

Thresholds of Increasing Complexity in Big History: A Critical Review

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ABSTRACT

In this article, the concept of Thresholds of Big History is critically examined. It should be abandoned because it is fundamentally flawed.¹

Introduction

The idea of thresholds of increasing complexity as the principal organizing principle for big history contains important flaws, and should be abandoned. A proper understanding of this controversial theoretical issue is vitally important not only for a good understanding of academic big history but also for teaching it both within academia and in secondary schools.

Over the past ten years I have offered earlier versions of this criticism many times in private but expand on them here in public for the first time. While I differ on this issue with David Christian, who is the originator and principal advocate of the Thresholds Approach, I continue to respect and highly value his pioneering work in big history.

To understand the issues involved, first a history of the Thresholds Approach will be sketched. This will be followed by a critical examination of this concept.

When and how did the concept of thresholds of big history emerge?

On March 2, 2011, David Christian gave a TED talk summarizing all of big history called "The History of World in 18 Minutes." This was part of a session with the title *Knowledge Revolution* that was guest-curated by Microsoft cofounder Bill Gates. This TED talk was intended to launch their joint initiative, called the *Big History Project* (BHP), to create a secondary school project for teaching big history by providing online all the needed materials.

In this talk, Christian suggested a structure for big history based on what he called thresholds of complexity, with each threshold indicating a further rise of complexity within big history. A total of eight thresholds were chosen. In his TED talk these thresholds were 1. Big Bang; 2. The stars light up; 3. New chemical elements; 4. Earth and the solar system; 5. Life on Earth; 6. The appearance of our species; 7. Agriculture; and 8. The Modern Revolution.

In his book *Origin Story: Big History of Everything* (2018) these thresholds became 1. The Big Bang; 2. The emergence of stars; 3. The emergence of the first heavy elements forged in large stars; 4. The emergence of our solar system; 5. The emergence of life on Earth; 6. The emergence of *Homo sapiens*; 7. The emergence of agriculture; 8. The emergence of the Anthropocene (starting in the 20th century); and 9. A future sustainable world order? In the time line of the same book, Threshold 8 is also mentioned as the 'emergence of the fossil fuel revolution.'

In his TED talk, Christian announced the Thresholds Approach as follows:

Each stage [of rising complexity in big history] is magical. They create the impression of something utterly new, appearing from almost nowhere in the Universe. We refer in big history to these moments as thresholds moments.

It was in January of 2011, after having received a request to comment on the first BHP course draft, that I became aware of the fact that David had begun structuring big history along those lines. Immediately, I sent some of my objections to the Thresholds Approach in an e-mail message dated January 20, 2011 (still in my possession)—a little more than a month before Christian’s TED talk. However, I did not receive a reply; after that, I was no longer consulted by the BHP.

Unknown to me, Christian had already begun promoting his Thresholds Approach at least four years earlier, namely in the audio version of his book *Maps of Time: An Introduction to Big History* (2004) that was released by *The Great Courses*.² On its website, the release date of that audio course is not mentioned. I may be wrong, but to the best of my knowledge, it was released early in 2008 (cf. Christian 2008). It was this course that Bill Gates had listened to—while working out on his home trainer, as the story goes—and that had stimulated him to initiate and support an online course for teaching big history in secondary schools.

However, in Christian’s earlier book, *Maps of Time*, these thresholds do not appear. I had not listened to—or even looked at—that audio course because David Christian had told me that it was an audio version of *Maps of Time*. He had never mentioned to me that in this audio version, the concept of thresholds was introduced as a structuring principle for big history. It was only in December of 2020, while investigating the history of the Thresholds Approach, that I became aware of this.

In this audio course (as it appeared on *The Great Courses* website in December of 2020), the Thresholds Approach is explained as follows:

To tell this epic, Professor Christian organizes the history of creation into eight “thresholds.” Each threshold marks a point in history when something truly new appeared and forms never before seen began to arise.

Starting with the first threshold, the creation of the Universe, Professor Christian traces the developments of new, more complex entities, including the creation of the

first stars (threshold 2);
the origin of life (threshold 5);
the development of the human species (threshold 6); and
the moment of modernity (threshold 8).

