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ARTICLE



## Cosmological and phenomenological transitions into how humans conceptualize and experience time

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### ABSTRACT

Cosmographies associated with Western cosmologies demonstrate transformations from classic wheels of time and chains of being to scales of nature, chronologies, and pedigrees. Pedigrees in turn are converted into linear timelines, bifurcating trees, and multidirectional networks. These diagrammatical transitions associate with changes in how time is conceptualized – as circular, linear, multilinear, multidirectional, and perhaps as non-existent. This paper focuses on delineating the phenomenologies associated with worldview turnovers. By identifying group-level dynamics, it demonstrates that time phenomenology extends individuals, and it demonstrates that paradigmatic shifts are driven by new observations, new jargon, and the invention of new quantitative methodologies and modelling techniques.

### ARTICLE HISTORY

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### KEYWORDS

Cycles; *scala naturae*; chronologies; timelines; networks

### Introduction: cosmological transitions on time evaluated by shifting cosmographies

This article elaborates on previous work (Gontier 2016), which demonstrated that Western cosmologies change in association with advances made in mathematics and with means to conceptualize and to represent causal relationships. These transitions can be studied by analysing shifts in how matter, space, and time is depicted differentially in cosmographies. Transitions include the shift from wheels or cycles of time and chains of beings to *scala naturae* that correlate with the transition from ancient to Judeo-Christian cosmologies; and the subsequent elaboration of the scales by early natural history scholars that eventually transform them into chronologies while continuing the use of pedigrees. The latter, in turn, have been converted into timelines, trees, and networks by contemporary scientists (Table 1).

Here we focus on how Western cosmologies conceptualize time and how this in turn induces differential phenomenologies, understood as feelings and awareness of time, at both an individual and a group level (the last row of Table 1).



**Table 1.** Transitions in Western cosmologies, as measured by their cosmographies.

<b>Cosmology</b>	<b>Late Neolithic to Ancient Greeks</b>	<b>Romans to Judeo-Christians</b>	<b>Classical physics and natural history</b>	<b>Modern physics and evolutionary biology</b>
<b>Cosmographies</b>	Wheels of time	<i>Scala Naturae</i>	Phylogenetic trees	Vector spaces and graphs
<b>Time depictions</b>	Chains of beings	Chronologies and pedigrees	Timelines	Networks
<b>Time directionality</b>	Strings	Stairs, ladders	Straight line	Multidirectional or non-existent
	Circular	Linear	Multilinear	
<b>Time concepts</b>	(Once created) eternal true vs relative time	Eternity vs cosmogonic and eschatological, numerical time	Absolute (mathematical) vs relative time	Spacetime vs geo-, chronobio-, phenomenological vs numerical time
<b>Causality</b>	Cyclical teleology	Divine, non-uniform teleology	Non-uniform and uniform teleology	Statistical probabilities and uncertainties
<b>Mathematics and geometry</b>	Sexagesimal number system and geometry (element thinking and trigonometry)	Numberless (timeless)	Decimal number system	Probability theory, graph theory
<b>Phenomenology</b>	<i>Eternal returns, reincarnation, predictability, determinism</i>	<i>Calendrical and numerical time (set in the Roman and decimal number system)</i>	Calculus and analytic non-Euclidian (coordinate) geometry	Uncertainty, indeterminism, contingency, free will
	<i>Providence, conceding to destiny, inevitability, having faith</i>	<i>Division into past, present, and future, uniqueness of events, counting down</i>	<i>Physical and biological determinism</i>	

Expanded from Gontier (2016). Italics denotes the point of focus of this article.

## Cyclic time and the ‘eternal return’

Western cosmologies have intellectual roots in more ancient cosmologies that were developed by Egyptian, Sumerian and Akkadian, Indo-Iranian, and Vedic (Indo-Arian) populations living in the Levant, Mesopotamia, and Eurasia. These populations share common genetic and linguistic histories (Cavalli-Sforza 2000). And they all developed major cities made possible through the invention of farming, in turn facilitated by predictive knowledge of the yearly returning seasons as well as the invention of calendrical systems.

