152–53. Or, to put this rather rudely, ideas change within the academy one death at a time!
[85]Ibid., 150.
[86]See "All About The Human Genome Project (HGP)" at http://www.genome.gov/10001772.
[87]Peter Enns, *Inspiration and Incarnation* (Grand Rapids, MI: Baker, 2005); Kenton L. Sparks, *God's Words in Human Words* (Grand Rapids, MI: Baker, 2008); Christopher M. Hays and Christopher B. Ansberry, eds., *Evangelical Faith and the Challenge of Historical Criticism* (Grand Rapids, MI: Baker, 2013).

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Derek C. Schuurman

Introducing Open Source and the Raspberry Pi to Schools in Developing Nations

Derek C. Schuurman

Several times my students and I have been involved with computing service projects for schools in both Central America and West Africa.[1] Several of these projects involved refurbishing computers and sending them overseas. However, when I went to West Africa in 2009, I realized that we needed to change our approach if we were best to help computing there. Some of the specific challenges and two partial solutions follow.

Particular Challenges

One of the challenges for schools in developing countries is the cost of proprietary software. This issue is compounded where the cost of software licenses is often significant in comparison with teacher salaries and other expenses. The temptation to pirate software is often strong, especially in countries where illegal copies of movies can be openly purchased at the market. To be sure, the issue of software piracy is not unique to developing nations; it is a topic that I regularly bring up with my own students.

A further challenge is the prevalence of computer viruses. Many of the computers that I encountered were laden with computer viruses and malware. In some cases this is caused by a lack of knowledge about anti-malware software, but in other cases, it is impossible to download security updates and virus definitions due to a lack of internet access. One person at a school in West Africa described to me an attempt to keep his software up-to-date by putting his computers in the back of his car and traveling to a location where he could access the internet. Many of the viruses are spread by USB flash drives which are readily available and frequently used. One computer lab I visited in West Africa had a sign prominently posted on the door: "The Use of USB Flash Drives Is Strictly by Permission."

A third challenge is the use of old hardware which is often found in schools in developing countries. Recently I visited some Christian schools in Nicaragua, many of which were using old and outdated equipment. I visited computer labs cobbled together with a ragtag collection of vintage computers, many of which were ten years old or older and running outdated software. Many computer labs have been established using donations of old computers, but besides being bulky and expensive to ship, these old computers present many ongoing maintenance issues. These maintenance issues can be exacerbated by hot climates and an unreliable power grid, leading to premature failures of power supplies and corrupted hard drives. I have wondered what happens to these old, donated computers and monitors when they eventually fail. Older monitors and computer circuit boards contain many toxic chemicals such as lead and cadmium. In particular, older CRT (cathode ray tube) monitors contain a significant amount of lead. In

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the United States, the Environmental Protection Agency has established rules to ensure safe disposal of CRTs.[2] Unfortunately, many developing countries lack the facilities to properly handle e-waste such as CRTs. At worst, endeavors to donate old equipment amount to little more than sending our e-waste overseas.

A modest computer lab at a Christian school in Nicaragua.

A fourth challenge I encountered in West Africa is electrical power, ranging from the inconvenience of different plugs and voltage standards to unreliable power grids and unclean power lines. Taming unreliable power with the use of uninterruptible power supplies (UPS) helps, but it increases costs and adds the ongoing maintenance headaches of backup batteries. The need for reliable power is increased by the necessity for air conditioning in hot climates for computer labs running many workstations.

A fifth challenge is adequate computer maintenance and teacher training. It is necessary to ensure that there are local people to maintain and take ownership of the computers (often this task falls to the teachers as well). Some of our early service projects involved refurbishing computers to be shipped to recipients overseas. Although we felt good about an opportunity to serve, and students had fun organizing computer "install-fests," I have grown skeptical of the wisdom of sending computers to places without local expertise and ownership to maintain them. The world of international development has many stories about failed projects where equipment was left rusting and languishing due to lack of local ownership, training, or a naive understanding of local culture.[3]

We have been exploring the use of open source software[4] and Raspberry Pi hardware as a practical approach to begin to address many of these issues.

Open Source Solutions

In the last number of years, a vast amount of high-quality software has become available for free. Free software provides an alternative model to proprietary software. The term "free software" means that users have the freedom to run, copy, distribute, study, change, and improve the software.[5] This movement has been called the "free software" or "open source" movement in which programmers collaborate over the internet and give their code away for free. In fact, copying, sharing, and contributing is encouraged.

We have made a conscious choice to use open source software in our overseas projects because we have found that it helps address some of the challenges described earlier. In particular, we have chosen to use Linux, a robust, freely available operating system that has many attractive features.[6] First, because Linux is free, it helps avoid the temptation to pirate software and provides an excellent alternative that does not require any software licensing fees. There is also a wide variety of open source educational software available for Linux, including LibreOffice, a freely available full-feature office suite.[7] Furthermore, Linux is typically immune from the wide variety of Windows viruses. What is more, the Linux operating system has a plethora of versions available, including some that are quite capable of running well on older computers with slower processors and with a modest amount of memory and hard drive space.[8] On a recent trip to Nicaragua, we encountered older computers that we had refurbished on an earlier trip with Edubuntu Linux which were still working reliably in the field four years later.[9]

Participants in the Raspberry Pi workshop in Managua, Nicaragua, December 2014

Open source software also lends itself to being more culturally appropriate. Because open source software is open and can be modified by anyone, people in various cultural settings can participate in its development and adapt the software so that it better serves local needs. Open source software has the possibility to improve communication and lingual norms by enabling people to translate menus, icons, manuals, and documentation into their local languages and dialects. Open source software provides options for the stewardship of hardware resources. Many new programs and operating systems require the purchase of newer hardware, encouraging people to discard older hardware even if it is still working well. In contrast, open source software includes many options for running on older or more modest hardware platforms. Expensive software licenses can exacerbate the "digital divide" in which legal use of software may exclude the poor, but open source software can be made freely available to all. Open source software also encourages sharing, which is one way of expressing the ethical norm to love our neighbor.[10] This sharing can extend to "open source curriculum" resources and lesson plans shared among local teachers.

Nevertheless, the need for adequate training remains essential. Each of our service trips have included workshops and training. Besides the technical training, we have been deliberate to include a perspectival aspect. People who work with technology can sometimes lose sight of the big picture when they focus on the "nuts and bolts" of technical work. In particular, well-intentioned Christian computing specialists must be careful not to inadvertently promote a "faith in science, technology, and material things."[11] One potential pitfall is to think that the primary problem faced by the poor is a lack of technology or information, and that the key to bring flourishing to communities is to provide technology and access to information. Each of my trips to West Africa and Central America included workshops with local teachers and professors that covered the topic of developing a Christian perspective of computer technology.

Introducing the Raspberry Pi

Although open source software can run on older hardware, the challenge of using old and outdated computers remains. The recent work in Nicaragua included the introduction of a nifty, new, little computer called the "Raspberry Pi."[12] It is a device about the size of a deck of cards and capable of running a full Linux desktop operating system while consuming only 2.5 watts of power.[13] It includes USB ports for connecting a keyboard and mouse along with a variety of other peripherals, an ethernet adapter, and an HDMI monitor connection. The Raspberry Pi was originally constructed for hobbyists, but promises to be an appropriate technology for use in schools in developing countries. Rather than shipping bulky, old, refurbished computers with all the associated problems, the Raspberry Pi is a very small device that can be easily shipped overseas. It is also manufactured to comply with RoHS (Restriction of Hazardous Substances) directives.[14] It requires no fans or moving parts; instead of a hard drive it relies on a single microSD card for its storage. It runs a variant of Linux called Raspbian, and there are a wide variety of educational programs that can be run on it. What is more, it can be purchased new with a case and power supply for around $60 US.

We recently brought thirty Raspberry Pi's for a pilot project to see how they would work over time and temperature in a few Christian schools in Nicaragua.[15] The project was launched in December 2014 with a four-day workshop for teachers on how to set up and configure the Raspberry Pi as well as introducing various educational programs.[16] Once again, the workshop also included discussions on a Christian perspective of technology. The Raspberry Pi's were distributed to a network of local Christian school computer teachers which calls itself

Some Christian school teachers in Nicaragua exploring the Raspberry Pi.

"RedProCom." It is hoped that this group of teachers will develop expertise in the use and maintenance of the Raspberry Pi so that they can train other teachers. Local ownership and participation with groups such as RedProCom are essential.[17] If the project proves successful, we hope to participate with local computer teachers and groups such as RedProCom to introduce more Raspberry Pi's in other Christian schools who are currently struggling with the challenges of old and outdated computers. Because the Raspberry Pi has modest power requirements, it promises to be a suitable candidate for solar power for use at sites with an unreliable power grid. Already we have experimented with using solar power to run the Raspberry Pi and a flat screen monitor with promising hopes of developing it further.

An experimental setup for a solar-powered Raspberry Pi.

Conclusion

It is exciting and encouraging to see the growth in Christian schools in the majority world. Despite their growth, many of these schools face challenges such as the establishment of reliable and affordable computer facilities in the service of learning. It is my hope that some of the things we were able to share about open source software and the Raspberry Pi will help equip Christian teachers as they teach about computer technology and seek to do so from a Christian perspective. ♦

Notes

[1]Our service projects have been in partnership with different organizations including Christian Reformed World Missions (CRWM) and EduDeo Ministries.
[2]http://www.epa.gov/osw/hazard/recycling/electron/.
[3]For an excellent discussion of many of these issues, see Steve Corbett and Brian Fikkert, *When Helping Hurts: How to Alleviate Poverty without Hurting the Poor … and Yourself* (Chicago: Moody Publishers, 2009).
[4]For an introduction to the concept of open source software, readers are encouraged to read the article on open source software that appears in this same issue of *PSCF*.
[5]See the free software definition at http://www.gnu.org/philosophy/free-sw.html.
[6]On my recent return trip to Nicaragua I was delighted to see several Christian schools successfully running Linux. One lab I visited had mounted on the wall of their computer lab a large styrofoam cut-out of Tux, a friendly looking penguin which has become the mascot for the Linux operating system.
[7]One Linux distribution dedicated for educational use is Edubuntu, http://www.edubuntu.org/.
[8]An example is Puppy Linux, http://puppylinux.org/.
[9]In fact, a few of them had experienced hard drive failures but were still being used by turning them into thin clients using LTSP under EduBuntu Linux, http://www.ltsp.org/.
[10]In fact, the free software definition explicitly states one of the freedoms as "The freedom to redistribute copies so you can help your neighbor," http://www.gnu.org/philosophy/free-sw.html.
[11]Corbett and Fikkert, *When Helping Hurts*, 94.
[12]We used the Raspberry Pi model B+, http://www.raspberrypi.org/.
[13]We set up the Raspberry Pi's with the Raspbian Linux distribution, http://www.raspbian.org/.
[14]http://ec.europa.eu/environment/waste/rohs_eee/.
[15]The Raspberry Pi project had help from Henry Brouwer and was done in partnership with Dave Stienstra from Nicaragua Christian Academy, a group of local computer teachers called RedProCom, the ACECEN (Association of Evangelical Christian Education Centers of Nicaragua), and EduDeo Ministries.
[16]The Raspbery Pi includes various educational programs including one named Scratch, a friendly tool for teaching children how to program, http://scratch.mit.edu/.
[17]Corbett and Fikkert, *When Helping Hurts*, 145–46.

