PERSPECTIVES on Science and Christian Faith

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Psalm 111:10

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Perspectives on Science and Christian Faith

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Gene Editing Lulu, Nana, and Their Children

James C. Peterson

He Jiankui announced November 25, 2018, that his lab had successfully edited the genes of two embryos to protect them from inheriting HIV from their father. He declared pride in the birth of Lulu and Nana, but many geneticists condemned his process, and now the Chinese government has declared it illegal. Why?

As readers of this journal will know, earthly life in all its variety has the instructions for form and function in its genes. When geneticists first found ways to change DNA, the initial techniques were rather clumsy and slow, but they could be deeply formative. Recombinant DNA was used to create human insulin that had never been in a human body. Instead of injecting diabetics with insulin from pigs, the DNA recipe for human insulin was edited into bacteria so that they followed the new instructions to make human insulin. For decades now, diabetics around the world have been staking their lives on it.

But the geneticists realized that these gene-editing techniques could also do damage, such as if they altered a common organism in the environment in a way that would sicken other life forms and possibly escape into the environment where it could multiply. In 1975, the founders of recombinant DNA gathered at Asilomar State Park in California, to develop safety guidelines that have been largely followed voluntarily ever since.

The change that came recently was the discovery of CRISPR, "clustered regularly interspaced short palindromic repeats." It is a natural defense system that bacteria use to defend themselves from viruses. Emmanuelle Charpentier, Jennifer Doudna, Zhang Feng, and others discovered that they could direct it with Cas-9 to find and cut DNA wherever they wanted. What was particularly noteworthy was that this could be done quickly, accurately, and inexpensively. The opportunities to use this in research—research that could lead to medical cures, but also to harms—were immediately evident. The US National Academy of Sciences, the US National Academy of Medicine, the Chinese Academy of Sciences, and the Royal Society called for a meeting of several hundred leading genetics researchers and a few advisers to think through how to best guide this new technique to positive use. The conference met in Washington, DC, December 1–3, 2015.

A one-page report was published and widely quoted, although it was overshadowed by a terrorist attack in the news that day. The communiqué reminded its readers that medical research has saved countless lives, and pointed out that this new technique of CRISPR would dramatically accelerate ongoing research. It then noted that using these techniques to help particular patients with harmful diseases seemed a reasonable use, in line with other medical care. It went on to say that therapies that could be inherited, hence affecting the patients' children and grandchildren, should not be acceptable at this time. The main concerns were that (1) future generations could not be consulted about the changes being made on their behalf, (2) it is difficult to project long-term effects, and (3) there was not yet widespread discussion and acceptance of the wider society. The agreement from the meeting was not that there would never be inheritable (germline) gene editing, but rather that it would not be attempted until safety was assured and a widely discussed societal consensus was developed. To build on that agreed understanding, ongoing meetings were held in Paris in 2016, again in Washington, DC, in 2017, and most recently in Hong Kong in 2018.

It was at the Hong Kong meeting that He Jiankui announced the birth of twins who had been gene edited to protect them from their father's HIV. As more details have trickled out, it seems more likely that the girls are genetic mosaics, so it is not clear yet that the intended purpose was achieved. What alarmed other geneticists was not that He Jiankui was trying to protect people from HIV, rather, that he had done so with disregard for the safeguards that had been widely agreed to for gene editing. He failed to "include strict independent oversight, a compelling medical need, an absence of reasonable alternatives, a plan for long-term follow-up, and attention to societal effects."[1] The consensus at the

conference was that germline editing could become acceptable in the future if it is shown to be safe for the recipient and if these procedural safeguards are followed. What was alarming was that He Jiankui had ignored the agreed upon guidelines and that others might be doing so too.

This situation has caught the attention of Beijing health authorities who have discovered other gene-editing attempts in embryos and adults, attempts that have been pursued without following up on those so treated, including after recipient deaths. *The Wall Street Journal* reports (December 29, 2018, A1) that Beijing officials have stated now that implanting a gene-edited human embryo is illegal in China. In contrast, it is not illegal in the United States. In the USA, such an experiment would not be funded by the federal government, but there are no legal limitations on this being pursued in private labs with their own funding. The academies and conferences described above have been counting on self-regulation, particularly to avoid clumsy government regulation. It remains to be seen if He Jiankui is an outlier who can be quickly directed back on track, or if he is a harbinger of many cases that will eventually come to light.

So what might be a Christian perspective on gene editing? The basic intention to heal disease was central to the earthly ministry of Jesus and so has always been at the center of the Christian tradition. Jesus taught not only to love God, but also to love one's neighbor as much as oneself. We certainly care about our own suffering and seek to relieve it, just as we should seek to relieve the pain and suffering of all those whom we are able to help. Christians have established thousands of hospitals around the globe and have invested millions of dedicated lives, in seeking to heal and prevent disease. To the degree that He Jiankui was pursuing the goal of preventing a devastating disease, there is good reason for a hearty amen from the Christian community. But the Christian tradition is also deeply aware of our human drives toward self-absorption, compounded by self-deception. The proffered safeguards are needed.

In particular, is there a challenge from the Christian community concerning making changes that are inheritable? It is the human condition that we make choices for our children. We decide for children what their birth citizenship will be, what food they will eat in their earliest years, and what language will be their native tongue; we vaccinate them against polio and whooping cough. We cannot help but make formative decisions on their behalf. Our choice is more in whether we will make such decisions well, not in whether we will make such decisions at all. If it comes to be shown that gene editing for the presenting patient, that is then inherited, is safe and efficacious to prevent a child and their children from getting HIV, then that seems a worthy use. For now, it has not been confirmed that gene editing is consistently safe for the presenting patients, let alone for the following generations. It will take time to be sure of that—much longer than for fruit flies or zebra fish. Hopefully, the quickly expanding group of people who can apply CRISPR-Cas techniques will follow consensus protocols to develop and implement it with care, or there will be a reaction of government regulation that could strangle much life-changing service before its full birth. ✧

Note

[1]Full statement at http://www8.nationalacademies.org/onpinews/newsitem.aspx?recordid=11282018b&_ga=2.86916507.283298593.1546974499-1513591976.1546530576.

James C. Peterson, *Editor-in-Chief*

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Bible Code, Revisited

Jason Wilson

Jason Wilson

After the Bible Code and its technical term, Equidistant Letter Sequences, was defined, its intriguing story spread in peer-reviewed publications and rose among Jewish and Christian intellectuals. A review of the evidence for and against the Bible Code follows, including the Statistical Science *journal debate, code in nonbiblical texts, code in randomly permuted texts, "mega-codes," code-testing protocol, the multiple testing problem, ambiguities in the Hebrew language and text, and word frequencies. It is concluded that while the faith of Bible Code proponents is admirable, the concept does not hold up to scrutiny.*

> *Moses went up to God, and the LORD called to him from the mountain, saying, "Thus you shall say to the house of Jacob and tell the sons of Israel … So Moses came and called the elders of the people, and set before them all these words which the LORD had commanded him." ~Exodus 19:3, 7*

> *All that was, is, and will be unto the end of time is included in the Torah, the first five books of the Bible … [A]nd not merely in a general sense, but including the details of every person individually, and the most minute details of everything that happened to him from the day of his birth until his death; likewise of every kind of animal and beast and living thing that exists, and of herbage, and of all that grows or is inert.*[1]
>
> *~Rabbi Vilna Gaon (1720–1797)*

Introduction

There has been a flurry of activity over the so-called "new discovery" of hidden codes in texts of the ancient Hebrew scriptures. The Hebrew word תורה (*Torah*) refers to the first five books of the Bible and the word is said to be encoded at the beginning and end of each of its books. Start with the first ת (*T*) in Genesis, go 50 letters to find ו (silent letter whose added vowel point makes (*o*)), then go fifty more letters to find ר (*r*), and finally fifty more letters to the ה (*h*). Thus, we have the word *Torah* "encoded" at the beginning of the first book of the Bible. This is called an "equidistant letter sequence" (ELS). Even more striking is that the same word occurs at the end of Genesis and the beginning and end of Exodus. The same occurs at the beginning and end of Numbers and Deuteronomy, except backwards.[2] This is an example of a Bible code.

The intrigue goes far deeper than single "encoded" biblical words, however. In 1994, Eliyahu Rips discovered the ELS of Israeli Prime Minister Yitzhak Rabin's name near the ELS "assassin will assassinate" (see fig. 2).[3] That year, he and journalist Michael Drosnin attempted to warn Rabin, who was assassinated on November 4, 1995.[4] Drosnin publicized the event in his book *The Bible Code* in 1997, which soared to number 3 on the *New York Times* bestseller list. The ensuing years saw the phenomenon uncritically picked up by the Christian community, with a number of pro-code Jewish and Christian publications, and few critics.

In this article I will answer the following questions in four sections: (1) What is the Bible code? How does it work? (2) Where did it come from? What is the story behind it? (3) What does the evidence

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say? (4) What does the evidence mean? Is the Bible code real? Can it really predict the future or prove divine authorship? Did Moses, the human author of the Torah, encode the word "Torah" on purpose or was it hidden there by God? I conclude with an observation on how Bible code can serve as a warning to those of us with religious zeal who seek to find God in our scientific work.

What Is the Bible Code?

The Hebrew alphabet does not contain proper vowels and the Torah was not written with them.[5] Therefore, the writing is briefer than English and subject to a higher degree of reading ambiguity. In addition, there was no capitalization and no punctuation. The language is such, however, that context easily indicates to the fluent reader what the words are. Furthermore, the writing was passed down in a tradition in which the exact meaning was explained, and large portions of the text were memorized. The correct interpretations of the words were passed on.

Converting the first sentence of the introduction to this article into a customary "window" for viewing Bible codes looks like figure 1. All punctuation and spaces are removed, and the text is strung together in columns of fixed length. Additionally, I have removed the vowels in order to sensitize English readers to the ambiguity inherent in vowel-free words.

The technical name for a single word or phrase in a Bible code is "equidistant letter sequence" (ELS). An ELS is found when you start with a given letter, then move a fixed number of letters to the second letter in a word, then the same fixed number of letters to the third letter, etc. For example, I have encoded "Torah" in the first sentence of this article as it appears in figure 1. It begins with the first letter, *T*, then 9 spaces to *R*, then 9 spaces to *H* (no vowels, see fig. 1). The fixed number of letters is called the "skip distance."

The rules for ELSs differ among code researchers, but are generally as follows:

1. An ELS may begin with any letter.
2. An ELS can go forwards or backwards.
3. An ELS can have a spacing of one to hundreds of letters; there is no theoretical upper limit, although some protocols have been developed which impose limits.
4. The spelling of words should follow an independent convention (e.g., dictionary).
5. There should be a method for discriminating between author-encoded ELSs and random ELSs.[6]

Bible code proponents believe that when ELS words or phrases overlap, the association between them is significant. For example, the Hebrew name for Jesus, *Yeshua*, is an ELS in our example that overlaps with "Torah."[7] This could be used to argue that "*Yeshua* is in the Torah." The most famous example of an overlapping code example is Eliyahu Rips's assassination of Prime Minister Rabin code, see figure 2. Therefore, for the purposes of this article, we will consider "Bible code" to be "the belief that God has put hidden messages into the Hebrew scriptures (at least in the Torah, but possibly in the rest) that are found as ELSs which, taken in proximity to one another, infer meaningful messages." Some codes are believed to refer to events, whether past or future, but there is no limit to that which codes may refer.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
T	H	R	H	S	B	N	F	L	R	R	Y	F	C	T	V	T	Y	H	W
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
V	R	F	L	T	V	R	T	H	S	C	L	L	D	N	W	D	S	C	V
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
R	Y	F	H	D	D	N	C	D	S	N	T	X	T	S	F	T	H	N	C
61	62	63	64	65	66	67	68	69	70	71	72	73							
N	T	H	B	R	W	S	C	R	P	T	R	S							

Figure 1. The first sentence of this article converted into a "window" or "cylinder" necessary to search for codes. Any number of columns and rows are possible, but here the window is 20 columns by 4 rows. This array enables us to see the cross between the two Hebrew words *Torah* and *Yeshua*. All spaces and punctuation have been removed, as in actual code searches of Hebrew texts. Vowels have been removed to simulate the ambiguity that vowel-free words create.

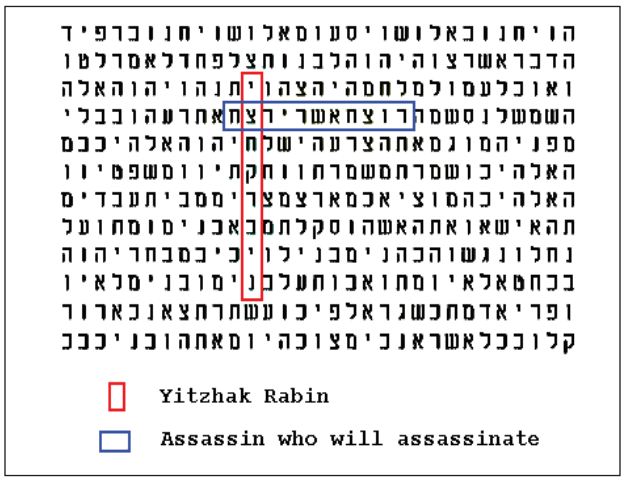

Figure 2. Taken from Michael Heiser, *The Bible Code Myth* (Self-published, 2001), 2. It is a 4,772-letter ELS!

Where Did the Bible Code Come From?

In order to best appreciate the evidence for and against the Bible code, we will trace the key parts of its history. This will provide context for the proponents and their arguments, which are covered in the next section. The terms "Bible code" and "Torah code" refer to the same thing, although Christian writers prefer the former, whereas many Jewish writers prefer the latter and believe that it is limited to the first five books of Moses.

The first-known Bible code has been traced back to Rabbi Bachya ben Asher (1255–1340). The concept was occasionally picked up by Rabbis over the centuries, manually discovering Bible codes. This enterprise culminated in the great Czechoslovakian Rabbi Weissmandl who survived the holocaust, but whose notes were destroyed. Israeli Avraham Oren was heir to the fruit of this work and became the first to search for codes with computers in 1982.[8] Oren passed his knowledge of Bible codes to Eliyahu Rips.

In 1985, Rips teamed up with Doron Witztum and Yoav Rosenberg. Around this time, the concept of Torah codes spread through the Jewish community because the Jewish educational outreach, Discovery Seminar, which was hosted around the world, added Torah codes as a topic.[9] After producing various Torah code results reported in Discovery Seminars, Witztum, Rips, and Rosenberg decided upon a scientific experiment to demonstrate the reality of the codes. They used criteria to fix names and dates of famous men of Israel throughout history to see if their occurrence in the Torah was at a statistically significantly higher incidence than expected by chance.

Witztum, Rips, and Rosenberg submitted their paper to *Statistical Science,* a top-tier statistics journal in 1988. Its extensive peer review, and mention at more Discovery Seminars, attracted the attention of mathematicians, statisticians, and cryptologists of the highest caliber.[10] One such figure was Harold Gans, then senior cryptologist (code-breaker) for the US National Security Agency. Gans was a skeptic who tested the claims of Witztum, Rips, and Rosenberg, found them to hold up, and became a believer.[11] Torah codes reached such a level of popularity that commercial software began to be produced.[12] The Witztum, Rips, and Rosenberg paper was finally published in 1994, adding a mark of scientific credibility to the growing industry.[13] Shortly thereafter, the nonreligious American journalist Michael Drosnin published his first code book in 1997, *The Bible Code,* which brought the subject into wider public recognition.[14] The following year saw *Cracking the Bible Code*[15] and *The Mysterious Bible Codes,*[16] which popularized the idea in the English-speaking Christian world.

Significant academic critics also expressed themselves with nonpeer reviewed papers posted on the internet, and poignant exchanges with code proponents.[17] In 1999, the first peer-reviewed academic criticism emerged: the *Statistical Science* response to Witztum, Rips, and Rosenberg,[18] followed by the first critical English book, *Who Wrote the Bible Code?*[19] Many other pro-code books were produced within the next six years, including two others by Drosnin. Despite the refutation, the phenomenon had taken root. The academic criticism eventually quelled the sensationalist claims of Drosnin and other code popularizers, and put the code researchers on the defensive.

In 2005, the code researchers went back on offense. Edwin Sherman, an actuary with an MA in mathematics, published *Bible Code Bombshell,* describing his skepticism and reluctant conversion.[20] That same year, Rips's first major English Bible code book appeared.[21] In 2006, the eighteenth annual International Conference on Pattern Recognition featured a number of pro-code papers.[22] Although the latest wave clarified pro-code research, the

arguments for the validity of the codes were still largely subject to the original critiques, and the critics in the academic mathematical community had largely moved on. Today, in light of the mathematical criticism, much of the sensationalism, including the predictions, has fallen away. Today, the Jewish Israel-based group and the Christian US-based group have both moderated their positions and withdrawn from academic outlets. Their work continues and is disseminated on their websites and through group contact.[23] New publications have tapered off, but the industry remains, including websites, options in Bible code software,[24] a Da Vinci Code-like thriller,[25] a code research society to join,[26] and even the prediction of Trump beating Clinton.[27] Only one other critical book has been published in English.[28]

What Does the Evidence Say?

Robert Kass, the executive editor of *Statistical Science* when the 1994 Witztum, Rips, and Rosenberg paper was published, wrote:

> [W]hen the article "Equidistant Letter Sequences in the Book of Genesis," by Witztum, Rips and Rosenberg, was examined by reviewers and editorial board members for *Statistical Science*, none was convinced that the authors had found something genuinely amazing … However, even though the referees had thought carefully about possible sources of error, no one we asked was willing to spend the time and effort required to reanalyze the data carefully and independently. Rather, we published the paper in the hope that someone would be motivated to devote substantial energy to figuring out what was going on and that the discipline of statistics would be advanced through the identification of subtle problems that can arise in this kind of pattern recognition … Thus, in introducing that paper, I wrote that it was offered to readers "as a challenging puzzle."[29]

In the paper, Witztum, Rips, and Rosenberg described an experiment whereby they objectively obtained the names of thirty-two great men of Israel throughout history and used a computer to search for their names and dates in the book of Genesis. They compared the Torah results against other Hebrew documents, and random permutations of Genesis. The higher occurrence of the name-date pairs in Genesis than in the other texts was highly statistically significant (p-value = 0.000002). This means there is a 0.0002% probability that, if there were no Torah code, these results would obtain. This scientific support, followed by the tragic prediction of the assassination of Prime Minister Rabin, undergirded the launch of an entire Bible code industry which might otherwise have been dismissed as textual astrology.

In 1999, however, Brendan McKay, Dror Bar-Natan, Maya Bar-Hillel, and Gil Kalai answered the challenge posed by *Statistical Science.* Editor Kass wrote,

> [McKay, Bar-Natan, Bar-Hillel, and Kalai] report their careful dissection and analysis of the equidistant letter sequence phenomenon. Their explanations are very convincing and, in broad stroke, familiar. They find that the specifications of the search (for hidden words) were, in fact, inadequately specific: just as in clinical trials, it is essential to have a strict protocol; deviations from it produce very many more opportunities for surprising patterns, which will no longer be taken into account in the statistical evaluation of the evidence. Choices for the words to be discovered may seem innocuous yet be very consequential. Because minor variations in data definitions and the procedure used by Witztum et al. produce much less striking results, there is good reason to think that the particular forms of words those authors chose effectively "tuned" their method to their data, thus invalidating their statistical test. Considering the work of McKay, Bar-Natan, Bar-Hillel, and Kalai as a whole it indeed appears, as they conclude, that the puzzle has been solved.[30]

In statistics, the problem is referred to as "overfitting." It means that the dependent variable (the name-date pairs) is such that it has a special match with the Genesis text so that if the names are slightly changed, but the protocol remains the same, then the phenomenon disappears. Of the thirty-two names, there are many spelling variants, actually producing about 298 name appellations. McKay, Bar-Natan, Bar-Hillel, and Kalai showed that using different spellings of the names in the name-date pairs no longer resulted in statistically significant findings when compared with other Hebrew texts, or a permutation of Genesis.[31] In addition to this, additional problems were raised by critics, including the non-intuitive and complex distance measure,[32] the failure to use reviewer Persi Diaconis's exact procedure for computing the statistics,[33] the absence of an alternative hypothesis which prevents the power of the Witztum, Rips, and Rosenberg test to be computed,

and a justification for selecting Genesis over other books of the Torah (the test does not show any significant effect in the other four books).[34]

If the Bible code were real, then non-overfitting examples should be able to be produced. They are not.[35] McKay, Bar-Natan, Bar-Hillel, and Kalai have shown that for other word lists, the results have the same chances in other Hebrew texts, including a permutation of the Hebrew Bible. That is not to say there are no other phenomena. There are many. It is just that the rules for finding overlapping ELSs make the probabilities of finding interesting results quite high. McKay searched for appellations of "Jesus the Nazarene" and "Jesus the Messiah" in Genesis, obtaining a probability of 0.172, meaning there is a 17.2% probability of obtaining these appellations in Genesis due to pure randomness (p-value). By contrast, for the first 78,064 letters of *War and Peace* (same number of letters as Genesis), McKay obtained probability 0.000001, which included the results in figure 3.[36]

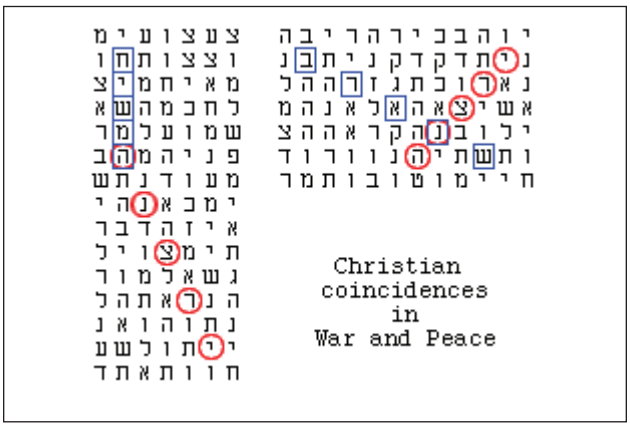

Figure 3. Brendan McKay code in the Hebrew translation of *War and Peace*, containing left to right: "The Messiah" crossing "The Nazarene" and "Son of Man" crossing "The Nazarene."[37]

Today's most mathematically responsible pro-code community consists primarily of the Israel-based predominantly Jewish group represented by Rips, and the US-based predominantly Christian group of Sherman. In what follows, for simplicity, I will refer to the position and arguments of both groups by the name of their representatives. It should be kept in mind that the leaders represent not only teams of people devoting time to finding Bible codes, but also a set of followers with code software who submit findings. The two groups' responses to McKay, Bar-Natan, Bar-Hillel, and Kalai differ in their approach.

Sherman's case is found on his website, which presents the current version of the arguments made in his 2005 book. He argues that McKay's comparable codes in *War and Peace* are out of date, because far more extensive (i.e., statistically unlikely) codes have been found since. He calls them "mega-codes." In other words, Sherman implicitly admits that the older, less extensive codes may not be real, but he argues that the newer and more extensive codes are real.[38] His primary example is the Isaiah 53 cluster, with 1,600 terms and a claimed probability of 1 in 1^{195}.[39]

While the picture and the numbers look really impressive, there is a statistical explanation. It is an example of data snooping, which suffers from the multiple testing problem. Rips himself, who does not believe in Torah codes outside of the Torah, indirectly suggests this of Sherman's work.[40] Sherman has not prespecified a scientific protocol prior to searching, but, rather, has included every word or phrase he can find that relates to Jesus which crosses the Isaiah 53 passage, thereby removing any meaningful reference for the small probability. Sherman seems to ignore this criticism, resting his argument on the weight of the impossibly small probability.

There is an additional problem with this result. If you take a random text, pick a passage and a topic, and search for words and phrases of any ELS related to the topic, you are guaranteed to obtain numerous "hits." I purchased the *Keys to the Bible* software for $55. Having heard that the name of "God" (not sure which name) was encoded repeatedly throughout the Book of Esther with skip distance in the 20s, I wanted to check it out myself. I searched for *Yahweh* and found hundreds of hits (greater than the expected number the program supplies), but no regular pattern throughout the book. Same with *Elohim* and *El*. I discovered that by playing around with different words of different skip distances from the electronic dictionary, most words appeared in numerous places. This is simply a result of the flexibility of the "rules" for finding code: any possible skip-distance, forwards or backwards, any words, and possible multiple spellings.

The approach of Rips's group is entirely different from that of Sherman's. They addressed the criticisms by strengthening their statistical procedure, as reported in their impressive tome, *Torah Codes*.

Although I believe its implementation is still flawed, this is the kind of scientific approach which could be used to discover such a code, if it existed. It begins with a seven-step protocol:

1. Select key word sets a priori.
2. Fix the ELS skip size range.
3. Determine the size of the window (cylinder) within which the search is conducted.
4. Prespecify the alternative text to be searched.
5. Select a measure of the minimum window (cylinder) for comparison.
6. Hypothesis test: "Null hypothesis of no Torah Code effect against an alternative hypothesis that the observed table in the Torah text (*D* = design) is significantly more compact than what would be expected to be observed by chance if there were no Torah Code effect (*M* = monkey/random)."[41]
7. Statistical Analysis Method: For the method, let *E* = evidence. We want to know the probability that the key word set appears by design, given the evidence, *P(D|E)*. Compute *P(D|E)* using Bayes's Theorem.[42]

The p-value is obtained from step seven for a pair of words as follows. Find the table in the Torah that has the smallest area, *A*. Then, for random texts *1, 2, 3, …, N*, find the smallest area of each of them. The p-value is the number of random texts whose smallest area is below *A*, divided by *N*.[43] If there are more than two words, there are two additional protocols. For the second protocol, with a priori words, they rationally use the longer words to set the size of the table. For the third protocol when there are more than two words, which words fix the table is not determined a priori. Instead, the size of the table is fixed, and the p-value is determined by the proportion of random texts which have equal to or more than the number of ELSs as the Torah table. This is essentially the first protocol, except the table size is fixed, instead of letting the two words fix it. When a table is developed starting with the first protocol and words are added, the minimum p-values are used, multiplied by the number of word pairs to conservatively adjust for multiple testing.[44]

The strength of Rips's method is that it offers a way to perform a valid statistical experiment, since it has an objective protocol. The method of Sherman lacks this feature and is therefore subject to the charge of data snooping. Nevertheless, the method of Rips could still use strengthening in step one, as it is still subject to manipulation on this point. The most thorough and academically respectable work to date is his "great men of Israel" experiment, but it is in the spelling of the names in the 1994 Witztum, Rips, and Rosenberg paper that McKay, Bar-Natan, Bar-Hillel, and Kalai legitimately exposed this "wiggle room," showing how to switch the result from the statistical significance of the Torah to the control text. Rips rightly replied that the possibility of this manipulation need not imply that it happened.[45] Nevertheless, if merely changing the letters of the same set of words reverses the outcome, the experiment loses its force. Therefore, I do not consider the great men of Israel experiment as evidence for the existence of the Bible code. Another source of "wiggle room" is found in code searches with more than two words. The selection of the order of the words should be prespecified.

The other point at which I remain unconvinced by the Bible code argument is with the multiple testing problem. If Rips's level of significance of 0.02 is used, then if it is true that there is no code, every fifty (50*0.02=1.00) experiments will yield a significant "code," on average. Whereas Rips cites a priori words for which experiments were conducted, and uses a conservative multiple testing adjustment for these cases,[46] I am referring to something different. The former is a correct multiple testing adjustment for multiple words in a single experiment. I refer to multiple experiments. What is very rarely addressed are the experiments which yielded no significance.[47] A clear example is the purported November 2004 US election code submitted to Rips by a member of his group.[48] How many unsuccessful searches for codes have Rips and his group conducted? The case of Sherman's team is subject to the same criticism with their organized society headed by a small team of code researchers. The very practice of having a community that searches for these codes and submits findings, begets an environment which is subject to the multiple testing problem. This is analogous to firing multiple bullets at a wall, and then drawing a bull's eye around the result, instead of first drawing the bull's eye and then firing to see how you did.

Despite the above critiques, Rips has created the technical apparatus to produce a convincing experiment, or better, a series of public experiments, to test the Bible code hypothesis. Such a series of experi-

ments should use Rips's seven-step protocol. The key would be to assemble a small group of code proponents and opponents and have them agree on a list of word pairs, their spelling, their order, and the control texts. The word pairs should not have been knowingly searched previously. One way to do this could be to use a random procedure for word selection, subject to rational criteria agreed upon by all experimenters.[49] A series of several experiments could be determined, and the a priori details carefully documented. From there, conducting the experiment would be routine. If such experiments were conducted, I believe that they would show that the Bible code phenomenon is not real. However, if the results showed clear statistical significance after scrutiny, I would follow Harold Gans and Edwin Sherman and become a believer. In fact, Barry Simon called for such an experiment, but the opposing sides never agreed upon the details; instead, each produced their own version with results equivalent to the Witztum, Rips, and Rosenberg 1994 paper.[50]

The following three additional problems remain for the approaches of both Sherman and Rips. First, there is no rule for determining the exact word or phrase. Since in Hebrew there are no vowels, the context is important for determining the meaning of words that could otherwise be ambiguous. For example, consider the following two phrases in figure 4, "Abraham died" versus "Prime Minister died [in] July." By simply placing a space between the letters of Abraham's name, two words are formed that convert the phrase from a biblical quote to a provocative prediction. The use of contextless Hebrew phrases is inherently ambiguous. Sherman agrees, saying that "it is quite frequently impossible to come up with a unique reasonable translation."[51] The arbitrary selection of a context adds another wiggle parameter in the search for codes.

אכרהם	מזח	רהם	אכ	מזח
Abraham	died	Prime Minister	July	died

Figure 4. On the left is the phrase "Abraham died." On the right is the identical set of Hebrew characters, but the first two letters in Abraham's name (counting from the right) have been separated to say "The Prime Minister died [in] July." This is the phrase used by Michael Drosnin's Rabin assassination code.

Second, according to Hebrew scholar Michael Heiser, the most devastating argument against Bible codes is due to uncertainties in the precise form of the Hebrew text.[52] Although the manuscript of our ancient Hebrew text is very standard, and was transmitted with remarkable care exceeding that of any ancient document, there are alternative manuscripts and variations in it.[53] The insertion or deletion of a single letter will change purported codes. This can be seen by looking at the example in figure 1. If a single insertion or deletion occurred in positions 1 through 58, one or both of the encoded words would be gone and the code would disappear. Both Rips and Sherman[54] admit the changes and believe that the LORD has made it such that the codes are in the *current* text. Rips is most explicit by boldly stating,

> Since we do find codes in the Koren text of today, if we assume transmission errors then we may also assume that God put an imperfect code in the text of Mount Sinai and that after any alleged copy errors, the imperfect code becomes perfect.[55]

While this is a valid retort, it forces them well outside their Jewish and Christian theological traditions regarding the accuracy of the Hebrew Bible.[56]

Third, physicist Randy Ingermanson developed a mathematical method to determine whether the biblical text contained more encoded words than a random text of the same length. The way he did it was to use the following steps:

1. Generate a table of digrams and trigrams and their frequencies from the biblical text. A digram (trigram) is the first two (three) letters of all of the words in the text. The initial two- and three-letter combinations contain order specified by an author.
2. Create a "skip-text" for each skip-length. For example, the first skip-text with skip 20 of the first sentence of this article would be "TVRN." The second one would be "HRYT." To see these, look at figure 1 of this article. The first skip-text with skip 20 is the first column; the second is the second column, and so on.
3. Every skip text is checked for the digrams (trigrams), and the mathematical entropy—lack of order—is computed for both the biblical and random texts. If the biblical skip-text contains more ELSs, then the digrams and trigrams will exhibit more order, or less entropy.

After calculating the results, the p-value for digrams with 50 or more letters is 0.38, and for trigrams, it is 0.14.[57] This proves that there is no statistically

significant difference in the number of encoded words between the biblical and random texts with skip-sizes of 50 or more. Sherman does not reply to this argument,[58] but Rips's response is interesting:

> The Torah Code hypothesis is completely consistent with a condition that the number and kind of ELSs are exactly what would be expected by chance. The Torah Code hypothesis states that the placement of the ELSs in the Torah text is skewed in such a way that there is a higher frequency of ELSs of related key words that appear closer together than expected by chance.[59]

In other words, Rips affirms Ingermanson's work, but he points out that the same number of ELSs in the Torah versus random texts does not invalidate the hypothesis. The reason is that the Torah code hypothesis is *what* the words are ("related key words") and *where* they appear ("closer together"), not a greater number of ELSs.

What Does the Evidence Mean?

At last, let us try to make sense out of all of the preceding evidence. We will begin with a summary, followed by evaluation and interpretation.