It is in this context that humans developed circular time notions that are depicted in *wheels of time* (Figure 1(a)), *chains of beings* (Figure 2(a)), and *cycles*. Examples include studies on the zodiac (that literally translates as a chain or belt of animals) and planetary motions around a geocentric earth (e.g. Plato 1960), religious ideas on reincarnation (found in Jainism, Hinduism, Buddhism, and Sikhism), or philosophical ideas on the existence of returning cycles of coming and becoming (e.g. Aristotle), or mutual generation and overcoming (e.g. the Chinese *Wu Xing*, Figure 1(b)).

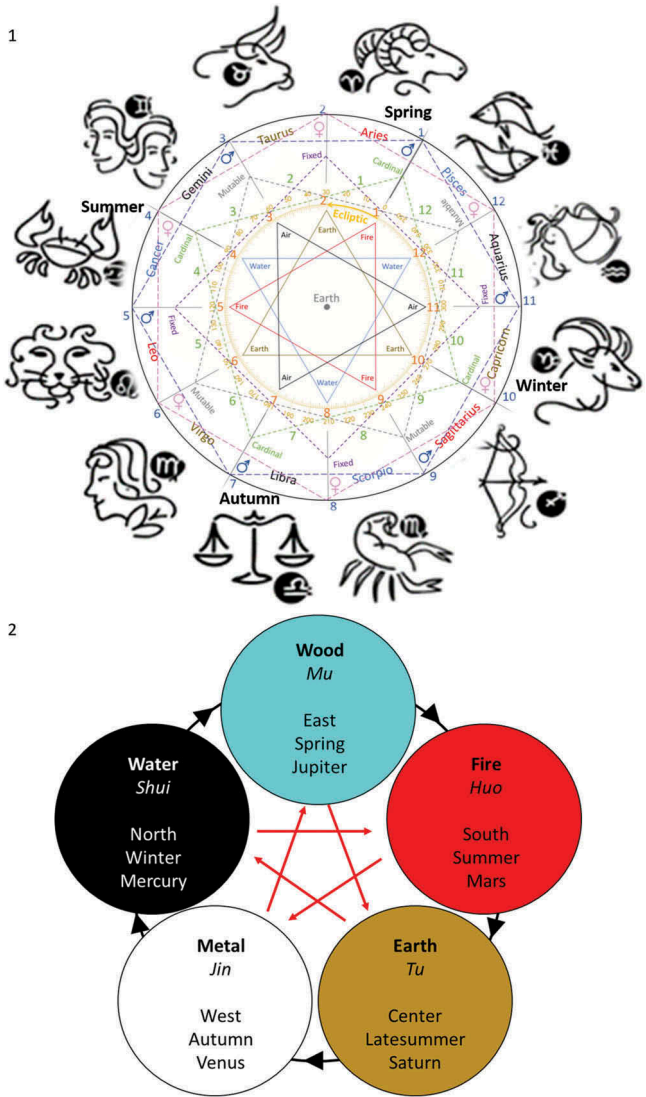
Phenomenologically, cyclic time generates ideas of an ‘Eternal Return’ (Eliade 1954) of the great year, the seasons, the months, the days and hours, and even of people. It engenders beliefs of predictability and complete determinism that annihilates historical uniqueness, individuality, human creativity, or control. Social and cultural practices instead focus on cyclic commemorations that re-enact the first cycle from which all meaning becomes derived, and beliefs in destiny rule, as for example seen in the practice of formulating horoscopes where an individual’s life (cycles) is given by their birth chart.

## Scales of nature, chronologies, timelines and linear time

Judeo-Christian scholars divide time into created time (understood as calendrical and numerical time) and timeless eternity, while natural history scholars understand time as a linear succession of matter in motion that constitutes events. They distinguish calendrical time from absolute, mathematical, and thus numerical time.