ASA Members: Submit comments and questions on this communication at www.asa3.org→FORUMS→PSCF DISCUSSION.

ENVIRONMENT

TRUE NORTH: Christ, the Gospel, and Creation Care by Mark Liederbach and Seth Bible. Nashville, TN: B&H Publishing Group, 2012. 173 pages. Paperback; $19.99. ISBN: 9781433676888.

It seems that everywhere we turn, environmental discussions are clouded by fear and hopelessness. These are the driving factors used to motivate action to combat climate change, reduce environmental degradation, and live responsibly. In *True North: Christ, the Gospel, and Creation Care*, Mark Liederbach and Seth Bible aim to reorient the Christian creation care movement by centering our "moral compass" on Christ instead. Their three goals are (1) to ground the creation care discussion in scripture, orthodox doctrine and theology, and biblical reasoning; (2) to construct a Christian framework for discussing environmental ethics; and (3) to illustrate how "biblical and theological teachings about the person of Christ" lead us to a lifestyle of worship which includes honoring him in "the way [we] treat and care for his universe" (pp. 3–4).

Liederbach and Bible accomplish their first purpose well, using scripture, doctrine, and biblical reasoning to argue for Christian creation care. Throughout *True North,* they root every explanation or argument in a biblical text. This scripture-based approach centers their argument on "serving God" instead of "saving the planet." They use a variety of Old and New Testament texts and consider verses within the context of the surrounding passages, making their biblical analysis robust and rounded. The authors do very little of their own exegesis; they rely on the work of a variety of theologians when analyzing a passage. Employing plausible and well-explained interpretations, they summarize and demonstrate how biblical texts form our understanding of creation care. Their critique of interpretations is logical, scripture-based, and respectful to other authors. Doctrine also supports their arguments. For example, Christ's full humanity and bodily resurrection are discussed at length to affirm the goodness of the physical world and to support our need to protect it. Overall, Liederbach and Bible's approach is easy to follow, logical, and biblically grounded, giving the reader a persuasive, focused, specifically Christian argument for creation care.

Developing a Christian framework for engaging creation care is the authors' weakest point. In a sense, the framework for Christian environmental ethics has already been established by multiple other authors, and *True North* mainly summarizes the recent literature; however, Liederbach and Bible's Christocentric perspective, rather than the human or Earth-centered arguments found even in some Christian environmental literature, adds to creation-care theology and enhances the "framework." The authors also clearly state why the incarnation affirms creation care. "Creating" the framework is stretching what the authors believe they have done, but "enhancing" or "clarifying" the current framework to focus on Christ, worship, and obedience is certainly true.

The greatest achievement of Liederbach and Bible is the way in which they address their third purpose. Their entire book focuses intensely on Christology and how understanding who Christ is and how he works should shape our understanding of creation care. Chapter 1 orients the reader toward Christ as *True North* and the center of our worldview. The authors capably critique and redirect the "crisis mentality" espoused in secular environmentalism and the "disembodied doctrine" of Christians who try to separate evangelism from creation care, arguing for a holistic, worshipful perspective that places Christ above crisis and unites preaching with action in gospel witness. Chapters 2 and 3 establish Christ as Creator, the inherent value and purpose he gives creation, and humanity's unique position as image bearers in the created order. Liederbach and Bible illustrate that because Christ creates, owns, and values his creation and calls us to imitate, worship, and obey him above all else, caring for creation becomes part of a fulfilling human existence. In chapter 4, the authors explore the importance of Christ's redemptive work on how we approach creation care. They address the Fall's effect on creation and explain the importance of Christ's death and resurrection in affirming the goodness of the created order, realigning humanity to God's example of headship, and imbuing all of creation with the hope of restoration. In light of that hope, chapter 5 addresses eschatology and the fate of creation when Christ returns. The authors reject the interpretation of 2 Peter 3:10 that insists the world will be destroyed by fire, arguing that scripture instead affirms its continuity in the end times. The final chapter asks the question: "How, then, shall we live?" Liederbach and Bible conclude that we, as God's people, must recognize the value Christ has given his creation and live as creative stewards—caring, investigating, enjoying, and enlarging creation (p. 156).

True North is well written, well organized, and easy to understand. I have a few criticisms. First, the writing can be wordy. Some chapter introductions and the gospel presentation seemed too long. Second, the

authors clearly state their focus on Christ, but in light of their desire to build a Christian framework for discussing creation care, I felt a conspicuous inattention to the roles of the Father and Holy Spirit. Finally, the main goal of this book was the Christ-centered perspective on creation care. The first two purposes the authors listed, while central to the aim of the book, support this main goal rather than stand on their own.

I recommend this book for anyone seeking a Christ-centered perspective on environmental ethics, especially for students in theology or environmental biology. Because the authors avoid jargon and clearly explain concepts and terminology, the book is easily accessible to people of multiple backgrounds. On a personal note, I deeply appreciated the earnest, rich message conveyed by the authors. In a culture driven by fear of environmental change and a tradition sometimes marked by ignorance and neglect for creation care, Liederbach and Bible make an excellent case for creation care filled with worship, hope, and Christ as part of a fulfilling lifestyle and holistic gospel witness.

Reviewed by Erin K. B. Vander Stelt, Holland, MI 49424.

ETHICS

COVENANTAL BIOMEDICAL ETHICS FOR CONTEMPORARY MEDICINE: An Alternative to Principles-Based Ethics by James J. Rusthoven. Eugene, OR: Pickwick, 2014. 314 + xv pages, including bibliography and index. Hardcover; $36.00. ISBN: 9781625640024.

In the early 1980s, Mayo Medical School asked me to help set up and teach a newly required course in medical ethics. The faculty overseeing the course—physicians all—did not feel qualified to teach the course, but they definitely had already chosen the textbook—*Principles of Biomedical Ethics*—which was also the name of the course. I was comfortable with using it, but I wondered how they chose the textbook. "Because the title conveys that there are accepted principles of medical ethics just as in the sciences, and our students need to see that," they said. The book by Tom Beauchamp and James Childress, then going into its 2nd edition, has now reached its 7th edition (Oxford University Press, 2012) and has become the most widely used text in medical ethics courses as well as in the many workshops offered to medical professionals.

James Rusthoven would like to pour a little water on this flame. As his subtitle indicates, he advocates for a covenantal ethics that he thinks is truer to the practice of medicine and better for nurturing medical practitioners because it is rooted in the transcendent God and God's revelation and not merely in what he sees as a baseless and minimalist common-denominator morality. His book is an impressive achievement. Rusthoven is a medical oncologist with a part-time clinical practice, and he is also a professor at McMaster University. Some time ago he decided to pursue his interest in ethics by enrolling at the University of Toronto Joint Centre for Bioethics; this book is a version of his PhD thesis.

Part One (four chapters) discusses the rise and dominance of principles-based biomedical ethics (usually called "principlism"). The author refers to most of the heavy thinkers in the debates since the late 1970s, and discusses the adequacy of Beauchamp and Childress's "common morality" approach, which located four principles that can serve as agreed-on considerations relevant to most biomedical debates—autonomy, nonmaleficence, beneficence, and justice. Utilitarians, Kantians, and natural law theorists will have different ways of justifying these, but they—and anyone using common sense—can converge on them as middle-level principles applicable to particular ethical decisions. Of course, these principles have to be specified when applied, and also balanced and prioritized when not all of them can be satisfied to the same degree in a given case; the devil is in these details.

I served on an ethics committee at our local hospital for a number of years, and these four principles were laid out as the framework for our decision making (introduced as "the accepted principles for medical ethics"). Often the committee could reach agreement on what to do in a given case, though it was not always clear how members linked their decisions to the principles. Most of the disagreements were actually over empirical issues such as whether the patient was competent and what would happen if a given decision or policy were implemented, but when the disagreement was normative, it was often over such matters as whether the patient's decision should be honored even if did not seem to be in his or her best interest. This, of course, is a difference over how to rank autonomy and beneficence, and Rusthoven is right in noting that there is no overarching principle to help decide.

That American individualism, as well as its legal system, promotes autonomy as the trump card is hardly a moral justification. Rusthoven covers quite comprehensively and perceptively the secular debate over the usefulness of the principles approach. Soon

after its introduction, its critics claimed that it served merely as a soothing mantra, or at best as a checklist of things to keep in mind, while providing no clear decision-making procedure. Rusthoven notes that most of the critics do not provide one either. In a well-informed survey of faith-based approaches, especially those of Paul Ramsey, H. Tristram Engelhardt, and Edmund Pellegrino, he provides a sympathetic account of their views, but even Pellegrino, whom he really likes and who provides "benevolence-in-trust" as an overarching principle (grounded in the dynamics of the physician-patient relationship), allows his Thomistic dualism to prevent a full-bodied Christian alternative (p. 255).

Part Two (four chapters) provides "a modest proposal for a biblical covenantal biomedical ethics." A covenantal approach includes an appreciation of the role of relationships in ethical thinking, an awareness of the effects of sin on our thinking, and an appeal to the *imago Dei* (and to God's care for all humans and the rest of creation) for grounding human dignity, so it is well equipped for ethical decision making, especially since covenants are such an important part of life in general and medicine in particular.

Rusthoven gives a clear and sympathetic explanation of earlier efforts at covenantal ethics, including those of Joseph Allen, William F. May, and the co-authors of *Christian Faith, Health, and Medical Practice* (of which I am one). He likes Dooyeweerd's social philosophy and thinks that it illuminates the role of relational networks in medicine; the sections on the latter especially reward careful reading (pp. 220–30). Jesus's basic teaching of agape love, as illustrated in the parable of the Good Samaritan, provides the key to biomedical ethics and also the context for interpreting and applying the four principles. One of the final chapters is titled, "The Four Principles Revisited." Rusthoven seems offended when Beauchamp and Childress see Pellegrino's and May's contributions as private moralities that can helpfully supplement the common morality for certain faith communities but not replace it (p. 243); he periodically says that the principles approach is itself a private morality, sometimes adding that it is a more widely accepted one because of its minimalism (p. 243). (He also sometimes says principlism is anchored in faith in reason alone [p. 122] while elsewhere noting that Beauchamp and Childress defend it as a common morality that is not grounded in reason [p. 244]).