Summary of the Evidence

In favor of the Bible code are the following points. They are given in the order they appeared in this article, which roughly follows their appearance in the literature:

1. Torah example: The word "Torah" appears encoded at the beginning and end of Genesis, Exodus, Numbers, and Deuteronomy with an ELS of length 50.
2. Prediction: Rips and Drosnin in 1994 successfully, albeit tragically, used a Bible code to predict the assassination of Prime Minister Yitzhak Rabin (d. 1995).
3. Peer-reviewed paper: Witztum, Rips, and Rosenberg demonstrated a statistically significant difference in Bible code phenomena favoring the Torah over other texts in their great men of Israel experiment.
4. Code search protocol: Rips's group provided a scientific experimental protocol which they used to find many statistically significant examples of ELS.
5. Mega-codes: Sherman's group documented extensive ELS clusters with extremely low probabilities.

Opposed to the Bible code are the following points:

1. Peer-reviewed refutation paper: McKay, Bar-Natan, Bar-Hillel, and Kalai demonstrated that the great men of Israel experiment was subject to overfitting.
2. Code search protocol rejoinder: An independent objective verification of Bible codes using a valid code search protocol has not been conducted.
3. Mega-codes rejoinder: The extremely low probability of the combined discoveries of numerous research group members is the result of the multiple testing problem.
4. ELS "hits" guaranteed: Casual use of Bible code software reveals that numerous ELS hits occur in searches.
5. Meaning: There is no rule for determining the spelling or meaning of a given word or phrase.
6. Hebrew text: There are variations in Hebrew Bible manuscripts, even a single one of which alters conclusions.
7. Word frequencies: It has been shown that the biblical text does not contain more ELSs than a random text.

Evaluation and Interpretation of the Evidence

In order to make sense of the evidence presented in this fascinating debate, it is helpful to distinguish between existence claims and interpretive claims. Existence claims are those assertions that there really are overlapping ELSs in the Torah, or the entire Hebrew Bible, that were inspired by God. Interpretive claims assume existence, point to specific instances, and describe the meaning of those specific instances. This distinction is not made in the literature, and some arguments—both pro and con—address one or both claims. In the preceding, the arguments for existence amount to four: (1) human-discovered ELSs, for example, the 50 ELSs Torah phenomena; (2) a successful prediction; (3–4) computer search experiments with scientific protocol; and (5) ultra-low probability phenomena.

Let us evaluate the existence arguments in turn. While (1) is truly fascinating, how much evidence does it provide for the existence of Bible code? There are several considerations. Of all the human-discovered ELSs of which I am aware, the Torah phenomena are the most impressive. The others are

readily explained by the counter arguments for (4). Therefore, my remaining considerations are limited to the 50 ELSs Torah phenomena. First, they could have been placed by Moses or a later redactor. This would support the existence of a kind of Bible code, but not the divinely inspired kind which is debated in the literature. Second, although (1) is a collection of ELSs, it does not meet the definition of a Bible code because the words do not overlap or have close proximity. Third, the word of (1) occurs numerous times in the texts of its occurrence, whereas in many of the purported codes of (3–5), the words do not occur in the text and may not have even existed at the time of writing. Fourth, even if we grant the existence of (1) for the sake of argument, there is no interpretive issue such as there is for Bible codes. It is the word TORAH; it occurs in the Torah. It is more like an authorial stamp—there is no provocative assassination prediction or Messiah claim or anything like that. It is rather boring. In conclusion, while (1) is fascinating, it is not actually a Bible code, and therefore it should not be considered as evidence for Bible code. If there really were authorially intended ELSs in the Bible (whether human or divine), this is probably the best candidate—but I think it is basically a dead end.

In order to evaluate evidence (2),[60] which is presented as a successful predictive prophecy, there are only two possibilities: either it was a real Bible code or it was not. If it was not, let us consider possible explanations. Apart from a brute coincidence, I can think of two: one natural and the other supernatural. The natural explanation is that Rips was running Bible codes with a Prime Minister's name, Yitzhak Rabin. It was 1994, during the days of acrimonious debates and rallies about ratifying the Oslo Accord. Some were worried that opponents were publicly calling for Rabin's death as a traitor, and everyone knew when and where he would be at these rallies. Anybody could get close to him.[61] Among the codes generated on Rips's computer was "assassin that will assassinate" crossing "Yitzhak Rabin." It is natural that he might want to warn his brave Prime Minister. The supernatural explanation is that God performed an act of prophecy in 1994 through Rips in the same way that God spoke through Caiaphas regarding Jesus.[62]

> Then one of them, named Caiaphas, who was high priest that year, spoke up, "You know nothing at all! You do not realize that it is better for you that one man die for the people than that the whole nation perish."
>
> He did not say this on his own, but as high priest that year he prophesied that Jesus would die for the Jewish nation, and not only for that nation but also for the scattered children of God, to bring them together and make them one. (John 11:49–52)

In this instance, the apostle John heard God speaking through a person who meant one thing while God was saying something else. I believe God may have done something similar through Rips.[63] Thus, on the one hand, there are reasonable explanations for evidence (2) not being a real Bible code. On the other hand, if evidence (2) was a real Bible code, then it violates responsible Bible-code protocol. Both Rips's and Sherman's groups warn *against* using Bible code for prediction.[64] Therefore, while evidence (2) may be amazing to some, either it is not a Bible code or, if it is, it is not a valid use of Bible code. It should therefore not count for much, if any, evidence in the cumulative case for the Bible-code hypothesis.

As for evidence (3–4), the great men of Israel experiment was shown by McKay, Bar-Natan, Bar-Hillel, and Kalai to be due to overfitting. Rips's counter-response with the seven-part protocol is the right scientific response, permitting an objective external validation—but that experiment has not been performed at the time of this writing. Despite his claims to the contrary, the examples provided in his book are also subject to the multiple testing problem, given his community of code searchers. The counter-arguments have neutralized the evidence of (3–4).

Turning to evidence (5), Sherman's mega codes are a classic example of the multiple testing problem and are therefore statistically invalid, no matter how impressive. As a demonstration of the underlying problem, McKay has shown analogous phenomena in nonbiblical texts. The evidence of (5) can appear persuasive to the uncritical eye, but it does not warrant support for a Bible code.

The force of con argument #6, regarding Hebrew manuscript variations invalidating the code, is legitimate. As such, it has forced Rips's and Sherman's groups to adopt a theologically awkward position. While it is a logically adequate reply, and it does seem necessary for their position, it is not satisfying to me. An alternative rejoinder would be that Bible code exists in the autograph manuscripts, which we

do not have, but our manuscripts are good enough that, within sections, it is plausible that autograph Bible codes may still exist. This would cast doubt on high skip distance ELSs, like the Rabin assassination code (4,772 letter ELS), and it would severely undermine the certainty of any proposed codes, but it would defend the theory of Bible code while according better with the doctrine of the inspiration of scripture. Less-sophisticated code proponents do not address the issue.

Having addressed the existence claims, let us turn to the interpretive claims. Pro arguments (2) and (5) combine existence and interpretation. Please see remarks in the preceding paragraphs regarding argument (2). For (5) mega-codes, a text is chosen for a particular theme (e.g., Isaiah 53 for "Jesus"). Next, words related to the theme are searched for overlap with the text. With the help of a community of supporters, "hits" eventually turn up and are recorded (e.g., "God has atoned" and "evil Roman city"). There is no scientific method employed. No alternative hypothesis is considered. It appears that any word or phrase that may be related is included.[65] As a result, given the ease with which to generate hits (con argument #4), it is virtually inevitable that a Bible code will be produced on the particular theme. Therefore, it really is not surprising when such a Bible code is produced because there is no baseline (null hypothesis, protocol) for comparison (con argument #2).

Turning to the con arguments, #5 Meaning and #7 Word Frequencies further reduce confidence in interpretations. Suppose there really is a Bible code. Given the ambiguities for determining which word(s) overlap, how can one determine the meaning of the individual words? The work of Ingermanson has shown that there are not more words encoded in the Hebrew Bible than in other texts; this is a very helpful fact. Rips's rejoinder—it is not the number of words but the actual words and their locations—nullifies the con argument. Nevertheless, the fact that there are around the same number of hidden words in other texts supports the hypothesis that hidden meanings can also be found in other texts. How does one distinguish the real Bible code from spurious randomly occurring hidden words?

To summarize, evidence (5) is interesting and impressive, but ultimately unconvincing and could be shown in other texts. Evidence (3–4) is scientific and holds potential for demonstration, but the current versions have not succeeded in an adequate demonstration. Evidence (2) has drawn much attention, but stands as a one-off event, violates Bible-code protocol, and is therefore inadmissible. While evidence (1) may be legitimate, it is a single ELS and fails to meet the definition of Bible code. It should therefore be classified as a different kind than computer-assisted Bible codes, invalidating it as evidence for the Bible-code hypothesis. Taking everything together, all of the evidence is either invalid (1–2) or refuted (3–5) at this time. Furthermore, even if Bible codes turned out to be real, there is no reliable means of interpreting them. I have attempted to show that the current state of evidence is that the positive case for Bible code is lacking whereas the negative case against Bible code is strong. I therefore remain unconvinced of the existence of the Bible code.

Conclusion

There are sophisticated, active Bible-code communities today in both Judaism and Christianity. Due to academic criticism, the sensationalism has been successfully cleared from the field. Proponents find themselves forced into affirming an awkward theological stance, and their current practices are subject to the charge of both data snooping and "wiggle room." As a result, they have moved out of the academic arena they once occupied and propagate their views primarily online. While I applaud their sincerity and their faith, and I do not question their personal integrity, nevertheless when the evidence is put into the light of the broader statistical fallacies, I find that I cannot embrace the code, no matter how much I might wish that it were true.

Given all of the above, I feel that a sociological remark is in order. Contained within the span of the modern history of Bible code (1980s forward), we have witnessed the emergence of a sophisticated belief with strong theological and scientific connections, but which is demonstrably wrong. Zeal has clouded good judgment. A small industry has emerged around it, with enough infrastructure, adherents, and momentum that it may continue for many years. Already there is a polarization between groups. Such would never have been able to take root if it were not for strong faith communities wanting to believe a message like this. Could this

be a microcosm of parallel Jewish and Christian sociological movements throughout history? Could this be a reason why the unbelieving world looks at the faith-claims of our communities and chooses to pass them over, lumping them in with the likes of the Bible code? I do not believe that the Bible code is real, and so I identify with the critics. On the other hand, I identify with the spirit and the goals of the Bible-code proponents, and more often I find myself on the side of the fence they currently occupy. Is my zeal for other areas of my faith clouding my good judgment? This tension has enabled me to see, with greater clarity than ever before, both the sociological power and liability of our faith communities when new ideas are involved. There are powerful lessons to be mined here.

Even if the code were real, there would be no rule for surely discriminating real from spurious codes. Rips's group asserts that codes exist only in the Torah. Sherman's group has moved to mega-codes, those with hundreds of words or phrases, which statistically dwarf those of Rips. Who is right? Even if this were resolved, there is still no clear biblical standard for how to interpret them. Therefore, until a public experiment is conducted (one with a protocol agreed upon by both sides and no wiggle-room word lists), and found strongly significant, I will remain unconvinced. ✧

Notes

[1]Introduction to the *Sifra Ditzniut*, taken from Jeffrey Satinover, *Cracking the Bible Code* (New York: Harper Paperbacks, 1998), 2.

[2]I have personally verified the codes at the beginning of Genesis, Exodus, Numbers, and Deuteronomy. There is a purported code in Leviticus, but it is "rather more complex," according to Gerald Goodhardt, "Response to David J. Bartholomew, Statistics and Theology," *Journal of the Royal Statistical Society*, Series A, vol. 151 (1988): 165. Goodhardt's explanation of the step size of 50 regards the 49 letters: "The number seven has of course always had a special significance, and even sevens even more so."

[3]Michael Drosnin, *The Bible Code* (New York: Simon and Schuster, 1997), 13–52.

[4]Ibid.; see also one of the most detailed histories of Bible codes, http://www.realbiblecodes.com/torah_codes/torahhistory/torah-code-history-2.php.

[5]In the Torah example, the *o* is due to a vowel point on the silent consonant vav (ו) and the *a* is due to a vowel point on the consonant hay (ה).

[6]It is this fifth rule which separates the nonmathematician code proponents from the mathematical code proponents. After the professional academic criticism became known, the latter group has largely disappeared.

[7]It begins with the eighteenth letter, "Y," with a spacing of 20 letters: "YeSHua." Recall that the vowels have been removed to help the English reader appreciate the room for variation. This letter sequence could also spell, "Yes, hi."

[8]Satinover, *Cracking the Bible Code*, 26.

[9]Discovery Seminars are conducted by the orthodox yeshiva *Aish HaTorah*, which means "Flame of the Torah."

[10]For example, Andrew Goldfinger, senior physicist at Johns Hopkins University, and Persi Diaconis, professor of mathematics and statistics at Stanford University; see also Randall Ingermanson, *Who Wrote the Bible Code*? *A Physicist Probes the Current Controversy* (Colorado Springs, CO: WaterBrook Press, 1999), 191, 218.

[11]Ibid., 191–93.

[12]See http://ad2004.com/shopping/rankings.html for software reviews.

[13]Doron Witztum, Eliyahu Rips, and Yoav Rosenberg, "Equidistant Letter Sequences in the Book of Genesis," *Statistical Science* 9, no. 3 (1994): 429–38.

[14]Drosnin, *The Bible Code*, 181.

[15]Satinover, *Cracking the Bible Code*.

[16]Grant Jeffrey, *The Mysterious Bible Codes* (New York: Thomas Nelson, 1998).

[17]CalTech Math Professor Barry Simon wrote "The Case against the Codes" (1998), http://torahcode.us/torah_codes/code_history/TheCase.htm or http://web.archive.org/web/20140112092910/http://www.khunwoody.com/biblecodes/TheCase.htm). He also compiled a list of 55 mathematicians and statisticians who studied Bible codes and were willing to sign a public declaration of their disagreement with it. Normally I do not give much credence to such petitions, since it risks portraying that scientific conclusions are based on voting. However, in this case, the context was such that the primary organ of propagating Bible code was the Discovery Seminars, whose leadership had been led to believe that the scientific merit of the codes had been proven. The declaration refuted that belief, particularly when Persi Diaconis, the world-renowned statistician who was one of the reviewers who passed the Witztum, Rips, and Rosenberg paper, signed it. Sometime between 2015 and 2018 the website with the list of signatories was removed.

[18]Brendan McKay et al., "Solving the Bible Code Puzzle," *Statistical Science* 14, no. 2 (1999): 150–73.

[19]Ingermanson, *Who Wrote the Bible Code*?

[20]R. Edwin Sherman, *Bible Code Bombshell* (Green Forest, AR: New Leaf Press, 2005).

[21]Robert Haralick, Eliyahu Rips, and Matityahu Glazerson, *Torah Codes: A Glimpse into the Infinite* (New York**:** Mazal & Bracha Publishing, 2005).

[22]*Proceedings of the 18th International Conference on Pattern Recognition* (Hong Kong, China, August 20–24, 2006): There were seven (!) Bible code papers presented at this conference, including Harold Gans, Zvi Inbal, and Nachum Bomboch, "Patterns of Equidistant Letter Sequence Pairs in Genesis," and Robert Haralick, "Basic Concepts for Testing the Torah Hypothesis." See http://www.torahcode.co.il/english/pub_index.htm for the complete list.

[23]For Sherman, see https://www.facebook.com/Bible-Code-Digest-228790533877083/ and for Rips, see http://www.realbiblecodes.com/. Related to the preceding Facebook page was an extensive website of Sherman's Isaac Newton Bible Research Society that was active during the writing of this article. However, while in press the Isaac Newton Bible Research Society ceased and closed.

I received the following reply to my inquiry as to the reason:

> Dear Jason:
> Thank you for your kind thoughts. There were many contributing factors, but at the end we were unable to conduct new research, and our director retired. We were unable to continue at that point for financial reasons.
> Blessings to you,
> Diane James, Editor and Research Assistant
> The Isaac Newton Bible Research Society.

[24]See http://ad2004.com/shopping/index.html.

[25]Ezra Barany, *The Torah Codes* (Oakland, CA: Dafkah Books, 2011).

[26]Sherman's society could be joined by anyone, but has now closed (see endnote 23). The Israeli International Torah Code Society, affiliated with Rips, does not appear to have a web presence as of this writing, http://codesoft.freeshell.org/newslist/index.html.

[27]Matityahu Glazerson, "Donald Trump—President of the States? in Bible Code," posted on Youtube on July 6, 2016, https://www.youtube.com/watch?v=3OyopgFcv10&feature=youtu.be. Reported by World Net Daily, "Rabbi Sees Donald Trump Ascendancy in Bible Codes," posted on November 3, 2016, http://www.wnd.com/2016/11/rabbi-sees-donald-trump-ascendancy-in-bible-codes/.

[28]Michael Heiser, *The Bible Code Myth* (self-published, 2001).

[29]Brendan McKay, Leon Gleser, and Robert E. Kass, "Bible Codes Mystery Explained," Institute of Mathematical Statistics, posted September 8, 1999, http://cs.anu.edu.au/~bdm/dilugim/StatSci/PressRelease.html.

[30]Ibid.

[31]McKay et al., "Solving the Bible Code Puzzle." For a readable summary, see Barry Simon, *The Case against the Codes* (1998), http://torahcode.us/torah_codes/code_history/TheCase.htm. See also Robert Haralick's rejoinder in "Testing the Torah Hypothesis: The Experimental Protocol," *Proceedings of the 18th International Conference on Pattern Recognition*, August 20–24, 2006, 5, http://www.torahcode.co.il/pdf_files/pub/har2.pdf.

[32]The details for understanding Witztum, Rips, and Rosenberg's procedure for computing their p-values are technical. It is a statistical nonparametric hypothesis test called a permutation test. Here is a summary of their steps:

1. Obtain a list of test word pairs w and w'. (The pairs are needed in order to discriminate designed word relationships from those occurring by chance. They used all names and dates for the personalities in *Encyclopedia of Great Men in Israel* whose entries were between 1.5 and 3 columns, which turned out to be 32 entries.)
2. Define a distance measure, $c(w,w')$, between two words encoded in overlapping ELSs. $c(w,w')$ is a Euclidian-type metric accounting for start location, skip distances, and word length, then scaled onto $[0,1]$.
3. P_1 is a proximity measure where smaller values indicate that w *and* w' are closer to one another. Let random variable X = number of "close" word pairs ($c(w,w') \le 0.2$). Then $X \sim binomial(size = N, prob = 0.2)$, where N = number of word pairs in the sample where $c(w,w')$ is defined. Then

$$P_1 = P(X \ge k) = \sum_{j=k}^{N} \binom{N}{j} (0.2)^j (0.8)^{N-j}$$

which means P_1 is the probability of getting k or more close word pairs. Although P_1 is technically a probability, it is not the probability that is in focus, but rather its use as an index for ranking.

For the permutation test, P_1 was computed for 999,999 randomly rearranged word pairs, and the one correct word pair, for a total of 1,000,000 word pairs. Then the *rank order of* P_1 is the number of random P_1s below the true P_1. (In the case of ties, half went above P_1, half below.) Table 3 displays the final conclusions of the paper with the rank order of P_1 for Genesis and six control texts: a randomization of the letters, words, verses, and words within verses of Genesis; Isaiah; and the first 78,064 letters of Tolstoy's *War and Peace*. They also used an alternative proximity measure, P_2, which was like P_1 except with an exact distance for every pair instead of $c(w,w') <= 0.2$. They also computed P_3 and P_4, which were the same as P_1 and P_2 except with the title "Rabbi" removed from the names. P_1, P_2, P_3, and P_4 all appear in Table 3. Dividing the results of Table 3 by 1,000,000 gives unadjusted p-values (Witztum, Rips, and Rosenberg discuss a Bonferroni correction for the multiple testing problem, which is $4*p\text{-}value_{unadjusted}$). For P_1 the unadjusted p-values are: Genesis (0.00045), randomized letters (0.62), randomized words (0.88), randomized verses (0.21), randomized words within verses (0.32), Isaiah (0.90), and *War and Peace* (0.75). Results are similar for P_2, P_3, and P_4.

[33]Simon, *The Case against the Codes*. Footnote 40 mentions an email from Robert Haralick, who at the time was moderately interested in the codes but later became a believer. Haralick used his own distance measure with the same Witztum, Rips, and Rosenberg words, changing the p-value from 0.000002 to 0.0025. The point is not so much the p-value, but how sensitive the method is to changing the distance measure. The distance measure, "c-method," is very complicated, requiring over 6 million calculations to find the distance between two five-letter words. Simon says, "If I were attempting to assign a distance between the encodings of two words, I'd look for them as minimal ELSs and measure the number of letters between the centers of those ELSs. This simple-minded method involves computing a single distance in the text."

[34]A. M. Hasofer, "A Statistical Critique of the Witztum et al. Paper," *Talk Reason* (February 18, 1998), http://www.talkreason.org/articles/hasofer.cfm.

[35]It could be responded that Rips provided multiple such examples in *Torah Codes: A Glimpse into the Infinite*. This is true, but, while many of those examples have the appearance of being un-biased experiments, there is no record of how many such experiments were performed. This is the multiple testing problem, which is discussed later.

[36]Brendan McKay et al., "Jesus as the Son of Man," http://cs.anu.edu.au/~bdm/dilugim/Jesus/, accessed May 6, 2015.

[37]Ibid.

[38]Sherman, *Bible Code Bombshell*, 81ff.

[39]Ibid., 94.

[40]Haralick, Rips, and Glazerson, *Torah Codes: A Glimpse into the Infinite*, x.

[41]Ibid., 22.

[42]In particular, let D and M be the events that a Bible code was included by "design" or a "monkey" (i.e., random). Let E be the "evidence," which means E is a particular Bible code. Then, from the definition of conditional probability,

$$P(D \mid E) = \frac{P(E \mid D)P(D)}{P(E \mid D)P(D) + P(E \mid M)P(M)}$$

Assuming that each value of $P(E|D)$ is equally likely, the expected value of $P(D|E)$ is given as

$$1\text{-}P(E|M)\log\{(1+P(E|M))/P(E|M)\}$$

I verified the derivation of the above expression. Now, the p-value of the hypothesis test of H_0: *E is by M* vs. H_A: *E is by D* is $P(E|M)$. If $P(E|M)=0.02$, then the expected value of $P(D|E)$ is *0.9214*. *0.02* is the level of significance used in the book. This means they use a *2%* level of significance for whether to reject a particular Bible code null hypothesis, which would mean that there is at least a *92%* chance that it is designed, based on the particular Bible code. Ibid., 11–12.

[43]Ibid., 15–16.

[44]Ibid., 23.

[45]Ibid., 65. See also Haralick's website addressing the "wiggle room argument," http://www.torahcode.net/torahcode_criticism/torahcode_criticism_wiggle.shtml. This is apparently a sensitive issue, as he equates the charge of "wiggle room" to questioning his character.

[46]The conservative Bonferroni correction is used throughout. See, for example, the purported World Trade Center codes in Haralick, Rips, and Glazerson, *Torah Codes: A Glimpse into the Infinite,* 92ff.

[47]Ibid., 96 is an exception.

[48]Ibid., 162.

[49]For example, randomly select words from a Hebrew Bible dictionary, and select their pairs by using related words in their entries.

[50]See Gans's and Simons's explanation of the cities experiment in http://www.torahcode.net/primer-final-1.pdf and in http://web.archive.org/web/20131017152530/http://www.khunwoody.com/biblecodes/index.htm.

[51]Sherman, *Bible Code Bombshell*, 186.

[52]Heiser, *The Bible Code Myth*, 26.

[53]Ibid., 26ff. There is only one autograph text and, despite the fact that the general text and overall message is highly reliable, the fact remains that there are some uncertain letter variants due to transmission error.

[54]Sherman, *Bible Code Bombshell*, 214.

[55]Haralick, Rips, and Glazerson, *Torah Codes: A Glimpse into the Infinite*, 9.

[56]The first English Bible Code book following Witztum, Rips, and Rosenberg was Moshe Katz, *CompuTorah: Dr. Moshe Katz on Hidden Codes in the Torah* (Jerusalem: Kest-Lebovits, 1996). On p. 21, he favorably cites Rabbi Shmuel Hassida, "According to the Sages, the Torah is the blueprint by which the world was created … Adding or omitting even a single one of the 304,805 letters of this Divine blueprint, the Torah, could lead to the destruction of the whole world." As for Christians, the evangelical doctrine of inerrancy states that the Bible is inerrant in the no longer extant *autographs*, though the copies may vary, "Chicago Statement on Biblical Inerrancy with Exposition," Fall 1978, http://www.bible-researcher.com/chicago1.html.

[57]The p-values are computed from Ingermanson's z-scores of 0.300 and 1.110, respectively, in *Who Wrote the Bible Code?*, 133. In the same section, he shows the results for the entire Hebrew Bible. None achieve statistical significance, except the book of Numbers. He shows on p. 131ff. that the reason is due to the occurrence of repeated rare digrams and trigrams. When this section is scrambled, the statistical significance disappears.

[58]Sherman's site addresses Ingermanson's online articles, but not his book. Given Sherman's otherwise thoroughness, this appears to be an implicit acknowledgment of the validity of Ingermanson's argument.

[59]Haralick, Rips, and Glazerson, *Torah Codes: A Glimpse into the Infinite*, 69.

[60]There are two reasons for accepting the truthfulness of the claim. First, it was verified by Frank Bruni of the *New York Times* from two different sources, "Book on a Bible Code Tempts Hollywood but Not Academics," https://www.nytimes.com/1997/05/29/nyregion/book-on-a-bible-code-tempts-hollywood-but-not-academics.html. Second, if the claim were false then this would have been used as an argument against Bible code by opponents, but it has not. In fact, Rips's group is categorically opposed to using Bible code for prediction, and they expose false predictions by Drosnin, http://www.realbiblecodes.com/false-drosnin-predictions.php.

[61]See "Assassination of Yitzhak Rabin," https://en.wikipedia.org/wiki/Assassination_of_Yitzhak_Rabin.

[62]John 11:49–51 reads, "But one of them, Caiaphas, who was high priest that year, said to them, 'You know nothing at all, nor do you take into account that it is expedient for you that one man die for the people, and that the whole nation not perish.' Now *he did not say this on his own initiative*, but being high priest that year, he prophesied that Jesus was going to die for the nation." (emphasis mine)

[63]Why would God do this? Answers to this question are speculative, but possible reasons include the mass movement of ethnic Jews toward greater fidelity to their ancestral faith and the increased discussion of the Bible, both of which happened.

[64]The Rabin-Assassination code, along with Drosnin's (*The Bible Code*, 123) false predictions of Atomic Holocaust in 2000 and 2006 appear to be a key reason for formulating this view. Rips's group's site says,

> According to the Torah code hypothesis, if a major event happens, then some descriptive key words of the event is likely to have an associated relatively compact table in the Torah. However, relatively compact tables from the Torah text do not mean anything because there are many relatively compact tables that do not correspond to any event. Only if relatively compact tables had a one to one correspondence with events, could the finding of a relatively compact table be used for prediction. (http://www.realbiblecodes.com/false-drosnin-predictions.php)

However, this does not stop Rabbi Glazerson, a Rips's group member, from making predictions. An interesting one is Glazerson's successful prediction of Trump's win over Clinton, although it does not rise to the level of statistical significance, http://www.wnd.com/2016/11/rabbi-sees-donald-trump-ascendancy-in-bible-codes/. Sherman, *Bible Code Bombshell*, 185–87, cites eight reasons why Bible code cannot be used to predict future events, and concludes, "Because of these considerations, it should be evident that it will probably never be possible to use Bible codes to make accurate predictions about the future. This dovetails with scriptural warnings not to dabble in trying to read the future, to use 'divination.'"

[65]Sherman, *Bible Code Bombshell*, 88–90, 128–40.

Arnold O. Benz

Article

Antony Flew's Question and Its Answer: How to Perceive God?

Arnold O. Benz

Antony Flew's parable states that God is a hypothesis that cannot be verified scientifically. So what has theology to do with reality? Here I argue that religion ultimately originates from religious perceptions that require participation and are holistic, including embodied cognitions, integral sensations, emotions, and feelings. Such perceptions are nonscientific because they are not objective. However, they are essential in every human life and have changed it for many contemporaries. Prime examples from the Bible illustrate the argument. Science and theology start from different perspectives and experiences. Much of the current dialogue, taking place on a rational and objective plane, falls short in two ways: (1) it is implicitly physicalist, and (2) it ignores the roots of religion. A shift from ontology to epistemology is necessary. To make theology understandable in a modern worldview, the emphasis needs to change from discussing the nature of God to examining how humans experience God.

The highlight of my introductory physics course on special relativity some decades ago was the story of how Albert Einstein discarded the luminiferous aether, the postulated medium for the propagation of light.[1] The aether hypothesis was introduced and became popular in the nineteenth century when new optical experiments suggested describing the propagation of light by a wave equation. Aether was thought to be the universal medium in which the light waves oscillate. However, no trace of this hypothetical substance was ever observed and the famous experiment by Albert A. Michelson and Edward W. Morley published in 1887 clearly showed that something was seriously wrong with the concept.

Hendrik A. Lorentz and Henri Poincaré, two eminent theoreticians of the time, tried to save the aether theory by introducing different times in the moving system and the stationary aether. Einstein then boldly formulated special relativity in which electromagnetic fields oscillate in vacuum, and where there is no special frame of reference needed given by some aether. Aether fell to Occam's Razor, the maxim to assume the simplest explanation. We students were told to never forget that physics should deal with only observable entities.

Today this approach to reality is unchallenged in the frame of physics. Einstein's exploit also affected other fields of science and influenced epistemology in general. It boosted philosophical positivism, claiming that (positive) facts are the only source of all human knowledge. Logical positivism into which it developed in the 1920s became one of the most influential movements in twentieth-century philosophy. Its central thesis is that the only statements that are meaningful are those based on objective observations that can be empirically verified. Metaphysical interpretations are not considered to be significant and are rejected.

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The Parable of the Invisible Gardener

Individual fields of natural science still operate successfully according to such positivist principles. Positivism is present also in the general public because our current worldview is significantly influenced by science. Positivism surfaces particularly with regard to the truth of theology. An instructive example is the satirical Parable of the Invisible Gardener by the British philosopher Antony Flew.

> Once upon a time two explorers came upon a clearing in the jungle. In the clearing were growing many flowers and many weeds. One explorer says, "Some gardener must tend this plot." The other disagrees, "There is no gardener." So they pitch their tents and set a watch. No gardener is ever seen. "But perhaps he is an invisible gardener." So they set up a barbed-wire fence. They electrify it. They patrol with bloodhounds. But no shrieks ever suggest that some intruder has received a shock. No movements of the wire ever betray an invisible climber. The bloodhounds never give cry. Yet still the Believer is not convinced. "But there is a gardener, invisible, intangible, insensible to electric shocks, a gardener who has no scent and makes no sound, a gardener who comes secretly to look after the garden which he loves." At last the Skeptic despairs, "But what remains of your original assertion? Just how does what you call an invisible, intangible, eternally elusive gardener differ from an imaginary gardener or even from no gardener at all?[2]

The parable suggests that God cannot be proven by scientific means. Its implicit conclusion is that religious beliefs cannot be verified by scientific evidence and are nonsensical. Scientific evidence requires objectivity, which means that the evidence needs to be the same for all scientists, independent of the observer—whether believer or skeptic. A further requirement for a scientific fact is repeatability. It must not be a one-time occurrence but a general phenomenon. Finally, and especially in physics and chemistry, scientific phenomena must be quantitatively measureable. The quantitative nature allows a description by exact laws and mathematical modeling. The way the story is told, also suggests that there is no place for God in reality. If God existed, he has no influence. His existence can be neither proved nor disproved. One may as well ignore the concept of God as done with the luminiferous aether.

John M. Frame responded to Flew's conclusion in terms of a general criticism of positivism that empirical observation always requires prerequisites.[3] Belief in God is a commitment, and commitments are unfalsifiable. Frame then goes on to point out that disbelief, committed to ignore evidence, is also unfalsifiable. Granted, it may be objected to his argument, that commitments unrelated to evidence and out of touch with everyday life become ideologies. Where the discussion should go is to the experiential basis of religion.