To the best of my knowledge, by March of 2011 David Christian was still one of the few academics, if not the only one, who was teaching big history while using this Thresholds Approach. That makes his TED talk claim, “We refer in big history to these moments as threshold moments,” an over-generalization. In reality, there was no such consensus at all within the small but growing field of academic big history, of which I was one of its early pioneers. Within this context it may be important to mention that as of 1995, while co-organizing the University of Amsterdam big history course, David Christian and I had intensively collaborated in shaping this new field.

Over the past ten years I have raised in private my questions and doubts about the Thresholds Approach many times, most notably with David Christian but also with other big historians who advocated the Thresholds Approach. The standard answer was that, indeed, the thresholds were chosen arbitrarily and other choices could have been made, but they had proven to be good pedagogical devices.

If these thresholds are, indeed, arbitrary, why make them central to the narrative of big history? Yet, according to those advocating the Thresholds Approach, while mentioning the Emergence of Life, for instance, we should instead be talking about The Fifth Threshold: The Emergence of Life. It was capitalized as such as a chapter title in both the original online of the BHP course and the textbook *Big History: Between Nothing and Everything* (2014), authored by David Christian, Cynthia Stokes Brown, and Craig Benjamin.

How warranted and convincing is that, given the arbitrary character of the thresholds? This question became especially urgent after many adherents of this approach began to talk, for example, about Threshold Five, without even further mentioning what it was about. Apparently, all of us engaged in big history were supposed to know what that meant. In doing so, a group of big history ‘thresholds insiders’ was taking shape, while those big historians who thought that the Thresholds Approach was, perhaps, not such a good idea suddenly became outsiders.

In David Christian’s book of 2018, these sequences within the chapter titles have been reverted, at least partially under pressure of my persistent criticism, or so I suspect. In that book it became *Life: Threshold 5*. Yet, for David Christian and his followers, the Thresholds Approach has remained central to big history although at least one of those thresholds was slightly altered over time, as noted above. My criticism in private may also have led to changes in the BHP, in the most recent version of which the Thresholds Approach has become considerably less dominant although it has not yet disappeared.³

What does the word ‘threshold’ mean in English?

In critically examining the Thresholds Approach, let us first examine the meanings the word ‘threshold’ in English as well as Christian’s use of it as a general scheme for big history. According to the Merriam-Webster online dictionary a ‘threshold’ holds several possible meanings.⁴

- 1 : the plank, stone, or piece of timber that lies under a door: sill
- 2a : gate, door
- b(1) : end, boundary specifically: the end of a runway
- (2) : the place or point of entering or beginning: outset on the threshold of a new age
- 3a : the point at which a physiological or psychological effect begins to be produced has a high threshold for pain

- b : a level, point, or value above which something is true or will take place and below which it is not or will not

The meanings mentioned under 2b (2) as well as under 3a and b do apply to David’s use of the term, but the other meanings do not, or apply only insufficiently. What about Threshold One: The Big Bang? Can we define any clear circumstances that allowed this to happen, or that held back the emergence of our Universe? To my knowledge, we do not know anything about what may have happened before the Big Bang.

By contrast, the emergence of more complex chemical elements within stars does require certain clearly-defined high temperatures and pressures within those stellar cores. As a result, that situation can indeed be described as a threshold. Can we similarly precisely define threshold circumstances for the emergence of life, of humans, or of agriculture? That does not appear to be the case, not least because in those latter situations, cause and effect are still at best only partially understood, while a considerable degree of chance effects would also have played a role in those transitions to greater complexity.

Let us pursue the meaning of thresholds in big history a little further, first of all the question: can all those thresholds of big history empirically be observed, such as stars for instance? For most of them there appears to be no way of doing so. What we can observe are changing processes that may include the rise of complexity within certain favorable circumstances but no observable barriers that were holding back the rise of them.

If most of these thresholds of big history cannot be observed empirically, they must be interpretations of that history. By itself, that is not a problem. All our scientific concepts are interpretations of reality. Let us take as an example the term *gravity* as defined by Sir Isaac Newton. This concept did not exist before the great scientist coined it, and it cannot be observed as such in nature; but its effects can empirically be observed and are thought to have existed almost as long as the history of the Universe. Yet according to

Einstein's interpretation, these effects—the mutual attraction of ordinary matter—are not caused by gravity at all, but instead by the warping of space-time by the mass of such bodies. In other words, Einstein's theory of relativity offers a different interpretation of the same observations.