The relationship between minimal and maximal values involves an ongoing debate, as Rusthoven indicates. Some have argued that minimal values are those necessary for social existence, so, of course, they are common and can be used as a check on those maximal values that can go beyond, but not against, the minimal values. In actual societies, the minimal (thin) and maximal (thick) values do not come in separate categories; the former are nurtured as an integrated part of the religious and cultural outlooks that include the maximal values that inspire and motivate people. Minimal values are teased out only when there is some conflict or issue that requires reducing commitments to whatever overlapping consensus there may be. The Belmont Report, well discussed by Rusthoven, is an example.

The question is whether such a reduced set of agreements can do any substantive work in a pluralistic society without being integrated into a more full-bodied ethic such as Pellegrino's Thomistic virtue ethic or Rusthoven's Dooyeweerd-influenced agape ethic. I think it can, as do Beauchamp and Childress, but even if it cannot, and it requires integration into a richer outlook that includes religious ideals, one could see the latter as less of an alternative than an interpretative context. Rusthoven could be clearer on which it is, alternating between "contrasting" principlism with his approach (p. 241) and seeing "principlism as contextualized through the spectacles of a biblical covenantal ethic" (p. 247). I see the latter as more than merely a supplement, but not really as a contrasting alternative. I think this point shows a helpful way to read Rusthoven's rich chapter on "The Four Principles Revisited," and one that either dovetails with or challenges (depending on how swiftly he came up with it) his labeling it a "modest" proposal.

Rusthoven argues that there is a universality in appealing to the transcendent God in one's ethics, but recognizes that it requires a nonuniversal belief. However, he plausibly points out some universally appealing aspects of a covenantal approach that "is generalizable for all humankind in practice" (p. 4) and claims that, when "engaging those of non-Christian faith beliefs, the idea that all of humankind is bound covenantally, based on common vulnerability and need, can be an attractive starter for dialogue" (p. 236). He is confident that when dialogue is conducted in a deliberative way, it can be productive: he even asserts that "differences in faith beliefs should be shared as sources of wisdom from each tradition rather than as impediments to care" (p. 238). A similar attitude should apply even within the Reformed Christian community, as not all will be persuaded by his arguments about, say, the moral status of embryos (p. 261).

There is a lot to like in this knowledgeable and wide-ranging book. It is true that Rusthoven sacrifices

depth for breadth; his effort to be comprehensive in treating other thinkers results in a conciseness that too often quickly summarizes a contribution and even more quickly evaluates it by simply noting that another contribution cautions us about the former. However, his interpretations are generally fair minded and perceptive. I thought an exception might be a misleading interpretation of Robert Audi on p. 115, but he interprets Audi correctly on p. 269, though even here Audi is dismissed rather quickly by citing another author. Moreover, frequently the book does have the flavor of the PhD thesis that begot it. The style of writing and terminology used may be fine for academics, but I do wonder how most health-care practitioners will respond to sentences, such as "However Pellegrino's Thomistic elevation of rationality is challenged by O'Donovan's caution that the rationalist tradition tends to move toward a reductive immanentism and premature eschatological fulfillment …" (p. 8; restated, but not much more clearly, on p. 249), or to Dooyeweerdian phrases such as "enkaptic interlacement" (p. 222). For nonacademics, I recommend beginning with the final few chapters (worth the price of the book), and then deciding what else to read. Some of it is slow going, but it is good work.

Reviewed by Edward Langerak, Professor Emeritus of Philosophy, St. Olaf College, Northfield, MN 55057.

FLOURISHING: Health, Disease, and Bioethics in Theological Perspective by Neil Messer. Grand Rapids, MI: Eerdmans, 2013. 256 pages. Paperback; $35.00. ISBN: 9780802868992.

Theologian and ethicist Neil Messer (University of Winchester) has produced a thorough and thoughtful review and analysis of the various theories and approaches to foundational issues concerning human health, disease, and disability as they relate to the concept of human flourishing. As such, this book will be of interest to anyone seeking a greater understanding of the major questions and contemporary discussions in these areas.

The first two chapters of the book could serve as a stand-alone text for addressing major modern theories of what constitutes health, disease, and illness and how best to evaluate and differentiate these concepts. In the first of these two chapters, Messer provides a particularly fine overview of several prominent evolutionary theories of what constitutes health and disease, including discussions and critiques from within the community of scholars espousing variations of these interpretations. Contrasting and relating these views to "the Good," as conceptualized classically from an Aristotelian framework, he helpfully illustrates both the strengths and weaknesses of the evolutionary perspective when applied to human health; these serve as a foundation for later theological discussions. Those not well versed in bioethics may find these chapters helpful in appreciating what the secular academy and the philosophical bioethics community contribute constructively to the broader bioethical discussion, and how these contributions can be given more substantial meaning, depth, and coherence within an explicitly theological framework.

Of particular interest to those coming from a background in neuroethics, rehabilitation, or psychology is the inclusion of the respective topics of mental health and disability within the broader discussion of human flourishing. Messer considers the concept of disability from several angles: as disease, as extreme examples of natural human variability, and within the broader social context in which members of a society can impede another's flourishing by their reactions to such variations. Once again—as with health in general—what constitutes disability still appears to be, at least intuitively, based upon an essentialist (Aristotelian) understanding of what constitutes normative human bodily and mental functioning. An intuitively understood normative functioning serves as a vantage point from which to determine what is also likely to constitute bodily and mental disease or disability. As will be apparent to many, philosophical concerns and questions have bedeviled medical and mental health ethics for some time. For instance, at what point does diversity and variability become pathology?

The third and fourth chapters of Messer's text constitute the major theological emphasis of the book, with chapter three providing the basic theological foundations and chapter four providing the application of the major theological ideas. Messer is explicitly indebted to the work of Swiss Reformed theologian Karl Barth and medieval theologian Thomas Aquinas, providing links to the thought of Magisterial Reformation Christianity as well as to the historic Western church and the Roman Catholic tradition. Messer draws heavily from Barth's "ethics of creation" and pairs this approach with the Aristotelian/Thomist emphasis upon teleology and essentialism, especially as teleology and essentialism apply to human beings and their characteristic functions as beings of a particular kind. From this "Barthian Thomism," Messer's main thesis in the second half of his book is that the ends, values, goals, or "goods" that evolutionary approaches found so elusive in the first half of the book can only be properly found in a Christocentric anthropology wherein health is seen as the "'strength

for human life': the God-given ability to answer the summons to flourish as an embodied creature of this particular, human kind" (p. 155). "Our flourishing, as creatures of a particular kind, consists in the fulfillment of the ends proper to that kind of creature" (p. 167). Within this framework that views each human life lived "as creatures of a particular kind," health and human flourishing (physical and mental) are viewed as proximate ends embedded in and given proper context and meaning within the ultimate ends provided in God the Father's revelation in Christ. Thus, the insights of various branches of human learning "can be critically assimilated to this theological understanding" (p. 170).

I believe that Messer's text can be extremely helpful in providing Christians with a lens through which to view analytically much of contemporary culture's focus on health and longevity as ultimate—rather than proximate or penultimate—goals. A focus on health for its own sake may actually keep people from engaging in activities that could contribute more fruitfully and fully to "being human" and relating to others through valued action and compassion.

A recurring element in the second half of Messer's book is Barth's notion of health as the "strength for human life." As someone with professional interests in psychology and neuroscience, my mind immediately went to possible conditions which could be considered threats to such creaturely flourishing from a mental health perspective, notably those conditions that impair our ability to see the good in day-to-day existence and impair our ability to take joy from our relationships with others and from our work.

I recommend Messer's book and hope that it is widely read by ethicists, clergy, and medical and mental health professionals. In addition to helping Christian bioethicists and philosophers to dialogue more constructively with the broader bioethics community, I believe that Messer's text will be very helpful in assisting those in the church (clergy and laity) to understand more profitably the concepts of health and disease from a distinctively Christian point of view.

Reviewed by Derrick L. Hassert, Department of Psychology, Trinity Christian College, Palos Heights, IL 60463.

AN IMAGE OF GOD: The Catholic Struggle with Eugenics by Sharon M. Leon. Chicago, IL: The University of Chicago Press, 2013. 226 pages. Hardcover; $45.00. ISBN: 9780226038988.

This book offers a detailed account of how American Catholics emerged as the fiercest opponents of sexual sterilization over the course of the first half of the twentieth century. Sharon Leon offers a close reading of texts produced by high-ranking American Catholics in concert with the texts of leading local eugenicists to trace a complicated relationship that at moments overlapped, but over time evolved into a contentious and deeply divided set of views over the sanctity of human life and its reproduction. It provides historians of medicine, eugenics, and Catholicism with a rich study of these high-level debates.

Leon concentrates on some of the leading figures in these discussions and covers nearly four decades of its discourse. In doing so, her study focuses on the period in American history when eugenics and sterilization have been presumed to be in their ascendency. Many scholars suggest that after the Second World War, the discussions changed dramatically, with the concurrent international attention to Nazi eugenics and human experiments, and a contemporary shift in discourse surrounding voluntary birth control, which dramatically altered the course of eugenics. Although historians of medicine such as Rebecca Kluchin, Wendy Kline, and Johanna Schoen have begun to problematize this chronological framing by demonstrating that eugenics programs had a much longer reach and maintained a more complicated relationship with both medical experimentation and birth control, Leon adheres to this periodization. The result is an in-depth look at how Catholic thinkers positioned themselves against eugenicists, and how Catholicism wrestled with eugenic science for the upper hand in moral authority over the modern family.

At its core, this book is an exploration of the battleground between eugenic reformers who harnessed science (however pseudo or incomplete it was) in their efforts to shape American society, and Catholics, who expressed religious and theological explanations for human behavior, and later politically reinserted the church into the domain of welfare and charity. Leon points out, however, that both Catholics and eugenicists borrowed interpretations and strategies from one another as they attempted to shore up support for their positions. At times, this jockeying meant that eugenicists shared or even borrowed perspectives from Catholics, namely support for pronatalism and positive eugenics. Conversely, while Catholics agreed on elements of pronatalism, in practice (whether or not this was consistent with papal doctrine), some even agreed in principle with the need to intervene on issues of mental deficiency

and later on anti-miscegenation laws. While the differences are evident, Leon is careful to draw attention to more subtle points of convergence that complicate our understanding of this contested past, and remind us of the overarching issues that brought these groups into the same arena.

The subtext behind this contest is less explicit. It appears that while the eugenicists and Catholics squared off over the subjects of eugenics and sterilization, the state loomed large in this wrestling match. Eugenicists often appeared to have the upper hand in working with the state to design eugenic laws, while Catholics, in Leon's account, resented what appeared to be an encroaching state that increasingly intervened in American lives, whether on points of secular marriages, welfare, or moral guidance regarding family life. The underlying wave of secularization brought Catholics together in defense of their place in American society. The state, which is more often an implicit player in this account, created another rallying point for Catholics, who appealed to a particular feature of Americanism that decried the paternalism of a secular state.

