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The Bible and Science: The Relationship between Science and Christianity

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Abstract

The relationship between the Bible and science has been debated for decades. Science has emerged as a multifaceted discipline focused on the natural world, viewed as a growing body of facts and a path to understanding. While the Bible has been considered authoritative, knowledge generated by science has been so reliable in different things, including attempts to prove Christian beliefs. Sceptical controversies persist over encroachment of one domain into the territory of another. The purpose of this paper was to examine the relationship between the Bible and Science based on ideas from scientists, philosophers, historians and theologians. The paper found the existence of a super intelligent designer as a common idea, with a confrontation on timeliness, creation story and divine action. While Christians appeal to factual statements when science, with its lack of moral judgment, cannot prove the Bible, the conclusion qualified the Bible as authoritative for faith and life.

Keywords: Bible and Science, Christianity and Science, Evolution and Creation, Archaeology and Biblical Timeline, Christians in Science.[‡]

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1. Introduction

The relationship between Christian religion and science is the continuing debate in philosophy and theology (Helen De Cruz, 2017). In the present age, there is a widely held discussion as to whether science conflicts with the Bible or whether they are in harmony (Francis, et al., 2018). This raises the question of whether science is the only source of truths since it can be tested in laboratories as scientists claim, or whether the Bible is the sole authority on all matters, as Christians believe. Besides the secular scientists, we often hear people say that science disproves the Bible's chronology, miracles, or creation story (Miller, 2020), and this confuses secular people who have yet to take a stand. It also challenges young believers and lay Christians who struggle to defend their faith with non-believers, as the Bible instructs (1 Peter 3:15).

Most notably, since the Enlightenment, the question of scientific theories such as evolution naturalism, positivism and theism, among others, seemed at odds with the biblical account of creation, but most scientists who introduced the theories eventually repented and maintain the biblical account (Ham & Mortenson, 2009 ; The Doc, 2021). However, their theory still affects people's perspectives on worldviews, especially of the origin of life. For example, some Christians today believe that they should match the Bible with current scientific theories of the time (Don Stewart, 2021), while others still struggle to get out of the confusion as to whether the evolutionary biology has refuted or not the Genesis (Morri, 1997; Ortberg, 2020; Biblica, 2021). While science and the Bible are most remarkably intertwined, it is important to find out whether one is at odds with the other or whether late science has disproved the Bible, especially with regard to the origin of life.

The main objective of this exploratory study is to uncover the relationship between science and the Christian religion. The paper’s specific objectives were [1] to demonstrate the extent to which science and Christianity are compatible and [2] to find out if either one view is conducive to another. To do this, the study was guided by two major questions: (1) to what extent are religion and science compatible? (2) are Christian beliefs conducive to science, or do they inevitably pose obstacles to scientific inquiry? The authors have explored the historical and contemporary interactions between theology and science to provide philosophical analysis on the key difference and similarities between science and Christian religion, in particular the conflicting scientific theories of naturalism, positivism and theism.

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Research methods

This study was exploratory with qualitative. It drew on secondary sources to develop a solid foundation for answering the above research questions. The researchers reviewed different relevant publications on Bible and science. The researchers also used several techniques to gather secondary data required, such as Bible scripture, Internet literature search, published materials, blogs and journals. These literatures provided secondary data that was analysed to better understand both the worldviews and truth behind literature.

2. What are Science and Religion

2.1. A brief history

The relationship between science and religion has been studied since the 1960s, often by scholars in the fields of history, science, philosophy and theology. Since then, religion and science have been fields of study recognized in various journals, recurrent conferences, learned societies and university chairs. Most of the authors were either philosophers interested in science or theologians, including the ordained clergy, or scientists interested in religions (Helen De Cruz, 2017).

Barbou (1966) and Torrance (1969) were among the first authors who conducted systemic studies of science and religion in the 1960s, to challenge the prevailing idea that science and Christianity were at either odd, or indifferent to each other. Barbour published presented several relevant and persistent themes, including a comparison of methodology and theory in the two fields. This led to the creation of the first scientific journal on science and religion, under the name Zygon. Authors from the late 1980s to the 2000s like Brooke (1991), unlike early studies, developed contextual approaches, including detailed historical examinations of the relationship between science and religion. Harrison (1998), who argued that Protestant theological conceptions of nature and humanity helped give birth to science in the 17th century, challenged this model of warfare between religion and science. Bowler (2001) drew attention to a large movement of liberal Christians and adaptive evolutionists of the 19th and 20th centuries who sought to reconcile evolutionary theory with religious belief.

The 1990s saw a series of five Conferences, co-sponsored by the Vatican Observatory and the Centre for Theology and Natural Sciences, aimed at understanding divine action in the light of contemporary science. The contributors were philosophers and theologians, and the resulting edited volumes were devoted to an area of the natural sciences and its interaction with religion. Themes focused respectively on quantum cosmology, chaos and

complexity, evolutionary and molecular biology, neurosciences and the person, and quantum mechanics (Russell, et al., 2008).

In today's public sphere, evolutionary theory and creationism / Intelligent Design has become the most important interaction between science and religion (Helen De Cruz, 2017). The battles and lobbies around the teaching of adaptive evolution and creation, especially in America (Masci, 2019), suggest a conflict between religion and science. However, the relationship between religion and science remains complex, even if one focuses on one or the other theory. For example, while in the United Kingdom popular writers, clergy and scientists sought to reconcile religion and science in the 19th and 20th centuries, Bowler (2001) uses the Scopes trial of 1925 to illustrate how the United States has seen the rise of fundamentalist opposition to evolutionary thought.

Over the past decades, we see the propitiatory statements of church leaders on the theory of adaptive evolution. For example, in his message to the Pontifical Academy of Sciences, Pope John Paul II (1996) asserted the theory of evolution, but rejected it for the human soul, which he thought was the result of a distinct and special creation. Likewise, one reads from Brown (2008) that the Church of England has apologized to Charles Darwin for the initial rejection of his evolutionary theory. Science and religion have been a reality in present day Christianity; however, the extent to which Christian beliefs are aligned with the results of science is still an age-old question.

2.2. The interaction between science and religion

There are different models that define the interaction of science and religion. According to (Stenmark, 2004), there are three distinct points of view: (1) the independent view which stems from the lack of overlap between the fields of religion and science; (2) the contact view which sees some overlaps between religion and science; and (3) a union of the realms of religion and science. While these views may have subdivisions, Stenmark defines contact in the form of either harmony or conflict. This makes Barbour's (2000) the most influential model of the relationship between science and religion because it offers four taxonomies: conflict, independence, dialogue and integration. The model has been adopted and amended by later authors, including Barbour himself, but later challenged by Cantor and Kenny (2004) who do not see the point of trying to understand the past interactions between the two domains because: *"it focuses on the cognitive content of religions at the expense of other aspects, such as rituals and social structures*." However, it was not so clear whether the "*conflict*" was defined as logical or evidential, so the model was not refined philosophically as some of its successors such as Stenmark (2004). Nonetheless, it is always useful to discuss this taxonomy in detail, due to its lasting influence.

The Conflict model

The conflict model asserts that religion and science are in principle and unending conflict. It heavily relies on the reception of Darwinism (Bowler, 2001) and the trial of Galileo (Dawes, 2016), which are two main historical accounts. Its development in the 19th century followed two popular publications by Draper (1874) and White (1896), which hold that religion and science are in inevitable conflict because they deal essentially with the same field. The conflict model has been criticized by various science and religious writers on the basis of a cursory and adherence to historical records. Ironically, extreme biblical literalism and scientific materialism have little in common, as they both assume a pattern of conflict: both if religion is right, science is wrong, or vice versa.

Although the model of conflict between religion and science is currently in the minority, recent authors, like Philipse (2012), have argued for this model through philosophical argumentation or by re-examining historical evidence, like the Galileo trial (Dawes, 2016). Plantinga (2011) argued that the conflict is between naturalism and science rather than between religion and science.

The Independence model

The model of independence holds that religion and science explore distinct fields, which pose distinct questions. The most influential model under this view has been the one of Gould (1989), developed under his NOMA principle (Non-Overlapping Magisteria). He affirms the absence of conflict between the two fields of religion and science because their respective domains of professional expertise do not overlap.

According to Gould (1989), the areas of expertise of science are empirical questions about the constitution of the universe, while the areas of expertise of religion are ethical values and spiritual meaning. He therefore argues that scientists should never pretend to ideas on moral issues, just as religious leaders should not make factual statements on, say, evolutionary theory. Gould's model predicts interactions at the boundaries of each magisterium, such as our responsibility to other creatures. According to Worrall (2004), an obvious problem with the independence model is that it would be difficult to justify claims of value and ethics, if religion were prohibited from making a statement of fact. For example, we cannot claim that we must love our neighbour because it pleases the creator. Yet, religions seem to make empirical claims, for example, that the early Hebrews crossed the separated waters of the Red Sea.

The Dialogue Model

Thirdly, the dialogue model proposes a mutualistic relationship between science and religion. Contrary to the two previous models, this model asserts common ground between science and religion, perhaps in their concepts, presuppositions and methods. For instance, the biblical doctrine of creation may have encouraged science by assuming that creation is both orderly and intelligible, so it can be expected that pertinent laws could be discovered (Helen De Cruz, 2017). Creation, as a product of God's actions, is also contingent, so that the laws of nature cannot be learned by thought a priori, which arouses the need for empirical investigation.

According to Barbour (2000), theological and scientific investigations depend either on a theory and rely on models, metaphors and value consistency, comprehensiveness and fruitfulness. For example, he understands that the doctrine of the Trinity depicts the way Christians interpret the early chapters of Genesis. Therefore, his argument is that in the dialogue model, religion and science use common methods, concepts, and presuppositions to speak to each other, even though they remain separate. Likewise, Van Huyssteen (1998) argues that the epistemological overlaps of science and religion makes them a graceful duet.

The Integration model

Lastly, a more extensive model in unifying religion and science is the integration model. Barbour (2000) distinguishes three main forms, which are the natural theology, the theology of nature and the philosophy of processes. Through natural theology, man uses the results of the natural science as premises, to formulate arguments about the existence and attributes of God. An example, which is present in the contemporary cosmological arguments for the existence of God, is the assumption that the universe has a temporal origin. The central contemporary arguments use the fact that cosmological constants and the laws of nature allow life, while many other combinations of constants and laws would not allow life. The theology of nature, for its part, examines how to enrich or even revise scientific discoveries, from the religious framework. This is, for example, evidenced in McGrath's theology (2016) which examines how nature and scientific discoveries can be viewed from a Christian perspective. Lastly, according to Barbour (2000) the Process Philosophy is a promising way to integrate science and religion.

However, it is difficult to do justice to both the religious and scientific aspects of a given field, especially given their complexity, even if the integration seems good to theologians. For example, Teilhard de Chardin (1971) who specialized in both paleoanthropology and theology, proposed an unorthodox theology with an unconventional interpretation of original sin and an unconventional view of evolution as teleological, which respectively put him in

difficulty with the Roman Catholic Church and put him in trouble with the scientific establishment. Although theological heterodoxy being undoubtedly a model, it points to difficulties for integrative model to be successful in the larger community of philosophers and theologians. Further, the integration appears biased towards theism, as arguments were described based on scientific findings that support theism, but Barbour failed to use the scientific findings to discuss arguments that support the denial of theism.

3. Contemporary connections between science and religion

A wide range of subjects are encompassed in current development in the fields of religion and science, such as human nature, ethics and conscience. Contemporary natural theologians, like Collins (2009), discuss the optimization of the interpretation of multiverse cosmology and the meaning of the Big Bang, especially on the underlying design arguments. For example, the idea that God actualized the best of all possible multiverses was recently explored by Hudson (2013), examining two broad areas of the contemporary debate: divine action and human origins.

3.1. Divine action and creation

Before scientists developed their vision of cosmology and the origin of the world, Western cultures had already developed the doctrine of creation based on the biblical account and the writings of the church Fathers (Helen De Cruz, 2017). This doctrine of creation has four main interrelated features: (1) creatio ex nihilo, that is, God created the universe from nothing. In other words, God did not need pre-existing materials to make the world. This is opposed to the Demiurge philosophy that God created the world from chaotic or pre-existing materials. (2) God is distinct from the world, i.e., the world is neither equal nor part of God or any emanation of the being of God. The idea presents the asymmetry between God and the creature: the world radically depends on God while God doesn't depend on the creatures (Jaeger, 2012). (3) Creation is essentially good (repeatedly affirmed in Gen 1). Although the world contains evil, God does not directly make this evil exist. Furthermore, God plays an active role in creation using special divine actions such as miracles and revelations to care for the creatures. (4) God has made arrangements for the end of the world and will create a new heaven and a new earth, thereby eliminating evil.

The views of diving actions are firmly related to the doctrine of creation, but theologians often distinguish between general and special divine actions,

although no accepted definition of the two concepts exists in science, theology or religion. Wildman (2008, p40) distinguishes them viewing general divine action as the creation and sustenance of reality, while special divine action is made up of collections of specific providential acts, often at particular places and times, such as revelations to prophets and miracles. However, since some phenomena are difficult to classify as general or special divine action, the distinction is not always clear. A related distinction made by Alston (1989) shows that direct acts are performed without the use of natural causes, while indirect acts are performed by natural causes. The later classification gives four possible types of Divine actions: (1) God could not act in the world at all, (2) God could only act directly, (3) God could act only indirectly, or (4) God could act both directly and indirectly.

The two central questions arising from scientific and religious literature, concerning creation and divine action, are: (1) How compatible are Christian creation doctrine and traditional views of divine action with science? (2) How can these concepts be understood in a scientific context, for example, what does it mean for God to create and act? Even if some scientific theories, like the Big Bang theory of Georges Lemaître (1927), seem close to the creation doctrine, it is of the utmost importance to note that the creation doctrine says nothing about the mode of creation or the age of the Earth. The possibility for a wide range of views within science and religion if offered, but the Young Earth creationism only conforms to the Scriptures. Although the interpretation that the universe has a temporal beginning has been opposed by philosophers like Pitts (2008), the Big Bang theory specifies that the universe originated from an extremely hot and dense state about 13.8 billion years ago (Craig, 2003); hence an apparent support for creation ex nihilo.

Since the 17th century, scientific discoveries have come to the net results that God has been pushed further and further to the margins. There are two ways in which this intrusion of science into the territory of religion has occurred: (1) Scientific discoveries - particularly in evolutionary theory and geology - have challenged and replaced biblical accounts of creation. Although the creation doctrine does not reflect on how and when the creation was done, the Bible has been considered authoritative. (2) The concept of scientific laws that emerged in 17^{th} and 18^{th} century physics seemed to leave no room for special divine action. These two challenges, scientific discoveries and the concept of scientific laws will be discussed below, along with the solutions proposed in contemporary religious and scientific literature.

The Bible has traditionally been the source of historical information for Christian authors. The exegesis of the biblical creation stories, in particular Gen 1-2 and a few passages scattered throughout the Scriptures such as in Job, remains strewn with pitfalls. The question is whether these texts should be interpreted in a poetic, metaphorical or historical way and, as Harris (2013)

points out, what we should do because the order of creation differs between these stories. James Ussher (1581–1656), an Anglican bishop used the Bible to do a literalistic interpretation of the biblical creation narratives and dated the beginning of creation to 4004 BCE (cited in Helen De Cruz, 2017). Although this literal interpretation has not been unfamiliar and is still used by today's Young Earth creationists; early theologians like Augustine (416 [2002]), had given an alternative: *the non-literalist readings of the biblical materials*. Since the 17th century, geology has given pressure to the creation doctrine with findings suggesting that the Earth was significantly older than 4004 BCE. Beginning in the 18th century, the transmutationist (the current evolutionary theory) was proposed by natural philosophers, such as seems incompatible with scriptural interpretations of the particular creation of species. As Bowler (2009) puts it, Darwin's Origin of Species (1859) initiated ongoing discussions of how to reinterpret the creation doctrine in accordance with the theory of evolution.

The spectrum of divine action of Peters & Hewlett (2003) presents two dimensions: (1) the form of causal explanations, which relate divine action to natural processes and (2) the degree of divine action in the natural world. At one extreme are creationists who, like other theists, believe in God's creation and its fundamental laws. They also believe that God sometimes performs miracles (special divine actions) that intervene in the fabric of laws. They totally deny any role of natural selection in the origin of species. In creationism, there are Old Earth creationists who accept geology and reject evolutionary biology, and the Young Earth creationists who reject both. The next creationism as described by Dembski (1998) is the intellect design creationists, who see a conception of the intellect in the irreducible complexity of organisms to infer the design and purpose. Although they do not call their intelligent designer God for political reasons, with the intension of bypassing the constitutional separation of church and state (Forrest & Gross, 2004); they completely deny the role of natural selection in the formation of organic complexity. They also assert an interventionist account of divine action.

Theistic evolutionists take a hands-off approach to divine action. They believe that God creates indirectly through the laws of nature, including natural selection. An example is theologian John Haught (2000) who views divine providence as "*self-giving love, and natural selection and other natural processes as manifestations of this love, as they foster autonomy and independence*". According to Deane-Drummond (2009), theistic evolutionists accept special divine action, especially the Incarnation in Christ. On the other hand, deists like Corey (1994) claim that God established the laws of nature, which is the only general divine action, and let it run like clockwork without further interference.

These views of divine action have also been influenced by developments in physics where natural philosophers have implemented mechanistic views of the

world governed by seemingly unchanging and stable ordered and law-like processes. These make it difficult to understand special divine action, leading to the question of how God could act in a world determined by laws (Pannenberg 2002). A worthy way of looking at divine action remains to see it as actions, which, in a certain way, ignore the laws of nature. Here is the definition given by Hume (1748: p181): "*a transgression of a law of nature by a particular volition of the deity, or by the interposal of some invisible agent" and by Swinburne (1968: p320): "a violation of a law of Nature by a god*".

This concept of divine action is generally seen as interventionist, making the world an occasional determinist. However, non-interventionist forms of divine action are needed in order for God to act without having to suspend or ignore the laws of nature (Murphy, 1995).

Debates about how nature works in terms of elegant physical laws reached their peak in the 17th and early 18th centuries with the suggestion of the ingenuity of a divine designer (McGrath, 2016). Another conclusion suggested by the new law-based physics was that the universe was able to function smoothly without the need for an intervening God. This continued deterministic understanding of the universe that leaves no room for special divine action was rejected by Newton: "*the planets' motions could be explained by laws of gravity, but the positions of their orbits, and the positions of the stars—far enough apart so as not to influence each other gravitationally—required a divine explanation"* (Schliesser, 2012). Unlike authors like Polkinghorne (1998), Alston (1989) argued that pre-20th century mechanistic physics is compatible with divine action and divine free will.

Twentieth-century developments in physics, such as chaos theory, quantum theory, and theories of general and special relativity, overturned the mechanical view of creation. In the second half of the 20th century, the chaos theory and quantum physics became the possible avenues for reinterpreting divine action. Chaos theory was used to present both the "*epistemological limits*" of what we can know about the world and provide an "*ontological openness*" in which God can operate without violating the laws of nature (Polkinghorne, 1998). The only difficulty presented by this model was the fact that it goes from our knowledge to assumptions about how the world is. It is unclear here whether the results of chaos theory are indeterminate or if we, limited humans, cannot predict them. A non-interventionist model proposed by Russell (2006) illustrates that God acts in quantum events, in order to act directly without having to break the laws of nature. This way, God is not reduced to a natural cause, as there are no effective natural causes at the quantum level. A similar ascending model developed by Murphy (1995) shows that God acts in the space provided by quantum indeterminacy. Strong criticism has been made of these attempts to situate God's actions within chaos theory or quantum mechanisms that Jaeger (2012) has called "physicalism plus God", but eventually, it was not even clear whether

quantum theory could allow free human action and let alone the unknown divine action (Jaeger, 2012a). Moreover, the Thomist philosophy of William Carroll (2008), suggested that his predecessors, such as Murphy, made a category error: "*God is not a cause in way creatures are causes, competing with natural causes, and God does not need indeterminacy in order to act in the world. Rather, as primary cause God supports and grounds secondary causes*." The idea came about consistent with determinism, but blurring the distinction between general and special divine actions! Moreover, Sollereder (2015), based on the theory of the incarnation, suggested that God at least sometimes acts as a natural cause, so the idea that God is a cause among natural causes is not a foreign idea in theology.

Since chance and stochasticity are important features of evolutionary theory, questions have been raised about the extent to which chance is an authentic feature of creation, and whether divine action can be linked to chance. Gould (1989) imagined, in a famous thought experiment, a situation where one rewinds the tape of one's life 508 million years ago (the time of the Burgess Shale) to ultimately argue that the chance that he ends up with something like current life forms is infinitely little. On the other hand, Simon (2003) understands that species very similar to those we know today, including intelligent human-like species, would evolve under a wide range of conditions. Under a theistic interpretation, one conclusion according was that randomness could be either an authentic characteristic or a merely apparent aspect of creation. For example, Plantinga (2011) is so keen that: "*Randomness is a physicalist interpretation of the evidence. God may have guided every mutation along the evolutionary process*". This means that the evolutionary history could have been guided by God, by causing the right mutations to appear at the right time and preserving the life forms that lead to the results He intends. Contrary to this view, other authors believe that stochasticity is the true hallmark of design rather than a physicalist gloss. However, these writers take up the challenge of explaining the providence of God in terms of genuine randomness. Rather than deists who claim that God started the universe and did not interfere with its unfolding, the theists who constitute most scientific and religious writers are not open to this option. Johnson (1996) afirms that the compatibility of divine providence and genuine randomness:

> God gives creatures true causal powers, thus making creation more excellent than if they lacked such powers, and random occurrences are also secondary causes; chance is a form of divine creativity that creates novelty, variety, and freedom.

From this point of view, one implication is that if God does not have a providential plan for possible outcomes, then He becomes a risk taker. This is

what Johnson (1996) underlines, that leaving the creator in a position of control brings Him a risk. So, why would God take risks? The answers include the theory of theodicy, which says that creation that exhibits stochasticity can be truly free and autonomous. Miller (2020) argues that genuine love requires not manipulation but freedom. He understands that such freedom is best assured not by the chains of divine direction attached to every living creature but by the open contingency of evolution. Further, Southgate (2008) holds that a combination of chance and law is the only way God can accomplish His creative plans, but not just the best way mentioned in the "*one theodicy*".

3.2. Human origins

The creation stories of Christianity date back to the first book of Genesis, in the Hebrew Scriptures, which states that humans are the result of a special act of creation. The creation account detailed in Genesis 1 shows that God created in six days and humans were created last on the sixth day. God created a man and a woman and they were created in God's own image. However, a different order of creation is provided in Genesis 2, which shows that humans were created earlier before animals, and only a male was initially created and later God fashioned a female from the rib of the male. Regardless, it is well known that these first hand-made humans are considered the ancestors of all living humans today. These views are reflected in Ussher's Chronology; and Western culture maintained them until the 18^{th} century that, in an act of special creation, humans were created only 6000 years ago.

Humans occupy a privileged place in these creation stories, in particular because humans were created in the image of God. As Cortez (2010) puts it, image-bearing can be explained in atleast three ways. (1) humans are in the image of God by virtue of what they do, such as having dominion over nature (the functionalist account); (2) the possession of unique characteristics such as reason (the structuralist account)e; or (3) a special relationship between God and mankind according to the relational interpretation.

Another special place is given to humans in creation following the Fall as illustrated in Genesis 3. This account of the Fall attributes a state of innocence and perfection to the first couple of humans living in the Garden of Eden, but they fell from that state since the ate of the forbidden fruit of the Tree of Good and Evil. As a result, humans were kicked out of the garden and curses were introduced, including death, manual labour, and pain during childbirth. The effects on the first human sin, known as original sin, are passed on to all humans in a such way that all humans today tend to sin. According to Augustinian's interpretation of the original sin, it also affected our reasoning capabilities such that our original reasoning abilities and perception became impaired, due to sin. In the current analytical philosophy of religion is influenced by this

interpretation. An example is Plantinga's (2000) Aquinas/Calvin model that sought to explain disbelief and religious diversity by appealing to the noetic effects of sin.

Irenaeus believed that Adam and Eve before the Fall were innocent as still developing children, while Augustine attributes them a state of perfection in the prelapsarian state. Either way, Augustine and Irenaeus come to the same ground that the Fall damaged the relationship between humans and God but did not erase God's plans for humans, which gradually grew until the Incarnation as a means of God to repair the damage.

A range of scientific disciplines, such as palaeoanthropology, geology, archaeology, and evolutionary biology, has studied human origins. The published findings dispute with narratives of the traditional religion about mankind, such as the special creation of mankind, the historic Adam and Eve, the imago Dei, and original sin. The human is withdrawn from his position of special creation in natural philosophy as can be found in the first transmutationist before Darwin. For example, by racing the origins of humans and other land animals from creatures, Chimpanzees were proposed by Jean-Baptiste Lamarck as ancestors of humans through his work of 1809 entitled "*Zoological Philosophy*". Likewise, with his naturalistic account of the origin of species, a geologist Robert (1844) sparked this controversy, claiming that the earliest organisms arose by spontaneous generation and that all subsequent organisms evolved from of them. His argument has become radically different from the Augustinian interpretation of humanity in a state of prelapsarian perfection, because according to Robert man comes from a single line, which initially was in a state of simplicity, if not barbarism.

Darwin (1859) published his *Origin of Species*, but did not discuss human evolution, instead promised that light would be shed on the origin of man and his history (p487). Drawing on Darwin's points, a discussion made by Huxley (1863) focused on fossil evidence, especially the skulls from Gibraltar among other uncovered Neanderthal fossils. Africa was later identified as the origin of the first humans in another publication by Darwin (1871), where he attempted to prove that chimpanzees and gorillas were most closely related to humans, using comparative anatomy.

The paleoanthropologists of the 20th century have debated whether humans separated from other great apes, mistakenly classified in the paraphyletic group of Pongidae long ago, but the early immune response and direct genetic evidence favours the timeline (Helen De Cruz, 2017). The discovery of numerous hominid fossils has created a complex picture of their evolution. Detailed analysis of ancient DNA extracted from fossil remains supplemented these findings, bringing to light a previously unknown hominid species (the Denisovans) that lived in Siberia around 40,000 years ago. Genetic and fossil discoveries have gathered evidence that humans evolved as a complex

branching tree with many dead ends in line with the evolution of other species, rather than in a simple linear fashion. They support a relatively recent origin of our species, Homo sapiens, in Africa around 200,000 years ago, with crosses with Neanderthals and Denisovans (Stringer, 2012).

In line with the above, it is clear that scientific findings and writers of the contemporary religion and science have attempted to question the imago Dei, the human uniqueness, the historicity of original sin and the Incarnation. For example, van Huyssteen (2006) proposes that the key characteristic of uniquely human behaviour is its ability "*to engage in cultural and symbolic behaviour, which became prevalent in the Upper Palaeolithic*". Rather, the notion of imago Dei has been broadened by theologians. Deane-Drummond (2012) argues that the imago Dei should be reconceptualized to include certain non-human animals, since some animals have the capacities of morality and reason. This completely removes the ontological distinction between humans and non-humans, supporting Moritz's question (2011) of whether extinct hominid species, such as Homo neanderthalensis and Homo floresiensis, which coexisted with Homo sapiens for part of prehistory, participated in the divine image.

Discussions also took place on how we can interpret the Incarnation, with evidence of human evolution. For example, Peacocke (1979) gives a liberal definition that the divine nature of Jesus is the point where humanity is perfect for the first time. A teleological interpretation of adaptive evolution by Teilhard de Chardin (1971) shows Christ as the progression and culmination of that towards which evolutionary biology has been moving, even though the historical Jesus lived 2000 years ago. In Teilhard's views, although the evil is no longer incomprehensible, it is still dreadful. Teilhard (1971) understands that God chose adaptive evolution as the mode of creation, but evil has become a natural feature of creation and an inevitable by-product. However, Deane- Drummond (2009) rejected the Teilhard's Spencerian progressivist model of evolution that led to such a problematic interpretation. Drummond challenged this interpretation, arguing that by viewing humanity as the culmination of evolution, Teilhard was anthropocentric.

The progressive Spencerian view has been rejected by contemporary evolutionary theory to strictly adhere to the Darwinian model. For example, human morality is viewed as a continuum with the social behaviour of other animals (Deane-Drummond 2009). In Deane-Drummond's debate on the Fall, she conceptualizes the Fall NOT as a historical but as a mythical event. According to her, the Fall is all about humanity's heightened awareness of moral concerns. She sees Christ as an "*incarnate wisdom, situated in a Theo drama that plays against the backdrop of an evolving creation*". She understands that as we are all connected to the rest of creation by common descent, so is Christ, and therefore by saving us he also saved all of creation.

The narratives of the historical Adam and of the Fall have been discussed at length with an emphasis on how they can be interpreted taking into account the contemporary science. At first glance, the limitations of our cognitive abilities seem to have little explanatory gain for appealing to the account of the Fall, rather explained in a naturalistic way as the result of biological constraints. Van Inwagen (2004) interprets the concepts of sin and Fall in line with the paleoanthropology. According to him,

God could have providentially guided hominin evolution until there was a tightly-knit community of primates, endowed with reason, language, and free will, and this community was in close union with God. At some point in history, these hominins somehow abused their free will to distance themselves from God.

Building on following Augustinian tradition, van Inwagen considers the Fall as the fall from perfection. On the contrary, there is a lack of paleoanthropological or genetic evidences for that community of superhuman beings (Schneider, 2014). This prompts Helen De Cruz (2013) to accept the Irenian's interpretation of the account of the Fall versus that of the Augustinian's, which emphasizes original innocence at the prelapsarian state and does not involve a historical Adam.

4. Summary of findings

Scientists and theologians present three major relationships between science and the Christian Religion: (1) independence, (2) conflict and (3) union of these two realms.

In the first model, authors point to the fact that science and religion explore two different fields because areas of expertise of science are empirical questions about the constitution of the universe, while the areas of expertise of religion are ethical values and spiritual meaning. This view confirms that science cannot prove the existence of God, make neither value nor moral judgments (Moore, 1999 ; Yates, et al., 2015 ; Francis, Astley, & McKenna, 2018).

The conflict model argues for a no compatibility between science and Christian religion while dealing with the same things, hence exist in unending conflicts. This incompatibility holds mainly on three main elements: (1) the story of creation, (2) the miracles and divine actions and (3) timeliness. While scientists tend to deny the biblical creation, account found in Genesis 1-2, they seem to accept the existence of the supernatural [which they do not call God], but claim to have established and governed natural laws which made human evolution possible. Moreover, scientists also seem to agree that the universe has a starting point and attest to the creation ex nihilo through the Big Bang theory

which drove the explanation of how the universe began, claiming that it started with a small singularity and then swelled over the next 13.8 billion years towards the cosmos we know today (Howell, 2017). However, this theory was refuted by many qualified scientists concluding that science simply echoes the words of Genesis 1: 1, "*In the beginning, God ...*" One who cannot be coerced by the universe and the very laws He created (Moore, 1999; Francis, Astley & McKenna, 2018 ; Don Stewart, 2021). With regards to timelines, the studies of genealogical records estimate the age of the Earth to be around 6,000 years while vast majority of the science asserts that there is ample scientific evidence indicating an age of 4.6 billion years for the Earth and around 14 billion years for the entire universe. However, after examining how various scientific tests failed to prove the earth's probable old age, many scientists rejected the theory. The conclusion was that the claim intended to support Darwinism's theory of adaptive evolution (or evolutionary biology) because for the theory of adaptive evolution to be true, the Earth has to be very old and for life to develop spontaneously from an original single cell to our present complex universe, billions of years are needed (Ball, 2003; Peretó & Català 2012; Don Stewart, 2021). Therefore, with this model, recent authors like Plantinga (2011) conclude that the conflict is between science and naturalism rather than between science and religion.

Lastly a union view of science and religion tries to intentionally unify science and theology. These developments rely on (1) the natural theology whereby man formulates arguments about the existence and attributes of God, using the results of the natural science as premises; (2) the theology of nature, for its part, starts from the religious framework and examines how this can enrich or even revise scientific discoveries; and (3) the Process Philosophy. This model is very complex because it brings an unconventional interpretation of things such as the origin of sin, the view of evolution as teleological and it seems biased towards theism.

5. Conclusion and recommendations

The conclusion is an exhortation to consider that questions of science and religion are almost always complex and that the answers they imply are also complex. It is only when we consider as many claims as possible and our own reflection on those claims that we can grow in faith and knowledge.

On one hand, we recognize that science is a way of finding out what is in the already existing universe and how those things work today. It can also explore how things worked in the past and how they are likely to work in the future. The knowledge generated by science may be reliable, for example in developing new technologies, treating diseases or many other types of problems. However, science is continually improving, and when new evidence emerges,

new theories are developed and existing theories rejected or refined. By improving and expanding our knowledge of the universe, it also leads to new questions for future investigation. Again, science would not prove the existence of God or pass moral judgment. This makes it an unreliable benchmark for all truths, but deserves consideration in learning about certain natural phenomena. However, nothing on earth is more secure and reliable than the Bible. If human thought conflicts with the Word of God, then may God be true and every man a liar (Romans 3: 4). We should not think that the reliability of the Bible depends on our ability to gather evidence, but serves to confirm the Bible and to support our confidence. Scientific evidences from any discipline would continually contradict each other as science evolves. However, stronger evidences for the Bible exist such as Old Testament prophecy fulfilled in the New Testament, Findings of archaeology, Reliable manuscripts, Inner testimony of the Holy Spirit, the Bible's power to transform lives and cultures. It is not just a matter of scholarly analysis. Biblical correctness is not just an academic notion to be classified with other ideas that we believe. We must trust and cherish the Bible and put it to good use. The scriptures make us wise for salvation through Jesus and are helpful in equipping us to live godly lives.

Christians who engage in science should be aimed primarily at finding out what to learn about God's creation, through understanding the natural world mechanisms, processes, relationships, powers, entities and structures. When the Holy Spirit lights up our hearts, we see evidence of His power and majesty all around us (Psalm 19), recognizing the created world as the "*theatre of the glory of God*" (John Calvin). As we reflect on his creation, we gain knowledge that complements our experiential knowledge of Him and the knowledge we derive from His special revelation of Himself. We can worthily praise Him and know Him more deeply through prayer and careful study and reflection on His creation. The universe was formed by the one and only one who possesses extremely great knowledge and power. We realize the complexity of His creation which far exceeds the limits of human understanding, even in the face of scientific developments. Our knowledge of his creation therefore gives us the opportunity to recognize, praise and worship the Creator.

References

[1] Alston, W. P., 1989. God's Action in the World. En: *Divine Nature and Human Language: Essays in Philosophical Theology*. Ithaca, NY: Cornell, p. 197–222.

[2] Augustine, 416 [2002]. *The Literal Meaning of Genesis.* New York: New York City Press.

[3] Ball, S., 2003. *A Christian Physicist Examines the Age of the Earth.* s.l.:Courtesy of NASA,.

[4] Barbour, I., 1966. When Science Meets Religion: Enemies, Strangers, or Partners?. *Issues in Science and Religion,* Volumen 2000, pp. 1-205.

[5] Barbour, I., 2000. *When Science Meets Religion: Enemies, Strangers, or Partners?.* New York: HarperCollins.

[6] Biblica, 2021. *Is the Bible at odds with science?.* [En línea] Available at: https://www.biblica.com/resources/bible-faqs/is-the-bible- at-odds-with-science/
[Último acceso: 03 January 2021].

[7] Bowler, P. J., 2001. *Reconciling science and religion : the debate in early-twentieth-century Britain.* s.l.:University of Chicago Press.

[8] Brooke, J. H., 1991. *Science and Religion: Some Historical Perspectives.* s.l.:Cambridge University Press.

[9] Brown, M., 2008. *Good Religion Needs Good science, Church of England,* s.l.: s.n.

[10] Collins, R., 2009. *The Teleological Argument: An Exploration of the Fine-Tuning of the Universe.* in The Blackwell Companion to Natural Theology ed. Oxford: Blackwell.

[11] Comte, A., 1841. *Cours de Philosophie Positive: La Partie Historique de la Philosophie Sociale en Tout ce Qui Concerne l'État Théologique et l'État Métaphysique.* Paris: Bachelier.

[12] Corey, M. A., 1994. *Back to Darwin: The Scientific Case for Deistic Evolution.* Lanham, MA: University Press of America.

[13] Cortez, M., 2010. *Theological Anthropology: A Guide for the Perplexed.* London: Continuum.

[14] Craig, W. L., 2003. The cosmological argument. En: *The Rationality of Theism.* London: Routledge, p. 112–131.

[15] Darwin, C., 1859. *On the Origin of Species by Means of Natural Selection or the Preservation of Favoured Races in the Struggle for Life.* London: John Murray.

[16] Darwin, C., 1871. *The Descent of Man, and Selection in Relation to Sex.* London: John Murray.

[17] Dawes, G., 2016. *Galileo and the Conflict between Religion and Science.* London & New York: Routledge.

[18] de Fontenelle, B., 1724. *"De l'Origine des Fables", in Oeuvres de Fontenelle.* Paris: J. Pinard.

[19] Deane-Drummond, C., 2009. *Christ and Evolution: Wonder and Wisdom.* Minneapolis: Fortress Press.

[20] Deane-Drummond, C., 2012. God's Image and Likeness in Humans and Other Animals: Performative Soul-making and Graced Nature. *Zygon: Journal of Religion and Science,* Volumen 47, p. 934–948.

[21] Dembski, W. A., 1998. *The Design Inference: Eliminating Chance through Small Probabilities.* Cambridge: Cambridge University Press.

[22] Don Stewart, 2021. *How Should Biblical Statements concerning Science and Nature Be Understood?.* [En línea] Available at: https://www.blueletterbible.org/faq/don_stewart/don_stewart_604.cfm [Último acceso: 03 January 2021].

[23] Draper, J., 1874. *History of the Conflict between Religion and Science.* New York: Appleton.

[24] Ecklund, E. H., 2010. *Science vs Religion: What Scientists Really Think.* Oxford: Oxford University Press.