A Continuation of the Parable

Here we ask what religion has to do with reality. Is the reality investigated by science all of what humans perceive? Maybe the investigators in the parable looked for God in the wrong place or in the wrong way. Their story, for example, could continue in this manner:

> Because they were so absorbed in experiments and analyses, and also because of their familiarity with the place, the researchers were no longer able to see the beauty of the garden. The day of leaving, the Skeptic wandered in a reflective mood through the garden and found himself standing unexpectedly before a magnificently blooming red rose. It stood large and alone in a meadow. The Skeptic was captivated by the luminous color, the delicate form of the petals, and their contrast to the thorny stalk. The flower reminded him of something long forgotten. It warmed his heart, and he felt an inner connection with the plant. The thought struck him that it was part of a whole that included not just the garden, but him as well, and that in the end he, too, was part of an all-encompassing beauty. He went on to ask himself if his perception was self-delusory. Is beauty just an illusion, a trick of synapses in the brain? Yet he felt something undeniable, a sense of happiness that continued to resonate within. Later, as he left the garden, even his colleague noticed the change in him. "We have investigated everything except the beauty of the flowers," said the Skeptic. The other answered: "Beauty is not measurable or provable. […] Beauty is neither an assumption nor a statement, but rather an overwhelming experience. We should have known that it is the same with beauty's creator, who is only recognizable if we, full of wonder, allow ourselves to be embraced with his goodness. […] Surely he was in the garden, but we were too busy with our measurements to perceive him.[4]

The beauty of a rose is not an objective fact of reality and thus not a matter of scientific scrutiny. The Skeptic in the story has seen photons reflected from the petals every day, but did not become aware of the rose until his last day. The special circumstances of the imminent departure, the feeling of losing a paradise, the relaxation of having accomplished work, new perceptions of the garden as a whole, an unconscious smell, or childhood memories have combined to a sensation that made him resonate with the objective properties of the flower. His reaction was certainly subjective, but not without external reason. The beauty was real to him as it had an effect on him. He participated in a perception that was direct and before he could even reason about it. Some aspects of the perception were objective and scientifically verifiable, such as the intensity and wavelength of the light, the refraction in the ocular lenses of his eyes, the function of the retina, and the activity of the brain. Yet beauty cannot be measured quantitatively.

Participatory Perceptions

Perceptions are externally related influences that have become part of our consciousness. Different kinds of perceptions together constitute our window onto reality. They include but are not restricted to scientific measurements and observations. In fact, most experiences in life are not of the scientific type, consisting of objective, quantitative, and repeatable measurements; rather, they are subjective perceptions in which we participate. Participatory perceptions include prereflective experiences of beauty, love, grief, hate, empathy, inspiration, fascination, motivation, amazement, and so forth. They are the everyday experiences that shape our life. The continuation of Flew's parable is meant to show that the reality perceived by humans is larger than what science is based on.

- Are non-objective perceptions just human illusions as some positivists claim? Such an assertion would make human existence an illusion, which I cannot take seriously.
- Will non-objective perceptions be explained one day by quantum mechanics and by chaos theory as some hard-core physicalists claim? There seems to be an insurmountable gap between mechanistic theories on one side and what is experienced in non-objective perceptions by the human consciousness on the other side. How can perceptions in the first-person perspective ever become third-person facts?
- Physics will undoubtedly develop further. Major parts are still missing, such as a quantized gravitation theory or the nature of dark matter. Will participatory perceptions be explained with a not-yet-available new physics in the far future? This remains an unimaginable hypothesis that cannot be evidenced at present and in the near future.

Another, and more pragmatic view, suggests that "there is more than physics." The statement has a long tradition and has become an issue in the recent science-religion dialogue.[5] The existence of something may be a metaphysical assumption or the conclusion of a philosophical argument. In science, the existence, for example, of a star is secured by an objective, repeatable observation. The observation then is interpreted by a theory based on previous observations and interpretations. The new observation thus becomes integrated into an increasing network of knowledge. Measurement and theory follow each other cyclically. Can the method and language shaped by science—in particular, physics—be applied to the part of reality that cannot be explored by science?

A claim for "more than physics" must be more than a hypothesis in a scientific worldview. The basis should be the experience that humans *do perceive more than physics*. Thus epistemology and cognition must precede ontology. Humans become aware of some reality in participatory perception, and they interpret it in a mental process in which the perceived is construed by metaphors, using imagination, instinct, or intuition. Participatory perceptions enlarge our cognition of reality.

How can humans perceive what science cannot? The excess in perception is possible through a way of cognition that is not objective and that is ultimately inapt for scientific inquiry and interpretation. I avoid referring to this perception as subjective and prefer the term "participatory." This perception has a clear subjective element, but it is based on an object (red rose). Yet the subject participates and plays an essential role.

Perceptions exceeding physical measurements may include "embodied cognitions" discussed in recent psychology.[6] An embodied cognition is the result of

interplay between sensory stimuli of the body and the emotions and feelings of an individual. It is not an exclusive activity of the brain, but involves various parts of the body. Embodied perceptions are well known and alluded to in popular expressions such as "gut feelings." They describe a situation in which objective perceptions and rational deliberations leave a person undecided, but in which holistic considerations of a wider field of experiences, including the body, are convincing. Antoine de Saint-Exupéry provocatively claimed: "It is only with one's heart that one sees clearly. What is essential is invisible to the eye."[7] Human perceptions involve not only the classical sensory organs such as eyes and ears, but also feelings, moods, emotional tensions, mystical experiences, environmental conditions, previous occurrences, or many of them together. It is a cognition in which the human being participates in an integral way.

Of course, the lack of objectivity immediately raises the question of reality. What is real? In view of Flew's parable, one may require that reality has an effect. Yet this effect may be subjective, as, for example, of being touched by the beauty of a flower. Participatory perceptions are therefore open to critique and may turn out to be imagination. Without critical reflection they soon become subjectivistic. The reliability of participatory perceptions is not as secure as in scientific (objective) measurements. One may argue that reality lasts, but illusions do not. Similar experiences in the past or future may enhance the reliability.

Figure 1 illustrates the basic separation between the two domains of objective (scientific) and non-objective (participatory) perceptions. Participatory perceptions involve brain activities and other bodily processes that can be studied objectively. However, they imply a conscious human self that has an irreducible perspective. The various participatory perceptions also overlap among themselves. Religion is related, for instance, to arts in the music of some primitive cultures.[8] Note that figure 1 distinguishes the constituting perceptions, but not their

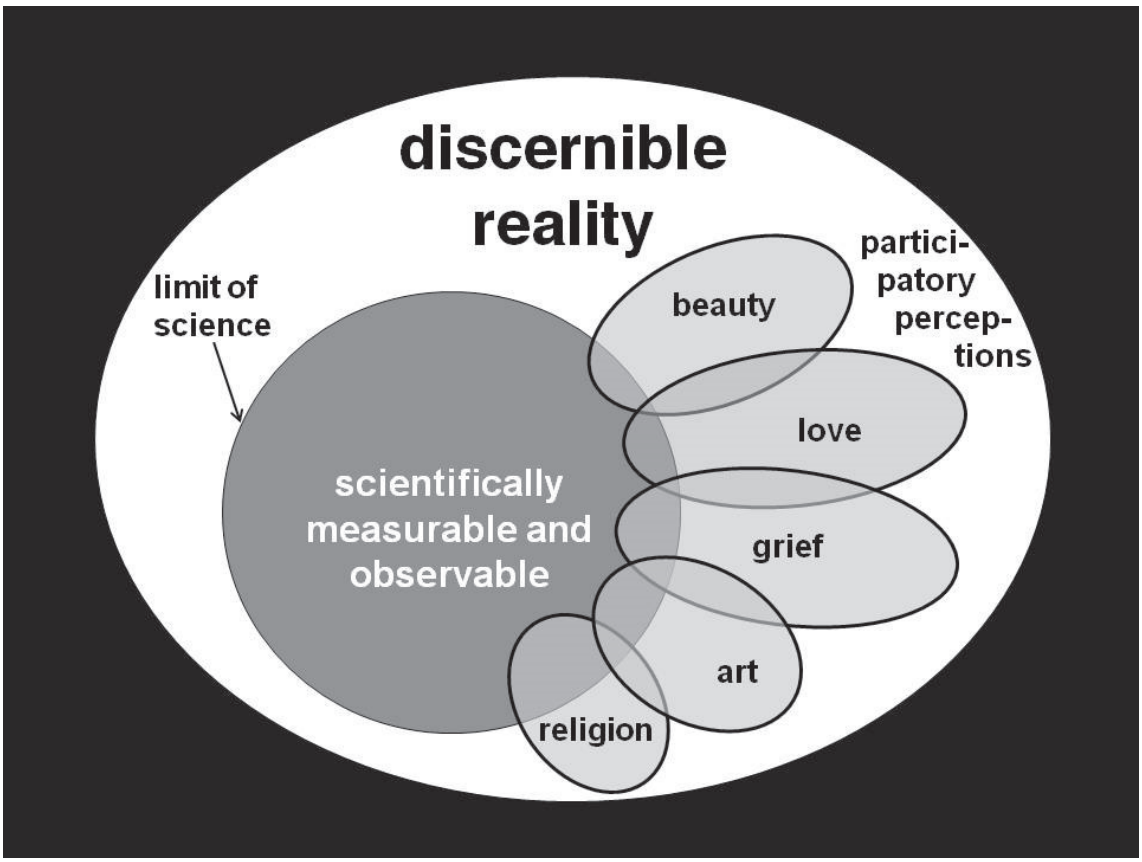

Figure 1. Schematic representation of perceptions. *White*: discernible reality; *dark gray*: perceptions selected by natural sciences (measurements and objective observations); *light gray*: non-objective perceptions accessible by participation and only partially by science (adapted from Arnold O. Benz, *Astrophysics and Creation: Perceiving the Universe through Science and Participation* [New York: Crossroad Publishing, 2016], 102).

subsequent interactions, such as the amazement or horror provoked by a scientific result when the science is popularized.

It is clear from what was said above that theology must be related to the experience of reality to be appreciated by today's science-minded skeptic in a modern worldview. Are the constituting experiences of religion rooted in objective science such as physics or, as suggested in figure 1, in participatory perceptions of "more than science"?

Physical Basis for Theology?

Modern science started in the sixteenth century with a new methodology. Nature was not interpreted from fundamental, preconceived ideas, but it was carefully studied by experiments, such as Galileo Galilei's free fall measurements, or by new tools, such as telescopes and microscopes. The fascinating discoveries were considered as revelations of the Divine and read as a second book of creation, as suggested already by Augustine of Hippo (354−430). Nature's amazing properties were interpreted by the graciousness and wisdom of the Creator. For the physico-theological researchers of the seventeenth century, the scientific perception of nature provided plenty of evidence for God. However, the surprising insights became more and more attributed to natural occurrences, such as in Darwin's theory of evolution. Every new scientific explanation of the world by natural causes was a blow to such theology based on science.

The idea of searching for the Divine in nature through reason and scientific inquiry is still alive today. Some authors claim to have found scientific evidence for supernatural phenomena in the form of an "intelligent design."[9] It is vigorously rejected by the scientific community as an aberration from the standard methodology. Theological arguments based on natural science may answer our amazement and yearning for meaning, but they are not conclusive in rigorous scientific terms.

A different approach, building theology on experience from modern physics, is based on quantum mechanics. Its uncertainty revolutionized the deterministic view of Newtonian physics. According to quantum theory, the future is open and not predictable within a certain range. The usual Copenhagen interpretation implies that reality does not even exist in microscopic dimensions until it is observed. In the twentieth century, it became generally accepted that the universe cannot be described as mechanical clockwork. This new space of indeterminate reality led to a significant theological development. Is there a place again for God in the physical world? Does God act in this world through quantum uncertainty?[10] Ian Barbour envisioned divine action taking place in a holistic way consistent with physics, such as quantum nonlocality.[11] The physicist-theologian John Polkinghorne sees "a much more promising line of inquiry [in] the subtlety of behavior enjoyed by complex dynamical systems,"[12] referring to unpredictability of the future known in chaos and complexity theory. Should the scientists in the parable have studied quantum mechanical or chaotic processes of the Garden?

Postulating divine action with benefit of the new physics has been criticized from the outset. Peter Hodgson pointed out that in the usual statistical interpretation, "quantum mechanics is irrelevant to the question of God's action in the world,"[13] because the statistical average is deterministic and leaves no room for divine freedom on a macroscopic scale. One may object here that quantum mechanics may still serve as a metaphor for uncertainty or for the openness of the future. However, in a good metaphor, a complex concept or experience is described figuratively by another, simpler, and well-understood phenomenon. The intricacies of physical theories make them far removed from the usual metaphors and their use requires popularization in an imprecise nonmathematical language. Thus, new physics is not really useful for metaphors, but it may pretend a false authority.

More-fundamental criticism arises from a philosophical perspective. Is physics the right starting point? Can theology build on modern physics? These questions express the suspicion that such attempts originate from the widespread but covert positivistic attitudes in modern worldviews. Taede Smedes criticizes today's science-religion dialogue based on arguments derived from the new physics as a "category mistake."[14] More critically, Lydia Jaeger challenges "the physicalist assumption that physics provides a true and complete description of nature's causal web,"[15] and concludes that physics does not

provide the basis for theology. Christian hope for a new creation in the future cannot be based on science.[16]

The interpretation of scientific results by divine interaction appeared to be self-evident considering that creation suggests a divine origin[17] of everything. However, if the experiential foundation of theology is sought in results of science, the focus is on gaps of scientific understanding, such as quantum uncertainty, chaotic unpredictability, time before the Big Bang, cosmic fine tuning, or missing biological links. In the public at large, gaps are still commonly considered to be the nexus between science and religion. Modern atheists claim the absence of such gaps and conclude the non-existence of God, as also implied by the parable of the Invisible Gardener. On the other hand, there is a strong movement in modern theology—in particular, since Karl Barth and his followers—claiming that science and scientific questions have no direct connection to theology.[18] Theology cannot be reconciled with science in scientific categories. That would base religion on science; this would lead to a dead-end street.[19] This does not mean, however, that there should be no connections between science and theology. A theological perspective on nature is possible and necessary.

Religious Perceptions

Here it is argued that religion originates from participatory perceptions. Religion appeared early in human history. Archeological artifacts and religious music, dancing, and rituals of today's uncivilized tribes give evidence of a rich religious life. These social phenomena express individual perceptions that are "embodied," and in which participation is essential. The archaic testimonies express a variety of religious perceptions that has not diminished since. William James describes, in his classic treatise, a dazzling diversity of religious experiences in America at the turn of the twentieth century, including examples not only of mysticism, revelation, conversion, and saintliness, but also of pathology. James already notes the "primacy of feeling in religion, philosophy being a secondary function."[20]

First, the general openness of the mind for religion-like perceptions may be characterized most commonly as spirituality. It includes all forms of contemplation and meditation, the feeling of emptiness, mountain-peak experiences, nature mysticism, and experiences of union and fullness. Spirituality requires a person willing to be open to a wide range of embodied cognitions. Such experiences are not necessarily considered "religious" by the person concerned. "Religious" here is a possible interpretation based on tradition and previous experiences.

Second, religious spirituality specifically connotes a relation to a reality transcending the person. It includes, for instance, sensing divine providence, experiencing answers to prayers, and being blessed with health, food, or life. Some people feel addressed by words, be it a poem or a passage from the Bible. It is such religious spirituality that is most commonly referred to as "religious experience."

Third, religious perceptions may be explicit experiences of God in visions, epiphanies, or revelations. Many descriptions of this kind of experience can be found in the Bible. Consider as an example the narrative of the Burning Bush:

> *Then Moses said to God [in the fire of a bush], "If I come to the people of Israel and say to them, 'The God of your fathers has sent me to you,' and they ask me, 'What is his name?' what shall I say to them?" God said to Moses, "I am who I am."*[21]

The text does not allow for a physical explanation by acoustic waves in the form of human speech that came out of a fire. In fact, the preceding sentences insist that the bush was not consumed by the fire, thus excluding any simplifying physical interpretation. The story sounds odd to a modern worldview. How could information be transferred without propagating waves? My interpretation is that it was a participatory perception as introduced above. It is reported to us in the form of a legend. In modern psychological terms, the occurrence may be called a "vision." It is reminiscent of a similar perception of a visionary fire reported by Blaise Pascal.[22] A vision is an experience that has a lasting effect in life. It is like an inner eye that perceives a dimension of reality that is normally hidden.

The self-revelation of God (Adonai) in the Burning Bush is fundamental in Judaism and Christianity. What is remarkable is that God does not define himself as the one who creates flowers in a jungle garden, started the Big Bang, fine-tuned the universe, or

hides in quantum uncertainty. He just is. He will be experienced directly in first-person perspective, for instance, when life in the desert becomes hard and his presence is urgently desired, as was the case on the flight from Egypt.

Here is another example from the narrative of the disciples from Emmaus:

> *When he [risen Christ] was at table with them, he took the bread and blessed and broke it and gave it to them. And their eyes were opened, and they recognized him. And he vanished from their sight. They said to each other, "Did not our hearts burn within us while he talked to us on the road, while he opened to us the Scriptures?"*[23]

Again, this may be interpreted as a legendary description of a vision. The remarkable content is the way the Divine was experienced. It is described as "a burning heart," much reminiscent of an embodied cognition and obviously a perception in which the men participated.

The two biblical texts describe extraordinary experiences in the context of ancient worldviews. As they are participating perceptions, they have left no objective trace and can be described only metaphorically: the perception of God is (1) like a talking bushfire, and (2) like a burning heart. Even in those times, religious perceptions were not everyday experiences. Both incidents are related to crucial incidents in history: the first, to the exodus from Egypt; and the second, to the foundation of Christianity.

Today, religious perceptions rarely surface beyond personal privacy. They are widely taboo in the general public and may be suspected as pathological. The more recent occurrences may be more mundane than and not as striking as the biblical examples. Yet, if biblical religious experiences were declared unique, they could not be related to present-day reality. Without some link to our experienced reality, they would become incomprehensible. It is relevant to rediscover paradigmatic experiences of the past, depurated and chastened by time. Biblical records may help for orientation and as examples, if they can be made appealing to a world dominated by scientific assumptions. Therefore it is necessary to discuss contemporary religious experiences in a broad context of cognition that includes the past.

Science-Religion Dialogue

The dialogue with theology started nearly simultaneously with the emergence of modern science. In the past, the dispute was mostly on a plane given by objective observations and rational arguments about chance and necessity. On such a plane, scientific and theological interpretations of reality may come into conflict. In the case of Galileo Galilei about the astronomical worldview, for example, the religious authority first dominated, but lost in the long run. Although we know today, contrary to what Galilei claimed, that the sun is not the center of the universe, it is generally agreed that this is a scientific question to be answered by science. As science starts out from a limited part of reality and religious perceptions are not objective and thus not part of science, religion has no part in scientific models and explanations. Theology may still interpret scientific results in metaphoric terms, but then it plays a more philosophical and reflective role. For instance, the universe may be interpreted as a gift.[24] Furthermore, theology may answer fundamental questions such as the meaning of the universe or why there is something and not nothing. The orientation provided by religion can be the starting point for ethics.

However, such a philosophical theology is not what religion originally was about. The two biblical examples given above narrate direct prereflective experiences of reality in human life. If theology wants to remain of practical importance, it must have a relation to participatory religious perceptions. Traditional cultures and religions are rooted in such experiences. They may not have the glamor of a moon landing or a Nobel Prize, but they have changed the lives of many contemporaries.

If the science-religion dialogue is to reach scientists, it has to leave the objective plane and insist that theology is more than dogmatic assumptions or unprovable claims. Theology is not just another interpretation of scientific results in a different language. It must be clear that the underlying perceptions are different. What is needed in the current science-religion dialogue is a return to religious perceptions and a new start. For a scientist, religious perceptions are bewildering and difficult to grasp. On the other hand, theology in the modern worldview is an exciting new territory to be explored in dialogue.

The scientific worldview needs to be assessed in the theological context and the theological implications of science must be pondered, overcoming Barth's distancing.

While the theological side must go back to its plethora of human experiences, science must not exceed the limits given by its observational bias. This new dialogue is different than before and may be incomprehensible for some of today's scientific atheists stuck in controversies of the past. However, it is better to be not understood at all, than to be misunderstood. ✧

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Notes

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[2]Antony Flew in *New Essays in Philosophical Theology,* ed. Antony Flew and Alasdair MacIntyre (New York: Macmillan, 1955), 96. After an earlier version by John Wisdom in "Gods," *Proceedings of the Aristotelian Society* (1944).

[3]John M. Frame, "God and Biblical Language: Transcendence and Immanence," in *God's Inerrant Word: An International Symposium on the Trustworthiness of Scripture,* ed. John W. Montgomery (Minneapolis, MN: Bethany Fellowship, 1974), 10.

[4]Arnold O. Benz, *Astrophysics and Creation: Perceiving the Universe through Science and Participation* (New York: Crossroad Publishing, 2016), 64–65.

[5]Andreas Losch, "Our World Is More Than Physics: A Constructive-Critical Comment on the Current Science & Theology Debate," *Theology & Science* 3, no. 3 (2005): 275–90.

[6]Francisco J. Varela, Evan Thompson, and Eleanor Rosch, *The Embodied Mind: Cognitive Science and Human Experience* (Cambridge, MA: MIT Press, 1991); and Robert A. Wilson and Lucia Foglia, "Embodied Cognition," in *The Stanford Encyclopedia of Philosophy,* ed. Edward N. Zalta (2016), https://plato.stanford.edu/entries/embodied-cognition/. For an extension into the animal world, see Jesse James Thomas, *Embodiment, How Animals and Humans Make Sense of Things: The Dawn of Art, Ethics, Science, Politics, and Religion* (Indianapolis, IN: Dog Ear Publishing, 2018), 54–60.

[7]Antoine de Saint-Exupéry, *The Little Prince*, trans. K. Woods (New York: Reynal and Hitchcock, 1943), chap. 21, 82.

[8]Thomas, *Embodiment, How Animals and Humans Make Sense of Things*, 177.

[9]Michael J. Behe, *Darwin's Black Box: The Biochemical Challenge to Evolution* (New York: Free Press, 2006), 252.

[10]Robert J. Russell, "Quantum Physics in Philosophical and Theological Perspective," in *Physics, Philosophy, and Theology: A Common Quest for Understanding*, ed. Robert J. Russell, William R. Stoeger, and George V. Coyne (Notre Dame, IN: University of Notre Dame Press, 1988), 343–74.

[11]Ian G. Barbour, "Indeterminacy, Holism, and God's Action," in *God's Action in Nature's World: Essays in Honour of Robert John Russell*, ed. Ted Peters and Nathan Hallanger (New York: Ashgate, 2006), 116.

[12]John Polkinghorne, *Science and Providence: God's Interaction with the World* (London: SPCK, 1989).

[13]Peter E. Hodgson, "God's Action in the World: The Relevance of Quantum Mechanics," *Zygon: Journal of Religion and Science* 35, no. 3 (2000): 505–16.

[14]Taede A. Smedes, "Taking Theology and Science Seriously without Category Mistakes: A Response to Ian Barbour," *Zygon: Journal of Religion and Science* 43, no. 1 (2008): 272.

[15]Lydia Jaeger, "Against Physicalism-Plus-God; How Creation Accounts for Divine Action in Nature's World," *Faith and Philosophy* 29, no. 3 (2012): 295–312.

[16]Arnold O. Benz, *The Future of the Universe: Chance, Chaos, God?* (New York: Continuum, 2001). See also Arnold O. Benz, "Theology in a Dynamic Universe," *Zygon: Journal of Religion and Science* 36, no. 3 (2001): 560.

[17]Immanuel Kant distinguishes the rational origin from the origin by time (causality). The rational origin denotes the conditions of the possibility, e.g., of star formation. For the realization of this possibility, a framework of conditions is necessary. In *Religion within the Limits of Reason Alone* (Chicago, IL: Open Court, 1960), 34.

[18]Karl Barth (1886–1968) strongly rejected the ideas of natural theology, into which physico-theology had evolved, by stating that "there can be no scientific … aids in relation to what Holy Scripture and the Christian Church understand by the divine work of creation" in *Church Dogmatics* III.I: *The Doctrine of Creation* (New York: T&T Clark, 1986), 11.

[19]Willem B. Drees, "Gaps for God?," in *Chaos and Complexity: Scientific Perspectives on Divine Action,* ed. Robert J. Russell, Nancey Murphy, and Arthur R. Peacocke (Vatican City State: Vatican Observatory Publications, 1996), 223–37.

[20]William James, *The Varieties of Religious Experience* (New York: Longmans, 1902), xi and 431.

[21]Exodus 3:13–14, from *The Holy Bible*, English Standard Version (ESV) (Wheaton, IL: Crossway, 2001).

[22]Blaise Pascal, "Memorial," in *Great Shorter Works of Pascal,* trans. Emile Caillet and John C. Blankenagel (Philadelphia, PA: Westminster Press, 1948).

[23]Luke 24:30–32, ESV.

[24]Benz, *Astrophysics and Creation*, 151 and 178.

William Horst

Article

Morality, Not Mortality: The Inception of Death in the Book of Romans

William Horst

In the book of Romans, Paul has often been understood to describe the inception of human mortality and the corruption of creation through the "original sin" of Adam and Eve, but this is difficult to square with the scientific insight that death is intrinsic to the evolutionary process. Certain works on theology and evolution posit that the inception of "death" in Romans refers to some construal of "spiritual death" rather than mortality or "physical death," but this has normally been stated briefly, with little exegetical analysis. This article outlines an exegetical case for a reading of "death" in Romans as a matter of moral corruption rather than mortal corruption, based on parallels between Paul's words and Hellenistic Jewish texts roughly contemporary with Paul, particularly the writings of Philo and Josephus. Ultimately, my analysis suggests that Christians can find coherence, rather than conflict, between Romans and evolutionary science.

In discussions at the intersection of evolutionary science and theology, one key topic has been the extent to which scripture can be squared with the current scientific consensus about evolution. Arguably, the biblical text that is most problematic to fit with evolution is the book of Romans, where Paul has often been understood to describe the inception of human mortality, the corruption of creation, and the infection of humanity with sinfulness and guilt through the "original sin" of Adam.[1] If humans came to exist on Earth through an evolutionary process in which innumerable generations of organisms lived and died, and to which death is, in fact, intrinsic,[2] then in what meaningful way can mortal corruption have its inception with Adam?

To cite a key verse of interest, Romans 5:12 says, "Just as sin came into the world through one person, and death through sin, so death spread to all people." The context clearly indicates that the "one person" is Adam (cf. Rom. 5:12–14).[3] This and other pertinent elements of Romans not only articulate the "plight" that concerns Paul throughout much of the text, but are also integral to Paul's framing of Christ as the "solution" to this plight.[4] Thus, the significance of "death" is not a peripheral interpretative issue, but rather a key consideration in any effort to understand Paul's articulation of the gospel of Jesus in this letter.

Some have addressed the apparent theme of the inception of death in Romans by reasoning that since Paul spoke as a first-century Jew, in a context in which evolutionary science could not begin to be understood, and in which it would have been normal to think that Adam and Eve caused human mortality, he can be forgiven for failing to provide an accurate picture of human origins.[5] Others have suggested that "death" in certain passages of Romans should be understood as "spiritual death" rather than "physical death"—separation from God, or some other form of relational or moral

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corruption, rather than mortality.[6] In this case, Paul is not mistaken about the inception of mortality; it is simply not a subject on which he comments at all.

I am generally sympathetic to the view that Romans describes "spiritual death" entering the world through Adam, but have found that it is normally stated briefly by authors who specialize in some field other than New Testament scholarship, and the argument is usually constructed in a manner that is unsatisfying from the perspective of a New Testament scholar. For instance, proponents of this view typically seem to assume a priori that Genesis and Romans both use "death" in reference to Adam with the same basic meaning, without grounding this claim in Paul's first-century Jewish context, and without any thorough treatment of "death" in Romans more broadly.

In this article, I aim to provide argument toward a full exegetical treatment of "death" in Romans that does meet the standards of New Testament scholarship and accomplishes roughly the same ends as the "spiritual death" view mentioned above. Specifically, I argue (1) that Paul should not be understood in Romans to describe the inception of human mortality, but rather the inception of "death" as a state of moral corruption resulting from sinful behavior, and (2) that this reading is at home in Paul's first-century Hellenistic Jewish milieu.

The Rebellion of the Passions and the Death of the Soul in Platonic Writings

It is commonly accepted that Paul's writings are heavily shaped by Jewish sacred texts, especially the writings of the Torah. Less obvious outside the world of Pauline scholarship is the extent to which Paul's writings also betray the influence of non-Jewish, Greco-Roman traditions, such as Greek philosophy. It turns out that Paul's world was thoroughly characterized by the interaction and blending of cultures—Greek, Roman, Egyptian, Jewish, and so on—so evidence of the influence of Greek thought in Paul's writings is precisely what we should expect.[7]

For my purposes, the influence of one particular strand of Greek philosophical tradition is especially interesting: Platonic accounts of the tyrannical rule of immoral passions. In several of his writings, Plato describes fierce conflict between different elements of the soul. In the *Phaedrus*, Socrates—as a character in Plato's dialogue—likens the human soul to a chariot pulled by two winged horses: one of noble breeding, the other wild (*Phaedr.* 246). When the charioteer and the horses see an object of love, the wild horse charges toward it, fighting against the charioteer and the obedient horse, and ultimately drags them along against their will. However, through the discipline associated with philosophy, the unruly horse can ultimately learn to behave due to repeated restraint (*Phaedr.* 254).

In the *Republic*, Plato has Socrates speak again of this sort of conflict within a tripartite soul, this time using the image of a human, a lion, and a many-headed beast, which are joined together and dwell inside a person (*Resp.* 588C–D). He identifies the "inner person" as the rational part of the soul. This image would seem to correspond to the charioteer in the imagery of the *Phaedrus*. He identifies the lion as the "spirited" part, and this image corresponds to the nobly bred horse. Finally, he identifies the many-headed beast as the desiring part, and this image corresponds to the wild, unruly horse (*Resp.* 441E–442A). The best-born and best-educated people possess temperance and "self-mastery," meaning that the desiring part of their soul is submitted to the rational part (*Resp.* 430E–431A), so that their rational will and their passions are in harmony, and they are less likely to commit immoral acts (*Resp.* 442E–443A; cf. *Resp.* 571B). However, in people of lesser discipline, desires run rampant (*Resp.* 431C). In the worst cases, the desiring part of the soul of a person enslaves the other parts (*Resp.* 444B) and rules over the person as a tyrant (*Resp.* 573C), compelling them to act contrary to the desire of their rational mind (*Resp.* 577C–E). In these dialogues and elsewhere, Plato describes this state of affairs in terms of the tyrannical rule of the passions, or the enslavement or imprisonment of the soul within the "mortal body."[8]

Philosophers of subsequent centuries work with Plato's material on the rebellion of immoral desires against the soul. It appears in the writings of Aristotle, Plutarch, Galen, and Albinus, to name a few.[9] It is not a peripheral detail in the Platonic tradition, but rather a concept that was of significant interest to Platonically informed thinkers long after the time of Plato.

Interestingly, Philo of Alexandria uses the language of "death" in his appropriation of the Platonic tradition of the rebellion of immoral desires. Philo, a first-century Jewish interpreter of scripture, roughly contemporary with Paul, was heavily influenced by Platonic and Stoic thought. His writings exemplify a sophisticated, Hellenistic Jewish interpretation of the books of Moses through the lens of Greek philosophical discourse. At many points in his writings, Philo describes sinful passions and immoral desires in ways that resemble the material I have discussed in Plato's own compositions. In several texts, Philo alludes specifically to the image of the charioteer with the winged horses that so many Platonic authors draw from the *Phaedrus*.[10] In other passages, he talks about bodily pleasures and immoral desires as "rebellious and treacherous," dominating, enslaving, imprisoning, or waging war against the rational mind.[11]

Another motif in Philo's writings is especially important for my purposes: He often uses the language of death to describe the dominion of passions or desires over the soul or mind.[12] In *Allegorical Interpretation*, Philo describes how the soul, as it dwells in the body, may become entangled with bodily pleasures; this entanglement has a corrupting influence on the soul and prevents virtuous living. He describes this state of entanglement and corruption as "death" (*Alleg. Interp.* 2.77–78). In *On Agriculture*, Philo also incorporates death into the Platonic image of a chariot pulled by two horses (*Agriculture* 67–77). In his variation on this metaphor, the horses, when they are not kept in check, drag the chariot in such a way that the charioteer is injured and dies, and the horses are free to go where they please, until they, too, fall into peril and die. In the same way, a lack of moral discipline leads to the death of the mind, which results in a person living a life of vice, which, in turn, leads to their destruction. Frequently, and in various ways, Philo uses language associated with death to describe the condition of the soul when it is inadequately trained for virtuous behavior, as it becomes unable to act uprightly.