By paying close attention to the high-level discussions, the voices and actions of lay people—whether patients or parishioners—are largely absent. The nuances in discourse are very well established, but the local interpretations of that advice as it made its way into civil society are less clear. Did families, for instance, adopt one interpretation universally, or did they select pieces from the eugenicists and Catholics as it suited their individual circumstances?

This book addresses a considerable gap in the literature on eugenics, and provides compelling evidence to support the oft-made claim that Catholics were the primary opponents to eugenics; Leon explains why. She delves into the murky science of heredity that shifted under the weight of religion and failed to prove that disability and feeblemindedness were indeed threatening, subhuman categories. Catholics, she shows, did not combat this view with religion alone, but engaged in the science of eugenics and joined intellectuals in their pursuit of understanding degeneracy. Only after reasoned consideration did Catholics emerge firmly against the popular wave of support for more interventionist approaches to designing families. This is not, therefore, a simple story of religion triumphing over science, but rather one of reason over unreason, and in this case, conservatism over change.

Reviewed by Erika Dyck, Associate Professor and Tier 2 Canada Research Chair, Medical History in the Department of History at the University of Saskatchewan, Saskatoon, SK S7N 5B5.

History of Science

A CHOSEN CALLING: Jews in Science in the Twentieth Century by Noah J. Efron. Baltimore, MD: Johns Hopkins University Press, 2014. 149 pages. Hardcover; $26.95. ISBN: 9781421413815.

Does a religious community's attitude toward science really matter? By illuminating the importance of science and technology for disparate Jewish communities throughout the twentieth century, Noah Efron's *A Chosen Calling: Jews in Science in the Twentieth Century* raises a number of questions that are important for anyone engaged in the science and religion conversation to consider. Why do religious communities adopt certain attitudes toward science? What might those attitudes say about the communities who hold them? How might they influence whether their members pursue scientific professions?

Efron is a historian and philosopher of science at Israel's Bar-Ilan University, a familiar commentator on Israeli politics, and an established science and religion scholar, being particularly known for writing *Judaism and Science: A Historical Introduction* in the Greenwood Guides to Science and Religion and a 2011 *Huffington Post* blog essay on the everyday meeting of science and religion. In short, although Efron is not writing about Christianity and science, he writes from a knowledgeable, unique, and valuable perspective. Those *PSCF* readers who are willing to consider how his approach and ideas might apply to the relationship between Christianity and science both globally and in particular church communities should find much to value in Efron's work.

Published as part of the Medicine, Science and Religion in Historical Context series, edited by Ronald Numbers, *A Chosen Calling* grew out of Efron's 2007 Gustave A. and Mamie W. Efroymson Memorial lectures at the Hebrew Union College–Jewish Institute of Religion in Cincinnati, Ohio. In this rather slim but well-produced volume, Efron seeks to address the disparate representation of Jews in the sciences in the twentieth century—a topic that has been debated both by ordinary Jews and intellectual luminaries as diverse as Thorstein Veblen, C. P. Snow, Norbert Wiener, Nathaniel Weyl, and George Steiner. Efron largely rejects the hypotheses of these thinkers who variously attributed Jewish success in science to such factors as outsider "skepticism towards received pieties," social structures that genetically favored breeding for scholars, and habits of thought derived from Talmudic disputation that emphasize creative

interpretation, critique, and "the ordering of all phenomena." None of these factors, Efron notes, explain why Jews were modestly represented in science prior to the late nineteenth century, or why most eminent Jewish scientists eschewed Talmudic study and rejected traditional Judaism for modern thought.

For Efron, the central question is not why Jews were disproportionately preeminent in twentieth-century science but rather why there was a sudden upsurge in Jewish enthusiasm for science in the late nineteenth and early twentieth century. Efron's answer is that Jews flocked to science because science provided a means for nationally and culturally alienated Jews to contribute to and find a place in the modern world. Aware that such a simple thesis runs the risk of imposing an unjustified metanarrative on the historical record, Efron spends the bulk of the book showing how science provided Jews with an opportunity to find a place in their world under widely differing circumstances—liberal capitalist America, the Soviet Union, and Zionist Palestine, the three great "destinations" pursued by Jews in the twentieth century.

After introducing the importance of science for contemporary American Jews by recounting his experience visiting Kentucky's Creation Museum with a vanload of rabbinical students and providing a brief introduction to the problem of Jews' "ridiculously disproportionate" contributions to twentieth-century science, Efron spends each of the book's three main chapters describing their experience in each "destination."

Chapter one tells how American Jews held "high the torch of civilization" in twentieth-century America. The meritocracy of science opened a path for Jewish immigrants to contribute to American progress and served as the exemplar of American liberal democracy, the latter in being a sphere where Jews could participate without fear of religious discrimination and an opportunity for Jews to make America more hospitable for Jews by resisting fundamentalist attempts to impose their beliefs onto an ideally nonsectarian American public life. In short, America provided Jews with opportunities both to participate in American society and to reshape it to be even more hospitable for Jews. Chapter two discusses the prominence of Jews in Soviet science due to a combination of anti-Jewish discrimination under the tsars, the appeal and opportunities introduced by the Soviet egalitarian ideal, and the importance of science as a pathway for Jews to contribute to Soviet society. Chapter three discusses the role science and technology played in Zionist enterprise, both as a reflection of the "science equals progress" mindset of the times and later as a way for Jews to use their modernizing of Palestine to justify their resettlement of the land in a sort of Zionist appropriation of colonialism.

So, in the end, has Efron demonstrated his thesis? Not really. Given that Efron spends the vast bulk of the book's 104-page argument focusing on the attitudes of Jewish communities and only rarely addresses the reasons why individual Jews pursued scientific eminence, perhaps he never really intended to demonstrate his thesis in any rigorous sense. Efron seems content to lend his thesis credibility by explaining how science was viewed as important and valuable among twentieth-century Jews—a task in which he succeeds admirably.

PSCF's readers can benefit from Efron's insights, though they may find that applying them to issues of science and Christian faith is far from simple. Aside from the usual difficulties associated with drawing lessons from history, Efron is not writing for Christians or even a general science and religion audience. Rather, he writes primarily for fellow Jews interested in understanding their communities' engagement with science. Moreover, since Efron justifiably considers Judaism as a cultural affiliation rather than as a devoutly held belief, the application of his insights to communities that emphasize personal faith commitments is far from clear. What, for example, are we to think about twentieth-century American Jews' embrace of science and technology, knowing that it also represented an embrace of modernity at the expense of traditional Jewish observances and beliefs? Nevertheless, Efron has given us something valuable—the voice of an experience that, while not our own, is one we can learn from.

It should also be noted that *A Chosen Calling* has merits beyond Efron's argument itself. Science and religion writers who put forward and critique various origins proposals could benefit from imitating Efron's humble, gracious, and fluid style, while scholars will appreciate the extensive endnotes and index.

Reviewed by Stephen Contakes, Assistant Professor of Chemistry, Westmont College, Santa Barbara, CA 93108.

NEWTON AND THE NETHERLANDS: How Isaac Newton Was Fashioned in the Dutch Republic by Eric Jorink and Ad Maas, eds. Amsterdam: Leiden University Press, 2013. 256 pages, index. Paperback; $37.00. ISBN: 9789087281373.

A number of recent historical studies have shown that place and locality matter in the reception, discussion, rhetoric, elaboration, and circulation of scien-

tific ideas and concepts. This collection of nine essays written by ten historians of science (all Dutch, but for Rob Iliffe, University of Sussex), provides an important contribution in understanding the response to Newton's work in the Dutch Republic. The Dutch were some of the first on the continent to adopt, adapt, and propagate Newton's natural philosophy. In this particular case, this book aims to locate eighteenth-century Dutch encounters with Newton. But, certainly, not in a way that simply parrots the "master," once described as "the miracle of our time" by Herman Boerhaave (1668–1738). A chapter section heading expresses it succinctly: "not all roads lead from London" (p. 172).

Two underlying patterns, descriptive of the Dutch assimilation of Newton, are identified in the introduction by Eric Jorink and Ad Maas: (1) Newtonianism was "not a stable, coherent system, originating in Britain and waiting to be implemented on the Continent, but a philosophical construction, adapted to local problems and circumstances"; and (2) the dissemination of Newton was a process in which "natural philosophy, religion and cultural factors, propaganda and practical concerns, and personal benefits, fear and precedence interrelated in a fascinating manner" (p. 8). The other nine chapters provide historical details in support of these theses.

The major historiographical issue which serves as a thread throughout these chapters asks: What does it mean to employ the term Newtonian? Is the concept Newtonianism empirically, that is scientifically, accurate or is it a term best used only when providing historical narrative? (All of these questions parallel issues in the discussion surrounding the term Darwinism and its use in more contemporary times.) In chapter 6, "Low Country Opticks: The optical pursuits of Lambert ten Kate and Daniel Fahrenheit in early Dutch 'Newtonianism,'" Fokko Jan Dijksterhuis argues that 'Newtonianism' is an extremely vague term. Upon examination, it is not just a physical theory, say, in this case, a specific optical theory. In his view, Newtonianism also functions as "a theological/philosophical concept that should be carefully distinguished from astronomical, physical, or chemical theories (p. 174). This point is echoed by Henri Krop in chapter 9, "Newtonianism at the Dutch Universities during the Enlightenment." We need, he argues, to carefully distinguish the "philosophical Newtonianism supported by the universities from a more popular Newtonianism of a markedly religious nature, which has the societies of enlightened burghers as its institutional background" (p. 228). In addition, the employment of a term like Newtonianism tends to neglect or downplay the contributions of others (for example, Robert Boyle, Leibniz, or Wolff), and it often assumes that there is nothing but one-way intellectual traffic. It does indeed seem to be increasingly difficult to identify the essential core of Newtonianism.

Other chapters describe how Dutch experimental physicists such as Willem Jacob 's Gravesande, Petrus van Musschenbroek, and Daniel Fahrenheit appropriated Newton and gave it a local interpretation. Rina Knoeff has contributed a chapter (3), "How Newtonian Was Herman Boerhaave?" about Herman Boerhaave, an influential Leiden University medical and chemistry professor, reflecting his initial use of Newtonian mechanical imagery in physiology. However, he later became increasingly disenchanted with its explanatory potential in chemistry and medicine.

