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The Dynamics of Evolution: What Complexity Theory Suggests for Big History's Approach to Biological and Cultural Evolution

Ken Baskin

Abstract

The twentieth century science, from physics to neurobiology, redefined our understanding of the world, overturning the linear worldview of Newtonian physics for a more dynamic image. Especially as illuminated by complexity theory, this worldview suggests a conception of evolution in which phenomena adapt to each other, at many scales, embedded in a continually expanding universe of interconnected agents. Given this conception, human culture has evolved to adapt to changing conditions which, thus far, have generated a social world whose complexity has increased to serve a larger, more technologically advanced, more highly interconnected population. To demonstrate this conception of evolution, one can examine the Axial Age and Modernity as cultural 'phase transitions,' periods of experimentation punctuating periods of relative stable social structures. Such an examination offers an insight into the potential for Big History to contribute to solutions of the many challenges that call for innovative adaptations across our world.

Keywords: *relational evolution, world story, Axial Age, Modernity.*

Big History often focuses on the increasing complexity in the cosmos, life on Earth, and human culture that evolution has produced. David Christian discusses 'the endless waltz of chaos and complexity' (2004: 511), and Fred Spier, 'the rise and demise of complexity at all scales' (2011: 21). Yet, with the possible exception of Eric Chaisson (2001), writers in our discipline have not examined the dynamics by which complexity increases. In this essay, I want to reframe this discussion, drawing on the principles of complexity theory, because, while Big History treats complexity as a *measure* of diversity and interaction, complexity theory treats it as a *dynamic* to be examined (Bondarenko 2007). My purpose is to explore how an understanding of this dynamic – and the conception of evolution it suggests – can become an intellectual tool for our discipline.

My argument is that evolution is a much 'thicker' process than traditional theory suggests. Such a conception of evolution can enable students of Big History to reconsider any number of issues and develop a deeper understanding of the dynamics of both biological and cultural evolution. To explore this argument, I want to touch on four major issues:

- two key principles of complexity theory;
- the conception of 'relational' evolution suggested therein;
- the resulting theory of historical evolution;
- an examination of the Axial Age and Modernity in terms of this theory, as periods of punctuation, and why this perspective can be so valuable.

In an essay of this length, I can only begin this exploration. In addition, I have little choice but to oversimplify a number of issues that deserve deeper consideration. So I want to ask the readers' indulgence for this obvious limitation. With that caveat, I turn to the dynamics explored in complexity theory.

Complexity Theory Dynamics

Complexity theory emerged in the late 1970s, as researchers in fields, ranging from fluid dynamics to economics, armed with desktop computers, modelled their subjects on non-linear mathematics and began finding striking similarities across disciplines and scales (for a full discussion see Pagels 1988). Those similarities suggested a meta-discipline, complexity theory, which, for me, is best understood as the study of 'the patterns that emerge as complex, multi-scaled phenomena evolve' (Baskin 2013: 4). I prefer the word 'phenomenon', to the more generally used 'system', to describe the networks complexity theory studies, because, where the concept of systems suggests mechanical stability, that of phenomena (see Barad 2007) indicates more dynamic structures.

Two principles of complexity theory are critical to my argument – the structure of matter as nested networks and 'attractors'. First, physical reality is composed of networks of agents embedded in networks at many scales, from atoms networked in molecules to organs networked in living bodies, and solar systems in galaxies. As a result, understanding the behaviour of an ant colony as phenomenon requires *at least* knowledge of the behaviour of the ants that are its micro-scale agents, the colony itself, and its macro-scale environment.

The second critical principle is the attractor, which represents the dynamic balance between the behaviour of the agents and the constraints of the environment. The term attractor comes from non-linear mathematics, describing the pattern in phase space into which the solutions to equa-

tions are drawn. Lorenz's 'Butterfly Attractor' is among the best known. In complexity theory, more generally, an attractor describes the pattern of behaviour, of all possible behaviours, that characterizes any phenomenon under specific conditions (Cohen and Stewart 1994: 204–207). Over time, a phenomenon's attractor will draw it to behave something like this figure, which I first scribbled as a 'back-of-the-cocktail-napkin' doodle when I was wrestling with complexity theory's basic principles.

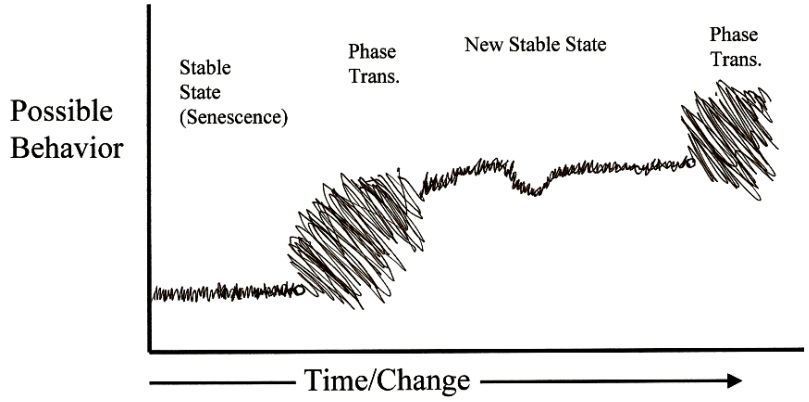

Fig. 1. Life Cycle of an Attractor

Put a chunk of ice in a pot on the stove and turn up the heat. It will remain solid until it approaches its melting point, then enter a turbulent phase transition, and transform into liquid. It will remain liquid until it approaches its boiling point, become turbulent again, and transform into gas. Phenomena, then, oscillate between turbulent phase transitions, in which their agents seek the behaviours that enable them to survive current conditions, and the stable states in which those behaviours form their characteristic attractors.

To my surprise, I soon realized that much human behaviour conforms to this pattern. Human psychological development, the economy's boom/bust cycle, and the rise and fall of human empires (Baskin 2008, 2009) – all conform to this pattern. It also reflects other thinker's analyses, from Foucault's evolution of Western *episteme* (1994) to Arrighi's cycles of Western Capitalism (1994). At some point, I realized that this pattern also reflects the still-controversial theory of punctuated equilibrium (Gould 2002), and that I had probably been strongly affected by the discussions of it I had read.