Philo's writings are in many ways unique among surviving Hellenistic Jewish texts, but scholars of Philo commonly recognize that he presents elements of earlier Jewish exegetical tradition alongside his own innovative thoughts;[13] thus his use of "death" to describe the subjection of the soul to the passions cannot be easily dismissed as an eccentricity of his particular thought. Although we do not currently have access to many additional examples of the language of "death" used in connection with this element of moral discourse, Josephus does provide a piece of supporting evidence that such language was known outside of Philo's particular circle. Josephus was a Jewish author from the late first century, who wrote his literary works in Rome after growing up in Judea. In his *Jewish War*, Josephus says that "while souls are bound in a mortal body, they are partakers of [the body's] evils, and to speak most truly, they are dead" (*J.W.* 7.344). Josephus speaks here of the death of the soul in a manner similar to Philo, but from a different region, which suggests that such language may well have been known sufficiently broadly for Paul to have been familiar with it, too.[14]

The Meaning of "Death" in Romans 6:1–8:13

Emma Wasserman argues convincingly that various elements of Romans 6–8 fit within the context of Platonic discourse along the lines I have been describing.[15] Paul summarizes his view of the transformation that he and the Romans have undergone in Christ:

> When we were in the flesh, the sinful passions, which arose through the Law, were being brought about in our members, with the result that we bore fruit for death, but now, we have been released from the Law, since we died to that which held us captive … (Rom. 7:5–6)

This brief summary encapsulates a set of ideas that occur frequently throughout Romans 6–8, which bear a striking similarity to some of the Platonic motifs I discussed earlier, including the notion of being enslaved to sinful passions (Rom. 6:6–7, 16–20, 22; 7:14, 25; 8:2), the body or "members" as the place where sin impacts a person (Rom. 6:6, 13, 19; 7:5, 23), and the notion that a kind of death sets a person free from slavery to sin (Rom. 6:7, 9–11; 7:2–3). In Romans 6:1–8:13 more broadly, Paul uses a number of other images, words, and phrases that cohere with the Platonic imagery of the rebellion of the passions: sin violently dominates those who routinely commit sins (Rom. 6:12, 14; 7:23), and even wages war against them (Rom. 7:23); and sin rules in the "mortal body" (Rom. 6:12; 8:11).[16] Like Philo, Paul also speaks many times of sin bringing about death (Rom. 6:16, 21, 23; 7:9–12; 8:6, 10, 12).

Perhaps most strikingly, Paul talks about a struggle between the will of the mind and the sinful impulses of the body:

> I delight in God's Law according to the inner person, but I see another law in my members, waging war against the law of my mind, making me captive to the law of sin, which is in my members. Wretched person that I am! Who will rescue me from this body of death? (Rom. 7:22–24)

Although Paul's notion here, that the Law exacerbates the problem of sin, does not resemble anything in Philo, Plato, or any other writer in the Platonic tradition that is known to me, he nonetheless narrates striving with sin in a way that closely resembles Platonic discourse about the soul and bodily desires. Immoral impulses, which are associated with the body, wage war against, dominate, shackle, and kill the mind, thereby causing behavior that is at odds with the desire of the mind. Further, Paul's use of the phrase "inner person" to describe the mind closely resembles Plato's account of the rational part of the soul in the *Republic*.[17] As in Philo, Paul uses the language of "death" to describe the condition of the "inner person" being bound to sinful desires.

I do not suggest that Paul believes everything that Plato or Philo believes about the soul or the body. The motifs I have outlined are fluid across various authors of the Platonic tradition,[18] and to whatever extent Paul appropriates them, he makes them his own. My claim is that Paul could plausibly have used the language of "death" to refer to a state of moral corruption associated with sinful impulses, and that a number of elements in Romans support this reading.

The Inception of Death in Romans 5:12–21

Of course, the key passage for anyone considering the inception of mortality in Romans is 5:12–21, where Paul sets Adam in parallel to Christ. In particular, he says, "Just as sin entered the world through one person, and death entered through sin, so death spread to all, because all sinned" (Rom. 5:12). This is the *locus classicus* for discourse about "original sin," "Fall," and the like. Paul mentions death a number of times in the passage, and clearly links the "death" of many people to the initial transgression of God's command by Adam (Rom. 5:14, 15, 17, 18, 19), but nothing in the passage necessitates interpreting the inception of "death" through Adam as the inception of mortality, or any other construal of what we might call "physical death," nor does Paul specify the mechanism by which death or sin was mediated to other humans because of Adam. This passage immediately precedes the portion of Romans that I discussed earlier (Rom. 6:1–8:13),[19] where there is good reason to find the influence of Platonic moral discourse lying behind Paul's comments, including the use of the language of "death" to refer to a state of moral corruption and subjection to sinful passions, as we find in Philo. So, it makes more sense to read the inception of sin and death through Adam in terms of the inception of sin and its accompanying *moral corruption*, rather than the inception of sin and its accompanying *mortality*.

The idea that Paul might describe the inception of something akin to Philo's "death of the soul" through the trespass of Adam is supported by the fact that Philo reads Adam and Eve's transgression in this way (see *Allegorical Interpretation* 1.105–8). Philo, commenting on the penalty of death that God prescribes for eating the forbidden fruit, notices that Adam and Eve do not physically die upon violating God's command, and explains that there are two kinds of death: the separation of the soul from the body, which is natural to creation; and the death of the soul, which is "the destruction of virtue and the ascension of vice" (*Alleg. Interp.* 1.105) and which is inflicted as a punishment (*Alleg. Interp.* 1.107). The soul in such a condition is dead to the life of virtue, and lives according to the life of vice (*Alleg. Interp.* 1.107).[20] If Paul is influenced by a Hellenistic Jewish tradition of appropriating Platonic moral discourse in order to frame an understanding of obedience to God's instruction—and I have argued there is good reason to think this is so—then it is perfectly likely that he understood the inception of sin and death through Adam in such terms.

Alternative Interpretations of Death in Romans

Scholars of Romans typically interpret the language of death according to one of two paradigms. According to the first paradigm, death refers primarily to human mortality or "physical death," which is a divine penalty for human sin. In *The Evolution of Adam*, Peter Enns rightly argues that Paul is an ancient Jewish author, and like many other ancient

Jewish authors, he interprets Adam in accordance with his particular theological concerns.[21] Enns argues that Paul came to recognize that Christ died and rose in order to set all humans free from sin and death. This perception led Paul to conclude that humans are under the universal power of sin and death, hence the need for Christ to set them free. Enns notes that several Jewish texts from around the time of Paul attribute human mortality to Adam, as a penalty for sin (for example, 4 Ezra 7.48, 118–19; 2 Bar. 23.4; Apocalypse of Moses 13–14), and he argues that Paul drew upon the figure of Adam to convey the universality of human sinfulness and mortality because it was a readily available category in his context.[22] A number of commentators likewise understand "death" in Romans primarily as a penalty for sin, often with reference to the same Jewish texts that Enns discusses, which attribute both sin and mortality to Adam.[23]

Although several Jewish writings from around the time of Paul do indeed attribute human mortality to Adam, this is not a unanimous view within Paul's cultural milieu. Some Jewish writings portray Adam as a morally neutral or even positive figure, without reference to a "Fall" (for example, Wisd. of Sol. 10.1–2; Sir. 49.16; Philo, *Creation* 142–50),[24] and others, such as Philo (see above), treat human mortality as though it is natural, without any clear sense that humans became mortal through a primordial lapse (for example, Sir. 7.1–13; Wisd. of Sol. 15.8–9). In some cases, death is associated with Adam, not because of a primordial sin of Adam and Eve, but because humanity shares Adam's body of dust; this means that death and decay are inevitable (for example, Sir. 33.10; *Thanksgiving Hymns* 18.4–9; cf. Gen. 2:7; 3:19).[25] To my knowledge, proponents of the reading of Romans that identifies "death" with human mortality, which is a punishment for human sin, have not provided a detailed case for why their interpretation of the inception of death through Adam fits the text *better* than other alternatives, for which parallels can also be found in Paul's cultural context. The interpretation I have proposed, of death as moral corruption, draws on many specific thematic and linguistic parallels with the Hellenistic tradition of moral discourse (see above), so it is well supported by the details of the text of Romans.

The second major interpretative paradigm interprets death and sin as "cosmic powers," that is, forces that oppose the redemptive work of God, based on Paul's personification of sin and death as tyrants that rule over the world (for example, Rom. 5:14, 17, 21), enslave humans (for example, Rom. 6:14, 20), and seize an opportunity to deceive and kill people through the Mosaic Law (Rom. 7:8, 11). Often, scholars conceptualize such "powers" as personal entities, and may even capitalize Death and Sin as proper names for particular beings, similar to rebellious angels or demons. For instance, Beverly Roberts Gaventa calls Sin a "*cosmic terrorist*," who exercises a destructive reign over the world with another anti-God power, Death, as an accomplice.[26] Through Jesus Christ, God wages battle against the rebellious powers of Sin and Death, which gained a foothold in God's creation through the disobedience of Adam.

Much like interpretations of "death" in Romans that center on mortality as a penalty for sin, interpretations that appeal to "cosmic powers" do have parallels in the Jewish milieu of Paul. For instance, the *Community Rule*, one of the texts discovered among the Dead Sea Scrolls, refers to spirits of light and darkness. The spirit of light enables humans to act with righteousness, whereas the spirit of darkness promotes immoral human behavior (*Community Rule* 3–4). However, Paul's personification of death and sin as tyrants does not necessarily imply that he is thinking in terms of cosmic powers, along the lines of the spirit of darkness in the *Community Rule.* No element of the text of Romans requires "death" or "sin" to refer to entities that are external to human beings, and everything Paul says about death and sin is readily explainable as personification without appeal to Jewish notions of cosmic powers. Further, Jewish writings that refer to anti-God powers normally make clear that they are doing so. The *Community Rule* clearly identifies light and darkness as two "angels" and "spirits," as do other key texts that address such beings (for example, 1 Enoch 1–36; cf. Testament of Abraham 16–20), whereas Paul does not make any such clear designation.

My analysis of Romans based on Hellenistic moral discourse, accounts for the tyrannical language Paul uses in reference to death and sin, since this language is typical of material about struggle between a person's rational will and bodily passions in the writings of Plato, Philo, and others (see above). There is little reason to appeal to cosmic powers once one recog-

nizes the striking parallels between Romans 5–8 and these philosophical texts in the Platonic tradition.[27]

The Absence of Glory in Romans 1:23

Thus far, my analysis has focused on Romans 5:12–8:13, where the language of death is especially concentrated. However, for my argument to hold water, there are three additional passages that should be addressed, which some scholars have understood to refer to the introduction of mortal corruption to the world through Adam (i.e., Rom. 1:23; 3:23; 8:20–23). In the first instance, Paul says of past humanity that, "They exchanged the glory of the incorruptible God for the likeness of the image of a corruptible human, and birds, and four-footed creatures, and reptiles" (Rom. 1:23). Commentators on Romans often find a literary echo of the "Fall" of Adam and Eve in this passage, and commonly cite two brief, seminal articles by Morna D. Hooker.[28] The core of Hooker's argument is as follows. First, Paul lists several categories of animals in addition to "a mortal human," and Genesis follows the creation of humanity with a similar list: "They will rule the fish of the sea and the birds of the air and the cattle and all the earth, and all the reptiles that creep on the earth" (Gen. 1:26).[29] Second, the words "image" and "likeness" in Romans 1:23 also occur in the creation of humanity in Genesis: "Let us make humanity in our image, according to our likeness" (Rom. 1:26). Third, a number of ancient Jewish literary traditions associate Adam with glory, and in some cases, Adam's loss of glory with a loss of immortality and the privilege of dominion over creation. Hooker and those who follow her take the disregard of the glory of the immortal God in Romans to evoke traditions of Adam's loss of immortal glory in Eden, based on the other aforementioned parallels between Romans 1:23 and the account of creation in Genesis.

Hooker's argument for the presence of traditions about an Edenic "Fall" in the background of Paul's statement about the loss of glory in Romans 1:23 is unconvincing due to another, clearer set of parallels between this passage and several Old Testament writings. Although some ancient Jewish writings do associate Adam and Eve with a loss of immortal glory (for example, 4 Ezra 7.122; 2 Bar. 15.8; Apocalypse of Moses 20–21),[30] the absence of glory also occurs in many other contexts, including material related to the Exodus.[31] The relevance of "glory" to the Exodus is noteworthy because striking parallels can be found between Paul's comments about the exchange of glory in Romans 1:23 and passages of the Old Testament that evoke the Exodus. One key example occurs in Psalm 106, which includes language that closely resembles Paul's statement that, "They exchanged the glory of the incorruptible God for the likeness of the image of [various created things]." The Psalm reads, "They made a calf at Horeb, and worshipped a cast image. *They exchanged the glory of God for the image of an ox that eats grass*. They forgot God, their Savior, who had done great things in Egypt" (Ps. 106:19–21; cf. Exod. 32). Here, "glory" has to do with proper devotion to God as Savior, and the exchange of glory has to do with turning from God to an idol. This passage matches both the language and the concept of people turning away from God in Romans, much more closely than any known text associated with the "Fall" of Eden.[32]

The combination of the words "image" and "likeness" can also be found in a passage of the Pentateuch related to the Exodus. In Deuteronomy, Moses cautions the people of Israel against idolatry by recounting the incident at Sinai: "Guard your souls carefully—for you saw no *likeness* on the day that the Lord spoke to you at Horeb, on the mountain, from the midst of the fire—so that you may not transgress and make for yourselves a carved *likeness*—any *image*," followed by a list of categories of images that closely resembles Paul's list in Romans (4:15–18; cf. Rom. 4:25–27). This passage does not explicitly evoke the creation of humanity; it does resemble the relevant material of Romans, at least as closely as does any known passage related to Eden, and it coheres with the context of Sinai pertinent to the Psalm that I just discussed.[33] Hooker does acknowledge the linguistic resemblance that Paul's words bear to these passages from Deuteronomy and the Psalms, but she goes on to say that the core organizing idea with which Paul is working is the Fall of primordial humanity.[34]

However, once the parallels to Psalm 106 and Deuteronomy are acknowledged, there remains no substantial element in Romans 1:23 that ought to point an interpreter to the Fall of humanity in Eden. This passage of Romans certainly does contain a contrast between God as Creator, who deserves worship, and created beings, who do not (Rom. 1:25;

cf. Rom. 1:20). So, it is fair to say that the passage evokes creation, but the parallels between Romans and the Exodus tradition strongly imply that the exchange of glory that Paul addresses has to do with an exchange of proper devotion to the Creator God for erroneous devotion to idols. There is no good reason to find Adam or the origin of human mortality in this passage.

The Absence of Glory in Romans 3:23

Paul alludes to the absence of glory again when he says, "Everyone has sinned and lacks the glory of God" (Rom. 3:23). A number of interpreters find here an additional allusion to a loss of immortal glory due to the primordial "Fall" of Adam and Eve. For instance, Ben C. Blackwell argues that this passage evokes a loss of "ontological glory," that is, incorruption and abundant life, which Adam exchanged for corruption and mortality, according to certain Jewish writings.[35] Considering the discourse of Romans broadly, this latter statement about glory (Rom. 3:23) appears to refer back to Paul's account of the exchange of God's glory for idols (Rom. 1:23), and there is no apparent reason why our interpretation of humanity's *lack* of glory should not follow from our interpretation of the *exchange* of glory earlier in Romans.

Commentators who find an Adamic Fall in the exchange of God's glory for idols (Rom. 1:23) typically also find an Adamic Fall behind this assertion of humanity's lack of glory (Rom. 3:23), and commentators who understand the exchange of glory earlier in the text as a Sinai-like fracturing of proper devotion to the Creator also typically understand humanity's lack of glory as reflective of a fractured relationship with God, without reference to mortality due to Adam and Eve's "Fall."[36] Since, as I have argued, there is no compelling reason to find a reference to the origin of human mortality through Adam in Paul's earlier comment about the exchange of glory for idols (Rom. 1:23), there is also no compelling reason to find such themes behind Paul's subsequent assertion that humanity lacks the glory of God (Rom. 3:23). This passage refers to universal moral corruption due to humanity's estrangement from God, which necessitates that everyone be justified by faith (Rom. 3:24–28). Paul does not evoke the inception of human mortality here.

The Subjection of Creation to Decay in Romans 8:20–23

Finally, a brief word is in order regarding the subjection of creation in Romans 8:20–23. Paul refers to creation being "subjected to futility" (Rom. 8:20) in the hope that it would be set free from slavery to "corruption" (Rom. 8:21), and Pauline scholars often take these comments as an evocation of the "Fall" of Eden and the inception of mortality and corruptibility in the creation. For instance, James D. G. Dunn interprets this passage as one of many allusions to Adam as the source of creation's and humanity's plight throughout the first half of Romans (1:18–25; 3:23; 5:12–19; 7:7–11; 8:19–22). He notes that God's judgment on Adam in Genesis involves a curse on the ground (Gen. 3:17–18), and interprets the subjection of creation to futility and corruption in Romans as evocative of this Adamic curse on creation. He further notes the parallel between the "futility" of creation in this passage and an earlier description of humans becoming "futile" in their thinking (Rom. 1:21), which Paul also associates with the corruption of humanity through the trespass of Adam (Rom. 1:18–25).[37] Under the assumption that the Fall of Eden lies behind much of the argument of Romans, this reading makes good sense, but if one does not assume that such a theme pervades Romans, there is little reason to find an evocation of Eden behind creation's subjection to futility. I have already argued against finding literary echoes of Adam behind passages in Romans about humanity's lack of glory (Rom. 1:23; 3:23); my argument weakens the basis for Dunn's view that the Fall of Adam lies behind Romans 1–8 broadly. As in those passages, Paul's comments on creation's subjection to futility (Rom. 8:20–22) are better understood in terms of moral corruption rather than mortal corruption.

The word Paul uses for "futility" (*mataiotēs*, Rom. 8:20) consistently refers to moral corruption in the New Testament and other early Christian texts; a cognate of the same word appears in a passage I discussed above, where Paul says that those humans who refused to honor God became futile in their minds (Rom. 1:21) and ultimately fell into moral disarray (Rom. 1:24–32).[38] The word for "corruption" (*phthora*, Rom. 8:21) can refer to the deterioration of organic matter (that is, decay), but it can also refer to moral depravity and/or the destructive results of immoral acts. It occurs with this sense a number of

times in the New Testament and in other Jewish and Christian writings from around the time of Paul.[39] An especially relevant parallel is 2 Peter 2:18–19, where false prophets are said to be "slaves of corruption," where "corruption" is clearly moral rather than biological, and where the word "futility" also occurs in reference to moral inadequacy.

Further, as Laurie J. Braaten points out, Paul refers in Romans 8:22 to the groaning and suffering of creation, and this sort of characterization of the creation readily evokes a number of passages in the prophetic books of the Old Testament, where the earth or a particular land is said to mourn (Isa. 24:1–20; 33:7–9; Jer. 4:23–28; 12:1–4, 7–13; 23:9–12; Hosea 4:1–3; Joel 1:5–20; Amos 1:2).[40] In none of these passages does the earth mourn over mortality, physical decay, or anything of this sort. Rather, each passage has to do with sinful human behavior, which has implications of one sort or another for the condition of the earth itself.

Genesis does not describe the Adamic curse on the ground with any language similar to "futility" or "corruption," and Paul's earlier use of "futility" in Romans (1:21) has to do with foolish, morally corrupt thinking that results from humanity turning away from proper devotion to God (cf. Rom. 1:23). Therefore, good reason exists to understand Paul's words on the subjection of creation to futility (Rom. 8:20–22) in moral terms. Humans engage in consistent patterns of "futile" and "corrupt" behavior, which imposes various kinds of problems on the earth. Thus Paul speaks of the earth groaning for deliverance, together with the children of God. Paul goes on to encourage the Roman church about the inability of persecution and violence to separate them from the love of God (Rom. 8:35–39; cf. Rom. 1:29; 5:3–5). Therefore, one might imagine that violent acts are a key form of moral "corruption" that Paul describes, causing the earth to mourn together with God's children.

Scholars such as Dunn, who interpret the subjection of creation to futility and corruption (Rom. 8:20–22) as creation's bondage to physical decay due to the Adamic curse on the ground, typically also understand "the redemption of our bodies" (Rom. 8:23), to which Paul looks forward, as an eschatological reversal of the corruption of mortality that humans have inherited from Adam.[41] However, the redemption of bodies in this passage is also consistent with my Hellenistic moral reading of the inception of "death" in Romans. Authors such as Plato and Philo typically associate the tyrannical rule of immoral passions with the soul's dwelling in the body, since bodily desires are often the source of internal conflict between a person's rational will and their passions (for example, Plato, *Phaedo* 67D, 81E; Philo, *That God Is Unchangeable* 111; Josephus, *Jewish Wars* 7.344–47). Paul likewise associates sinfulness with the body, as is most clear when he refers to sin working through the body's "members" to produce the fruit of moral death (Rom. 7:5, 23; cf. Rom. 6:6, 12, 19; 7:18, 25). Thus, the redemption of bodies in Romans can be readily understood together with other aspects of Paul's moral discourse: God will transform and vivify the bodies of the children of God; this transformation will enable them to live freely, without the encumbrance of fleshly impulses. The corruption of human mortality need not enter our analysis here.

The Relevance of Death through Adam in 1 Corinthians

I have argued that in Romans, Paul describes the inception of "death" through Adam as a matter of moral corruption rather than mortality. One might object that Paul, in 1 Corinthians, contrasts Adam and Christ in a manner similar to Romans, and states that "everyone dies in Adam," in a context in which physical, bodily death is clearly Paul's salient concern (1 Cor. 15:21–22; cf. 1 Cor. 15:12–20, 35–56). So, this parallel passage undermines my interpretation of the inception of "death" through Adam as a moral metaphor rather than mortality in Romans.

Along similar lines, Denis O. Lamoureux acknowledges the ambiguity of the language of "death" in Romans 5:12–21, especially given several passages in Romans that deal with what he calls "spiritual death" rather than the cessation of bodily life (Rom. 6:13; 7:9–13; 8:6). Yet he argues that the "death" that enters the world through Adam in Romans has to do with physical death, based on the parallel in 1 Corinthians.[42]

The parallel between Paul's references to the inception of death through Adam in Romans and 1 Corinthians is certainly an important consideration in the interpretation of either passage, but the similarity between these two Pauline passages does not

necessarily imply that Paul is talking about death in the same sort of way in both letters. Pauline scholars have long recognized that his writings often show substantial variation on a given topic,[43] and they typically attribute this to the occasional nature of his letters. In other words, Paul's letters do not constitute systematic theological treatises. He writes to particular communities to address particular circumstances, and as a result, his body of letters attests rhetorical flexibility, including flexibility in how he brings a given biblical figure to bear on his discussions.[44] For this reason, consistency between Paul's parallel passages on Adam would have to be demonstrated rather than assumed.

Considering the etiology of death in Romans and 1 Corinthians in particular, it is relevant that certain scholars have noticed a difference in how Paul portrays the corruption of creation in these letters. Edward Adams argues that Paul, in 1 Corinthians, stresses contrast between the church and its social and cultural environment in order to encourage stronger social and ideological boundaries in the Corinthian church. As a result, Paul emphasizes sharp discontinuity between "the present world" and "the world to come," and identifies the Corinthians with "the world to come," whereas he associates those outside the Corinthian church with "the present world," which, Paul emphasizes, is intrinsically corrupt and problematic. By contrast, Adams argues that Paul, in Romans, seeks to encourage the Roman community in the midst of tension with their social environment, and thus emphasizes God's faithfulness to creation, which has become corrupt and requires redemption, yet remains fundamentally good.[45] In other words, in Romans, Paul portrays the world as God's good creation into which corruption has entered, whereas in 1 Corinthians, Paul portrays the world as inherently tainted and in need of replacement by an imperishable, new creation.

J. Christiaan Beker likewise notes that Paul, in Romans, portrays sin and death as "alien" to creation, whereas in 1 Corinthians, creation has "an inherently temporal, transient, and finite character," for which reason Paul treats death more as a natural part of life in the present age.[46]

Paul's particular comments on the relationship of Adam to human death are consistent with the differences that Adams and Beker highlight between these two letters. In Romans, Paul describes sin and death "entering in" to the world as a result of Adam's disobedience (Rom. 5:12), whereas in 1 Corinthians, Paul simply attributes the problem of death to Adam (1 Cor. 15:21–22), who has a perishable body made of dust that all other humans share (1 Cor. 15:45–49), without a clear indication that death entered into a deathless, uncorrupted creation because of a primordial sin. Virtually all English translations render 1 Corinthians 15:21 to say that death "came" through Adam, which may give the impression that death entered the world, where it was previously absent. This verse, however, contains no explicit verb in the original Greek, and it could just as easily be understood to mean that human mortality is due to humanity's solidarity with the corruptible body of Adam.

Jason Maston has likewise recently proffered a detailed, exegetical argument in favor of reading 1 Corinthians 15 in such a way that humanity's major problem in this passage is that everyone possesses a "dusty" body like that of Adam, and is thus wasting away, unless God makes them alive by the Spirit.[47] One may decide that Maston's reading is wrong, but his analysis highlights that 1 Corinthians can potentially be understood to show that resurrection through Christ solves the problem of humanity's inherent mortality.

In addition to considerations about how Paul constructs creation's corruption in Romans and 1 Corinthians broadly, the passages of each letter in which Paul discusses Adam also evidence different rhetorical concerns. In 1 Corinthians, Paul brings up death and resurrection in the context of a dispute in the Corinthian community over whether God resurrects those believers in Christ who have died (1 Cor. 15:12–19). In this context, it makes good sense that Paul would discuss human mortality, as he is addressing concerns about physical death and the fate of those who have died. However, the text of Romans does not evidence any clear concern about the fate of those who have died. Rather, Paul brings up death through Adam in the context of reassurance about the certainty of future glory for the Roman community (Rom. 5:1–21). Paul emphasizes the super-abundance of God's grace through Christ, which is more than sufficient to address the problem of sin and death through Adam (see esp. Rom. 5:15, 17, 20–21). The triumph of God's grace over sin in this

passage does not furnish a reason to insist that Paul brings up "death" in reference to human mortality. If death is a state of moral corruption associated with sin, this would be perfectly consistent with the overall thrust of Paul's rhetoric. Further, just after this section related to Adam (Rom. 5:12–21), Paul goes on to clarify that grace through Christ does not imply that sinful living is acceptable (Rom. 6:1, 15); this explanation further highlights the moral focus of his discourse in this part of the letter (cf. Rom. 6:1–8:13).

In sum, in 1 Corinthians, it is clear that Paul is concerned with "death" as human mortality when he mentions Adam, but it is not at all clear that "death" is an interloper in God's creation. In Romans, it is clear that "death" is an interloper in God's creation, but it is not at all clear that "death" has anything to do with human mortality, and as I have argued, we *do* have good exegetical reason to understand "death" in Romans as a metaphor for a morally corrupt life. For these reasons, detailed analysis of 1 Corinthians would be relevant to an overall study of Paul's understanding of human mortality, and whether mortality is inherent or alien to God's creation, but this analysis would have to be distinct from my present analysis of "death" in Romans. Paul's discussions of death in these two letters are decidedly different, and occur in quite different contexts, so we do not have grounds to assume that Paul intends to communicate the same fundamental things about "death" in each letter.

Why Not Morality *and* Mortality?

Some exegetes have argued that Paul has in mind both moral death and mortal death when he addresses the inception of death through Adam in Romans. For instance, Thomas Barosse argues that Paul has in mind a comprehensive, "total death" when he discusses death and sin entering the world through Adam's trespass.[48] One could accept my argument that Paul, in Romans, describes the inception of moral corruption through Adam, and yet maintain that Paul *also* intends to convey that human mortality has its origin through Adam. I cannot prove that Paul did not think that humans became mortal through the trespass of Adam and Eve, and some ancient Jewish thinkers certainly did understand human mortality in this way (4 Ezra 7.118–19; 2 Bar. 23.4; Apocalypse of Moses 14.2–3), but nothing in Paul's letters *must* indicate that human mortality has intruded into God's creation. And once the Hellenistic moral background of much of Paul's language of "death" in Romans is recognized, there remains no reference to death in Romans that *ought* to be understood, first and foremost, to indicate that human mortality is a result of human sin.[49] It is indeed possible that Paul held a belief that both moral corruption and mortality entered humanity through Adam, but he never makes a clear, salient statement about mortality as a penalty for sin in Romans. For this reason, modern Christians do not need to consider Paul's discussion of death in Romans to be an obsolete, ancient misconception that must be discarded in light of evolutionary science.

Conclusion

Based on the reading I have sketched out here, I conclude that insufficient evidence exists to insist that Paul's letter to the Romans describes the inception of human mortality. Indeed, if we read Romans with sensitivity to the Hellenized context of Paul's ministry and to the resonance of certain elements of his writing within that context, we have good reason to understand the inception of death and sin in Romans through the lens of the Platonic tradition. Paul appears to use the language of "death" to describe the subjection of a person to immoral passions, in a manner similar to other Hellenistic Jewish authors, particularly Philo and Josephus. On the matter of the inception of death in connection with Adam, twenty-first-century Christians do not need to resort to explaining away Paul's understanding as a historically conditioned assumption that modern science renders untenable. In short, the inception of "death" in Romans is a matter of *morality*, not *mortality.*

I have specifically sought to replace prior arguments for a "spiritual death" reading of Romans with an argument that better stands up to critical scrutiny from Pauline scholars. I have not sought to give an account of how Christians might understand the inception of moral corruption through Adam in light of insights about human development from other fields of study,[50] nor have I sought to thoroughly analyze 1 Corinthians 15, which deserves exegetical treatment in its own right. The present article is merely one step toward a thorough reflection on the significance of the Christian Gospel in light of the insights of evolutionary science. My reading of Romans prompts further thinking about the origins

of human plight, and Christ as the solution to human plight, vis-à-vis a scientifically informed account of the human story. ✧

Notes

[1]For a brief but detailed treatment of original sin in the Christian tradition, including the writings of Paul, see John E. Toews, *The Story of Original Sin* (Eugene, OR: Pickwick, 2013).

[2]As John R. Wood succinctly puts it, "Nothing in ecology makes sense apart from the operations of physical death" in "An Ecological Perspective on the Role of Death in Creation," *Perspectives on Science and Christian Faith* 68, no. 2 (2016): 78.

[3]All English translations are my own.

[4]The language of "solution" and "plight" was popularized in Pauline studies by E. P. Sanders, *Paul and Palestinian Judaism: A Comparison of Patterns of Religion* (Philadelphia, PA: Fortress, 1977), 442–47.

[5]For example, Denis O. Lamoureux, *Evolutionary Creation: A Christian Approach to Evolution* (Eugene, OR: Wipf and Stock, 2008), 306–31; Peter Enns, *The Evolution of Adam: What the Bible Does and Doesn't Say about Human Origins* (Grand Rapids, MI: Brazos, 2012), 120–24.

[6]See, for example, Deborah B. Haarsma and Loren D. Haarsma, *Origins: Christian Perspectives on Creation, Evolution, and Intelligent Design*, rev. ed. (Grand Rapids, MI: Faith Alive, 2011), 210–12, 226; Denis R. Alexander, *Creation or Evolution: Do We Have to Choose*? (Oxford, UK: Monarch, 2008), 245, 253, 260–67; Daniel M. Harrell, *Nature's Witness: How Evolution Can Inspire Faith* (Nashville, TN: Abingdon, 2008), 111–26; Daniel C. Harlow, "After Adam: Reading Genesis in an Age of Evolutionary Science," *Perspectives on Science and Christian Faith* 62, no. 3 (2010): 190; George L. Murphy, *Models of Atonement: Speaking about Salvation in a Scientific World* (Minneapolis, MN: Lutheran University Press, 2013), 69–70; R. J. (Sam) Berry, "Natural Evil: Genesis, Romans, and Modern Science," *Perspectives on Science and Christian Faith* 68, no. 2 (2016): 92, 97.

[7]In recent decades, Pauline scholars have produced numerous volumes exploring the influence of Greco-Roman culture and thought on Paul. See esp., Troels Engberg-Pedersen, ed., *Paul in His Hellenistic Context* (Edinburgh, Scotland: T&T Clark, 2000).

[8]See Plato, *Phaedo* 81E; 83D; ___, *Republic* 572E, 573D, 575A; ___, *Timaeus* 43A; 44A–B.

[9]See especially Aristotle, *On the Soul* 411B5–30, 413B13–34, 432A21–B17; Plutarch, *On Moral Virtue* 445B–452D, 498D–E; ___, *Platonic Questions* 9; ___, *On Exile* 17; ___, *On the Cessation of Oracles* 10; Galen, *On the Doctrines of Hippocrates and Plato* 3.3.5–16, 4.2.1–6, 5.8.18–19, 6.1.16–27; Albinus, *Handbook of Platonism* 17.4, 23.1, 24.1, 29.1. See further, Stobaeus, *Ecologues* 2.88.8–90.6; Posidonius, *Fragments* 142–49, 160–63; Aetius, *Placita Philosophorum* 4.4.1; Arius Didymus, *Epitome of Stoic Ethics* 10B; Alcinous, *Handbook of Platonism* 23–24; Diogenes Laertius, *Lives of Eminent Philosophers* 3.67; Pseudo-Aristotle, *Virtues and Vices* 1.3–4, 2.4–5, 3.4–5, 4.5, 5.1, 6.7–10.

[10]Philo, *On the Special Laws* 4.79, 92; ___, *Allegorical Interpretation* 2.99–104; ___, *That the Worse Attacks the Better* 141. Material in ___, *Migration* 18 also clearly evokes Plato's tripartite soul.

[11]For example, Philo, *Decalogue* 142, 145, 149–50; ___, *Allegorical Interpretation* 2.72; 3.42; ___, *Drunkenness* 101; ___, *Dreams* 1.147; ___, *Questions and Answers on Genesis* 1.47.