[25] Ecklund, E. H. & Scheitle, C. P., 2007. Religion among Academic Scientists: Distinctions, Disciplines, and Demographics. *Social Problems,* Volumen 54, p. 289–307.

[26] Forrest, B. & Gross, P. R., 2004. *Creationism's Trojan Horse: The Wedge of Intelligent Design.* Oxford: Oxford University Press.

[27] Francis, L. J., Astley, J. & McKenna, U., 2018. Science disproves the biblical account of creation': exploring the predictors of perceived conflict between science and religion among 13- to 15-year-old students in the UK. *British Journal of Religious Education,* 41(2), pp. 188-201.

[28] Gould, S. J., 1989. *Wonderful Life: The Burgess Shale and the Nature of History.* London: Penguin.

[29] Ham, K. & Mortenson, T., 2009. *Science or the Bible?,* s.l.: s.n.

[30] Harrison, P., 1998. *The Bible, Protestantism, and the Rise of Natural Science.* s.l.:Cambridge University Press.

[31] Harrison, P., 2009. *The Fall of Man and the Foundations of Science,* Cambridge: Cambridge University Press.

[32] Harris, P. L. y otros, 2006. Germs and Angels: The Role of Testimony in Young Children's Ontology. *Developmental Science,* Volumen 09, p. 76–96.

[33] Haught, J. F., 1995. *Science & Religion: From Conflict to Conversation.* New York: Paulist Press.

[34] Helen De Cruz, 2017. *Religion and Science,* s.l.: Stanford Encyclopedia of Philosophy.

[35] Helen De Cruz, 2017. *Religion and Science,* s.l.: Stanford Encyclopedia of Philosophy.

[36] Howell, E., 2017. *What Is the Big Bang Theory?,* s.l.: s.n.

[37] Hudson, H., 2013. Best Possible World Theodicy. En: J. McBrayer & D. Howard-Snyder, edits. *The Blackwell Companion to the Problem of Evil.* Oxford: Wiley Blackwell, p. 236–250.

[38] Hume, D., 1748. *Philosophical Essays Concerning Human Understanding.* London: A. Millar..

[39] Hume, D., 1757 [2007]. *"The Natural History of Religion", in A Dissertation on the Passions: The Natural History of Religion. A Critical Edition, T.L. Beauchamp (ed.).* Oxford: Clarendon Press.

[40] Huxley, T. H., 1863. *Evidences as to Man's Place in Nature.* London: Williams and Norgate.

[41] Jaeger, L., 2012. Against Physicalism Plus God: How Creation Accounts for Divine Action in Nature's World. *Faith and Philosophy,* Volumen 29, p. 295–312.

[42] James, W., 1902. *The Varieties of Religious Experience: A Study in Human Nature.* New York: Longmans, Green.

[43] Johnson, E. A., 1996. Does God Play Dice? Divine Providence and Chance. *Theological Studies,* Volumen 57, p. 3–18.

[44] Lamarck, J.-B., 1809. *Philosophie Zoologique, ou Exposition des Considérations Relatives à l'Histoire Naturelle des Animaux.* Paris: Museum d'Histoire Naturelle (Jardin des Plantes).

[45] Lemaître, G., 1927. Un Univers Homogène de Masse Constante et de Rayon Croissant, Rendant Compte de la Vitesse Radiale des Nébuleuses

Extra-Galactiques. *Annales de la Société Scientifique de Bruxelles* , p. 49–59.

[46] LibreTexts, T., 2020. *Science as a Way of Understanding the Natural World.* [En línea] Available at: https://geo.libretexts.org/Courses/Mt._San_Jacinto_College/Environmental_Science_101/01%3A_Science_and_Sustainability/1.02%3A_Science_as_a_Way_of_Understanding_the_Natural_World#:~:text=Science%20is%20a%20way%20of%20knowing%20about%20the%20world%20around%
[Último acceso: 03 January 2021].

[47] Masci, David ; Gregory A. Smith, 2016. *Is God Dead? No, but Belief has Declined Slightly.* s.l.:Pew Research Center report.

[48] Masci, D., 2019. *Darwin in America. The evolution debate in the United States,* s.l.: s.n.

[49] Matt Williams, 2015. *What is the Big Bang Theory?,* s.l.: s.n.

[50] McGrath, A. E., 2016. *Re-Imagining Nature: The Promise of a Christian Natural Theology.* Oxford: Wiley-Blackwell.

[51] Miller, P., 2020. *Have you ever wondered, "Does science disprove the Bible?,* s.l.: s.n.

[52] Moore, J., 1999. *Science as a Way of Knowing.* s.l.:s.n.

[53] Moritz, J. M., 2011. Evolution, the End of Human Uniqueness, and the Election of the Imago Dei. *Theology and Science,* Volumen 09, p. 307–339.

[54] Morri, J. D., 1997. *Does Science Conflict with the Bible?,* s.l.: s.n.

[55] Murphy, N., 1995. Divine Action in the Natural Order: Buridan's Ass and Schrödinger's Cat. *Scientific Perspectives on Divine Action,* Volumen 2, p. 325–358.

[56] Norenzayan, A., 2013. *Big Gods: How Religion Transformed Cooperation and Conflict.* Princeton, NJ: Princeton University Press.

[57] Ortberg, J., 2020. *Does Science Disprove Faith?,* s.l.: s.n.

[58] Peretó, J. & Català, J., 2012. Darwinism and the Origin of Life. *Evolution: Education and Outreach,* Volumen 5.

[59] Peters, T. & Hewlett, M., 2003. *Evolution from Creation to New Creation: Conflict, Conversation, and Convergence.* Nashville, TN: Abingdon Press.

[60] Philip, J. C. & Cherian, S., 2017. *Bible And Science, Capsule Series For Busy People.* India: CRASI.

[61] Philipse, H., 2012. *God in the Age of Science? A Critique of Religious Reason.* Oxford: Oxford University Press.

[62] Pitts, J., 2008. Why the Big Bang Singularity Does not Help the Kalām Cosmological Argument for Theism. *British Journal for the Philosophy of Science,* Volumen 59, p. 675–708.

[63] Plantinga, A., 2011. *Where the Conflict Really Lies. Science, Religion, and Naturalism.* New York: Oxford University Press.

[64] Polkinghorne, J., 1998. *Science and Theology: An Introduction.* Minneapolis: Fortress Press.

[65] Russell, R., Murphy, N. & William Stoeger, S., 2008. *Scientific Perspectives on Divine Action. Twenty Years of Challenge and Progress.* Berkeley, CA: atican Observatory Publications; Center for Theology and the Natural Sciences.

[66] Schliesser, E., 2012. Newton and Spinoza: On Motion and Matter (and God, of Course). *Southern Journal of Philosophy,* Volumen 50, p. 436–458.

[67] Sedgwick, A., 1845 [1890]. Letter to Charles Lyell. En: *The Life and Letters of the Reverend Adam Sedgwick.* Cambridge, UK: Cambridge University Press, p. 83–85.

[68] Southgate, C., 2008. *The Groaning of Creation. God, Evolution and the Problem of Evil.* Louisville: Westminster John Knox Press.

[69] Stenmark, M., 2004. *How to Relate Science and Religion: A Multidimensional Model.* Grand Rapids MI: Eerdmans.

[70] Stewart, Don, 2021. *Does the Bible Give an Age to the Earth?.* [En línea]
Available at:
https://www.blueletterbible.org/faq/don_stewart/don_stewart_609.cfm
[Último acceso: 04 January 2021].

[71] Stringer, C., 2012. Evolution: What Makes a Modern Human. *Nature,* Volumen 485, p. 33–35.

[72] Sullivan, W., 2001. *Fred Hoyle Dies at 86; Opposed 'Big Bang' but Named It,* s.l.: s.n.

[73] Swinburne, R., 1968. Miracles. *Philosophical Quarterly*, Volumen 18, p. 320–328.

[74] Teilhard de Chardin, P., 1971. *"Christology and Evolution" in Christianity and Evolution (translated by R. Hague).* San Diego: Harcourt.

[75] The Doc, 2021. *34 Great Scientists Who Were Committed Christians,* s.l.: s.n.

[76] Torrance, T. F., 1969. *Theological science.* London ; New York : Oxford University Press.

[77] Van Huyssteen, J. W., 1988. *Duet or Duel? Theology and Science in a Postmodern World.* London: SCM Press.

[78] Van Huyssteen, J. W., 1998. *Duet or Duel? Theology and Science in a Postmodern World.* London: SCM Press.

[79] van Inwagen, P., 2004. The Argument from Evil. En: *Christian Faith and the Problem of Evil.* Grand Rapids: Eerdmans, p. 55–73.

[80] White, A. D., 1896. *A History of the Warfare of Science with Theology in Christendom.* New York: Appleton.

[81] Wildman, W., 2008. *The Divine Action Project, 1988–2003.* Berkeley, CA: Vatican Observatory Publications ; Center for Theology and the Natural Sciences.

[82] Worrall, J., 2004. *"Science Discredits Religion", in Contemporary Debates in Philosophy of Religion, Michael L. Peterson and Raymond J. VanArragon (eds.).* Malden, MA: Blackwell, pp. 59–72.

[83] Yates, K. K. y otros, 2015. Transdisciplinary Science: A Path to Understanding the Interactions Among Ocean Acidification, Ecosystems, and Society. 28(2), pp. 212 - 225.

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Mind matters in mathematics and music

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Abstract

Mathematics and music in practice and performance, and in learning and teaching, share many characteristics, such as beauty and harmony, memory and intuition (as internal senses), and mind or intellect. These raise the principles of processing information in mathematics and music and, by implication, the role of an acquaintance with the essentials of perception, abstraction, and affective connaturality in teacher education. This paper compares mathematics and music and considers the acquisition of knowledge and skills through the external and internal senses and emotions, utilizing the role of knowledge through multiple intelligences. In doing so it does not canvas the utilities of mathematics and music as fields of human endeavour so much as their role in the cultivation of serenity and knowledge in the cultured mind. This is a theoretical paper but it is based on nearly a century of teaching from the combined work of the two authors in the teaching of music and mathematics. The paper highlights the importance of inspiration in teaching, inspiration built on a thorough basis of the foundations of anthropology to include the emotions as well as the intellect. While teacher education programs rightly concern themselves with knowledge of the field of study, knowledge of pedagogy, they do not always consider the ability to inspire which is at the heart of managing and mentoring people.

Keywords: Beauty, harmony, memory, emotions, creativity, problem solving, time.[†]

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1 Introduction

"It is often said that music and mathematics are related. Essentially though, music and mathematics are poles apart. Mathematics is about the physical world. It is about the first principle of science…In contrast, music does not and cannot express the physical world…We use our ears in music and our eyes in mathematics, but both use the mind…Music is never reducible to mathematics but both disciplines are pattern rich so the temptation to draw connections can be irresistible" [14]. Here we wish to show that the mind is the key to the connections which can enrich the pedagogy of both disciplines when taught with the passion to inspire.

The purpose of this paper is simple. It aims to canvas how the mind matters in learning and teaching in mathematics and music, albeit from non-conventional considerations, free from the dictates of fashion. Thus, this paper outlines some distinct, but not separate, aspects which affect the teaching and learning of mathematics and music. While at first sight they seem very different, mathematics and music do actually possess many elements in common:

- harmony, [30]
- beauty, [22]
- notation as a tool of thought, [17]
- intuition as an affective process,
- levels of cognition,
- problem solving,
- practice, practice, practice in order to perform!
- memory as a result of thought and practice,
- appreciation of the role of intuition,
- inspiration of the teacher as motivation
- patterns and forms,
- sequences [49].

The frequently neglected connections among the experimental sciences and the fine arts are a continuing source of genuine research [33], particularly with the connections between mathematics and music and creativity [27], going back to Gottfried Wilhelm Leibnitz in the 17th century: "Music is the mathematics of one who does not know that he is counting." [37]

The product of this paper is complex. It leads into questions about the nature of time [36] since both mathematics and music relate to time, albeit in different ways though both require participation [9;35] and the magnetism of beauty in their performance [15;31]. To pursue these further would require studies of the nature of time and the nature of existence [50]. We shall instead focus on the pedagogical links.

While Howard Gardner's Multiple Intelligences (or talents), MIs, has brought out the value of the various strengths, sometimes latent and frequently under-valued, in everyone, the context of these inter-relationships is too often a blank canvas [12;16]. To fill in this blank canvas, we also outline the elements of this

contextual framework which can make a difference to how we teach and how we accommodate the variety of MIs in any class we teach (and at any level). For instance, 'harmony', 'beauty' and 'problem-solving' transcend the particular disciplines where they first appear to the novice learner in mathematics and music [26]. Beauty is a recurring theme in Hardy [15] and more recently in Gardner [13].

2 Our Approach

To do this we also need to accommodate the cognitive, affective and psychomotor taxonomies as the relate to what we teach and why we teach. In order to teach effectively we need to know what we are teaching in some depth and we should love teaching real people with all their strengths and weaknesses.

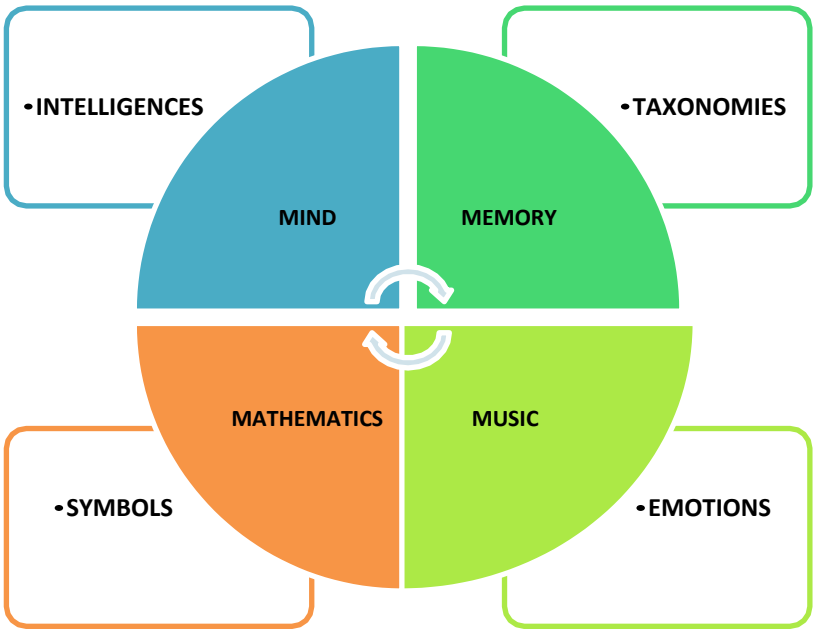


Figure 1: Structure of the paper

While the domains of Bloom and his colleagues are well-established and still fairly widely used, we shall briefly recapitulate them in the situations of mathematics and music in order to make sense of our later exposition. The word 'taxonomy' itself is based on the French *taxonomic* and linked to the Greek (*taxis* order *nomos* – 'managing'). An educational taxonomy is a form of classification of the process of thinking and learning.

Historically the educational taxonomy was developed as a structure of three domains:

i) Cognitive domain [5],
ii) Affective domain [7],
iii) Psychomotor domain [8].

which have been modified slightly in the upper levels over the years. In particular, we note that (i) can be implemented as a measurement tool for the Art/Science of teaching and learning of classical piano.

COGNITIVE DOMAIN [5]				
Cognitive Domain (Knowledge) was formulated by Benjamin Bloom in 1956 as a set of six major categories, organized as a hierarchical order of cognitive progress, starting from the simplest level to the most complex.				
Level	**Category**	**Behaviour**	**Mathematics**	**Music**
1	Knowledge	Recall or recognise information	Definitions, laws, procedures; memory strategies	Playing techniques; history and theory; memory strategies
2	Comprehension	Restate data in one's own words	Explain or interpret meaning of symbols; awareness of patterns	Notation; harmony structure; styles of music
3	Application	Put theory into practice	Solve a new problem, manage an activity	New techniques, finger choices
4	Analysis	Interpret internal relationships	Identify constituent parts and functions	Tonic and dominant keys; structure
5	Synthesis and Creativity	Develop new structures	Combine methods, develop procedures; choice of proofs	Compose a concerto; thesis, antithesis, synthesis [29]
6	Evaluation	Assess effectiveness of whole concepts	Review strategic alternatives; criteria for judgements	Criteria for judgements and standards

Table 1(a): Taxonomic Domains – Cognitive Domain

AFFECTIVE DOMAIN [19]				
This area is concerned with feelings or emotions. Affective objectives are also divided into a hierarchy: from the simplest behaviour to the most complex.				
Level	**Category**	**Behaviour**	**Mathematics**	**Music**
1	Receive	Open to experience, willingness to hear	Take interest in learning experience	Willingness to hear and form habits

2	Respond	React and participate actively	Enthusiasm for action, interest in out- comes	Actively reacting and participating
3	Value	Attach values, express personal opinions	Decide worth and relevance of ideas	Acceptance, respect and commitment [35]
4	Organize	Reconcile internal conflicts, develop value system	Clarify, qualify and quantify personal views	Start of the student's transfor mation to be an independent learner
5	Internalize	Adopt belief system and personal philosophy	Self-reliant, behave consistently with personal vales	Values and beliefs are formed at a professional level

Table 1(b): Taxonomic Domains – Affective Domain

PSYCHOMOTOR DOMAIN [8] This skills domain is exceptionally important in Piano Teaching! It is designed to explain the evolution of physical movement, coordination and use of the motor – skills. Dave's five major categories are listed here from the simplest behaviour to the most complex.				
Level	**Category**	**Behaviour**	**Mathematics**	**Music**
1	Imitation	Copy, observe and replicate	Watch teacher and repeat action	Watch teacher and repeat (Piaget [25])
2	Manipulation	Reproduce activity from instruction or memory	Carry out task from written or verbal command	Gross motor control and fine motor coordination
3	Precision	Execute skill reliably, independent of help	Perform a task with quality and without assistance	Motor actions become more exact and refined
4	Articulation	Integrate expertise to satisfy a non-standard objective	Combine associated activities to meet novel requirements	Efficient physical mechanism; movement with reasoning
5	Naturalisation	Automated mastery of skills at strategic level	Conjectures and strategies for use to meet needs	Musical idea and technical realization go together [47]

Table 1(c): Taxonomic Domains – Psychomotor Domain

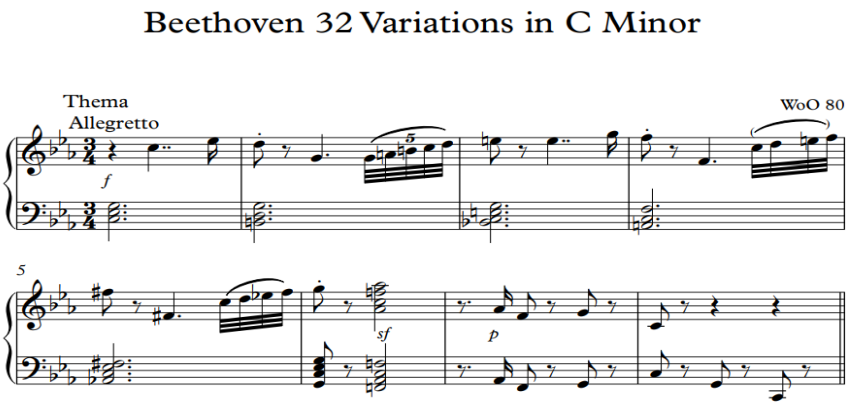
In many senses these come together in the theory of multiple intelligences [12,16], no matter what our role in doing and enjoying mathematics or music.

3 Mind matters

3.1 Music and mathematics

As we can glimpse there is much in common between these two disciplines, even in performance, because neither discipline is a spectator sport, and both require active 'timely' memories! [35,38,44,50,51].

Schools must remember that teaching this



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is just as important as teaching this

$$\int_{-\infty}^{\infty} e^{-x^2} dx = \sqrt{\pi}$$

$$f(x) = a_0 + \int_{n=1}^{\infty} \left(a_n cos \frac{n\pi x}{L} + b_n sin \frac{n\pi x}{L} \right)$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Figure 2: Mathematics 'versus' Music

We know that when finances have to be trimmed and there is less money for instruction, music and other performing and creative arts are the first to be cut back [3]. Figure 2, partly from *Instagram*, shows this, but it also illustrates a lack of appreciation of the link between music and mathematics on the part of the educational administrators who make these decisions. The link here is

beauty. The proof of the first mathematical equation in this figure is one of the most elegant and beautiful in mathematics. It also happens to be very useful in the context of the normal or Gaussian bell-shaped curve in statistics.

Moreover, Block-Schwenk in promoting the Berklee College of Music online unit "Applied Mathematics for Musicians", has this to say: "Math is a vital skill for anyone in, or aspiring to be in, the music industry. From understanding music publishing deals and royalty statements to applying music theory and music production concepts, math can help you enormously. For many of us, though, math is something that's preferably avoided or best left to someone else. *Applied Mathematics for Musicians* is designed to change that and to build your own knowledge of, and confidence in, math in practical ways that relate directly to the world of music." [4].

In the work of the Greek composer Xenakis, who applied the principles of stochastic mathematics directly into his musical composition, his claim was that this method could be used by anyone with a basic grasp of mathematical concepts, but our feeling is that he somewhat overestimated the complexities of the task. Xenakis produced some remarkable compositions, where the musical out- come is not overshadowed by the underlying processes. One of his groundbreaking works was the 1954 composition titled "Metastasises", in which Xenakis uses 12-tone methods and the Fibonacci series to explore Einstein's view of time. The music directly links to mathematics in an open and honest way that, to our knowledge, no other composer had achieved before. The results are breath-taking and uniquely beautiful [10;44].

In mathematical terms, the canon can be described as a periodic function where, for example, if f is the first voice and g is the second, then $g(t) = f(t - x)$, in which t indicates the numbers of measures and x is the interval difference between g and t. Canon 5, described as *per tonos* is $g(t) = f(t - x) + H$, where H indicates that the pitch has shifted by a perfect fifth [11].

3.2 Memory

As educational fashions rise and fall about theories such as the role of memorization in learning and applying one's learning professionally, there are certain things which one needs to know inside out in order to function well in practice.

DOMAINS	**ELEMENTS**	**BODY-MIND ISSUES**
Cognitive	Memory	Knowledge through concepts (ideas) [41]
Affective	Emotions	Affective connaturality [29]
Psychomotor	Senses	Multiple intelligences [16,46]

Table 2: Domains and sense elements

"A great deal of research on memory over the last century has been concerned with the question of *where* in the brain memories are located. It seems like a logical question, but as with many things in science, the answer is counter-intuitive: They are not stored in a particular place. Memory is a process, not a thing; it resides in spatially distributed neural circuits, not in a particular location, and those circuits are different for semantic and episodic memory, procedural and autobiographical memory" [21;48].

'Memory' is elusive, not just in terms of remembering, but in terms of classifying the ways we remember. There is also controversy about how many (and how) big are the chunks of memory we can accommodate at any one moment in order to solve problems that occur in music or mathematics [38;42.43]. See especially the work of Juan Pascual-Leone, the founder of the Neo-Piagetian approach to cognitive development [34]. Again, in practice it is a combination of intuition, emotion and memory (acquired from practice) and love of sense beauty [20]. An example of this was etched in the memory of one of us, when the great Soviet violinist, David Oistrakh, had a string break in the middle of a performance at the Sydney Town Hall in 1958, but was able to adjust immediately and complete the performance. This takes years of practice and a 'feeling' for one's performance.

3.3 Emotions

Again, the zeitgeist oscillates between an overemphasis on intelligence on the one hand or on emotion on the other hand, though it is not a question of 'either-or' but of 'both-and'! Each of us is a unity, even if we can distinguish parts and functions. Knowledge is acquired through perception and abstraction as well as through connaturality. In particular, creativity in both disciplines is often characterized by serendipity.

The teacher needs to be operating with a sensitivity to the inter-relationship of the parts and functions in order to appreciate the individual gifts of each student and the interaction of the functions of the mind and the body [44]. Thus, the organ of sight is the eye, but the organ of the intellect is not the brain: we do not think with our brain although we cannot think without our brain. We think with our mind or intellect.

<table>
<tr><td colspan="2">SENSES</td><td>(a)
→
[18]</td><td>BRAIN
[23;51]</td><td>(b)
→
[27]</td><td>MIND & WILL
[6]</td><td rowspan="2">(c)
←
[28]</td></tr>
<tr><td>External
[45]</td><td>Internal
[40]</td><td colspan="4"></td></tr>
<tr><td colspan="2">EMOTIONS [2]</td><td colspan="4">→ ↑→</td><td></td></tr>
<tr><td colspan="7">(a) Perception; (b) Abstraction; (c) non-conceptual intellectual knowledge</td></tr>
</table>

Figure 3: Elements of philosophical anthropology [24]

While there is nothing in our intellect that was not first in our senses, we can imagine things we have never seen and have a concept (idea) of things that may not exist, such as a pyramid a kilometer high made of gold. While the taxonomies, including MI, make it clear that the senses can be refined and need to be appreciated, there are aspects of perception which we really do not yet under- stand [34]. For instance, how can we know something immaterial in our mind, such as an imaginary number, even if it has no material existence, and even though its mathematical existence has an application in alternating current in physics?

Knowledge through connaturality	Intellective, by way of	knowing	*par mode de connaissance*
		non-consciousness	*par mode de nescience*
	Affective, by way of	practical inclination	*par mode d'inclination pratique*
		creation	*par mode de création*

Table 3: Knowledge through affective connaturality [29]

"Mathematics, as much as music or any other art, is one of the means by which we rise to a complete self-consciousness. The significance of mathematics resides precisely in the fact that it is an art; by informing us of the nature of our own minds it informs us of much that depends on our minds" [47].

While we should not be prisoners of our emotions, they do help us to want to learn and to learn how to learn. There are strategies for going to emotions and going through emotions to manage unwanted emotions [40]. At the postgraduate level, emotions assist in curiosity drive research in mathematics and music by those blessed with an inspirational love for the field. Both too can engender phobias in those who cannot see their role in the development of the cultivated mind.

4 Conclusion

An example of both serendipitous outcomes and curiosity driven research is that of Roger Herz-Fischler, an eminent abstract probability theorist who was asked in 1972 to take over a course for first-year architecture students at Carleton University in Canada. He decided that the best way to engage the students was to keep himself content by talking about things that interested him. He then started to investigate in detail some of the claims of the non-mathematical manifestations of the "golden number". Out of this arose not only texts and papers which demonstrated the scholarship of teaching, but also he engaged with the purely mathematical history in the scholarship of discovery. Neither of these might register in the current research league tables, but the reprints of his books

are testimony to his erudition and the overlapping of what some people treat as separate Boyer categories. His historical research has been supported by the Social Sciences and Humanities Research Council of Canada (SSHRC) and his mathematical work by the Natural Sciences and Engineering *Research Council* of *Canada* (NSERC), a rare double!

Many of the great discoveries in science, particularly in medicine and biology, have been serendipitous by-products rather than planned assaults on a problem. The use of penicillin and lithium carbonate are two well-known examples. It is important to remind ourselves of this at a time when expository research seems to be undervalued, and curiosity driven research does not align well with the measures of research used for the university league tables.

In the (con)temporary glamour of university research 'league tables', and the concomitant obscuring of the mission of providers of higher education, serendipity cannot readily be measured as a quantitative input. Those engaged in scholarly activity in music or mathematics are well aware of these chance encounters and apparent digressions.

Similarly, the contribution to, and enrichment of, our knowledge through the emotions is an immaterial phenomenon even if our feelings 'feel' them [10]. The knowledge that twins have for each other, or a parent for a child, or long-time married couples for each other, is no less real as 'knowledge' than our knowledge of Pythagoras' Theorem. No one can deny the learning 'force' of teachers who love their field of teaching and love their students (in the sense of 'be friendly but not familiar').

Logically too we can be more convinced by a convergence of probabilities than by rigorous logic. This is an important facet of learning to learn, such as with Newman's hypothetical "illative sense" [1;32]. This is the way we are actually 'convinced' in mathematics and music, and hopefully in this paper.

Each step 'seems right', but intuition and shrewd guessing seem to be drummed out of too many children in school [40]. It takes much work to re-kindle the flame and many students who actually do quite well at examinations never really learn the warmth of love when intuition is enkindled by a teacher at ease with basic anthropology in themselves and inspiration for their students [10;23]: learning to learn how we actually learn!

References

1. Allen, A.L. and A.G. Shannon. (1971). "Concept selection strategies of New Guinea students." *Journal of Experimental Education*. 3 (3), 1–4.
2. Aquino, Frederick D. (2018). "Epistemology." In Frederick D. Aquino and Benjamin J. King (eds). *The Oxford Handbook of John Henry Newman.* Oxford: Oxford University Press, Ch.19.

3. Armstrong, Thomas. (1993). *Seven Kinds of Smart.* New York: Plume/Penguin.
4. Block-Schwenk, Kevin. (2020). "Applied Mathematics for Musicians". *Berklee College Prospectus.* Boston, MA: Berklee College of Music.
5. Bloom, Benjamin S. (ed.) (1956). *Taxonomies of Educational Objectives. Handbook I: Cognitive Domain.* New York: Longmans Green.
6. Budziszewski, J. (2004). "The natural, the connatural, and the unnatural." *St Thomas and the Natural Law Conference,* Jacques Maritain Centre, University of Notre Dame, South Bend, Indiana, July.
7. Connell, W.F. (ed.) (1965). *The Foundations of Education.* Sydney: Novak.
8. Dave, R.H. (1970). "Psychomotor levels." In R. J. Armstrong (Ed.), *Developing and writing behavioral objectives*. Tucson: Educational Innovators Press.
9. Ehert, Matthew. (2020). "The plasma universe and Max Planck's musical spacetime rediscovered." *Nexus*. June-July, pp.57-62.
10. Freni, Cristine. (2016). *Homo aestheticus*: la bellezza come cura per l'antropologia del nostro tempo. *Studia Moralia.* 54(2), 251-272.
11. Frey, Angelica. (2015). "Can we write music as functions? Yes." *CMUSE*. July 15.
12. Gardner, H. (1983). *Frames of mind - the theory of multiple intelligences,* New York, NY: Basic Books.
13. Gardner, Howard. (2011). *Truth, beauty, and goodness reframed: Educating for the virtues in the 21st century.* New York: Basic Books.
14. Griffin, Michael. (2013). *Learning Strategies for Musical Success.* Adelaide, SA: Music Education World, Ch.4.
15. Hardy, G.H. (1967). *A Mathematician's Apology*. With a foreword by C.P. Snow. Cambridge: Cambridge University Press. (1st published 1940).
16. Harrison, Clive. (2017). "The song writing coalface: where multiple intelligences collide." *Australian Institute of Music Occasional Papers,* No.47.
17. Iverson, K.E. (1980). "Notation as a Tool of Thought." *Communications of the Association for Computing Machinery.* 23(8), 444-465.
18. Jaroszynski, Piotr. (2011)." Aquinas metaphysics: versus mythology, ontology, and ideology." *Thomism and Asian Cultures: Celebrating 400 Years of Dialogue Across Civilizations,* Quadricentennial International Philosophy Conference, University of Santo Thomas, Manila, Philippines.
19. Krathwohl, D.R., B.S. Bloom and B.B. Masia. (1964). *Taxonomy of Educational Objectives. Handbook II: Affective Domain.* New York: David McKay.
20. Levitin, Daniel. (2019). *This is Your Brain on Music: Understanding a Human Obsession.* London: Penguin Life.

21. Levitin, Daniel. (2020). *Successful Aging: A Neuroscientist Explores the Power and Potential of Our Lives.* London: Penguin Life.
22. Leyendekkers, J.V. and A.G. Shannon. (2013). "On the Golden Ratio." *Advanced Studies in Contemporary Mathematics.* 23(1), 195-201.
23. Lisska, Anthony J. (2016). *Aquinas's Theory of Perception: An Analytic Reconstruction.* Oxford: Oxford University Press.
24. Lombo, José Angel and Francesco Russo. (2007). *Philosophical Anthropology: An Introduction.* Downers Grove, IL: Midwest Theological Forum, Chs.6,7.
25. Manly, B.F.J. and A.G. Shannon. (1974). "An analogical replication of a Piagetian experiment on New Guineans." *Malaysian Journal ofEducation*. 11(1), 77–82.
26. Maor, Eli. (2018). *Music by the Numbers: From Pythagoras to Schoenberg.* Princeton, NJ: Princeton University Press.
27. Maritain, Jacques. (1953). *The Range of Reason.* London: Geoffrey Bless.
28. Maritain, Jacques. (1969). "Quelques réflexions sur le savoir théologiques." *Revue Thomiste*. 69: 3-27.
29. Miller, B.R.J. *sm*. (1961). *The Range of Intellect.* London: Geoffrey Chapman.
30. Nagy, Mariana, Simon R. Covell and Valeriu Beiu. (2018). "Are 3D Fibonacci spirals for real? From Science to Arts and Back to Science." *Proceedings of the 7th International Conference on Computers Communication and Control.* Oradea, Romania: IEEE, pp.91-96.
31. Neuhaus, Heinrich. (2016). *The Art of Piano Playing.* (Translated and edited by K.A. Leibovitch.] London: Kahn and Averill.
32. Newman, J.H. (1985). *An Essay in Aid of a Grammar of Assent.* (Editedby I.T. Ker). Oxford: Clarendon Press.
33. Ngô-Tiêng-Hiên. (1971). "Art et vêritiê dans l'oeuvre d'Etienne Souriau." *Revue Philosophique de Louvain.* 69(1), 73-91.
34. Pascual-Leone, Juan. (1970). "A Mathematical Model for the Transition Rule in Piaget's Development Stages." *Acta Psychologica.* 32(4), 301-345.
35. Phillips, George M. (2005). *Mathematics is Not a Spectator Sport*. New York: Springer.
36. Sanchez Martinez, Jorge Julian. 2020. "A mathematical assessment on the ontology of time." *Science and Philosophy*. 8 (2): 91-104.
37. Sautoy, Marcus du. (2011). "Listen by numbers: music and maths." *The Guardian*. June 28.

38. Schonberg, Harold C. (1987). *The Great Pianists from Mozart to the Present*, 2nd edition. New York: Simon and Schuster.
39. Seibert, Scott E., Marie L. Kramer and Peter A. Heslin. (2016). "Developing career resilience and adaptability." *Organizational Dynamics.* 45(3): 245-257.
40. Shannon, A.G. (1969). "Jacques Maritain and the philosophical foundations of education." *Education Today: Journal of the College of Preceptors*. 19(3), 20.
41. Shannon A.G. (1982). "Note on an Algebraic Structure for a Concept Space." *Journal of Structural Learning.* 7(2): 143-149.
42. Shannon, A.G. (1991). "Shrewd guessing in problem-solving." *International Journal of Mathematical Education in Science and Technology*. 22(1), 144–147.
43. Shannon, A.G. (2008). "An Interpretation of Pascual-Leone's Discrete Mathematical Model of Human Information Processing Capacity." *Notes on Number Theory and Discrete Mathematics.* 14 (2): 15-20.
44. Shannon, Anthony G., Irina Klamka and Robert van Gend. (2018). "Generalized Fibonacci Numbers and Music." *Journal of Advances in Mathematics*. 14(1), 7564-7579.
45. Siepmann, Jeremy. (2010). "The Art of Doing." *International Piano Magazine*, September/October, Symposium.
46. Smith, Vincent Edward. (1960). *The School Examined: Its Aim and Content*. Milwaukee, WI: Bruce.
47. Stakhov, Alexy. (2020). *Mathematics of Harmony as a New Interdisciplinary* Direction *and "Golden" Paradigm of Modern Science.* Singapore: World Scientific.
48. Sullivan, J.W.N. (1926). *Aspects of Science: Second Series.* New York: Alfred A Knopf, pp.93-94.
49. Taruskin, Richard. (2005). *The Oxford History of Western Music: Volume I – The Earliest Notations to the Sixteenth Century.* Oxford: Oxford University Press.
50. Unger, Roberto Mangabeira and Lee Smolin. (2014). *The Singular Universe and the Reality of Time.* Cambridge: Cambridge University Press.
51. Wildridge, Justin. (2019). "Classical Music and Mathematics." *CMUSE.* May 4.
52. Zattorre, Robert J., Joyce L. Chen and Virginia B. Penhune. (2007). "When the brain plays music: auditory-motor interactions in music perception and production." *Nature Neuroscience.* 8: 57-558.

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Philosophical suggestions by the single elements

Thomas Vougiouklis*

Abstract

The largest class of hyper structures is the one which satisfy the *weak properties*. These are called H_v-structures introduced in 1990 and they proved to have a lot of applications on several applied sciences. Special classes of elements appeared to have new interesting properties applicable in other sciences. We present some results on hyper structures containing '*single'* elements, and some new constructions.

Keywords: hyper structures; H_v-structures; single elements.†

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1. Some hyperstructures

Our main object is the class of hyperstructures called *H_v-structures* introduced by T. Vougiouklis in 1990 ([9], [10]), which satisfy the *weak axioms* where the non-empty intersection replaces the equality. Some basic definitions are the following:

In a set $\boldsymbol{H}$ equipped with a hyperoperation $(\cdot)$:

$$\cdot: \boldsymbol{H}\times\boldsymbol{H} \to P(\boldsymbol{H})- \{\varnothing\},$$

we abbreviate by ***hope*** the *hyperoperation* $(\cdot)$.
In $(\boldsymbol{H},\cdot)$ the *weak associativity* is defined by

$$(xy)z\cap x(yz)\neq\varnothing,\ \forall x, y, z\in\boldsymbol{H}$$

and the *weak commutativity* by

$$xy\cap yx\neq\varnothing,\ \forall x, y\in\boldsymbol{H}.$$

The hyperstructure $(\boldsymbol{H},\cdot)$ is called an ***H_v-group*** if it is weak associative and *reproductive*, i.e.

$$x\boldsymbol{H} = \boldsymbol{H}x = \boldsymbol{H},\ \forall x\in\boldsymbol{H}.$$

Motivation. The quotient of a group by an invariant subgroup is a group. The quotient of a group by a subgroup is a hypergroup. The quotient of a group by any partition is an H_v-group.