The Life Cycle of an Attractor is meant to be what Bruno Latour (2005) calls a 'panorama' – overly neat and coherent, an approximation

of the networks it maps, not a mathematical or even literal representation. The panoramic map is not the territory, merely a guide for the explorer. Nonetheless, the behaviour of many evolving phenomena conforms to this figure, suggesting a model of evolution.

Evolution like Molasses

We live today in an environment in which a new worldview is emerging (see Laughlin 2005; Boje and Baskin 2010; Smolin 2013), and our understanding of evolution is changing to meet this new worldview. The traditional conception of evolution, the 'neo-Darwinian' 'modern synthesis' 'asserts that this history of life at all levels – including and even beyond the level of speciation and species extinction events, embracing all macroevolutionary phenomena – is fully accounted for by the processes that operate within populations and species' (Hoffman 1989: 39). Like the Newtonian worldview in which it developed, neo-Darwinian evolution is linear, focusing on cause-and-effect changes in distinct entities, a 'straight line of continuous transformation of one species into the next' (Tattersall and Schwartz 2001: 33). Richard Dawkins' theory of the 'selfish gene', which reduces organisms to vehicles for their genes, is an excellent example of this approach (Dawkins 1976).

Mainstream cultural evolution articulates a similar conception of 'evolutionism'. As Robert Carneiro (2003) notes, evolutionism has gone in and out of favour with anthropologists since Herbert Spencer began discussing the idea in the 1850s. Much of the disagreement about such cultural evolution centred on the Newtonian sense of determinism often associated with its 'stages' and 'directionality'. Carneiro insists that this Newtonian reading misinterprets such thinkers as Leslie White and Gordon Childe. With his more dynamic reading of evolutionism, for example, Carneiro explains that, while cultural evolution has a direction, increasing social complexity – that is, movement toward more hierarchical socio-political levels – 'a process can have a direction without having a goal' (*Ibid.:* 163). He goes on to define cultural evolution as 'a series of adaptive readjustments, each adding to the structural complexity of the society and often initiating a series of other internal changes that further contribute to its evolution' (*Ibid.:* 199). Nonetheless, Carneiro does not develop a fully dynamic interpretation of cultural evolution.

With this traditional view of evolution, researchers made great strides during the twentieth century. However, a more dynamic and non-linear worldview is emerging today, and the conception of evolution itself is evolving. The point I want to make is not to criticize theorists such as Dawkins or Carneiro; the traditional understanding of evo-

lution reflects the worldview in which it developed. As a new worldview emerges, so does a different understanding of evolution. I shall follow Lee Smolin (2013: xvi) in calling it 'relational' – that is, phenomena are best described in the context of the networks of which they are part. Many of my ideas are certainly not original. I draw on or independently developed ideas, to name only a few, that include the 'punctuated equilibrium' of Niles Eldredge and Stephen Jay Gould (2002), Stuart Kauffman's 'adjacent possible' (2000: 150), Henri Claessen's Complex Interaction Model, which incorporates many of the dynamics of my model (Claessen 2000); and Mark Taylor's image of living things as both 'genuinely creative' individuals and the 'product of the matrix of relationships in which they exist' (Taylor 2007: 335). By organizing such ideas with a complexity-oriented discourse I am trying to move toward a fuller and a more coherent theory.

Consider the image most often used to express the traditional conception of evolution – the 'Tree of Life' (*e.g.*, Pyne and Pyne 2012: 269), a static, two-dimensional image, beginning in its roots as the most primitive form of life and growing to its apogee in Man. With dynamic evolution, a more appropriate image might be molasses moving downhill, a colloid of many particles, affecting each other, and being affected by both the hill and the weather. Relational evolution moves, then, at multiple scales, along the balance between the demands of external conditions and the conditions of a set of phenomena's internal networks. Over time (see Fig. 1), the still-weakly-connected agents of an incipient phenomenon in a phase transition – whether the living things in an ecosystem after an extinction event or the people in a social network after a collapse – search for behaviours that enable them to survive and thrive in current conditions. When those agents find successful behaviours, they begin to practice them and continue as long as the behaviours produce success.

Over time, they build relationships by practicing these behaviours, and the longer they succeed, the deeper the relationships become and the more the welfare of the agents comes to depend on those relationships. It is this dependence on specific behaviours and relationships that gives any attractor its power to constrain its agents' responses. Agents in the phenomenon continue to adapt to external change, until, at some point, those agents have become too wedded to their behaviours to adapt. At this point, the phenomenon enters 'senescence', a concept Stan Salthe (1993) developed to describe the evolution of ecosystems, and the agents subsume environmental change to their characteristic patterns. Finally, the external change becomes so great that agents can no longer

survive; so the attractor collapses. At that point, agents, often connected in less extensive networks, must either dissipate so that the phenomenon no longer exists as a functioning network or re-enter the phase transition so that it can develop another attractor. Clearly, other processes – ageing or the tendency to form self-reinforcing cycles – are also at work, often interacting with evolution. A fuller consideration would touch on them more.

Today, societies across the world seem in senescence. One sees evidence in the gridlock in American government or the corruption in Russia and China, in the economic crisis in the European Union or the chaos of the 'Arab Spring'. Overwhelmed by decades of rapid change, those in power depend so deeply on the old attractors that support their wealth, power and sense of self, that they cannot make the fundamental changes today's conditions demand.

Because phenomena evolve at many scales simultaneously, the agents that make up any network continually undergo what Francois Jullien (2011) describes as 'silent transformations'. The process of ageing goes on every moment of every day throughout our bodies, even though most people rarely note it. In this way, Jullien notes, we are not so much getting older as the ageing world is taking us with it. Most of these transformations are habitual, often programmed; others are essentially experiments by which agents strive to respond to changes in their environments, Kauffman's exploration in the adjacent possible (Kauffman 2000). In this way, a myriad of micro-scale changes among agents, often barely noticeable, are tested within the phenomenon, and those that survive become available for further development. Such micro-scale changes are only partially expressed in stable states; however, during a more chaotic phase transition the agents are freed to explore the full potential that these changes have inherent within them. In biological evolutionary theory, these tendencies are described as 'developmental canalization' and 'developmental plasticity', respectively (Hoffman 1989); similarly, Elman Service (1988) described this dynamic as the 'Law of Evolutionary Potential'. One advantage of a complexity-oriented conception of evolution is that it explains this dynamic in both organic and cultural evolution at a more detailed level.