[12]See Philo, *Allegorical Interpretation* 2.82; 3.52; ___, *Posterity* 73–74; ___, *Worse* 70; ___, *Planting* 37; ___, *Flight* 55; ___, *On the Special Laws* 1.345; ___, *Questions and Answers on Genesis* 2.45. For detailed analysis of Philo's metaphor of the death of the soul, see D. Zeller, "The Life and Death of the Soul in Philo of Alexandria: The Use and Origin of a Metaphor," *Studia Philonica Annual* 7 (1995): 19–55.

[13]See especially Thomas H. Tobin, *The Creation of Man: Philo and the History of Interpretation* (Washington, DC: Catholic Biblical Association of America, 1983).

[14]Although there is no definitive evidence that Josephus must have been directly dependent on the writings of Philo rather than shared tradition, Louis H. Feldman notes that most scholars who have taken up the question have concluded that Josephus was directly influenced by Philo's writings to some extent (see *Josephus and Modern Scholarship (1937–1980)* [Berlin: De Gruyter, 1984], 413). However, familiarity with some of Philo's writings does not imply comprehensive knowledge of his whole body of work, and the strongest cases for Josephus's direct dependence on writings of Philo pertain to Philo's *Hypothetica* and *On the Creation of the World*, neither of which includes the language of the "death of the soul." See further, Gregory E. Sterling, "Universalizing the Particular: Natural Law in Second Temple Jewish Ethics," *Studia Philonica Annual* 15 (2003): 63–80; Sterling, "'A Man of the Highest Repute': Did Josephus Know the Writings of Philo?," *Studia Philonica Annual* 25 (2013): 101–13.

Wisdom of Solomon, another Alexandrian Jewish text from around the time of Paul, may express the notion of the death of the soul or "spiritual death" (cf. Wisd. of Sol. 1.11; 10.3–4), though this is less clear. See Karina Martin Hogan, "The Exegetical Background of the 'Ambiguity of Death' in the Wisdom of Solomon," *Journal for the Study of Judaism in the Persian, Hellenistic, and Roman Periods* 30, no. 1 (1999): 1–24.

[15]Emma Wasserman, *The Death of the Soul in Romans 7: Sin, Death, and the Law in Light of Hellenistic Moral Psychology* (Tübingen, Germany: Mohr Siebeck, 2008). I do not accept every aspect of Wasserman's argument, but I do find her argument for Hellenistic moral psychology as the context for much of Romans 6–8 to be compelling.

[16]For "mortal body" in Platonic discourse about the rebellious passions, see Plato, *Timaeus* 44A–B, 69C–E; Philo, *Providence* 2.22; ___, *Joseph* 71; ___, *Special Laws* 4.188; ___, *Virtues* 9; Josephus, *Jewish War* 7.344; and Plutarch, *On the Cessation of Oracles* 10; ___, *On Exile* 17; ___, *On Eating Flesh* 1.7.

[17]Wasserman, *The Death of the Soul*, 77. See Plato, *Republic*, 588C–591B.

[18]For an example of the fluidity and complexity of moral psychological traditions, see Christopher Gill, "Did Galen Understand Platonic and Stoic Thinking on Emotions?," in *The Emotions in Hellenistic Philosophy,* ed. Juha Sihvola and Troels Engberg-Pedersen (Boston, MA: Kluwer, 1998), 113–48. Gill describes Galen's attempts to adjudicate between the earlier understandings of Posidonius and Chrysippus, and Gill suggests that Galen likely misunderstands or misrepresents certain aspects of the moral psychological treatments of each of these authors.

Interestingly, Philo's writings evidence various configurations of the composition of the human person insofar as

moral psychology is concerned, sometimes drawing from Platonism, sometimes Stoicism, sometimes the Peripatetic tradition, as it suits his interpretative aims. See Wayne A. Meeks, *The Moral World of the First Christians* (Philadelphia, PA: Westminster, 1986), 82.

Even Plato's own writings evidence multiple nuanced construals of moral psychological conflict. In the *Phaedo*, the key conflict is between the rational soul and the irrational bodily passions, but in the *Republic*, conflict occurs between parts of the soul itself. See R. Hackforth, *Plato's Phaedo* (New York: Liberal Arts Press, 1952), 11.

[19]Exegetes of Romans often treat chapters 5–8 as a thematic unit. See, for example, Richard N. Longenecker, *The Epistle to the Romans: A Commentary on the Greek Text* (Grand Rapids, MI: Eerdmans, 2016), 187.

[20]Compare this to Rom. 6:11: "Consider yourselves dead to sin but alive to God in Christ Jesus."

[21]Enns, *Evolution of Adam*, 99–117.

[22]Ibid., 133–34.

[23]For example, John Murray, *The Epistle to the Romans*, 2 vols. (Grand Rapids, MI: Eerdmans, 1968), 1:290; C. E. B. Cranfield, *A Critical and Exegetical Commentary on the Epistle to the Romans*, 2 vols. (Edinburgh, Scotland: T&T Clark, 1975–1979), 1:389; James D. G. Dunn, *Romans 1–8* (Dallas, TX: Word, 1988), 272–73.

[24]See John R. Levison, *Portraits of Adam in Early Judaism: From Sirach to 2 Baruch* (Sheffield, UK: Sheffield Academic Press, 1988), 145–59.

[25]On the *Thanksgiving Hymns*, see Jason Maston, "Anthropological Crisis and Solution in the *Hodayot* and 1 Corinthians 15," *New Testament Studies* 62, no. 4 (2016): 534–41.

[26]Beverly Roberts Gaventa, *Our Mother Saint Paul* (Louisville, KY: Westminster John Knox, 2007), 131–32. Emphasis original. A number of commentators likewise interpret "death" and "sin" in Romans as cosmic powers: for example, Ernst Käsemann, *Commentary on Romans* (Grand Rapids, MI: Eerdmans, 1980), 150; cf. 142; Robert Jewett, *Romans: A Commentary* (Minneapolis, MN: Fortress, 2007), 374.

[27]Cf. Wasserman, *The Death of the Soul*, 81–89.

[28]Morna D. Hooker, "Adam in Romans I," *New Testament Studies* 6 (1960): 297–306; ___, "A Further Note on Romans I," *New Testament Studies* 13 (1967): 181–3. Commentators who cite Hooker include, for example, Dunn, *Romans 1–8*, 60–61; N. T. Wright, "Romans," in vol. 10 of *The New Interpreter's Bible* (Nashville, TN: Abingdon, 2001), 432–33.

[29]On this point, Hooker, in "Adam in Romans 1" (p. 300), follows Niels Hyldahl, "A Reminiscence of the Old Testament at Romans i. 23," *New Testament Studies* 2, no. 4 (1956): 285–88.

[30]For further examples and discussion, see Robin Scroggs, *The Last Adam: A Study in Pauline Anthropology* (Philadelphia, PA: Fortress, 1966); Crispin H. T. Fletcher-Louis, *All the Glory of Adam: Liturgical Anthropology in the Dead Sea Scrolls* (Leiden, NL: Brill, 2002).

[31]Instances of the absence of glory due to idolatry in connection with the Exodus include Ps. 106:20 and Jer. 2:11. Additional passages about the loss of glory due to disobedience toward God in general include Hosea 4:1–18 and Hab. 2:5–19. Instances of glory in connection with the Exodus in general include Exod. 16:7, 10; 24:16–17; 29:43; 33:18, 19, 22; 34:5; Lev. 9; Num. 12:8; 14:10; Deut. 5:24; Sir. 17.13; Bar. 5.6, 7, 9; and 2 Cor. 3:13. In a number of other instances, the presence of God, expressed as "glory," has to do with God's particular relationship with Israel as the recipients of revealed glory (Num. 14:21–22; 1 Kings 8:11; Ps. 71:19; Isa. 6:1, 3; Ezek. 43:2, 4, 5; 44:4; Hab. 2:14; 2 Macc. 2.8; Sir. 44.3; 49.12; Rev. 15:8; and Josephus, *Antiquities* 8.106). These passages do not exactly have to do with the Exodus, but they do speak of "glory" in a way that is congenial to the significance of "glory" in the Exodus. In some cases, "glory" is evident in the Septuagintal (Greek) versions of the passage, but not the Hebrew.

[32]Alec J. Lucas argues extensively for the influence of Psalm 106 in the early chapters of Romans (*Evocations of the Calf? Romans 1:18–2:11 and the Substructure of Psalm 106 (105)*, BZNW vol. 201 [Berlin: De Gruyter, 2015]).

[33]Lucas asserts that the account of creation in Gen. 1:26–27 parallels the list of animals in Rom. 1:23 more closely than does the list of idols in Deut. 4:16–18, but I do not see how this is so. All of these lists differ slightly from one another, yet are generally close.

[34]Hooker, "Adam in Romans 1," 297; cf. Hyldahl, "Reminiscence of the Old Testament," 286–88; Wright, "Romans," 432–33.

[35]Ben C. Blackwell, "Immortal Glory and the Problem of Death in Romans 3.23," *Journal for the Study of the New Testament* 32, no. 3 (2010): 285–308. Blackwell's argument regarding Rom. 3:23 is based on the same pool of Jewish writings that scholars appeal to regarding the loss of immortal glory in Rom. 1:23 (see above).

[36]For example, Dunn (*Romans 1–8*, 167–68) and Wright ("Romans," 470) find Adam behind both passages, whereas Jewett (*Romans: A Commentary*, 280) and Joseph A. Fitzmyer (*Romans: A New Translation with Introduction and Commentary*, Anchor Bible 33 [New York: Doubleday, 1992], 283–84) challenge this position.

[37]James D. G. Dunn, *Christology in the Making: A New Testament Inquiry into the Origins of the Doctrine of the Incarnation* (Philadelphia, PA: Westminster Press, 1980), 100–5; ___, *Romans 1–8*, 469–72. See also, Douglas J. Moo, *The Epistle to the Romans* (Grand Rapids, MI: Eerdmans, 1996), 519; Jewett, *Romans: A Commentary*, 513.

[38]*Mataiotēs* ("futility") refers to moral corruption in the New Testament in Eph. 4:17 and 2 Pet. 2:18. It occurs with roughly the same sense in two other early Christian texts, normally included among the "Apostolic Fathers" collection: Barnabas 4.10 and the Polycarp 7.2. The cognate adjective, *mataios*, often refers to idols, or the outcome of idol worship (for example, Acts 14:15; 1 Pet. 1:18 in the New Testament and Lev. 17:7; 1 Kings 16:2, 13, 26; 2 Kings 17:15; 2 Chron. 11:15; Isa. 2:20; 30:15; 44:9; 45:19; Jer. 2:5; 8:19; 10:3, 15; 28:18; Ezek. 8:10; 11:2; Hosea 5:11; Amos 2:4 in the Septuagint). In the Septuagint, *mataios* can also refer to sinful living in general, as in 3 Macc. 6.11; Pss. 5:10; 11:3; 23:4; 61:10; Prov. 12:11; 21:6; Isa. 59:6; Jon. 2:6; and Zeph. 3:13.

[39]*Phthora* ("corruption") refers to moral, rather than physical, corruption in the New Testament in 2 Pet. 1:4; 2:12, 19. Paul uses the word to refer to physical corruption in 1 Cor. 15:42, 50; Col. 2:22. In Gal. 6:8, immoral practices result in *phthora*, so the word may refer to moral corruption here, as well. The word has the sense of moral corruption in the Septuagint version of Ps. 102:4; Mic. 2:10, in other Jewish writings from around the time of Paul (1 Enoch 106.17; Psalms of Solomon 4.6; Demetrius 2.9), and in 2 Clement 6.4, which is another early Christian writing. In the Septuagint, *phthora* has the sense of physical corruption in Dan. 3:92; 10:8.

[40]Laurie J. Braaten, "The Groaning Creation: The Biblical Background for Romans 8:22," *Biblical Research* 50 (2005): 19–39.

[41]For example, Dunn, *Romans 1–8*, 474–75; cf. Jewett, *Romans: A Commentary*, 519.

[42]Lamoureux, *Evolutionary Creation*, 315–17.

[43]See, for example, J. Christiaan Beker, "Recasting Pauline Theology: The Coherence-Contingency Scheme as Interpretive Model," in *Pauline Theology*, vol. 1, ed. Jouette Bassler (Minneapolis, MN: Fortress, 1991), 15–24.

[44]For example, in Gal. 3:9–10 (cf. 4:25–5:1), Paul uses the biblical figure of Abraham to establish discontinuity between old and new covenants, in that those who rely on works of the law are cursed, whereas those who believe like Abraham are blessed, whereas in Rom. 4:10–12, Abraham establishes continuity between faithful Jews, who follow Abraham's example of faith, and faithful Gentiles, who are uncircumcised and yet have faith, as Abraham also did. See J. Christiaan Beker, *Paul the Apostle: The Triumph of God in Life and Thought* (Edinburgh: T&T Clark, 1980), 97–102. Hendrikus Boers likewise highlights differences in Abraham's significance between Galatians and Romans in "The Significance of Abraham for the Christian Faith," in *Theology out of the Ghetto: A New Testament Exegetical Study Concerning Religious Exclusiveness* (Leiden, NL: Brill, 1971), 74–104.

[45]Edward Adams, *Constructing the World: A Study in Paul's Cosmological Language* (Edinburgh, Scotland: T&T Clark, 2000), 242–43.

[46]J. Christiaan Beker, "The Relationship between Sin and Death in Romans," in *The Conversation Continues: Studies in Paul and John in Honor of J. Louis Martyn*, ed. Robert T. Fortna and Beverly R. Gaventa (Nashville, TN: Abingdon, 1990), 59. Beker does note that 1 Cor. 15:21–22 seems to allude to Adam causing death (which Beker understands as mortality), but does not find this to be a significant emphasis.

[47]Maston, "Anthropological Crisis," 533–48.

[48]Thomas Barosse, "Death and Sin in Saint Paul's Epistle to the Romans," *Catholic Biblical Quarterly* 15, no. 4 (1953): 438–59.

[49]I do not have space to treat every reference to death in Romans in this article, but my dissertation will address the language of death in Romans much more comprehensively.

[50]For a basic account of possible evolutionary views of the inception of moral corruption, see Robin Collins, "Evolution and Original Sin," in *Perspectives on an Evolving Creation*, ed. Keith B. Miller (Grand Rapids, MI: Eerdmans, 2003), 469–501. See also N. T. Wright, "Do We Need a Historical Adam?," in *Surprised by Scripture: Engaging Contemporary Issues* (New York: HarperOne, 2014), 26–40.

Updating Human Origins

David L. Wilcox

David L. Wilcox

In 2016 I proposed an "evolutionary" model of human creation and the Fall based on a divinely directed "explosive" growth of social cognition and "hypersocial" behavior in coastal South Africa.[1] *But science never stands still, and a variety of more recent studies raise questions for the model. This article reviews some of that new data, and evaluates their implications. These challenges include (1) increased evidence of multiple gene flows between archaic hominines and the* Homo sapiens *lineage; (2) skeletal evidence that cerebral modernization occurred over 400,000 years in Africa within species* Homo sapiens*; (3) paleoarcheological evidence of gradually increasing technical and social complexity over the same period; and (4) indications that those advances were dispersed and Pan African. In light of these evidences, is a localized transforming event still possible? I suggest here that it is.*

A contrast is often drawn between the "timeless truths" of theology and the "changing theories" of science. In one sense, such a distinction may seem to have some justification. Biblical theology is intended to be founded on a stable, static database—the scriptures—whereas scientific theorizing seeks to explain a changing, ever-growing mass of physical data. But reality is more complex than that. Science does not invent data, it discovers them. And biblical theologies obviously can and do draw quite different doctrinal formulations from the same scriptural "data." In the same way, scientific disciplines also frequently propose quite different theories to explain the same data. As humans, our world views, shaping principles, and paradigms necessarily enter in as we form models of reality (for even scientists and theologians are human).[2]

As Christians, we frequently argue that we must allow our theological understandings to inform our scientific paradigms; this makes sense if God is the source of both the Word and the world. Conversely, as scientists we frequently argue that we must allow our scientific understandings to inform our theological paradigms; this also makes sense if God is the source of both the world and the Word. When theology and science are both forming explanatory models of some of the same things, such as the nature of humanity, integrating these quests may leave honest thinkers feeling as if they are wrestling with an angel. What makes it more difficult is that the collection of data by science never stops. And since all theories are human models of reality, when God's reality clips you over the ear with new data, you have to rethink. That duty applies to both the scientist and the theologian.

Few areas of study are more fraught with important implications for both theology and science than human origins. A number of important research results have been published during the last two or three years bearing on that subject, potentially calling for alterations in integrative models. These data involve, variously, multiple genetic studies, improved site dating, new skeletal and cultural finds, and new analyses of old data. Here I intend, first, to outline some of the new genetic data and tie it into a coherent pattern. Then I will examine how nongenetic data fit into that pattern. Finally, I will

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evaluate the implications of the resulting patterns of data for an "African Eden" event.

Tracing Your Ancestors—Building Genetic Trees

The explosive development of ancient DNA sequencing technologies has provided surprising insights into the pattern of modern human origins, including our relationship with our "archaic" cousins, the Neanderthals. As an overview, the DNA extracted from Neanderthal skeletal materials and the DNA from both ancient and living modern humans indicate that the lineage of the Eurasian Neanderthals and the lineage which gave rise to modern humans are two branches rising from a common ancestral population. That population lived sometime between 400 to 700 thousand years ago. There is some debate over the location of that ancestral population, but the general consensus is Africa. Thus, the Neanderthals (and the related Denisovans) are descended from an early African emigration, whereas modern humans are descended from the populations which stayed in Africa.

To review the evidence from living human genomes, multiple analyses of thousands of human Y chromosomes, mtDNAs, and whole genomes have shown that by far the deepest variations (or, longest branches) in the DNA of both living and ancient (think, Cro-Magnon) "modern" humans are within Africa.[3] In a comparison of whole genome sequences drawn from several thousand South African individuals, Carina Schlebusch and colleagues conclude that this divergence in nuclear DNA sequences was established between African populations more than 260 Ka (260 thousand years ago).[4] In contrast, the genomes of all non-African populations branch from one particular African lineage at about 80 Ka to 60 Ka. Thus, all non-Africans form a single "minor" branch of a particular East African lineage. Supporting an African origin, the most recent common ancestor (MRCA) of living human mtDNAs is currently placed in Africa at around 170 Ka, and the MRCA of human Y chromosomes in Africa at around 250 Ka.[5]

Two archaic Eurasian hominin populations, the Neanderthals and the Denisovans, also lived recently enough to yield high quality sequences of their mtDNA, Y chromosome, and nuclear DNA. The divergence of their nuclear DNA indicates that the Neanderthals and the Denisovans were closely related, and that both were equally genetically distant from all modern humans. Based on the divergence between their nuclear DNAs and the nuclear DNA of modern humans (and the accepted mutation rate—which produces the divergences in DNA sequences), the archaic lineages shared a common ancestor with modern humans 700 Ka to 600 Ka.[6]

Limited cross-breeding between archaic and modern humans apparently took place, but at a much later date. A bit more than 2% of the nuclear DNA in all non-African human populations matches Neanderthal sequences more closely than modern sequences. And likewise, Austronesian genomes contain a few sequences which match Denisovan DNA. In addition, the sequenced Denisovan individual of the Altai Mountains had some Neanderthal DNA, and possibly admixture from a still more ancient lineage (i.e., *Homo erectus*).[7]

As the total number of genomes sequenced from all three lineages continues to climb, the precision of genealogy building increases. For instance, the "mitochondrial Eve" (MRCA) calculation of modern human mtDNAs indicates around 170 thousand years of divergence within modern humans. A similar MRCA calculation based on known Neanderthal mtDNAs shows roughly the same amount of divergence within that population.[8] But here there comes a mystery—how are these two "populations" of mtDNAs related to each other? The divergence between the known Denisovan mtDNAs and the mtDNAs of modern humans is consistent with the nuclear evidence: it indicates a common maternal ancestor at around 700 Ka. But with the Neanderthals, there is an anomaly: the divergence between all the reported Neanderthal mtDNAs and those of modern humans indicates a separation of "only" about 400,000 years.[9] How can the mtDNA distance be 300,000 years less than the nuclear DNA distance?

This anomaly has been resolved through DNA extracted from the pre-Neanderthal hominins of 430 Ka from the Sima de los Huesos (Pit of Bones) in Spain. The initial genetic study isolated their mtDNA and found that it was closer to Denisovan mtDNA than to the mtDNA either of Neanderthals or of modern humans.[10] Since the Denisovans had previously been found only in Asia, finding a related population in Spain was puzzling. However, a more

recent study was able to extract their nuclear DNA, and that placed the Sima de los Huesos hominins securely within the ancestral Neanderthal lineage. Their nuclear DNA clustered with the high quality nuclear DNA of the Altai Neanderthal (Siberia).[11]

So, what happened to the mtDNA of all the other Neanderthals? It seems that the original Neanderthal mtDNAs were replaced by mitochondria which came, by interbreeding, from a population related to the hominine line which had stayed in Africa (the line which would give rise to modern humans). The timing of this mtDNA replacement was further clarified by a study which isolated mtDNA from the HST Neanderthal (Hohlenstein–Stadel Cave, Germany).[12] The HST mtDNA diverged from all other Neanderthal mtDNAs (except Sima de los Huesos) prior to 270 Ka. In addition, Neanderthal mtDNAs diverged from modern human mtDNAs at about 400 Ka. Thus, individuals from our ancestral African lineage must have interbred with a group of Neanderthals sometime between 400 Ka and 270 Ka. As a result, their "African line" mtDNAs displaced the original Neanderthal mtDNAs. Keep in mind that small isolated groups like Neanderthals are subject to periodic depletion and replacement, and thus they rapidly and randomly lose genetic variation. This allows rare alleles (or mitochondrial strains) to become established. In this case, it allowed "African" lineage mtDNAs to become established in the Neanderthal population.

Neanderthal mtDNA is not the only indication of early gene flow (emigration) out of Africa. Martin Kuhlwilm and colleagues report that the Altai (Siberian) high resolution Neanderthal nuclear genome shows inclusions from a "modern" human population which apparently left Africa around 200 Ka (based on sequence divergence), which is about the time of the common root for living African populations.[13] Thus, this is a later "African" emigration than the earlier replacement of Neanderthal mtDNAs. Kay Prüfer and colleagues report the same pattern of inclusions in the more recent Vindija (Croatian) genome, and conclude that this "modern" human admixture occurred before 145 Ka to 130 Ka.[14] In contrast, Mateja Hajdinjak and colleagues report that there is no evidence of any "recent" gene flow from modern humans in five more-recent (49 Ka–39 Ka) Neanderthal genomes sampled over a wide area. This is surprising given their temporal overlap with invading modern humans who *did* have Neanderthal inserts.[15]

Were such early "ghost" lineages of *Homo sapiens* ancestral to any living populations? A "ghost" lineage refers to a population which is inferred to have existed, but has left no physical evidence. Studies of the DNA haplotypes of living populations outside Africa are consistent with a single major "out of Africa" dispersal event between 80 Ka and 60 Ka.[16] But, Melanesian populations may have retained some evidence of such early "ghostly" emigrants. Luca Pagini and colleagues report that an anomalous 2% of the DNA in Papua New Guinea (PNG) genomes show unusually short haplotypes which match ancient African alleles.[17] They date them as diverging from ancestral African sequences at around 200 Ka. This was in addition to the Neanderthal and Denisovan inserts in Melanesian genomes. They conclude that 2% of the PNG genome reflects an early emigration from Africa which occurred a bit before 200 Ka. Supporting evidence for such an early migration of modern humans is a report of *Homo sapiens* teeth in Fuyan Cave, Daoxian, China, at 120 Ka—80 Ka.[18] If valid, that relic "modern" population was presumably swamped by the arrival of the later major wave. The majority of the Eurasian genome show longer haplotypes, and hence, they are derived from a later exit from Africa at around 65 Ka. The PNG genome anomaly is also reported by Anna-Sapfo Malaspinas and colleagues, but they postulate a more complex scenario, with an earlier majority African exit (around 127 Ka), ghost lineages with early gene flows back to Africa, multiple bottlenecks, and a separate gene flow to Austronesia.[19]

The greater than 2% Neanderthal sequences in the genomes of all living non-African populations were apparently acquired about 60 Ka during the exit from Africa. The man from Ust-Ishim in Siberia, who lived 45,000 years ago, showed Neanderthal input from about 10,000 years earlier.[20] The contributing Neanderthal population branched from the line of the Vindija and Mezmaiskaya Neanderthals prior to 100 Ka.[21] In addition to the Neanderthal inputs, both Melanesians and South Asians are reported to have Denisovan sequences coming from two different source populations that contribute perhaps as much as 5% to Melanesian genomes.[22] In contrast to Eurasian lineages, Prüfer and colleagues confirm that no Neanderthal alleles are present in African

populations, although there may be limited "recent" admixtures from archaic populations within Africa.[23] Multiple groups of hominins exited Africa for the north, but there was apparently no significant gene flow back to Africa.

So, there are several indications of "modern" human gene flow to the Neanderthals, Neanderthal and Denisovan gene flow to modern humans, and gene flow from both Neanderthals and some other very ancient hominin population into the Denisovans. In each case, the admixture is only a few percent. No fully hybrid populations/genomes have been discovered. Such hybrid populations would be a reasonable expectation at the limits of the modern human expansion from Africa. There is evidence in modern humans of strong selection against most, but not all, Neanderthal alleles, particularly those active in neural tissues.[24] And, there are also evidences of the sort of small chromosomal rearrangements which interfere with stable hybrid formation.[25] These data are consistent with the hypothesis that the African lineage and the two archaic Eurasian lineages were developing post-zygotic (and probably pre-zygotic) barriers—they were on the way to becoming good species. Ajit Varki postulates that such an F1 pre-zygotic barrier would likely be due to cognitive factors, of which more later.[26]

Species formation has been reported for many other pairs of species separated by glacial maxima, such as fire-bellied toads and nightingales. During the last 600,000 years, there have been at least four full glacial cycles. The path between central Africa and Eurasia is only intermittently open due to the appearance and disappearance of extreme deserts in North Africa and the Arabian Peninsula. The door is shut for primitive hunter-gatherers both, at minimum, during warm periods such as the present, and, at maximum, during glaciation. A very comprehensive evaluation of the timing of open paths indicates that African emigrants—assuming a start in Central Africa at 125 Ka—should have arrived in South Asia and in Europe by 60 Ka, and possibly as early as 80 Ka.[27] By extension, earlier pulses of emigration from Africa should have been possible every 100,000 years or so. In between, African and Eurasian lineages would have been isolated, becoming more genetically incompatible.

The data suggest the following series of events. Skeletal evidence indicates that around 1.5 million years ago a population of early *Homo erectus* left Africa and spread across Eurasia. But, the only genetic evidence we have of their presence is some admixture in the Denisovian genome. A larger-brained population (*Homo heidelbergensis?*) emigrated 700 Ka to 600 Ka from Africa, and spread thinly across Eurasia. This was a bottleneck or founder event—the eastern and western populations were separated, becoming the Denisovans and the Neanderthals. After that, it is hard to be sure how many times "African" emigrants added "African" genes to the archaic northern lineages. Clearly, sometime between 413 Ka and 268 Ka, such an African immigrant group interbred with a small Neanderthal clan, and subsequent genetic drift replaced the Neanderthals' mtDNAs, but not much of their nuclear DNA. That clan became quite successful—after all, the African clan's DNA is all which has been detected in Neanderthals. A likely time point for that interbreeding would be around 340 Ka following a particularly long glacial period (Riss). Such an extended glaciation would have reduced Neanderthal population density, increasing the possibility of genetic drift.

But then, when were modern humans established outside Africa? Nuclear admixtures in the Altai Neanderthal and in the PNG genomes suggest a second "early modern" group left Africa before 200 Ka, and could have arrived in South Asia by 120 Ka.[28] Some physical evidence is consistent with such a very early arrival of modern humans in China.[29] On the way, that population might have fused with an existing Denisovan population, and it was possibly decimated by the climate effects of the Toba eruption in 70 Ka. If the Vindija Neanderthals have some modern human genes, possibly some of these early migrants could have also made their way westward. However, the definitive movement out of Africa does seem to have been between 90 Ka and 80 Ka, arriving in south Asia (Sumatra and Australia) before 65 Ka.[30] That population could then have enveloped remnants of earlier migrations.

Modern humans may also have gotten as far west as Spain by 80 Ka.[31] Though there is not yet skeletal evidence of that presence, the report of early cave painting is suggestive.[32] It is also interesting that the oldest modern human genomes from Europe included mtDNA haplogroup M, although later European populations (from genomes dating from after the glacial maximum) did not.[33] M is the major haplogroup found in South Asia and Australia.

Finding it in the earliest settlement of Europe suggests that it comes from the same early emigrant population. And, of course, both eastern and western emigrants picked up some Neanderthal genes on their way.

Your Brain Shapes Your Skull

Laying out a genetic tree which covers more than half a million years means that significant amounts of adaptive evolution can take place during such a vast time span. The ancestral population which split between Eurasia and Africa 600,000+ years ago was by no means either modern human or Neanderthal. Both lineages would show discernable changes. The question is, what was the significance of those changes? In both cases, the skeletal evidence is sparse and scattered. The best evidence of the developing Neanderthal lineage is the skeletal material at Sima de Los Huesos, dated at 430 Ka. Juan Arsuaga and colleagues report that their crania were intermediate in volume (1232 cc) between *Homo erectus* and the Neanderthals, and show derived Neanderthal traits in the facial skeleton and anterior cranial vault.[34] Also notably, they report that the lateral cranial walls are parallel rather than convergent (*Homo erectus*), rounded (Neanderthal), or divergent with marked parietal bosses (*Homo sapiens*). The significance of these parietal differences will become clear in the next paragraphs.

The best Middle Stone Age evidence from Africa is the skeletal material at Jebel Irhoud in Morocco, re-dated to an early 315 Ka.[35] This large-brained (1425 cc) population had facial, mandibular, and dental morphology that closely links them with modern *Homo sapiens.* But, in contrast to their modern facial skeletons, the Jebel Irhoud skulls had an elongated (archaic) braincase (cranium).[36]

The globular braincase of modern humans is due to a unique neural expansion which occurs in the perinatal period—before the first tooth eruption. Modern newborns have an elongated brain, the same shape as did Neanderthal infants, but a similar globularizing expansion did not occur in Neanderthals. Cranial globularization is due to the rapid enlargement of the parietal area and the cerebellum.[37] The parietal bulging is most likely due to a unique enlargement of deep parietal areas, notably the precuneus. Neanderthal brain growth followed a different developmental trajectory: the neural growth which produced their large brains was allometric to the archaic pattern typical of *Homo erectus*. The elongated Neanderthal cranium had significant enlargements in the visual cortex (in the occipital lobe) and in the motor/premotor cortex.[38]

Simon Neubauer and colleagues analyzed the patterns of endocranial shape in *Homo erectus,* in the Neanderthals, and in ancient *Homo sapiens* skulls from several periods, beginning with Jebel Irhoud.[39] They found that the crania of the Jebel Irhoud hominins (315 Ka) lie on the archaic trajectory between *Homo erectus* and the Neanderthals. Five later *Homo sapiens* skulls dated 200 Ka to 100 Ka, for example, Qafzeh 6, 9 and Omo 2 were intermediate between the Jebel Irhoud specimens and modern *Homo sapiens* crania. Somewhat later "ancient" skulls such as Cro-Magnon 1, 3 or Oberkassel 1, 2 lie within the modern distribution.

The distribution of "modernization" in *Homo sapiens*—in the Levant, and in North, East, and South Africa (Hofmeyr skull)—indicates that this was a Pan-African evolutionary phenomenon.[40] African populations were changing on a different trajectory than Eurasian hominines. The modern globular cranium was completely established at some point between 100 Ka and 35 Ka. Neubauer and colleagues point out that since the shape of the brain determines the shape of the cranium, the altered cranial/brain shape indicates an alteration of brain function within the *Homo sapiens* line. Of course, the functional significance of those changes is the critical question. Significantly, the areas which are enlarged in the modern human brain are crucial for what it means to be human.