Two of the chapters, 1 and 7, highlight situations which resonate in contemporary discussions. Chapter 1,"The Miracle of our Time: How Isaac Newton Was Fashioned in the Netherlands," by Eric Jorink and Huib Zuidervaart, provides a review of the historical context in an attempt to understand the ready acceptance of Newton's work in the Dutch scene. They attribute this welcoming environment to (1) an existing tradition of empirical research founded in Leiden in the early seventeenth century into which Newton fitted, and (2) a scientific culture characterized by an intense "circulation of knowledge." Dutch intellectuals and Protestant refugees from the Spanish Netherlands, Scandinavians, and Germans escaping the Thirty Years War, as well as Sephardic Jews and later French Huguenots were involved in these discussions. The Netherlands, at the time, was the publishing heart of Europe. This diversity of thought was not overly encumbered by a long-standing scholastic tradition, which was not cemented in the recently established universities (Leiden, 1575; Utrecht, 1636). This encouraged universities to be more innovative and open to new curricular and intellectual approaches, and attracted many foreign students and professors. There was also a stunning array of non-university groups (for example, Amsterdam mathematical enthusiasts and Mennonite enthusiasts) which routinely discussed the latest scientific findings. In addition, Dutch society displayed a stunning pluriformity of denominations and sects. This also stimulated discussion. The role of the Reformed church and its adherence to the Belgic Confession (1561), Article II, viewing nature as God's creation in which God reveals himself, was also crucial in stimulating scientific investigation and discussion. Many people interested in natural theology and physico-theology saw an ally in Newton, since

he seemed to pose no religious threat and could be employed to respond to the rationalism of Descartes as well as Spinoza's attack on the authority and trustworthiness of scripture.

These last concerns are echoed in the contribution by Rienk Vermij, "Defining the Supernatural: The Dutch Newtonians, the Bible and the Laws of Nature" (chapter 7). Vermij argues that the Dutch fascination with Newton (in his various guises) was occasioned by a complex social and intellectual context (1) to find an answer to the confessional strife of the seventeenth century, (2) to respond to and find an alternative to Cartesian philosophy, and (3) to deliver a decisive blow to Spinoza. It was a search for "social and religious peace" in which some form of harmonization would hold. But "in the end the issue that mattered most was the authority of the Bible. Purely philosophical problems were secondary" (p. 186). Was there a way of understanding the relation between God and nature which gave reassuring answers to both scientific and religious demands?

A complex "cocktail of ideas" and practices are adduced by Vermij: (1) invoking universal gravitation (nonmechanical forces) meant mechanical principles could not explain everything (a direct appeal to Newton's 2nd edition of the *Principia* and particularly Roger Cotes's preface to this edition); (2) an argument from design and the rise of physico-theology; (3) a long tradition of experimental philosophy which challenged Cartesian speculation and Spinoza's thorough geometrical way of reasoning; and (4) an element of theological voluntarism. Newtonian natural philosophy seemed to offer a way to maintain an active divine presence which encouraged a search for "a definition of laws of nature which left room for divine miracles" (p. 191).To deny the reality of miracles implied a denial of the biblical narrative and an undermining of all religion. But in the search for this definition, they, as well as many moderns, face a paradox: the supernatural was defined, delimited, circumscribed by what people deemed to be natural, explainable, nonmiraculous, and scientific.

This book is one for readers with a keen historical interest. Reading it carefully, along with the extensive research that supports the theses advanced, will make one more aware of how theories function in complex social, intellectual, and ecclesiastical contexts. Historical echoes of this eighteenth-century struggle are all around us today in our deliberations about evolution, miracles, and natural law.

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ORIGINS

EXPLORING FAITH AND REASON: The Reconciliation of Christianity and Biological Evolution by Bruce Glass. Houston, TX: DBG Publishing, 2012. 296 pages. Paperback; $13.25. ISBN: 0578110474.

I had high hopes when I began Bruce Glass's book, *Exploring Faith and Reason: The Reconciliation of Christianity and Biological Evolution*. Part 1, entitled "Christianity and Evolution," lives up to the title. Here, Glass skillfully defends a belief in a personal God and the divinity of Jesus in light of the evidence for evolution. Parts 2 and 3, "The Theory of Evolution" and "The Evidence of Evolution," comprise over half the book and give a broad overview of the overwhelming evidence supporting evolutionary theory. Although Glass claims to have written a book for people of all views, the majority of the book speaks to Christians who are unfamiliar with evolutionary theory and the evidence supporting it. These sections are probably less interesting to *PSCF* readers, as most will be well versed in this science already. Part 4 goes through the history of "intelligent design" theory and creationism in the United States, and the misuse of Darwinism to defend racist delusions. While these chapters are interesting to those who want to have a fairly comprehensive overview of the important role of Darwinism in our society, they contribute little to the book title's goal of showing that faith and evolution are altogether compatible.

Part 1 discusses how God's providence and transcendent nature are fully compatible with biological evolution. Glass first notes that "Christianity declares that the physical universe is separate and apart from God" (p. 50). God created the universe and is therefore above, not part of creation. Glass quotes Thomas Aquinas who described God as the "first cause" because God created the physical universe from nothing, and that anything within that creation can happen as a result of "secondary causes." This perspective allows for an independently changing natural world with space for biological evolution, evil, and the "free will" to accept or reject God's grace by confessing Jesus as Savior. Glass notes,

> Christianity teaches us that the natural world, therefore, is the foundation or the platform from which we must rise and exercise our free will in accepting and obeying the call of Eternal Truth … He is active in our own lives when we invite him into them. But we know that God is not in direct control of everything that happens in the world … because such a notion would implicate him as an

> accomplice to the evil that we see around us and that we perpetrate. (pp. 67–68)

Glass explains that this idea hinges on the premise that the Bible is not a scientific encyclopaedia but rather a collection of divinely inspired writings in which the character of God and his plan for humankind is revealed. The narrow literal interpretation of the Bible and of the six-day creation story in particular precludes acceptance of natural causes of the living world. Glass talks about the unprecedented literalism in scriptural interpretation, starting with the Reformation and having taken firm roots in certain groups of Christian believers. He argues that more truth can sometimes be gleaned from allegorical interpretations of certain passages in the Bible, and that Jesus himself used many parables to reveal deep truth. He reminds us that we do not need science to confirm our belief in God. Likewise, no scientific discovery can refute the existence of God because the Christian God is incomprehensible and not constrained by creation.

I enjoyed reading this section as it provides a fresh and compelling case for reconciling faith and science. Glass's tone is pleasant. He describes himself as an agnostic and therefore an impartial observer, refraining from cringeworthy rhetoric that one often finds in books on either side of the topic.

In Parts 2 and 3, the author shares the most important cases supporting the theory of evolution and explains the scientific method. While this broad overview is written in concise and generally accessible prose, most chapters are disappointing for several reasons.

First, Glass's attempt to be comprehensive resulted in a long list of various lines of evidence for evolution and natural selection that lacks clarity and depth. An explanation of the imperfect "design" of the human eye covers almost two pages. After reading it a second time, I did not learn much more than that the light-sensitive rods of the retina are located behind the nerves and blood vessels, which is imperfect from an engineering standpoint. I found myself wishing that more explanation was given as to what evolutionary steps led to this imperfect design.

Second, the cover of the book shows the DNA helix, which refers to one of the most important revolutions in the history of science—the advent of molecular biology and its rapid progress in recent years. Glass chose to be light on genetics and molecular biology, though he does give a list of genetic evidence in his chapter entitled "Tree of Life." A figure would have been helpful to explain some of these difficult but very compelling cases (similar to the way Francis Collins illustrates the relationships between very different vertebrates based on chromosome anatomy and genome structure in his excellent book, *The Language of God*). This is a missed opportunity because molecular evidence for evolution and the signatures of our evolutionary past in our genomes is absolutely stunning, but it requires more explanation to appreciate its significance.

Third, the book is flawed with respect to several important biological concepts. For example, genetic recombination does not occur only when germ cells fuse and parental chromosomes combine, but also during meiosis by chromosomal crossover. Also, Glass discusses Darwin's book *Pangenesis* in which Darwin reintroduces the old Lamarckian idea of the inheritance of acquired characteristics. He goes on to describe it as Darwin's "great blunder" (p. 107). Although Darwin was indeed wrong about the precise mechanism of inheritance and his theory was highly speculative, some of Darwin's pangenesis principles do relate to heritable aspects of phenotypic plasticity. It has been known for a long time, and recently more widely accepted, that characteristics acquired during life, resulting from environmental or social stressors, can be transferred to the next generation without necessarily altering the DNA code but by the way genes are activated. This so-called epigenetic transgenerational inheritance adds an entirely new dimension to understanding evolutionary change, and perhaps Glass chose to ignore it to make his case more concise.

Throughout the book, Glass accumulates a lot of evidence supporting evolutionary theory, which is not difficult because there are "Clues All Around," as the title of chapter 7 says. He refrained from laying out some weaknesses of the theory that are often overlooked by the majority of scientists. The enormous complexity at many levels of biological organization, ranging from complex cellular processes to the working of the human mind, is truly amazing. Showing evidence that this was formed by spontaneous events and the forces of evolution—and the evidence is indeed overwhelming—is not the same thing as explaining exactly how such a complex structure or cellular process evolved. In other words, we have evidence that all life shares the same origin. We also know how genes and characteristics change at the molecular level, but we cannot revisit our evolutionary past. While Glass refers to this issue, I found myself wishing he had taken a stronger stance against the arrogance with which the evidence is often presented—as if scientists have or will have all the answers to life's problems and questions.

Finally, evolutionary theory can only illustrate how life changed and diversified over time. It cannot explain how life came into existence. While Glass acknowledges this, I would have preferred a more explicit statement that we do not know how self-replicating entities evolved from nothing. I am always surprised to hear that most people think that science has all the answers, in spite of introductory biology textbooks being very clear about this. More generally, I am not proposing that we imply divine action in this or that area where scientific understanding is currently lacking ("God of the gaps" approach), nor am I negating the evidence for evolution. I think Glass could have presented a more balanced case, clearly pointing to areas where science does not have all the answers to date.

In Part 4, "The Politics of Evolution," Glass covers a brief history of creationism and the ID movements. The last chapter entitled "Darwinism" talks about the misuse of Darwinian theory. Herbert Spencer coined the phrase "survival of the fittest" and took it to the next level by claiming that the poor were unfit and inferior. Darwin's half-cousin Francis Galton came up with eugenics. His idea was supported by many prominent people including Winston Churchill, Theodore Roosevelt, and Adolf Hitler. Glass notes that "Today, thankfully, such ideas are seen as horribly immoral" (p. 266). This part of the book is an interesting read and places Darwinism in a more historical perspective.

Glass's compelling case for evolution's compatibility with Christianity in Part 1 of the book is an enjoyable read. The remainder of the book is a fairly comprehensive introduction to evolutionary biology; it might be of benefit to those who are unfamiliar with evolutionary theory and the evidence that supports it but not as compelling as other books on evolution. However, the fact that the evidence is presented by an impartial observer makes it suitable to readers of all viewpoints.

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BIOLOGICAL INFORMATION: New Perspectives
by Robert J. Marks II, Michael J. Behe, William A. Dembski, Bruce L. Gordon, and John C. Sanford, eds. Hackensack, NJ: World Scientific Publishing, 2013. 584 pages. Hardcover; $178.00. ISBN: 9789814508711.