In genetic theory, mutations build up in organisms when ecosystems are stable, and remain latent or not fully expressed until the more chaotic phase transitions, when organisms explore survival strategies (Cohen and Stewart 1994). Mammals first appeared about 210 million years ago; they remained 'mainly small, nocturnal, tree-dwelling creatures' (Leakey and Lewin 1995: 66), surviving in ecological niches in

which they could avoid dinosaur predators. They would then accumulate the mutations that would enable those that survived to dominate all the world's ecosystems, until the extinction event that removed the dinosaurs 65 million years ago. It was only in the ensuing ten-million-year phase transition that mammals could explore the full potential of their 140 million years of silent transformational mutations, in the wide-open ecosystems they now inhabited. Once again, I have oversimplified; any dynamic as complex as the emergence of mammal dominance deserves much fuller examination than is possible here.

In cultural evolution, innovations, such as writing, also develop through millions of silent transformations. Written notation appeared in a variety of times and places, as knots, notches, or pictographs, as an aide to memory (Fischer 2001). With growing populations, agricultural surpluses, and increased trade, such marks became invaluable for keeping records. Full writing systems appear to have emerged as a part of the process of state-formation, in order to manage increasingly great resource bases, in the late fourth century BCE in, first, Sumer, and, then, Egypt (Nissen 1988). Throughout the pre-axial period, however, the resulting literacy would remain what Assmann (2012) calls 'sectorial' – that is, used in the accounting, religious, and government sectors in which it emerged. Used more and more widely in such cultures, it was still constrained in a stable state where culture was predominantly communicated and managed orally. With the phase transitional Axial Age, people in such cultures as Greece, India, and China, freed of the constraints of their stable state, would experiment with writing and develop its most powerful potentialities. Literacy would become 'cultural', penetrating 'into the central core of culture' (Assmann 2012: 383), enabling the personal reflection that reading drove or the 'religions of the book', for instance (Ong 1982).

What makes relational evolution different from the neo-Darwinian approach is not the facts of evolution; many neo-Darwinians will agree with most of what I have thus far written here (*e.g.*, Hoffman 1989). The difference is in the basic discourse, some would call it a paradigm that makes these agreed-upon facts significant. The discourse in traditional evolution focuses attention on the development of individual changes, the most extreme example being Dawkins' selfish genes (1976). A relational approach, on the other hand, focuses on both individual developments and the context of wide, deeply interconnected networks of evolving phenomena, perhaps even of the universe itself. Evolution therefore suggests the thickness of molasses. It occurs on many scales – biological evolution on the molecular, cellular, organic, species and eco-

system, geologic and climatic scales, and cultural evolution on the individual, family, social organizational, cultural, ideological, technological and economic scales. The interaction of all such changes creates evolutionary patterns. In addition, the evolution of the inanimate Universe, life on Earth, and human culture all affect each other. The first major shift in human social evolution occurred after a development in inanimate evolution, the end of the Ice Age, which made more complex social structures necessary. Similarly, events in the evolution of life, the domestication of grains and animals, for example, have contributed to human social evolution. Thus, interactions between events in the three forms of evolution further thicken the process.

This relational discourse suggests ways to re-examine a variety of issues in biological and culture evolution. For example, is evolution gradual, as neo-Darwinians believe, or subject to punctuated equilibrium (*e.g.*, Hoffman 1989)? So intense was the disagreement that, in *The Blind Watchmaker* (Dawkins 1986), Dawkins entitles a chapter 'Puncturing punctuationism'. Yet, a relational approach largely resolves the disagreement. On the micro-level, agential evolution, in genes or individual people, is gradual; however, when the stable state of the macro-level goes into phase transition, the environment, whether ecosystem or culture, punctuates its equilibrium, driving radical adaptive changes for survival purposes at the micro- and meso-levels. Both processes are essential to evolution; to focus on only one is to misrepresent the full complexity of the facts. Similarly, the suggestion that biological and cultural evolution are different because the biological is mostly 'Darwinian' and the cultural, mostly 'Lamarkian' (*e.g.,* Grinin *et al.* 2011) shifts with relational evolution. The difference here is in the carriers of 'genotypic' information. In biological phenomena that carrier is DNA, embedded in the body; in cultural phenomena it is a variety of stories, narratives, and meta-narratives people in any culture tell each other (*e.g.*, Lyotard 1984). Take into account these differences in how information is carried, and the mechanism of both types of evolution seem remarkably similar.

Toward a Dynamic Theory of Human Social Evolution

From this relational point of view, a panorama of human history over the last 50,000 years might look something like this (first presented in Baskin and Bondarenko 2011).

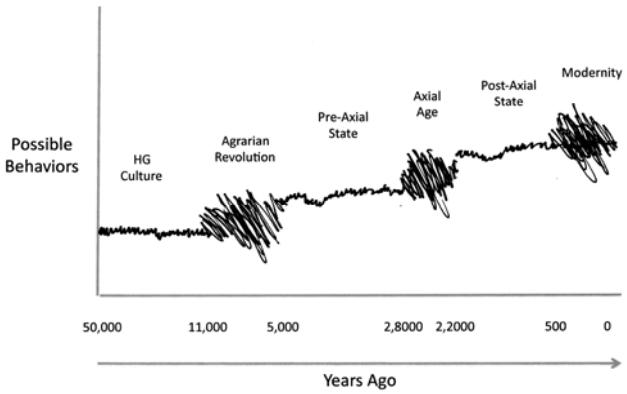

Fig. 2. Human history as 'punctuated equilibria'

History is too messy and abundant, and, what we know with certainty, too limited, to assume that events should conform to our abstractions; so I left this figure imprecise. For example, the movement indicated in the figure is overly linear. For the most part, cultural stable states do not simply end and phase transitions begin; rather, societies often move back and forth between the two. Still, the basic pattern seems valid as a Latourian panorama, rather than attempt to articulate the truth.

This conception of cultural evolution has a significant explanatory power. For instance, the period from c. 3000 BCE to 1500 CE is often defined as the 'tribute' (Tainter 1988; Amin 2009) 'stage' of society. Yet, the social institutions in Greece, India and China, before and after the Axial Age, are clearly distinct – mythic religion *vs.* religions of the book, for example, or government by royal lineage *vs.* bureaucracy (*e.g.,* Lewis 1990). The evolutionary model I am developing explains those differences as two cultural stable states that represent adaptations to different levels of complexity. This understanding was recently validated by its similarity to the more mathematically rigorous work of Korotayev and Grinin (2012: 34), in modeling the growth of urban populations.