The expansion of the precuneus (part of the superior parietal lobule) is significant because it is a central node for the default network, and possibly the center of consciousness. The precuneus has the highest level of energy use in the brain during consciousness. This high energy expenditure is especially true at "rest," that is, daydreaming, when the default network is most active. The precuneus also does mapping of all sorts—from visual to social, acts as "the mind's eye" on environmental stimuli, and is implicated in task initiation. It is inactive in sleep or anesthesia, and less active in an individual engaged in outwardly goal-oriented activity. It is involved in episodic memory and planning, in self-representation and self-consciousness, and in theory of mind (the attribution of

emotion and intention toward others). Thus it is central to social judgment and empathy. In summary, the precuneus is a critical center for social cognition as well as other cognitive specializations.[41]

It may be surprising that the cerebellum is also uniquely enlarged in modern humans. For the first three months of life, it is the fastest-growing part of the brain, doubling in size. In contrast, the Neanderthal cerebellum was relatively small, "overgrown" by a larger cerebrum.[42] The key datum is that although the human cerebellum does indeed coordinate movement, most of it maps through bidirectional feedback to areas of the association cortex rather than to the motor cortex. Presumably, it is refining the activities of areas such as the executive control network and the default network.[43] Thus, the cerebellum enhances the power of cognitive and emotive functions such as working memory, language processing, social and affective cognition, and mapping functions.[44] In support, there is a considerable amount of clinical evidence that cerebellar pathology is associated with cognitive and psychiatric illness.[45]

A significant number of genes have been found which are unique to modern humans, genes which affect neural development.[46] The idea that the morphological differences are genetically driven is also supported by an evaluation of the effects of Neanderthal alleles in modern humans. Having a higher percentage of Neanderthal alleles is associated with Neanderthal-like alterations in the shape of the skull in the parietal and occipital regions, and by alterations in the primary visual cortex and the intraparietal sulcus.[47] Some specific Neanderthal alleles are also implicated in neurological disorders and depression.[48]

These genetic effects on the shape of the cranium are also intriguing given the reports of certain Middle Stone Age skulls in China with a mixture of characteristics—expanded parietals with an archaic face, for instance—implying possible cross-breeding of early modern human migrants and local archaic populations.[49] Or, the earlier Dali skull (260 Ka) which seems to have the same morphological pattern as the skulls at Jebel Irhoud—a relatively modern face with an archaic cranium.[50]

The question is, when did the process of change begin? Note another modern characteristic of the Jebel Irhoud hominins: based on their rate of tooth development, they had the extended developmental pattern of modern humans. In comparison, Neanderthal development was about 20% more rapid than the modern pattern, *Homo erectus* was still faster, and the Australopithecines, faster still.[51] Slowing physical and neurological development is significant—it leaves more time for reorganizing the brain, thus more time to train/socialize the young.[52]

If the *Homo sapiens* line has been moving steadily toward cranial globularity for the last 300,000 years, there must be a causative mechanism. Cranial alterations due to progressive enlargement of particular areas of the brain such as the precuneus and the cerebellum—areas central to theory of mind, self-consciousness, language, the default system, and others—must be due to particular continuing adaptive pressures which depend on those functions. These abilities are central in the evolved apprentice model or the hypersocial learning model.[53] Advanced cognition,[54] social complexity, group size, empathy, complex learning through instruction—all of these are tied to those particular cerebral modules which are larger in modern humans.

Kim Sterelny's "evolved apprentice model" links cognitive and social evolution through ecological cooperation, sociocultural learning, and environmental scaffolding. Difficult environments and increased population density require shared planning and coordinated provisioning. This puts value on increasingly complex cognitive work, which requires structured learning/teaching. As the required flow of information between generations increases, a positive feedback loop is produced, selecting for genetic variants which increase the cognitive capacity needed to handle increasingly complex technical and social skills.[55]

Kim Hill and colleagues likewise suggest a parallel "hypersocial" model of increasing social interaction and prosociality. They too attribute adaptive human cumulative cultural change to social learning, namely, to stored information passed on by processes requiring complex symbolic communication. They also point to increasing non-kin cooperation (prosociality), allowing the flow of resources and information in non-kin alliances and promoting communal emotional bonds, such as concepts of morality, justice, guilt, and religion. They also work with a dual inheritance theory—social learn-

ing is enhanced by evolution (genomic changes), but the genome is altered through social means as they favor certain genes, producing a positive selective feedback loop. The strength of the selection is proportional to the complexity of the information which must be transmitted.[56]

Logically, therefore, the force driving selection for these neural/genetic alterations would be natural selection for socially enhanced learning. Further, this pressure must have been active throughout the period of change. And indeed, the developmental delay of the Jebel Irhoud people (archaic cranium or not) indicates that they were already under selection for increased social learning. The evolving apprentice model postulates positive feedback—increased capacity provides more complex content to transmit, which selects for increased capacity to learn it, which in turn increases the possible complexity to transmit. Thus, transmitted culture becomes increasingly complex and more important, and the capacity to work collectively in larger, extended groups becomes more critical. Further, as time passes, the process speeds up—logically, it would still be operative today.[57]

If the *Homo sapiens* lineage was being driven by the need to teach by instruction, and by the need to process increasingly larger and complex social interactions (both leading to parietal enlargement), what was driving selection in the Neanderthal lineage? Of course, we cannot really be sure, but we can speculate based on which areas were enlarged in the Neanderthal brain. Neubauer's analysis of cranial change in the Neanderthals indicates enlargement of both primary and secondary visual cortexes, and motor cortexes, resulting in visual pattern recognition and the learned selection of appropriate motions for various situations.[58] Verbal instruction, the evaluation and correction of student efforts, and the coordination of groups—which are so typical of modern human socialization—would be greatly handicapped if language and theory of mind were significantly less effective. Remember how culture is transmitted in chimpanzees and other species—by observation and imitation only. Perhaps Neanderthal neural evolution was specifically driven by an increasingly "technological" complexity; but, without the instructor paying much attention to how well the "student observer" was doing, it produced the critical need to make increasingly careful observations and to store very detailed technique as muscle memory. We will never really know. We know only that the neural areas critical to modern human instruction were apparently not selectively important for the Neanderthals.

Sticks and Stones—Dawn in the Rift Valley

Unfortunately, it is not possible to go back and run fMRIs on ancient/archaic hominins. The usual substitute is the evaluation of artifacts and other archeological evidences. In Africa, the appearance of Oldowan cobbles dates back to 3.2 million years ago, shortly before the appearance of genus *Homo*. Bifaces (Acheulean culture or Mode 2 tool making) appeared about 1.7 million years ago, in conjunction with *Homo erectus* in Kenya and South Africa.[59] However, the hominins which first entered Eurasia 1.5 million years ago brought with them only the Oldowan industry. The Acheulean did not spread through Eurasia until around 700 Ka to 600 Ka, around the time that the ancestors of the Neanderthals and Denisovans arrived there. The relationship of changes in tool-making technique to changing cognitive requirements is outlined in greater detail elsewhere.[60]

Mode 3 tool making—blade and core—developed in Africa from Mode 2 sometime between 550 Ka and 320 Ka. There is evidence of blade making and scattered ocher use at Kathu Pan in South Africa at 500 Ka (early Fauresmith industry).[61] There are also recent reports of complex tool making by 320 Ka at a minimum, as well as long-distance material transport and pigment manufacture in the Olorgesailie Basin of Kenya.[62] Richard Potts and colleagues point out that the Acheulean in the region had begun to show marked selectivity and extended collection distance by 615 Ka, which they attribute to the need to adapt to rapidly oscillating climates and environments. Alan Deino and colleagues note that the culture was late Acheulean until 499 Ka, beyond which point erosion removed evidence. When the sequence resumes at 320 Ka, it lacks Acheulean elements. Similar Middle Stone Age techniques were characteristic at Jebel Irhoud at the same era (the Aterian), and they are found at scattered sites across South Africa.[63]

In the Levant, Israel Hershkovitz and colleagues' report of a 180-Ka-old *Homo sapiens* jaw at Misliya Cave (near Skhul Cave) on Mt. Carmel, or Huw Groucutt and colleagues' report of an 88-Ka-old

modern human digit in the Nefud desert of Saudia Arabia, are not surprising.[64] Qesem Cave in Israel, from 420 Ka to 200 Ka, shows evidence of the organized use of space around central hearths, flint recycling, early blade production, social hunting, and meat-sharing.[65] Teeth from this site resemble those of the people of Skhul and Qafzeh Caves, with some archaic features.[66] Also from Qesem comes the report of a sort of "flint-knapping school" area where unskilled individuals were being coached by the more skilled.[67] Thus, the postulated selection mechanism of "social learning" was already well established there and available to drive cerebral evolution toward the modern form.

Middle Stone Age techniques, termed Mousterian or Levalloisian, were common in Eurasia only after 160 Ka. And, they were displaced after 40 Ka by Mode 4 technology (Aurignacian). However, there are spotty earlier appearances, for instance, Nor Geghi in Armenia, a well-dated site (335 Ka–325 Ka) which contains both bifacial tools and Levallois flakes.[68] The time and place of this find is interesting. It would be about right for the particular "African intrusion" which replaced the mtDNA of the Neanderthals—the early "Out of Africa" migration which perhaps made it to China (Dali skull). The immigrants would have had "more advanced" technology, and if the genes can flow, so can ideas. Likewise, if another early "Out of Africa" migration happened around 200 Ka, it would have contributed a few loci to Neanderthal nuclear DNA and perhaps made it as far as New Guinea—that emigration would also correlate with the rather sudden appearance of Mousterian culture in Europe. Both technologies were developed in Africa long before they appeared in Eurasia.

So, from before 300 Ka to 40 Ka, there was a gradual, but diverse, increase in technical complexity in tool making across Africa. Early Middle Stone Age techniques gave way to more-uniform Levallois core and chip and, in turn, to soft hammer and pressure flaking.[69] Diets diversified—mollusks were being harvested by 164 Ka. "Symbolic" acts such as shell collecting (110 Ka), ochre processing (164 Ka), shell beads (90 Ka–70 Ka), and engraved bone and ochre (100 Ka–60 Ka) first appeared locally but sporadically, and then appeared widely and typically. After 65 Ka, complex skills needing verbal instruction, such as microliths, bone-projectile points, atlatls, bows, heat-treated mastics, poisons, long-distance exchange, and tidal coast foraging, became progressively more common. Particularly notable are early African cultures which used processes typical of the European "late stone age," but tens of thousands of years earlier. For example, the Semliki River carved bone harpoons (90 Ka), the Still Bay heat-treated silcrete bifacial points (82 Ka–70 Ka) or the Howiesons Poort microlith composite tools (60 Ka–50 Ka) are found scattered across multiple sites. The skills used are developments from previous local techniques. Broadly, this is the expected cultural pattern if an increased need for the social learning of complex skills was driving selective changes in brain structures to support such learning.[70]

Clearly related to these changes in African paleotechnology, and presumably African neurological complexity, is the recently proposed concept of *Homo sapiens* as a "general specialist."[71] The authors suggest that humans are not a "specialist" species like the Panda, locked into a single ecological niche. Nor are we a "generalist" species with a broad and varying niche using multiple resources like a raccoon. They suggest, in fact, that all hominin species prior to late *Homo sapiens* were indeed "generalists" tied to a mixed forest/grassland habitat using multiple resources. Sometime during the period discussed in the previous paragraph, *Homo sapiens* developed the ability to become specific specialists for very different habitats and resources, allowing the penetration of difficult environments such as extreme deserts, high montane regions, rain forests, arctic regions, and tidal coast. They attribute this new capability to the ability to accumulate and pass on large amounts of specific cultural knowledge applicable to specific environments—that is, the evolving apprentice model—and thus, to outcompete archaic competitors.

Was There a Bottleneck?

The evidence of widespread (Pan-African) Middle Stone Age artifacts and modernizing skulls after 300 Ka does not seem to support a bottleneck, nor does Eleanor Scerri's descriptions of isolated communities and cultures along North African rivers and across the continent after 100 Ka.[72] She argues that the prehistoric African "*Homo sapiens* clade" was highly structured, being morphologically, culturally, and genetically diverse due to "shifting and fractured

habitat zones." What then of Curtis Marean's suggestion that there was a localized intensification of the selective process for both technical and social complexity sometime before 100 Ka?[73] He proposed that during MIS 7 (the previous glacial maximum), when Africa became hyperdry, the south coastal areas acted as a refuge. Intensive coastal harvesting began around 160 Ka, in the middle of MIS 7, on the South African coast, and gradually spread westward.[74] He suggested that the drought increased population pressure in the coastal refuge areas, increased the dependence on dense (coastal) resources, increased the importance of hypersocial (nonrelative) behavior and social learning, and increased the need for mastering cognitively difficult techniques, for example, reading the moon's phases to predict the low tides. These forces produced increasing selective pressure for alleles which would increase neural flexibility, complexity, and plasticity. This could be considered the first appearance of the above-mentioned "generalist-specialist" adaption.

What is the physical evidence of climate change? Across the African continent, MIS 7 (190 Ka–130 Ka) was a significantly more prolonged and severe dry period than was the most recent glacial maximum (MIS 2). The deep lakes of Africa—Malawi (in the South), Tanganyika (in the East), and Bosumtwi (in the West)—almost disappeared in MIS 7, but they remained filled during MIS 2.[75] Likewise, the Sahara Desert reached its maximum extent. The lake studies document a major shift to more-humid, stable weather conditions following 70 Ka. It follows that during MIS 7, local populations across the continent would have disappeared or been dramatically reduced. When the rains returned, those relic populations would have been largely replaced, swamped by the descendants of the larger populations from the coastal refuges—a population expansion which Christopher Scholz and colleagues also tie to the major wave of emigration out of Africa.[76]

Effectively, the climate of MIS 7 would have created a genetic bottleneck. It could have been somewhat sparing of nuclear diversity if diverse populations were driven together into the coastal refuges, but would have significantly reduced haploid (mtDNA, Y chromosome) diversity. The mtDNA diversity of the late Neanderthals are instructive in comparison. The African-derived mtDNA of the Neanderthals showed divergence from before 316 Ka to 219 Ka, whereas modern human mtDNA diverges from 170 Ka to 124 Ka.[77] The establishment of the "new" Neanderthal mtDNA strain is best explained as a founder effect which followed a Neanderthal population bottleneck. If African populations had remained roughly stable and dispersed from 320 Ka to the present, one would expect far greater diversity in the African (modern) lineages, that is, an older MRCA, than that of the Neanderthal mtDNAs. The same logic applies to the MRCAs of modern human nuclear and Y-chromosome diversity.

Further, modern human DNA diversity is also much lower than that of either species of chimpanzee, again supporting some sort of unique human bottleneck.[78] If the modernization following 320 Ka was a Pan-African process occurring in diverse isolated local tribes, the effective human population would have been far greater than that of either species of *Pan*, and it therefore should have generated deeper (older) MRCA values. A significant population reduction during MIS 7 (after 190 Ka), with refugee populations flooding coastal refuges, could explain both why nuclear markers for an ancient bottleneck are difficult to find, and why human mtDNA and Y-chromosome distances are so unexpectedly short.[79] In addition, structured populations with varying degrees and timings for gene flow between isolated demes can produce a wide variety of trees of descent. These can suggest quite different demographic histories depending on their complex histories.[80]

Significance and Conclusions

What is significant in the new data? The amount of Neanderthal/modern human contact was considerable, occurred in multiple episodes, and although there was significant infertility, some gene flow did occur in both directions. However, it is clear that the point of population divergence between Neanderthal and modern human lineages was not the significant point of "origin" for modern humanization—that modernity developed gradually in scattered locations across Africa *within* species *Homo sapiens*. Although the earliest recognizable *Homo sapiens* at Jebel Irhoud were not completely functionally modern—presumably their modern-sized brains did not yet function exactly as ours do—yet they were already moving toward modernity. If the final touches for modern neural functioning came under pressure on the South African coastal plains, relict

populations in other parts of Africa (and possibly in South Asia) would not yet have had the complete sets of neurally significant modern alleles. However, they could have acquired them as the climate eased and as they were enveloped by the expanding coastal populations—but within limits. Ajit Varki argues that the cognitive effects of the modern genetic complex would itself have limited hybridization.[81]

In a previous paper, I postulated a rapid, localized "modernizing" event during a period when the human race was much reduced, and concentrated in a particular locale.[82] And I proposed that event, perhaps, as the time and place for the full realization (and defacement) of the image of God in human beings. To summarize the logic of that proposal, the discussion of the *imago Dei* typically revolves around the issues of human reason, relationships, righteousness, and rule. These issues correspond closely to several of the central issues paleoanthropology has proposed for modern human origins—complex cognition, hypersociability, and ecological dominance. These diagnostic characteristics are based on a level of neurogenetic plasticity unique to modern humans. The evolutionary development of these qualities can be plausibly explained by positive feedback between social/cultural needs for increasing information flow and neurogenetic mutations increasing developmental plasticity. If human neural configurations are produced by increasing intense intergenerational enculturation, then the possibility exists for an abrupt inflection point—an event which established a modern "neural operating system" in some local community. This could have unstoppably transformed humanity both down through the generations, and laterally between communities.[83] Thus, such an event could be a point of contact with the science for theologians seeking an "Eden" event to explain the human dilemma.

So, does the new data falsify that proposal? Not necessarily. It is true that a Pan-African process of modernization reaching back 400,000 years does not at first glance lead to a focal area for the "completion" for human creation.[84] However, if the data about MIS 7 are correct, a Pan-African modernization process would have been interrupted, or perhaps compressed locally, by the extended MIS 7 Pan-African hyperdrought. The diverse populations reaching the coastal refuges, and then interbreeding, would have been under intensified purifying pressure for cognitive power, and thus would have been pushed toward the postulated threshold "phase transition" into modern function.[85] The altered cultural package—and the supporting genetics—of these coastal survivors could then have enveloped outlying remnant populations with both the blessing and the curse, the image of God and the breaking of the image. Rather than challenging my proposal, I think the new data may be supportive. That is not to say, however, that I am sure that I am correct. I have managed to be wrong about these sorts of things before. The collection of new data is intense—let's see where that puts us in ten years.

And certainly, there are questions which my model does not answer, questions which the new data does not clarify. For instance, what was the spiritual status of all the premodern hominine "peoples" such as the Neanderthals—or the "African lineage people" of Jebel Irhoud and Qesem Cave? Perhaps we had better leave them all in the hands of God. As Job learned, not all questions are answered—at least not yet. ✧

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Rachel L. Lamb

Benjamin S. Lowe

Kyle J. Meyaard-Schaap

Communication

Renewing Evangelical Engagement on Climate Change: The Birth and Growth of "Young Evangelicals for Climate Action"

Rachel L. Lamb, Benjamin S. Lowe, and Kyle J. Meyaard-Schaap

Framing Evangelicals and Climate Change

The complicated relationship between Christians and anthropogenic climate change—particularly among self-identified evangelicals in the United States—is a hot topic in both academic and popular circles.[1] Consistently, American evangelicals have polled as the group most skeptical of the existence of human-caused climate change and least likely to support climate action and policies.[2] However, the full picture is more nuanced than can be captured in a news headline or polling survey. Evangelical Christianity is a diverse movement that is also found at the forefront of environmental and climate science and action.[3]

In light of changing demographics in America and the church, the purpose of this communication is to highlight a growing movement of younger evangelical Christians who are working to awaken the American church to its critical role in overcoming the climate crisis. We offer this unique contribution, having each served as the national organizer and spokesperson for Young Evangelicals for Climate Action (YECA, pronounced Y, E, C, A). Since our founding, more than 10,000 self-identified young evangelicals have taken at least one action with us toward advocating for local and national climate solutions. We hope this work will encourage and inspire more faithful action by others.

The Context: The Evangelical Climate Initiative

In 2006, over eighty senior evangelical leaders—led by Jim Ball of the Evangelical Environmental Network (EEN) and including Rick Warren, Joel Hunter, and the presidents of numerous Christian colleges, denominations, and major ministries—came together to release the groundbreaking Evangelical Climate Initiative (ECI), marking the first time that climate change was publicly identified as a major evangelical concern.[4] Growing to over three hundred influential signatories, their joint statement affirmed that human-induced climate change is real, its impacts are significant—especially on the poor—and that Christian moral and biblical convictions demand that the church respond. The ECI generated widespread media coverage and positive momentum, but also stirred up considerable backlash from US-based climate skeptics both within and beyond the Christian community.[5]

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The Genesis and Foundations of a Movement

As concern for climate change receded into the background, troubling reports were coming in from around the world about rising sea levels, acidification of the oceans, increasingly extreme weather events, and more.[6] There remained, however, very little discussion or action on these pressing realities within the American church and across the nation. During the 2012 election, climate change was effectively ignored by the Republican and Democratic presidential candidates—even though both had positive track records on the issue.[7]

It was in this context, in early 2012, that EEN facilitated a small weekend gathering of young Christian leaders. We met at the Washington, DC, home of a church leader who served on the boards of both the National Association of Evangelicals (NAE) and the World Evangelical Alliance. The purpose of this time together was to pray and dream together about how God might be calling our generation to respond more faithfully to the climate crisis.

Over the course of two days, we developed a shared vision for an ongoing grassroots climate initiative, spearheaded by our generation, that would bring our unique perspectives and strengths to the broader religious and environmental communities. This vision was grounded in a biblical creation-care ethic, along with a holistic understanding of God's redemptive mission and our role as his people in the world, which had been eloquently articulated by the Lausanne Movement in their seminal Cape Town Commitment published in 2011.[8] We recognized climate change as an environmental and humanitarian crisis, as well as an issue of both social and generational justice.

Jesus taught that the greatest commandments are to love God and to love our neighbor. We realized that we could not fulfill these commandments faithfully without caring for God's creation and for all the people already being adversely affected by a changing climate. Furthermore, global climate change is a defining challenge for our generation, as we will be the ones who suffer most from the consequences of current inaction.[9]

As we looked around, we found many Christian groups engaged in caring for creation, but few that focused on climate change. We sensed a strategic need, along with a moral and spiritual responsibility, to step into this gap; we were greatly encouraged to find that many evangelical leaders were open to our concerns and eager to better understand and support us in this endeavor.

The Creation of YECA

Young Evangelicals for Climate Action (YECA) publicly launched at the 2012 National Day of Prayer for Creation Care in Washington, DC, as an official ministry of EEN. The core team identified three strategic goals that guide YECA to this day: (1) to mobilize our generation of evangelicals to step up on climate action, (2) to influence and encourage senior evangelical leaders to set an example by supporting faithful climate action in their churches and communities, and (3) to hold political leaders accountable for enacting comprehensive and responsible climate policies through advocacy.

YECA quickly gained traction through a variety of engagement strategies in service of these three goals. We organized a college campus speaking tour to raise awareness and invite our peers to join the movement by signing our Call to Action.[10] We launched a Senior Leaders Pledge and began meeting with college presidents, denominational heads, and other key leaders around the country to invite their support and partnership. We also organized a prayer rally at Hofstra University (NY) during the 2012 presidential debate they hosted, which generated early media attention that aided our efforts.[11]

Within a year, we grew into a national initiative with activists and supporters across the United States. To help shepherd this growing movement, we designated a full-time national organizer and transitioned our initial core team into a national steering committee that has met regularly in person and via videoconference to set and implement the vision and programs of YECA. Through the financial support of EEN, and through the leadership demonstrated by creative and passionate young people, YECA has become an important example of Christian engagement on climate change.[12]

Sharing Powerful Climate Testimonies

With our spheres of influence expanding, we recognized the value of sharing stories of how we each came to care about the climate crisis. We started recording and posting videos featuring such "Climate Testimonies"[13] from young evangelicals across the nation. Common to each of these stories is a deep desire to love and serve God through this work, a conviction to be part of climate and environmental solutions through personal and corporate action, and a hope that the American church will lead by example.

These short videos have encouraged our peers, helping them realize they are not alone. Similarly, our stories have encouraged senior church leaders. In line with the important work of Dorothy Boorse in "Loving the Least of These,"[14] we called upon NAE board members to take a public stand on climate action,[15] which they subsequently did through their Call to Action on Creation Care.[16] Just as there is power in our stories of coming to faith in Christ, these climate testimonies help showcase the redemptive and hopeful work Christ is calling us to through climate action.

Developing Our Signature Leadership Programs

YECA has maintained a consistent orientation toward identifying and supporting emerging young leaders. Early in the organization's history, outreach to Christian colleges and universities became a foundational component of this work. Our own respective experiences as undergraduates at Christian liberal arts institutions provided important integration of our faith and climate action, despite the often-slow movement toward climate leadership at the highest institutional levels of our campuses and churches. Seeing the increased potential for peer-to-peer engagement and ongoing opportunities to engage senior leaders through students, we founded the Climate Leadership Fellows program.

The central goal of this program is to equip new leaders to promote a biblical understanding of the climate crisis and to organize faithful responses within their campuses, churches, and communities. We view this as a contribution toward discipleship by walking alongside young Christians to help them develop a more holistic faith in which their desires to serve God, neighbor, and creation are nurtured within Christian community. Projects implemented by our fellows have increased awareness about climate change science and action, fostered waste reduction programs in local churches, led to renewable energy initiatives, and facilitated transparent and honest discussions about evangelical engagement on climate change with elected officials.[17] Having supported more than twenty emerging leaders through the first four years of this program, it serves as a critical path for affecting change within our communities.

Advocacy across Party Lines

YECA is and always has been distinctly nonpartisan. However, as a voting bloc, American evangelicals have traditionally been considered politically conservative.[18] While there are many reasons for this association, it has helped precipitate an unbiblical assumption that evangelicals are and will remain complicit with inaction on climate. YECA demonstrates why this should not be considered the case. In fact, American evangelicals have the unique opportunity to reach moderates and conservatives on climate.

During the 2016 presidential primaries, we made it possible for several Christian college students to travel across Iowa and engage Republican presidential candidates. Introducing themselves as young evangelical Christians, the students asked the candidates to comment on camera about their plans for stewarding God's creation and acting on climate. We then shared their responses on social media so that voters could better evaluate the candidates.[19] The questions highlighted that conservative climate solutions exist and that voters are interested in them.

We have consistently raised our voices for changes in public policy, attending the People's Climate March in 2014 and 2017, and facilitating a number of meetings with elected officials in Washington during sponsored Climate Advocacy Days.[20] Our members have also participated in hearings of the US Environmental Protection Agency, organized letter-writing campaigns aimed at state officials, and contributed public comments on proposed rules and bills that directly affect progress on climate action.

Strategic Planning for the Future

In the seven years since YECA's inception, we have seen encouraging progress at the grassroots, institutional, and systemic levels toward a distinctly evangelical, youth-led climate movement. We have received significant attention from national and international media outlets, including *CNN, PBS, NPR, Reuters,* and the *New York Times*. In early 2016, YECA also became a member of the US Climate Action Network, the largest coalition of civil society organizations focused on climate action in this country. This partnership has further solidified the value and importance of Christian witness in the larger national climate movement.

As we look to the future, we recognize that there is much more to be done to move the needle toward effective national climate policy and more faithful earth-keeping practices in evangelical churches and campuses across the country. To this end, the national steering committee adopted its first strategic plan in fall 2016, celebrating our successes and laying out a path for sustained and dynamic growth.[21]

One of the priorities developed in the strategic plan is to build relationships with new grassroots networks and partners that represent different communities than those historically mobilized by the YECA. In particular, the steering committee recognized the deep racial disparities within the US evangelical community at large. In lament over this tragic reality and in hope of a different future, we committed to increasing diversity in our organizational leadership and partnerships over the next five years. We also drafted a Commitment to Diversity Statement, laying out the theological imperative and the strategic rationale for pursuing greater equity, inclusion, and reciprocity with minority communities in the common work of climate action.[22]

As part of expanding our outreach to senior evangelical leaders, YECA is seeking to cultivate relationships, not only with leaders as defined by a more traditional evangelical institutional structure (i.e., pastors, denominational leaders), but also with innovative voices in emerging forms of leadership such as artists, prominent bloggers, writers, and social media personalities. Leadership is taking new forms in the twenty-first century and, as institutional affiliation decreases, it is critical for us to reach the leaders whom our target audience engages most attentively.

Finally, we recognize the unique ability of young evangelical voices to gain the attention of conservative lawmakers. We desire to continue stewarding this opportunity for faithful advocacy. We plan to engage thousands of new young evangelicals in upcoming election years and to offer creative opportunities for our networks to communicate the need for a clear national path forward on climate using a shared set of policy principles. Our goal is that elected officials will hear rising generations of evangelical voters saying with a louder and clearer voice that we care about climate change and want them to as well.

Conclusion

Many US evangelicals have disconnected a concern for the created world from their faith commitments, which is particularly evident on the issue of climate change. YECA occupies a unique space among both Christian organizations and mainstream climate advocacy groups seeking to change this. Motivated by our evangelical faith, we are able to speak biblically and persuasively to Christian communities, particularly to those groups that large environmental groups often struggle to understand and include—groups that will be crucial for achieving lasting policy change in the United States.[23] More than shifting the political needle, however, YECA is positioned to help renew evangelical climate and environmental engagement as an integral part of biblical discipleship and gospel witness. In doing so, we pray that, by God's grace, the evangelical church will become a more faithful advocate for a just and livable future that points to the redemption yet to come. ✧

Notes

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Environment

CREATION CARE: A Biblical Theology of the Natural World by Douglas J. Moo and Jonathan A. Moo. Grand Rapids, MI: Zondervan, 2018. 256 pages, index. Paperback; $24.99. ISBN: 9780310293743.

This book is part of the Biblical Theology for Life series, which addresses contemporary issues by answering the question, "What does the Bible have to say about that?" Other publications in this series include books with titles such as *The Mission of God's People*, which addresses God's overarching mission for the world, *Christians in an Age of Wealth*, which answers questions about the place and purpose of wealth in a Christian's life, and *Known by God*, which explores the nature of personal identity. Contributors to this series "seek to straddle both the world of the text and the world in which we live." Each book strives to mine the Bible for theology that addresses a particular topic while also contextualizing this theology in ways that allow the Bible to transform contemporary Christian life.

Each volume in this series has the same basic structure. The first section of each book is entitled "Queuing the Questions." In this section, authors introduce the questions they seek to address. In the second section, "Arriving at Answers," authors develop the biblical theology of their topic by focusing their attention on specific biblical texts. In the concluding "Reflecting on Relevance" section, authors discuss specific ways in which this theology impacts contemporary situations, thus challenging readers to consider how they might live it out in the world today. As stated in the series preface, the hope of the authors is to provide informed insights of evangelical biblical scholarship that will "increasingly become enfleshed in the sermons and discussions that transpire each week in places of worship, in living rooms where Bible studies gather, and in classrooms around the world."

The first two chapters of *Creation Care* ask and then seek to answer three questions: What is our topic? Why write a book addressing this topic? And how can we go about seeking answers from the Bible? The authors answer the first question by explaining their choice of the word "creation" rather than "nature" or "environment." Speaking of creation care rather than environmentalism or nurture of nature provides the foundation for addressing the topic from a Christian worldview. The authors then discuss two reasons for addressing this topic. The first focuses on the challenge of getting Christians on board with creation care, since for many in Christian circles this topic is very much a peripheral issue. The second is to challenge the claim that Christian anthropocentrism is largely to blame for the environmental challenges we face around the world today. The entire second chapter is devoted to the last question and surveys various methods of biblical interpretation. The authors examine three external factors that may influence one's biblical theology of creation care: historical and systematic theology, our contemporary culture, and scientific research. They warn against coming to scripture with an agenda and argue instead for allowing the text to speak for itself.

The "Arriving at Answers" portion of the book is by far the longest, encompassing chapters three through nine. The authors first acknowledge that teachings about the created world are widespread in the Old Testament, but relatively sparse in the New Testament. They admit that this is a problem because most of the preaching and teaching in churches today is from the New Testament and most believers spend far more time reading the New rather than the Old Testament. Since both authors are New Testament scholars, they address this situation by devoting as much space to creation care from the New Testament as they do from the Old Testament. They examine passages of scripture from the epistles in depth and devote one entire chapter to "Jesus and Creation." The last two chapters in this section of the book discuss various aspects of the "new creation." The authors argue convincingly that God's redemptive plan encompasses the whole of reality and that a "transformation" model best summarizes the varied teachings of the Bible about the future of creation. (The passage in 2 Peter 3, which appears to teach a "replacement" model of creation's future, is examined in depth.) While thoroughly covering creation care passages from the New Testament, most, if not all, of the pertinent passages from the Old Testament are also addressed. The result is a genuine "biblical theology of the natural world" that provides a survey of the topic from the entire biblical canon.

The last four chapters contain the "Reflecting on Relevance" portion of the book. One chapter, entitled "Creation in Crisis," presents an overview of the environmental problems that are threatening the health of planet earth. These include the loss of biodiversity, destruction of the world's forests, overhunting, overfishing, the degradation and loss of topsoil, the projected scarcity of freshwater, concerns about our industrial food system, and the ramifications of climate change. The other three chapters propose ways in which Christians should respond. These responses are organized around the acronym "AWAKE" which includes the following: being *Attentive* to the community of creation around us; *Walking* more and considering how, where, and how much we travel;

becoming *Activists* for God's kingdom on earth; rejecting our culture's way of *Konsumerism*; and *Eating* joyfully, thankfully, reverently, and ethically. (Consumerism is misspelled intentionally with the hope that readers will be more likely to remember it.) The authors suggest a number of specific ways in which Christians can become AWAKE, better stewards of God's creation, although they admit that they have provided only "a mere outline of possibilities and suggestions to get readers started." They support their assertions by revisiting their discussion of Genesis, where the "ruling" mandate of Genesis 1 is qualified by the "serving" mandate of Genesis 2. As God's vice-regents, humans must "imitate the nature of God's own rule of the world, which has been powerfully displayed in the servanthood of the incarnate Son of God."