This volume contains the proceedings of a symposium held May 31, 2011, through June 3, 2011, at Cornell University. Since the famous 1967 Wistar Symposium on "Mathematical Challenges to the Neo-Darwinian Interpretation of Evolution," the mathematical and biological challenges posed to the modern evolutionary synthesis (neo-Darwinism) have not been resolved. As far as I know, this symposium is the first to address these challenges, incorporating the intelligent design perspective as a possible *scientific* approach. All contributors are active researchers from reputable institutions who question the conventional perspective of neo-Darwinism that natural selection accompanied by mutations is capable of generating new information in the biosphere.

Section One: Information Theory and Biology
The first authors define biological information theoretically as what enables the narrowing down from prior uncertainty to later certainty. Using human language as an analogy, Oller suggests biological information has to be generated and comprehended by intelligence. Random mutation and natural selection lead to pruning of pre-existing content. Basener applies mathematical dynamic modeling analysis to evolution based on an extinction of human civilization and in vitro Qβ replicase experiments. They predict that either evolution runs its course to the equilibrium or the system will continue to repeat some state infinitely often. As a result, no new information is generated.

Ewert, Dembski, and Marks II examine the computer program Tierra that simulates the creation of artificial life with evolution. It is characterized by an initial period of high activity producing a number of novel adaptations followed by barren stasis. New functional instructions are generated but these are dwarfed by the size of other changes. Long-term evolutionary progress is dependent on the generation of new information as exemplified in the Cambrian Explosion, which is not explainable by the Tierra model.

Montañez, Marks II, Fernandez, and Sanford demonstrate that DNA in higher genomes is often optimal and poly-functional with nucleotides being used in overlapping genes. Thus, using analyses of the balance between beneficial versus deleterious mutations and the multidimensional analogy with crossword puzzles, beneficial mutations necessary for directional evolution are extremely rare. Sewell addresses the thermodynamic improbability of an open earthly system amenable to evolution from molecule to human. While this may be an argument of the improbability of building order, the need for capturing sunlight energy into usable biological energy is the crucial challenge to abiogenesis. McIntosh contrasts bottom up, materialist, emergence models with top down, nonmaterial, constrained models. He aptly identifies the weakness of the former models as the need

for the conversion of free energy in an open system into usable biological energy necessary for the compensation of the increasing disorder of earth, namely, conversion of sunlight energy into ATP by a machine such as chlorophyll. He proposes the third model in which nonmaterial information constrains the local thermodynamics to be in a non-equilibrium state of raised free energy.

Section Two: Biological Information and Genetic Theory
Wells presents evidence for the functionality of nonprotein-coding DNA to refute the concept of "junk DNA." This includes pervasive transcription of the genome, conservation of many nonprotein-coding sequences, sequence-dependent functions of RNAs transcribed from introns, pseudogenes, repetitive DNA, functions almost independent of the exact nucleotide sequence, chromatin topology in gene expression and centromere placement, and the light-focusing property of heterochromatin in inverted nuclei.

Sanford and others use numerical simulation of evolution by random mutation and natural selection by a population genetics program, Mendel's Accountant. Applying realistic levels of biological noise such as the actual mutation accumulation with the H1N1 influenza virus, they show an ongoing accumulation of low-impact deleterious mutations, with deleterious mutation count per individual increasing linearly over time that will not generate new information. Typical functional nucleotides in a large eukaryote genome have contributions to fitness much smaller than is necessary for the origin of these nucleotides. They contrast their results with another evolutionary simulation program, Avida, which leads to production of genetic information by the neo-Darwinian mechanism of mutation and natural selection. The apparent disparity between the two programs results primarily from differences in default settings. When settings reflecting biological systems are applied to both, they reveal barriers that can prevent the progressive evolution of novel genetic information. The theories of mutation count and synergistic epistasis that accelerate selection against deleterious mutations are falsified with realistic biological conditions. To demonstrate the efficacy of their Mendel Accountant simulation program, they report that it models the observations that most strains of influenza appear to routinely go extinct because of natural genetic attenuation due to mutation accumulation in recent viral outbreaks in Asia and Africa.

Seaman compares the human genome with computer codes. Data visualization reveals that executable codes regularly make extensive use of tandem repeats that exhibit similar visual patterns in higher genomes. These suggest convergent evolution constrained by design algorithms. Johnson presents the new fields of biocybernetics, the study of life's hardware and software systems, and biosemiosis, which studies biological systems made of two independent worlds connected by the conventional rules of a code. He uses the artificial synthesis of a bacterium by Craig Venter's team to illustrate that when the operating system (DNA) was replaced, the interacting computers in the cell (ribosomes, ER, etc.) remained intact and were able to function by using the replacement software. Thus, neo-Darwinian theory needs to provide scientific explanations of the origin of cellular information compatible with information science.

Section Three: Theoretical Molecular Biology
Macosko and Smelser present recent evidence that the Standard (genetic) Codon Table is optimally tuned for the transmission and maintenance of biological information. If design is considered without materialistic bias, the discovery and future research of its optimization may be accelerated as compared to the discovery of the Rosetta Stone in deciphering hieroglyphs. Dent proposes that the high fidelity and efficiency of intracellular processes and the molecular motion in the cytoplasm is not truly random, but is vibrationally directed and coherent due to a community of oscillator structures within chromosomes and proteins. Even though no surface vibrations were detected by laser-Doppler vibrometry in living cells, DNA vibration evidence may suggest future productive research.

Behe examines experimental work in recent decades and current genomic studies of adaptation in natural populations. They attest to the importance, even dominance, of loss-of-function mutations in short-term evolutionary episodes, thus threatening the progressive evolution of new traits that depend on the accumulation of gain-of-function mutations. Wells reviews the evidence that two- and three-dimensional information-carrying patterns in membranes are likely to entail more specified complexity than the one-dimensional information in DNA sequences, making beneficial "mutations" in such patterns much less probable than beneficial mutations in DNA.

Axe and Gauger review the systematic difficulties that a bottom-up Darwinian process of a metabolic pathway faces, from the multiple levels of gene expression to causal metabolic interactions networks. They propose tentative principles that assume a top-down paradigm consistent with biomimetics, reapplying biological innovations in human technology, and sys-

tems biology, performing measurements on whole systems instead of their isolated parts to replace it.

Section Four: Biological Information and Self-Organizational Complexity Theory
Noted self-organization theorist Stuart Kauffman boldly proposes that no law entails the detailed evolution of the biosphere and the end of a physics worldview. He uses self-organization as a kind of "natural magic." The spontaneous assembly of molecules interacting with selection creates the biosphere. It seems to echo James Shapiro's natural genetic engineering, a form of vitalism.

Finally, acknowledging the challenges posed by developmental biology and the evolution of complex systems, Weber advocates an emergentist position, in which both the upper and lower levels are with causality. He and Kauffman seek a possible fourth law of thermodynamics and see progress being made under the Darwinian Research Tradition. He seems to represent the paradigm of current thinking in meta-evolution that emphasizes the evolution of mechanisms that assist evolution.[1]

This volume is a milestone in the scientific discussion of the origin and development of biological information not encumbered by a commitment to methodological naturalism (MN). Even though many Christians believe that a commitment to MN is not the same as a commitment toward philosophical naturalism, some argue that in the realm of origins science, philosophical commitment directly influences the direction of research.[2] Since MN is a *provisional* and not a *necessary* requirement for scientific research,[3] this volume should serve as a stimulus for others who question the efficacy of neo-Darwinism to persist in their effort to find new solutions in the controversial origins of biological information.

Notes

[1]L. Caporale, *Darwin in the Genome: Molecular Strategies in Biological Evolution* (Columbus, OH: McGraw-Hill, 2003).
[2]P. Pun, "Response to Professor Alvin Plantinga's article on 'When Faith and Reason Clash: Evolution and the Bible,'" *Christian Scholar's Review* 21, no. 1 (1991): 46–54; N. Geisler and J. K. Anderson, *Origin Science: A Proposal for the Creation-Evolution Controversy* (Grand Rapids, MI: Baker, 1987).
[3]A. Plantinga, "Methodological Naturalism?, Part 1 and Part 2," *Origins and Design* 18, no. 1 and no. 2 (1997), http://www.arn.org/docs/odesign/od181/methnat181.htm; http://www.arn.org/docs/odesign/od182/methnat182.htm.

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Religion & Science

IN PRAISE OF DARWIN: George Romanes and the Evolution of a Darwinian Believer by J. David Pleins. New York: Bloomsbury Academic, 2014. xviii + 294 pages, chart, appendix, notes, bibliography, index. Paperback; $34.95. ISBN: 9781623565947.

Some books do not fit neatly into genre categories. J. David Pleins offers us an excellent example of a multidisciplinary work with *In Praise of Darwin*. It is part history, part literary critique, part philosophy, and part theology.

The book begins with a chapter exploring the personal history of George John Romanes. Romanes, a lesser-known figure amongst the giants of Victorian science, was the youngest of Darwin's close friends, and the heir apparent to Darwin's work at the time of his death. The opening chapter sketches Romanes's personal struggle with faith and his relationship with Darwin. Stricken by grief and existential angst after the death of his mentor in 1882, Romanes crafted over the following years a 50-page *Memorial Poem*, wherein he struggles through the questions of life, death, love, and faith.

Pleins found the full version of this poem, long thought to be lost, and has published it here for the first time. The heart of *In Praise of Darwin* is a five-chapter, poem-by-poem exposition of the composite *Memorial Poem*. Pleins calls the whole piece "one of the most daring treatments of the relationship between faith and science to come to us from the nineteenth century" (p. 14). The savvy reader, after the opening chapter, will not proceed directly to chapter 2, but will flip to the book's appendix and read the full *Memorial Poem* to experience the raw passion and power of the piece at once.

Chapters 2–5 each explore a different theme that groups the short poems of the larger work into sections. Chapter 2 explores the poems relating to Darwin's funeral in Westminster Abbey, which serve to shed further glory on the already-immortal figure of Darwin. Chapter 3 contains poems of the passionate struggle with the finality of death, including what Pleins calls an "anti-sermon on greatness and grief" in which Romanes chastises those who extolled from pulpits Darwin's great accomplishments without having known or loved the man behind the work. These reflections lead naturally into chapter 4 on the nature of fame. To pursue it is folly, yet—paradoxically—fame still stands as a sure marker of greatness.

Chapter 5 expounds upon the poems that emerge from Romanes's return to Down House a year after Darwin's death. Once again he struggles through his profound sense of loss and the emptiness of the world without his beloved mentor. Yet, he realizes that now he sees nature through Darwin's eyes, with evolutionary lenses. Thus Darwin lives on and nature is enlivened anew.