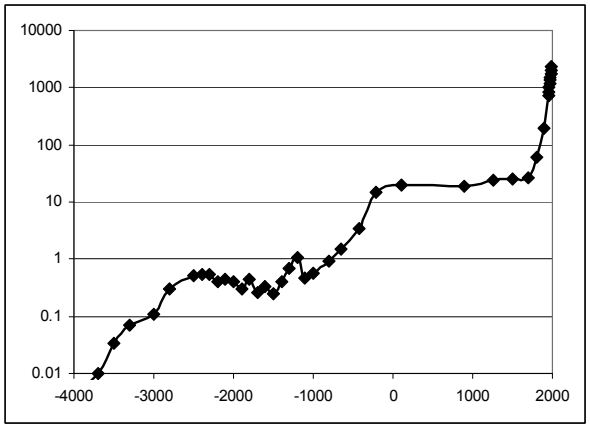

Fig. 3. Dynamics of World Urban Population

Note: In millions, for cities of more than 10,000, 4000 BCE–1990 CE, logarithmic scale.

Here we see that urban population remains essentially flat in pre-axial and post-axial stable states, while it increases exponentially in the Axial Age and Modernity. According to Korotayev and Grinin, such rapid population growth results largely from an acceleration in technological innovation. Viewed in terms of relational evolution, this acceleration of innovation reflects the phase transition and the enhanced ability to experiment with and to socially integrate the wide range of social mutations – manifested, for example, in the feedback loops of increased collective learning – that had already developed, as well as new innovations.

In the rest of this essay, I shall explore whether, as a relational theory of evolution suggests, the Axial Age and Modernity share similar dynamics. Space limitations make it impossible to explore key issues such as capitalism, imperialism, or developments outside Eurasia in any detail. If this theory does seem accurate, however, it should offer fascinating insights into such topics at another time.

At the heart of events in both cultural phase transitions is the transformation in the cultural 'phenotype', the institutional structures that enable continuing survival, which requires a new cultural 'genotype', the equivalent of organic DNA. Bondarenko and I call that cultural genotype a 'world story'. Such culture-defining sets of stories must answer a series of questions about survival including:

- How did we human beings get here?
- What is our purpose?
- Who are 'we' as a group, and how should we behave toward each other and our world?
- How should we manage the communities in which we live?
- Why, in a world full of fear and pain, should we not kill ourselves?

In this way, the world story of hunter-gatherers had to explain the 'profane', day-to-day issues of survival, from how to hunt and gather, house and clothe themselves to social relationships in groups that rarely exceeded 30 members; yet, it also had to explain the sense that 'sacred' forces 'incomprehensible, intractable but eminently efficacious' (Caillois 2001: 22), were continually moving things – from climate shifts to the animals they hunted and the flora they gathered. Such world stories are not merely 'religious' (see Nongbri 2013); they articulate a discourse that integrates spiritual concerns with social, economic and political questions, encoding any society's cultural attractor. Moreover, as Taylor (2007) notes of his expanded concept of religion, world stories function both to create the ground for social structure and to destabilize it, especially during times of cultural phase transition.

The world stories of the predominant pre-axial states (*c.* 3000 BCE – *c.* 800 BCE) focused on maintaining order amid the forces of chaos that threatened large societies dependent on agricultural surplus. In Sumeria, Egypt, and China, for example, controlling the sacred forces threatening large-scale agriculture, from drought and flood to the devastation of war, was central. In all of them, the king was conduit to the divine, whether as god himself or, more often, master of order-creating ritual. In Egypt, for example, the pharaoh had to practice the rituals that ensured *Ma'at*, both the triumph of order over chaos and justice for society at large (Assmann 2008, 2011). The resulting societies were institutionally integrated, so that worship, politics, and economics – as in the use of temples for grain collection and distribution (*e.g.*, the story of Joseph administering the seven years of plenty and seven of famine, Genesis, 41) – function as parts of an order as integral and natural as the order and chaos they balance. This style of world story successfully governed these societies until *c.* 1000 BCE, when the combination of increased trade and wealth, a wider use of writing, and rapid improvements in warfare, especially the iron metallurgy that made weapons cheaper and more plentiful (McNeill 1982), as well as a doubling of world population between 3000 and 1000 BCE (Livi-Bacci 1992), demanded a new way of living in the world.

The Axial Age

Pre-axial social structure began to break down in the Mediterranean world *c.* 1200 BCE, when the 'Sea People' (*e.g.*, Sandars 1987) destroyed both Hittite and Mycenaean cultures and drained the power of Egypt during the twelfth century BCE. In China, the Zhou Dynasty began losing control of its territories by the middle of the tenth century BCE, eventually disintegrating into 170 competing kingdoms (Fairbank and Goldman 2006). Karl Jaspers (1953: 1) named the resulting transition the Axial Age (800–200 BCE), the 'axis in world history ... which has given birth' to everything that followed. The school that follows his lead (*e.g.*, early Bellah 1976; Eisenstadt 1982; Armstrong 2006) explains the similar experiences in these states largely in terms of a spiritual transformation that, for them, happened unpredictably in unconnected cultures. Relational evolution, on the other hand, suggests that this period represents, as Assmann (2008, 2012) points out, cultural breakdowns followed by breakthroughs that drove total social transformations in societies that were experiencing the same sort of increase in complexity.

To adapt to it, people in these societies needed to recreate their institutions, from the pre-axial order that emphasized loyalty to one's lineage to a more formal connection and sense of obligation. In describing China's axial experience, Mark Lewis (1990: 246) notes that, just as warfare was transformed from a means of defending honor among aristocrats to the tightly organized extension of armies of hundreds of thousands directed by the will of a single man, the commander, 'all of society was re-imagined in terms of the hierarchical ties of superior and subordinate'. In Greece, this movement toward order and control appeared in the phalanx and later the troops of Philip of Macedon, as well as the bureaucratic empires that emerged from Alexander's conquests.