What are my major objections to the Thresholds Approach as a valid general interpretative scheme for big history?

The question now becomes this: how valid is the Thresholds Approach as an interpretative scheme for big history? This problem becomes pressing as soon as one realizes that there have been a great many processes leading to greater complexity, far more than only the eight thresholds mentioned by Christian. This is not only the case within the history of the Universe as a whole, but also—and perhaps most notably—within Earth's developing biosphere, in which a great many processes leading to greater complexity occurred between the emergence of life and that of anatomically modern humans. More about that below —

This raises the fundamental question: when does a transition leading to greater complexity qualify as a threshold, and when not? In other words, what are the academic criteria for defining thresholds? To the best of my knowledge, this question has not yet systematically been addressed by those who have adopted the Thresholds Approach. As a result, it appears as though such clearly defined criteria do not yet exist. Instead, it appears as though those eight thresholds of rising complexity have sprung forth from Christian's imagination without any further attempt at academically systematizing them, for instance by wondering what the academic criteria are for a rise in complexity to qualify as a threshold.

By itself, it is not at all bad that scientific concepts spring forth from an academic's imagination. They all do. However, in order to be used in academia, they must first be submitted to rigorous scrutiny. That has as yet not happened. This is another major flaw of the Thresholds Approach.

As soon as we start doing so, we find ourselves in considerable trouble. First of all, Thresholds 1, 2, and 3 apply to all of big history. Yet, Thresholds 4 to 8 do not do so at all. Threshold 4 is about the emergence of our solar system. Surely, in the entire Universe a great many solar systems must have emerged, many of them much earlier than ours. This makes one wonder how accurate it is to focus the story for Threshold 4 almost exclusively on our solar system. Clearly, by doing so, as mentioned above, Threshold 4 is no longer valid for big history as a whole, but instead only for a very tiny portion of it.

One may argue that the emergence of stars with rocky planets such as Earth was a major step in the rise of complexity within the Universe as a whole. That may well have been the case, but because we know so very little of the entire observable Universe at those relatively small scales, how can we be sure that what happened within our solar system is valid for all of big history? There may well have been other forms of greater complexity in big history that we may not even be able to imagine right now.

Like all empirical science, big history is based on the best available observational evidence. Because today we can observe so little of those relatively small yet potentially very complex objects within the Universe as a whole, in that very important aspect we are currently staring into a big unknown. This unknown should be recognized as such. It should not be swept under the carpet by suddenly concentrating the attention solely on our cosmic neighborhood and our own planet without mentioning this enormous change of focus, while continuing to employ the Universe-wide concept of thresholds, which is from that period onward in time, applicable to only solar system and Earth history.

This situation signals, therefore, a major systematic and methodological flaw in terms of the Thresholds Approach presented as being a general big history scheme, which it is not. Over the course of cosmic time, it turned instead into a solar system-centric scheme, yet implicitly (and perhaps unintendedly) presented as part of the measure of all things during all times.

It gets worse. Because Threshold 5 is about the emergence of life on Earth, while using this general big history concept, we suddenly find ourselves focusing exclusively on our own planet. One could argue, of course, that we do not know any life elsewhere within our solar system, let alone in the rest of the Universe. Even so, this lack of knowledge should not lead us to imposing this supposedly universal concept 'thresholds of big history' solely on one single planet, as though from that moment onward Earth history would be the measure of all things during all times.

Similar arguments apply to Thresholds 6, 7, and 8: the emergence of humans, of agriculture, and of modernity, all of which are anthropocentric. The change in 2018 of Threshold 8 into 'the emergence of the Anthropocene' makes it a little less anthropocentric. However, it is still far from being applicable to the entire Universe, of which we know hardly anything on this relatively small scale.

Furthermore, one may wonder whether, during the long period between the emergence of life and humanity, there may have been other major transitions toward greater complexity within our biosphere that might qualify as thresholds. What about the emergence of plate tectonics; the emergence of life capturing sunlight; the emergence of complex life; or of life moving on land, to name a few? What about the established geological epochs? Why would they not qualify as thresholds of some sort, and on which grounds, not even as 'mini thresholds' (a term later used by Christian to characterize the emergence of states)?