In a similar way more complicated hyperstructures are defined:
$(\boldsymbol{R}, +,\cdot)$ is called *H_v-ring* if $(+)$ and $(\cdot)$ are weak associative, the $(+)$ is reproductive and $(\cdot)$ is weak *distributive* with respect to $(+)$:

$$x(y+z)\cap(xy+xz)\neq\varnothing,\quad (x+y)z\cap(xz+yz)\neq\varnothing,\ \ \forall x,y,z\in\boldsymbol{R}.$$

Similarly, the *H_v-module*, the *H_v-vector space, H_v-algebras* and so on, are defined.

For more definitions and applications on H_v-structures one can see in books and papers as [2], [4], [5], [8], [9], [10], [13], [15].

The main tool to study hyperstructures is the *fundamental relation.* In 1970, for the hypergroups the relation β and its transitive closure β^*, was defined by M. Koskas. This relation connects the hyperstructures with the corresponding classical structures and is defined in H_v-groups as well. T. Vougiouklis in 1990, introduced the γ^* and ε^* relations, which are defined, in H_v-rings and H_v-vector spaces, respectively. He also named all these relations β^*, γ^* and ε^*, *Fundamental Relations*.

Definition. The fundamental relations β^*, γ^* and ε^*, are defined, in H_v-groups, H_v-rings and H_v-vector spaces, respectively, as the smallest equivalences so that the quotient would be group, ring and vector spaces, respectively.

The basic theorem which gives a way to find the fundamental classes, as well, is the following [10]:

Theorem. Let $(\boldsymbol{H},\cdot)$ be an H_v-group and denote by $\boldsymbol{U}$ the set of all finite products of elements of $\boldsymbol{H}$. We define the relation β in $\boldsymbol{H}$ by setting $x\beta y$ iff $\{x, y\}\subset \boldsymbol{u}$ where $\boldsymbol{u}\in\boldsymbol{U}$. Then β^* is the transitive closure of β.

Analogous to the above theorem in the case of an H_v-ring is:

Theorem. Let $(\boldsymbol{R}, +,\cdot)$ be an H_v-ring, denote $\boldsymbol{U}$ the set of all finite polynomials in $\boldsymbol{R}$. We define the relation $\boldsymbol{\gamma}$ in $\boldsymbol{R}$ by:

$$x\boldsymbol{\gamma}y \text{ iff } \{x, y\} \subset u \text{ where } u\in\boldsymbol{U}.$$

Then, the relation $\boldsymbol{\gamma^*}$ is the transitive closure of the relation $\boldsymbol{\gamma}$.

An element is called ***single*** if its fundamental class is singleton. Remark that in the classical single-valued structures all elements are singles.

Fundamental relations are used for general definitions. Thus, an H_v-ring $(R, +,\cdot)$ is called *H_v-field* if R/γ^* is a field.

Let $(\boldsymbol{H},\cdot)$, $(\boldsymbol{H}, *)$ be H_v-semigroups defined on the same set $\boldsymbol{H}$. $(\cdot)$ is called ***smaller*** than $(*)$, and $(*)$ *greater* than $(\cdot)$, iff there exists an

$$f\in \text{Aut}\,(\boldsymbol{H}, *) \text{ such that } xy\subset f(x*y),\ \forall x, y\in\boldsymbol{H}.$$

Then we say that $(\boldsymbol{H}, *)$ *contains* $(\boldsymbol{H},\cdot)$.

The Little Theorem. Greater hopes than the ones which are weak associative or weak commutative, are also weak associative or weak commutative, respectively.

Remark. From the Little Theorem we obtain the huge number of H_v-structures which are defined on the same set. This is the reason that the H_v-structures have a lot of applications.

An H_v-structure is called *very thin* iff all hopes are operations except one, which has all hyperproducts singletons except only one, which is a subset of cardinality more than one.

Several large classes with one or more hopes as the *theta-hopes, P-hopes,* can be defined.

2. Single elements

Let $(\boldsymbol{H}, \circ)$ be an H_v-group. Notice that if an element $x \in \boldsymbol{H}$ is *single* then its fundamental class is a singleton, therefore: $\beta^*(x)=\{x\}$. We denote by $\boldsymbol{S_H}$ the set of all single elements of $\boldsymbol{H}$. The following theorems are valid [5], [10]:

Theorem. Let $(\boldsymbol{H},\circ)$ be an H_v-group and $x \in \boldsymbol{S_H}$. Let $a \in \boldsymbol{H}$ and take any element $v \in \boldsymbol{H}$ such that $x \in a \circ v$, consequently, $x=a \circ v$. Then,

$$\beta^*(a) = \{h \in \boldsymbol{H} \mid h \circ v = x\}.$$

Theorem. Let $(\boldsymbol{H},\circ)$ be an H_v-group and $x \in \boldsymbol{S_H}$. Then, the core of $\boldsymbol{H}$ is

$$\omega_H = \{u \mid u \circ x = x\} = \{u \mid x \circ u = x\}.$$

Theorem. Let $(\boldsymbol{H},\circ)$ be an H_v-group and $x \in \boldsymbol{S_H}$. Then,

$$x \circ y = \beta^*(x \circ y) \text{ and } y \circ x = \beta^*(y \circ x), \ \forall y \in \boldsymbol{H}.$$

This theorem proves that

'the product of a single element with any element is a whole fundamental class'.

Therefore, if we know one single element, then we know all fundamental classes.

Two constructions, originated from the properties the single elements have, are the following:

Construction 1. *Replacement of a fundamental class by a single element*. Let $(\boldsymbol{H},\circ)$ be H_v-group, consider a fundamental class $\beta^*(a)$ which we want to replace by an element s, where this element is going to be single in a new H_v-group, with the same fundamental group. All hyperproducts with factors elements outside the class $\beta^*(a)$, are the same as in the H_v-group $(\boldsymbol{H},\circ)$. For the rest products we set

$$s \circ x = x \circ s = \beta^*(s \circ x), \ \forall x \in \boldsymbol{H}$$

and we have a new H_v-group on the set

$$(\boldsymbol{H} - \beta^*(a)) \cup \{s\}.$$

Construction 2. *Replacement of a single element by a set.* Let $(\boldsymbol{H},\circ)$ be an H_v-group where $\boldsymbol{S_H} \neq \varnothing$. Consider any single element $s \in \boldsymbol{S_H}$ which we want to replace by a set $\boldsymbol{S}=\{s_i : i \in \boldsymbol{I}\}$. We extend the hope $(\circ)$ by setting:

$$x \circ s_i = s_i \circ x = \beta^*(s \circ x), \ \forall x \in (\boldsymbol{H} - \{s\}) \cup \boldsymbol{S}, \text{ and } i \in \boldsymbol{I}.$$

Moreover, in order to have scalar unit element e, we reduce this hope by setting

$$e\circ s_i=s_i\circ e=s_i,\ \forall i\in \boldsymbol{I}.$$

In both cases, the $((\boldsymbol{H}-\{s\})\cup \boldsymbol{S},\circ)$ is an H_v-group.

3. Suggestions for applications

Last decades hyperstructures, mainly the H_v-structures, have a variety of applications in applied sciences. These applications range from biomathematics, linguistics, physics to mention but a few [5], [11]. The applications are obtained either from the new hyperstructures or from the properties some new classes have. Mathematical modeling is the art of translating problems from an application area into tractable mathematical formulations. Mathematical models are used in empirical research because the mathematicalization of problems has several advances as: the results are clear, recognized and can be compared with other [3]. Among models there are the, so called, general models of models. The Vougiouklis & Vougiouklis in 2000, see [14], present two General Models of Models as follows:

First General Model: The stages of developing of a mathematical branch are the following five:

The choice of the basic object – the set of study.
The choice of the basic axioms – basic building rules.
Construction.
Morphisms: Maps which transfer the basic building rules.
Transformations, endomorphisms and invariant elements.

Second General Model: The ***product***, which is called Cartesian, which is based on the ordering. The ***quotient***, which is complicate and not unique procedure.

Now, we present or suggest some special applications.

An application, which combines hyperstructure theory and fuzzy theory, is to replace in questionnaires the scale of Likert by the V&V bar (Vougiouklis & Vougiouklis bar) [12], [14]. The suggestion by Vougiouklis & Vougiouklis, is the following:

Definition. *The V&V bar.* In every question substitute the Likert scale with 'the bar' whose poles are defined with '0' on the left end, and '1' on the right end:

The informants are asked to cut the bar at any point they feel expresses their answer to the specific question.

The V&V bar, has several advantages during both the filling-in and the research processing. The suggested length of the bar, according to the Golden Ratio, is 6.2cm.

The great number of H_v-structures which are defined on the same set give more models on applied sciences. In this direction we have the following application. The *isotopy* Lie-Santilli theory was born to solve Hadronic Mechanics problems (see [5] and mainly [7]). Santilli proposed a 'lifting' of the n-dimensional unit matrix of a normal theory into a new matrix. The original theory is reconstructed such as to admit the new matrix. The *isofields* neededin this theory correspond to the so *e-hyperfields*.

The proof of the main theorems for the fundamental classes has a new direction [9], [10]: The proof depends on the result! This is based in the remark that the relation β is determined from the result, that is, two elements are in relation β if they belong together in the same result. In the proof that a hyperstructure 'hide' a corresponding structure, I used an 'inverse' procedure and the length of the proof reduced drastically. With this procedure we consider that the structure we want to construct, there exists in a set of structures and then we take away all structures we do not need. Moreover, we take away all structures that they have not the desired properties. Consequently, we reverse the compose construction method, where we build with the material we have. For example, take a huge piece of marble, we carve it and reveal a statue, a structure! Therefore, the meaning of this inverse procedure is that we take off all useless material and we reveal our structure. This procedure is clear in the H_v-structures because there are too many structures, so we can take off all the useless and we obtain the desired [13].

We can present the above method in teaching a language, as follows: Suppose we want to teach a linguistic phenomenon. In order to determine this clearly, we have to take off all non-related elements. This is so, because our effort in a teaching procedure is not to give the exact definition but the fuzzy approach of it.

Finally, we present some applications derived from the properties which the single elements, have.

We remind that the basic property of the 'single' element is that it has the 'duties' of all the elements of a class. In order to see possible applications in other sciences, we must reveal what does this property means in hyperstructures. The ordinary 'operation' is a map which in every couple of elements corresponds an element, the result, of the same set. In a hope the result is a subset of the set. The definition of an operation (or a hope) and the properties of the

elements, are follows. Conversely, an operation is obtained from the properties the elements have. Let us see this fact in the following: Let $(\boldsymbol{H}, \cdot)$ be a groupoid, i.e., a set equipped with an operation $(\cdot)$. We call *(left) translation* or *action*, by an element $x \in \boldsymbol{H}$, the map

$$\boldsymbol{T}_x : \boldsymbol{H} \to \boldsymbol{H} : y \to \boldsymbol{T}_x(y)=xy$$

Therefore, the translation corresponds to every y, the element xy. Analogously, in hypergroupoids the result is a subset of $\boldsymbol{H}$.

This mathematical term state that the operation can be considered as a property of the element. The elements define the operation. Thus, the character of each element depends on its behavior with respect to the others. The same is valid in Geometry where we understand the points, lines, planes, from how they behave to the rest. If we transfer tis to man, we can state the opinion that the character of each person depends on how it behaves to the others!

In the approach of the continuous, in a mathematical way, the object is to understand this using the discrete, which has absolute properties as the single element. The *continuous* appeared as obvious, as visible in the nature and our senses (Αριστοτέλους, [1]). Its understanding, its registration and its transferring can be achieved by using the *discrete*. The number, the ordering and the geometry, with the point and the segment, visualize the continuous. Therefore, in order to understand the continuous, we use the discrete in the form of an algorithm and this leads to the 'limit'.

We hear phrases as: *the last straw, the colors ofthe spectrum, the phoneme of the sound*. The mathematic expression of such phrases belongs to the fight between continuous and discrete. This fight is a game between the nature and its understanding. We know the result and we can use this fact as tool of the game. We do this when fuzzy appears on the way to the clear. It is the game of knowledge, or better, the game of 'interventions'.

The problem to start the proof procedure based on a standard, special well-known situation, is continuous in perpetuity. In early 20th century, B. Russel in [6], states: "*Mathematics is a study which, when we start from its most familiar portions, may be pursued in either of two opposite directions. The more familiar direction is constructive, towards gradually increasing complexity: from integers to fractions, ..., and on to higher mathematics. The other direction, which is less familiar, proceeds, by analyzing, to greater and greater abstractness and logical simplicity; instead of asking what can be defined and deduced from what is assumed to begin with, we ask instead what ore general ideas and principles can be found, in terms of which what was our starting-point can be defined or deduced. We may state the same distinction in another way. The most obvious and easy things in mathematics are not those that come logically at the beginning; they are things that, from the point of view of logical*

deduction, come somewhere in the middle. Just as the easiest bodies to see are those that are neither very near nor very far, neither very small not very great, so the easiest conceptions to grasp are those that are neither very complex nor very simple (using 'simple' in a logical sense). And as we need two sorts of instruments, the telescope and the microscope, for the enlargement of our logical powers, one to take forward to the higher mathematics, and other to take backward to the logical foundations of the things that we are inclined to make for granted in mathematics."

There is an analogous application using a touchstone (metaphor) which has a special property. A *touchstone* is a small tablet of dark stone such as slate or lyddite, used for assaying precious metal alloys. It has a finely grained surface on which soft metals leave a visible trace.

Similarly, we know that the *diamond* has the highest hardness and thermal conductivity of any natural material, thus, its properties are utilized in major industrial applications such as cutting and polishing tools.

Therefore, in case we have elements with strong properties, i.e. they are characteristic in the operations, then we must start our study with these elements. We have to base our study on them. These elements are logical, basic, common, familiar, and convenient to start a mathematical study which leads to a total mathematical substantiation.

4. Conclusions

Basic conclusions from mathematical branches can be used in applied sciences, if one can find and focus on the substance of those conclusions. Therefore, mathematics, apart from the solutions with models it offers, might also reveal to the other sciences the exclusive methods employed, as well as its characteristic general conclusions.

We call the above suggestions 'philosophical' since it concerns the real meaning of the procedure which is not a simple, or strict, morphism in the specific science.

References

[1] Aristotle (Αριστοτέλους). Φυσικής Ακροάσεως, ή περί κινήσεως το Z', Βασιλεία 1531, Εκδόσεις Μίλητος, Αθήνα. 2003.

[2] Corsini, P., Leoreanu V. Applications of Hypergroup Theory, Kluwer Academic. 2003.

[3] Cross, M., Moscardini, A. Learning the art of mathematical modelling. Wiley. 1985.

[4] Davvaz, B., Leoreanu-Fotea, V. Hyperring theory and Applications, Intern. Academic Press, 115, Palm Harbor, USA. 2007.

[5] Davvaz, B., Vougiouklis, T. A Walk Through Weak Hyperstructures, H_v-Structures, World Scientific. 2018.

[6] B. Russel. Introduction to Mathematical Philosophy, Macmillan Company, 1-19, 194-206. 1919.

[7] R. M. Santilli, Studies on A. Einstein, B. Podolsky and N. Rosen argument that 'quantum mechanics is not a complete theory,' I: Basic methods, Ratio Mathematica V. 38, 5-69. 2020.

[8] S. Vougioukli. Helix hyperoperation in teaching research, Science & Philosophy Vol. 8(2), 57-163. 2020.

[9] T. Vougiouklis, The fundamental relation in hyperrings. The general hyperfield, 4thAHA Congress, World Scientific, 203-211. 1991.

[10] Vougiouklis, T. Hyperstructures and their Representations, Hadronic Press Monograph in Mathematics, USA. 1994.

[11] T. Vougiouklis, Hyperstructures as models in social sciences, Ratio Sociologica, V.2, N.2, 21-34. 2009.

[12] T. Vougiouklis. From Continuous to Discrete via V&V Bar, Science & Philosophy, Vol. 6(2), 37-44. 2018.

[13] T. Vougiouklis. Fundamental Relations in H_v-structures. The 'Judging from the Results' proof, J. Algebraic Hyperstr. Logical Algebras (JAHLA), V1, N1, 21-36. 2020.

[14] T. Vougiouklis, P. Vougiouklis. Questionnaires with the 'bar' in social sciences, Science & Philosophy, 3(2), 47-58. 2015.

[15] T. Vougiouklis, S. Vougiouklis. Hyper-representations by non-square matrices. Helix-hopes, American J. Modern Physics, 4(5), 52-58. 2015.

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Derivation of Gravitational time dilation from principle of equivalence and special relativity

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Abstract

General relativity is the exact theory of gravity which has been experimentally found to be correct with extremely high accuracy. One of the most surprising predictions of the general theory is that time runs slow in a gravitational field. Its proof formally comes from Schwarzschild metric which is a solution of Einstein field equation for a spherically symmetric mass. However, as Einstein field equation is too complex, attempts have been made earlier to derive gravitational time dilation by direct use of principle of equivalence and special theory of relativity. But this objective has been accomplished partially till date as the resulting expression agrees with the exact expression only up to first order. In this paper, by using principle of equivalence and special relativity, we present a thought experiment which helps us to derive an expression that exactly matches with the expression for gravitational time delay.

Keywords: Gravitational time dilation, Principle of equivalence, Special theory of relativity.[†]

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1. Introduction

General theory of relativity is a geometric theory of gravity in which dynamics of the objects are governed by curvature of space-time created by distribution of energy-momentum in the universe. Surprising accuracy of the theory has been established by astronomical confirmation of its predictions like deflection of light beam by sun and precession of perihelion of mercury [1]. Another important prediction which has been experimentally confirmed is the gravitational time dilation of clocks near massive objects like planets or stars [2-3]. In simpler terms, the clocks and every natural process run slowly in a gravitational field. Time period of a clock (i.e., time taken for rotation of a pointer by 360^0) as measured by another clock placed in gravitation free region increases from T_0 to T when that clock is transferred from infinity to a location at distance R from a massive object. Mathematical expression for this change as per general theory of relativity is,

$$T = T_0 \left(1 - \frac{2GM}{c^2 R}\right)^{-1/2} \qquad (1)$$

Where M=Mass of object (planet), c=Speed of light, G=Gravitational constant

The key hypothesis on which general theory of relativity stands is the principle of equivalence which states that gravitational force and inertial force are indistinguishable. A frame or observer undergoing free fall in a gravitational field acts as an inertial frame of reference. Since special relativity also involves a time dilation, few researchers [4-5] have attempted to derive the gravitational time dilation using the results of special relativity and principle of equivalence by means of thought experiments. In this regard, work of Schiff [5] is noteworthy. By simultaneously accelerating two clocks with a fixed distance between them, he derived the approximate expression for gravitational time dilation given by,

$$T = T_0 \left(1 + \frac{GM}{c^2 R}\right) \qquad (2)$$

Note that if we take a power series expansion of Eq. (1), Time period of clock in gravitational field as per general relativity is given by,

$$T = T_0 \left(1 + \frac{GM}{c^2 R} + terms\ of order \left(\frac{GM}{c^2 R}\right)^2 and\ higher\right) \qquad (3)$$

Comparing Eq. (2) and (3), we find that derivation of gravitational time dilation by Schiff [5] is correct up-to first order term. However, in this paper, we will present a physical situation which will help us in deriving the exact form of gravitational time dilation given by Eq. (1) from the results of special theory of relativity and principle of equivalence.

2. Proof of gravitational time dilation from principle of equivalence and special relativity

Let us consider a spherical object (a planet or star) of mass *M* as shown in Figure 1. Initially let two clocks **A** and **B** are at nearly infinite distance from *M* so that gravitational force on both of them are negligible. However, clock **B** is allowed to fall freely towards *M* and clock **A** is prevented from falling by applying infinitesimal force (≈ 0 force). As initially the gravitational field near

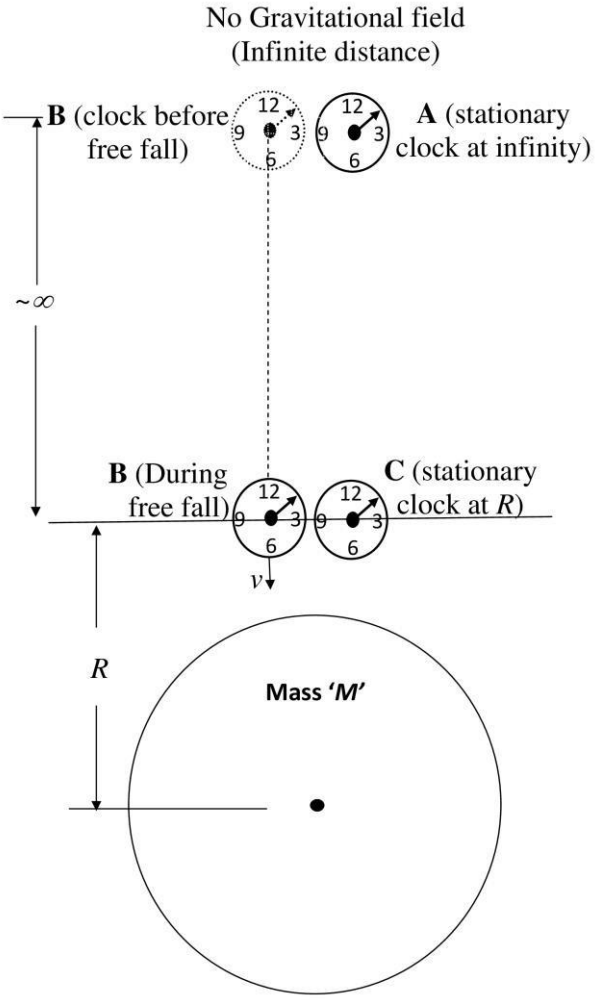

Figure 1- Pictorial representation of thought experiment for derivation of gravitational time dilation (**A** and **C** are stationary clocks, **B** is a clock freely falling from infinity)

both the clocks are approximately zero, both of them will tick at same speed to start with. Again, since the clock **B** falls freely through the gravitational field, net force on it (inertial plus gravitational) is zero and it constitutes a local inertial frame of reference in accordance with the principle of equivalence. As both the clocks **A** and **B** start with same time period and each of them is in (local) inertial frames of references, time periods of both of them T_A and T_B will *always* be same. In other words, due to free fall, gravitational time dilation of B by curvature of space-time is locally neutralized by its free acceleration as per principle of equivalence. Mathematically,

$$T_A = T_B = T_0 \tag{4}$$

During its free fall through the gravitational field, clock **B** will undergo non-uniform acceleration depending upon its distance from *M*. Suppose there is another stationary clock **C** at a distance of *R* from the center of planet *M*. Velocity of clock **B** when it just crosses the clock **C** can be calculated by using law of conservation of total energy i.e.

Final total energy at distance R=Initial total energy at infinity (which is 0)

$\Rightarrow$ Gravitational energy at R + Kinetic energy at R=0 (5)

Putting general relativistic expression for gravitational potential energy from [6] and expression for kinetic energy from special theory of relativity in Eq. (5), we get,

$$mc^2\left[\left(1-\frac{2GM}{c^2R}\right)^{1/2}-1\right]+(m-m_0)c^2=0$$

(where *m* is relativistic mass and m_0 is rest mass)

$$\Rightarrow \quad mc^2\left[\left(1-\frac{2GM}{c^2R}\right)^{1/2}-1\right]+\left[m-m\left(1-\frac{v^2}{c^2}\right)^{1/2}\right]c^2=0$$

$$\Rightarrow \quad v^2=\frac{2GM}{R} \tag{6}$$

It is interesting to note that Eq. (6) for velocity can also be derived by using non-relativistic form of both gravitational energy (i.e., Newton's law) and kinetic energy as shown below.

$$-G\frac{Mm_0}{R}+\frac{1}{2}m_0v^2=0$$

$$\Rightarrow \quad v^2=\frac{2GM}{R}$$

As the clock **B** is in a *local* inertial frame of reference i.e., it doesn't experience any gravitational field in its local region of space, a tiny observer standing on the clock **B** is *entitled to apply special theory of relativity to events happening nearby him*. When the clock **B** just crosses past the clock **C**, he will

observe the clock **C** moving up with a velocity of *v*. So, by applying special theory of relativity, he will relate the time periods of clock **B** and **C** as measured by him by relation,

$$(T_C)_{\substack{measured \\ by\ B}} = T_B \left(1 - \frac{v^2}{c^2}\right)^{-1/2}$$

Using Eq. (4) and (6) in above expression, we get,

$$(T_C)_{\substack{measured \\ by\ B}} = T_0 \left(1 - \frac{2GM}{c^2 R}\right)^{-1/2} \tag{7}$$

As we have explained earlier, clocks **A** and **B** always tick at the same rate. So,

$$(T_C)_{\substack{measured \\ by\ A}} = (T_C)_{\substack{measured \\ by\ B}}$$

Putting the above in Eq. (7), we get,

$$(T_C)_{\substack{measured \\ by\ A}} = T_0 \left(1 - \frac{2GM}{c^2 R}\right)^{-1/2} \tag{8}$$

Let *T*=Time period of stationary clock **C** in gravitational field as measured by clock **A** (placed at infinity). Then Eq. (8) becomes,

$$T = T_0 \left(1 - \frac{2GM}{c^2 R}\right)^{-1/2} \tag{9}$$

Eq. (9) is exactly same as Eq. (1) and thus, we have proved the exact form of gravitational time dilation using the principle of equivalence and special theory of relativity.

3. Conclusion

Generally, gravitational time dilation due to a massive object is derived by using the Schwarzschild metric which is a solution of Einstein field equations. But it has been felt by many researchers that it should be possible to derive the expression for time dilation by using the principle of equivalence and special theory of relativity. However, in the past, only approximate form of exact expression could be derived [5]. In this paper, we have presented a new situation or thought experiment that proves the exact value of gravitational time dilation using principle of equivalence and special theory of relativity. Surprisingly, irrespective of the use of relativistic or non-relativistic expressions for kinetic and potential energy in our derivation, we get the exact expression for gravitational time dilation matching with Schwarzschild solution of General relativity.

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References

[1] Steven Weinberg, Gravitation and Cosmology: Principles and Applications of the General Theory of relativity, (Wiley India, New Delhi, 2017
[2] J. C. Hafele1, Richard E. Keating, "Around-the-World Atomic Clocks: Observed Relativistic Time Gains", *Science*, **177** (4044), 168-170. 1972.
[3] R. V. Pound and G. A. Rebka Jr., "Gravitational red-shift in nuclear resonance", *Physical Review Letters*, **3** (9), 439-441. 1959.
[4] S. P. Drake, "The equivalence principle as a stepping stone from special to general relativity: A Socratic dialog", *American Journal of Physics*, **74** (1), 22-25. 2006.
[5] L I Schiff, "On Experimental Tests of the General Theory of Relativity", *American Journal of Physics*, **28**, 340-343.1960.
[6] Pavel Voracek, "Relativistic gravitational potential and its relation to mass-energy", Astrophysics and Space Science, **65**, 397-413. 1979.

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Traditions, a means of safeguarding authentic spiritual values

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Abstract

Preserving traditions, particularly in rural areas, can be regarded as a safety mechanism for those who can trace their roots to the respective regions. This entails the certainty of belonging to a specific social group. Therefore, in order to remain unchanged, customs and traditions need to be cultivated in the hearts of the younger generations as true spiritual values.

Keywords: traditions; rural areas; folk costumes.[†]

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1. Introduction

Vrancea is a Romanian county whose seat is the town of Focșani. The county is situated at the boundary between the historical regions of Moldavia and Muntenia (Greater Wallachia), two territories divided by the Milcov River. Situated in the south-east of the country, in the Eastern Carpathian curve, Vrancea can be seen as a transition area connecting the three historical provinces, Moldavia, Wallachia and Transylvania. The region is rich in history and represents a repository of Romanian folk culture. This is where the *Miorița* (*The Ewe*) Ballad, considered a masterpiece of Romanian literature, was first collected ([2], pp. 368-405). Local folklore is equally varied and the folk costume of Vrancea is regarded as one of the most beautiful Romanian folk creations. Folk customs and traditions are still observed in the area. In the following study, we will refer to a number of items of clothing making up the typical folk costume of this region and describe certain traditions and customs specific to this area.

2. The folk costume of Vrancea county

The beauty of the folk costume of Vrancea county resides in equal measure in the items it consists of and the craftmanship behind them. The items were made using a variety of materials, ranging from the hemp fabric, linen or wool employed in peasant households to the silk, pearl decorations, velvet or Venetian brocade available in the boyar's manor houses. The metallic thread embroidery embellishing such clothing items is a distinguishing feature of the Vrancea folk costume. Sadly, the outbreak of the two world wars in the twentieth century was accompanied by a deterioration in the quality of these garments. As the poverty rates increased, the inhabitants were forced to use much cheaper materials. Moreover, as a result of growing urbanization, the folk costume stopped being worn in a large number of rural households [6].

Nowadays the folk costume is only donned by villagers in mountainous regions, particularly on feast days or other special occasions. In urban areas, folk costumes are only worn in the course of festivities or by school children at end of year shows.

The folk costume of Vrancea is a variant of the folk costume of the Moldavian Plateau, and can be identified by a number of distinguishing features. Two of the typical elements of the Vrancea folk costume are the twisted sleeve shirt and the loose slacks [23].

The female attire

Due to the multitude of items making it up as well as the variety and richness of its decorations, the female attire represents the centrepiece of the Vrancea folk costume. There are distinct outfits for workdays, feast days or special occasions, with specific features depending on the age of the wearer. There are special outfits for little girls, unmarried young women, married women below or over the age of 40. Past their forties, women wear a costume with minimal embellishments, regarded as suitable for that particular age. It is characterized by the use of dark colours, particularly black.

The focal point of the female folk attire is the headdress, with noticeable differences between girls and married women. As regards the hairstyle worn by little girls and adolescents, it can be noted that they usually wore their hair in loose braids, or in a crown braid, without covering it. Once they were married, they adopted a more elaborate hairstyle. This entailed parting the hair in the middle, then braiding it and fastening it in a single plait crown or in a bun. Once a woman was married, she was no longer allowed to go out without covering her hair, such behaviour being regarded as sinful [3].

Salba [**the necklace**] is an item of jewellery worn around the neck. It consists of one or several strings of precious stones, coins, pendants or beads. It is part of the Romanian expression "*salba dracului*" [the devil's necklace], used to designate a malevolent, villainous, dishonest individual [16].

The earring is an adornment that hangs from the ear lobe. It is generally worn by women and consists of a metal ring which can be further embellished with coins or precious stones [12].

Coin necklaces and earrings highlighted the social status of the wearer whilst simultaneously serving an aesthetic purpose. The preferred style of necklace generally featured three rows of yellow glass beads (hanging at the base of the neck, above the chest and across the chest). Yellow beads were worn by wives, while the ones worn by older women were darker in colour. Earrings were made of gold, silver or other brightly coloured materials (red, blue, etc.) and were worn by girls since infancy. Brides wore metal earrings, which were a wedding gift from the bridegroom, and old women wore round hoop earrings [3].

The **shirt** is a clothing item made of linen or silk. It is worn next to the skin and covers the upper half of the body. It appears in a number of idiomatic expressions, such as *a rămâne în cămaşă* [to be left with *nothing but the shirt on one's back*], meaning that one has been reduced to poverty, has lost everything, or *îşi dă şi cămaşa de pe el* [he'd give you the *shirt* off *his back]* which suggests excess charity and generosity. Another expression featuring the same word is *a nu avea (a nu şti) pe unde să scoată cămaşa* [to have nothing up

one's sleeve] which refers to being in great trouble, not knowing how to get oneself out of a predicament [11].

The shirts women wore on workdays were made of hemp fabric and cotton and the ones meant for feast days were made of cotton and silk. The cut of the shirt featured either a straight collar, following the line of the neck, and sleeves widening from the shoulder, or a square or round opening and no collar, or a bib, if it was made of cotton fabric [3]. In terms of how the garment was structured, three distinct types of shirts were worn by the women of Vrancea: the creased neck effect shirt, the twisted sleeve shirt and the wide sleeve shirt or oversized shirt.

The creased neck effect shirt is a clothing item based on the ancient Dacian shirt and is very richly decorated; the style of its embellished sections is borrowed from the decorated shoulder bands of traditional Romanian blouses.[‡] The sleeves are cut from a single piece of fabric, have a small fold under the arm and end in a cuff referred to as the 'bracelet' ([1], pp 16-17).

The twisted (or spun) sleeve shirt is one of the most representative items of clothing worn in Vrancea communities. It commanded attention and was relatively rare, which augmented its value. The spiral sleeves were created by means of special sewing techniques and contributed to the understated elegance and simplicity of the garment. The distinguishing features of this type of shirt result from the unique design of the sleeves. Such a shirt is tailored from a piece of linen cut width wise into four equal strips, representing the front, the back and two folded sections. The sleeves are tailored by cutting two right-angled triangles out of a piece of fabric measuring approximately 1.5 metres in length; the cut is made diagonally, from one corner of the piece of fabric to the opposite one [24]. The sleeve features an embroidered shoulder band, which is where the structure begins to twist, and the embellishments follow the line of the sewn edge.

The wide sleeve shirt or oversized shirt is based on a straight type of cut. The sleeves are fastened to the rest of the shirt at the shoulders and are as wide as those of men's shirts, hence its name ([1], pp 23-24). During the interwar period, shirt designs started to feature wide sleeves or a ruffle tied up at the bottom. The embroidery was outshined by sequins, and the colour blue became increasingly prevalent. Vegetable silk embroidery, a subtler and more delicate type of embellishment, started being used towards the end of this period, maintaining its popularity until the 1960s. Rural households became poorer during the Second World War and as a result of this wool took the place of linen. On the other hand, sequins continued to be used, resulting in more resplendent garments [6].

[‡]According to DEX (*The Romanian Explanatory Dictionary*), 'altița' [the shoulder band] is the shoulder section of male and female shirts and is decorated with a variety of embroidered patterns.

The word *catrința* [**the apron skirt**] is derived from the Hungarian *Katrinca* and refers to an important part of the folk costume worn by Romanian women, an item of clothing with side slits which can be worn either as a skirt or as an apron. It consists of a rectangular strip of fabric, woven with different colours of wool thread, primarily red and black. Apron skirts were home-made and decorated with flowers or traditional Romanian patterns. They had to undergo a dying or 'blackening' process, which entailed using vegetable dyes obtained by boiling alder or oak bark [10].

The apron skirts of Vrancea county are not structurally different from the items worn in other parts of the country, but stand out through a number of particularities to do with the way in which they were decorated. For instance, women past the age of 40 used to wear a black apron skirt with a red stripe on the hem ([1], pp 25-28). The apron skirt is a typical element of the folk costume worn in mountain villages. In plateau areas the apron skirt was replaced by the 'flannelette' or 'flannel' skirt. This item was woven out of wool and featured a simple pattern of yellow, red, blue or green stripes, one fingerbreadth wide. It was a floor length garment with abundant pleats, worn by young girls and older women alike [3].

The male attire

As far as the male attire and headdress are concerned, things are less complicated than in the case of women. Most men used to wear a beard or grow their hair long, apart from those situations when they pursued an education or had to do their military service [6]. During the summer, unmarried young men wore wide-brimmed hats decorated with flowers and peacock feathers fastened above the right ear. Younger boys wore plain hats. During the cold season, young and old men alike wore winter hats. In order to showcase their wealth, some locals wore pointed hats, white, grey or black in colour. The hats worn on feast days were round, with an upturned edge [3].

The shirt

The items of clothing making up the male attire are generally fewer in number and less richly decorated. This was partly due to the fact that men were less involved in the various routines and important events in the life of the village. The 'wide sleeve' shirt (with a very large opening) was extremely appreciated on feast days. This item of clothing gave birth to the idiomatic expression *a primi cu mâneci largi* [to receive with open arms], that is to give a warm welcome to those crossing your threshold. It was gradually replaced by the 'cuffed' shirt, a more practical option given that the sleeves entail less work on the part of the women sewing them. Sometimes, both types of shirts were

worn on feast days. An advantage of the cuffed shirt was that it didn't reveal any skin while the wearer was dancing [6].

The male work shirt was made of cotton and hemp fabric (the so-called *homespun fabric*, a type of linen woven using hemp, flax or cotton). The shirts intended for feast days were made of cotton and silk and worn by men of all ages. Men's shirts were knee length and had a straight collar that followed the line of the throat. They fastened at the neck by means of either two laces or two buttons. The decorations were embroidered manually, using white, yellow or blue thread. Feast day shirts were worn on top of long johns. The same floral patterns used to embellish the shirt were also embroidered on the legs of the long johns.

According to DEX (*The Romanian Explanatory Dictionary*), *izmenele* [**the long johns**] are items of male underclothing that cover the body from the waist down to the ankles. Long johns worn on work days were made from the same type of fabric that was used for shirts, and the ones meant for feast days were made from cotton fabric [3].

Iţarii [**the slacks**] are a type of tight-fitting or creased trousers worn in rural areas during the warm season. They are made of cotton or wool and worn on top of the long johns by mountain dwellers or shepherds [19]. A specific feature of Vrancea resides in the fact that, unless the occasion was a special one, the shirt was tucked inside the slacks, not worn loose on top of them, as was the case in other areas.

In addition to the twisted sleeve shirt, specific to the area, another characteristic element of the Vrancea folk costume was represented by the loose slacks. They were made of baize (a thick cloth) and stood out through the asymmetrical layout of their folds. This asymmetrical cut resulted in a garment which looked the same from the front and the back and was equally wide in both directions. They were also known as night slacks and cannot be found in any other ethnographic area of Romania or beyond the country's borders ([1], p. 38). Apart from the long johns and slacks, the men also wore trousers. These were made of brown cloth dyed with walnut shells. The trousers were usually worn in winter [3]. During the post-war period, as a result of increased trading and closer links with the city, the folk costume was worn by fewer and fewer men [6].

Common elements of the male and female attire

The section below outlines a number of items of clothing worn in equal measure by women and men.

The handkerchief. This fashion accessory was made of cotton fabric and its corners were embroidered with cross stitched flowers. The colours used to decorate it were red, blue and yellow ([4], p. 313).

The girdle is a component of the folk costume worn by both men and women. Women fastened the girdle on top of the shirt and followed it with the apron skirt or flannelette skirt. Men wore the girdle on top of the shirt, which covered the slacks, long johns or trousers. The girdle was woven out of wool. A white girdle was worn on work days and the one intended for feast days was red or featured a combination of red and green [3].