To transform their institutions in this way, they would first have to re-interpret their world by evolving new world stories. As Assmann (2011) notes of the Israelite experience, the new world stories evolved through roughly three phases. In each, people, freed of their older world-story attractors, behaved according to their evolving stories, experienced the results, and then changed the stories in response. Assmann identifies the phases of axial world story as 'foundational texts', 'religious texts', and 'commentary'. Rather than his 'religious texts' (for a discussion of some problems with this term, see Nongbri 2013), I shall use the term 'tragic/new world story texts', to include Timothy Reiss' understanding of tragedy. For him, the tragic reflects a 'sense of injustice' and 'the inevitable gap between the human known and knowable and all that escapes discourse', 'appearing at certain moments of seem-

ingly abrupt epistemic change ... making a new class of discourse possible' (Reiss 1980: 20, 2). Tragedy recognizes the terror that people experience as their old order no longer works.

For the sake of brevity, I shall focus on the axial experiences in Greece and China (for a treatment of the process in Israel, see Assmann 2011; for the Indian experience, several essays in Eisenstadt 1986).

Each culture's foundational texts articulate group identity as 'remembered past', mixing myth and history (Assmann 2011: 59), translating pre-axial mythos into a world where the cultural attractors have collapsed. The fear of chaos dominates all of them. In Greece that fear appears in the poetry of Hesiod and the epics of Homer, articulated in divine figures who eat their children and precipitate a decade-long war over a beauty contest. Faced with this chaotic and capricious world, Homer shows the aristocracies of the Greek states as fractious brothers, coming together to protect each other's honor, going to war over Helen and defeating the eastern enemy, Troy. The Greek *poleis* enacted this story when they cooperated to defeat the Persians in 490 and 480 BCE. Having achieved this success in enacting their foundational texts, these city-states acted like brothers again, fighting among themselves over political and economic control in alliances led by Athens and Sparta. The devastation of the Peloponnesian Wars would drive Greece's Golden Age of tragic/new world story texts.

In China, the foundational texts are also about taming chaos, although the High God of the Shang Dynasty (*Di*) had been translated into the concept of Heaven (Schwartz 1985). Order was Heaven's gift so that the key issue would be why people introduce disorder by deviating from it. The actors in China's axial foundational texts are not divinities, but early 'sages', such as Yu, who invented irrigation and water control after the Great Flood of the Yellow River, or the kings Yao and Shu, who exemplified an ordered practice of public rule (*Ibid.*; Lewis 1990). The ideal inherent in this foundational myth was of order through strong kingship in an extremely hierarchical, united China. Partly as a result, the central theme of China's Axial Age was the movement from fragmentation to unity, from chaos to order. In this way, in the Spring and Autumn period (771–476 BCE) early Axial Age China witnessed a constant state of war – one account lists 540 interstate wars and more than 130 civil wars in one 295 year period (Lewis 1990: 36) – intensifying the fear of chaos that had existed previously. By the end of the Spring-and-Autumn period, warfare had reduced the number of competing states from 170 to seven. It would also stimulate the tragic/religious texts that appeared in late axial China.

In the axial societies, the terror provoked by these wars would combine with the increased integration of writing beyond the scribes and formal keepers of social order to encourage a level of reflection previously unknown (see Assmann 2012). Literacy facilitated the rise of individualism, as reading, an individual activity, begins to replace communal storytelling, and it became possible for people to become more reflective with a text in front of them (Ong 1982). The tragic / new world story texts in these societies would be one result of this increased reflection.

In Greece, those texts appeared first in the tragedies of Aeschylus, Sophocles, and Euripides, which span the fifth century BCE, from the beginning of the Persian Wars in 499 BCE to the end of the Peloponnesian Wars in 404 BCE. The tragedies demonstrated how even good people become caught up in chaotic forces, no matter how hard they resist. These texts demonstrate Reiss' (1980: 21) 'moment of rupture', as people recognize that the old ways do not work, and that the order provided by reason can be disrupted by dark sacred forces.

The new world story to explain this chaos and terror emerges in Greece from its tradition of philosophy, with all the experimental variety one would expect in a period of phase transition: the Pythagoreans (fifth and sixth centuries BCE) insisted on the ultimate reality of numbers; Heraclitus (fl. 550) saw reality as a constant change; and the atomists, such as Democritus (fl. 410), viewed reality 'as a lifeless piece of machinery' (Lindberg 2007: 29–30). All this intellectual searching culminated in the philosophy of Plato (427–328 BCE) and Aristotle's practical application (384–322 BCE).

Having lived through the devastation of the Peloponnesian Wars, Plato knew first hand that human-induced chaos had to be controlled. To do so, his philosophy emphasizes rationality, insisting that the world was created by a rational spirit, the Demiurge (see *Timaeus*), based on the abstract Forms of things, their true reality. Chaos crept into the world, not because of the Forms, but the material with which the Demiurge worked (*e.g.*, Bellah 2011). Because, as the Parable of the Cave (*Republic*) indicates, most citizens never understand the reality of Forms, they are governed by emotions and appetites, and government must prevent those emotions and appetites overwhelming citizens' reason. To make such government work, Plato replaced the heroic leaders of Homer with his *theoros*, the philosopher who 'loves the spectacle of truth' (Nightingale 2004: 98). The *theoros* would allow most citizens to have their 'unfalsifiable' mythic beliefs (*mythos*), but they themselves would live by the rational, 'falsifiable' *logos*. Plato recognized that such a rationally governed life was only for a very few. For the rest, he sug-

gested that the gods, goddesses, and narratives of the old world story would be sufficient.

Aristotle, born after this devastation, 'was able calmly to look around the new world that Plato had opened up and explore its many possibilities, without rancor' (Bellah 2011: 395–396). Plato's Demiurge would become Aristotle's 'Unmoved Mover', a divinity of pure thought, beyond our world of matter, and the cosmos it created contained both the chaotic, ever changing world below the Moon and the unchanging Heavens (Freely 2012: 28), rotating in perfect circles. Humans created chaos only because they would not allow the pure intellect of the divine to guide them. To avoid chaos, the *polis* must train citizens in using their reason. Aristotle's many other studies continued to apply his own rational principle to one field of study after another, answering the questions behind any world story. His *Ethics*, for example, explored how the individual could achieve *eudaimonia* to live the life of *theoria*. In these and other explorations, Aristotle would 'sketch out most of the fields of inquiry that would preoccupy later thinkers' (Bellah 2011: 395).