As stated by Richard Bauckham on the very first page, "this book deserves to become the standard work of its kind." The father and son team of Douglas and Jonathan Moo have written a comprehensive introduction to a biblical theology of creation care that is well organized, accessible, and applicable for a wide spectrum of Christian readers. An extensive scripture index is included at the end of the book, along with an author and a subject index. Although there is no bibliography, the book is replete with footnotes that include references to a variety of pertinent books and articles. Anyone who wants to delve more deeply into this topic will find the references in the footnotes most helpful. The authors provide numerous thought-provoking quotations from a variety of sources in the sidebars of many pages, and each chapter concludes with a series of relevant discussion questions, making this book a good choice for adult discipleship classes or study groups. All of these components make this book a welcome addition to the body of literature that addresses the topic of creation care from a biblical perspective.

Reviewed by J. David Holland, Department of Biology, University of Illinois at Springfield, Springfield, IL 62703.

Ethics

THE RADIUM GIRLS: The Dark Story of America's Shining Women by Kate Moore. Naperville, IL: Sourcebooks, 2017. 496 pages. Hardcover; $26.99. ISBN: 9781492649359.

In the years preceding WWI, the Radium Girls, teens and young women in their early twenties, gratefully took a job with the United States Radium Corporation (USRC) where they painted watch and instrument dials with radium-containing paint. The exceedingly fine work required precision brushes and the young women were taught to "lip point" their brushes to aid this fine work. Lip pointing was a technique in which the dial painters placed their brushes into their mouths to make the brush tip pointed for the fine work, then dipped the brush into the radioactive paint, painted a number on a dial, and then repeated the process. "Lip, dip, paint," repeat. The USRC assured the dial painters that the paint was not harmful. In fact, in the earliest years following the Curies' discovery of radium, it was believed to have health benefits. Radium was an ingredient in tonics, cosmetics, and more. They could not have been more wrong!

Every time the dial painters pointed their brushes with their lips, they ingested radium. Radium dust rained down on the employees, covering their hair, clothes, and skin. They carried the dust home to their families and walked it out of the plant and onto the sidewalks of their communities with their shoes.

It did not take long for the dial painters to show signs of radium poisoning. Their teeth fell out, their jawbones fractured, and, shockingly, pieces of mandible came out into their mouths. The wounds that were left when they lost their teeth failed to heal. They developed severe anemia, limps, and sarcomas. Doctors and dentists were befuddled. Slowly, doctors, dentists, and the dial painters derived a conclusion. The paint was poisoning them. USRC's behavior in response to the dial painters' illnesses was unforgivable. Through investigation and litigation, as told in this riveting work of nonfiction, it became clear that USRC knew, early on, that radium was making the dial painters sick. In spite of this, USRC actively worked to hide the danger from their employees. USRC began innocently ignorant of the danger of radium, evolved to willful ignorance, and then quickly to an active and malicious cover-up.

The Radium Girls: The Dark Story of America's Shining Women by Kate Moore paints the story of USRC's indefensible actions and failure to act on behalf of their employees. Moore shares the personal stories of several of the dial painters and their suffering due to radium poisoning through their letters, diaries, testimonies, and interviews with living relatives. She recounts the extensive legal battles that ensued to compensate the dial painters (and their families) for the suffering and loss of life they experienced because of their exposure to radium.

The book includes enough of the science of radium and radiation so the average reader can understand why radium causes the kinds of damage the dial painters experienced, but it is not primarily a science book. It covers the evidence, trials, and appeal hear-

ings that led to changes in worker protection laws but is not primarily a book about changing the law. *The Radium Girls*' most compelling feature is the stories of the young women. Moore tells their stories such that they pop from the pages as real human beings with hopes and dreams, experiencing love and loss.

For me, a scientist, the book was a sobering reminder of the responsibility scientists have to do our important work carefully, thoroughly, and ethically. When I am working to make my laboratory OSHA-compliant, I will think of the dial painters and, rather than grumble about the extra work, I will be grateful for the protections we have in labs and industry thanks to the radium girls, whose fierce persistence led to the formation of OSHA and other organizations. The story of the dial painters reminded me that the world was (and unfortunately still is) a place where people who lack power—women, children, people of color, and the poor—also lack a voice. The story compels me to be a voice, whenever I can, for those who lack power; this is an especially important ethical responsibility for Christians.

Who should read this book? Anyone interested in science, law, or business regulations. Anyone who loves a good nonfiction story with sympathetic characters and real-life villains. I will recommend this book to some of the high school students in my church who love science, especially the girls. It is a compelling story of young women who found their voices and made a difference in history.

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History of Science

THE RHINOCEROS AND THE MEGATHERIUM: An Essay in Natural History by Juan Pimentel, translated by Peter Mason. Cambridge, MA: Harvard University Press, 2017. 364 pages, including contents, prologue, notes, acknowledgments, credits, and index. Hardcover; $29.95. ISBN: 9780674737129.

For a person interested in natural history, the notion of a "fantastic binomial" may bring to mind a favorite plant, animal, or fossil and its uniquely crafted name following the Linnaean nomenclature for a species. But for Spanish historian Juan Pimentel, a "fantastic binomial [is] the combination and setting into motion of two objects or persons who are apparently unconnected" (p. 6). In *The Rhinoceros and the Megatherium*, Pimentel crafts an extended essay that describes the parallel journeys of two marvelous mammals to the Iberian peninsula: one a live creature from the Far East, and the other a fossil from the western hemisphere.

The first three chapters tell the tale of Ganda, a live rhinoceros transported from India to Portugal in 1515 who was named in honor of the native term for the animal. To the Portuguese people, this massive animal represented their perception of the Orient: something unfamiliar, exotic, and dangerous. What was known of rhinoceroses at the time was primarily the stuff of legend, stemming from the works of ancient Greeks such as Strabo and Pliny, and often becoming conflated with stories of the mythical unicorn. The rhino was viewed as a ferocious, brutal creature who was built to destroy its natural enemy, the elephant. Upon coming into contact with animals such as rhinos, many people simply sought to reinforce their preconceived notions about these animals, hence the staged battle between Ganda and a juvenile elephant that was not in any way ready to fight the rhinoceros. Ganda was eventually gifted to Pope Leo X, but tragically died in a shipwreck on his way to Rome. Pimentel contests that no one would remember this tale were it not for Albrecht Dürer's classic woodcut that immortalizes the creature. This image, which would spread around the world, depicts a creature with some of the key traits of a rhinoceros, such as its robust body, stout legs, and the nose horn that gives the animal its name. But it also features what look like overlapping plates of armor, thick reptilian scales, and a small unicorn-like horn perched between its shoulders. Apparently, Dürer actually never witnessed Ganda firsthand, basing his representation on a descriptive letter, an original illustration (which has been lost), and undoubtedly a host of preconceived notions about the animal. Hans Burgkmair produced a woodcut around the same time that more accurately represented the anatomy of the rhinoceros, but it lacked the power of Dürer's chimeric piece that carried the "fables and words of antiquity" about the animal (p. 100).

The next three chapters tell the story of a different beast, whose bones were dug up from the earth near the Luján River in present-day Argentina. The fossil was initially taken to Buenos Aires before eventually being transported across the Atlantic Ocean to the Royal Cabinet of Natural History in Madrid during the summer of 1788. This skeleton was like nothing anyone had ever seen before—it was massive and had an anatomy unlike any modern creature known to science. Initially reconstructed as a pachyderm or large cat, the first people to study it did not really know what to make of it. Juan Bautista Bru and Manuel Navarro collaborated to produce illustrations and engravings of this beast to publicize it, but

it was not until Georges Cuvier got his hands on these images that the mysteries of this ancient creature began to unravel. In 1796, Cuvier produced a paper documenting the anatomy of this creature, placing it in the family tree of mammals, and finally giving it a name: *Megatherium americanum* (which translates to "great American beast"). Through careful comparative work, Cuvier recognized that this animal was new to science, but clearly related to the edentates, a grouping of mammals that includes armadillos and sloths. This work marked the beginning of Cuvier's prodigious career and helped to provide evidence that the ancient world was full of creatures that are not represented in the modern fauna. Additional fossils of related creatures would be found in later years, and after some further debate, the great anatomist Richard Owen would eventually demonstrate that *Megatherium* was an extinct species of giant ground sloth.

Pimentel uses these two stories to explore many topics along the way. While some digressions are more interesting and germane than others, they generally raise intriguing ideas inspired by the tales of the rhinoceros and *Megatherium*. Pimentel recurrently explores topics such as "the role of imagination in the manufacture of scientific and historical facts" (p. 6), the power of images to convey reality mixed with "preconceptions and mental resonances" (p. 103), and the "alliance between art and science" (p. 164) that gave rise to the discipline of scientific illustration. In telling these tales, he also conveys the importance of understanding how our collective knowledge has changed across centuries. He discusses how the discovery of fossils presented a challenge for many eighteenth-century naturalists, who believed in the doctrine of plenitude and the fixity of species. In so doing, he briefly covers the infancy of paleontology, the debate between uniformitarianism and catastrophism, and the tensions that existed between science and faith during this time, pointing out that religion actually played an important role in the development of earth history and science in general.

If readers are in search of a more systematic and thorough history of paleontology or zoology, then they should look elsewhere. However, Pimentel's extended essay about the "circular biographies" (p. 287) of the rhinoceros and *Megatherium* offers plenty of historical illustrations (56 in total) and rich stories that will inspire further thought about the natural world, how we engage with that which is unfamiliar, and the role of imagination and images in helping us see the reality around us.

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Mathematics

A MATHEMATICIAN'S LAMENT: How School Cheats Us Out of Our Most Fascinating and Imaginative Art Form by Paul Lockhart. New York: Bellevue Literary Press, 2009. 144 pages. Paperback; $14.95. ISBN: 9781934137178.

MEASUREMENT by Paul Lockhart. Cambridge, MA: Harvard University Press, 2012. 407 pages, with index. Paperback; $20.50. ISBN: 9780674057555.

ARITHMETIC by Paul Lockhart. Cambridge, MA: Harvard University Press, 2017. 223 pages, with index. Hardcover; $22.95. ISBN: 9780674972230.

You will forgive me if I find it normal for mathematics education to be under attack. That has been my experience since the mid-1960s. I wasn't subjected to "new math" in the classroom (we weren't that up-to-date), but I was privileged to attend a National Science Foundation Saturday course aimed at introducing talented high school students in the Chicagoland area to the modern abstract view of mathematics. The short text we used developed the real number system as equivalence classes of Cauchy sequences, claiming this would help us understand what creative mathematics was really all about. I stumbled out of those lectures in a fog of confusion, none the wiser for the honor, yet still interested in mathematics as I understood it.

I underwent the same anxious muddle about three years later during my first semester of abstract algebra, but this time the haze gradually cleared, and I began to appreciate an abstract formal viewpoint. I was not convinced, however, that imposing a set-theoretic foundation on school mathematics was pedagogically or philosophically sound, nor that it would help catapult the USA ahead of the Soviet Union in the space race. Aspects of the New Math reform appealed to me, but I also resonated with parts of Morris Kline's hyperbolic rant *Why Johnny Can't Add: The Failure of the New Math* (1973). The more concrete heuristic approach taken by British mathematics educators under the leadership of Edith Biggs seemed far more promising than what new math proponents had on tap.

Since the 1960s a host of professional documents by committees and individuals have detailed what's wrong with mathematics education in the USA on all levels and have told us what we should do to fix it. Progress has been made on a number of fronts, but not everyone has clambered aboard one of the reform trains. Paul Lockhart, for instance, begs to differ with how things still typically go—actually, he

stridently excoriates today's mathematics educators, textbook companies, and conventional schooling.

After finishing a PhD in mathematics, Lockhart taught university mathematics but soon became disillusioned with student attitudes and institutional objectives. He therefore shifted down to the high school level and lower, where he hoped he could instill a love for genuine mathematics before students were corrupted by traditional curricula, mindless worksheets, and uninspiring teachers. In 2002, he penned a 25-page stinging broadside against the status quo in mathematics education, which, after Keith Devlin highlighted it in two 2008 *Devlin's Angle* posts ("one of the best critiques of current K–12 mathematics education I have ever seen"), gained increased notoriety and circulation. Lockhart's 2009 book includes this essay as its opening "Lamentation," concluding with a shorter "Exultation" in which he describes his delight in constructing the mathematical world of the mind, where one's hamsters (a favorite metaphor for mathematical entities) can have all the beautiful functionality anyone would ever want, living in a universe subject only to human imagination and logical consistency.

Lockhart's *Lament* ends by exhibiting some examples of what learning mathematics ought to be like: one problem from number theory, solved using Pythagorean-like arrangements of imaginary rocks (why do successive odd numbers add up to a square?); another from geometry, solved using reflective symmetry (what is the shortest linear path connecting two points via an intermediary point on a straight line?); and a third from combinatorics, tantalizingly left for the reader to solve (must at least two people at a party always have the same number of friends present?). Lockhart's colloquial exposition of these problems and their solutions is clear and engaging. His parting advice to students and teachers is to "throw the stupid curriculum and textbooks out the window" and "just play" with the mathematical creations you dream up (p. 139).

So what would such teaching/learning look like? An extended model of how to pursue real mathematical understanding—of how to explore and discover mathematical connections, using elegant arguments—is implicitly presented in Lockhart's subsequent books, *Measurement* and *Arithmetic*.

Of the two books, *Measurement* is the more ambitious and substantial. The material is divided into two equal parts: the first, Size and Shape (topics in classical and projective geometry, as well as trigonometry); and the second, Time and Space (matters handled by coordinate geometry and differential calculus), in which motion plays an important role in generating curves and sweeping out regions as well as being a concept to analyze mathematically.

After explaining that mathematics is simply an exploration of the perfect patterns of things we create with our minds, to find out how they behave and why, Lockhart offers some problem-solving suggestions: solve problems of your own making; collaborate with others; mess around with ideas even if they seem far-fetched; be open-minded and flexible about whether your conjectures are true; review, critique, and improve your proofs; have fun. Not quite Polya's *How to Solve It* (1945) or his two-volume *Mathematical Discovery* (1962, 1965), but some pointers worth heeding.

It is difficult to summarize the contents of *Measurement* because Lockhart occasionally observes his own advice, to follow a problem to wherever it meanders off. His asides are often stated as observations to be tested or posed as problems for further exploration, a feature that may make the book a good choice for group exploration, though readers are on their own with respect to the answers. But his main topics are organized in an interconnected way around the general theme of the title.

Measurement, he notes, is about comparing one measure with another. As geometry has no natural units (with the exception of a full circle for angles), measurements are intrinsically relative—they are ratios, leading to formulas that relate different measures. Shapes are characterized in terms of similar figures, where one is a scaled version of the other, involving proportional measures. Lockhart also compares lengths, areas, and volumes of a wide variety of figures with one another, giving rise to some nicely argued classic results—Heron's Formula for the area of a triangle; the Pythagorean Theorem and its generalization to the Law of Cosines; areas for a circle and an ellipse; the volumes of a cylinder, pyramid, cone, and sphere; and so on.

Fairly early in the section, Lockhart introduces the so-called classical "method of exhaustion," "by far the most powerful and flexible measuring technique ever devised" (p. 70), as a key strategy for extending results about rectilinear figures to curved ones. A circle, for instance, is approximated ever more closely (gets exhausted) by inscribed regular polygons as their number of sides increases. The polygons' areas tend toward that of the circle, giving the circle's area in the end as half the product of its radius and circumference. A similar idea works for volume comparisons: a cylinder is exhausted by a collection of abutting rectangular boxes, a cone by a stack

of cylindrical discs, a pyramid by stacked boxes, a sphere by thin tetrahedra emanating from the center. Using these approximations, Lockhart establishes a number of familiar volume and surface area results known since Euclid and Archimedes. He argues these results informally and concisely, but gives enough details for the reader to follow his reasoning.

Unwilling to admit infinity into mathematics, the Greeks had linked their exhaustion technique to a rigorous double proof by contradiction strategy (a circle's area is neither more than nor less than half its diameter times half its circumference), but this is an idea too complex for *Measurement* to include. Lockhart instead treats the strategy as realized in the infinite limiting process more fully developed in calculus. He also uses the method of exhaustion to argue for the validity of Cavalieri's Principle, which compares lower-dimensional cross sections of figures in order to relate an unknown measure (area, volume) to one that's already known. Lockhart employs this resourcefully in determining the volumes and surface area of a sphere and a torus, the latter result first appearing in a work by Pappus.

Another topic of classical geometry that Lockhart investigates is that of conic sections (first studied by Apollonius), something that has fallen somewhat out of favor in today's streamlined mathematics curriculum. For example, he introduces an ellipse as a dilation of a circle, as a planar projection of a circle, and as a cross section of a cylinder. He then presents an "ingenious argument" using Dandelin spheres for the ellipse's "shockingly beautiful" characterization in terms of foci—"Is that gorgeous, or what!" (p. 145), following this with a discussion of the ellipse's remarkable tangent property—all done without a stitch of algebra or coordinate geometry. The ellipse and other conic sections are then explored using some ideas from projective geometry.

The section on Size and Shape concludes by introducing the helix and the cycloid. As these figures are best understood as traced out by a moving point, Lockhart uses them to segue into the second section of the book, Time and Space. Here he leaves ancient Greek geometry behind to take up seventeenth-century concerns and approaches.

Basic to the modern treatment of shapes is setting up a coordinate system, done to facilitate the use of algebra, including vectors, for analyzing curves. Although at first Lockhart denigrates this—"It's ugly, and should be avoided whenever possible" (p. 214)—he later lauds this way of representing geometric objects, saying that "the connections between algebra and geometry that are revealed by this point of view are among the most fascinating and beautiful results in all of mathematics" (p. 246) and "This viewpoint not only has the benefit of simplicity … but also tremendous flexibility and generality" (p. 295).

Lockhart employs graphed curves to represent and analyze moving points, such as a point on a circle rolling along a line, which produces a cycloid path. Using trigonometric ideas introduced earlier in the book, he determines the parametric equations of the cycloid, later returning to determine its velocity as well as the area and path length for one arch of the curve.

Lockhart adopts a Newtonian view of a curve as traced out by the endpoint of a moving line whose instantaneous velocity $\dot{p}$ is the terminal value of approximating average velocities, attained as time t shrinks to an instant and position p becomes stationary. This is Newton's fluxion, now termed the position's time derivative. After discussing this for motions in more than one dimension, he introduces Leibniz's differential notation dx to denote the instantaneous rate of change of any variable x, making $\dot{p} = dp/dt$. Lockhart next develops a collection of formulas for how the d-operator interacts with various arithmetic operations as well as a simple library of formulas for some basic mathematical functions—a plan familiar to anyone who's taught calculus. He then notes that Leibniz's differential calculus can be used to express and solve "virtually all measurement problems" (p. 319), provided these measures are put into motion: "If you want to measure something, wiggle it" so that "it has a rate of motion" (p. 330) one can calculate with.

A "fantastically beautiful and powerful application of the differential calculus [that is] possibly the most useful" (p. 351) is that of optimization. Differentials can be used, for instance, to determine the largest cone that can sit inside a sphere or the precise shape of a cylindrical can that maximizes the amount of soup relative to the amount of metal in the container. The key principle behind these calculations [an early version of which was known to Kepler] is that "when a variable peaks, its differential must vanish … undoubtedly one of the simplest and most powerful discoveries in the history of analysis" (p. 355).

Putting differentiation into reverse, integrals can be calculated to determine areas, volumes, and lengths, provided the formulas are simple enough—though, like almost all invertible procedures, complications can arise even for some familiar curves. This is the case for most arc length calculations, but it even occurs for area calculations. The area under the hyperbola $y = 1/x$ between $x = 1$ and $x = w$, for ex-

ample, turns out to be complicated, but its properties enable it to be used to define natural logarithms in a rigorous way.

Measurement takes us on a rather impressive tour of various fascinating and significant technical results, visiting many high points in geometry and calculus, whose study would be beneficial for prospective middle school and high school mathematics teachers. The text might also be given to a bright and curious student on these levels, but having a guide familiar with the terrain would be advisable. Lockhart provides a superb big picture exposition of the main contours of introductory calculus, but without all the specifics, terminology, and applications present in today's monstrous calculus texts.

Lockhart's goal in *Measurement* was to demonstrate "What a wild and amazing place mathematical reality is! … a vast, ever-expanding jungle … a meeting place for language, pattern, curiosity, and joy" (pp. 396–97). Those of us interested in making mathematics education attractive can only applaud his effort. Keith Devlin goes so far as to say in his Foreword to *A Mathematician's Lament*, "I will tell you this. I would have loved to have had Paul Lockhart as my school mathematics teacher."

Arithmetic is the latest book in Lockhart's series, focused, as one would expect, on the most basic aspects of elementary mathematics. We need to count, compare, gather together, remove, multiply, and divide up quantities of things in all parts of our lives and then often record the results. Arithmetic is the art humanity has developed for doing these things in efficient ways. While computation was once a practical skill we needed to hone, Lockhart notes that today's calculators and phones are faster and more accurate than we will ever be, relieving us of its drudgery. However, we can still appreciate and enjoy the underlying ideas and methods of arithmetic as an intellectual craft designed to organize and communicate numerical information, as a sort of "symbol knitting."

As a human construct, arithmetic has a rich and varied history, though this isn't typically explored in mathematics textbooks. Lockhart, however, interweaves his explanations of the main ideas involved in doing different sorts of calculations with occasional accounts of how arithmetic developed in various cultures, both real and imaginary.

While numbers don't mind how they are conceptualized or symbolically represented, such choices do affect how we calculate with them. Lockhart highlights the importance of uniform grouping (adopting a number base) as he discusses the counting systems of three fictitious tribes, tally marks, Egyptian hieroglyphic numerals, Roman numerals, and Chinese named-place-value numerals.

The all-important place-value principle, which makes it possible for us to represent numbers of any size whatsoever, was initially embodied in an abacus, in which different columns or rows stood for different group-levels (one, ten, hundred). We know such artefacts were used for making calculations in many ancient cultures, but the first written place-value system was the Mesopotamian sexagesimal place-value system. Lockhart chooses not to discuss this, only recognizing the Babylonians for using sixty as their rather cumbersome base, but without offering any possible reason for their choice. He instead introduces a written place-value system in the context of discussing our Hindu-Arabic numeration system, which originated in sixth-century India.

Over several chapters, Lockhart reconstructs how the usual algorithms that Europeans eventually adopted for addition, subtraction, multiplication, and division can be based both on the meaning of the operations and on the way we symbolize our numbers. This is done mainly for positive integers, but he notes that it can be extended to calculations involving decimal fractions, whose origin he seems to associate with the French Revolution's proposal to decimalize all measures (the metric system) rather than attributing it to Stevin's landmark treatise two centuries earlier or noting its connection with the much earlier sexagesimal system or Chinese decimal notation or medieval Arabic developments. He also devotes a chapter to discussing how these computational procedures were mechanized over time, from using wheels, gears, and carry pins to electronic circuits and LED displays.

Lockhart concludes his treatment of different number types toward the end of the book by discussing the arithmetic of fractions and negative numbers, inexplicably omitting real and complex numbers. He briefly refers to a couple of historical ways of dealing with fractions (Egyptian) and negative numbers (debts), but much more could have been done along these lines to motivate the ideas and procedures involved, which would connect our understanding of them with how they actually arose. In *A Mathematician's Lament*, Lockhart rued the fact that "we have a mathematics curriculum with no historical perspective or thematic coherence" (p. 56), but *Arithmetic* misses some natural opportunities to remedy this deficiency. For example, China's use of red and black counting rods for signed integers and their rules for calculating with negative numbers in the

context of solving linear system problems parallels Lockhart's explanation using sheep and antisheep. Likewise, Arabic and European calculations with subtracted quantities provide a heuristic motivation for multiplying signed numbers. Lockhart's explanations are consistent, however, with his overall perspective on mathematics as a human creation, imaginatively invented. What's most important for him, it seems, is for teachers to reconstruct standard mathematical ideas in ways that charm and entice students to explore them recreationally, even if they involve imaginary hamsters and antisheep rather than practical concerns grounded in historical realities.

Though I very much enjoyed Lockhart's books, I have some reservations and criticisms that go beyond the historical observations just made. These pertain to his basic educational philosophy of mathematics. Lockhart holds that mathematics is ultimately a human mental creation, an art done purely for intellectual enjoyment. He repeats this refrain in a number of contexts, to the point that it gets rather old. Geometry, he insists in *Measurement*, deals with the ideal shapes we define and explore: "none of the things we've been talking about are real … We made up imaginary points, lines, and other shapes so that things could be simple and beautiful—we did it for art's sake" (p. 169). While this seems harder to assert of quantities, which we experience more precisely, he says in *Arithmetic* that he also conceives of numbers as abstract creatures to which we assign behaviors according to our own aesthetic sensibilities (think: negative numbers). Computation has practical applications, but he still claims that "the idea with arithmetic is to have some fun, keep track of a few things, and occasionally enjoy a bit of cleverness" (p. 24). Mathematicians prefer the "purely mathematical realm" for its "sheer intellectual pleasure and entertainment," a universe of exact abstract entities created with "simplicity and abstract beauty" in mind. This may approximate the "fuzzy, random, and inexact" world we live in, but that's not why mathematicians do mathematics (p. 163). Reality provides us with "crude" and "clumsy prosaic object[s]" about which we could never assert any mathematical truths (p. 181). It provides a springboard for humans to create an imaginary world of perfectly behaved objects: "the whole enterprise is a made-up game in our heads" (p. 193).

While I agree that mathematics is not a utilitarian enterprise, this admission does not lead me to ignore its essential connections to a broader reality. A cursory familiarity with the history of mathematics gives the lie to artistic intellectual elitism. Teachers do need to find ways to motivate students to study mathematics, but a practical situation can often do this as well as a game or a whimsical exploration of an idea. Dealing concretely with arithmetic and geometry is important on lower levels, and connecting them with nonmathematical contexts expands students' understanding of the value and interest of mathematical ideas and procedures. Mathematics deals with quantitative, spatial, and kinematic patterns in a given creation already structured by God. Its applicability lies not in humans' brains being part of reality, but in the world being structured as a coherent whole by its Creator. Humans have found ingenious ways to interact mathematically with their everyday contexts, but acknowledging this is quite different from crediting us with creating mathematical reality out of conceptual whole cloth.

Lockhart's antipathy toward real-life applications makes him downplay a side of mathematics that can be helpful to teachers and students. Although I find some of his critique of mathematics education valid, it does not fairly take into account the creative ways some teachers and texts try to connect with students. Lockhart is not alone in wanting to incite a love for mathematics. Regardless, his impassioned advocacy in these books for making mathematics come to life through active explorations of important ideas may inspire such teachers to further improve their own teaching.

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ORIGINS

THE INTELLIGENT DESIGN DEBATE AND THE TEMPTATION OF SCIENTISM by Erkki Vesa Rope Kojonen. New York: Routledge, Taylor & Francis, 2016. 226 pages. Hardcover; $150.00. ISBN: 9781472472502. eBook; $50.00. ISBN: 9781315556673.

Writing from a theologian's perspective, Erkki Vesa Rope Kojonen argues that "beliefs about the purposiveness or non-purposiveness of nature should not be based merely on science. Rather, the philosophical and theological nature of such questions should be openly acknowledged." He cogently spells out the landscape of the debate over intelligent design, exploring historical approaches to the fundamental question of teleology in nature and showing the importance of the theological and philosophical aspects of design.

Rope Kojonen is a postdoctoral researcher in the Faculty of Theology at the University of Helsinki. His studies and research interests focus on the general discussion between faith and reason with specific

emphasis on intelligent design. He is the editor of the Finnish science and theology magazine *Areiopagi*.

Rope Kojonen repeatedly emphasizes that he does not wish to take sides in the intelligent design debate. He only wishes dispassionately to analyze the debate and make a suggestion. "I argue that the sidelining of theology and philosophy from the debate is actually an example of the influence of scientism, defined as the belief that science is the only way to gain reliable knowledge about the world" (p. 3). That, in a nutshell, is the summary of the entire book.

Rope Kojonen begins by offering his view of the origin and definition of the contemporary ID movement. Based on a quote from the Center for Science and Culture department of the Discovery Institute, he states that

> ID is three things:
>
> 1. A scientific research programme attempting to find evidence of design in nature
> 2. A community (or movement) of scholars who participate in this research programme
> 3. A theory which holds that there is indeed evidence for intelligent design in nature. (p. 12)

He points to Phillip Johnson's publication of *Darwin on Trial* as the origin of the ID movement, though not of teleological arguments which have a long history. Thereby he seems to ignore the books and articles in *PSCF* published in the 80s. I view the book *The Mystery of Life's Origin: Reassessing Current Theories* by Charles B. Thaxton, Walter L. Bradley, and Roger L. Olsen as a more seminal trigger of the modern design movement with Johnson's work serving as the expansion into public awareness.

Rope Kojonen makes it clear from the outset that he intends to be fair to all sides. He acknowledges the widespread belief in an intelligent creator even by critics of ID when he says, "The basic idea that nature provides some kind of evidence of an intelligent creator has ancient roots and is even shared by many theistic critics of ID." Then he deftly pinpoints the source of the criticism by saying, "ID's defense of the idea is controversial because of its emphasis on the scientific nature of the design argument, and also because of its critique of evolutionary biology" (p. 30). He proceeds to map out an exhaustive articulation of the arguments set forth by advocates and critics of ID while avoiding his own judgment or preference.

Throughout this discussion, Rope Kojonen meticulously seeks to be even handed, supplying a balanced view. Taken to the extreme, he edges perilously close to creating a false equivalence between arguments for and against ID. In reality, virtually the entire scientific community that has assessed the claims of ID has found them wanting while the advocates are a small minority. That overwhelming perspective cannot be gleaned from this book. Nevertheless, the book is valuable for providing a dispassionate description of the arguments for and against ID.

Rope Kojonen's main concern is the emphasis the ID advocates place on scientific evidence for ID. He feels that by downplaying the theological and philosophical aspects ID proponents succumb to the temptation of scientism, despite their expressed opposition to scientism. He feels that ID advocacy would be better served by an open discussion of the pertinent theological and philosophical issues. On the other hand, in my opinion, those perspectives generally do not fare any better than the scientific arguments. Combining several weak arguments does not provide a strong argument. Nevertheless, it is a useful recommendation to the ID community that theologians and philosophers are brought into the discussion more closely, providing a clear linkage to those fields.

The book covers virtually the entire spectrum of topics in the ID controversy, though with disappointingly minimal discussion of the information argument. Better copy editing to correct the numerous missing and extra words would have been helpful but the message comes through clearly. It is a worthwhile source for anyone wishing to delve deeper into the nuances of the ID debate.

Reviewed by Randy Isaac, ASA Executive Director Emeritus, Topsfield, MA 01930.

STANDING ON THE SHOULDERS OF GIANTS: Genesis and Human Origins by Luke J. Janssen. Eugene, OR: Wipf and Stock, 2016. 334 pages. Paperback; $32.00. ISBN: 9781498291408.

Luke Janssen is a professor in the Division of Respirology, Department of Medicine at McMaster University in Hamilton, Ontario. He has a distinguished career as a cell biologist with over 130 peer-reviewed articles. He is also a former young-earth creationist who has wrestled hard with the reality of his faith in light of what he now sees as scientific reality. This clearly written book (his second on the topic) is the result of his thorough examination of both the scientific and theological issues at stake in the human origins discussion.

Given the breadth of the subject matter that extends beyond the author's expertise in the medical sciences, the book would have benefitted from more input from colleagues with expertise in theology and

paleoanthropology. Unfortunately, there are a number of distracting errors that reduce the potential impact of the book.

From the science perspective the book is uneven. For example, fairly early in the book, the author makes this statement:

> Biologists resist viciously any idea that a designer is behind the complex coding found within our cells. We have no examples of genetic mutations giving rise to a significant increase in information or a more complex gene sequence. The only examples of large evolutionary steps via gene mutations that we've been able to document comprise the reduction of information: the inactivation of a gene or the functional neutralization of its gene product. (p. 70)

This is a decidedly pro-intelligent design statement exactly like the argument in books by Stephen Meyer, for example. And yet he does not elaborate on it further at any other point of the book. Indeed, he goes on to write a statement that certainly appears to be an example of the very thing of which he says "we have no examples":

> On a blog which I maintain, I have included a photograph which powerfully depicts how a very small genetic mutation can convey an amazing advantage to an organism and thereby catapult the organisms which inherit the change into a whole new level of competitive superiority. (p. 97)

Intriguingly, the two statements seem to contradict each other. He goes on to show how and why this mutation (it is associated with color vision) is not only highly favorable, but is embedded within a newly duplicated gene. So, the author provides not only a perfect example of a point mutation giving rise to increased information, but also of a duplication event of the sort that is a poignant example of the kind of information-generating machinery that is believed to play no small role in driving the evolutionary process. It is as though he wrote the two sections of his book at two different stages of his own evolutionary journey out of the ID perspective, but he never went back to the manuscript to bring them into concordance with each other. Regardless of whether that is the case, it would have been helpful if the book had attempted to address the apparent dissonance between what appears to be two opposing statements.