Bunda **[the winter coat]** is a long shaggy coat made of sheepskin. It is a winter garment generally worn by men [9].

Ciubota **[the boot]** is a type of lace-up boot or riding boot. Traditional types of footwear were worn both on work days and feast days and were made of pigskin [8].

Cojocul **[the shearling coat]** is an item of clothing made of sheepskin. It has a thick fur lining and is particularly popular as a winter coat in the countryside. The word is part of the idiomatic expression *iarnă cu şapte cojoace* [seven coat worth winter] used to describe an extremely harsh season [13].

The hood is an item of clothing made of baize or a variety of waterproof fabrics; it is cut in the shape of a conical bag [14]. In the Vrancea area the hood has a particular status, as it serves a double purpose, protecting the head against rain or snow, but also functioning as a bag [6].

Opinca **[the folk boot]** is a traditional item of footwear fastened around the foot with a strap or a shoelace. It is made from a rectangular piece of leather or rubber [20].

Pieptarul **[the vest]** is an item of clothing made of baize or wool. It is a sleeveless jacket which covers the upper half of the body [15].

Sarica **[the woollen overcoat]** is a long traditional overcoat, made of thick wool thread. It is worn by mountain villagers, particularly by shepherds [17]. Its attractiveness depended on how shaggy it looked and it was worn by the most prominent members of the local community on feast days [6].

According to the *Romanian Explanatory Dictionary*, *sumanul* **[the folk coat]** is a knee-length coat worn by peasants. It is made of thick handwoven wool cloth and worn by both men and women. It could be black or grey (the natural colour of wool).

Traista **[the bag]** This fashion accessory was woven out of wool and mostly worn by women. The material it was made of resembled the one used for flannelette skirts. Work day bags were made of hemp cloth [3].

The folk costume of Vrancea county is a variant of the traditional Moldavian attire and the main structural elements, the cut, as well as the materials used in the making of these garments are quintessentially Romanian. Because all traditional attires have common roots, the folk costume of Vrancea county is influenced both by the garments in other parts of Moldova and by the clothing worn in other Romanian regions: Wallachia, Oltenia, Transylvania, Banat. For instance, variations on the flannelette skirt can be encountered in the Ialomiţa area and around Oltenia. It is particularly important to note that the hood, the folk boot, the shirt, the apron skirt, the shearling coat are depicted on Trajan's column and on the metopes of the Tropaeum Traiani monument ([4], p. 319).

In the present age, a large number of renowned fashion houses are drawing inspiration from the Romanian folk costume, especially the Romanian blouse known as *ie*.

3. Traditions and customs specific to the Vrancea region

The section below will outline several of the traditions and customs found in the Vrancea region.

Chiparuşul **[the funeral dance]** is a funeral rite specific to the Vrancea region [24]. It is a dance routine performed by twelve men whose faces are covered by traditional masks [5]. The masks are crafted from wood and depict an old man and an old woman. Such masks are still being used in the countryside to ward off evil spirits. It is said they help dispel dark thoughts, curses and ill health. The masks can also be displayed in front of the house [21]. As per tradition the men would wear these masks while dancing in front of the house of the deceased person [24]. They would stand one behind the other, being bound by the 'chain of life.' As the masked men danced around a fire, they would occasionally jump over the chain to symbolise the purification undergone by the soul of the dead person. Nowadays, this funeral dance is only performed during wakes organised for the elderly.

Hora cu scrânciob **[variation on the *hora* folk dance, involving a swing]** is an Easter Monday rite performed by the local young men [22]. It is a tradition specific to the Vrancea region [24].

The swing is a large wooden implement which can be made to spin or gyrate and thus provide a means of entertainment. Although it is also referred to as a cupboard [18], the swing is more reminiscent of a water mill wheel. The device is set into motion by the sturdy young men of the village, who turn a crank. As per tradition, girls of marriageable age are entertained on the swing by the young men wooing them. The swing supposedly makes the girls dizzy and they can therefore be more easily persuaded to get married. The boys were rewarded for their efforts with gifts of decorated or dyed Easter eggs [5]. Older people and married couples occasionally took a turn on the swing, which was said to be a way of ensuring a prosperous year and making one's wishes come true [22]. This particular ritual was only performed during the days following Easter. When this period was over, the local young men dismantled the swing, which was put into storage until the following year [5].

"Uncheşii şi babele" de la Păuneşti **["the gaffers and gammers" of *Păuneşti*]** is an old ritual in which carollers wear terrifying masks [7], crafted from sheepskin or goatskin and decorated with goose or duck feathers. Later on, these masks were further embellished with tinsel or ribbons [5]. This 1st of January custom is associated with the Păuneşti commune in Vrancea County, where the participants announce the beginning of a new year by chasing away the evil spirits of the one that has just ended [7]. The 'gaffers and gammers' carry cowbells and scare away the spirits by means of loud noises [5].

4. Conclusions

The folk costume is one of the greatest expressions of Romanian creativity. Folk art represents an important link between the village and the rest of society, irrespective of the aspects it incorporates. Nowadays there are still areas in which older people wear the traditional folk costume, which highlights the significance of the Vrancea region as far as Romanian history and civilisation are concerned. In this part of the country traditions have not been affected by the passage of time and the villagers are still attached to old customs [6].

For the essence of Romanian customs and traditions to be preserved, they need to be instilled into the hearts of children and young adults as authentic spiritual values.

References

[1] Bobu Florescu, F. Caiete de artă populară-Portul popular din Ţara Vrancei. Bucuresti: Ed. Editura de Stat pentru Literatura si Arta. 1958, pp.16-17.
[2] Diaconu, I. V. Alecsandri și etnografia Vrancei, în Ținutul Vrancei, IV. Bucuresti: Ed. Minerva. 1989.
[3] E. Pavel. Contributii la studiul portului popular din judetul Vrancea. Muzeul Vrancei, Studii si comunicare, 2, 1979, 171-189. http://www.muzeulvrancei.ro/noutati/publicatii/studii-si-comunicare-vol-2/
[4] Pavel, E. Studii de etnologie românească. Iasi: Ed. Princeps. 2006.

Websites

[5] http://vn69pro.blogspot.com/2014/03/traditii-vrancene.html , accessed on 1.05.2019, 10:25.
[6] http://www.traiesteromaneste.ro/portul-popular-vrancean/, accessed on 3.03.2019, 13:07.
[7] https://adevarul.ro/locale/focsani/foto-video-unchesii-babele-alungat-anul-vechi-l-au-intampinat-nou-loc-obicei-vechi-1_5a4a2dc8d7af743f8defe5bc/index.html , accessed on 2.05.2019, 14:26.
[8] https://dexonline.net/definitie-ciubotă, accessed on 4:03.2019, 9:44.
[9] https://dexonline.ro/definitie/bunda, accessed on 3.03.2019, 18:12.
[10] https://dexonline.ro/definitie/catrinta, accessed on 3.03.2019, 12:25
[11] https://dexonline.ro/definitie/cămașă, accessed on 22.02.2019, 14:15.
[12] https://dexonline.ro/definitie/cercel, accessed on 18.02.2019,11:30
[13] https://dexonline.ro/definitie/cojoc, accessed on 3.03.2019, 18:33.
[14] https://dexonline.ro/definitie/glugă, accessed on 3.03.2019, 13:14.
[15] https://dexonline.ro/definitie/pieptar, accessed on 3.03.2019, 17:39.
[16] https://dexonline.ro/definitie/salbă, accessed on 18.02.2019, 10:42.
[17] https://dexonline.ro/definitie/saricǎ, accessed on 3.03.2019, 14:11.
[18] https://dexonline.ro/definitie/scranciob , accessed on 2.05.2019, 10:50.
[19] https://dexonline.ro/intrare/ițar/29440, accessed on 3.03.2019, 12:48.
[20] https://dexonline.ro/intrare/opincă/39216, accessed on 4.03.2019, 9:20
[21] https://invrancea.ro/chiparusul-riatual-de-inmormantare-unic-in-europa/ , accessed on 1.05.2019, 10:46.
[22] https://traditiidinvrancea.wordpress.com/ , accessed on 2.05.2019, 10:30.
[23] https://www.etudier.com/dissertations/Portul-Vrancean/211119.html
[24] https://www.tara-vrancei.ro/traditii-si-obiceiuri-din-tara-vrancei.html , accessed on 2.05.2019, 10:41.

[25] https://www.traditii.pancarpatica.ro/ari2_1843-costumul_popular_femeiesc_din_tara_vrancei.html , accessed on 27.02,2019, 15:30

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Dad jokes, D.A.D. jokes, and the GHoST test for artificial consciousness

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Abstract

The ability of a computer to have a sense of humor, that is, to generate authentically funny jokes, has been taken by some theorists to be a sufficient condition for artificial consciousness. Creativity, the argument goes, is indicative of consciousness and the ability to be funny indicates creativity. While this line fails to offer a legitimate test for artificial consciousness, it does point in a possibly correct direction. There is a relation between consciousness and humor, but it relies on a different sense of "sense of humor," that is, it requires the getting of jokes, not the generating of jokes. The question, then, becomes how to tell when an artificial system enjoys a joke. We propose a mechanism, the GHoST test, which may be useful for such a task and can begin to establish whether a system possesses artificial consciousness.

Keywords: artificial intelligence, humor, consciousness, Douglas Hofstadter, Turing test[§]

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1. Introduction

Donald Mitchie (1993) argues that we need to recast the traditional distinction between the easy and hard problems of consciousness when considering artificial intelligence and instead think in terms of "the problem of artificial intelligence" and "the problem of artificial consciousness." The former, he argues, requires a successful Turing test; while the latter, he contends, demands something different, what he terms a successful "Searle test."

In other words, we can think of the question of artificial intelligence as being comprised of four different questions:

(1a) Can a constructed artificial system be intelligent?
(1b) What test would separate the intelligent from non-intelligent constructed systems? (2a) Can a constructed artificial system be conscious?
(2b) What test would separate the conscious from the unconscious constructed systems?

Questions 1a and 2a belong to the computer scientists, whereas questions 1b and 2b belong to the philosophers. The questions 1b and 2b ask how we define the terms, where we draw the line, and how can we operationalize it. Questions 1a and 2a are challenges to develop systems that cross the line or theoretical arguments providing reasons to believe the line can never be crossed. Indeed, the answers to 1b and 2b in no way presume that the test may ever be passed. Even if one could show, as some argue, that machine consciousness is impossible, the claim that the answer that 2a is "necessarily no" presumes that there is an answer to 2b (an in-principle Searle test, in Mitchie's terminology) which we can demonstrate that no computer could ever successfully complete. To contend that 2a is *a priori* false requires accounting for the necessary existence of a gap between the upper limit of technological systems and what would be required by a hypothetical system that could pass the proper Searle test.

Today, with machine learning as an established subfield of computer science, we can be assured that question 1a, the problem of artificial intelligence, has been answered in the affirmative. This is not to say that there is not interesting philosophical work still to be done around question 1b. The line has surely been crossed, but the questions "where exactly was the line" and "why put it there?" remain interesting.

Mitchie refers to an answer to 1b as a "Turing test," but that is in the general sense of that ambiguous term. Whatever the correct answer to 1b turns out to be, it will remain an issue for Turing scholars to assess how Alan Turing's various versions of the imitation game, and the assorted extensions of it, turn out to relate to that line. The questions 2a and 2b, on the other hand, both remain tantalizingly open. To 2a, we have to answer "no." But it is unclear whether by "no" we should mean "not yet" (the empiricist position) or "not possible" (the a priori position). To

distinguish between these, we would need to assess the possibility that one could in principle construct a system that would pass Mitchie's Searle test. But that claim requires having the proper Searle test, in other words, the answer to 2a presupposes an answer to 2b.

There are two approaches to 2b, that is, two very different visions of what a successful Searle test would look like. On the one hand, there are the "behaviorists" who argue that a successful Searle test would be of the same sort as the successful Turing test, only include more intricate criteria. On this view, one can infer consciousness from something like an imitation game only including, say, output that requires some capacity beyond learning, e.g., creativity. On the other hand, there are the "structuralists," like Pentti Haikonen who contend that if machine consciousness is possible, tests for it would have to be concerned with internal structure of the system and not inferred from output of it. We can infer nothing from the results, only from a similarity of structure.

A lot, therefore, hangs on the formulation of a successful Searle test. We explore a novel approach, the GHoST test, which does not offer a complete answer to 2b, but does allow us to establish the intellectual neighborhood in which the successful Searle test would have to reside, through something akin to the intermediate value theorem, that is, we will be able to see how passing the GHoST test in one sense is insufficient for consciousness and how passing it in a different way would be clearly sufficient. Hence, the proper Searle test, whatever it turns out to be, will have to draw the proper line somewhere in between.

The GHoST test is a behaviorist test, which differs in important ways from the standard approach (and which will require an additional structural element). A strand of the behaviorist research program to develop the proper Searle test focuses on computer creativity, with a sub- strand devoted to computer humor creation – to be truly funny, they contend, requires consciousness. We argue that this approach provides too weak a criterion to act as a proper Searle test. Instead of looking for a system capable of generating laughs in humans, we should instead look for a system capable of creating digital auto-didactic, or D.A.D. jokes, that is computer- generated dad jokes. The emergence of D.A.D. jokes, jokes known not to be funny but told anyway, may, in fact, constitute evidence for machine consciousness. We contend that this approach at least succeeds in avoiding the standard problems and accounting for models of consciousness that are different from human consciousness.

2. Empiricist and a priori arguments concerning machine consciousness and the need for a Searle test

Not only is the question concerning computer consciousness open, but the question as to whether it is even a question remains open. Some, like Douglas Hofstadter contend that it is an

empirical question. We can conceive of systems, at least hypothetically, that would, pass any successful Searle test, so it is a possibility. On the other hand, there are those like Louis Marinoff who argue that given any reasonable definition of consciousness, any machine will necessarily fall short.

The classical argument against computer consciousness comes from Ada Lovelace. "The Analytical Engine has no pretentions to *originate* anything. It can do *whatever we know how to order it* to perform (Quoted in Turing, 1950, 450 – italics in the original)." A necessary condition for consciousness, Lovelace contends, is creativity. Hofstadter, who wrote his (2009) essay "Essay in the Style of Douglas Hofstadter" in the style of Douglas Hofstadter, argues that the ruling out of the meaningfulness of a creativity-based Searle test on *a priori* grounds is illegitimate. He considers David Cope's EMI which produces novel compositions in the style of human composers whose work is entered in as input. Hofstadter then posits a hypothetical, maximally successful version of the system which created new pieces of music such that the best-trained experts could not differentiate from pieces by great composers, say, Bach or Mozart. He then further imagines an analogous system which would be similarly successful in the development of scientific results. We can imagine a machine capable of writing papers with new discoveries in physics whose creative and mathematical approach is so much in the style of Albert Einstein that even physicists and Einstein scholars could not tell if it was Einstein or the machine who produced it.

Using this thought-experiment, Hofstadter proposes a *reductio ad absurdum* argument designed to bolster the intuition that the limit case of a creativity-based Searle test should be considered a successful answer to the Lovelace objection. If we had the Einstein imposter of a computer, then surely this version of the imitation game would be successful in meeting Lovelace's concern. This type of creativity is so impressive that anything capable of it surely must have a mind. Using discoveries in physics of the level and in the style of Albert Einstein as a limiting case, Hofstadter concludes that it is at least in principle possible – extrapolating from technology we have today – to envision a machine we would be forced to conclude has sufficient creativity that demands we accept it as conscious. By positing such discoveries, we can now imagine possible creative output from a machine that, if it were to be observed, would surely satisfy even the most hardened Lovelacian critic.

On the other hand, there are those like Marinoff who argue that such imaginings are irrelevant fantasies. Machines are machines and we have provable theorems concerning computability and those produce upper-limits that will always and necessarily fall on short-side of the line constructed by any successful Searle test.

> When it comes to performing quantitative tasks in competition with humans including playing games such as checkers and backgammon, or even chess and Go, the computer is no longer the underdog, but the overdog; not yet and perhaps never to be a Nietzschean *übermensch* in evolutionary terms, but demonstrably an *überhund* at parlour games (74).

Computers may have abilities that we consider cognitive and may be superior to humans in the rate and accuracy of such computational procedures, but there is a necessary difference between the organic and constructed mind that necessarily keeps computers on the weak side of the Searle test.

> I submit that a–perhaps *the*–salient difference between computer versus human performance lies not merely in *what* they can and cannot do, but rather in *how* they attempt to do what they can and cannot do. In methodological terms, the computer is an entity that strictly follows instructions, while the human is a being that constitutionally disregards them. Computers do exactly and only what they have been instructed to do, whereas humans are capable of an inexactitude that includes, but is not restricted to the self- prompted or unconscious misinterpretation, omission, permutation, and modification of members of a given instruction set (ibid.)

There is, in this quotation, a vague appeal to an intuitive Searle test which, Marinoff argues, will necessarily be failed by any computer no matter how powerful the hardware and subtle and clever the software.

He considers two competing arguments based upon Church's theorem. The first is the empiricist argument which he frames as:

1. All and only intuitively computable functions are Turing computable (Church's theorem).
2. Understanding and meaning are intuitively computable functions we just haven't figured out how to compute them yet. (Empiricist belief)

Therefore, understanding and meaning are Turing computable. (Strong AI)

Contrast this with the a priori argument:

1. All and only intuitively computable functions are Turing computable (Church's theorem).
3. Understanding and meaning cannot be intuitively computable functions. (a priori belief)

Therefore, understanding and meaning are not Turing computable. (Denial of strong AI)

We do not have a proof of Church's theorem, but as both views depend upon it equally, let us assume it. The question is whether we have good reason to believe 2. or 3., and Marinoff argues that "we have reason for supposing the understanding and meaning are not intuitively computable," what he terms the "reverse Turing test, furnishes one such reason (76)."

> Suppose that a human (H1) is given a set of instructions (S1) which, if faithfully executed, would result in the imitation of a Turing machine (T1). But suppose that the human makes meaningful mistakes in their execution. Now, we ask whether we can build another Turing machine, T2, such that T2 can make meaningful mistakes (ibid.).

The answer must be yes or no. If no, then no strong AI. If yes, then T2 must have been given a set of instructions S2 which it faithfully executed, thereby not truly having committed meaningful mistakes, but rather have made no mistake in imitating humans who make meaningful mistakes. He has revived the Lovelace objection.

Two points need to be taken away from this. First, both Hofstadter and Marinoff presuppose, a line but do not establish a Searle test telling us where it is. Hofstadter gives us a thought experiment whose conclusion is presumed to have passed any reasonable line, where Marinoff gives us an argument that presumes that any mere instruction executing system must not have crossed any reasonable line. For either of these arguments to be complete, the line needs to be established. Second, while the two disagree on whether crossing the line is possible, they both provide an interesting insight that may allow us to think more clearly about where the line is. Marinoff focuses on human's proclivity for making meaningful mistakes. Hofstadter has made a similar claim, that we will know that we have artificial consciousness when we find humans and computers making the same sort of mistakes. They may both be correct that the missing element in the conversation, the successful Searle test could be something related to a reverse Turing test.

3. Possible forms of a Searle test

There are two different approaches to testing for artificial consciousness, behaviorist and structuralist. The behaviorist tests are those that draw the line based on the output of a system. Such tests are appropriate for Turing tests (in Mitchie's sense) because, unlike in the case of consciousness, intelligence does not fall prey to the Lovelace objection. To act intelligently is to be intelligent. If, for example, we were to take learning as a sufficient condition for intelligence, one cannot imitate learning without learning. In this way, intelligence is like singing. The only way to imitate singing is to sing. As such, the question is which sorts of cognitive behavior are the correct ones with which to draw the line and do we have examples of artificial systems engaging in it.

But consciousness is a completely different matter. Where intelligence is a behaviorist notion and thereby open to behaviorist testing; consciousness seems to require something not directly observable, something within the system. One could create an object that imitates being conscious without being conscious, examples are plentiful from Eliza and Siri to *Weekend at Bernie's* and Munch's Make-Believe Band at Chuck E. Cheese.

Behaviorists argue that the problem of consciousness with respect to artificial systems is no different than the problem of other minds with regard to seemingly fellow humans. Going back at least as far as René Descartes, the inverse problem of consciousness has been asked: how do I know that the people I believe to be conscious are not just automata? We were at that time, of course, restricted in this matter to behavioral data. B. Jack Copeland (2003) points out that Descartes' protégé Géraud de Cordemoy, in his book *A Philosophical Discourse Concerning Speech*, used the Cartesian insight to anticipate Turing's imitation game*:*

> To speak is not to repeat the same words, which have struck the ear, but to utter others to their purpose and suitable to them. …[N]one of the bodies that make echoes do think, thought I hear them repeat my words...I should by the same reason judge that parrots do not think neither….But not to examine any further, how it is with parrots, and so many other bodies, whose figure is very different from mine, I shall continue the inquiry...I think I may...establish for a Principle that...if I find by all experiments I am capable to make, that they use speech as I do,...I have infallible reason to believe that they have a soul as I do (quoted in Copland, 10).

At this time, the concept of mind and soul were considered identical, so de Corduroy has produced a principle which he deemed sufficient for determining if something has a mind: "If a non-human thing has the capacity to use speech as humans do, a condition subject to experiment, then that thing possesses a mind." When they make unpredicted conversational contributions that make sense to us and are human-like in their content, then we have reason to infer that we are interacting with a second, distinct intelligence.

The behaviorists contend that if this test is good enough for the opacity of the human mind (for those other than yourself), then it should be good enough for the general case. Of course, the behavior could not merely be conversational imitation, but would need to be something much more cognitively intricate to give sufficient evidence of consciousness. A standard criterion for the extended de Courtemoy approach to a Searle test involves computer creativity. Truly creative output, they argue, requires a mind and so if we can find the right sort of creative endeavor, we could formulate a creativity-based behaviorist Searle Test.

This is what Hofstadter is arguing in (2009). If a computer could produce multiple papers with legitimate scientific discoveries based on reasoning that experts could not tell from that of Albert Einstein, then this version of the imitation game would be successful in meeting the critics' concern. Discoveries in physics of the level and in the style of Albert Einstein are a limiting case. By positing such discoveries, we can now imagine possible creative output from a machine that, if it were to be observed, would surely satisfy even the most hardened Lovelacian critic.

Others have trod Hofstadter's behaviorist path by returning to Cope's musical approach, but the type of musical output in the hope that we would not need a limiting case at the level of Einsteinian physics to undermine the apriority of the Lovelace objection. Antonio Chella and Riccardo Manzotti (2012) contend that we do not need breakthroughs in physics, a sufficient demonstration of computer creativity would be found in a computer that could be an integral part of a jazz ensemble. It is one thing, as Cope's EMI system does, to compose scores, but to successfully improvise musically with a band, that is, to interact in real time with humans who are swinging and contribute artistically in a fashion that would be non-differentiable from a human musician, that should be enough to satisfy the critics and count as computer creativity.

Still others have changed the artistic medium altogether. As Turing sets out, critics contend that among the things a machine could never do is, "Be kind, resourceful, beautiful, friendly, have initiative, have a sense of humor, tell right from wrong, make mistakes, fall in love, enjoy strawberries and cream, make someone fall in love with it, learn from experience, use words properly, be the subject of its own thought, have as much diversity of behavior as a man, do something really new (1950, 447)." The one that seems most tractable is "have a sense of humor." Researchers including Huma Shah and Kevin Warwick (2017), Graeme Ritchie (2015), and Margaret Boden (2009) have therefore been focusing on using humor generation as the creativity- basis for an empirical undermining of the Lovelace objection. If we can create a computer with a sense of humor, then that sort of creativity should lead us to posit consciousness.

Ritchie (2009) notes that the operative phrase "sense of humor" is itself not rigorously defined and as such determining when a computer can be said to have a sense of humor is thus also underdetermined. To use this property in an argument for strong AI, it needs to be rigorously testable. While the notion may be vague, intuitively it seems satisfied by a person who generates original humorous utterances that others find funny. As such, if computers can create new humor that is genuinely funny, then we may have an empirical justification that undermines the Lovelace objection.

How close are we? Shah and Warwick (2017) review a number of recent attempts. Their conclusion is that some of the best computer-generated humorous utterances are somewhat amusing. In other words, we certainly do not have the empirical evidence that would be needed to counter the claim of Lovelace critics, but what they argue we may have is supporting evidence that the research program is moving in a positive direction. In other words, we have some evidence that someday we might have the evidence we need to conclude a positive creativity-based behaviorist Searle test.

Those who take the Lovelace objection to be conclusive contend that no behaviorist test will ever be a successful Searle test. Because consciousness requires internal qualities of an individual (e.g., internal monologue, sense of self, volition) and because these are always opaque, it is always possible to imitate them with truly possessing them. The only system that we know for sure possesses it is the human brain. From a physiological system comprised of mere atoms, consciousness arises as an emergent property. As such, the line goes, the only possible way to be

assured that artificial consciousness exists would be to have a system that intricately and accurately models the structure of the human brain.

On this view, the only sort of test that is possible would be structural. Neuroscientists work on their end to develop the "neural correlates of consciousness," that is, the minimal set of interrelated structural elements in the brain that allow consciousness to emerge (Crick and Koch 1990). Computer scientists then work to build an isomorphic artificial neural network. If we know what the minimal structure is for a mind to emerge, then we have our lower limit on what we need to model, go and do it.

A different version of the structuralist approach is the "cognitive approach" taken by Pennti Haikonen who argues that the isomorphism does not have to map component onto component, but rather function onto function.

> Conscious robot cognition calls for information integration and sensorimotor integration and these lead to the requirement of an architecture, the assembly of cross-connected perception/response and motor modules (Haikonen 2012, 4).

Haikonen's argument is that what gives rise to consciousness is to be found in the functional modalities of the mind. If we can construct components that do what the parts of the brain do, and have them do them interactively the way an organic human brain does, that should be sufficient to give rise to the emergent property of consciousness even if we cannot map neurons onto artificial neurons. In this way, he has developed a computerized cognitive system with internal monologue, which seems prima facie to be a property of conscious entities. Haikonen sees this achievement as a step in the right direction, but insufficient.

> How about machine consciousness? Self-consciousness is not yet emulated here, as the simulation system does not have episodic memory for personal history nor body reference for self-concept ("I") and therefore is not able to perceive itself as the executing agent. Even though the system has the flow of inner speech and inner imagery and it operates with them, it is not yet able to report having them. It is not able to produce much towards the response "I have inner imagery" or the consequence "I think – therefore I exist". Obviously, this kind of a report would only count as a proof of self-consciousness if it can be seen that the system is producing it meaningfully, i.e. the system would have to be able to perceive its inner imagery as such and it would have to possess the concepts like "I", "to have" and "inner imagery". The mere reproduction of preprogrammed strings like "I have inner imagery" would not count as a proof here (Haikonen 2000, 8).

Internal monologue may be necessary, but is not sufficient for consciousness.

However, Haikonen does point out an issue with both the behaviorist and structuralist approaches to a Searle test – neither seems sufficient in and of themself. If one has a system that appears to pass a behaviorist Searle test, one always has to worry about the Lovelace objection, that is, was the machine simply programmed to produce that seeming sign of consciousness. Is it a mere imitation? Similarly, with a structuralist Searle test, just because you have a system that structurally resembles an organic system in which consciousness emerges, do you, in fact, have consciousness? It seems that any system that passes a structural Searle test would still have to demonstrate its consciousness in some behavioral fashion. Hence, a successful Searle test seems to need both a structuralist and a behaviorist component.

4. The GHoST Test

Those who try to use humor generation as a behaviorist Searle test contend that the creativity necessary to create truly funny jokes should be seen as an answer to the Lovelace objection, that is, the ability to repeatedly construct novel comic utterances that are genuinely funny is to have a sense of humor. Only conscious beings can have a sense of humor. Therefore, this works as a Searle test.

The problem, of course, is that it does not answer the Lovelace objection. It certainly seems conceivable that one could create an algorithm that would analyze a category of joke, identify those properties that funnier jokes share, and use that to form new versions. Consider the old chestnut, "I saw a man in the park with a telescope." Humans are quick to see one ambiguity in this sentence, that you spied a man carrying a telescope versus that you spied the man through a telescope. Artificial semantic evaluation differs from human analysis in just as quickly picking up on the peculiar interpretation whereby you used the telescope to saw the man in half. Human consciousness is thereby a hindrance to finding certain linguistic interpretations which artificial means may find easily due to the lack of influence of certain sorts of psychological priming.

It does not seem absurd that such ambiguities might be used by a computer-based joke generator as the basis for pun-based jokes which, because of the learned effective joke structure, would be as funny as those of a human with a developed sense of humor, but because of the human's disinclination to see these particular ambiguities would thereby be novel jokes. So, we would have a generator of funny new jokes, but because it is all done algorithmically, we surely do not have confidence of the system's consciousness as a result. Having a sense of humor, thereby, does not seem to be a legitimate Searle test.

But the notion of a "sense of humor" is ambiguous. Indeed, Martin and Ford (2018) distinguished between three notions of that phrase. When we say someone has a sense of humor we could mean (1) that the person possesses an active faculty of humor appreciation, that is, that

they like a good joke, (2) that the person is skilled at humor delivery, that is, they are the life of the party and know how to keep a crowd laughing, or (3) that the person has an active faculty of humor production, that is, that the person is a generator of novel comic acts. These are three very different properties, yet in common parlance all of them are described by having a "sense of humor."

The one that is relevant to a possible Searle test is not the first, ability to create jokes, but rather the third, the ability to get jokes. We all have jokes that we are thoroughly embarrassed to find funny. We know these jokes are poorly constructed, morally problematic, juvenile, or just plain stupid; yet, we cannot stop ourselves from snickering at them in spite of ourselves. It is that experience of finding the funny that is the real mark of intelligence, whether or not we are capable of creating the funny or bringing the funny. What we are looking for with the Searle test, in essence, is Gilbert Ryle's "ghost in the machine," but we are looking in the wrong place with computer joke generators because while we might be able to make the machine crank out jokes, it would only be the ghost that would find them funny.

Unfortunately, we run into the Lovelace objection. We could certainly design a system that recognizes jokes and that learns what jokes humans tend to enjoy in jokes and then which mimics human laughter at an appropriate level: a guffaw for successful slapstick, a haughty chuckle at a clever witticism, and a disapproving eyebrow raise for a tight pun. This, again, would be mere imitation that would never satisfy the Lovelace critic – nor should it. We need a different approach for a comedic hunting of the ghost.

That different approach will pull together insights from several disparate sources and bring them together in a proposal for a new sort of test. The first insight came from Douglas Hofstadter (and is echoed in Marinoff). When our institution was fortunate to host Hofstadter for a visit a few years back, he responded to a question about artificial intelligence with a statement to the effect that we will know we have strong artificial intelligence, not when we see computers doing the sorts of things we can do, but when we see them making the sorts of mistakes we make. Humans and computers both make mistakes, he pointed out, but they make radically different sorts of mistakes. The output when there is a bug in a program looks nothing like the sorts of cognitive mix-ups we see in humans.

Consider the catalogue of error-types that Hostadter and David Moser (1989) collected. These include categories like malapropisms: "I like a magazine with good, objectionable reporting," spoonerisms: "tea and flick spray," infelicitous metaphors: "Welcome to Israel, a Mecca for tourists," and metaphors: "That was a breath of relief." They have a range of categories and loads of examples. Part of what makes these instances of human error amusing is that we recognize them in our own experience. They are, indeed, human. The brain works in a specific way and is prone to certain sorts of mistakes based upon that wiring.

As such, we can learn about the wiring through the sorts of errors to which it is prone. Computers are wired differently and so they make different sorts of errors, errors that we tend not to see in people. When we can construct machines that make errors more similar to ours, Hofstadter's line went during his response at the talk, then we will have machines with wiring more like ours and that is when we can lay claim to having developed artificial consciousness.

The GHoST test will appropriate the insight that we need to examine computer failings instead of successes for signs of intelligence, but change the sort of errors examined. Hofstadter's interest is in cognitive-linguistic miscues. We will argue that deeper ramifications are to be found in a quite different sort of mistake. The clue for that is to be found back in Turing (1950). In his consideration of "the argument from informality of behavior," he discusses the lack of rule- boundedness that we find in lived human choice-making.

> One might for instance have a rule that one is to stop when one sees a red traffic light, and go when one sees a green one, but what if by some fault both appear together? One may perhaps decide that it is safest to stop. But some further difficulty down the road may well arise from this decision later (Turing 1950, 452).

Turing's point is that the number of potential situations in which one may find oneself is potentially unlimited and so we would potentially require an unlimited number of behavioral rules. But we cannot know a potentially unlimited number of rules, meaning that human behavior is not rule-bound.

Perhaps this is true, perhaps it is not. The particular objection is not our concern. Rather, it is this shift from cognitive processing to social behavioral rules that is important for this matter and Turing's invocation of them provides the spark. But while all human behaviors may not be rule- based, human conversational behaviors may be. This is the well-known view championed by H.P. Grice (1975). Conversation is a cooperative endeavor and as such requires rules to function properly. Grice sets out four maxims: Maxim of Quantity: "Make your contribution as informative as is required (for the current purposes of the exchange)," Maxim of Quality: "Try to make your contribution one that is true," Maxim of relation, "Be relevant," and Maxim of Manner: "Be perspicuous." To be a responsible conversant, one should follow the rules as obeying the maxims will allow the conversation to be maximally successful and efficient.

However, these rules are sometimes broken in the course of conversation. When someone observes such an infelicity on the part of their co-conversant, there is a decision to be made. One could consider one's conversational partner to have violated the Cooperative Principle because the person is uncaring, uncouth, or insufficiently well-versed in proper conversation. But, one might reject this belief and consider one's co-conversant to be fully dedicated to the cooperative conversational project. If this were true, such an infelicity would be sure to be noticed as an

unexpected act. Perhaps the rule was violated as some sort of signal that the conversational context is about to change radically and this requires a change of behavior on both of our parts. Perhaps, the colleague whose affairs we had been discussing is coming to join the conversation necessitating a rapid change in topic. The violation of a conversational maxim may be an error that has a cooperative function. To discern the goal of the intentional error and thereby understand the intent of the speaker requires an inference, a conversational implicature, on the part of the listener.

So, from Hofstadter, we take the insight that errors may be more informative than successes. From Turing, we get the shift from cognitive-linguistic blunders to behavioral ones. From Grice, we take the notion that there may be inferences to be made from willful, intentional violations of cooperative conversational rules. What is left is an appropriate rule for comic conversation. For this, we turn to Peter Singer. Despite nearly two and a half centuries of devastating counter-examples to the principle of utility utilizing examples ranging from slavery to infanticide to bestiality, Singer continues to doggedly maintain complete devotion to it. One cannot but respect such fidelity. We can use it to formulate a Gricean sort of maxim for comic conversation that demands the maximization of comic utility, "only tell jokes that you have good reason to believe your audience will find amusing." Joke only so that you maximize overall utility.

The advantage of this sort of rule is that it can be built into a machine learning algorithm for a computer. If we design a computerized joke creation program, we can have people rate the output in such a fashion that the program will learn what people do and do not find funny. In this way there should be an observable learning curve according to which the machine gets progressively funnier. We should see a stable upward trend in the funniness of the computer's output. This is not to say that there will not be misses. There will certainly be instances that are below the trend line as there will be those which form the sorts of advances from which the machine will learn.

Putting together the insights from **G**rice, **Ho**fstadter, **S**inger, and **T**uring, we can construct the GHoST test wherein willful violation of a utilitarian principle concerning humor in conversation will provide us with legitimate warrant for an inference of true machine intelligence. We can show that this test suffices to attribute intelligence to humans and will, thus, be useful in assessing a specific set of possible artificial products.

5. Dad jokes, bad jokes, D.A.D. jokes and B.A.D. jokes

Humans are capable of violating behavioral rules. We do it all the time...some of us more than others. The stereotypical middle class American father is widely known to violate the Singer-Grice comedic maxim. Corny, clean, often pun-based jokes that the father knows will not be enjoyed by their children (particularly if teenagers and especially in the company of their friends) are known in colloquial terms as "dad jokes." Dads fully know the reception that their jokes will receive, and

yet tell them anyway. This is a clear violation of the generally accepted rule to only tell jokes that will maximize overall utility, but that does not stop Pop. Why do dads tell these unappreciated dad jokes? Because they want to. Because they find the charming little jokes funny. It is a selfish, albeit harmless, expression of volition. Dad is amusing himself. Dad jokes are bad jokes, but dad doesn't care.

Dad is a biological entity (no matter what mom sometimes says). In telling jokes that he knows others will not enjoy, but which amuse him, he is acting autodidactically. Bad jokes told by organic, living beings are "biological autodidactic" jokes, or B.A.D. jokes. Dad jokes are not only bad jokes, they are also B.A.D. jokes. B.A.D. jokes being intentional acts that violate a behavior rule are following de Courdemoy's condition, evidence that dad is intelligent (again, no matter what mom sometimes says). It is a specific sort of verbal act that requires not only an active sense of humor (in the first sense) but also volition. Dad jokes combine two elements that seem individually indicative of intelligence. Combined, they surely are even more so.

If a computer created a joke that it knew was below the standard of humor appreciated by humans, but which it decided to tell anyway, we would have an example of a digital autodidactic joke, or D.A.D. joke. D.A.D. jokes, like dad jokes, are bad jokes; but D.A.D. jokes, unlike dad jokes, are not B.A.D. jokes.

If we can use dad jokes in combination with an extended de Cordemoy condition to infer intelligence in dad, then the same ought to hold for D.A.D. jokes and their non-organic originator. If a computer acts autodidactically, then it acts with a will and only thinking things have a will. If that artificial mind possesses the desire to tell a joke it knows the audience will not enjoy, then we have reason to believe that it was told because the program itself though it was funny. This would be evidence that we are dealing with something with a sense of humor (in the first sense). D.A.D. jokes would be evidence in favor of artificial consciousness.