The Chinese experience with tragic/new world story texts manifested itself as the philosophical flowering of the 'hundred schools', which arose in the century leading to the Warring States period (403–221 BCE). These schools reflected the wide variety of thought responding to the violence of the Spring-and-Autumn period, as articulated by the *shih*, the growing class of often-wandering scholars dispossessed from their noble lineages (Schwartz 1985). All of them were trying to understand the same tragic dilemma: If order was the gift of Heaven, why was chaos so widespread? Why had men lost 'the Way of Heaven'? Three of these schools would define the positions that would be negotiated into China's post-axial world story. For the Confucians, the issue was social: the Zhou had already achieved a 'universal, all-embracing, ethicopolitical order' (*Ibid.:* 65). Only by re-establishing that order could social order be recaptured. To do so, Confucius (551–479 BCE) and his followers focused on living life according to the ritual formulas for one's position and on education as a means for both individuals and society at large to understand the 'Way' of humans in society. For the Daoists, the issue was more personal: the overly civilized order of the Confucians had made it impossible for people to behave naturally, in consonance with the Way and the Heaven-given laws of change (Graham 1989). Only by the individual learning the Way and acting according to it could order be returned. Finally, the Legalists believed that the problem was the passionate, unruly nature of human beings and that order required clear, harshly enforced laws so that people knew exactly what behavior

would be expected and what would happen if they did not conform (Feng 1976). Throughout the Warring States period, the intensity of warfare increased, as armies reached several hundred thousand men (Lewis 1990). By 300 BCE, even Mencius (*c.* 372–289 BCE), the strongest Chinese believer in human goodness, recognized that the only way to social order was unity (Schwartz 1985). With a complex cosmology already in place (*Ibid.*: 350–382), these three perspectives would become more and more closely intertwined throughout China's commentary period.

Assmann (2011: 269) describes the period of commentary as 'an indispensable accompaniment to the cultural transformation ... keeping those texts alive by bridging the ever widening gap between them and the changing reality of life'. In this way, as Alexander spread Hellenism, Rome rose in the West, and the Qin united China at the end of the Axial Age, as population and wealth increased, and technology accelerated, new ways of governing and behaving in increasingly complex societies could be articulated and enacted.

In Greece, this commentary would play itself out in philosophy and science, continuing its evolution through the Hellenistic period and later. The rationalist commentary that began with Plato and Aristotle continued through the work of thinkers such as the Cynics and Neo-Platonists in the Hellenistic period, early scientific thinkers such as Ptolemy and, later, the Fathers of the Church, such as Augustine and Origen (*e.g.*, Gillespie 2008). Significantly, their central assumptions were set in place by Plato and Aristotle, including the analysis of the world as distinct 'things', the concept of a soul separate from the body, the idea of an Unmoved Mover, and the emphasis on moral distinctions. All these assumptions would be integrated into the world stories of the Roman Empire and, later, that of Western culture.

The Chinese commentary period seems to have been underway in the fourth century BCE. Throughout it, the Chinese thinkers of all schools would borrow from each other to develop the most effective philosophies for aiding kings in the seven states in their efforts to unite the country. The Legalist Han Fei (d. 233 BCE), for example, briefly the chief minister for the King of Qin as he was uniting China, borrowed from Daoist *Laotzi*'s ideas about the Way and *wu-wei*, probably best translated as effortless action (Slingerland 2003), to provide a metaphysical basis for his emphasis on punishment (Graham 1989). In spite of a reaction against the extreme Legalistic policies of the First Emperor, so that it lost its position as a school of philosophy, the concepts of Legalism remained key assumptions for the Chinese government. Neo-Confucianism, with its emphasis on right behavior and education, in-

corporating elements of both Daoism and Legalism, would become the state philosophy (Fairbank and Goldman 2006).

Modernity as Another Axial Phase Transition

The terms in which Modernity is often described – Latour's (1993: 10) 'new regime, an acceleration, a rupture, a revolution in time', for example, or Samir Amin's (2009: 13) 'claim that human beings, individually and collectively, can and must make their own history' – could also characterize the Axial Age. As a result, it makes sense to examine Modernity (*c.* 1500 CE to the present) as a phase transition in human history with remarkably similar dynamics.

As with the Axial Age, the ability of an older world story to govern an increasingly complex society was breaking down. For more than a millennium, the bureaucratic empires of Byzantium, the Islamic world, and China had justified themselves with world stories in which religions of the book were integrated with the efforts of the secular kings and bureaucracies that enabled them to govern vast territories. So successful were the post-axial empires that the conquests of the Yuan Dynasty, led by descendents of Genghis Khan, united Eurasia as a world economic system in the thirteenth century (Abu-Lughod 1989). Then, in 1453, the Ottomans took Constantinople, threatening to overwhelm Christian Europe.

Yet, within 200 years, these empires were losing the ability to respond to the social complexity that they had enabled. With a world population that would exceed one-half billion before the end of the sixteenth century (Livi-Bacci 1992: 31), the first system of worldwide trade by the end of the thirteenth century (Abu-Lughod 1989), and acceleration in the rate of technological innovation in Islam and China (*e.g.*, Lindberg 2007; Temple 2007), their old world stories began to falter. As Jack Goldstone (1991) notes, the inability of government to adapt to the needs of growing populations as economic activity evolved caused the mid-seventeenth century revolts in England, China and the Ottoman Empire. The Ottomans and Chinese fell back into the older behaviors that would enervate them when faced with Western imperialism. The English, in the midst of their phase transition, moved forward.

In addition, the European politics was fragmented, as in early axial China and Greece, with Italian city-states, German principalities, and emerging national states in Spain, Portugal, France and England (*e.g.*, Bondarenko and Korotayev 2011). In fact, writers such as Eric Jones (2003) claim that Europe's political fragmentation in 1500 CE was key to its subsequent rise. Moreover, as the axial transformations were partly driven by innovative applications of writing and iron metallurgy, early

modern Europeans took printing (Eisenstein 2005) and the commercially efficacious machine, both invented in China, 'to a high pitch' (Jones 2003: 58), that, together, made a higher level of complexity possible, and with it the ability to respond to a more complex environment.

Since the fall of Rome, Western Europe had experienced a chaos of diverse influences – from the rationality of ancient Greece, through the memory of the Roman Empire, and monotheism, through Christianity, to the Germanic, Viking and Islamic invasions. By the end of the twelfth century, the foundational text of the modern period began to emerge, initially in the stories of the Quest for the Holy Grail (Spengler 1932), combining the restless spirit of multiple invasions with the Christian, theocentric tradition of worship and belief, especially as articulated in the Apocalyptic millennialism of that period (*e.g.*, Noble 1999; Gillespie 2008). As suggested below, these stories would not express their full power until some time around 1500, when the breakthrough of the modern phase transition followed the breakdown of the medieval period.