What about human history? Why would, for instance, tool use and the domestication of fire, both with enormous effects on humans and the biosphere, not qualify as thresholds? What about the 'mini threshold' of the emergence of states? What are the academic criteria for determining that? What about the first wave of globalization after Columbus's encounter with what soon would be called the Americas, with enormous worldwide social and ecological effects? What about the current wave of informatization using ever more complex computers connected to each other

by rather complex electronic networks, all with huge social and ecological consequences? Why would these spectacular changes not be thresholds of some sort? These examples are only some more obvious ones.

In this respect, a calculation that I made while writing a book about the biosphere's history may be helpful (Spier 2022). Human history (defined here as starting seven million years ago) forms only 0.175 percent of the biosphere's history (defined here as about 4 billion years). The period after humans began to use fire represents 0.038 percent; the period of agriculture 0.0003 percent; the period of states 0.00015 percent; the past 530 years since Columbus and his crew first stepped ashore on a Caribbean island 0.000013 percent; the period of the industrial revolution 0.0000067 percent; and the proposed Anthropocene (defined as the geological period in which nuclear traces resulting from human action began to appear in the biosphere) as little as 0.0000016 percent of the biosphere's history.

These numbers provide a first indication of the extraordinarily fast acceleration of human history, including its similarly growing influence within the biosphere. They do not inform us at all about anything that has been happening in the rest of the Universe during that period, with the exception of spacecraft circling Earth and traveling through our solar system, some of them carrying humans into space, as well as electromagnetic radiation generated by humans moving out into the cosmos. All of that is almost negligible given the size of the Universe. Yet in the Thresholds Approach, human history, which represents at most 0.175 percent of the biosphere's history and only 0.05 percent of big history, contains four out of a total of eight thresholds of big history.

What about the future?

What about the future, of which we do not know anything, empirically speaking? Is Threshold 9, the transition to a 'sustainable world order,' indeed the only important new phase to be expected in big history? Isn't that a little anthropocentric as well? What about, for instance, Earth's biosphere after humans; the end of the solar system after the Sun burns out; and the future

of the Universe as a whole?

In the book *Big History: Between Nothing and Everything* (2014), such longer-term questions about the future were discussed in chapter 13 with the question, “More thresholds?” on its title page, while no specific thresholds were attached to any aspect of the big future. At the end of the book *Origin Story: Big History of Everything* (2018), while trying to look further into the future, David Christian also discussed a few of these longer-term trends, such as the end of plate tectonics and the Sun nearing the end of its existence, while the rest of the future Universe received some attention as well, again without mentioning any further thresholds. Apparently, the Thresholds Approach does not work very well for the future Universe. It is too much tied to human history to be applicable to a universe within which humans no longer exist.

What about the decline and disappearance of complexity in big history?

Are there other reasons why the Thresholds Approach would not work well for considering the future? Is that because in our expected big future, no further rise of complexity would take place but, instead, only the decline and disappearance of greater complexity would occur? Even if that were the case, this raises the profound question of whether the Thresholds Approach perhaps mostly, if not exclusively, focuses on the rise of complexity while neglecting its decay. Here we see another important defect of the Thresholds Approach.

This bias toward rising complexity is more generally present in Christian’s work, most notably perhaps in his term ‘collective learning.’⁵ While employing this term in 2010, I suggested also systematically including ‘collective forgetting.’ In terms of the Thresholds Approach, the notion of ‘collective forgetting’ offers a great many situations in which thresholds were crossed downward as part of declining or completely disappearing complexity.

In fact, big history as a whole can be characterized by the interplay of processes of emerging, rising, declining, and disappearing complexity, as I argued in

my article about this subject (2005), including its title “How Big History Works: Energy Flows and the Rise and Demise of Complexity.” Today, such a decline in complexity would include the biological simplification of the biosphere over the past 12,000 years through human action. While considering these rather profound questions, this additional major weakness of the Thresholds Approach becomes clear, namely, that it mainly, if not exclusively, focuses the attention on rising complexity while neglecting its decline and disappearance.

Which circumstances may have contributed to this erroneous interpretation of big history?