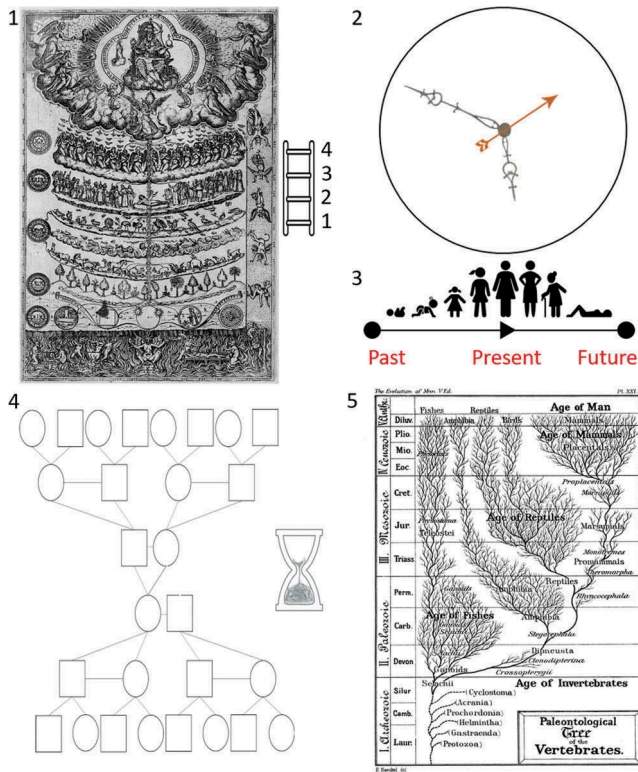
### *Timeless scales of nature*

Judeo-Christian scholars transformed the Aristotelian chain of being into *scala naturae* (Figure 2(a)), which can be read as ‘ladders’ or ‘stairways to heaven’. Assuming to represent the true, fixed, and divine order in the world, these scales originally lack any reference to time. At most, they demonstrate an assumed directional gradient going from less to more perfect beings as measured by how close or how far these creatures find themselves from the Judeo-Christian deity.



**Figure 1.** Examples of cycles of time.

(a) The tropical zodiac or *chain* of animals as set in a 360° circle that indicates the use of a sexagesimal number system and (sacred) geometry and trigonometry. The circle represents different means to calculate *relative* times, including the sun's hypothesized 360-day long yearly cycle through the 12 signs/months of the zodiac, with one degree representing one day. The zodiac begins with point zero of Aries that used to align with the spring equinox, and from which the autumn equinox and solstices, and thus the seasons could be inferred. Due to the phenomenon of precession, the equinoxes shift over time, resulting in spring currently occurring in the sign or Age of Pisces and in the future occurring in the Age of Aquarius. The return to the original starting position associates with the Platonic Great Year and what Plato called *true* time. In addition, the zodiac provides a means to track planetary motions through its 12 houses and to measure the angles between planets as they circle around a geocentric earth, from which meaning is derived in the form of horoscopes. Finally, signs are attributed two alternating genders that form hexagons (2 × 6), the signs are also divided into fixed, mutable, and cardinal signs resulting in three squares (3 × 4), and the division of signs into the four Western elements leads to four triangles (4 × 3). These diagrams hint at the origin of the tropical zodiac in more ancient cosmologies including Babylonian, Vedic, Egyptian, and Far Eastern philosophies. Especially in the Chinese and Japanese zodiac, for example, the signs also represent 2 hours (made up of four quarters, each lasting 30 minutes) of the day in a 12-hour-long system (e.g. the hour of the snake, which lasts from 9:00 to 11:00 am), while in the West, a 24-hour day is divided into 2 × 12 hours, with each hour made up of 60 minutes and each minute composed of 60 seconds. (b) The Chinese Wu Xing that associates with element thinking, planetary motions, the cardinals, and the Chinese five seasons. Black lines represent the cycle of mutual generation, red lines the cycle of mutual overcoming.