Even as the grail quest literature was championing the authority of a social order joining the Catholic Church and the feudal economic/political class, events continued to provoke chaos. The loss of Jerusalem in 1187, followed by the failure of the Third Crusade (1189–1192) to retake it, undermined the legitimacy of the Papacy's claim to represent God on Earth. After the Mongol creation of a world economic system in the thirteenth century, increasing trade and wealth would build the fortunes that would finance the Renaissance, but also encourage the corruption in the Church, especially the Papal indulgences, which allowed the rich to 'buy' salvation, outraging Martin Luther. Finally, the Black Death (1348–1350) and the Hundred Years War between England and France (1327–1453) would devastate the population of Europe (Gillespie 2008). The medieval world story would then break down and the modern phase transition would begin.

This phase transition would consist of a series of social explorations of Kauffman's adjacent possible, each of which led to a social consensus, the enactment of that consensus, a series of (mostly unexpected) results, and new explorations. Perhaps the most striking, this evolving modern world story repeatedly destabilized the institutions and belief systems created when it was enacted.

At the beginning of the sixteenth century, both the Renaissance and Reformation looked to different paths for governing an increasingly complex society. The printing press introduced by Gutenberg *c.* 1450 (see Eisenstein 2005) changed the nature of communication, making increasing amounts of knowledge available to the Renaissance and personal

reading of the Bible to the Reformation, generating a significant acceleration of the collective learning so central to cultural evolution (Christian 2004); the machine, employed in everything from the printing press to the newly improved firearms, intensified politics, warfare and commerce. Building on these innovations, the Renaissance strove to improve human life by employing the increasing store of knowledge; the Reformation used the availability of Bibles in the vernacular to challenge the often-abused spiritual monopoly of the Catholic Church (Gillespie 2008). For Martin Luther, the End of Time was near. As a result, for many in the Reformation, there was no need for the attempts at education and reform championed by Renaissance spokesmen such as Erasmus. The Reformation won out, plunging Europe into 150 years of devastating religious wars, as the Spring-and-Autumn wars had devastated China.

Even before these wars culminated in the Thirty Years' War (1618–1648) and the English Civil War (1642–1651), the tragic/new world story texts would begin appearing in Shakespeare's major political tragedies, *Hamlet*, *King Lear,* and *Macbeth*, in the first few years of the seventeenth century. There, he demonstrates the inadequacy of the medieval model of monarchy, with its dependence on family lineages and the relationship between the king and his knights. As with the Greek tragedians' criticism of Homeric ideals, Shakespeare points us to Reiss' (1980) moment of rupture when a new way of governing a more complex world must emerge. By the end of the religious wars, the new world story was also emerging.

That story had roots in a growing tradition of scientific rationalism. Francis Bacon (1561–1626), for example, called for an experimental science whose priest-like devotees would 'discover the hidden powers by which nature moves in order to gain mastery over it' (Gillespie 2008: 39). In addition, Kepler, Copernicus and Galileo conceived of 'the machine of the universe ... similar to a clock', to use Kepler's words (quoted in Dolnick 2011: 182), and written in the language of mathematics. The explorations of this mechanistic worldview turned on the issue of how best to apply scientific realism to govern a world weary of war's chaos.

For René Descartes (1596–1650), science was the rational search for the Truth that would 'discover the ground for a radical transformation of European society' (Gillespie 2008: 177). Such a science of *certainty* was possible for two reasons. First, the human being alone was a thinking being with the godlike ability to remake the world. Second, science can be true because mathematics, as the language of the universe, is true, and, Descartes believed, God is not a deceiver. A different version of this rational world story came from Thomas Hobbes (1588–1679), for whom science was not so much the search for the truth, but for knowl-

edge of how things worked. Because God was omnipotent – and thus capable of deceiving human beings – science must study the dynamics by which God willed motion to occur. Human beings can never know the truth of these dynamics, only that an explanation works, enabling them to manipulate a segment of the world (*Ibid.*).

Descartes' version, with its emphasis on the ability of science to achieve certainty, would become the central statement of the modern era's world story for the next 300 years. Its emphasis on mathematics, in particular, allowed those enacting the story to dismiss the messiness of life, especially after the century and a half of religious wars, as deviation. Only mathematics, the language in which God revealed His Book of Nature, was real. Such a science would fulfill the growing belief in progress, 'leading toward ever greater perfection of human nature' (Nisbet 1970: 5). The story would be enacted and further articulated in Robert Boyle's experiments in physics, William Harvey's description of the circulation of blood, Isaac Newton's mechanical physics and calculus. In many ways, Descartes and Newton were Modernity's Plato and Aristotle, the two thinkers who finally crystallized the theory and practice of their world story.

Meanwhile, Europe's grail quest knights were exploring the world – first the Spanish and Portuguese, then the Dutch, English and French – trying to do God's work of bringing salvation to the heathens and, incidentally, profits back home. They looted the gold and silver of the Americas, buying themselves ever more tightly into the world economic system and whetting their taste for the fine products of the East (Frank 1998).

The commentary on the new world story would emerge over the next 250 years, exploring how best to apply it. Among the key issues were the transformation of worship and belief from a shared part of the common world story to a private matter (Nongbri 2013) and the intensified application of Modernity's great social experiments – nationalism, the nation state and capitalism – throughout the Enlightenment. Among the mutations of the world story that would contribute to this process are:

- Baruch Spinoza's (1632–1677) 'obscene', 'profane', and 'blasphemous' (Nadler 2011: 2–3) interpretation of the Bible, his identification of God with Nature, and his insistence that democracy and freedom of expression would enhance the power and stability of the state;
- John Locke's (1632–1704) social contract with which people form government to protect their interests (Pagden 2013), key for the democratic nation-state; and

- Adam Smith's (1723–1790) 'invisible hand', which created a quasi-religious free-market philosophy to replace Christianity's omnipotent God (Israel 2011).