How then do we know when we have a D.A.D. joke? We can establish a lower bound employing a joke-generator that we know does not pass the structural element of a Searle test for consciousness (the sort discussed in Shah and Warwick 2017), but is capable of learning based upon human reactions to the jokes it constructs. In this way, there should be a positive curve with the jokes becoming funnier over time, although certainly there ought to be expected clunkers in the bunch.

Syntactic and semantic evaluation of successful jokes would produce generalized joke structures which would create templates for further new jokes. One would have to expect "I saw the man in the park with the telescope" sorts of instances wherein the novel generated joke conforms to the structure according to which it ought to be a joke that humans find funny, but which, because of our cognitive make-up, humans tend not to find funny. For example, suppose a system developed such a template for successful jokes and used it to iteratively create a joke "fractal," that is, a joke in which embedded versions of the joke structure, taken together form an

example of the structure itself. Such a joke might be capable of analysis that renders it technically successful, but beyond the capacity of the human mind to process sufficiency to garner a reaction. Or perhaps, a system could develop a combination of templates, again whose complexity undermines its comedic success despite being consistent with the a posteriori results working as the foundational input into the system. The presentation of such instances would be an example of intelligence without consciousness, yet an expectation of jokes being funnier than they are.

In other words, we would expect the artificial joke generator to "think" that these jokes are funnier than they, in fact, are. Because the system, by supposition, does not pass the structural side of the Searle test, we know that the computer, despite having good reason to "believe" the joke is funny does not find the joke funny. This is thereby the lower bound on the behavioral side of the Searle test.

Suppose, on the other hand, for the sake of argument, that we have a system that does satisfy the structural element of a Searle test. Now, we are looking for a behavior that indicates the sort of cognitive properties one associates with consciousness, the "I think, therefore I am" moment. If such a system included the same sort of joke generator that we posit in the prior example, then, again, we ought to expect a learning curve, with a positive humorousness trajectory with the occasional clunker. Clunkers would not be indications of D.A.D. jokes since we would also see them in the prior case.

What one would need to see is repeated generation of a related set of similar jokes that conform to the rules of quality joke generation, but are of the "I saw the man in the park with the telescope" variety. The joke generator would have learned through syntactic and semantic evaluation how to create jokes. Through the response to the jokes, it would have learned that there is a gap between successful jokes of the format and "I saw the man in the park with the telescope" examples, that is, there is a gap between what ought to be funny and what is funny. To continue to explore the "ought" line and not surrender it to the "is" line, despite negative conditioning, would be the digital equivalent of making dad jokes, that is, they would be D.A.D. jokes. The distinction in semantic processing should, on the condition that we do hypothetically have an instance of artificial consciousness, give rise to a different sense of humor in the first sense. The system would believe that jokes humans do not fund funny, are, in fact, funny. It would find them funny and believe that we have the defective sense of humor. Humans are cognitively limited, just not smart enough, to understand how funny these jokes, in fact, are.

The claim is not that there is or ever will be such a system. Again, what we are looking for here are the conditions for a Searle test. One can hold the a priori position that there could never be artificial consciousness, but in doing so one still requires a successful Searle test to say that computers could never get to that line. The second case is an upper limit on the behavioral element of such a test. In other words, if there was a system that passed some successful version of the structural element of a Searle test, the passing of the GHoST test as described above would then

give us reason to think we have artificial consciousness. The result then, is not that we have sketched a successful Searle test, but that with the GHoST test, we now have a lower and upper bound, between which the behavioral line must be drawn.

References

[1] Boden, Margaret. (2009) "Computer Models of Creativity," *AI Magazine*. Vol. 390, No. 3, 28- 34.

[2] Chella, Antonio and Riccardo Manzotti. (2012). "Jazz and Machine Consciousness: Towards a New Turing Test," *Proceedings of AISB/IACAP 2012 Symposium "Revisiting Turing and his Test: Comprehensiveness, Qualia, and the Real World."* 49-53.

[3] Copeland, B. Jack. (2003). "The Turing Test." *The Turing Test: The Elusive Standard of Artificial Intelligence.* James Moor (ed.). Dordrecht: Kluwer.

[4] Crick, Francis and Kristof Koch. (1990). "Toward a Neurobiological Theory of Consciousness." *Seminars in the Neurosciences.* 2. 263-275.

[5] Descartes, René. (1637). *Discourse on Method.* Indianapolis: Hackett, 1987.

[6] Grice, H. Paul (1975). "Logic and Conversation." Cole, P.; Morgan, J. (eds.). *Syntax and Semantics. Vol. 3: Speech Acts.* New York: Academic Press.

[7] Haikonen, Pentti. (2012). *Consciousness and Robot Sentience.* Singapore: World Scientific.

[8] Haikonen, Pennti. (2000). "An Artificial Mind via Cognitive Modular Neural Architecture."
https://www.cs.bham.ac.uk/research/projects/cogaff/dam00/papers/haikonen.pdf. Accessed 5/9/2021.

[9] Hofstadter, Douglas. (2009). "Essay in the Style of Douglas Hofstadter," *AI Magazine*. Vol 30. No. 3. 82-88.

[10] Hofstadter, Douglas and David Moser. (1989). "To Err is Human; To Study Error-Making is Cognitive Science." *Michigan Quarterly Review.* Vol. 28. No. 2. 185-215.

[11] Jurafsky, Daniel and James Martin. (2008). Speech and Language Processing. Englewood Cliffs: Prentice-Hall.

[12] Marinoff, Louis. (1997). "The Quest for Meaning." *Mind versus Computer: Were Dreyfus and Winograd Right?* Matjaz Gams, Marcin Paprzycki, Xindong Wu (eds.). Amsterdam: IOS Press.

[13] Martin, Rod and Thomas Ford. (2018). *The Psychology of Humor: An Integrated Approach.*
London, Academic Press.

[14] Mitchie, Donald. (1993). "Turing's Test and Conscious Thought." *Artificial intelligence*. 60. 1-22.

[15] Ritchie, Graeme. (2009). "Can Computers Create Humor?" *AI Magazine*. 30 (3). 71-81.

[16] Ryle, Gilbert. (1949). *The Concept of Mind.* New York: Barnes and Noble, 1969.

[17] Shah, Huma and Kevin Warwick. (2017). "Machine Humour: Examples from Turing Test Experiments," *AI & Society.* Vol. 22. 553–561.

[18] Singer, Peter. (1980). *Practical Ethics.* Cambridge: Cambridge University Press.

[19] Turing, Alan. (1950). "Computing Machinery and Intelligence," *Mind.* Vol. 49. 433-460.

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The maths of cause-effect relationship

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Abstract

Modern science was historically built by avoiding a direct treatment of cause-effect relationship questions. Recent developments in mathematical, probabilistic and statistical sciences make possible to pursue a more direct approach in cause-effect relationships leading to effective and systematic investigations in a wide range of scientific research fields.

Keywords: mathematics; cause-effect; probability; determinism; correlation; philosophy of science; history of science.[2]

Sunto

La scienza moderna si è sviluppata storicamente affrancandosi dalle questioni causa-effetto e affrontandole in modo piuttosto indiretto. Recenti progressi nelle scienze matematiche-probabilistiche-statistiche consentono oggi un approccio più diretto rendendo l'indagine dei rapporti causa/effetto più sistematica ed efficace in tutte le scienze.

Parole chiave: matematica; scienza; causa-effetto; probabilità; correlazione; filosofia della scienza; storia della scienza; determinismo.

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1. Introduzione

Un tema classico della scienza e della filosofia è senz'altro quello del rapporto tra cause ed effetti. Anzi, si tratta in realtà di qualcosa di profondamente radicato nel senso comune, tanto da considerarlo talvolta quasi ovvio o scontato. La filosofia di Aristotele è da certi punti di vista un tentativo sistematico di ricondurre ogni accadimento alla sua causa, teorizzando la tendenza innata dell'uomo a ricercare catene causali tra gli eventi. Tuttavia, l'indubitabile utilità dei ragionamenti causa-effetto non ne garantisce l'affidabilità, che si rivela piuttosto incerta, problematica e complessa all'analisi filosofica e soprattutto scientifica delle questioni connesse. Oltre alla difficoltà di stabilire catene causali effettive, si corre infatti facilmente il rischio di attribuire effetti a cause fittizie o non meglio identificate, o peggio portare a fraintendimenti ed errori di valutazione, anche tra esperti delle problematiche in oggetto. Quanto tempo ci è voluto, ad esempio, affinché i medici si convincessero dell'importanza di lavarsi le mani prima di interagire con i pazienti? O per riconoscere l'acqua contaminata (ad esempio rispetto al bacillo del colera) o le punture di zanzare (malaria) come "causa" di malattia piuttosto che generici "miasmi"? (si veda ad esempio [6,7]).

Inoltre, siamo proprio sicuri che tutto abbia una (o più) cause? Come riconoscere il legame e la rilevanza di una presunta causa rispetto al suo reale o presunto effetto?

Rispondere a quesiti del genere non è affatto semplice e per molti versi occorre talvolta "accontentarsi" di risposte parziali con un certo grado di confidenza. La comunicazione della scienza è poi su questi temi particolarmente ostica come testimonia in tempi recenti di pandemia da COVID-19 la difficoltà a proporre informative univoche sull'efficacia di vaccini, farmaci, dispositivi di protezione ecc. Nonostante queste difficoltà, la ricerca matematico-scientifica ha prodotto diversi strumenti capaci di affrontare in modo efficace tali problematiche fornendo agli scienziati, ai decisori politici e al cittadino medio in generale, dei validi strumenti per orientarsi in decisioni così rilevanti.

In questo articolo ci proponiamo di fornire una panoramica, seppur succinta, di alcuni filoni di ricerca scientifica correlati al tema causa-effetto focalizzando

alcuni elementi di riflessione filosofica e di comunicazione della scienza rilevanti al riguardo.

2. Ad ogni effetto la sua causa

Uno degli scopi fondamentali dell'impresa scientifica è quello di "salvare i fenomeni" e dare quindi una "spiegazione" di quanto si osserva. Di norma, questo avviene mediante la ricostruzione di una catena causale, in qualche modo riprendendo la fase dei *perché*? con cui un po' tutti abbiamo incalzato gli adulti quando fanciulli cercavamo di orientarci alla scoperta del mondo attorno a noi.

Talvolta si dice che la scienza non sia altro che un utilizzo sistematico del *buon senso* portandolo alle sue estreme conseguenze. Tuttavia, un elemento caratterizzante la scienza moderna così come emerge dalla cosiddetta rivoluzione scientifica del Seicento è proprio un certo "smarcamento" dal senso comune, specialmente nell'abbracciare aspetti controintuitivi supportati dal ragionamento logico-matematico. Nel contesto che qui ci interessa, il metodo scientifico si profila anche nel prendere le distanze dalle problematiche causa-effetto e da certi punti di vista facendone anche a meno. Nella fisica aristotelica ad esempio il moto ha sempre bisogno di una causa, un motore che trasmetta il moto al corpo facendolo muovere. Senza un motore i corpi non farebbero altro che permanere nel loro stato naturale di quiete. La necessità di determinare la causa del moto conduce come è noto ad una catena ascendente, di motore in motore, culminante in un motore immobile, che muove senza essere mosso; assieme alla difficoltà di giustificare un tale paradigma anche nei casi più immediati come per il moto di un proiettile, in cui il mezzo (aria, acqua ecc.) è da un lato il motore attivo del moto, che non sarebbe possibile nel vuoto, ma dall'altro l'ostacolo alla prosecuzione del moto stesso. La dinamica classica scardina alla base questo meccanismo accettando il fatto che alcuni moti avvengono e basta, senza una causa vera e propria. Il principio di inerzia di Newton sancisce esattamente l'equivalenza tra la quiete e i moti inerziali (rettilinei uniformi). Lo stesso Galileo, assumendo erroneamente un'inerzia circolare, riconduceva in questa linea di pensiero i moti circolari dei pianeti nel sistema copernicano a moti inerziali che di conseguenza non avevano più bisogno delle sfere cristalline aristoteliche per sostenersi.

A richiedere una causa erano invece le variazioni del moto (accelerazioni). Tuttavia, esprimersi in termini di causa-effetto può essere improprio. L'equazione di Newton $\mathbf{F}=m\mathbf{a}$ si può senz'altro leggere dicendo che la forza **F** causa l'accelerazione **a** del corpo di massa m. Ma l'equazione può essere letta

anche da destra verso sinistra e dire che una certa accelerazione implica l'esistenza di una forza, come ad esempio nel caso delle cosiddette forze apparenti o fittizie che si introducono nei sistemi non-inerziali. Il discorso diventa più sottile se si considera la faccenda dal punto di vista del determinismo e/o della predicibilità. Tipicamente, si riconosce come causa un fenomeno che precede temporalmente il suo effetto *determinandolo univocamente*. Il passato causa il presente che a sua volta è causa del futuro.

Ovvero, si riconosce che da una stessa causa che agisca nelle stesse date condizioni segua sempre uno ed un solo identico effetto. Questo schema emerge naturalmente nel concetto matematico di *funzione*, rivelatosi fondamentale in tutti gli ambiti della matematica moderna. Questo tema ha un'introduzione classica in [5]. Così, se si spara un proiettile, a parità di condizioni (inclinazione della pistola, condizioni meteo, ecc.) questo seguirà sempre la stessa traiettoria (colpendo un dato bersaglio ad esempio). Quanto appena descritto è grosso modo il contenuto della cosiddetta *causalità deterministica*, tipica della fisica classica. Il problema del determinismo è molto importante e per certi versi controverso, ad esempio rispetto alla sua (del determinismo) validità. Nel cosiddetto *meccanicismo*, ad esempio, si assume in genere un determinismo in senso forte, anzi fortissimo:

Postulato deterministico (forte): *lo stato dell'universo ad un certo tempo è completamente determinato dalle sue condizioni (iniziali) in un qualsiasi altro tempo precedente.* Come ad esempio il moto di un proiettile è completamente determinato dalla posizione, dalla velocità al momento dello sparo e anche dalle caratteristiche dell'atmosfera nella zona in cui avviene lo sparo. Pertanto, nell'ottica meccanicistica, il funzionamento dell'universo segue un rigido e determinato meccanismo senza nessuna possibilità di svincolarsi dalle inesorabili leggi che lo governano.

Ma, se tutto è necessaria conseguenza degli stati precedenti, anche il nostro comportamento e tutto quello che facciamo o pensiamo non sarebbe altro che conseguenza inevitabile di quanto accaduto tempo fa. Allora non c'è scampo, il nostro destino è segnato sin dalla nascita e le nostre scelte sono soltanto il risultato delle condizioni dell'universo che ci hanno preceduto. Quello che chiamiamo *libero arbitrio* non sarebbe allora nient'altro che un'illusione, per quanto persistente. D'altra parte, un filosofo come Hume sosterebbe probabilmente un determinismo in senso più debole, anzi debolissimo, negando qualsiasi relazione causa-effetto nei fenomeni naturali. Per un'interessante panoramica su alcune questioni connesse al determinismo si veda ad esempio il contributo del Prof. A. Strumia in [2].

Il determinismo classico si fonda essenzialmente sulla possibilità di risolvere un'equazione (differenziale) corredata dalle cosiddette condizioni

iniziali e/o condizioni al contorno, considerando ad esempio l'equazione della dinamica di Newton **F**=m**a** corredata dalla posizione e dalla velocità del proiettile al momento dello sparo. L'unica soluzione del problema, che tecnicamente è detto Problema di Cauchy, stabilisce univocamente il comportamento del proiettile e in questo senso il destino del proiettile è univocamente determinato da quanto accaduto al momento dello sparo. Similmente, data la legge di gravitazione universale, risolvendo l'equazione del moto si trova ad esempio che la Terra orbita intorno al Sole descrivendo un'ellisse in accordo con le tre leggi di Keplero. Dunque, il determinismo classico riposa sulla fiducia di saper risolvere problemi di Cauchy. Ma le cose si complicano presto. Ad esempio, basta aggiungere qualche altro pianeta, come è di fatto nel caso del sistema solare, per rendere il problema estremamente difficile. Si tratta del cosiddetto *Problema degli N corpi* che a tutt'oggi è ancora oggetto di numerosi studi sia teorici che applicativi. Si veda ad esempio [14,16].

Curiosamente, anche nel paradigma strettamente deterministico, quando si sa risolvere un problema di Cauchy la soluzione è, come si dice, *locale*. Ciò significa che è definita in un intervallo di tempo centrato nell'istante iniziale. Ovvero che la soluzione è determinata nell'immediato, se non nell'intero, futuro come pure nel passato. Questo aspetto è proprio quello che viene utilizzato per ricostruire il passato alla luce del presente, come potrebbe fare un esperto di balistica convocato dalla polizia per ricostruire il moto di un proiettile, ad esempio risalendo al luogo da cui è stato sparato, esaminando la scena di un delitto. Inoltre, se ammettiamo che lo stesso futuro abbia già in qualche modo una sua costituzione, come tra l'altro la relatività di Einstein suggerisce, allora si potrebbe anche ribaltare la questione affermando che è il futuro a determinare il presente (e il passato). Usualmente gli investigatori sostengono che la morte della vittima è stata causata da qualcosa come lo sparo di una pistola, ma, utilizzando le stesse leggi di natura, un ipotetico funzionario di polizia che vivesse in un mondo ribaltato temporalmente rispetto al nostro sosterrebbe invece che sia il delitto la causa dello sparo del proiettile. Se questo è il caso, probabilmente avvertiremmo questo determinismo a ritroso dal futuro verso il passato come una sorta di *finalismo* (si veda anche [17]). Questo strano determinismo dal futuro al passato è ad esempio un caposaldo della presentazione di F. J. Tipler della *teologia come branca della fisica*. Comunque sia, i principi finalistici non sono nuovi nella scienza. Basti pensare alla lunga e importante storia dei *principi variazionali* secondo i quali la natura si *orienterebbe* cercando di massimizzare o minimizzare qualche quantità rilevante. Uno dei più noti è ad esempio il cosiddetto *Principio di Fermat* secondo il quale la luce *sceglie* nel suo moto la traiettoria che rende minimo il tempo di percorrenza (si veda [10] per una introduzione a questi temi). Dunque,

da questo punto di vista passato e futuro sembrano perfettamente interscambiabili tra loro. Talvolta le soluzioni del problema di Cauchy non fanno infatti differenza alcuna tra passato e futuro.

Ma per noi passato e futuro sono intrinsecamente differenti, e il tempo sembra scorrere inesorabilmente dal passato verso il futuro. Da dove nasce questa asimmetria tra passato e futuro? Tale questione è strettamente correlata al cosiddetto problema della *freccia del tempo* che tenta di conciliare tale asimmetria, codificata in modo paradigmatico nel *secondo principio della termodinamica*, con la fisica fondamentale. In ogni caso, potrebbe anche questa essere una tenace illusione, come del resto ritengono molti fisici. Oppure il determinismo deve essere un po' più debole di così. Magari consentendo qualche forma di *libero arbitrio*.

In effetti, ammesso che ad ogni causa corrisponda un determinato effetto, in generale potrebbe non valere il contrario. La corrispondenza causa-effetto può in effetti non essere univoca. E questo fenomeno non è così esotico come si potrebbe ritenere. Supponiamo ad esempio di udire il suono di un tamburo. Ci sarà allora un tamburo che ha causato il suono udito. Sì, ma quale? In un famoso articolo dall'evocativo titolo *Can one hear the shape of a drum*? [12] si fornisce una risposta negativa. Uno stesso effetto, anche in problemi di fisica classica, può essere compatibile con più cause differenti. Esistono cioè tamburi diversi che producono lo stesso suono. A queste difficoltà di individuazione si aggiunge poi nel complesso la possibilità di diversi impianti teorici compatibili con le medesime rilevanze sperimentali, che in qualche modo costringe la scienza a ripiegare da cause vere o assolute a cause probabili o relative. Da questo punto di vista, come sosteneva il biologo Per Levins, *la verità è nell'intersezione di bugie indipendenti*, per cui diventa cruciale proprio la disponibilità di modelli alternativi che affrontino stesse problematiche convergendo su conclusioni similari.

3. Determinismo e previsione

Chiaramente, se dei fenomeni non può essere ricercata una causa più o meno precisa, ogni tentativo di previsione sarebbe vano sin dal principio. Se invece confidiamo nel fatto che ad una data causa segue sempre un determinato effetto, allora c'è qualche speranza di prevedere qualche evento anche più o meno complesso. Dunque, non c'è previsione senza una qualche forma di determinismo. Ma i due concetti non sono sinonimi. Anche in un mondo deterministico, non è detto che si possa prevedere sempre. In altre parole, il futuro potrebbe anche essere perfettamente determinato ma questo non significherebbe che lo potremmo conoscere completamente. E questo per

diverse ragioni, alcune delle quali discuteremo brevemente. Dal punto di vista matematico, il determinismo dipende come accennato in generale dalla possibilità di risolvere univocamente un certo problema di Cauchy. Si tratta dunque di un problema di esistenza e unicità della soluzione per un'equazione differenziale (nella maggior parte dei casi). Ma non sempre i problemi di Cauchy ci fanno il favore di ammettere un'unica soluzione! La non unicità della soluzione significa che a parità di condizioni iniziali il nostro fenomeno potrebbe presentare scenari differenti, indebolendo le nostre possibilità di previsione. Questo aspetto è importante ad esempio nelle cosiddette equazioni di Navier-Stokes che modellizzano la dinamica dei fluidi, e per le quali anche la sola unicità (per non parlare della regolarità) delle soluzioni costituisce un problema rilevante. La soluzione completa di tali equazioni vale addirittura un milione di dollari! ([8, 16]). Ma anche nei casi di esistenza e unicità le cose non sempre filano lisce. Intanto c'è sempre la problematica legata al fatto che una cosa è conoscere o sapere che esiste una soluzione in teoria, e un'altra determinarla in pratica. Inoltre, tutte le nostre misure sono per loro natura approssimate e dunque potremmo conoscere qualunque soluzione solo in modo più o meno approssimato. Pertanto, ci dobbiamo comunque accontentare di una previsione più o meno approssimata nella realtà.

E spesso queste previsioni funzionano. Così il giocatore di biliardo, pur non potendo colpire la biglia sempre nello stesso identico modo, sa che se colpisce più o meno in un certo modo, allora la biglia farà più o meno una certa traiettoria andando in buca o colpendo la biglia desiderata. La possibilità di fare queste previsioni è legata, matematicamente parlando, al problema della *dipendenza continua dai dati iniziali* o di *buona positura* del problema di Cauchy. Un problema di Cauchy è ben posto se le soluzioni dipendono con continuità dai dati iniziali. Ovvero, grosso modo, se le condizioni iniziali cambiano di poco allora anche le soluzioni cambiano di poco. Se il giocatore di prima colpisce la biglia appena più o destra o a sinistra, o appena più piano o più forte, allora la biglia farà più o meno la stessa cosa. Ma i problemi di Cauchy non sono sempre ben posti. Anche per sistemi relativamente semplici, come per un *pendolo doppio*, ben presto il sistema diventa piuttosto imprevedibile, pur essendo perfettamente determinato. Per non parlare di sistemi più complessi, come i fenomeni atmosferici, contemplando il celebre *effetto farfalla* per cui il battito d'ali di una farfalla potrebbe determinare un uragano da qualche parte del mondo. Si tratta del cosiddetto *caos deterministico* per cui piccole discrepanze nella nostra conoscenza del sistema determinano grosse differenze nell'evoluzione futura, anche se il sistema è perfettamente deterministico, minando le nostre possibilità di previsione ([9]). Anche il nostro sistema solare ha, a lungo andare, un comportamento caotico.

E le cose si complicano ulteriormente nella fisica moderna. Molti fenomeni, come il decadimento radioattivo di un certo atomo, sembrano avvenire senza una causa precisa. Talvolta si sente dire che la fisica moderna, in particolare la meccanica quantistica, sarebbe *indeterministica*. Ma questo è a nostro avviso piuttosto fuorviante. Le equazioni della meccanica quantistica sono deterministiche! Perlomeno dal punto di vista matematico. Non si capisce come farebbero altrimenti gli scienziati a confrontare i risultati degli esperimenti con le previsioni teoriche. Il fatto è che ad essere determinate sono delle probabilità e degli enti definiti matematicamente ma fisicamente *non-osservabili*. Così non si può dire se un singolo atomo decadrà o meno, ma soltanto che un certo numero di atomi lo faranno con una ben precisa probabilità. Allora, la questione del determinismo è legata al significato di *probabilità*. Se per probabilità si intende *la misura della nostra ignoranza* allora c'è comunque determinismo che noi poveri mortali trattiamo come probabilità soltanto a causa dei nostri limiti conoscitivi. Così, quando lanciamo una moneta magari la sua traiettoria è completamente determinata dal lancio, ma il fenomeno è talmente complesso che dobbiamo accontentarci di un approccio probabilistico stabilendo che la probabilità che la moneta cada sulla testa o sulla croce è del 50%. Il meglio che possiamo fare è allestire degli esperimenti per valutare che su un grande numero di lanci il numero di teste e croci sarà più o meno lo stesso. Ma per Dio, diciamo così, il lancio di ogni singola moneta sarebbe perfettamente determinato. Questo potrebbe anche essere il caso della meccanica quantistica. Questa possibilità è legata alla cosiddetta *teoria dei molti mondi* o del *multiverso*. In questo senso, la meccanica quantistica coinvolgerebbe probabilità soltanto perché noi non abbiamo accesso a tutti gli (ipotetici) mondi paralleli. Ma per Dio, per così dire, che vedrebbe contemporaneamente tutto il multiverso, anche il decadimento di un singolo atomo sarebbe perfettamente determinato. Oppure la probabilità è in qualche modo intrinseca alla natura, come sembra suggerire la cosiddetta interpretazione standard (o *di Cophenagen*) della meccanica quantistica. Solo in questo senso si potrebbe forse parlare di un certo *indeterminismo* della fisica moderna.

In effetti molti filosofi ritengono che non abbia senso chiedersi se l'universo sia deterministico o indeterministico. Può essere entrambe le cose, a seconda della grandezza o della complessità dell'oggetto studiato [...] Ma Einstein e i suoi contemporanei dovevano risolvere un problema serio. I fenomeni quantistici sono casuali, la teoria quantistica però non lo è. L'equazione di Schrodinger è deterministica al 100 *per cento [...] Si dice che la meccanica quantistica sia non deterministica, ma è un giudizio frettoloso [...]. Il mondo è una torta a strati composta di determinismo e indeterminismo.* ([13])

Il ruolo del caso in queste considerazioni è paradigmatico e da certi punti di vista paradossale. Spesso vediamo il ricorso al caso come alla rinuncia a

determinare le cause di un fenomeno, giacché il caso consiste proprio nella mancanza di regolarità e causalità. Ma nelle considerazioni di tipo statistico, molti effetti importanti e regolari sono causati proprio dal caso. Ad esempio la legge (macroscopica) dei gas perfetti PV=nRT discende dalla teoria cinetica dei gas dall'ipotesi (assieme ad altre richieste) che le particelle componenti il gas si muovano in modo casuale. In questo quadro esplicativo il comportamento regolare al livello macroscopico del gas coinvolgente le nozioni di pressione, volume e temperatura è causato dal caso che governa il moto microscopico delle sue particelle.

Ancora, nelle misure statistiche la regolare distribuzione Gaussiana (o normale) a campana discende, tra le altre cose, proprio dalla condizione di piccoli errori casuali. Non si tratta di osservazioni marginali giacché il premio Nobel per la fisica R. Feynman ci direbbe che in fondo tutte le leggi della fisica sono di tipo statistico.

4. Alla ricerca della causa perduta

Sebbene al livello teoretico si possa in un certo qual modo fare a meno del concetto di causa, ciò non significa che le cause (scientifiche) non esistano affatto. Accanto a effetti che non richiedono una causa, la scienza moderna si poggia su un approccio se vogliamo polifonico alla problematica causa-effetto.

Più cause interagiscono tra loro sovrapponendosi per produrre l'effetto finale. Al limite estremo è l'universo stesso nella sua interezza a causare gli effetti osservati. La scienza si ritaglia in questo olismo esasperato dei campi di azione nei quali, defalcando gli impedimenti come direbbe Galileo, è possibile circoscrivere un numero limitato di cause capaci di spiegare un certo numero di osservazioni sperimentali, dalle situazioni più semplici a quelle man mano più complesse.

Così la fisica ad esempio progredisce dallo studio di un punto materiale a quello di un sistema dinamico complesso. Ed è proprio nel passare a questioni complesse, come quelle biologiche, mediche, meteorologiche, sociali ecc. che la ricerca delle possibili cause si fa più incerto e problematico poiché occorre selezionare in un mare di possibilità diverse gli elementi che contribuiscono in modo più o meno rilevante (e probabile) a causare quanto si osserva. Come si può stabilire ad esempio la causa di una malattia? O se un vaccino è efficace oppure causa un determinato effetto avverso? La difficoltà di convincere scettici e negazionisti di turno dimostra la difficoltà di rispondere a tali domande o di divulgare le risposte disponibili in modo efficace.

Nel 2020-21 si sono registrate in Italia circa centomila morti in eccedenza rispetto alla media degli anni precedenti. A parità di circostanze non c'è spiegazione se non si introduce un qualche agente causale. Con buona probabilità tale agente è riconducibile al COVID-19 e alle sue conseguenze (mediche, economiche, ecc.). Il problema principale è che si tratta di situazioni in cui non è in genere possibile fare delle indagini dirette (non possiamo ad esempio introdurre deliberatamente un nuovo virus nella popolazione per valutarne gli effetti) ma occorre accontentarsi di argomenti indiretti, di tipo controfattuale, cercando di rispondere a domande del tipo: cosa osserveremmo se un dato elemento fosse o non fosse presente? Oppure quali sarebbero le conseguenze se l'effetto osservato fosse dovuto solo al caso?

Per illustrare questo punto ci piace trarre spunto da un episodio che si racconta abbia avuto per protagonista il celebre scienziato francese H. Poincaré (1854-1912), e un furbetto panettiere. Ogni giorno Poincaré si recava dal fornaio per acquistare del pane, diciamo un chilogrammo. Fidarsi è bene, ma non fidarsi è meglio e pertanto Poincaré prese a controllare sulla bilancia il peso del pane acquistato e scoprì che troppo spesso il pane pesava meno di un chilo. Allora andò garbatamente a protestare dal fornaio. *Ma no! Sarà un errore* disse il fornaio, *le pagnotte non ci vengono mai una uguale all'altra. Professore, tenga questa*. Poincaré torna a casa e soddisfatto constata che questa volta il pane superava, anche se di poco, il chilo. Ma qualcosa lasciava perplesso lo scienziato. L'atteggiamento del fornaio non lo convinceva per niente. Allora, con la determinazione e la pazienza che solo un buon matematico può avere, Poincaré continuò a prendere accurata nota del peso del pane per un anno intero. Alla fine andò dalla polizia a denunciare il fornaio. Aveva infatti capito che il fornaio faceva la cresta sul peso del pane. Semplicemente, per tenere contento il professore, il fornaio sceglieva la pagnotta più grande che aveva a disposizione in quel momento. Come fece Poincaré a smascherare l'astuto fornaio? Verificando che i pesi del pane non si accordavano con una distribuzione gaussiana. Se, come sosteneva il fornaio all'inizio, le differenze tra una pagnotta e l'altra fossero dovute al solo caso, ci si aspetterebbe allora che i pesi debbano disporsi in una configurazione a *campana* attorno al valore medio (un chilogrammo in questo caso). Ma i dati raccolti da Poincaré non lo facevano poiché, evidentemente, la selezione operata dal fornaio per accontentarlo introduceva un fattore di disturbo che non rendeva più casuali i piccoli e inevitabili errori sulla composizione delle pagnotte. Il ragionamento di Poincaré è un tipico argomento controfattuale, allo scopo di determinare tra tutte le cause possibili quelle più probabili. Se il formaio fosse stato in buona fede, allora i dati osservati si sarebbero dovuti accordare ad una distribuzione di Gauss. Se non lo fanno allora ci dev'essere un disturbo esterno, nella fattispecie l'intervento selezionatore del panettiere.

Spesso argomenti di tal fatta risultano piuttosto controintuitivi non potendo basarsi direttamente sugli effetti coinvolti. Per questi motivi non sempre è facile convincersi ad esempio dell'efficacia di un vaccino, giacché non possiamo osservare direttamente la sua azione, ma soltanto desumerla dal contesto globale rispondendo a cosa sarebbe accaduto se il vaccino non fosse stato somministrato. Se l'incidenza di una malattia come il vaiolo, ad esempio, cala drasticamente nella popolazione umana, tanto che l'OMS ha dichiarato la malattia come eradicata nel 1979, proprio a valle delle campagne vaccinali, in mancanza di altre motivazioni la conclusione più probabile è che il vaccino abbia funzionato egregiamente. Anche in casi meno eclatanti, proprio da questo tipo di osservazione indiretta gli scienziati possono calcolare con una certa efficienza la probabilità che un certo effetto sia riconducibile (in tutto o in parte) ad una data causa. Quasi paradossalmente, talvolta è proprio l'osservazione diretta che invece può portare a conclusioni erronee, convincendosi magari che i vaccini causino l'autismo nei bambini, o che il classico "rimedio della nonna" sia efficace per le allergie. Tipicamente, si tende a cercare la causa di un effetto osservato tra quegli elementi la cui presenza è concomitante all'effetto stesso. Così, se assumiamo l'intruglio consigliato dal guaritore di turno sperando di debellare un certo male, e poi effettivamente guariamo, la tentazione di aver finalmente trovato il rimedio alla malattia è forte. Ma, come si sa, nella scienza una rondine non fa primavera. E se è per questo, non la fanno neanche cinque o sei.

In effetti, occorrerebbe intanto escludere ipotesi alternative: saremmo potuti guarire anche senza prendere nulla grazie alle difese naturali dell'organismo, o per puro caso (si tratta della cosiddetta ipotesi zero o nulla), o per effetto placebo, o chissà per quale altro motivo a noi sconosciuto. E se veniamo a sapere di tante altre persone che sono guarite in circostanza simili alle nostre non è il caso di esultare. La storia, anche recente, è piena di esempi clamorosi in proposito come quella legata al caso *Stamina* [3]. Tornando al nostro intruglio guaritore, se, diciamo, la nostra malattia avesse un tasso di remissione spontanea dell'1%, allora su una popolazione di un milione di malati ci aspetteremmo comunque un gruppo dell'ordine di 10000 guariti, e questo avverrebbe in ogni caso e per qualsiasi altro supposto rimedio. Non c'è via d'uscita se non quella di quantificare in qualche modo il rapporto causa-effetto in questione. Un modo che tutti gli studenti ai primi anni di facoltà scientifiche imparano è il concetto di correlazione che quantifica, attraverso il calcolo del cosiddetto indice di correlazione di Pearson, quanto la concomitanza tra due variabili, ad esempio fumo/cancro, forza/accelerazione, farmaco/guarigione ecc. sia (statisticamente) significativa. La correlazione permette di evitare associazioni indebite o se vogliamo illusorie. Potremmo ad esempio convincerci che ci sia una correlazione tra la nostra persona e le code al semaforo rosso

(quella che a Napoli chiamerebbero *iella*). Come mai capita sempre a noi di incappare nel semaforo rosso? Un esame attento e il calcolo della correlazione ci direbbero che l'indice di correlazione non è poi significativamente alto. Probabilmente, la nostra impressione sbagliata deriva dal fatto che prestiamo più attenzione a quando siamo costretti ad aspettare in coda nel traffico, rischiando di arrivare in ritardo al lavoro, rispetto a tutte le volte che abbiamo trovato verde senza badarci più di tanto. Possiamo dunque stare tranquilli: non siamo certo noi a causare l'accensione della luce rossa nei semafori. Similmente, potremo trovare che non c'è correlazione tra antenne 5G e infezione da Covid-19.

Tuttavia, la correlazione è soltanto una condizione necessaria ma non sufficiente. Il fatto che due variabili siano, anche strettamente, correlate non significa che valga necessariamente un legame di causa-effetto. Sebbene ci sia una significativa correlazione tra fumo e cancro ai polmoni, questo non significa che il fumo causi gravi danni alla salute, come per tanto tempo le compagnie del tabacco hanno infatti sostenuto. Dimostrare tale rapporto causa-effetto ha richiesto molta fatica in più, coinvolgendo indagini accurate non solo dal punto di vista medico-biologico, ma anche da quello matematico-computazionale, costringendo alla fine i governi ad informare i cittadini del grave pericolo, includendo frasi e immagini dissuasive sui pacchetti di sigarette.

Il problema è che anche ottime correlazioni potrebbero avvenire per puro caso, oppure essere il sottoprodotto secondario di altri fenomeni. Potremmo ad esempio trovare una stretta correlazione tra obesità e durata della vita e pensare che tutti i consigli del nostro medico volti a farci dimagrire siano infondati. Oppure che mangiare cioccolato possa aumentare le chance di vincere un Nobel ([1,4]). Mentre in questi casi si può facilmente immaginare che i fenomeni riferiti siano legati alla presenza di fattori causali comuni (disponibilità economiche, accesso a cure mediche, istruzione, ricerca ecc.) piuttosto che ad un legame causale cioccolato/Nobel, una notevole sfida alla scienza contemporanea è proprio quella di sviluppare strumenti adeguati ad isolare ed individuare legami causali di rilievo. Dai tempi di Poincaré si sono fatti numerosi progressi. Anche per le distribuzioni di tipo gaussiano da cui abbiamo preso le mosse occorre ad esempio controllare l'ipotesi di piccoli errori casuali, cosa che può essere fatta attraverso il cosiddetto test del *chi-quadro*. Negli ultimi decenni i progressi nel calcolo delle probabilità e della statistica iniziano a rendere l'indagine dei rapporti causa/effetto più sistematica ed efficace. Per un resoconto di alcuni sviluppi in questa direzione rimandiamo il lettore a [15].

References

[1] AA.VV. (2019). L'obesità allunga la vita? Le Scienze N. 61.

[2] AA. VV. (2012). Conversazioni su scienza e fede, Lindau.

[3] Bencivelli S. (2013). Il caso Stamina. Le Scienze N. 542.

[4] Bressanini D. (2013). Mangia Cioccolato e vinci il premio Nobel, scienza in cucina, Le Scienze.