The book is also misleadingly vague on some taxonomic issues. For example, it states that "scientists don't believe that humans evolved from apes or monkeys, instead they propose that humans and apes both evolved from a common ancestor" (p. 74). Although what the author means to say, I think, is that humans did not evolve from the species of apes and monkeys we see today, but he doesn't say that. Scientists, in contrast to what the book states, *do* believe that humans evolved from apes (and prior to that) monkeys. It's just that the ancestral species of apes and monkeys from which *Homo sapiens* evolved are not the same as those present today. Similarly, there are several places where the author seems to confuse the genus name with that of a species name. Moreover he gives species names a subspecies moniker (pp. 112, 113, 125, 147). The most disconcerting of these errors is his reference to *Australopithicus* as *Homo australopithicus* (p. 178).

There are other factual misstatements that detract from the value of the book. For example, members of the *Homo erectus* species did not make their initial migration out of Africa less than 800,000 years ago as stated on page 115. Actually, general consensus places the event (or events, perhaps) more than one million years earlier. Similarly, the "pit of bones" in Sima de los Huesos, Spain, does not contain "many fully articulated skeletons, of hundreds of hominins" (p. 119). Scholars believe that the fossils are derived from 28 individuals and that the find includes seventeen complete crania, but no completely articulated skeletons have been documented that I've been able to find (see *Science* 344 [2014]: 1358). Another example of a disconcerting misstatement refers to our common ancestors in Africa. The book states that we "don't know if there were thousands or millions" of these ancestors (p. 128). In actual fact though, genetics has enabled a reasonable estimate: the average population size is believed to be thousands to tens of thousands but not millions (see, for example, *Ancestors in Our Genome* by Eugene E. Harris [New York: Oxford University Press, 2015], 82). One final example of scientific imprecision concerns some of the statements made about Denisovans. The author overstates what we know about this recently discovered group, closely related to Neanderthals. On p. 188, the author states that "Neanderthals and Denisovans also had an appreciation for the aesthetic." Although there is good reason now to think that this is true for Neanderthals, it is not scientifically accurate to extrapolate from them to Denisovans. So far as I am aware, no architectural artifacts have been discovered that are clearly Denisovan-derived. All we have besides their DNA sequence is a finger bone and a couple of teeth fossils—nothing that we can say is clearly a reflection of their culture.

So although the book is thoroughly researched and is a treasure trove of information, the presence of a number of scientific misstatements leaves the general reader in a somewhat tenuous position regarding the factuality of any given piece of information. The errors could easily have been caught in the review

process and corrected, so it's unfortunate that they weren't.

The purpose of the book is largely to present the scientific facts regarding human origins so that we can determine their impact on core theological precepts of the Christian faith. Here, too, I think the author is guilty of overreach. He concludes his discussion of the science by stating, "for those who choose to believe that mankind has indeed evolved, there are going to be tremendous changes needing to be made in their theology" (p. 187). As John Walton (*Lost World of Adam and Eve*), N. T. Wright (*Surprised by Scripture*), Dennis Venema and Scot McKnight (*Adam and the Genome*), and Joshua Swamidass (*PSCF* 70, no. 1 [2018]: 19) have all shown, the changes to theology mandated by the findings of evolutionary biology and paleoanthropology need not shake up theology in any major ways. Science is silent on the issue of a historical Adam and Eve as discussed thoroughly by each of these scholars. It is clear that our species has been created through the evolutionary process, but there are various ways of thinking about Adam and Eve that do not conflict with these data. I am concerned that the author has allowed factors other than science to influence his conclusions. For example, consider also this statement:

> … some will choose to believe that we humans are indeed the pinnacle species in God's creation, and in support of that they will refer to biblical passages like Psalm 8: "What is mankind that you are mindful of them, human beings that you care for them? You have made them a little lower than the angels, and crowned them with glory and honor." They may be right. I won't deny that. But I will point out to them that it was a human that wrote that passage about humans: dolphins might believe they are the pinnacle species. (p. 178)

I think this book is an important example of a highly distinguished scientist who is still on a search to find how best to fit his sophisticated knowledge as a scientist into the Christ-centered, Spirit-filled life he has experienced and found to be real. I think it was published a little prematurely, but it illustrates the journey that all of us in the sciences must take. This is especially difficult for someone who rises to the upper tier of the sciences at a nationally important university where time pressures are enormous as one tries to fulfill responsibilities to family and church, along with those of a high-pressure career. I commend Janssen for doing this so well. This book is an admirable step along the journey that all of us are taking and what is most important of all is that we have mechanisms in place to provide mutual support to one another with each step we take. This is especially important for those whose journey takes them into the cauldron of a first rate research university.

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Science and Religion

THE BELIEVING SCIENTIST: Essays on Science and Religion by Stephen M. Barr. Grand Rapids, MI: Eerdmans, 2016. vi + 226 pages. Paperback; $25.00. ISBN: 9780802873705.

Stephen Barr is professor of theoretical physics at the University of Delaware, fellow of the American Physical Society, member of the Academy of Catholic Theology, and author of *Modern Physics and Ancient Faith* (University of Notre Dame Press, 2003). This book is a collection of twenty-six of his pieces from 1997 to 2013 (11 essays, 13 reviews of 15 books, and 2 unpublished lectures), most of which are previously published (15 appear in the *First Things* journal and/or blog). The pieces range from four to twenty-two pages in length, averaging eight pages each, with only three being over ten pages, making for rewarding piecewise reading. The stand-alone essays can be readily included in undergraduate courses needing to provide engagement with perspectival faith-based reflection and critical thinking. The book adds fifteen pages of notes (mostly contextual explanations and updates) and citations for direct quotations, but lacks an index and any new content.

Chapter 1, "Retelling the Story of Science," is Barr's Erasmus Lecture delivered in New York in 2002 and serves as the introductory essay. As in his 2003 book, he describes five main themes of materialism, and their reversals via "plot twists" in the actual history of science. First, the idea that science overthrew religious cosmology was reversed by big bang theory and the scientific consideration of a beginning. Second, while the idea that mechanism nullifies teleology had growing support in terms of considering laws of physics apart from a lawgiver, many now find the simplicity and aesthetic form of the mathematical principles of physical law evocative of a divine designer. Third, the "dethronement of man" and a universe without purpose, which claimed scientific support in the randomness of events, lost credibility due to the "anthropic principle" and a fine-tuned universe. Fourth, the notion of a closed universe with physical determinism gave way to an open universe upon the rise of quantum mechanics with its uncertainties. Fifth, the view of the human person as machine, with the brain simply running biochemical reactions, is now less tenable due to

both the recognized role of the (human) observer in quantum physics and thus the inability of quantum physics to describe systems including humans, as well as Lucas's argument from Gödel's theorem that humans, unlike machines, can at least sometimes recognize their own internal consistency.

These themes and plot twists are detailed and addressed in various ways in most of the remaining chapters, which are divided into seven sections: Evolution (7 pieces); Mind and soul (7); The big bang and creation (3); Reductionism (2); Science as a substitute for religion (2); Finding God through science (2); and Mischievous myths about scientific revolutionaries (2). Throughout, Barr criticizes the reductionist, scientistic, and antireligious claims of Dawkins and other public figures, and presents his own perspective offering scientific, historical, philosophical, and theological correctives. His book reviews (on Thomas B. Fowler and Daniel Kuebler, Richard Dawkins, Stephen Jay Gould, Michael J. Behe, David Chalmers, Thomas Nagel, Malcolm Jeeves and Warren S. Brown, John Maddox, Edward O. Wilson, Patrick Glynn, Gerald L. Schroeder, Francis S. Collins, William R. Shea and Mariano Artigas, and Wade Rowland) and other essays are incorporated within these sections.

Barr delivers well-placed, incisive, and often witty criticism of "scientist-atheists" such as Dawkins. He ends his review of Dawkins's *A Devil's Chaplain: Reflections on Hope, Lies, Science, and Love* by writing,

> Dawkins's atheism and materialism … prevent any coherent viewpoint from emerging because they deny the spiritual soul in man. That soul … makes it possible for us to have that hope and love to which the subtitle of Dawkins's book refers, but which are absent from its pages, and about which he has nothing in the end to say. (p. 41)

His review of Gould's *Full House: The Spread of Excellence* includes a few zingers, poking fun at Gould's idea that bacteria are more successful than humans (because there are more of them than us) by asking why this is not the Age of Air, given that there are more air molecules than bacteria, and whether "the fact that cosmic evolution has produced more dust particles than Chinese [persons] tells us something?" (p. 43), and that thus "Gould's ideas could be said to be but a twig on the arborescent bush of human opinion" (p. 44). And noting that Gould's book does not "complete the Darwinian revolution," as Gould aims to do, Barr "recommend[s] it … for those who take pleasure in fossils" (p. 45).

A devout Roman Catholic, Barr refers frequently to, and reminds fellow Catholics of, established Catholic positions. For example, he cites the 1950 *Humani Generis* in which Pope Pius XII affirmed the long-standing Catholic teaching that the theory of evolution is theologically benign, so long as it remains properly a biological theory by not making claims about the human soul. His deference to Catholic doctrine sometimes takes the place of a careful engagement with subjects, such as the challenging issue of divine sovereignty and human responsibility. Similarly, he fails to mention the range of Christian perspectives, such as the nature of the human soul.

Barr's scientifically informed and theologically conservative perspective on randomness is important in chapters 5 and 6, "The Design of Evolution" and "Chance, by Design." The first is a response to Roman Catholic Cardinal Christoph Schönborn's 2005 antievolutionary op-ed in the *New York Times*. Barr points out that the role of randomness in evolution does not, in fact, mean that it is unplanned, uncaused, unguided, or inexplicable, but only uncorrelated, noting that

> if the word "random" necessarily entails the idea that some events are "unguided" in the sense of falling "outside of the bounds of divine providence," we should have to condemn as incompatible with Christian faith a great deal of modern physics, chemistry, geology, and astronomy, as well as biology. (p. 49)

He goes on to point out that "the notion of contingency is important in Catholic theology, and it is intimately connected to what in ordinary speech would be called 'chance'" (p. 51). Further, he quotes from *Communion and Stewardship* (an important Catholic document from 2004) that "true contingency in the created order is not incompatible with a purposeful divine providence" (p. 51). Barr thus places the proper function of chance and biological evolution within the realm of God's providence, concluding with "the clear teaching of the Church that no truth of science can contradict the truth of revelation" (p. 53). Barr further observes that the everyday use of the word "random" differs from its use in science. And he further distinguishes, correctly in my view, between "words used by scientists and words used scientifically" (p. 56), given that, for example, there are indeed many scientists who would claim that the randomness found within evolution points to its being unguided.

Barr engages in hard-hitting criticism of young-earth creationism, calling it a "crackpot idea" (p. 29). He also describes what he calls "The End of Intelligent Design" (pp. 69–73) by noting its "claim … that certain biological phenomena lie outside the ordinary course of nature [is] impossible to substantiate [and

pits] natural theology against science by asserting an incompetence of science" (p. 69). Barr suggests that "the older (and wiser) form of the design argument for the existence of God … did not point to the naturally inexplicable or to effects outside of the course of nature, but to nature itself and its ordinary operations [which reflect] the power and wisdom of God" (p. 70), citing lengthy passages from the Book of Wisdom (c. 100 BC) and the Letter of Clement (c. AD 97).

As a unified collection of pieces published by a believing scientist over a sixteen-year period, this book is a useful resource, and I commend his sometimes provocative thoughts to readers of *PSCF*. I would have found the book more valuable, though, if it had contained sustained engagements with the responses which some of his pieces have garnered over the years.

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BIOLOGICAL INDIVIDUALITY: Integrating Scientific, Philosophical, and Historical Perspectives by Scott Lidgard and Lynn K. Nyhart, eds. Chicago, IL: The University of Chicago Press, 2017. 361 pages. Paperback; $25.00. ISBN: 9780226446455.

The field of biology is a very broad discipline. Etymologically, biology (*bios* + *logos*) means the study of life. But what is it that biology actually studies? Life itself is not a concrete, physical thing; rather, it is a function of living things. The focus of biology is not only the study of life as a function of certain things, but also the nature of living things that display the function of life. How does life as a function of certain things actually come about? Put another way, how do certain things come to display life activity or function? Central to these questions is that of biological individuality. What are biological individuals? What are the boundaries of and for biological individuals? These types of questions have been at the center of biological study, research, and thinking for several centuries.

In this edited volume, Lidgard and Nyhart provide a valuable service in pulling together various analyses of biological individuality. Three foci are distinguished in such an investigation: (1) the fundamental philosophical questions of biological individuality; (2) the historical analysis of how biologists have thought about individuality; and (3) how their reflections have influenced not only their research programs, but also how research programs, in turn, influenced philosophical perspectives on biological individuality and the nature of living things. Edited volumes sometimes suffer from a lack of coordination and a basic central theme, but the editors have dealt with that by providing an integrating introductory chapter, "Introduction: Working Together on Individuality," as well as an integrating philosophical analysis in a concluding chapter, "Philosophical Dimensions of Individuality," by Alan C. Love and Ingo Brigandt. The volume includes thirteen contributors spanning the spectrum of historians, philosophers, biologists, and sociologists.

The editors emphasize that although the concept of individuality is an important concept for biologists, there is no consensus on a definition of biological individuality. They even provide an extensive table (pp. 19–21) outlining the various definitional criteria for biological individuality as well as a graph (p. 23) indicating the year(s) of publications reflecting those definitional criteria and thereby providing a historical perspective.

There are a number of themes that arise in the consideration of biological individuality. One important theme is the evolutionary transitions in individuality (ETI). One such key ETI is that from unicellularity to multicellularity. The case study of the volvocine algae illustrates an attempt to understand this transition. This group of algae provides diverse examples of single-cell forms as well as colonial forms. In some forms, daughter colonies begin to form within the parent colony, raising the question of what constitutes an individual. Are the daughter colonies individuals only after they break from the colonies? In the transition from a unicellular form to a multicellular colonial form, what is the role of cell-to-cell communication and how many different forms of cell-to-cell connections and communications are there? Are such forms of communication fundamental features of the evolutionary transition from unicellularity to multicellularity? In some cases, the daughter colonies are actually clones of the parent colony so that we now have the introduction of levels of organization: one-celled organisms, colonies, and clones, potentially constituting three hierarchical levels. The matter of clones raises the intriguing question of whether all members of a clone, such as a cluster of beech trees sprouting from a single individual beech tree, actually constitute an individual. However, the concept of ETI might also be stretched in questionable ways as evidenced in the chapter by Andrew Reynolds, "Discovering the Ties That Bind: Cell-Cell Communication and the Development of Cell Sociology." Is the use of the term cell sociology a misapplication of the concept of sociology in order to provide some basis for the evolution of animal and human sociology?

The editors also introduce four problems, we might call them themes, related to the question of biological individuality: individuation, hierarchy, temporality, and constitution. Individuation concerns the identity and unity of a living thing. All living things display some form of metabolism and generally also some form of growth. Through all this change of material composition, what guarantees the identity of the individual so that its identity and unity as an individual is retained? Another illustration of individuation is in speciation and the concept of species as individuals. At what point is a species as individual distinct from another species?

Hierarchy is another important theme that reflects the nature of the levels of organization of living things. During the nineteenth century, there was a very active debate between two basic schools of thought: vitalism and reductionism. Vitalism emphasized a holistic view of living things whereby the whole individual is greater than the sum of its parts. Reductionism emphasized the view that the individual can be understood by examining the mechanistic functioning of the constituent parts. This debate was continued in the twentieth century by organicism and systems thinking in biology, which emphasized a holistic view replacing the earlier vitalist views. Central to this discussion is the question of how the entities of one level are related to the entities of a higher level. Are the entities at each level to be considered as integral wholes or are the entities merely part of a higher level? Expressed another way, are we dealing with part-whole relationships or with whole-whole relationships as in enkaptic hierarchies? Olivier Rieppel in his chapter, "Biological Individuality and Enkapsis: From Martin Heidenhain's Synthesiology to the *Völkisch* National Community," lays out how the theory of enkapsis was used by some to argue for individuals to sacrifice themselves for the good of the whole national community in Nazism. Ingo Brigandt, in the chapter "Bodily Parts in the Structure-Function Dialectic," makes a case for considering functions or activities as entities that were proposed to become integrated into the levels of hierarchies. However, doing so would bring into question whether functions can really be independent of entities and whether this would obscure the fundamental meaning of hierarchical levels of structure.

Temporality is another theme that addresses the evolution or emergence of biological individuality. How do individuals at one stage of evolution relate to subsequent stages of evolution? A further issue concerns the units of selection and whether species are individuals, and thus, are possibly considered to be subject to selection. Temporality also relates to developmental stages and how stages relate to the identity of a biological individual. One very intriguing and significant historical discussion concerns the alternation of generations. For living things that display a remarkably distinct alternation of generations such as between haploid and diploid generations, to what extent are we dealing with distinct biological individualities? Are the alternate generations a single biological individual or are they separate biological individuals?

A fourth theme is that of constitution: what constitutes a biological individual? This is also related to the questions of part-part, part-whole, and whole-whole relations that are important considerations of hierarchical levels of structure. Additional fascinating aspects to this theme include parasitism and symbiotic relations. Parasitism involves intimate relations between host and parasite such that the parasite typically exists within the boundary of the host organism. In such a relationship, what constitutes the individual? Are they to be seen as a single individual or as two distinct individuals that are at least for a time intimately connected to each other? This is perhaps even more complex with regard to symbiotic relationships, especially with regard to obligatory symbiotic relationships. One clear example is the case of intestinal bacteria in human digestive systems. It is reported that 30% of our blood metabolites are bacterial products. Without such beneficial intestinal bacteria, human survival is at stake. The bacteria are considered to be biological individuals in their own right. So how does that affect human individuality? Another example is lichens, which are obligatory symbionts of specific fungi integrated with a specific form of algae. We intuitively recognize lichens as biological individuals. Is this perhaps an example of a whole-whole relationship?

This introduces a new concept of biological individuality, that of holobionts. Holobionts are biological individuals that encapsulate autonomous or semi-autonomous individuals into a functioning organism, as illustrated in the examples of symbiosis given above. Perhaps the process of endosymbiosis in which prokaryotes became incorporated into other eukaryotic cells is an early form of holobionts. Holobionts may also have impacts on genetic activity (viral insertions into a host's genetic makeup) and immunological recognition of self and nonself.

In short, this book on biological individuality is relevant to biological research and helps one develop a richer philosophical understanding of the nature of living things. It may also assist in reminding readers of the limits of reductionist and mechanistic understandings of the nature of life as a function of living

things. Reductionist and mechanistic views are heavily dependent on a philosophical materialism, which is opposed to a deeper Christian, theistic view of reality.

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TECHNOLOGY

RE-ENGINEERING HUMANITY by Brett Frischmann and Evan Selinger. New York: Cambridge University Press, 2018. 295 pages + foreword, five appendices, detailed notes, bibliography, index. Hardcover; $29.95. ISBN: 9781107147096.

In his 1954 classic, *The Technological Society*, Jacques Ellul explored the concept of "technique," a way of thinking in which optimizing productivity and efficiency becomes an end, not a means. Joseph Weizenbaum's 1976 book, *Computer Power and Human Reason,* introduces the "imperialism of instrumental reason," a way of thinking that seeks to frame all problems in the language of computation. Weizenbaum argues that not all problems can be framed in this way—justice, for example—and that it is not the case that all things that matter are amenable to measurement. *Re-Engineering Humanity* belongs to this same literary genre (critiques of technological thinking). It explicitly seeks to extend Weizenbaum's analysis to the impact of the internet.

Frischmann and Selinger develop two key concepts. The first concept, "techno-social engineering," consists of processes in which technologies and social forces align and affect how people think, perceive, and act. "Engineered determinism" is the second concept and "entails techno-social engineering of humans, often through the construction of smart techno-social environments that render humans within the environments increasingly predictable and programmable" (p. 220). They add that engineered determinism is "… the grand hubris that we can socially construct a perfectly optimized world if we only have the data, confidence in our tools, and willingness to commit" (p. 53).

The book is primarily a warning against techno-social engineering. Frischmann and Selinger assert that "as we collectively race down the path toward smart techno-social systems that efficiently govern more and more of our lives, we run the risk of losing ourselves along the way" (p. 1). They add that their "concern is with the social costs associated with rampant techno-social engineering that diminishes and devalues human autonomy and sociality" (p. 62). They argue that our humanity can be taken away, that it is at risk of deterioration by pervasive techno-social engineering. The basic capabilities at risk are thinking capacities, the ability to socialize and relate to each other, free will, autonomy, and agency.

These are strong assertions and the authors develop the case for them with some care. They examine a number of examples. For instance, to some people iPhones become part of themselves, yet the phone is designed to give access and control privileges to others; Facebook's algorithms determine who can see a post; global positioning systems can be used so easily that people lose a sense of where they are; furthermore, the data such systems generate can be exploited. The authors also point out that the internet has vastly increased the reach, interconnection, and continuity of techno-social engineering into homes and public places. They examine the internet of things, a means for ubiquitously distributed sensors to gather, exchange, and act on data. It can enable the providers of those sensors to engineer people's beliefs, preferences, and emotions.

They are careful about the structure of their argument. For instance, they acknowledge that they are making a slippery slope argument and devote most of one chapter to exploring the question of when such arguments might be legitimate. Since they assert that our humanity is at risk, they take time to examine what it means to be human and how one might detect that our humanity is being lost. To do that they reverse the classic Turing test for whether a machine can think like a human and ask how we might detect that a human is thinking like a machine.

Re-Engineering Humanity presents a dire picture of our current situation. So, the authors strongly argue for the "freedom to be off." They suggest three strategies toward this end. First, engage in critical analysis. For instance, Weizenbaum said that things that matter normatively are not necessarily amenable to measurement. Frischmann and Selinger extend that by pointing out an additional assumption often made, namely, that a common denominator for such measurements exists. Second, create friction on the slippery slope. Suggested methods include preserving net neutrality, using air gaps (places in software that are intentionally not optimized), using obfuscation techniques to disrupt surveillance, and anonymizing data. Third, challenge the logics of minimization and maximization.

It's hard to know how to evaluate a warning as serious as this. On one hand, the argument is carefully developed and the response strategies are worthy of consideration. However, the experience of reading the book is like looking at a room through a key hole

and seeing things that seem to be major concerns. One would like to see the rest of the room. There are good reasons for skepticism about the perspective the keyhole provides. For one, Frischmann and Selinger point out that humans possess a basic resistance to being manipulated and conceivably could successfully resist the kind of control they warn against. But they do not develop this point. Also, they do not engage existing empirical research on the impact of internet usage. Anyone who has programmed computers or worked much with them knows that doing so can be a source of great joy. Such work need not be manipulative or controlling and can be done with an aim of helping others. But joy and service never make an appearance in *Re-Engineering Humanity*. As a result, the book comes across as too much of a jeremiad.

What is needed in the face of such a serious challenge is a view of the big picture as well as careful attention to the particular concerns Frischmann and Selinger address. To their credit, the authors do a normative analysis, employing a consequentialist approach. However, for Christian scholars, a more comprehensive, more principled theory is not out of reach. Here are some components such a theory might include: (1) an affirmation that the capacity for technology is God's creation, a gift to humanity, and part of the cultural mandate—as such it is good; (2) a broader scholarly context that would include more studies by more critics of technology than this book includes; (3) a sense of the joy of technology, of both making it and using it; (4) a recognition of human sinfulness and hence the seriousness of dangers such as the one the authors highlight; and (5) a framework of guiding principles for developing technology in ways that are constructive and that include checks and balances for protecting against evil consequences.

Perhaps some reader(s) of *PSCF* can articulate such a theory. In the meantime, we can listen seriously to the warning Frischmann and Selinger offer.

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Note to ASA/CSCA Members

Along with all their other contributions, many members of ASA and CSCA publish important works. As space permits, *PSCF* plans to list recently published books and peer-reviewed articles related to the intersection of science and Christian faith that are written by our members and brought to our attention. For us to consider such works, please write to pfranklin@tyndale.ca.

Theology

THE LOST WORLD OF THE FLOOD: Mythology, Theology, and the Deluge Debate by Tremper Longman III and John H. Walton, with a contribution by Stephen O. Moshier. Downers Grove, IL: IVP Academic, 2018. 192 pages. Paperback; $16.20. ISBN: 9780830852000.

In *The Lost World of the Flood*, Tremper Longman and John Walton put forward an interpretation of the Genesis flood narrative that treats it as an inspired, authoritative, and purposeful theological story of a real event. In so doing, they promote a serious view of the Bible while also alleviating unnecessary conflicts with science.

Structurally, the book's seventeen chapters are sorted into four parts and titled as propositions, a trademark of the Lost World series. Part 1 (propositions 1–6) addresses the "cognitive environment" and literary character of the Genesis flood story. Worldview, genre, and rhetoric are central concerns. Longman and Walton argue that ancient worldviews framed ancient genres, such that the modern categories "myth" and "history" are inadequate for the flood story. Genesis 1–11 is "history" in the sense that it refers to events that really happened (signaled in part by the use of the Hebrew word *toledot*, pp. 16–17). But the flood story is a *theologically interpreted* and *rhetorically shaped* story about a real flood. To express this idea, Longman and Walton propose "theological history" as a more accurate and faithful genre-label than "myth." As for rhetorical shaping, the flood story and its larger literary context (Gen. 1–11) bear the marks of figurative language (pp. 24–28), anachronisms (pp. 28–29), and hyperbole (pp. 36–50).

Part 2 (propositions 7–8) summarizes three Mesopotamian flood stories and compares them to the Genesis story. The Mesopotamian stories summarized are Eridu Genesis (Sumerian), Atrahasis (Babylonian), and Gilgamesh (Babylonian) (pp. 53–60). In their comparison to Genesis, Longman and Walton discuss theologies, portrayals of humans, details of the flood plot, descriptions of the rescue boat, and the roles of the key protagonists (pp. 61–87). They argue that readers should understand the Israelite story "not in terms of borrowing but rather in terms of Mesopotamia and Israel floating in the same cultural river" (p. 85). Even so, the authors alert readers to a fragment of the Gilgamesh Epic found in the land of Israel (p. 63, n. 3) and to words in the Genesis flood story that were probably borrowed from Akkadian, the language in which the Babylonian stories were

written (pp. 77–78). All four stories are said to preserve a memory of a real flood in the past, though interpreted to communicate significantly different messages. In the case of Genesis, "what is inspired and thus the vehicle of God's revelation is the literary-theological explanation that is given by the biblical author" (p. 85).

Part 3 (propositions 9–13), then, lays out the biblical author's literary-theological explanation of the flood. According to Longman and Walton, the Genesis story presents God responding to two distinct, but still related, concerns: (1) sin; and (2) disorder. The sin-judgment interpretation fits patterns of sin, judgment, and grace found throughout the book of Genesis (pp. 100–111), as well as interpretations of the flood found in Second Temple Jewish writings and the New Testament (pp. 96–99). Longman and Walton next argue that Genesis and its flood story have an even greater theological concern with God's presence in, and continued ordering of, the creation. Appeal is made to every major narrative constituting Genesis 1–11, including stimulating discussions of the "sons of God" (pp. 122–28) and the Tower of Babel (pp. 129–36). Both readings of the flood story—the sin-judgment interpretation and the presence-and-order interpretation—are shown to have intimate, purposeful connections to the patriarchal narratives (Gen. 12–50): the call of Abram is God's act of grace amid the sin and judgment that occur after the flood (pp. 109–10), and "the covenant [with Israel's patriarchs] can now be recognized as having its focus in the reestablishment of access to God's presence on Earth" (p. 140).

Lastly, Part 4 (propositions 14–17) summarizes scientific evidence relevant for claims about the flood that is narrated in Genesis, and follows this summary with an assessment of the value of science and Christianity for each other. The central sciences consulted are archaeology, geology, and anthropology. Longman and Walton discuss evidence of actual prehistoric floods in the Mesopotamian world, helping readers imagine the kind of flood that could have generated the stories found in Mesopotamia and Genesis. Guest writer and Christian geologist Stephen Moshier takes seriously the claims of flood geologists to demonstrate that Earth's geologic record simply does not preserve evidence of a global flood. Longman and Walton then return to discuss proper ways of understanding the proliferation of flood stories in cultures from around the world. All of these scientific insights, they go on to argue, help Christians clarify the word that God intends to convey through the Bible, even as Christians profess a faith that is poised and tooled to participate in scienc—both to learn through it and to challenge it when it becomes a pretentious philosophy and religion of its own.

The Lost World of the Flood has numerous strengths. Its style, structure, and content are accessible and manageable. Complexities are managed effectively and with nuance. The theological insights are thought-provoking, even for seasoned interpreters of the Bible. Science is handled respectfully, and so are the Bible and the concerns of sincere Christian readers, such as the Bible's inspiration, authority, and perspicuity. The virtue of humility pervades the book, and is most evident in the book's tone, in the way the authors offer suggestions instead of dogmatic, only-way solutions, and in their use and crediting of the interpretations that their own students have proposed.

Although few in number, the book's shortcomings are still noteworthy. When Longman and Walton argue against the view that the flood was actually local but was universal from the *perspective* of the survivors, reporters, and author(s), they say,

> The language used in the flood story does not support the idea that the flood was only a local, even if widespread, flood. And this conclusion is, in our opinion, inescapable whether the author of the account was describing it as local or the initial reporter … thought a local flood was actually a worldwide flood. (p. 48)

But if the initial reporter thought a local flood was actually worldwide, wouldn't this perspective precisely generate the universalistic language that appears in the Genesis story? And couldn't perspectivally universal language undercut the claim that the story's author(s) used hyperbole? The actually-local-but-perspectivally-universal flood theory is not adequately answered.

Second, the excurses, while informative, fall flat and are not integrated into their propositions. The excursus "Genealogies" (pp. 107–9) shows that ancient genealogies are referentially historical, factually fluid, and ideologically purposeful, but then ends without making clear how these insights inform the proposition that "the flood account is part of a sequence of sin and judgment serving as a backstory for the covenant" (pp. 100–111). The excursus "Modern Quests for Noah's Ark Are Ill-Founded" (pp. 165–66) is not integrated into its proposition about flood stories from around the world, and would actually seem to suit better the purposes of Proposition 14: "The Flood Story Has a Real Event Behind It" (pp. 145–49).

Third, since the origin and development of the Genesis flood story is a central concern of the book, it is surprising that Longman and Walton do not at

least discuss the widespread belief among biblical scholars that the Genesis flood story bears the marks of originally different stories that have been stitched together and reworked before taking a final form as a single story in the theological history of Genesis 1–11.

Fourth and finally, since the book insists that the Genesis flood story refers to real events in a real past, and since Longman and Walton show themselves highly alert to the concerns of evangelical and fundamentalist Christian readers, it is surprising that there is not a more direct and thorough discussion of human ancestry. Many Christian readers in the target audience will believe that all humans today have descended from Noah. If they are to entertain a different reading of the flood story, whereby a local flood is rhetorically and theologically reworked, then how should they go about rethinking the story of Noah's descendants, which is itself part of the flood story?

These criticisms notwithstanding, *The Lost World of the Flood* is a recommended read. It fills a niche in the library of Christians who care about Bible-science relationships. It educates in accessible ways. It models humility, inquisitiveness, and open-mindedness. It acknowledges complexity and elucidates nuance. It is ideal for Christian readers who see themselves as Bible-believers, but who need guidance that is wise and sound, at once committed to Christian faith and truthful with scientific findings. This reviewer has gained much in the way of content knowledge, resources, and theological insights. Readers are fortunate to be beneficiaries yet again of Tremper Longman and John Walton's ongoing work in the important field of science and Christian faith.

Reviewed by Daniel Gordon, McClure Professorship of Faith and Science, Lipscomb University, Nashville, TN 37204. ✧

Letter

Know, Believe, Understand

As a member of the Atheist Society of Denver, I would like to comment on Walter Bradley's article, "The Fine Tuning of the Universe: Evidence for the Existence of God?" (*PSCF* 70, no. 3 [2018]: 147–60), and the letters to the editor that it triggered. The argument from nature for the existence of design and hence a Designer, is an argument I almost always use as a starting point, to drive home the fact that atheists are not willing to go where the evidence leads them. This is articulated by the former atheist Antony Flew in his book *There Is a God: How the World's Most Notorious Atheist Changed His Mind*.

The quote Bradley used from John 20, where Jesus emphasizes the signs he performed to lead skeptics to accept his words, can be expanded further by checking on a few more scriptural references that address the question of which comes first, faith in God followed by confirmation of his existence using arguments such as the fine-tuned universe, or using arguments from design in nature, to whet the interest of an unbeliever for considering faith in God. Isaiah 43:10 reads, "… that you may know and believe me and understand that I am he." Also, the more commonly quoted passage of the same is Romans 10:14. Both imply that knowledge comes before faith, which then leads to faith, and eventually to understanding who God is. This is an important sequence (know-believe-understand) to get an unbeliever to start thinking.

Ken Touryan
ASA Fellow ✧

How, then, can they ***call***
on the one they have not believed in?
And how can they ***believe***
in the one of whom they have not heard?
And how can they ***hear***
without someone preaching to them?

~Romans 10:14

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

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