Throughout this period, people would enact this evolving world story, introducing social mutations ranging from a host of scientific discoveries and technologies to more effective industrial organizations, better weapons to more efficient military structures, as well as the imperialistic successes they enabled. As long as society seemed to exhibit the Enlightenment ideal of progress, the rationality so critical to its worldview seemed to promise the perfection of man envisioned by Descartes (*Ibid.*). However, when French finances began to fail and the monarchy could no longer meet its responsibilities to the people (Goldstone 1991), a wave of destabilization, articulated by *philosophers*, such as Diderot and D'Alembert, in France, and Priestly in England, began to create a 'widespread consciousness in influential circles of the need to abolish privilege and rank' (Israel 2011: 229), as well as a conservative reaction. When the French monarchy failed, however, the result was not government by the ideals of Enlightenment rationality, but a devastating destabilization in an explosion of full-flowered nationalism and revenge, leading to two decades of war, evoking the same emotions religion had during the religious wars.

After Napoleon was finally exiled in 1815, Europe continued following its ideal of progress, with further commentary on the world story and enactment of it. The Industrial Revolution and its critics, from Charles Dickens' novels to Karl Marx's economics, drove the evolution of the new world story into new areas of the adjacent possible. And Bacon's 'priests' of science would continue to destabilize the world story as they enacted it. The geological theories of Charles Lyell and evolutionary theory of Charles Darwin set the stage for driving God out of the modern world story, exciting the same reaction as Spinoza had. More and more, the modern world story was appearing increasingly unstable.

Then, in the twentieth century, it began to collapse. First, scientists, practicing the Newtonian methodology they had learned, discovered that their worldview was, if not wrong, then, at least, askew. Albert Einstein's theories of relativity showed the dead matter of Newtonian physics to be structures of transformed energy. Then quantum mechanics demonstrated that Newtonian distinct 'things' were intimately interconnected, and its determinism open to chance and contingency (Smolin 2013). Second, after three generations of peace in Europe, at a point where Enlightenment progress appeared to be pointing toward human perfection, two world wars erupted, with levels of devastation proving

that rationality could not be the cornerstone of human nature Descartes and those who followed him had believed (*e.g.*, Berman 1992).

In addition, since World War II, the modern confidence in the value of education, free trade, and human equality has destabilized the political order by which Western Europe had dominated the world for more than two centuries. As people in formerly 'backward' nations have taken advantage of scientific education, they have entered into full partnership in a world economy where China is likely to become the leading power. As the Internet has accelerated the process of global interconnection, the nations of the world are becoming increasingly interdependent in trade, financial dealings, and resource allocation, as well as their attempts to control the dangers posed by terrorism, environmental contamination and global warming (Sachs 2008). Here one of the most powerful experiments of the modern world story, national culture, has become one of the chief obstacles to solving all these problems (*e.g.*, Smith 1995). Because different national cultures, based on their unique histories, include different ways of thinking about the world, it has become increasingly common for people from those cultures to experience the world very differently (*e.g.*, Nisbett 2003). For example, Western and Chinese business people have different understandings of the concept of Law (Baskin 2009), leading to significant mutual antagonism over issues of intellectual property.

In order for our societies to adapt to all these changes, still another world story is emerging. Nobel Laureate in Physics Robert Laughlin (2005) calls its worldview 'emergent', David Boje and I (Boje and Baskin 2010) 'post-Newtonian', Smolin (2013) 'relational'. In this paper, I have used Smolin's relational, a term used similarly in Taylor (2007), because it implies that the 'things' we experience as distinct behave *both* as agents *and* as members of networks interconnected to other agents, in the moment and historically. Such a worldview, I believe, stands at the heart of Big History, and has also been incorporated in other social sciences – Latour's (2005) sociology of actor networks, for example, or the philosophy of Karen Barad (2007) as well as much of Michel Foucault's (1994) 'anthropology'. It is, after all, the relational interconnection of agents, often on many scales, in both space and time, that makes a relational conception of evolution so thick.

Conclusion

Despite the unavoidable oversimplification, I hope that I have demonstrated that the basic dynamics of the Axial Age and Modernity seem similar, from the social breakdown and political fragmentation through

the intense social, political and technological innovation, from the terror roused by periods of intense warfare through the evolution of new world stories. Clearly, the Axial Age and Modernity also have significant differences. The axial transformation occurred in four very different cultures, which remained only tenuously connected. On the other hand, the modern transformation began in one area and spread across a globe that became increasingly interconnected. Yet, both periods seem unmistakably to confront the need to adapt to a significantly higher level of social complexity.

I believe that further examination will show relational evolution can be valuable to the study of Big History. A relational perspective, after all, offers tools to explore how national cultures evolved as parts of their societies' world stories, under deep historical pressures. This analysis is essential because it is the world story that contains any culture's definition of identity – our group *vs.* the other. As Ed Hall (1976) points out, most people still believe that anyone who does not behave according to their own culture is a barbarian, uncouth at best and insane at worst. Yet, with all the problems the world faced that can only be solved by international cooperation, the human community needs to redefine this issue of identity. Such a redefinition has been part of past cultural phase transitions. During the Agrarian Revolution, group identity was expanded from membership in a small band to membership in a state. During the Axial Age, it was again from the state to the empire. Unfortunately, we humans seem to need to define the world as 'us' and 'other'. Yet, without an invasion from space, we have run out of others.

The alternative is, not to expand, but to thoroughly redefine what we mean by us and other. As Big History demonstrates, the human race comes from a single origin. The differences between us are a matter of adaptations to different circumstances, and the question becomes whether human beings can let go of the implication of enemy that has been built into the other. Can we see the other as someone like us, who merely found a different story? Without such a redefinition, it seems unlikely that people from different cultures can come together to discuss issues of mutual interest – from economic integration to nuclear proliferation and ecological degradation – without the distortions of cultural difference and enmity.

At first, this seems an impossible goal. When the United Nations cannot address the chaos in Syria, the European Union is increasingly troubled, and some of the most industrialized nations refuse to agree with treaties on global warming, the combination of power politics and cultural difference seems insuperable. Yet, who, living in a hunter-gatherer band 1,500 years ago could have imagined identifying as

a member of a city of 80,000, such as Ur in 2800 BCE (Modelski 2003: 28), or a nation of a billion, such as China and India today? We, human beings, are capable of learning to live and think very differently, especially when our survival depends upon it. For me, Big History has the potential to contribute to this effort of relearning what it means to be a human being in a fully globalized world, rather than one largely segregated by culture, as the world was even 500 years ago. And I invited the reader to consider the analysis in this essay, as sketchy and oversimplified as it is, as a set of tools in the further development of Big History.

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