The reader, at this point, will emerge with a rich picture of the private sides of both Romanes and Darwin. Particularly evident is Romanes's passionate hero-worship of Darwin, and the momentous effect of his death. These are not philosophic treatises on the relationship of science and religion; they are a poignant reflection on the nature of grief, love, life, and death. Each short poem is divided from the others by Pleins's commentary. His exposition is interspersed with contextual details, short anecdotes, and letter excerpts that help illustrate what Romanes might have been alluding to in his poetic musings. Yet much of the commentary is simply breaking down the poem:

> With "Reason" as the anchor, the unsettling "chaos" of line 2 is tamped down by the steadiness of "calmness" of line 3. The poet scatters throughout the quatrain a smattering of "s," "sh," "c," and "ck" sounds, like so many bricks strewn around a collapsed building. (pp. 171–72)

Chapters 6 and 7, however, contain perhaps the most interesting parts of the book for the scientifically minded reader. Chapter 6 contains the last part of the poem, in which Romanes reflects openly on the question of natural selection and the ubiquitous suffering in the evolutionary process. He anticipates, by more than a century, Holmes Rolston III's concept that nature's suffering is "cruciform"—that the great goods of evolution emerge directly out of the great harms, and that this emergence is analogous to the redemption found in the death and resurrection of Jesus. He ends with a vision of science and religion as bride and groom and recognizes that great mystery is involved in every part of the human search for truth.

Chapter 7 moves on from the *Memorial Poem* and traces Romanes's ongoing struggle between rationality and faith, both in the public sphere and in the private. Drawing from letters, poems, articles, and lectures, Pleins presents the most sensitive and nuanced account of Romanes's inner journey now in print.

If one small criticism is to be made, it is that where other historians have been too quick to dismiss Romanes's journey toward theism (such as Frank Turner and Joel Schwartz), Pleins presents sometimes too unproblematic a view of that journey. Pleins does not make enough of Romanes's statements of disbelief, at least not in the main text. The nuance of the poet's doubt is left largely to those who delve into the detail of the endnotes and have access to compilations of Romanes's letters. And, occasionally, Pleins downplays the importance of the shocking nature of some of the doubts Romanes expresses in his *Memorial Poem*. For example, when Romanes claims "Love, thou art God, and God is love," and two poems later writes, "Almighty Death! … love made not thee; thou madest Love," the implication that Romanes is saying that God is simply the creation of the human response to death is not perceived.

Some will want to read this book because of the poignant reflections on grief and loss. Some will be enriched by Romanes's vision of the compatibility of science and religion. Others will appreciate the light it sheds on Romanes's much-contested faith journey. Whatever else this book achieves, historians will now have to include the *Memorial Poem* as Romanes's fourth great theological work, alongside the other already-recognized three: *Christian Prayer and General Laws, A Candid Examination of Theism*, and *Thoughts on Religion*.

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THE BODY OF FAITH: A Biological History of Religion in America by Robert C. Fuller. Chicago, IL: The University of Chicago Press, 2013. 231 + xiv pages. Hardcover; $35.00. ISBN: 9780226025087.

The first blurb on the dust jacket asks: "What would a history of American religion look like if it were grounded … in the genetics, hormones, sexual organs, bilateral structures, and sensorium of the human body? That is precisely what Robert C. Fuller gives us …" (Jeffrey J. Kripal). The expectation was not fully met, and could not have been at this time, because we do not yet know enough. But Fuller has made a worthy attempt.

This volume is part of the Chicago History of American Religion series. I am not a historian, but even this biologist has heard of the work of the University of Chicago on the history of religion in the US.

Body of Faith is about Christianity, and religions related to Christianity, in the US. It barely mentions Canada and other parts of the New World, or Native American religions, in spite of the subtitle. With these limits, it does describe much of the important history of religion in America.

The author says little about the supernatural aspect of religion. Instead, he is concerned about the political, social, psychological, and geographical influences on belief. He is convinced that religious behavior, at least in part, is the result of natural selection. The title, like the blurb quoted above, implies that the book will show that diet, blood pressure, and the like also influence religious belief and practice. They probably do, but the author's case is not strong. He dwells on emotions and sets considerable store on their influence. "Distinct emotions have distinct biological functions …" (p. 39) but "identifying specific emotions, however, is neither easy nor precise" (p. 39). That is an understatement.

The discussion of the history of the Mormons was fascinating. As Fuller says, "The Latter-Day Saints were bold and adventurous," and had "little … concern for conformity …" (p. 66). But that does not describe them now. Why? Fuller does not have a solid biological explanation for this. But he does say that Joseph Smith, the founder, inspired awe, an emotion, and that there may have been selection for conformity among Mormons as time passed.

Fuller also discusses the history of the Great Awakening and the Second Great Awakening. He mentions African-American religious practice. He realizes that more women than men are involved in religious bodies, and suggests that the reason has to do with the desire for stability, which is stronger in women than in men. Religious practice is usually comforting and provides a sense of security.

Fuller writes about the decline of liberal church attendance and the increase in attendance in more-conservative churches, attempting to explain this by our need to be bonded into social units. He considers the relatively high level of participation in religion in the US, compared to Europe, and concludes that people in the US are under more stress than they are in the Old World. This seems highly speculative.

The book has an appropriate scholarly apparatus with lots of notes. But the author does not always treat his sources well. On page 49, the author quotes Charles Grandison Finney, noted revival preacher, as saying that a conversion "is not a miracle or dependent on a miracle in any sense … it consists entirely in the right exercise of the powers of nature." Yes, Finney said that, but, in the original, Finney was not discussing conversion, but revival. In the same lecture, Finney also said,

> Religion is the work of man. It is something for man to do. It consists in obeying God with and from the heart. It is man's duty. It is true, God induces him to do it. He influences him by his Spirit, because of his great wickedness and reluctance to obey. If it were not necessary for God to influence men—if men were disposed to obey God, there would be no occasion to pray, "O Lord, revive thy work." (Finney, *Lectures on Revivals of Religion*, Lecture I; Public Domain, http://www.ccel.org/ccel/finney/revivals.iii.i.html)

The author's statement indicates that Finney believed that all that was necessary for conversion was to manipulate the emotions. However, Finney clearly believed in the necessity of God's supernatural work, based on the second quotation from the same work. Finney's point was that the church should not sit back and expect God to revive it, but that the church should do those things that lead to revival, so that God can work. Fuller took a few words out of context to support his thesis, when the original source does not.

As another brief example, on page 90, Fuller says that the book of Revelation portrays the Antichrist. Not by name, it does not.

The book is a decent enough history of religion in the US. The author's idea that our emotions, and even our genetic history, may influence our religious practice is probably valid, at least to some degree. It is also true that the rituals of religious practice (whether formal or informal) are important. Movements and utterances by participants and the sense impressions accompanying various activities within a church probably influence us to become part of a religious body and to stay within it. Fuller is to be commended for pointing all of this out. But that should not be the whole story of Christianity, and the book almost leaves the impression that Fuller believes that it is. In closing, Fuller does admit that there may be real and supernatural influences on us: "Our experience of life thus hints at the possible—even probable—existence of some metaphysical reality." Indeed.

Body of Faith is not essential reading for most, but scholars and collections specializing in the history of religion in North America should consider it.

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A TROUBLESOME INHERITANCE: Genes, Race and Human History by Nicholas Wade. New York: Penguin Press, 2014. 288 pages. Hardcover; $27.95. ISBN: 1594204462.

Christians who work in science, especially in the biological sciences, are often at pains to explain to

other scientists and many of their Christian brethren how they reconcile their faith with their scientific worldview. When popular science writing conveys a distorted picture of science, it does not help the overarching issue of reconciliation of God's Book of Words with God's Book of Works. We are all familiar with the abuses of scientism in this regard, such as the fallacy of genetic determinism and the misuse of evolutionary science.

The new book by Nicholas Wade, *A Troublesome Inheritance*, is a troubling example of nonscience being used to bolster a bad idea. In particular, the book is a good illustration of the dangers of certain widespread misunderstandings about the science of evolution and genetics. Wade concludes that human evolution proceeded recently and divergently among "the three major races" and that such "genetic evolution" explains many behavioral differences, including, among other things, why Jews are smart and why western cultures are more technologically advanced than others.

In his review of human history, Wade claims that genetic changes were involved in major transitions. We are told, for example, that within the few centuries just prior to the Industrial Revolution, people in England genetically evolved to be less violent, more hardworking, and more trusting of government and strangers, while people in the Middle East remained largely tribal in their behaviors and Islamic civilization declined as a consequence. The proposed reason for this difference is that, in the Middle East, modern-state-compatible behaviors were not selected for because people lived under "largely predatory" regimes that "extract[ed] taxes from their citizens but provide[d] few services." How this circumstance was not true for medieval England is not clear, and of course the actual genes supposedly responsible for these changes are not identified.

In many parts of the book, what Wade claims to be a central concept is nicely refuted by his own writing. When it comes to the question of how many races there are, Wade usually refers to three or five "major races," and admits that it is possible to think of seven races. He even says, "the more DNA markers that are used … the more subdivisions can be established in the human population." It is not clear why Wade does not see this as a fatal error in his overall thesis. He is absolutely correct that the number of races defined by genetics is indeterminate and that fact renders the concept of racial biology meaningless. Furthermore, if one *were* inclined to divide the human population into three groupings according to genetic distances (F_{st}), they would not be Africans, Asians, and Europeans (as Wade says), but Africans, Australians, and everyone else, including everyone from Asia, the Americas, and Europe.

In his discussion of the genetics of populations, Wade follows a minimalist definition of evolution as an inherited change in allele frequencies in populations. Allele frequencies differ to various degrees among all populations, defined in any way one likes. Most people think of evolution as the mechanism by which new species arise from common ancestors (descent with modification), but this is emphatically not what Wade is talking about.

The fact that there is some extent of allelic frequency variation in the human population (though actually very little compared to other primates) does not in any way imply evolutionary changes leading to permanent divergence, which requires fixation of alleles in defined and usually isolated populations. For example, we know that chimpanzees and humans evolved from a common ancestor and that the differences between chimp and human behavior are understood to be genetically fixed and a result of evolution. From this, it follows—Wade tells us—that the differences in social behaviors between different human cultures are the result of genetic evolution too. But even Wade admits that none of the human allelic changes found between populations have become fixed; all of them are reversible, and they do not lead to permanent or significant alterations in the critical phenotype of any human population. The analogy to human/chimp evolution is scientifically absurd.

While it is true that Africans have some unique genetic polymorphisms (one of which was discovered by one of us[1]) and that the mutations allowing for malaria resistance and lactose tolerance in adults began as regional changes under strong selection, these examples of population-specific genetic alterations actually refute rather than support Wade's racially based evolutionary claims. Lactose tolerance began as local variants, but has spread over the globe, and is still spreading.