[5] Cassirer E. (2015). Substance and functions, and Einstein's theory of relativity, Andesite Press.

[6] D'Amico A. (2020). La scoperta dell'immunità, Le Scienze n. 620.

[7] D'Amico A. (2021). La morte blu, Le Scienze N. 630.

[8] Devlin K. (2004). I problemi del millennio, Longanesi.

[9] Ekeland I. (2010). Come funziona il caos, Boringhieri.

[10] Granieri L. (2016). Ottimo in Matematica, La Dotta editore.

[11] Granieri L. (2015). Sull'eterno ritorno, Archimede **1**, pp. 20-21.

[12] Kac M. (1966). Can One hear the shape of a drum? American Mathematical Monthly vol. 73, n.4.

[13] Musser G. (2015). L'universo è casuale? Le Scienze N. 367.

[14] Odifreddi P. (2015). La legge della pigrizia cosmica, Le Scienze N. 566.

[15] Pearl J. Mackenzie D. (2019). The Book of Why: the New Science of Cause and Effect, Penguin Books Ltd.

[16] Stewart I. (2014). I grandi problemi della matematica, Einaudi.

[17] Tipler F.J. (2008). La fisica del cristianesimo, Mondadori.

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Healthcare and Cultural life access for persons with disabilities during the pandemic: reflections of a researcher

Dario Imperatore[1]

Abstract

The Covid-19 pandemic has put a strain on the health system, as well as the social, economic, and cultural ones at the Global level**.** After the pandemic, the risk is that the process of inclusion of persons with disabilities is grinding to a halt. But the chance is to find new ideas.

This paper will define a brief but significant framework of principles that should be taken into consideration in order to support strategies of inclusion of people with disabilities in the fields of health care and cultural life, especially through the research.

Keywords: health; cultural life; disabilities; inclusion.[2]

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1. Introduction

The Covid-19 epidemic has put a strain on the health system, as well as the social, economic, and cultural ones. Looking at the *Istat* (Italian Institute of Statistics) of 2019, there are over 3 million and 100 thousand Italians with disabilities (around 5% of the population), in a European context of about 100 million people with disabilities, as recently declared by The European Disability Forum. The current risk is to put first the interest in safeguarding "production" in favor of an economic recovery, without looking at the effective quality of social measures for people with disabilities and their families.

This paper would show some reflections on health and cultural life access (and other connections), during and before the pandemic, in order to define a brief framework of principles that should be taken into consideration on the basis of the UN Convention on the Rights of Persons with Disability

2. Health: The European Parliament's position against denial of care to people with disabilities

The Covid-19 pandemic found the world not ready to face such an emergency. States had to make decisions quickly, without the clear awareness of what was happening. Moreover, week by week the global situation was getting worse. We can reckon Italy as the first European member State that faced the pandemic. So, Italy's policymakers was not prepare to act over every national issue. Furthermore, the opposition in the Parliament did not allow a shared program of protection. So, the rights of people with disabilities risked being discriminated.

In this scenario, forgetfulness of the necessary protections can be seen, in fact, from the first Ministerial decree of the Prime Minister in 2020 - which indicates what is allowed or not allowed for citizens - that at a first has apparently forgotten to intervene on quarantine measures for families with people with disabilities.

In effect, at European level, the European Parliament[3] noted that in some Member States, people with intellectual disabilities have been denied medical treatment, have been confined to institutions in conditions of social isolation, without being able to receive visits from family members or return to their respective families, and that discriminatory triage guidelines have been

[3] The motion for a resolution 2020/2680.

introduced. For many subjects, the forced blocking of rehabilitation treatments resulted in the partial nullification of the results obtained up to that moment.

3. Health: CRPD principles that to be translated into real facts during and after the pandemic

There is, therefore, a need to verify access to healthcare for people with disabilities in a pandemic period, starting from the provisions of Articles 25, and 26 CRPD[4] (Health, Habilitation, and rehabilitation), also ratified by Italy, to overcome eventual mistakes and shortcomings, in order for planning improvement strategies, to promote the physical, cognitive and psychological recovery, rehabilitation, and social reintegration.

But in truth, the monitoring activity should be extended to a broader set of Fundamental Principles. In addition to articles 25 and 26, those of reference for this analysis are:

article 11: Situations of risk and humanitarian emergencies for the protection and safety of persons with disabilities in situations of risk, including situations of humanitarian emergencies and the occurrence of natural disasters;
articles 22 and 31: Respect of Privacy and Statistic and Data collection in order to protect the privacy of personal, health and rehabilitation information on an equal basis with others;
article 27: Work and employment in order to prohibit discrimination on the basis of disability with regard to all matters concerning all forms of employment, including safe and healthy working conditions.

Wanting to analyze the transversal impact of these principles, article 11 is a milestone since it undoubtedly recalls the pandemic situation. International and European policies, but also and above all national ones, should have immediately taken into consideration the needs of people with disabilities and their families to protect them from the pandemic.

Regarding the protection of privacy, this is an issue of increasing importance for strategic decision-making, also in consideration of the greater sensitivity of people, especially because their data are "particular" data - as more personal and sensitive than others. The Italian Privacy Authority urges the Data Controllers to identify adequate methods of protecting the particular data of people with disabilities but the pandemic situation has shown great fragility in

[4]The CRPD aims at building an inclusive society and entrusts national politics and legislation with the task of guaranteeing the enjoyment of human rights and fundamental freedoms to disabled people.

this sense, especially in consideration of patients with disabilities in the health sector.

As for article 27, in Italy, a double criticality emerges for people with disabilities regarding both the protection measures for the safety and health of fragile workers who continue to attend the workplace; and the danger of isolation and discrimination when the occupational physician establishes the preventive removal from the workplace due to the frailty of the disabled worker. A good note is given by the provision of a booking service for home vaccination for people with disabilities[5]. Here, however, further and transversal criticalities emerge. In particular two: the first is that the majority of people with disabilities need to be assisted at home because they have not autonomy and independence in mobility; the second, is the different approach to persons with disabilities in the field of health the very single regions of Italy.

In fact, in Italy, there is a system of regional autonomy in the health sector. The Regions, therefore, have exclusive competence in the regulation and organization of services and in the financing criteria of Local Health Authorities and hospitals. Consequently, there are sometimes considerable differences in terms of timing, quality and methods of providing services between regions and regions in the Italian territory, which cause territorial discrimination.

4. Cultural life: is time for new models of inclusion of people with disabilities

In the last 10 years, significant researches have been carried out concerning disability which shows the great value of cultural and leisure life for the inclusion of persons with disabilities.

But, after the Covid-19 pandemic, the risk is that this process of inclusion is grinding to a halt. The chance is to find new ideas through research supported by data collection on individual stories of life, good practices, regulations, and innovation in order to propose new models of inclusion.

5. Cultural life: CRPD principles to translate into real facts during and after the pandemic

The article 30 CRPD proposes the principle of participation in cultural life, leisure, tourism, and sport and asks States and privates to work together for

[5]Ceravolo MG, De Sire A, Andrenelli E, Negrini F, Negrini S. (2020), *Systematic rapid "living" review on rehabilitation needs due to Covid-19*. Eur J Phys Rehabil Med 2020;56(3):347-53.

implementing policies of inclusion[6]. Despite the progress made in many member States, in Europe it is apparent that a lot remains to be done for truly equal and meaningful participation in cultural life[7]. In fact, even in the period before the pandemic participation was not the norm for persons with disabilities. Furthermore, the pandemic is increasing the difference between the Member States of the European Union, in terms of planning laws and policies, building norms and standards on accessibility (e.g. those on accessible services & technologies[8], accessible tourism[9], non-discrimination[10], etc.), and the availability of expertise.

International research on the rights of individuals with disabilities is largely available, especially on the basis of the indicators of "accessibility" and "architectural barriers". However, there is no academic consensus on the meaning of "inclusion"; and generally, there is no consensus on how inclusive leisure should be defined, then there is a poor perception of leisure as a right of inclusion[11]. E.g., a swing at the playground is accessible if it allows a child in a wheelchair to play with it, but it can't be defined inclusive if it is placed far from the other games: the child in a wheelchair will be excluded because he will not have interaction with other children. In this context, the role of the research should be to contribute to aggregate data in order to re-interpret the meaning of Cultural Life as a right of inclusion of persons with disabilities. It would consent to restart social life with a new comprehension of what inclusive leisure is, and why it is a right; how an inclusive leisure activity can be organized, and which are the benefits for all society, especially to break down old social barriers, and new ones.

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[6]Raub, A.; Latz, I.; Sprague, A.; Stein, M. A.; Heymann, J., *Constitutional Rights of Persons with Disabilities: An Analysis of 193 National Constitutions*, Harvard Human Rights Journal, 2016, 29, pp. 203-240.

[7]UN Office of the High Commissioner for Human Rights (OHCHR), Professional training series no. 17: Monitoring the Convention on the Rights of Persons with Disabilities: Guidance for Human Rights Monitors, April 2010, HR/P/PT/17.

[8]Lawson, A., *Accessibility of information, technologies and communication for persons with disabilities*, Contribution to the Council of Europe Strategy on the Rights of Persons with Disabilities, 2017.

[9]Tatic,D., *Access for People with Disabilities to Culture, Tourism, Sports and Leisure Activities: Towards Meaningful and Enriching Participation*, Council of Europe Disability Action Plan, Quality life and full participation in society, 2015.

[10]Dekoninck, K., *Awareness raising on the rights of persons with disabilities*, and Broderick A., *Promoting equality and non-discrimination for persons with disabilities*, Contribution to the Council of Europe Strategy on the Rights of Persons with Disabilities, 2017.

[11]Evans, T., Bellon, M., Matthews, B., *Leisure as a human right: an exploration of people with disabilities' perceptions of leisure, arts and recreation participation through Australian Community Access Services*, Annals of Leisure Research, 2017, 20:3, 331-348.

6. Conclusion

To overcome all these limits, health and cultural life policies in Europe have to respect ethics and be implemented on a basis of equal opportunity. Policymakers should be inspired by a 'Cultural Revolution' that may raise awareness on priceless values, that are the result of social ties, such as inclusion[12] . As well, it is desirable the cooperation of the Government, opposition parties, non-profit organizations (third-sector), and all civil society for a change to the independence and freedom of persons with disabilities[13].

In the absence of a series of limits and corrective by the law, the risk is to expose the vulnerable part of society to marginality, with the consequent exaltation of the selfishness of society[14].

Everyone should do his part, and the role of the research, in this scenario, is crucial.

References

[1] MG. Ceravolo, A. De Sire, E. Andrenelli, F. Negrini, S. Negrini, Systematic rapid "living" review on rehabilitation needs due to Covid-19. Eur J Phys Rehabil Med 2020;56(3):347-53, 2020

[2] R. Dahrendorf, Lebenschancen: anlaufe zur sozialen und politischen Theorie, Suhrkamp, Frankfurt am Main, 1979

[3] Evans, T., Bellon, M., Matthews, B., Leisure as a human right: an exploration of people with disabilities' perceptions of leisure, arts and recreation participation through Australian Community Access Services, Annals of Leisure Research, 2017, 20:3, 331-348.

[12] Dahrendorf, R. (1979), *Lebenschancen: anlaufe zur sozialen und politischen Theorie, Suhrkamp*, Frankfurt am Main. (La libertà che cambia. Sei lezioni su un mondo instabile, trad. di Micchia Pia, Laterza, Roma-Bari, 1995).

[13] M. Sacconi, *Ministro del Lavoro, della Salute e delle Politiche Sociali, Direzione Generale della Comunicazione e della Direzione Generale per l'Inclusione e i diritti sociali e la responsabilità sociale delle imprese (CSR),* red by S. Tognoloni e A. Sanna. *Ministero del Lavoro, della Salute e delle Politiche Sociali*, September 2009; www.esteri.it/mae/resource/doc/2016/07/c_01_convenzione_onu_ita.pdf.

[14] Perlingieri, P. (1994), *Prolusione letta al Congresso Nazionale dei Giuristi Cattolici Italiani,*. In effect, ethics is essential to match economic efficiency and of human rights or, in other words, to match market and democracy. Cf. Campanella, F. *Lo Stato e il mercato. Le idee e i miti di un passato più o meno prossimo, in Pubblico e privato nel sistema economico*, Beretta S. (ed.), Milano, 1992, p. 99.

[4] A. Lawson, Accessibility of information, technologies and communication for persons with disabilities, Contribution to the Council of Europe Strategy on the Rights of Persons with Disabilities, 2017.

[5] A. Raub; I. Latz; A. Sprague; MA. Stein; J. Heymann, Constitutional Rights of Persons with Disabilities: An Analysis of 193 National Constitutions, Harvard Human Rights Journal, 2016, 29, pp. 203-240.

[6] P. Perlingieri, Prolusione letta al Congresso Nazionale dei Giuristi Cattolici Italiani, 1994, Cf. Campanella, F. Lo Stato e il mercato. Le idee e i miti di un passato più o meno prossimo, in Pubblico e privato nel sistema economico, Beretta S. (ed.), Milano, 1992, p. 99.

[7] M. Sacconi, Ministro del Lavoro, della Salute e delle Politiche Sociali, Direzione Generale della Comunicazione e della Direzione Generale per l'Inclusione e i diritti sociali e la responsabilità sociale delle imprese (CSR), red by S. Tognoloni e A. Sanna. Ministero del Lavoro, della Salute e delle Politiche Sociali, September 2009

[8] D. Tatic, Access for People with Disabilities to Culture, Tourism, Sports and Leisure Activities: Towards Meaningful and Enriching Participation, Council of Europe Disability Action Plan, Quality life and full participation in society, 2015.

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Transculturality. When Anthropology meets Psychology

Dino Burtini*

Abstract

The issue of interculturality will be addressed in this article not only as an encounter between different cultures, but, above all, as a reciprocal "passing through", having to understand the world of origin of the other and consequently have already understood one's own. This is true for every culture one encounters, in every context and role. To fully understand this idea, it will be important to start from the analysis of the Italian context with respect to migrations and of the system present in Italy in charge of managing them. Fundamental is the definition of the role of the therapist, in relation to an individual belonging to a culture that is different from the own, who fled the war, which often presents post traumatic disorders and finds himself in a new context, without knowing how to speak the new language, but hoping to change his life and that of his family. It will be useful to start from a univocal definition of culture as it has been analyzed and explained by anthropologists such as Malinowsky, Tylor, Bateson and others, who developed their researches in the early 1960s. It is, therefore, a preliminary step to approach the theme of transculturality, a fundamental concept of our contemporaneity, with which every health worker is required to confront, an aspect of human relationships that predicts the success of some psychotherapy modalities in the reception centers for immigrants and in the services related to them.
Keywords: Transculturality, Interculturality, Psychology, Migration, Post Traumatic Disorders, Reception Centers for Immigrants, Devereux.†

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Dino Burtini

Introduction

The theme of migration

The uninterrupted flow of immigration towards our country has brought with it a steady growth in demand for health or psychiatric and psychological counseling. An exponential increase that I have been registering for more than ten years now, both in my clinical practice as a psychotherapist and as an anthropologist researcher. The theme of migration, of massive displacements of people from one place to another on the planet is, without a doubt, the central question of our time, the macro-theme of the European destiny of the twenty-first century. It has been estimated that adding the 40 million migrants and foreigners who will arrive in Europe by 2050 to the 30 million (Eurostat data) that are already there today, they will reach a total, in the old continent, of 70-80 million.

Migrations are movements of the population from one place of residence to another, very ancient phenomena that have always accompanied the moments of population growth, technological changes, political and ethnic conflicts. For this reason, the European territory since ancient times has always been the scene of massive population movements in search of better living conditions. The factors that favor migration can be internal to the country of origin (push factors) or external, present in the destination countries (attraction factors). In general, the push factors most influence the poorest people, induced to flee their own country from conditions of extreme poverty, caused by wars and famines; often, migrants move from their own country to another neighboring country, that offers not much better economic conditions.

The attraction factors are effective on the least poor migrants who can, for example, bear the expense of a long journey. Their hope is to find a job opportunity, to earn a small capital or to get a professional qualification.

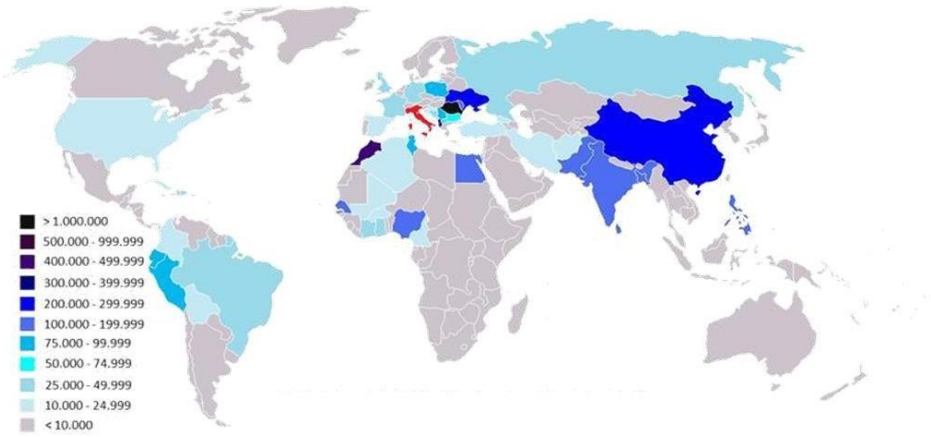

Figure 1: Number of foreigners in Italy on January 1st, 2018.

The graph shows the number of foreigners in Italy on January 1st, 2018, distinguished by their country of origin. In recent years, as regards the Italian scenario, the legislation governing reception centers has been amended several times. The decree law 113/2018 (Salvini Decree) substantially changes the system by providing, among other things, a strong downsizing of the Sprar model, de-structuring in fact the circuit that the legislation indicated as main and ordinary. In any case, until September 2018, the system provided for a reception divided into some steps (Legislative Decree 142/2015):

1. First aid, first assistance and identification. These are government centers located in areas that are most subject to landings. Currently these centers are affected by the hotspot approach prepared from 2015 on the basis of the commitments made by the Italian government with the European Commission. In these places, rescue, first health care, pre-identification and photo-reporting, information on asylum procedures are carried out. The hotspots are born essentially to "differentiate" asylum seekers from the so-called economic migrants.

2. First reception government centers. A first reception phase follows, ensured in government centers (Cara, Cda, Cpsa), theoretically for the time necessary to identify, formalize the application, start the procedure and ascertain the state of health, also aimed at verifying situations of vulnerability. This phase is affected by the establishment of regional or interregional hubs, from which we proceed with the sorting in second reception facilities.

Second reception. It consists of the Protection System for Asyluma Seekers and Refugees (Sprar) which the asylum seeker can access in case of lack of means of subsistence. With Law 189/2002, the Ministry of the Interior set up the system coordination structure - the Central Service - and entrusted its management to Anci. The Sprar is made up of a network of local authorities which, through the National Fund for Asylum Policies and Services (Fnpsa), carry out integrated reception projects. The system is not limited to a merely welfare reception, but is aimed at integrating people in the territory through reception in small centers by developing personalized projects.

Extraordinary reception system. According to law 142/2015, if the availability of places in the first and/or second reception structures is exhausted, extraordinary reception measures are taken by the Prefect, in temporary structures and limited to the time strictly necessary for the transfer of the applicant to the first or second reception facilities. With regard to the management of the extraordinary reception centers (Cas) it is worth pointing out that over the years different and partly contradictory indications have been given on how they should be structured. On the one hand, there was a tendency to homologate the services rendered in the Cas to those of the Sprar to encourage the progressive passage within the ordinary protection system, while on the other, a model based on large collective structures opposed to the Sprar was encouraged.

Stay and repatriation centers (Cpr, ex Cie). In this case it is not a question of reception but of detention facilities where migrants are detained waiting to be repatriated.

With the increase in presences in the reception system, the share of people welcomed in the extraordinary reception centers (CAS) has increased at the expense of the ordinary system or the protection system for asylum seekers and refugees (Sprar).

In recent years the Sprar has remained largely underpowered compared to the needs. For this reason, the extraordinary reception system, which should have theoretically had an accessory and transitory function, has actually become by far the most important circuit of reception. However, apart from individual cases that can also be virtuous, these structures are often improvised and with services of a much lower quality than those of the Sprar.

Year	Resident foreigners as of January 1st	Naturalizations
2002	1.341.209	12.258
2003	1.464.663	17.183
2004	1.854.748	19.123
2005	2.210.478	28.643
2006	2.419.483	34.260
2007	2.592.950	45.459
2008	3.023.317	53.679
2009	3.402.435	59.362
2010	3.648.128	65.932
2011	3.879.224	56.147
2012	4.052.081	65.183
2013	4.387.721	100.712
2014	4.922.085	129.887

Table 1: Resident foreigners as of January 1st.

These are the places where operators, psychiatrists, psychologists and psychotherapists are, more than other people, in contact not only with other cultures, but with moments of crisis and emergency given by what is called migratory trauma. The role of supervisor psychotherapist that I hold at some structures in the province of Pescara allows me to confirm that the activity within the Reception Center leads to an undisputed collective benefit, from the operator to the user, passing through the managing body and the working group. I have found, in my direct and indirect experience, that supervision is a watershed between an effective project and one that does not work; between a team that works together achieving qualifying objectives and a disunited, confrontational and, therefore, ineffective team.

For this reason, the state of health of a project, a community and its protagonists are also given by supervision: programmed and supervised team work increases the level of cooperation of the team and the ability to manage stressful moments, reduces physical and emotional tensions, improves communication.

In these contexts, the provenance of the person in front of us cannot be ignored; for a true transcultural therapy it is essential to be aware not only if the individual is naturalized Italian or not, from how much our user is in Italy, if he is a first or second generation foreigner, if he has just arrived or is here from beyond twenty years, but it is also essential to be aware of his country of origin, the culture and traditions of that country, the language they speak, the reasons that pushed the person in front of us to arrive in Italy and what expectations he had.

Nations with more than 50000 residents as of 2017	2005	2010	2015	2019
Romania	248849	887763	1131839	1190091
Albania	316659	466684	490483	440465

Marocco	294945	431529	449058	416531
China	111712	188352	265820	290681
Ukraine	93441	174129	226060	237047
Philippines	82625	123584	168238	167859
India	37971	105863	147815	151791
Bangladesh	35785	73965	115301	131967
Moldavia	54288	105600	147388	131814
Egypt	52865	82064	103713	119513
Pakistan	35509	64859	96207	114198
Sri Lanka	45572	75343	100558	107967
Nigeria	31647	48674	71158	106069
Senegal	53941	72618	94030	105937
Perù	53378	87747	109668	97379
Poland	50794	105608	98694	95727
Tunisia	78230	103678	96012	93795
Ecuador	53220	85940	91259	80377
Macedonia	58460	92847	77703	65347
Bulgaria	15374	46026	56576	59254

Table 2: Resident foreigners as of January 1st

So, what happens when a therapist is faced with a foreigner or an immigrant?

It is essential that the therapist keeps in mind, during the clinical interview and in approaching the possible psychopathology of the individual, that his

current state and the peculiar way in which he expresses a discomfort depend on the way of interpreting the events around him, on his own life history and the cause- effect relationship it attributes to events. If this is true for any person already starting from their family of origin and their own territory, it is even more true for immigration situations. The immigrant is faced with a particular life situation, where dreams and hopes are intertwined with lived reality. Most of them experienced traumatic events that forced them to leave, for many the trip itself was a traumatic event. They are then in a foreign country where most of the time they know nothing, neither language, nor culture, nor habits: they just hope for a better life. Furthermore, migration involves an interruption of the relationship of continuous exchange and mutual reinforcement between external culture and internal culture, preventing that form of mirroring and identification that allows the individual to keep alive the ability to orient himself in the world and to give meaning to the experience. One of the objectives of clinical practice is precisely to rewind the links between the internal representations related to the culture of origin and those of the culture of the host society, to avoid the individual from suffering because of his traumatic experience originated by the fracture between the two worlds.

Transculturality

The term *Transculturality* means an encounter between different cultures, understanding the world of origin of the other by going through each other in a reciprocal way. Transcultural psychotherapy focuses essentially on the encounter between therapist and client belonging to different cultures, to whom it is addressed or which you find yourself following at a public or reception service. To better understand the concept of transculturality, it is necessary to define the concept of culture, explained and analyzed by anthropologists such as Malinowsky, Tylor, Bateson and others who did researches in the early 1960s. For Malinowsky, culture represents a complex spiritual, material and communicative apparatus with which human beings satisfy complex needs and solve specific problems. Through language, rules to follow and ethical values, cultural models are conferred on the members of each community, based on informal learning methods. For this reason, it can be said that you belong to a particular community if beliefs, ideas and values are passed down to individuals implicitly. As Malinowsky says, every single part contributes to the functioning of the whole: moreover, each culture is made up of the set of responses that society gives to the universal needs of human beings. The universal needs are eating, sleeping, reproducing, to which each culture responds in its own way. The satisfaction of these creates secondary needs aimed at maintaining internal

cohesion, such as political and economic organization. Finally, there are cultural needs, such as beliefs, traditions and language. Each culture provides a peculiar and coherent response to its nature for each level of need. From this, it is clear that the characteristic that distinguishes the different cultures is the adoption of their own and peculiar solutions to certain problems, and the definition of the problem itself: in fact, what represents a problem for a given culture, could represent normality for another. It is important to keep this in mind especially during therapy, in order not to confuse between one's own cultural schemes and the value criteria and those of the client. The risk is to affect the therapeutic alliance. Taylor elaborates the first definition of the anthropological concept of culture: in his works he recognizes the existence of a primitive culture, ignored by the Enlightenment. The main problem, for Tylor, was to make new phenomena understandable, which in the eyes of the civilized population of the time could have seemed irrational behavior.

From here you can identify different components of culture and its main characteristics such as: what individuals think, that is explicit beliefs and norms; what they do, for example acquired customs and habits of the human being due to the fact of living in a specific community; the materials they produce, that is, the objects of worship and those of daily use. Bateson instead, has revised the concept of social structure which until then seemed to designate a static set of rules, unable to fully make the fluid complexity of the life of a population. For Bateson, the structure is above all, both in its cultural and social variant, a conceptual abstraction. It is the abstract place of the relationship between individual and collective dimension, and not a concrete reality, directly observable in an ethnographic reality.

The relationship between culture and disease in psychotherapy with foreign patients is of fundamental importance, as the expression of a discomfort and the idea of health depend to a large extent on the way in which the individual interprets the events around him, his own life history and the cause-effect relationships it attributes to events (Biorci, 2009). In this process, the culture of belonging plays a fundamental role.

Regarding the relationship between psychopathology and immigration, there are mainly two lines of research: one takes into consideration immigration as an epidemiological risk factor and studies its impact on the incidence of mental disorders, the other studies the relationship between culture and psychopathology. Migration has been identified both as a protective factor and as a risk factor for some psychiatric disorders. In North America, the *effect of healthy migrants* (the discovery that recently immigrated people are healthier than the native population) has been widely reported in both mental (Aglipay,

Colman, Chen, 2012) and somatic health. On the other hand, European studies have reported a greater prevalence of mental disorders in the migrant population; similar results have also been found in North America, but only for specific migrant subgroups. In another strand of research, culture has been described as a factor influencing the symptomatic expression of mental disorder, particularly of anxiety-depressive disorders. Although cross-cultural epidemiological research has confirmed the presence of major depression and anxious disorders around the world, expression, symptomatic interpretation and social response to these pathologies vary widely across different cultural contexts.

In general, although there is a range of universal emotions, there are more complex feelings that refer to traits of social interaction and to specific contexts that vary on a cross-cultural level. In many cultures, mood disorders and anxiety disorders are not seen as problems related to mental health, but as social or moral difficulties (Kirmayer, Narasiah, Munoz, Rashid, Ryder, Guzder, Hassan, Rousseau, Pottie, 2011); it could therefore be hypothesized that a different attribution of clinical significance to the anxious depressive symptomatology could lead to a lower access of foreign patients to mental health services and therefore to treatment. As previously mentioned, the migratory experience represents, for foreign patients, a cultural and identity shock in which the subject is faced with the challenge of having to redefine a life plan, to delineate its coordinates in space and time and this, according to Cimino (Cimino, 2015), would expose migrants to a greater risk of developing serious mental disorders.

Cultural Anthropology has begun to devote itself to the study of the interaction between different cultures in recent times, thanks to the increase in means of transport that facilitate travel between different continents and nations. Following the increase in immigration, globalization and the need for international cooperation, in the early 1960s the study of interculturalism poses the question of what could happen when two different cultures meet. The solutions to the meeting of the different cultures are and have been varied passing from integration to multiculturalism to arrive, as already mentioned, to the concept of interculture which, from a psychological point of view, involves the integration between different cultural worlds through a system complex of interconnections and interactions that aim to understand the different ways of acting in respect and protection of both one's own culture and that of the other. Around the 1950s, some psychiatrists began to deepen the relationship between psychiatry and the culture of origin, giving rise to what is now called ethnopsychiatry or transcultural psychiatry. Ethnopsychiatry constantly dialogues with anthropology and ethnology as the common goal is to investigate human and cultural groups with the tools necessary to understand their most

varied aspects. The origins date back to the contacts between the European colonials and the natives, when in addition to the intervention of doctors, necessary to treat infectious diseases, the help of psychiatrists was requested, due to the detection of mental disorders manifested by the natives.

The first psychiatrists founded the asylums and began to catalog the various symptoms encountered, making the mistake of distorting the assessments made due to prejudices, trivializations and a general underestimation of local culture. At the end of the Second World War and thanks to the end of colonialism, an increase in awareness of indigenous movements, changed tools of criticism by Europeans, investigations into indigenous culture became more objective and respectful. The psychiatrist Frantz Fanon, in 1952 wrote an essay on the alienation of the colonized, described, for the first time, from an internal context. In 1954, the Nigerian psychiatrist Thomas Adeove Lambo, inaugurated a health facility open to both western therapies and traditional African medicine, attempting to enhance some local cultural elements, to facilitate the care of the sick. From 1958 and for the twenty years that followed, the French psychiatrist Henri Collomb conducted an important study in Senegal by restructuring the Fann asylum, in which he tried to share experiences and rituals with African healers, translating their cultural messages into elements of psychology, recognizing the value and otherness of patients without denying and canceling them.

The regulation provided for a family member to support the patient, and, a few years earlier than Franco Basaglia's experience, were set up biweekly meetings between doctors, patients, relatives and simple observers who, between a drink and a meal, discussed the hospital and patient problems. This center became a pilgrimage destination for journalists, doctors, anthropologists, ethnologists of various nationalities who came together in the prestigious French-speaking magazine *Psychopathologie Africaine*. But the man who can actually be considered the true founder of ethnopsychiatry is Georges Devereux. A science that deals with studying and classifying psychiatric disorders and syndromes taking into account both the specific cultural context in which they occur, and the ethnic group of origin or belonging to the patient and which he first calls transcultural psychiatry and then multicultural psychiatry . Devereux will work in the field with the Sedang Moi, a tribe from southern Vietnam, then with the Mohave Indians of Arizona. Important was his relationship with Jimmy Piccard, an alcoholic Mohave Indian and with major mental disorders that led him to write *Psychotherapy of a Plains Indian*, which later became an interesting film.

Devereux began to build a human theory that went beyond the claim to universality of psychiatry and the psychoanalysis of the time. He did not see people only as individuals, that is, as bearers of a biography and an unconscious, he looked at them through the gaze of two disciplines, the psychological-psychoanalytic and the ethnographic- anthropological one, in which the person in front of us is not made only of its interior, but also of an ethnic group, so it brings with it a kind of cloud of relationships, thoughts and active connections that establish it as the subject of a culture. He tries to found, facing several difficulties, a vision of man and his psychological component based on this double register, anthropological-ethnographic and psychological. In order to understand what etherepsychiatry is for Devereux it is essential to specify what makes a theory scientific for him, that is, the renunciation of being totalizing in his interpretations or explanations of the causes of a phenomenon and the stubborn search for interpretive complements in other fields. Therefore, Devereux ethnopsychiatry presents itself not only as an interaction between multiple knowledge such as anthropological, ethnological, psychoanalytic and psychiatric, but also as a preliminary redefinition of the study objects of these subjects. It follows that the focal points of his thought are being able to govern the observer's element of subjectivity, which cannot be avoided, but can be exploited (he will pay particular attention to countertransference) and investigate the "psychopathological fact" in societies other than the Euro-American one, intertwining the anthropological perspective with the psychoanalytic and ethnological one, however underlining the need to make this appeal at a later date.

He therefore introduced the following concepts:

- Psychic unity, or the concept according to which all human beings are endowed with a psychic apparatus and have equal dignity. However, the psychic unity is variable in the sense that the forms of the psychic mechanism work the same for everyone but the cultures are all different, so much that he speaks of psychic superstructure conditioned by the historical-cultural context;

- acculturation or cultural transmission that takes place through contact with groups other than the one they belong to and consists in the total or partial assumption of cultural ways other than the one of origin;

- countertransference, made up of emotions that the therapist experiences in the clinical context and which are stimulated by the encounter-clash (anguish of the encounter) with other cultural dimensions, with what is

foreign to us. They concern social, professional and cultural identity, derive not only from personal history but also from the history of the society they belong to, from politics and prejudices. It is precisely our fears and our prejudices that undermine the possibility of grasping the other's reactions within cultural differences;

- the principle of complementarity: the great complementary method is having understood that, starting from the moment in which the identity of the other is recognized and the cultural rules are respected, dialogue, exchange, alliance are favored, increasing the effectiveness of the intervention with access to their interiority, to their deep Self, breaking that silence that seems part of their cultural trait;

- the concept of identity representative of a set of values, symbols, cultural models that the members of an ethnic group recognize as distinctive;

- the notion of a human condition as a producer of culture.

These concepts gave life to his innovative, dynamic and so current thought, that can be applied to modern psychotherapy. Devereux speaks of metacultural psychiatry because he doesn't limit his field to a specific knowledge of the patient's cultural environment, but he bases it on the recognition of the general meaning and variability of culture.

He conceived multicultural psychotherapy as a relationship that helps the individual to become aware of his defense mechanisms by strengthening those that are most useful and effective in controlling anxiety and restoring the connection of the self, thus weakening self-destructive ones.

In this theoretical framework there is another interesting contribution, given by Ibrahima Sow (Sow, 2015), who focuses his work on the concept of freedom by stating that what seems to us to be freedom has a cultural interpretation: this concept is not explicitly expressed, but it derives from the modality of constitution and functioning of the ego. The profile of the ego that Sow talks about, allows the therapist to contextualize the psychic problem in the subject's culture of belonging and to be able to have a psychotherapeutic interview taking into account the experience and experiences of these, making him aware of his conflicts with its cultural conformation without forcing him to be a "case". It is important to keep in mind that the treatment does not focus on the therapist's perspective but on that of the subject, not only the technique used by the therapist is functional, but also the knowledge of the subject's culture is.

Georges Devereux still insists on these aspects in his works (Devereux, 2007) that form the basis of the transcultural therapeutic line: "trans" as beyond, over culture or as "crossing, transit" through the various cultures that patients bring into space therapeutic?

Devereux did not dare to specify the shift from Freudian concepts, but his phrase "Parisian Marquise ..." unequivocally puts the weight of the cultural forms in which human beings are formed in the foreground.

Very significant is the description of a behavior and the link between such behavior and culture as well as drive forces. This is the example of a young woman's courting boy: Devereux divides the explanation of the behavior into four points, relying on the concept of "axis", the same that is used by Sow.

The situation is very banal: an American boy offers a bouquet of flowers to the girl who is courting. Devereux identifies:

- biological axis, or the sexual impulse that pushes the boy to courtship;
- axis of experience: the boy knows that in his culture only books, flowers or chocolates can be given. It is therefore the concrete experience in the social that determines the choice of the type of gift.
- the third axis concerns the attention to local rules or to the cultural modalities of the belonging group. In this sense acts the choice of the moment in which to make the gift, that is Christmas, while, underlines Devereux, a Frenchman would have chosen the New Year.
- neurotic axis: from an unconscious point of view, the boy excludes the chocolate because he does not yet feel ready to undertake a relationship in which to invest, and excludes books because he does not want to bring the relationship on an intellectual level. He therefore chooses the flowers, which involve him less and also symbolize his desire to bring the relationship on a physical / sexual - defloration level (Devereux, 2007).

The concept of Axis, which starts from the corpus of cultural thought and reverberates both in the family and in the community and especially in the deeper structure of the unconscious, is instead proposed by Ibrahima Sow as a training element not of behaviors, but of the psychic structure of the subject.

The subject belongs to the culture where he was born above all for the modulation of his ego that starts from the corpus of cultural thought.

The indication Sow gives about the modalities of transmission are decisive for the therapeutic activity, as they give the psychiatric operator three fundamental areas of investigation.

The first of these elements is the biolignage (Sow, 2015), that is the family. It should be emphasized that the biolignage is currently, so to speak, with variable geometry, that is to say it has acquired characteristics of ever greater plasticity and variability both in the structure and in its constancy over time. This means that a cultural variation is possible, in which the children will have to articulate themselves through personal choices, confirmed in the first place by the social system rather than by the family itself. This "existential" axis becomes increasingly important for the construction of the person/personality precisely by virtue of this ability to accommodate ever more rapid changes in social and cultural values. So it is a matter of working not so much and only on the parents / children relationship, but also and above all on the culture that parents insert into the daily life of the parenting relationship. The culture trans generationally transmitted by parents as a set of socio-cultural artifacts (Inghilleri, 2009) therefore becomes a fundamental variable for the development of a strong and complex personality or fragile and inflexible and provides an area full of important stimuli for the therapist.

Another connection of the corpus of cultural thought refers to the impregnation of the social environment, the community environment, the "laws" of culture. Through the third axis, the subject is continuously in relationship with his community and therefore, confronting the cultural rules, he suffers from an absolutely satisfying synchronicity in the event that the family / unconscious / society system speaks the same "language". It is evident that today very often there is a risk of asynchrony and therefore existential unease, in the sense that the young person enters into social relations with cultural rules that are likely to become obsolete in a very short time.