Which more general aspects may have contributed to the adoption of the Thresholds Approach? Within this context it is important to mention that at the beginning of his TED talk, Christian raised what he saw as the great puzzle of big history: “How does the Universe make complexity?” This quotation exhibits a certain degree of anthropomorphic language. Seen from an academic perspective, the Universe does not make complex things. With the exception of the artificial complexity created by animals including humans, all the rest has emerged all by itself.

This criticism may appear trifling, but I think it is not. This type anthropomorphic or otherwise dramatic language is rather common in David Christian’s big history accounts. To be sure, many terms in the natural sciences were coined while using daily language. The ‘attraction’ by gravity offers such an example. Yet while explaining big history, one should be careful to follow the established scientific language and avoid adding more anthropomorphic terms, especially when they are not correct.

David Christian’s answer to the question of how the Universe makes complexity was “With great difficulty,” while subsequently mentioning as an explanation the idea of Goldilocks circumstances—favorable circumstances that allow the emergence of greater complexity—while correctly crediting me for that approach.⁶

Physically speaking, however, Christian’s answer is only part of the answer. In his groundbreaking book

Cosmic Evolution: The Rise of Complexity in Nature (2001), the US astrophysicist Eric Chaisson had already given an excellent explanation of the rise of complexity in all of cosmic history in terms of what is known in physics as non-equilibrium thermodynamics. Within this context it is important to note that Chaisson is a true pioneer of teaching and researching what he calls “cosmic evolution,” which is, in essence, the same as big history, but in Chaisson’s approach with a much larger emphasis on cosmic history.

In a very short summary of Chaisson’s explanation of the rise of cosmic complexity, energy flows through matter are required for greater complexity to emerge, including the need to dissipate the inevitable larger chaos (entropy) into the rest of the Universe in the form of low-energy radiation. This is possible thanks to the expansion of the cosmos, which has turned it into ever-increasing, mostly empty, and very cold space. Seen from a thermodynamic point of view, this cosmic expansion has, therefore, turned the Universe into an ever-increasing space for entropy.

However, while describing this general process, Chaisson did not systematically explore the important role of Goldilocks circumstances. While *Cosmic Evolution* can be a difficult read for those who have not studied physics, my explanation of Chaisson’s seminal work in *Big History and the Future of Humanity* (2010) was clearly made.

Why, then, was Chaisson’s approach in terms of energy flows through matter as a major requirement for the emergence of greater complexity in cosmic evolution not even mentioned in David Christian’s TED talk while seeking to answer this fundamental question, or adopted in his further work, including the BHP course? It is exactly this approach to cosmic evolution/big history that ties every moment of Earth history, including human history, inextricably to the history of the Universe.

What about the lack of an ‘Earth at a distance’ view?

What may further have caused the uncritical adoption of the Thresholds Approach? Although at first

sight this subject may again appear trifling, advocates of the Thresholds Approach rarely, if ever, use images of ‘Earth at a distance’ as exemplified by the famous *Earthrise* photo, which was taken in December of 1968 by the astronauts of Apollo 8 as well as the similarly famous *Full Earth* photographed in 1972 by the Apollo 17 crew.⁷

This lack of attention to ‘Earth at a distance’ views can, for instance, be observed in David Christian’s choices for pictures to illustrate big history, which are almost always Earthbound scenes looking out into the sky. There are a few exceptions. Within the textbook of 2014 (but not its cover) and on the *BHP* website, there are a few pictures of our planet seen from low Earth orbit. Yet these photos do not show our entire planet surrounded by black space. To the best of my knowledge, also among other adherents of the Thresholds Approach, photos of ‘Earth at a distance’ are rarely used, if at all, to illustrate big history. The only exception known to me is offered by the *Great Courses* website as viewed in February of 2022, which sports a *Full Earth* picture, as well as the cover of their *Course Guidebook* (Christian 2008).