Among the most telling cases of self-refutation of Wade's hypothesis is the example he gives of African Americans losing the sickle cell trait SNP because malaria is no longer providing a strong selection pressure on this population. His example refutes the idea that Africans have undergone any sort of actual evolution, since within a very brief time span the proposed phenotypic segregation of Africans due to selection for the S allele in hemoglobin is being *reversed*. The same kind of malleability is true of

many so-called racial features such as skin color and body shape.

Human populations have been on the move and intermixing for the past 50,000 years. While some human genetic isolates exist, they are rare and represent a tiny fraction of the total human population. Wade does admit that there exist some populations that he calls "admixed," such as the modern residents of Ethiopia who are genetically more European than African. But what he does not seem to understand is that all human populations are mixed—there are no genetically "pure" populations. The idea of a pure race is pure myth.

Wade speculates that Jews have undergone some kind of selection for genes conferring higher intelligence because some of them (actually the wrong ones) were bankers during the middle ages. Wade bases this absurd idea on a misunderstanding of the scientific literature. What the key paper actually showed was that by principal component analysis of 550,000 genetic markers, European Jews can be identified and differentiated from non-Jewish Europeans.[2] This does not mean that Jews differ in any allelic frequencies from other Europeans, only that familial relationships can be detected. It would be quite surprising if the results presented in the paper were not obtained, and they have nothing whatever to do with "evolution."

Despite being a respected science journalist, the author frequently fails to distinguish between scientific arguments based on data and conjectures that are not. Two examples illustrate this serious deficiency. Wade mentions and does not dispute the work of Richard Lewontin showing that there is less genetic variation between populations than between individuals regardless of what population they belong to. To counter this, Wade cites Sewall Wright, as quoted in a famous textbook.[3] The very same textbook clearly indicates that the total average human F_{st} is less than that of different villages within the Amazon tribe of the Yanomamö, confirming Lewontin's point. Neither the textbook's authors nor Wright disagreed with Lewontin's conclusions on the relative importance of genetic diversity within compared to between populations.

The use of pseudo-scientific arguments to advance philosophical and political agendas is quite familiar to most readers. From eugenics to social Darwinism to some of the antitheistic arguments of the new atheists, the name of science has been misused to cloak questionable ideas in a mantle of unassailable truth. The Christian belief that all human beings are created equal in the image of God is a matter of faith and not a scientific statement; there is no scientific evidence to refute it.

Notes

[1]F. Crofts, G. N. Cosma, D. Currie, E. Taioli, P. Toniolo, S. J. Garte, "A Novel CYP1A1 Gene Polymorphism in African-Americans," *Carcinogenesis* 14, no. 9 (1993): 1729–31.

[2]A. C. Need, D. Kasperaviciute, E. T. Cirulli, D. B. Goldstein, "A Genome-Wide Genetic Signature of Jewish Ancestry Perfectly Separates Individuals with and without Full Jewish Ancestry in a Large Random Sample of European Americans," *Genome Biology* 10, no. 1 (2009): R7, doi:10.1186/gb-2009-10-1-r7.

[3]Daniel L. Hartl and Andrew G. Clark, *Principles of Population Genetics,* 3rd ed. (Sunderland, MA: Sinauer Associates, 1997).

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TECHNOLOGY

THE GLASS CAGE: Automation and Us by Nicholas Carr. New York: W. W. Norton, 2014. 288 pages, notes, index. Hardcover; $26.95. ISBN: 9780393240764.

Nicholas Carr, author of popular technology books including *The Shallows*, *The Big Switch*, and *Is Google Making Us Stupid?* preaches another sermon in *The Glass Cage*, his newest book about technology. He echoes millennia of concerns about the detrimental effects of technology on humans if we continue to lunge full steam ahead toward a future of unintended consequences. Carr's sermon ends with a poem. That reminded me of classical Chinese thinkers who valued harmony with nature as more important than conquest of nature, and therefore elevated poetry over technology and mathematics.[1]

Only recently have Western philosophers criticized technology. Aristotle "argued that slaves and tools are essentially equivalent" (p. 224). But he was in favor of both. Adam Smith in 1776 claimed that because of industrial machines, laborers would lose "the habit of ... exertion, and generally become as stupid and ignorant as it is possible for human creatures to become" (p. 106), but he also claimed that the machines would bring workers "convenience and luxury" (p. 22). Alfred North Whitehead a century ago encouraged the use of "technological aids" (p. 65) to free hands for greater dexterity, to free minds for richer intelligence and decision making, and to free souls for a broader perspective (p. 66). But today the

human is the clerk and the automated system is the decision maker (p. 66). Carr asks, "What if the cost of machines that think is people who don't?" (p. 113).

Carr details his complaint in at least three areas. First, in controlling a plane or car—or in wayfinding in general—automation results in humans losing skills. Pilots "without their digital assistants … feel helpless" (p. 12). New generations of Inuit who find their way across the tundra using GPS lose their ability to find their way without automation. They die when their GPS dies (p. 126). Second, computer-aided architecture gives way to an inhospitable style called "parametricism" that begins with the CAD software instead of beginning with insight and pencil sketching (p. 140). Third, computerized medicine actually hinders evidence-based practice of medicine. When a physician diagnoses a patient based on electronic medical records, she loses the ability to grasp how thick the patient's file is, how many different hands have prepared it, and how intensely each contribution is or is not made—all tacit clues that inform her judgments.

To keep workers thinking, claims Carr, we must design tasks that involve moderate stimuli—neither unusually weak nor unusually strong stimuli. Psychologists Yerkes and Dodson discovered over 100 years ago that mice learned best in such an environment (p. 89). We must promote "human-centered automation," which, thanks to regular feedback, is "adaptive," keeping "the operator at the peak of the Yerkes-Dodson performance curve" (pp. 164–65). We must limit technology (p. 154). We must avoid "an almost religious faith in technology" (p. 160). We must not allow computer programmers to "legislate" what should be automated (p. 161).[2]

But who is this "we"? In the case of Inuit wayfinders, Carr is clear: The "tribal elders" decide. Carr is rightly concerned about Big Brother deciding for us (p. 194). He fails to offer examples to support his concern that technology can be used for evil. I offer a strong example: Adolf Hitler used tabulating machine cards—the height of technology of his time—to track Jewish families marked for destruction.

Carr admits that ethical issues can challenge a pluralistic society. A Roomba automatic vacuum cleaner, for example, is an ethical robot in the sense of Isaac Asimov's Three Laws of Robotics because it harms no humans, but not ethical for a Jainist because it harms insects (p. 185).

Initially Christians were optimistic about technology. Carr gives as an example Sir Francis Bacon's seventeenth-century utopian novel *New Atlantis*. In recent decades, however, Christians have been more pessimistic about technology. Readers of *PSCF* will be familiar with Michael Polyani and Jacques Ellul as two examples, although Carr mentions neither author. As early as 1953, Polyani warned us that although machines can model algorithmic knowledge, they overlook tacit knowledge—a point which Carr makes as well (pp. 9, 105, 144). Ellul worried that with technology "means … have established primacy over ends"[3] and Carr echoes the warning.

Christians know that work is not the curse of Adam. Carr agrees with Christians that work should bring joy and freedom (pp. 20, 232). But we miswant: "We're inclined to desire things we don't like [such as leisure] and to like things we don't desire [such as work]" (p. 15). The term "miswant" is only fourteen years old; the sentiment is as old as Romans 7, for we too easily sell our birthright of long-term gains for the mess of pottage that is immediate gratification.

The strength of Carr's book is that it is a lively, up-to-date, interesting, often first-person account of the problems that society faces in the "quasi-Darwinian process" (p. 173) of increasing technology. The weakness of Carr's book is that it is short on solutions. But that is true of most other accounts of our technological future. The book includes an index and endnotes, but a bibliography would have been helpful. If you do not already know what Carr has said repeatedly in blogs, news articles, and his previous books, then *The Glass Cage* is an excellent introduction to his passion for the right use of technology. He should say more about how we decide what that right use is.

Notes

[1]Frank J. Swetz, "How does a society support and nurture the growth of an intellectual discipline?" Lecture at Messiah College, Mechanicsburg, PA, March 4, 2010.

[2]Several books use the term "technological priesthood" instead of Carr's weaker term "technological legislators." For example, Robert C. Scharff and Val Dusek, eds., *Philosophy of Technology: The Technological Condition – An Anthology*, 2nd ed. (Hoboken, NJ: Wiley-Blackwell, 2014). They all credit Alvin M. Weinberg as coining the term "technological priesthood" in his "Social Institutions and Nuclear Energy," *Science* 177, no. 4043 (July 7, 1972): 34. In fact, that article contains the term "military priesthood," but not "technological priesthood."

[3]Jacques Ellul, *Living Faith: Belief and Doubt in a Perilous World*, trans. Peter Heinegg (San Francisco, CA: Harper and Row, 1983; Eugene, OR: Wipf & Stock, 2012): 86.

Reviewed by Gene B. Chase, Professor Emeritus of Mathematics and Computer Science, Messiah College, Mechanicsburg, PA 17055. ♦

A Different View of *Touching a Nerve* by Patricia Churchland

Patricia Churchland is the queen of eliminative materialism and a committed atheist. Why did *PSCF* review her latest book in the December issue (Churchland, "Touching a Nerve: The Self as Brain," *PSCF* 66, no. 4 [2014]: 259–61)? There are many good reasons! She is one of the most respected neuroscientists in America and received a MacArthur Fellowship for her work. This book is not just a rehash of her previous work; it presents fundamentally new philosophical stances for her. Previous work assumed that conscious thought was merely an epiphenomenon; Churchland joined many colleagues in adopting that stance. In this book, she presents the perspective that our conscious thoughts are real objects of investigation and denotes this position as "mental realism." This is a huge step forward for both Churchland and for the whole field of neuroscience. The full range of conscious experiences of actual humans is now under consideration.

While Christians often minimize the importance of our chemical and biological parts in a description of our mental and religious life, Churchland takes on this issue directly. Specific chemicals have demonstrable effects on human thought. She also acknowledges that specific thoughts have demonstrable influences on brain chemistry. This paradigm also applies to biological structures and human thoughts. She has important things to say to those of us who believe. Both biological and chemical influences must be taken into account when dealing with extreme religious experiences. Scripture admonishes us to "test" the spirits. When "visions" are the result of drugs, sensory deprivation or communal hysteria, scientists rightly point out the known and observable factors that are within their purview. God has graciously given us human bodies so that we can worship and serve him here on earth, but we must face the realities of being incarnated.

Human experience is highly complex, and there are many factors that enter into any actual historical situation. Scientists talk in terms of levels or worlds of discourse. The chemical level of description does not contain all the information that matters, any more than the biological or social. *Touching a Nerve* is the best popular book on the brain and human functioning yet written.

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♦

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"Upholding the Universe by His Word of Power" Hebrews 1:3