**Figure 2.** Examples of linear time.

(a) Diego Valadés' (1579) religious interpretation of Aristotle's Chain of Being as depicted in the *Rhetorica Christiana*. Image obtained from Wikipedia and distributed under a Creative Commons licence ([https://en.wikipedia.org/wiki/Great\\_chain\\_of\\_being#/media/File:Great\\_Chain\\_of\\_Being\\_2.png](https://en.wikipedia.org/wiki/Great_chain_of_being#/media/File:Great_Chain_of_Being_2.png)). From bottom to top, Aristotle's chain becomes interpreted as a linear ladder or stairway to heaven that runs through hierarchical strands or stages of perfection. Following Aristotle's distinction between inanimate matter and animate matter that he in turn divides into beings with a vegetative, sensitive, or intellectual soul, the scale goes from the inanimate elements to plants, land animals, birds, and beings with an intellectual soul (i.e. humans and saints). The Christian God is depicted above the chain and is conceptualized as standing outside 'Creation', making him the only being that stands outside matter, space, and time. On the right, fallen angels are on their way to hell that is roamed by the devil, the most imperfect being. (b) The replacement of cyclic and returning time(s), traditionally depicted by the 360° circle, by time's arrow that emphasizes the uniqueness of events and the directionality of time. (c) The division of time into a unique past, present, and future characterized by equally unique and singular events such as birth, coming of age, and death. (d) A hypothetical pedigree demonstrating family history, with squares representing males and circles females. Tracing one's ancestry into pedigrees brings forth hourglass-like shapes. (e) Haeckel's paleontological tree of vertebrates depicts common descent with modification of fishes, reptiles, and mammals. The image depicts when major taxa first originate in the geological timescale that combines time with space because the scale is based upon geological strata that indicate deep time. Note that the geological timescale neither has uniform stages, nor is it set against a uniform number line (numerical time). Instead it refers to ages, periods, and epochs. (The image comes from the 1879 English translation of Haeckel's (1874) work and is made available under a Creative Commons license at [https://en.wikipedia.org/wiki/Timeline\\_of\\_human\\_evolution#/media/File:Age-of-Man-wiki.jpg](https://en.wikipedia.org/wiki/Timeline_of_human_evolution#/media/File:Age-of-Man-wiki.jpg)).

In matters of faith in divine will, assumptions on predestination, and metaphysical or earth-transcending order, finding one's place inside temporal earthly life is not of the essence. At most, temporal life becomes conceptualized as a time of waiting – for a 'New Age' and a new 'Messiah', for example, in Jewish traditions; or

for the 'resurrection of the dead' and the 'reunion of the body and soul'; or, as particularly argued by the Christian churches, for a possible integration into 'heaven' where believers will be (re-)united with their loved ones and their deity and where they will be given 'eternal afterlife'. Scales provide a practical means for contemplation on how to transcend earthly life by following Platonic asceticism and climbing the ladder by making use of one's intellectual soul.

### *Chronologies set in calendrical, non-uniform time*

The outlook of Judeo-Christian scholars is cosmogonic and eschatological: the cosmos results from a unique creation act that constitutes matter, space, and time, and all will end with a predicted apocalypse. This gives directionality or an *arrow to time* (Figure 2(b)). Phenomenologically, time associates with waiting, but also with fear for punishment and a life of virtue as a means to pass the forthcoming 'judgement day'. As can be read throughout the Tanakh and the Bible, one's days are numbered. To number the days, Judaic scholars continued to use a luni-solar calendar while Christians adopted a reformed solar-based Roman calendar that in turn was refined by the Julian and Gregorian calendar. Both religions divide time into a past, present, and end, and they attempted to predict 'the last hour' by calculating the *creation days* and the earth's *ages*.

Such practices also enable the tracking of one's personal life by dividing it into a single *past, present, and future* (Figure 2(c)). The old cycle(s) of life become straightened into a predictable linear chronology divided by unique historical events that mark rites of passage. The *stages* or *phases* of development and maturation provide a countdown to one's end, but also social and cultural rules and norms that define behavioural conduct adequate for one's *age*. The past, present, and future of an individual can also be traced in familial pedigrees (Figure 2(d)) that visually resemble an hourglass which brings forth ideas that 'one's time should not be wasted', for it 'flies by' and is 'spent' or 'wasted' 'easily'. Traditionally, such genealogies were introduced to trace ancestral histories and kinship relationships to demonstrate noble or other descent; but they were also applied to religious figures such as Jesus, whose descent was traced in Jesse trees (Gontier 2011). Also, on a societal and cultural level, calendrical time-keeping associates with record keeping of a person's individual actions as well as with planetary and earth history that becomes recorded into almanacs, chronicles, and natural chronologies.

Note that such timelines, although linear, are not uniform. The passage from a baby to a toddler stage to puberty, for example, differs in the number of years it takes to reach that stage. Calendrical time is also not uniform, for it consists of 365 days intermitted by a 366th day added every four years. Original chronologies and timescales do not follow a straight decimal number line; instead they mark unique events as they occur in natural history over calendrical time. The geological timescale (Figure 2(e)) breaks with that tradition, first by delineating the



geological strata as they appear in space, and later taking these strata to indicate 'deep time' that surpasses calendrical time calculations. The geological record is jumpy and bumpy or non-uniform because it follows catastrophes and bursts of new biodiversity as they present themselves in geological strata. The geological timescale derived from these strata also does not follow uniform years or uniform stages set at equal length or distance from one another. Instead, periods and epochs have different lengths or duration.