Within this context it may be worthwhile to pay some attention to what Apollo 8 astronaut William Anders had to say about this subject. In December of 1968 while in lunar orbit, Anders took the famous photo of the Earth above the stark lunar surface that soon became known as *Earthrise*. In 2009, Anders formulated his change of view as follows:

The biggest philosophy, foundation-shaking impression was seeing the smallness of the Earth.... Even the pictures don’t do it justice, because they always have this frame around them. But when you...put your eyeball to the window of the spacecraft, you can see essentially half of the universe.... That’s a lot more black and a lot more universe than ever comes through a framed picture.... It’s not how small the Earth was, it’s just how big everything else was.⁸

Within this context, my article “On the Social Impact of the Apollo 8 *Earthrise* Photo, or the Lack of It?” published in 2019 in the *Journal of Big History* may also be relevant. The lack of such pictures among adherents of the Thresholds Approach makes one wonder whether they perhaps missed that profound change of view.

This lack of an ‘Earth at a distance’ view may also be visible in the design of David Christian’s first big history course. Its 1992 study guide bore the title, *HIST 112: An Introduction to World History*.⁹ This is the study guide, still in my possession, that we used as a model for our first big history course at the University of Amsterdam. The 1995 study guide offered essentially the same course, while both study guides do not mention the term ‘big history.’ Yet in his article “The Case for Big History” (1991), David Christian had already launched this term publicly for characterizing his revolutionary course.

Why would that be? This more conservative course title may have been part of a political move to get and keep this revolutionary course accepted within Macquarie University’s School of History, Politics & Philosophy, but it may go deeper than that. In 1992 this course consisted of Introduction: A Sense of Time (2 lectures); Part 1: Before Humanity (six lectures); Part 2: The First Human Societies (four lectures); Part 3: Agriculture and Tributary Societies (six lectures); and Part 4: Capitalism and the Modern World (7 lectures); by 1995 its lecture content had hardly changed.

This understandable focus on human history, given its place within the School of History, Politics & Philosophy is, however, also found in David Christian’s TED talk of 2011, which had the title “The History of Our World in 18 Minutes.” Why not “The History of Our Universe in 18 Minutes”? In following this approach, cosmic history is presented as an introduction to world history, and not as a vastly larger entity within which Earth and human history have evolved.

To be sure, David Christian’s pioneering attempt to look so much farther into the past than only human history was revolutionary. Still big historians need to take further mental and theoretical steps to put Earth

and human history in their proper place within the scheme of cosmic history.

Concluding Remarks

All of this leads to the following conclusions. Because of its lack of precision in defining what a threshold is; the lack of clearly defined academic criteria to establish them; its erroneous use as a concept for structuring all of big history; and its focus on rising complexity while ignoring its decline, the concept of thresholds of big history is fatally flawed and ought to be abandoned.

I am not alone in my criticism. Also, Eric Chaisson (2014) and the UK astrophysicist Michael Garrett (in Crawford 2019; Garrett 2021) have independently criticized the anthropocentric character of the Thresholds Approach. Yet because of the Thresholds Approach’s simple, rhetorically seductive, and at first sight persuasive character, it has rather uncritically been embraced by a great many people, none of whom has apparently taken the time and mental distance to scrutinize this scheme carefully. Some of them may simply have been too busy to do so, while perhaps lacking sufficient experience in this field. Others may not have done so because they may have assumed that this scheme must be good since it is promoted within a project supported by one of the wealthiest men in the world, with the expectation that it had been carefully peer reviewed.

From my point of view, it is great that Bill Gates chose to support big history in this way. Regrettably, however, his pioneering initiative did not lead to a BHP course that was set up according to sufficiently rigorous academic standards. As a result of this situation, a new myth clothed in academic attire has been going around the world. It is promoted with the support of Bill Gates’s money and prestige as part of a secondary school project for teaching big history to young people worldwide in a way that is not sufficiently in accordance with carefully-amassed empirical evidence and academic interpretations. Furthermore, by taking this erroneous track, any further theoretical progress in big history has become virtually impossible.

The approach advocated in my book *Big History*

and the Future of Humanity (2010, 2015) still works considerably better, or so it seems to me. In that book I argue along the lines of transitions to greater complexity while not prioritizing any of them according to a fixed and numbered scheme that was claimed to be valid for all of big history but while also paying considerable attention to the decline and disappearance of complexity.