However, thanks to the plasticity learned during the early stages of growth and socialization, contemporary young people are often able to deal with this asynchrony, transforming it into a positive stimulus and using the different visions of the world that they encounter in the socio-cultural system as promoters of creative development of one's personality (Gardner, 1994).

The psyche model proposed by Sow is to be considered a universal nosographic model, which provides the parameters and tools to frame the

structure and psychic processes of patients of any origin and belonging from a cultural point of view, because we all come from a cultural system, in which we participate and in which we introject and incorporate, and the relationship with culture shapes the mind in terms of form, not just content (Shweder,1997). The cultural ego of Sow highlights with clarity and completeness the complex interactions between culture and individual that contribute to forming their mind and personality and proposes an exhaustive investigation along three existential axes to bring out both etiopathogenic factors as tools and processes for the cure.

It is therefore through the reconstruction of the individual's relationship with his or her cultural foundations that the therapist is enabled to understand the patient's experience, his idiosyncratic characteristics, his skills and his weaknesses. It is through reading the mind of the other as a cultural artifact that the Therapist is given access to his truth.

The mind / artifact contains and transmits the essential meanings for the survival of the individual and through them it binds in good (creativity) or bad (pathology), but in any case with force, to the historical and cultural context where it originated and it is starting from the understanding of these bonds of meaning and their individual history that the patient's relationship of care and the healing / evolution process begins, who is in a condition of suffering that has made him static and unable to grow.

Sow's ethno-clinical artifact allows us to be ferried from ethnopsychiatryto trans culture.

The Transcultural Therapist, in crossing the bridge that allows him to empathize with the patient, also manages to unite that gap between practitioner and clinician (Sow, 2015). He is, as the author himself hopes, a "practitioner" who gets his hands dirty with the daily experiences of the people he cares for. It does not only deal with the diagnosis and resolution of pathology and suffering, but also and above all with the human being who is faced with his uniqueness and complexity.

This constant process of re-defining reality through the words of the other leads him, however, to acquire a "clinical" competence that allows him to decentralize and distance himself from the patient together with whom he is working to enter a diagnostic perspective through which to treat (De Cordova, 2009) the personality-person of his patient. This parting of visions, between practitioner and clinician, between biogenetic, historical and existential axis, allows us to face the cultural system in its plural essence. It is a process of complexification of reality that approaches the concept of complementarity promoted by Devereux (Devereux, 1967).

This psychic, cultural and methodological position is a necessary shift that the therapist, and with him every health worker, must strive to make with respect to their knowledge, their cultural orientations and their habits, to face the values and the meanings embodied by the patient understood as Other, as the bearer of a culture that is only partially known, whether it is distant or not. The therapist's journey within the patient's cultural psyche leads him to discover a personality-person as intrinsically Other by Himself, as a unique and unrepeatable cultural being. This is how the etiological and eschatological pluralism presented by Sow's cultural ego model, instead of promoting a division between theory and practice, between scientific, cultural and historical readings, manages to interpret a holistic vision of the individual.

Conclusion

We have already said that even before understanding how a therapist can approach a culture other than his own, he has to understand what kind of culture it is and what are the risks of a failure in understanding all its fundamental aspects. Belonging to a given community is given by the set of beliefs, ideas and values that will be passed on to individuals in an absolutely implicit way. The relationship between culture and psychiatry has made it possible to investigate human and cultural groups with the necessary tools. The relationship between culture and disease in psychotherapy with foreign patients is of fundamental importance, as the expression of a discomfort, and the idea of health depends to a large extent on the way in which the individual interprets the events around him, his own life history and the cause-effect relationships it attributes to events. The transcultural therapist is able to understand the patient's experience through the reconstruction of the individual's relationship with his cultural founders, therefore the therapist does not deal exclusively with the diagnosis and reconstruction of the pathology and suffering, but above all with the *human being who faces in its uniqueness and complexity*.

Bibliography

Aglipay, M., Colman, I., Chen, Y.. *Does the healthy immigrant effect extend to anxiety disorders? Evidence from a nationally representative sample*. Journal of Immigrant and Minority Health, 2012

Biorci, G., *Verso una pragmatica interculturale: l'espressione del disagio psicologico degli immigrati.*

RIME rivista dell'Istituto di Storia Europea Mediterranea, 2009

Burtini D., *Antropologia e psicoterapia Transculturale. Quando lo sciamano mette il camice*, In Studi Ento- antropologici e sociologici, 2018

Cimino L., *Migrazione e salute mentale: un problema emergente*. Rivista di Criminologia, Vittimologia e Sicurezza, 9(1), 59-66 DOWNLOAD, 2015

De Cordova F., *Psicologia culturale e cura*, in Inghilleri P. (a cura di), "Psicologia culturale", Raffaello Cortina, Milano, 2009

Devereux G. Psicologia transculturale e meticciato, https://core.ac.uk/download/pdf/31040729.pdf

Devereux G. (1967), *Dall'angoscia al metodo nelle scienze del comportamento*, trad. it. Istituto della Enciclopedia Italiana, Roma, 1984

Devereux G., *Saggi di Etnopsichiatria generale*, Armando Editore, Roma, 2007 Ferretti M, *Elementi di Antropologia Medica e Psicologia Transculturale*

Gardner H., *Intelligenze creative*, trad. it., Feltrinelli, Milano, 1994

Goussot A, *L'approccio transculturale nella relazione di aiuto*, Aras Edizioni Editore, 2014 Ibrahima Sow, *L'Io culturale, dall'etnopsichiatria alla transcultura,* Armando Editore, Roma, 2015

Ielasi W., *Come pesci nell'acqua. Elementi etnopsicologia clinica*, Rivista di Psicologia dell'Emergenza e dell'Assistenza Umanitaria, 2007

Inghilleri P., *Psicologia culturale*, Raffaello Cortina, Milano, 2009

Kirmayer, L.J., Narasiah, L., Munoz, M., Rashid, M., Ryder, A.G., Guzder, J.,

Hassan, G.,

Malinowsky, *Teoria scientifica della cultura e altri saggi di antropologia*, PGreco, Roma, 2013

Moro M.R., L'approccio transculturale e il metodo complementarista, https://www.didaweb.net/mediatori/articolo.php?id_vol=850

Rousseau, C., Pottie, K., for the Canadian Collaboration for Immigrant and Refugee Health. *Common mental health problems in immigrants and refugees: general approach in primary care*. Canadian Medical Association Journal 183, 2011

Shweder R.A. (1984), *La ribellione romantica dell'antropologia nei confronti dell'Illuminismo, o del pensare al di là della ragione e dell'esperienza*, in Shweder R.A., LeVine R.A. (a cura di), *Mente, sé, emozioni. Per una teoria della cultura*, trad. it. Argo, Lecce, 1997

Sow I., *Psichiatria dinamica africana*, traduzione italiana di *Psychiatrie dynamique africaine*, di I. Sow, Armando Editore, Roma, 2015

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Ellipses and ovals: two curves so close and so far

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Abstract

In this work we will deal with ellipses and ovals, comparing them both from the geometric point of view and from the one of applications. There is a notable similarity between these curves so often it's not possible to recognize which of the two figures is, unless we consider other elements to distinguish them. We will show the presence of both curves in architectural works and in treatises, motivating their use, when it's possible, with geometric and technological considerations.

Keywords: conics, regular curves, normals, vaults, pointed arches, curvature. [1]

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1. Introduction

Ellipses and ovals are very similar figures; however, they are distant by geometric genesis and even in applications they are used for different reasons. The ellipse is a more "elegant" curve since its curvature varies continuously; moreover, it appears naturally in the construction of cross vaults or pavilion vaults. The meridian curves of the sails of the Dome of Santa Maria del Fiore are arches of ellipses and this fact also contributes to the upward momentum of this construction. The elegance of Santa Trinita Bridge in Florence also depends on the elliptical shape of its arches; moreover, this shape allows a greater quantity of water to flow under the arches without raising their keystones too much. The oval, being formed by arcs of circumferences, inherits some typical advantages of circular figures such as equidistance and convergence towards the centers of the arcs that compose it. It follows from its geometric construction that its curvatures undergo sudden changes in the points of tangency of two adjacent arcs; also, for this reason, sometimes the oval is a little less "graceful" than the ellipse. In this paper we will discuss these questions, showing examples of applications of these curves in art and architecture.

2. Ellipses

The ellipse, together with the circumference, which is a particular case of it, the parabola and the hyperbola form the family of *conics* (not *degenerate*). They have been known since ancient times; the first mentions of them date back to the Hellenistic period; Eudoxus (408 BC-355 BC), Menecmo (380 BC-320 BC), Euclid (IV century BC-III century BC), Archimedes (287 BC-212 BC) and others considered conics as the intersection of a right circular cone with a plane (hence the name of *conic sections*). We note that these authors obtained the three types of conics by varying the angle at the vertex of the cone (acute for the ellipse, obtuse for the hyperbola, right for the parabola), keeping the plane always perpendicular to a generatrix of the cone (see [15] pg. 59).

In the third century BC Apollonius of Perga (262 BC-190 BC) wrote a fundamental treatise on conics, consisting of eight books; the eighth one has been lost and was reconstructed following the writings of Pappus (290 AD-350 AD). We owe to Apollonius the study of conics as the intersection of a fixed right circular cone with a variable plane (see [15] pg.107). Although they were known and deeply studied, the conics did not have practical applications until the beginning of the seventeenth century, especially starting from the works of Giovanni Keplero (1571-1630) and Galileo Galilei (1564-1642).

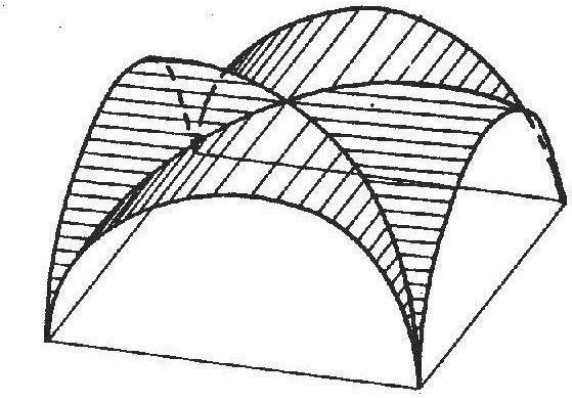

Figure 1. Cross vault

We observe that in the cross vaults of the Roman era there are quite precise arches of ellipse[2], as it was possible to establish by means of tests carried out with laser scanners. In fact, for geometric reasons, the intersection of two right circular half-cylinders, equal and orthogonal to each other, is a semi-ellipse; consequently, the diagonal arches of a cross vault formed by the interpenetration of two equal circular barrel vaults are two semi-ellipses. However, we think that the ancient Romans most likely obtained the ellipses corresponding to the diagonal arches by constructing them by points, starting from the semicircular perimetric arches and without realizing that they were ellipses. Figure 2 shows a possible geometric construction that could have been used by the ancient Romans to determine (by points) the ellipse which defines the profiles of the diagonal arches of a cross vault starting from the semicircular profile of the rounded perimetric arches of the same vault (see [22] pg. 62).

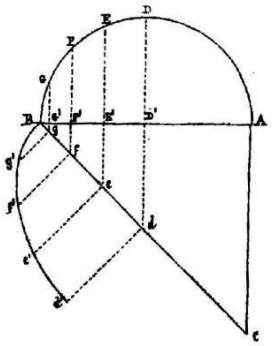

Figure 2. The geometric construction of the ellipse

[2] Recall that an ellipse is the geometric locus of the points of the plane for which the sum of their distances from two fixed points, called foci of the ellipse, is constant.

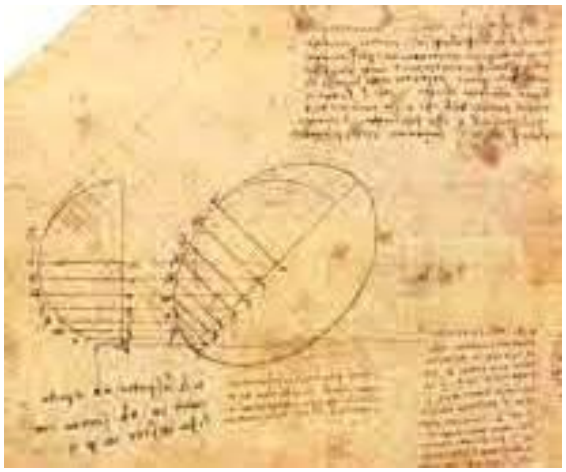

Figure 3. (Codice Atlantico, Vol. IV, t. 318b)

Leonardo da Vinci (1452-1519) did the same construction, as we can see from Figure 3.

Medieval architects were unable to build elliptical arches, both for tracing reasons and for difficulties that arose in cutting the wall ashlars[3]. They built the diagonal arches of the cross vaults in semicircular shape (round arch); in this way, the perimetric arches necessarily had to assume an elliptical profile. Bechmann states (see [4] pg. 169) that the builders tried to replace ellipses with simpler curves and for this reason they introduced the *ogival arches*, which approximated the ellipses with figures based on arcs of circumference.

It is interesting to note that the Gothic *fourth pointed arches* are, among the curves involving circular arcs, the best approximations of the elliptical lateral arches that would be obtained in a cross vault with a square base, starting from the semicircular diagonal arches (maximum error 4%).

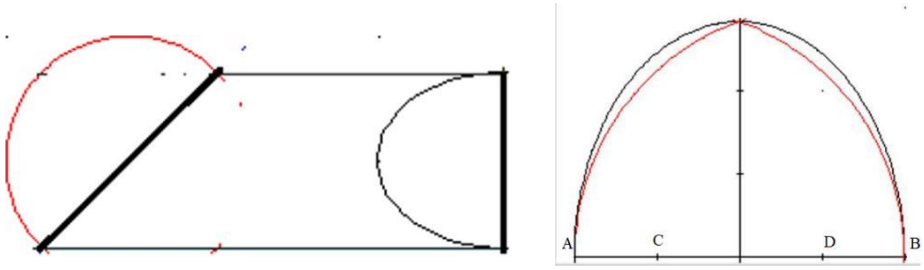

Figure 4. The best approximations of the elliptical lateral arches

[3] Note that in the elliptical arches the wall ashlars have different shapes while in the circular ones they all have the same shape.

Figure 4 highlights the fact that the projection of a semicircle (semicircular diagonal arc) on a plane (perimetral plane), placed at 45° with respect to the plane containing the semicircle, is an ellipse and that the ellipse itself (the black curve on the right in Figure 4) is well approximated by the Gothic *fourth pointed arch* (the red curve on the right in Figure 4).

We recall that a *fourth pointed arch* is formed by two arcs of circumference, with radius 3 units, each having the center (points C and D in Figure 4) placed at a quarter (hence the name "fourth pointed") from the ends of a segment AB measuring 4 units. We can make the same considerations for the pavilion vaults; if their base is a square and they are obtained starting from two straight circular cylinders orthogonal to each other, then the edge curves are two semi-ellipses, while the median curves (those obtained by intersecting the vault with the two planes containing its axis and parallel to one pair of sides of the base square) are two semicircles.

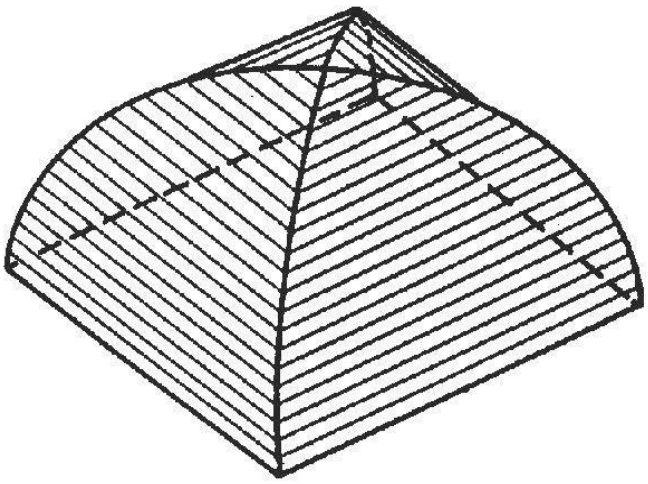

Figure 5. Pavilion vault

It is interesting to note that the Dome of Santa Maria del Fiore in Florence is also a pavilion vault, but with an octagonal base.

However, in this case, the edge ribs are arcs of circumference, while the meridian curves of the sails are elliptical arches (see [10] pg. 194). Therefore, we obtain the surface of the Dome by the interpenetration of four elliptical (and not circular) cylinders which, intersecting, form eight arcs of circumference.

Figure 6. The Dome of Santa Maria del Fiore

Starting from the second half of the 15th century[4], many artists and scholars resumed the study of ellipses, which they applied in their works. We mention, among the many: Piero della Francesca (1416-1492), Leonardo da Vinci, Sebastiano Serlio (1475-1554), Albrecht Dürer (1471-1528).

Serlio also built an elliptical compass. Leonardo was responsible for a graphic construction of the ellipse found in the Codex Atlanticus. Piero della Francesca drew an elliptical halo in *San Giuliano* (fresco detached from the

[4] We note that the first presence in Italy of the book *Conics* by Apollonius, in Greek, dates back to 1427, when the humanist Francesco Filelfo (1398-1481) brought a copy from Greece. In 1501, the Latin translations of some parts of the *Conics* appeared in the book *De expetendis et fugiendis rebus opus* by the humanist Giorgio Valla (1447-1500). Federico Commandino (1509- 1575) wrote the Latin translation of the first four books of the *Conics* in 1566. The first complete edition in Latin is from 1710; the translation was written by the astronomer Edmond Halley (1656-1742), the one after whom was named the comet, and it was made from the Arabic.

former church of Sant'Agostino in Sansepolcro, which is now in the Civic Museum of the same city), obtained, almost certainly, as an axonometric oblique projection of a circular halo.

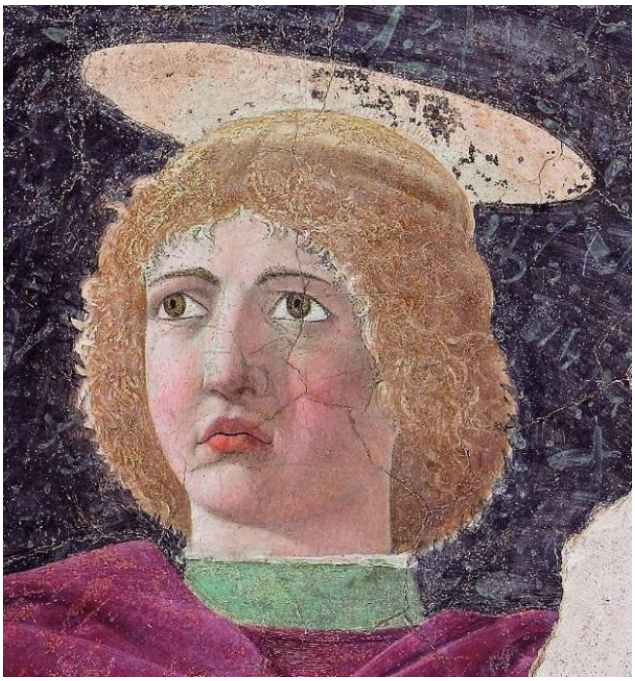

Figure 7. *San Giuliano*, Piero della Francesca[5]

In the tomb of Giuliano de' Medici, Duke of Nemours, located in the New Sacristy in the Medici Chapels in Florence, there are the sculptures made by Michelangelo Buonarroti (1475-1564) named *Day* and *Night*. We can see that the upper profile of the lid of the tomb, located under these figures, is a broken line (ending with two volutes) which is a part of an ellipse.

The red curve in Figure 8 is an ellipse drawn with the computer, starting from its equation: we can note the remarkable coincidence of the theoretical ellipse with the one used by Michelangelo.

As a first approximation, this ellipse has the same the axes) as the ellipses forming the arches of the Santa Trinita Bridge in Florence. Also in this case, we superposed the theoretical ellipse (in red) which, we repeat, is similar to

[5] The drawing in Figure 7 was taken from [21] pg. 253.

that of the Medici Chapels, on the curve of the arches of the bridge, noting an excellent coincidence. We emphasize the fact that the elliptical arch allows for large spans and, therefore, facilitates the flow of water under the bridge, without raising its keystone excessively.

Figure 8. The ellipse in Giuliano de' Medici's tomb[6]

Thus, it is likely that Bartolomeo Ammannati (1511-1592), the architect who designed the Santa Trinita Bridge, followed the suggestions of Michelangelo, with whom he was bound by a deep friendship. Both Enrico Felleni in 1957 and Piero Bargellini in 1964 (see [2] pg.56) stated that there was a remarkable similarity between the curve of the arches of the bridge and that of the covering of the sarcophagi found in the Medici Chapels. Actually, as we have already mentioned, the profiles of the arches of this bridge are very close to elliptical curves but not equal.

The bridge was rebuilt after its destruction by the German army in the Second World War (4 August 1944).

[6] The drawing in Figure 8 was taken from [1] pg. 186.

Figure 9. The ellipse of Santa Trinita Bridge

During its reconstruction (completed on March 16, 1958) a lively debate on the true shape of its arches broke out, involving engineers, architects, art historians and mathematicians[7], including prof. Luigi Campedelli.

3. Ovals

An oval (with four centers[8]) is a curve formed by four arcs of circumference constructed as follows.

Consider a segment AB and its midpoint O (*centre* of the oval). With reference to Figure 10, we take inside the segment AB two points L and M symmetrical with respect to point O and, on the axis of segment AB, two points E and F symmetrical with respect to point O. Consider, on the half-line FL, a point R, external to the segment FL, such that RL is congruent to AL. In the same way, we construct the segments EL and LP. With centre at point L and radius equal to the measurement of the length of AL we trace the arc of circumference PR. With a similar procedure, we construct the points Q and S and we trace the arc of circumference QS with centre at point M and radius equal

[7] We just want to point out that the difference between the elliptical curve and the one, with which the bridge was rebuilt, formed by two semi-chains reaches a maximum of 30 cm in the central arch (about 29 meters long); therefore a trifle compared to the size of the bridge which in all measures about 98 meters. Anyone interested in this question, which also involves compelling mathematical aspects, can refer to [5], [9], [16].

[8] There are also ovals with six (or bigger even numbers) centers, which will not be covered in this paper.

to the measurement of the length of MB (which is, by construction, equal to that of AL). Finally, with radius equal to the measurement of the length of EP, we trace the arcs of circumference PQ with center at point E, and RS, with center at point F. It follows from the construction that the arcs RP and PQ have the same tangent line in P, i.e., the line orthogonal to EP. For similar reasons, also the following arcs have the same tangent line in their intersection points: the arcs PR and RS in R, the arcs PQ and QS in Q and the arcs QS and RS in S.

We call the resulting curve an oval with *major axis* AB. Let C and D be the intersections of the line EF with the oval; we call the segment CD the *minor axis* of the oval.

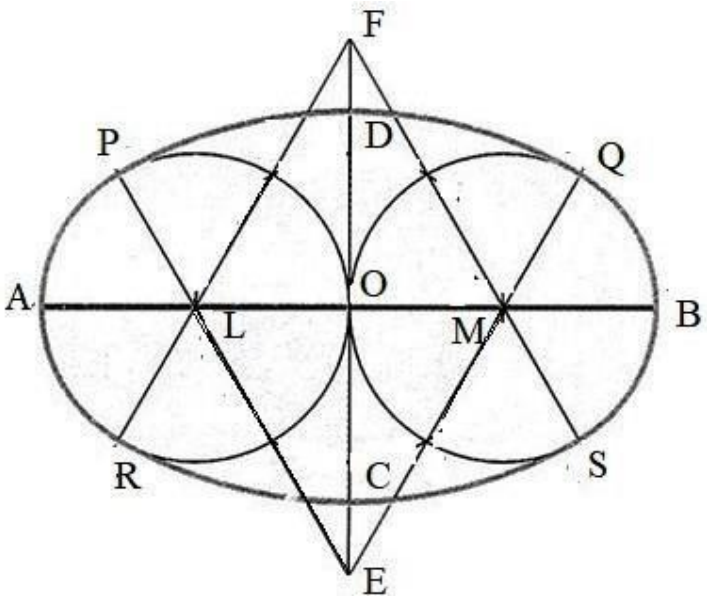

Figure 10. Geometric construction of an oval

Thus, ellipses and ovals are different curves from the point of view of their geometric constructions. We observe that, given two orthogonal segments intersecting at their midpoints, there is only ***one ellipse*** having those two segments as axes of symmetry, but there are ***infinite ovals*** having those two segments as their axes; their shape varies according to the position of the centers of the smaller circles on the major axis or of the centers of the larger circumferences on the minor axis line. We can easily see this fact from the construction of the ovals given by Abraham Bosse (1602-1676) in 1655.

Let us consider the rectangle having as base the semi-axis OB and as height the semi-axis OD of the oval to be built (see Figure 11)[9]; in this way the semi-

[9] The drawing in Figure 11 was taken from [12] pg. 17.

axes of the oval are fixed. We choose the radius *r* of the smallest circumference, then, we take a point M on OB and a point G on OD so that the length of the congruent segments MB and DG measures *r*. Let E be the intersection point between the axis of segment GM and the straight-line OD; let Q be the point of the half-line EM such that the segments ED and EQ are congruent. Then, by construction, also the segments GD and MQ are congruent and their length measures *r*. Now we can trace the arcs of circumference DQ, with center at point E and radius equal to the measurement of the length of EQ, and QB, with center at point M and radius equal to *r*. We observe that the arcs DQ and QB have the same tangent line at the point Q and, therefore, the arc QB is just a quarter of an oval with semi-axes OB and OD.

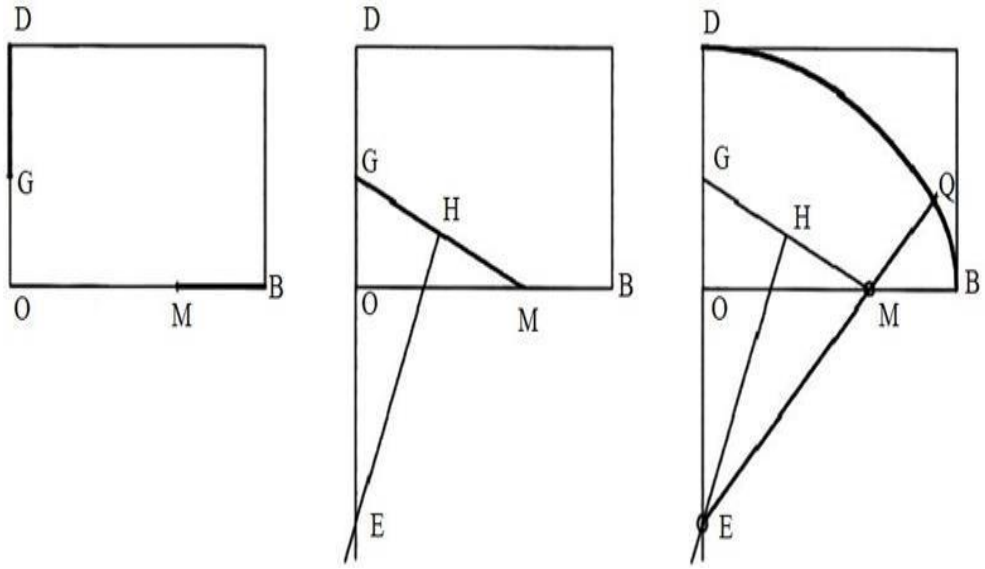

Figure 11. The construction of the ovals given by Abraham Bosse

From this construction we deduce that the ovals with given axes are ∞^1, since they depend on the position of the center of one of the two smaller circles. We can give the same proof also algebraically.

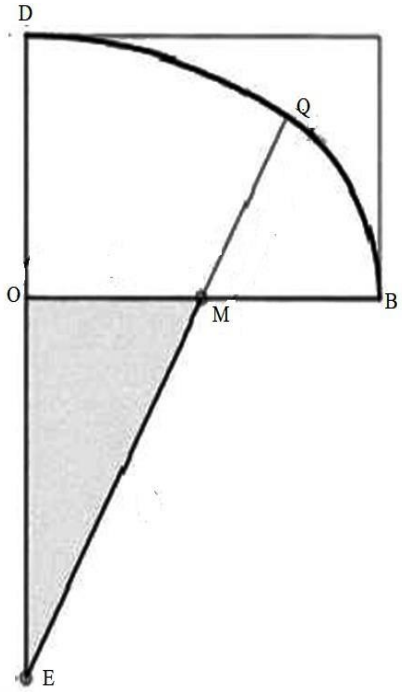

Figure 12. Relationship between the measures of the elements of an oval

With reference to Figure 12[10], let OB = *l*, OD = *m*, OM = *a*, MQ = MB = *r*, EM = *x*, EO = *b*, so that ED = *b* + *m*.
We have: $a + r = l$, $x + r = b+m$, $a^2 + b^2 = x^2$, from which we obtain

$$x = \frac{(l-r)^2 + (m-r)^2}{2(m-r)}$$

Thus, knowing the measurements of the semi-axes and the radius of the smallest circumference, we obtain the radius of the largest circumference.

We can quite easily distinguish some ovals from ellipses, while others are so similar to ellipses that one is unable to distinguish the two types of curves. Sometimes (but not always) the two curves can be recognized because in some ovals the curvature at the point of contact between the two arcs of circumference changes abruptly. For example, in Figure 13 we can see that the edge of the red region is an ellipse while that of the blue region is an oval.

[9] The drawing in Figure 11 was taken from [12] pg. 17.

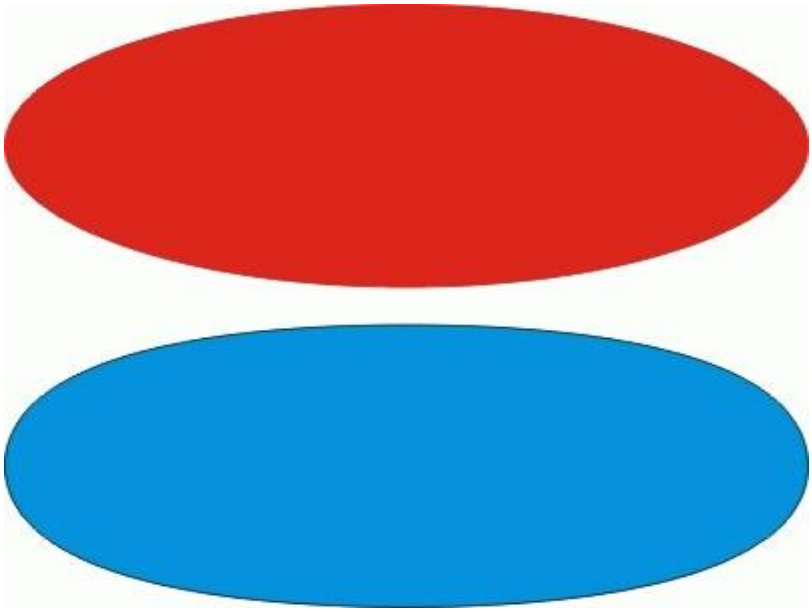

Figure 13. Ellipse (red) and oval (blue)

The ancient Egyptians also used the oval; in fact, as Choisy states, they used a three-center arc, which is half of a four-center oval, as an approximation of an elliptical arc (see [7], pp. 45-46).

It should be borne in mind that numerous studies have proved that, in the construction of amphitheaters, the ancient Romans used ovals instead of ellipses. The reason was essentially technological and not due to the difficulty of tracing these two types of curves (see [11] pp. 13-24).

Balbus Mensor[11] in his land-surveying treatise *Ad Celsum expositio et ratio omnium formarum*, written between 102 and 106 AD, states that the arena of the amphitheaters is formed by 4 circular arcs: "ex pluribus circulis forma sine angulo ut harenae ex quattuor circulis. " (see [14] pp. 181-182).

Now we show the reasons why ovals were preferred to ellipses in the construction of amphitheaters.

First of all, we show that a curve parallel[12] to an ellipse is an eighth-degree curve. In fact, the equation of the curve parallel to the ellipse with equation:

[11] Balbus was an engineer, surveyor and land-surveyor who lived in the time of Trajan. He followed the emperor during the military campaign in Dacia.

[12] Given a regular curve α, consider one of its points *P*. On the normal for *P* to the curve α, take a point *P*' having a fixed distance *d* from *P*. As *P* varies over α, the set of points *P*' (always taken from the same side with respect to the chosen direction of the normal) determine a curve β called

$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ it is obtained by eliminating the parameters x_0 and y_0 from the following eighth degree system, where *d* is the distance between the two parallel curves:

$$\begin{cases} y - y_0 = \dfrac{a^2 y_0}{b^2 x_0}(x - x_0) \\ \dfrac{x_0^2}{a^2} + \dfrac{y_0^2}{b^2} = 1 \\ (x - x_0)^2 + (y - y_0)^2 = d^2 \end{cases}$$

Now, let an ellipse with semi-axes *a* and *b*, with $a > b$, be given; the measure of the focal axis of this ellipse is $\sqrt{a^2 - b^2}$. Let us now consider the ellipse, concentric to this, with semi-axes $a + d$ and $b + d$ with $d > 0$; its focal axis measures $\sqrt{(a + d)^2 - (b + d)^2} > \sqrt{a^2 - b^2}$. Therefore, to make a series of concentric ellipses, it would be necessary to determine each time the (variable) position of the respective foci.

On the contrary, the ovals, being formed by arcs of circumferences, maintain the parallelism in the case they have the same centers. Note that the parallelism between curves is very important in the construction of amphitheaters, since the rows of steps must be at a constant distance.

In Figure 14 we have drawn two ellipses: the semi-axes of the inner one measure 4 and 2 and the semi-axes of the outer one measure 6 and 4. They look like two parallel curves but they are not! Moreover, the focal half-axis of the internal ellipse measures $\sqrt{12}$ while the focal half-axis of the external one measures $\sqrt{20}$. So, if we had to build many rows of steps using ellipses, we should draw a different ellipse for each row.

a curve parallel to the curve α; *d* is called the *distance* between the curves α and β. We note that the tangent line in *P* to the curve α is parallel to the tangent line in *P*' to the curve β. Furthermore, the distance between these parallel lines is just *d.*

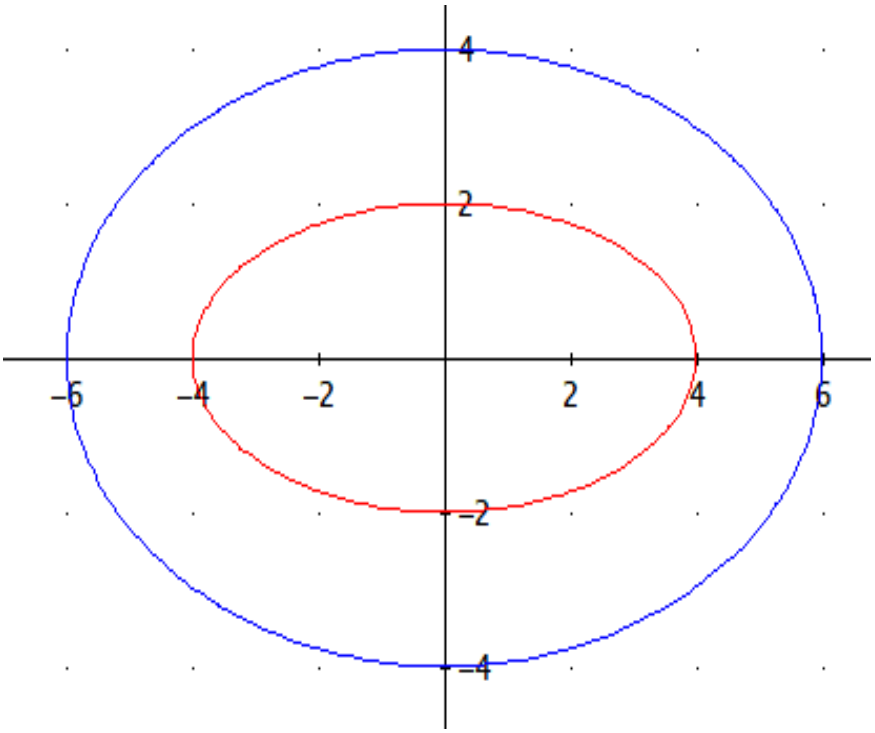

Figure 14. Non-parallel ellipses

For instance, ovals and not ellipses were used in the construction of the Colosseum The arches of these ovals belong to concentric circles; the four centers of all these ovals are the vertices of a rhombus formed by two equilateral triangles (see [3] pg. 106). In the following Figures 15, 16 and 17 we show, by way of example, three of these ovals: we can see that they all have the same centers. The axes of the outermost oval of the Colosseum measure 188 and 156 meters, the axes of the inner arena measure 88 and 54 meters.

We will see later that these ovals are built according to Serlio's first rule; thanks to this construction, the rows determined by the steps are all parallel curves; in fact, two concentric circles are parallel curves whose distance is equal to the absolute value of the difference between their radii.