### *Unilineal timelines and uniform, numerical time*

Particularly philosophers and natural history scholars secularize the older *scala naturae* and Christian chronologies. Instead of looking for divine order that is rooted in metaphysics, they search for the natural and historical order whereby unique events succeed in time and whereby living beings originate and disappear, first in space and later in time, which they root in equally metaphysical assumptions on the existence of natural, invariant, and determining laws of nature. These historicist laws in early biological research are orthogenetic, and in early anthropological research, they are unilineal, assuming a straight-line trajectory *directed* toward 'progress' – from fish to reptiles to mammals, for example, or from hunter-gatherers to farmers to industrialized societies. Earth, cultural, linguistic, and societal history is broken up into phases or a series of scales or stages that follow one another sequentially, which leads to ideas on causal determinism that in turn leads to positivism, scientism, physicalism, cultural, biological, and genetic determinism.

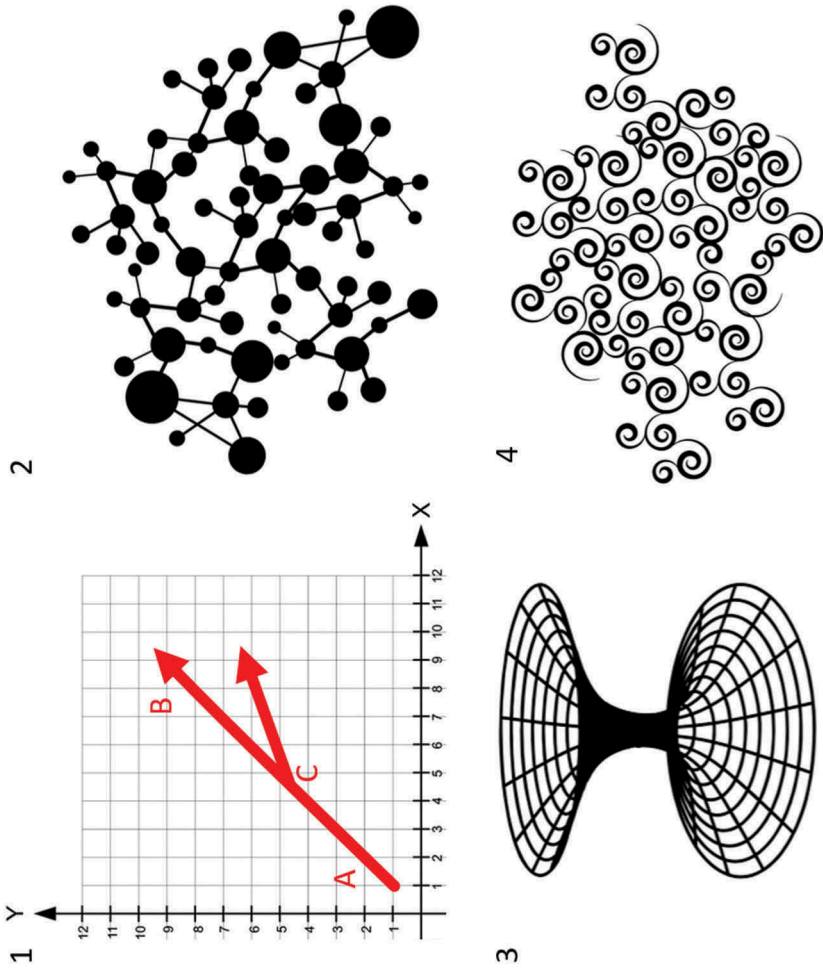
Phenomenologically, western modern man knows true and mathematical from relative, calendrical time, and past from future, and the scientific and moral systems he builds make him know right from wrong and truth from falsehood. He knows the 'natural' sequence and causal event chain whereby events unfold, the fundamental levels of causation, and not only can he predict the future, he already knows it is determined and directed. The use of the linear decimal number system eventually leads to linear timelines where numbers are set apart at an equal distance, leading to uniformitarian ideas (Lyell 1830-3). This 'homogenous ordering of points' (Heidegger 1915) on the one hand breaks the flow of time but on the other enables for its exact measurement.