Regarding the place of Earth and human history within big history, at the beginning of Chapter Four: Our Cosmic Neighborhood: The Emergence of Greater Complexity, I wrote the following (2010, 62-3):

We do not know whether life and culture as we know them are unique, or whether they have also emerged elsewhere in the universe. [. . .] If there is life elsewhere in the universe, it may well have preceded life on Earth. The first heavier chemical elements needed for life probably emerged as early as 10 billion years ago. Given the enormous numbers of galaxies—perhaps 100 billion in the known universe, each harboring perhaps as many as 100 billion stars—the chances appear considerable that life and culture would have emerged in other places also, quite possibly much earlier than on our home plan-

et. Moreover, seen on a cosmic scale we do not even know whether life is, in fact, the next step toward greater complexity. Perhaps other forms of greater complexity exist out there that we are currently unable to detect or even imagine. As a result, while discussing the emergence of life and culture on Earth, our big history account by necessity becomes solar-system focused and Earth-centered.

To me all of this still appears reasonably correct, uncontroversial, and considerably more precise than the Thresholds Approach. Yet as I keep emphasizing, no current big history account should be seen as mature. We still find ourselves at the beginning of summarizing big history, and great progress seems still possible.

“We have a choice,” the US planetary scientist Carl Sagan (1934-1996) said within a different context. His public program in the 1980s called *Cosmos* served as a great inspiration for David Christian to think of big history and start his revolutionary course. Yet to my knowledge Carl Sagan’s rhetoric never compromised any serious science that he sought to popularize.¹⁰ I very much hope that all of us will follow his great example, each of us in our own ways.

Notes

1. I owe many thanks to Gijs Kalsbeek, whose careful commentary—as so often during the past 40 years—has helped me to say what I think and recognize what I needed to think of. The editorial skills of Lowell Gustafson, another good friend, as well as his many excellent suggestions very much improved this article as well. Another great friend, Armando Menéndez Viso, provided great commentary that has added further clarity and structure to the text, while also Olga García Moreno, another highly-valued friend and colleague from Asturias, Spain, offered her stimulating comments. Also, my colleague and great friend Esther Quaedackers helped to improve this text. As an external reviewer, Tyler Volk contributed useful

suggestions for further improvement. As always, I remain solely responsible for the final text.

2. Course title: *Big History: The Big Bang, Life on Earth, and the Rise of Humanity*. Course No. 8050. Last accessed February 20, 2022. <https://www.thegreatcourses.com/courses/big-history-the-big-bang-life-on-earth-and-the-rise-of-humanity>.

3. *BHP*. Last accessed February 20, 2022. <https://www.bighistoryproject.com> and <https://www.oerproject.com/Big-History>.

4. *Merriam-Webster.com*. s v “threshold.” Last accessed February 20, 2022. <https://www.merriam-webster.com/dictionary/threshold>.

5. Christian first introduced the term ‘collective learning’ in his book *Maps of Time* (2004). It essentially

means the same as the term ‘culture’ as defined by the British anthropologist Sir Edward Burnett Tylor (1832-1917), by many considered as the father of cultural anthropology. On page 1 of his famous book *Primitive Culture* (1871) he defined ‘culture’ as follows: “Culture or Civilization, taken in its wide ethnographic sense, is that complex whole which includes knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by man as a member of society.” My notion of cultural forgetting: Spier 2010, p.114; 2015, 182-3.

6. The idea of such favorable circumstances as conditioning the rise and demise of complexity within big history was first presented in my article about this subject of 2005. It was later elaborated in my book *Big History and the Future of Humanity* (2010; 2015).

7. For the impact of the *Earthrise* photo or the lack of it, see Poole 2008 and Spier 2019. Also, during

unmanned space flights, high-impact pictures of Earth at a distance were taken, most notably perhaps the *Pale Blue Dot* photo of Earth taken by Voyager 1 in 1990 from 3.7 billion miles away and the Cassini mission’s picture taken in 2017 of Earth from under the rings of Saturn.

8. Chaikin and Kohl (2009, 158).

9. Macquarie University, 1992 Study Guide HIST 112: An Introduction to World History, School of History, Politics & Philosophy. Among Anglo-Saxon historians, ‘world history’ usually means ‘human history.’

10. For instance: Carl Sagan’s *Cosmos* series, now on *YouTube*, and his lecture “The Age of Exploration” (1994). <https://youtu.be/6-jtyhAVTc>.

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