## **Spacetime depicted by trees and networks**

### *Trees and two-dimensional spacetime*

Measurement over time and space eventually becomes combined into the Cartesian coordinate system where the items quantified are set apart on the *x* and *y* axis at an equal and uniform distance provided by the decimal number system (Figure 3(a)). Phylogenetic trees such as those provided by Haeckel (Figure 2(e)) understand the spatial appearance of fossils in geological strata as





**Figure 3.** Examples of multilinear and non-linear spacetime(s).

(a) The two-dimensional Cartesian coordinate system. The red arrows demonstrate two scenarios of species evolution (phylogenesis): anagenesis and cladogenesis. In the case of anagenesis, species A gradually evolves into species B. In cladogenesis, species C evolves from species A by splitting (called a speciation event). (b) A hypothetical undirected network where nodes (also called vertices, i.e. the points) are connected by edges (the lines). (c) A schematic representation of a wormhole linking separate points in spacetime. (d) A schematic interpretation of multiple and connected universes.

indicative of deep time, and the phylogenetic trees track how species diversify from one another in both space and time, or spacetime, by *anagenesis* (A transforming to B) and *cladogenesis* (C splitting off from A). The directionality of time remains linear but especially tree diagrams, which demonstrate the bifurcation and ramification of lineages through time, already demonstrate multilinearity. This questions the older ideas on 'directional progress' as defended adherents of unilinealism and orthogenesis that associates with linear timelines and phase-thinking, and it requires a more contextual interpretation as to why some species evolve and others go extinct.

### **Networks and multidimensional spacetime**

Tree structures set in Cartesian coordinate systems are currently being replaced by networks made possible by the development of graph theory in mathematics. Most networks lack any reference to time as measured by a number line – at most, the length of edges and the distance between nodes are indicative of time. As argued in previous work (Gontier 2016), such networks (Figure 3(b)) enable a true modelling of the multidirectional interactions between entities in what can be understood as 'spacetime'. Rather than model the past or natural history, networks attempt to understand what, following Husserl (1964), can be called an 'extended present'.

The new evolutionary sciences are extending the scope of the modern synthesis by demonstrating the multidirectional nature of information exchange. And in the new physics, the discovery of gravitational waves or ripples in spacetime, and research on Einstein–Rosenberg bridges or wormholes (Figure 3(c)), are providing new means to conceptualize the interconnectedness of matter in this world, and possibly of multiple universes (Figure 3(d)).

Phenomenologically, these theories call out for interactionalism, contextualism, historical particularism, pluralism, pragmatism, in/underdetermination, and they engender ideas of free will and contingency (Gould 1989). Knowing that our essence is what we make of it during our existence (Sartre 1946) can be both liberating and depressing, because a single lifetime measured against the vastness of Ricœur's (1985) cosmological time, or perhaps multiple spacetimes, is rather insignificant. Nonetheless, our phenomenological perception of time that mimics our flow of consciousness, and that is both biologically and culturally determined, though sensed as real, might not even be true (McTaggart 1908).

### **Future prospects**

Studying time phenomenology requires acknowledgement of the following five aspects.

- (1) How time is conceptualized and experienced is partly *biologically determined*. Many species have a 'sense' of time, by evolving circadian rhythms, demonstrating seasonal behaviour and migration, and by ageing. Humans, in particular, have in addition evolved a phenomenological sense of time, which cognitively associates with their flow of consciousness.
- (2) The phenomenology of time is partly *culturally determined*. The various cultures that exist today have evolved different worldviews resulting in different definitions and experiences of time. This requires an understanding of time phenomenology as extending individual or idiosyncratic conceptions. How time is perceived results from group activities.
- (3) How we as cultural groups experience time is a historical *learning process* that correlates with the development of number systems, causality theories, and modelling techniques.
- (4) This historical and cultural learning process can be studied by investigating transitions in cosmographies.
- (5) These transitions provide insight into a more fundamental sequence of events whereby human knowledge evolves. Namely, any kind of knowledge acquisition follows a pattern of *identification* (observation and recognition of structures), (verbal, mental, and diagrammatic) *symbolization*, and *quantification* and modelling of the observed and symbolized. This sequence is far from trivial and provides a logical sequence whereby knowledge evolves over time. The sequence furthermore has heuristic potential for researchers, and it will help research to go beyond the study of material culture and to find the origin of cosmologies.

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## Declaration of interest

No potential conflict of interest was reported by the author.

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