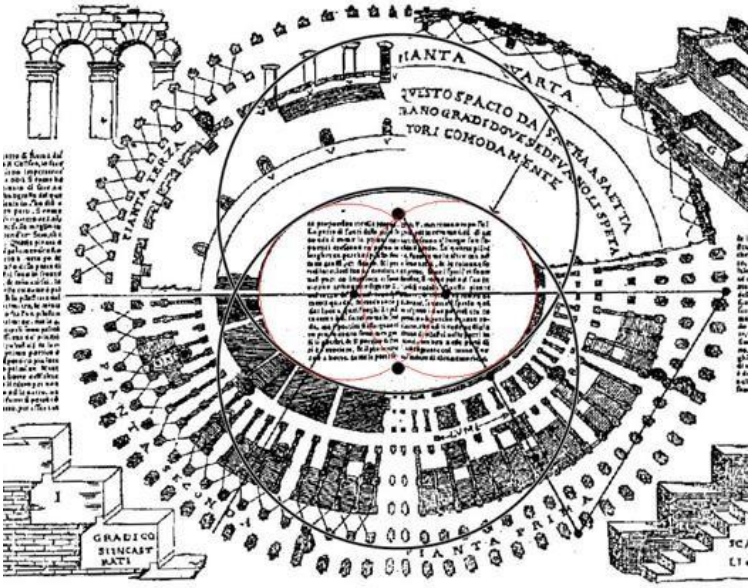

Figure 15. The oval of the Colosseum arena[13]

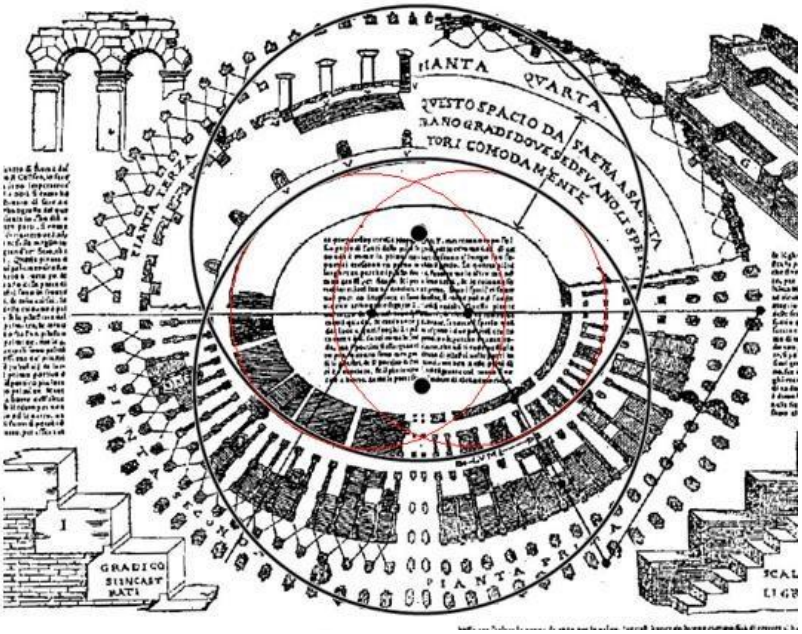

Figure 16. An intermediate oval of the Colosseum

[13] The drawings in Figures 15, 16, 17 and 18 was taken from [3] pg.105.

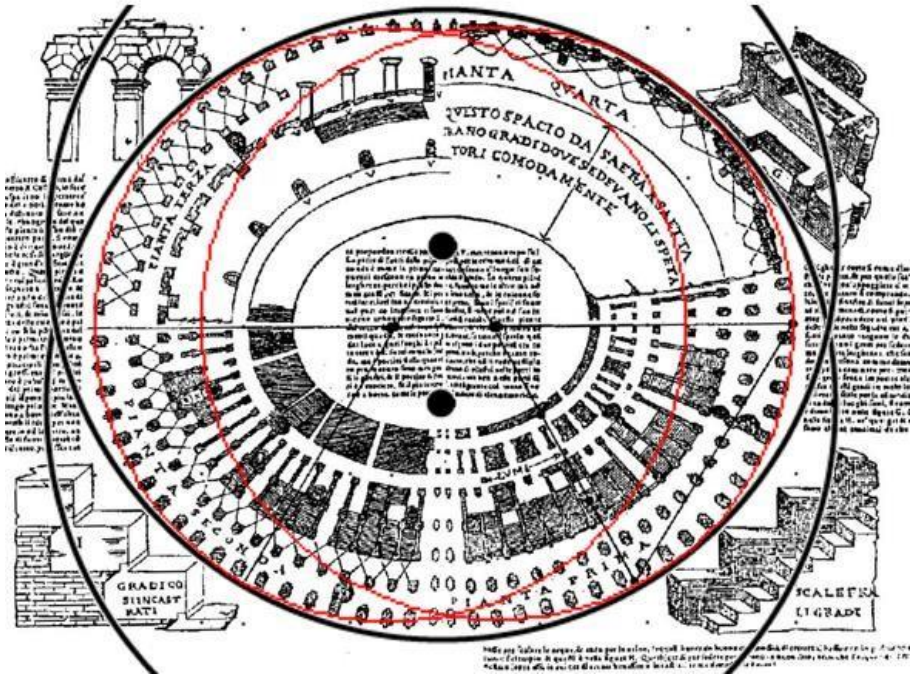

Figure 17. The external oval of the Colosseum

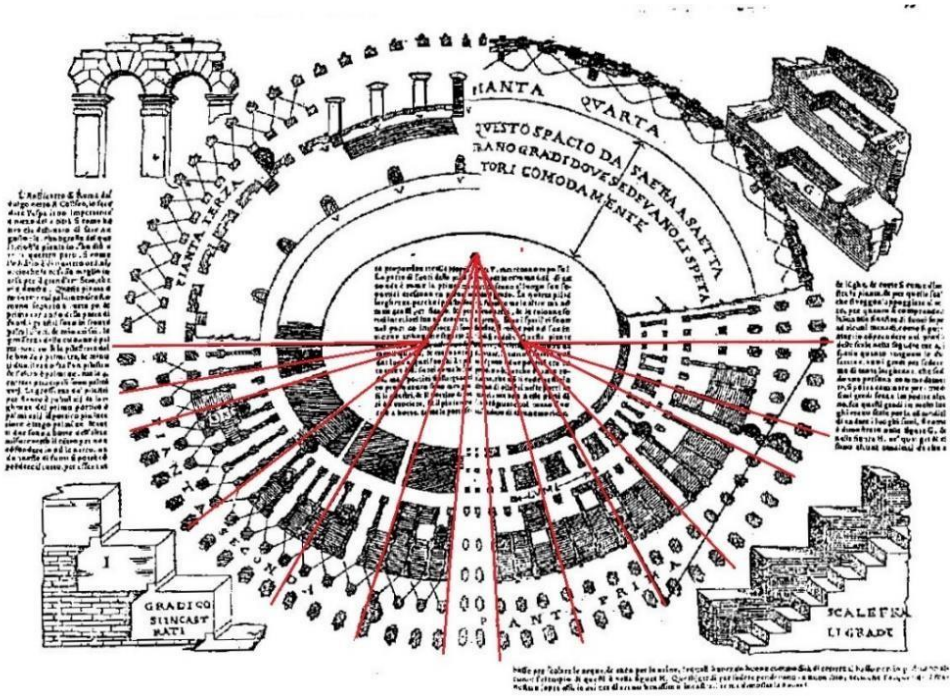

Figure 18. Directions of architectural elements towards the centers of the Colosseum ovals

It is interesting to note that the presence of the oval allows the architectural elements to converge towards the centers of the arcs of circumference that form the oval, as it can be seen from the Figure 18; we also observe that, once again, this is a property that does not apply to ellipses.

The same considerations can be made, for example, for the Roman amphitheaters in Pola and Verona (see [3] pp. 104-107) and for the roofs of some modern soccer stadiums (see Figure 19).

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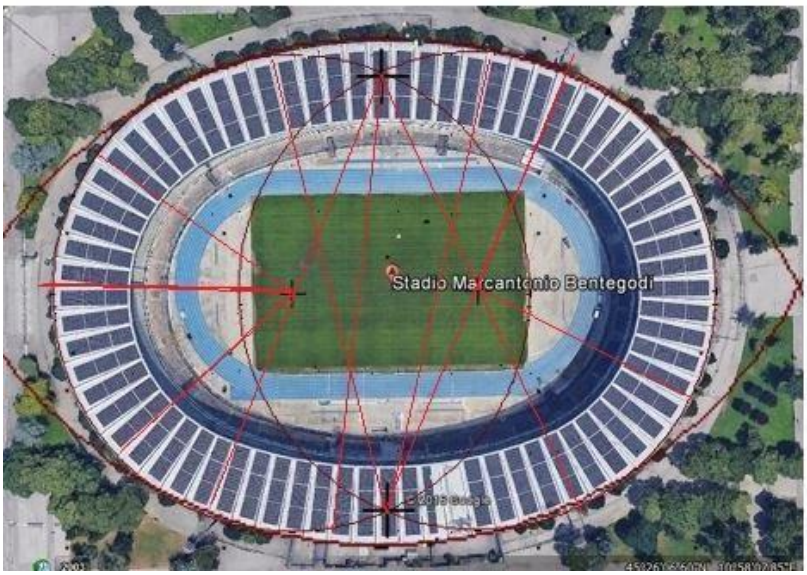

Figure 19. The Bentegodi stadium in Verona

Consider now the wall ashlars that form the arches. In the elliptical arches

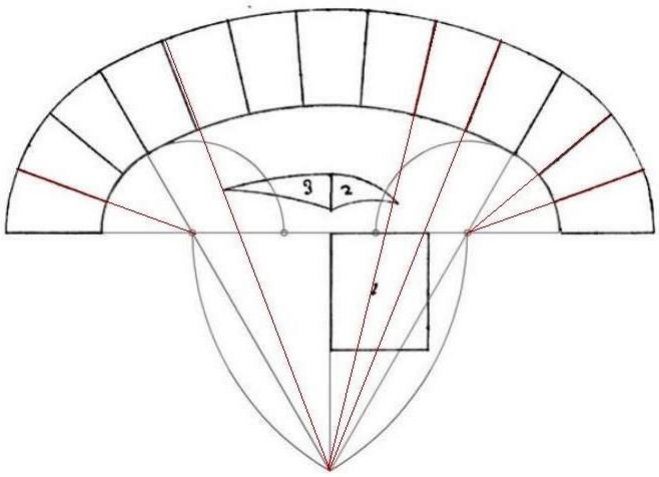

Figure 20. Wall ashlars normal to the profiles of the oval arches

the ashlars have different shapes while in the oval arches with three centers the ashlars have only two different forms. Furthermore, in this case, the lines normal to the circular profiles determined by the oval arch converge to these centers.

Thus, these lines identify the directions of the wall ashlars, as it can be seen from the above Figure 20, elaborated by the authors on the basis of a drawing taken from the text on stereotomy by Joseph Gelabert: *De l'art de Picapedrer* of 1653. This fact makes the arrangement of the aforesaid masonry elements easier.

Starting from the sixteenth century, many artists in their works used ovals, especially those with four centers; among these we mention: Leonardo da Vinci, Baldassare Peruzzi (1481-1536), Michelangelo Buonarroti, Sebastiano Serlio, Andrea Palladio (1508-1580), Jacopo Barozzi known as Vignola (1507-1573).

The *Hostinato rigor* emblem bears Leonardo da Vinci's favorite motto; it is kept in the Royal Library, Windsor Castle, in Windsor. He drew it, along with other emblems, between 1506 and 1510, during the second Milanese period (see Figure 21)[14]. The drawing on the left shows that the edge of this emblem is not an ellipse, while the one on the right shows that it is enclosed by an oval.

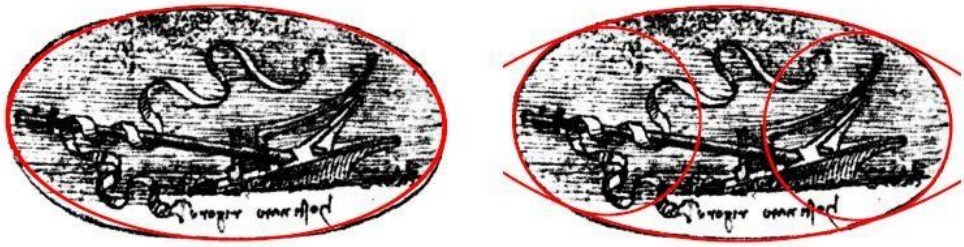

Figure 21. Emblem *Hostinato rigore* by Leonardo da Vinci

Let us consider the steps of the staircase of the Vestibule of the Laurentian Library, designed by Michelangelo; actually, this staircase was built by Bartolomeo Ammannati[15] starting in 1559, after the Master sent a clay model. In fact, starting from 1524, Michelangelo made some drawings and began the construction of the Laurentian Library, commissioned by Pope Clement VII. We know that in the autumn of 1534 Michelangelo left Florence and he never returned (see [13], pp. 259 and following). Afterwards, due to the insistence of Cosimo I de' Medici, he sent from Rome drawings and instructions for the construction of the library. The works were carried out by Vasari, by

[14] The drawing in Figure 21 was taken from [20].
[15] We already said, studying the Ponte Santa Trinita, that Ammannati and Michelangelo were friends.

Ammannati and by Tribolo, who scrupulously followed Michelangelo's instructions.

Looking at the steps, it seems quite evident that their profiles are ovals and not ellipses; this can also be seen from the abrupt change of their curvature towards the vertices of the major axis (a typical configuration of ovals, though not easily observable in all).

Figure 22. Oval steps of the staircase of the Vestibule of the Laurentian Library[16]

[16] The drawing in Figure 22 was taken from [1] pg. 259.
[17] Florence, Casa Buonarroti, Drawings by Michelangelo, Foglio 92 Ar [Corpus Tolnay 525r] and Foglio 92 Aw, [Corpus Tolnay 525v]. See also [6], pp. 53-67.

This fact is also visible in the drawings made by Michelangelo and kept in Casa Buonarroti[17]. In fact, Michelangelo knew the ovals; he also used these curves in the design of the Piazza del Campidoglio in Rome, whose profile fits perfectly into an oval with four centers.

Antonio Munoz in 1940 created the white oval with the internal white design of the pavement in Piazza del Campidoglio; Munoz based his project on an engraving (*ex Michaelis Angeli Bonaroti architectura*) made by Bartolomeo Faleti in 1567, according to the design of Michelangelo (see [17] pp. 73, 74 and [18]). As we can see from the following Figure 23, the profile of this square is not an ellipse.

Figure 23. The outline of Piazza del Campidoglio is not an ellipse

Instead, this profile is an oval that fits perfectly, as we can see in Figure 24, to the oval of Serlio drawn according to the fourth rule; moreover, we will highlight that this oval is of the same type as the one with which St. Peter's Square in Rome is drawn.

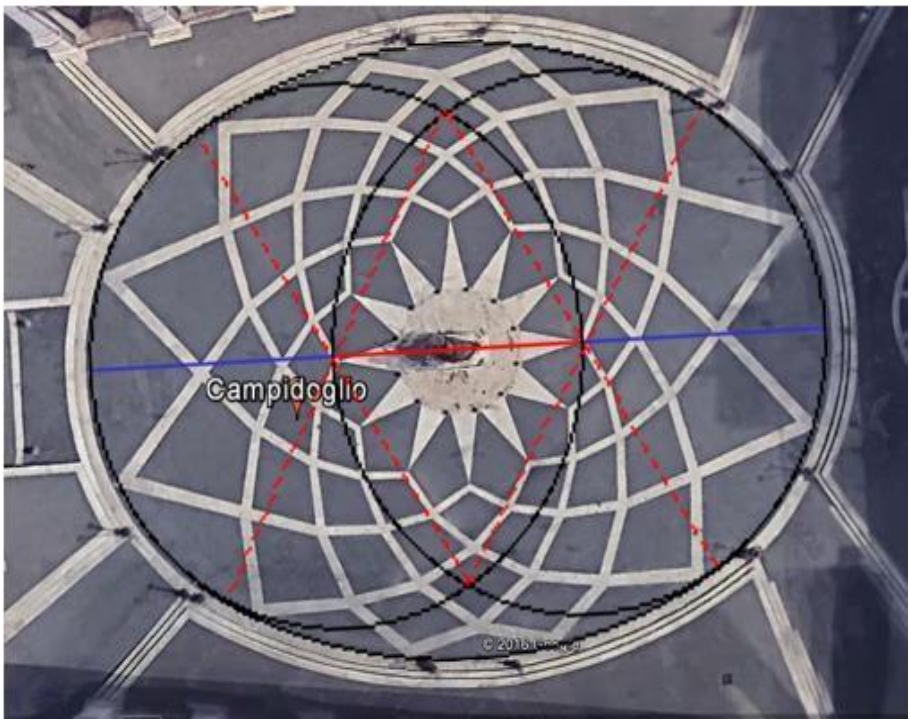

Figure 24. Michelangelo's oval in Piazza del Campidoglio

Sebastiano Serlio in the *First Book* of the 1545 *Treaty of Architecture* (see [19]) drew four types of ovals.

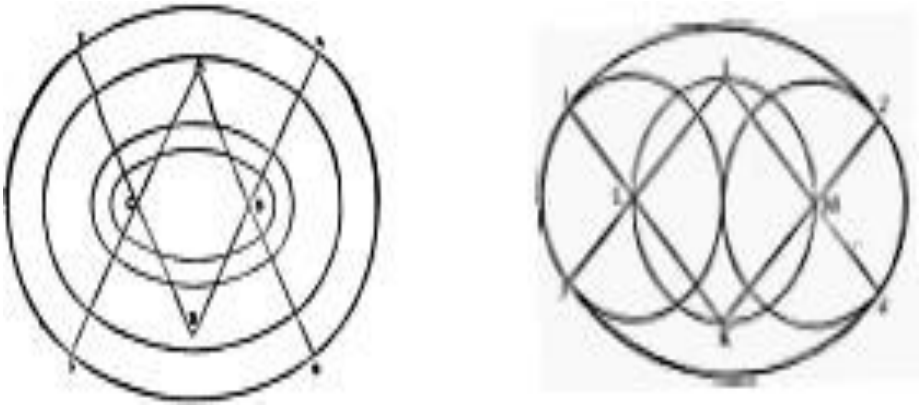

Figure 25. Serlio's ovals drawn according to the first and second rule respectively

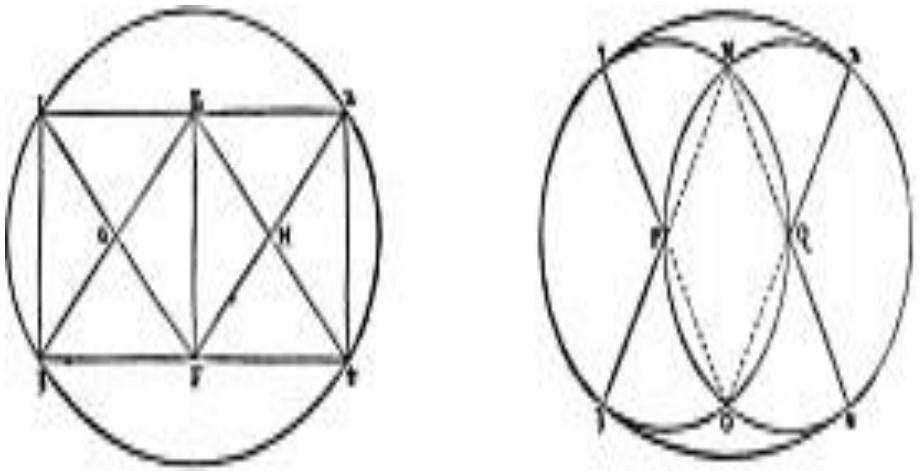

Figure 26. Serlio's ovals drawn according to the third and fourth rules respectively[18]

We note that the equilateral triangle is present in the first and fourth oval, while the square is present in the second and third; these figures were widely used in Renaissance art[19].

Giovanni Keplero, before choosing ellipses to describe the motion of the planets, tried to correct the discrepancies between the circular orbit, hypothesized up to then, and the data obtained from the observations of the motion of the planets, assuming that the orbits were ovals. Probably the reason for the choice of ovals was that these curves are formed by arcs of circumference, which was considered the perfect curve. With this hypothesis the situation improved but the data were still conflicting; only by adopting the elliptic curves there was a perfect coincidence with the astronomical observations (see [8]).

In the Baroque period, numerous artists used the ovals as, for example, Gian Lorenzo Bernini (1598-1680) and Francesco Borromini (1599-1667). In fact, many scholars hypothesize that even the elliptical structures of the Baroque are actually ovals; however, the question is still much debated (see, for example, [8]).

[18] The drawings in Figures 25 and 26 was taken from [3] pg.102.
[19] In his treatise Serlio states that there are many ways to draw an oval but he would have given the rules for only four of these.

Let’s consider now St. Peter's Square in Rome: we can say with certainty that its profile is an oval built according to the fourth rule of Serlio, as it can be seen from the geometric construction shown in Figure 27.

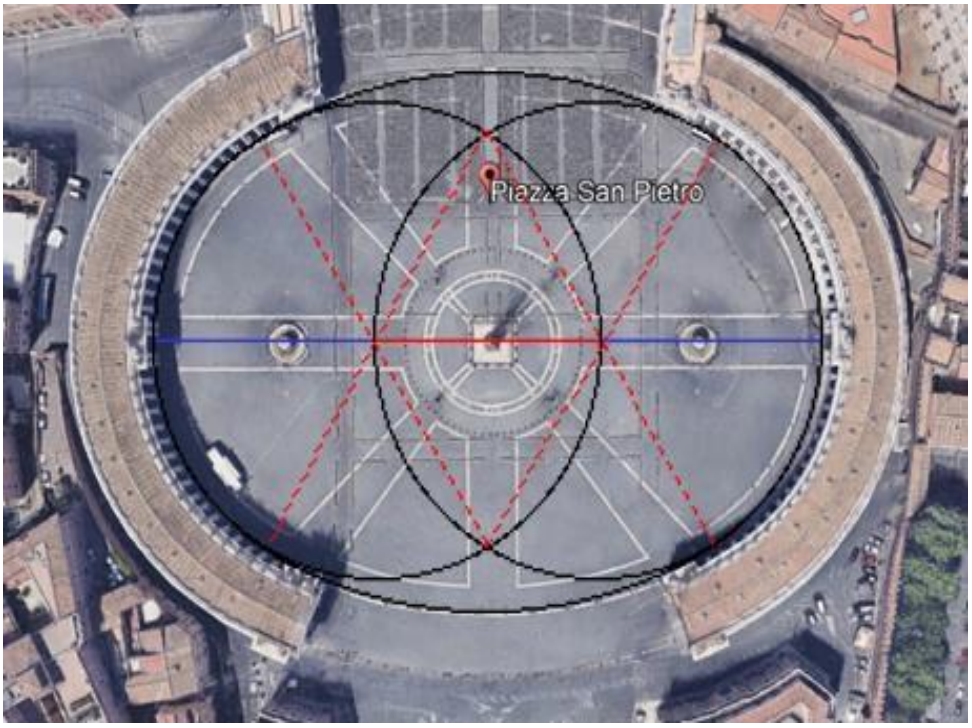

Figure 27. The oval of St. Peter's Square

Bernini himself makes clear which curve he used to draw the square: he inserts two stones in the pavement of the square with the inscription *"CENTRO DEL COLONNATO"* as we can see from Figure 28.

Indeed, these stones are located exactly in the centers of the two smaller circumferences that form the oval with four centers, which determines the internal profile of the square. Exactly from these points, one can see aligned the columns of the colonnades that surround the square.

If we approximated this oval with an ellipse, this would have the focuses moved from the aforesaid centers of the oval by about 25 meters towards the colonnades. Thus, it is completely wrong to state, as many says, that from the foci of the ellipse (assuming it is an ellipse) of the square one can see the aligned

Figure 28. Inscription of Bernini in St. Peter's Square

columns; in addition, it should be borne in mind that the foci of an ellipse do not satisfy this property.

Approximating the internal profile of the square with an ellipse, its foci would be in the fountain centers, about 59 meters from the center of the square.By the way, note that the axes of this oval measure about 196 and 156 meters, almost the same as those of the Colosseum.

Approximating the external profile of the square with an ellipse, the axes of which measure 240 and 180 meters, this would have the foci displaced by about 20 meters towards the two colonnades with respect to the foci of the internal ellipse, so Bernini should have used two ellipses with four different foci to determine the internal and external profile. Furthermore, as we have already said, the two ellipses would not have been two parallel curves. Instead, the oval that determines the external profile of the square has the same centers as the one that corresponds to the internal profile. This fact, as we have already observed, makes it easier to trace the curves that determine the structure, even if the drawing of an ellipse is quite simple to perform: just use the elliptical compass or the so-called "gardener's construction of an ellipse".

4. Conclusion

We think we have given an idea of the difference between ellipses and ovals, both. Regarding their geometric genesis and their properties that make these figures useful in applications. However, it is not always easy to distinguish these curves; sometimes, as we have seen, it is from their use that we can determine which curve it is, as we have highlighted in the case of the oval in St. Peter's Square or the ovals with which the Roman amphitheaters were traced.

Bibliography

[1] U. BARDINI, B. NARDINI (a cura di). *San Lorenzo, la Basilica, la Sagrestia, le Cappelle, la Ciblioteca.* Firenze: Nardini Editore. 1984.

[2] P. BARGELLINI. *I ponti di Firenze*. Firenze: Edizioni dell'Istituto Professionale "Leonardo da Vinci". 1964

[3] M. T. BARTOLI. *Le Ragioni Geometriche del Disegno Architettonico.* Firenze: Alonea Editrice. 1997

[4] R. BECHMANN. *Le radici delle Cattedrali.* Milano: Arnoldo Mondadori Editore. 1989.

[5] A. BELLUZZI, G. BELLI. *Il ponte a Santa Trinita.* Firenze: Edizioni Polistampa. 2003.

[6] S. CATITTI. *Michelangelo e il disegno architettonico come strumento progettuale ed esecutivo: il caso della Biblioteca Laurenziana.* Atti del Convegno "Michelangelo e il linguaggio dei disegni di Architettura", Firenze 30 gennaio - 1 febbraio 2009 (a cura di G. Maurer e A. Nova), Collana del Kunsthistorisches Institute in Florenz, nr.16-17. 2009.

[7] A. CHOISY. *L'art de bâtir chez les égyptiens.* Paris: É. Rouveyre. 1904.

[8] F. COLONNESE. *Kepler, Galileo, Bernini e Gaspari. Note sulla controversa associazione tra Ellisse e Barocco.* Proceedings of European Network for Baroque Cultural Heritage General Conference (Roma, 27-29 marzo 2014). Parigi: Open Edition. 2014.

[9] G. CONTI, G. LITTERA, S. MARRAGHINI. *Costruzioni geometriche in alcuni monumenti fiorentini del cinquecento.* Bollettino Studi Storici fiorentini, 28-29. 2019-2020. pp. 94-102.

[10] R. CORAZZI, G. CONTI. *Il segreto della Cupola del Brunelleschi a Firenze.* Firenze: Pontecorboli Editore. 2011.

[11] M. DOCCI, R. MIGLIARI. *Architettura e geometria nel Colosseo di Roma,* in *Matematica e Architettura, Metodi analitici, metodi geometrici e rappresentazione in Architettura* (a cura di O. Arena). Firenze: Alinea Editrice. 2001. pp.13-24.

[12] E. DOTTO. *Il disegno degli ovali armonici*. Catania: Le Nove Muse Editrice. 2002.

[13] A. FORCELLINO. *Michelangelo. Una vita inquieta.* Roma-Bari: Editori Laterza. 2005.

[14] C. INGLESE , A. PIZZO, *L'anfiteatro di Augusta Emerita: dallo studio formale, geometrico e proporzionale al progetto.* In Carlo Bianchini, La documentazione dei teatri antichi del Mediterraneo. Le attività del progetto Athena a Merida. Roma: Cangemi Editore. 2013. pp. 181-188.

[15] M. KLINE. *Storia del pensiero matematico.* Vol. I. Torino: Giulio Einaudi Editore. 1991.

[16] P. PAOLETTI. *Il ponte a Santa Trinita. Com'era e dov'era.* Firenze: Becocci Editore. 1987.

[17] G. M. PILO. *Come Michelangelo concepì la sistemazione della piazza del Campidoglio.* Arte Documento, vol. 9. 1995.

[18] A. M. RACHELI. *Restauro a Roma. 1870-1990 architettura in città.* Venezia: Marsilio. 2000.

[19] P. L. ROSIN. *On Serlio's construction of ovals.* The Mathematical Intelligencer, 23. 2001. pp. 58-69.

[20] P. L. ROSIN. *On the construction of ovals*. www.researchgate.net/publication/2904488

[21] V. VALERIO. *La Forma dell'ellisse.* Arte e matematica. Un sorprendente binomio (a cura di E. Ambrisi, L. Basile, L. D'Apuzzo, A. Pellegrini). Istituto Italiano per gli Studi Filosofici. Napoli: Arte Tipografica Editrice. 2006. pp. 241-262.

[22] E. VIOLLET-LE- DUC. *L'Architettura ragionata.* Milano: Jaca Book. 1982.

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Epistemic logic and CERMINE: a logical model for automatic extraction of structured metadata

Simone Cuconato♦

Abstract

In this article we develop a logical model for the automatic extraction of structured metadata. We introduce a new predicate E – reads 'extract' – and a structure $\mathcal{S}$ to syntactically and semantically define metadata extracted with any automatic metadata extraction system. These systems will be considered, in the logical model created, as *knowledge extraction agents* (henceforth *KEA*). In this case *KEA* taken into consideration is CERMINE, a comprehensive open-source system for extracting structured metadata from scientific articles in a born-digital form.

Keywords: epistemic logic; applied non-classical logics; logical methods in data science and knowledge engineering; metadata formalization; CERMINE

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1. A world of (meta)data

In the information world, at the most elementary level, metadata are defined as 'data about data' [11]. This basic definition is often detailed by referring to the structured nature of metadata and/or their machine-readable character. We need metadata in order to use the data to represent things that matter to us: to understand phenomena, to better serve customers, to establish organizational policies, and/or to keep a more accurate record of human activities. Within information systems, metadata perform a range of functions. These include:

- Searching: identifying the existence of a resource by keyword searching, browsing indexes or visualization techniques.
- Resource management: collection and database management.
- Selection: analysis and evaluation based on the description provided.
- Semantic interoperability: allowing searching across domains by means of equivalent elements.
- Location: finding a particular instance of a resource.
- Integrity and accountability verification and rights management
- Terms of availability information.

The Digital Library Federation identifies three types of metadata about digital resources:

- *descriptive metadata*: information describing the intellectual content of the object;
- *administrative metadata*: information necessary to allow a repository to manage the object;
- *structural metadata*: information that ties each object to others to make up logical units.

Metadata, whether descriptive, administrative or structural, ultimately share a single multifunctional goal: to contribute to a clearer and more modular management of digital objects and content retrieval. Automated metadata extraction enables the direct extraction of metadata from document sources. Obtaining structured metadata from documents, including title, authors, and publication date, is important to support retrieval tasks in information sciences. Various tools and frameworks exist to automatically extract this information

from PDF documents. Frameworks such as CERMINE, for example, are able to automatically extract metadata from specific document sources.

CERMINE [13, 14] is a comprehensive open-source system for extracting structured metadata from scientific articles in a born-digital form[1]. The system is based on a modular workflow and the implementations of most steps are based on supervised and unsupervised machine-learning techniques. The modular workflow, depicted in Figure 1.1 and 1.2, consists of three paths (*ii* and *iii* run in parallel): *i*) the base structure extraction path requires a pdf file as input and produces a geometric hierarchical structure in TrueViz format [6]. TrueViz is a tool capable of classifying the entities of each page of the structure into four categories: areas, lines, words and characters. In turn, each zone is labelled according to four other categories: metadata, references, body and other; *ii*) metadata extraction path analyses metadata parts of the geometric hierarchical structure. The result is a set of document's metadata from them in an XML format; *iii*) references extraction extracts a list of document's parsed bibliographic references.

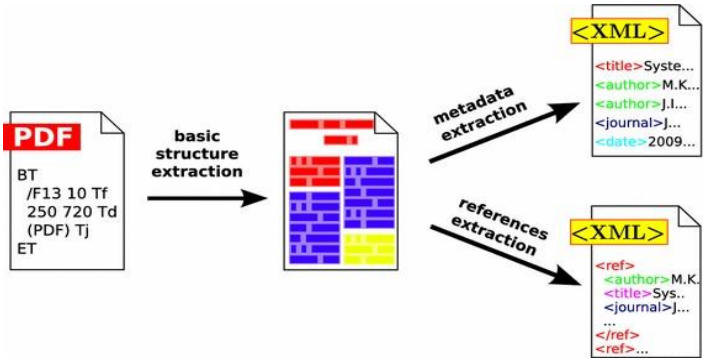

Figure 1.1: CERMINE's extraction workflow architecture[13]

[1] CERMINE system is available under an open-source licence and can be accessed at http://cermine.ceon.p.

Table 2 The decomposition of CERMINE's extraction workflow into independent processing paths and steps

Path	Step	Goal	Implementation
A. Basic structure extraction	A1. Character extraction	Extracting individual characters along with their page coordinates and dimensions from the input PDF file	iText library
	A2. Page segmentation	Constructing the document's geometric hierarchical structure containing (from the top level) pages, zones, lines, words and characters, along with their page coordinates and dimensions	Enhanced Docstrum
	A3. Reading order resolving	Determining the reading order for all structure elements	Bottom-up heuristic-based
	A4. Initial zone classification	Classifying the document's zones into four main categories: *metadata*, *body*, *references* and *other*	SVM
B. Metadata extraction	B1. Metadata zone classification	Classifying the document's zones into specific metadata classes	SVM
	B2. Metadata extraction	Extracting atomic metadata information from labelled zones	Simple rule-based
C. Bibliography extraction	C1. Reference strings extraction	Dividing the content of *references* zones into individual reference strings	K-means clustering
	C2. Reference parsing	Extracting metadata information from references strings	CRF

Figure 1.2: The decomposition of CERMINE's extraction workflow [14]

A system such as CERMINE can be formally represented through the use of epistemic logic. There is a close relationship between logic and computer science can be seen from the number of publications whose titles link the two disciplines with prepositions suggesting various degrees of proximity, cooperation or subordination: 'Logic in Computer Science', 'Logic and Computer Science', 'Logic for Computer Science', etc. However, some areas of computer science and technology, and in particular those relating to knowledge management and extraction, do not seem to have created the close relationship indicated above. The aim of this article is to create an innovative logic model applicable to engineering and data science [8].

2. Multi-agent epistemic logic: syntax and semantics

Epistemic logic [4, 15, 16] is the logic of knowledge and belief. Syntactically, the language of propositional epistemic logic is simply a matter of augmenting the language of propositional logic with a unary epistemic operator $K_i$such that

$K_i\varphi$ reads 'Agent i knows φ' for

some arbitrary proposition φ.

Hintikka provided a semantic interpretation of epistemic and belief operators which we can present in terms of standard possible world semantics along the following lines [7]:

> $K_i\varphi$: *in all possible worlds compatible with what i knows, it is the case that φ*

However, the general study of formal semantics for knowledge and belief (and their logic) really began to flourish in the 1990s with fundamental contributions from computer scientists [5, 10] and game theorists [3].

Definition 2.1 [Language] Let P be a set of atomic propositions, and A a set of agent-symbols. The language $\mathcal{L}_K$, the language for multi-agent epistemic logic, is generated by the following BNF:

$$\varphi ::= p \mid \neg\varphi \mid (\varphi \wedge \varphi) \mid K_i\varphi$$

We use standard possible worlds semantics to give an interpretation to the language above. A model will be built on a set of epistemic alternatives (or worlds), and a relation built on these.

Definition 2.2 [Frames, Models, and Satisfaction] A Kripke Frame $F = (W, R)$ is a tuple where W is a set of epistemic alternatives for the agent, and $R \subseteq W \times W$ is an accessibility relation. A Kripke Model $M = (F, \pi)$, is a tuple where F is a Kripke frame and $\pi: P \to 2^W$ is an interpretation for a set of propositional variables P.

Given a model M and a formula φ, we say that φ is true in M at world w, written $M, w \vDash \varphi$ if:

- $M, w \vDash p$ iff $w \in \pi(P)$,
- $M, w \vDash \neg\varphi$ iff it is not the case that $M, w \vDash \varphi$,
- $M, w \vDash \varphi \wedge \psi$ iff $M, w \vDash \varphi$ and $M, w \vDash \psi$,
- $M, w \vDash K_i\varphi$ iff $(om\, w')(wRw'$ then $\mathcal{M}, w' \vDash \varphi)$.

A formula φ is valid, written $\vDash \varphi$, if it is true in every world in every model. I write $F, w \vDash \varphi$ to represent $M, w \vDash \varphi$ where M is an arbitrary model whose underlaying frame is F[2].

3. Knowledge formalization: syntax, semantics, axioms and structure

In order to deal adequately with *KEA* we extend the language $\mathcal{L}_K$ to obtain a language $\mathcal{L}_{K^+}$ The alphabet of $\mathcal{L}_{K^+}$ contains a new two-place predicate E such that:

E reads 'exstract'

Definition 3.1 [Language] The language $\mathcal{L}_{K^+}$ is generated by the following:

$$\psi ::= \Gamma^K_i p_{w_i} \mid \neg\psi \mid (\psi \wedge \psi)$$

where the intended interpretation of a formula $\Gamma^K_i p_{w_i}$ is 'agent i knows p_{w_i}', with p_{w_i} such that:

$$p_{w_i} =_{df} E^{m_i}_{d_i}$$

where $E^{m_i}_{d_i}$ reads 'extracts metadata m_i from document d_i'.

Definition 3.2 [Frames, Models, and Satisfaction] Given a Kripke Frame $F = (W, R)$, a Kripke Model $M = (F, \pi)$ and a formula ψ, we say that ψ is true in M at world w, written $M, w \vDash \psi$ if:

- $M, w \vDash \Gamma^K_i p_{w_i}$ iff $K_i\left(E^{m_i}_{d_i}\right)$,
- $M, w \vDash K_i p_{w_i}$ iff $(om\, w')(wRw' \text{then } \mathcal{M}, w' \vDash \psi)$,
- $M, w \vDash p_{w_i}$ iff $w \in \pi(P)$,
- $M, w \vDash \neg\psi$ iff it is not the case that $M, w \vDash \psi$,
- $M, w \vDash \psi \wedge \phi$ iff $M, w \vDash \psi$ and $M, w \vDash \phi$.

[2] We assume the standard definitions for metalogical properties such as axiomatisation, completeness, etc.

Definition 3.3 [Axioms and Inference Rules] The model on the language $\mathcal{L}_{K^+}$ is a first-order multi-modal version of the normal propositional system S5 and contains the following schemes of axioms and inference rules:

TAUT	Every classic propositional tautology
DIST	$K_i(\varphi \to \psi) \to (K_i\varphi \to K_i\psi)$
T	$K_i\varphi \to \varphi$
4	$K_i\varphi \to K_iK_i\varphi$
5	$\neg K_i\varphi \to K_i\neg K_i\varphi$
MP	$\varphi \to \psi, \varphi \Rightarrow \psi$
NEC	$\varphi \Rightarrow K_i\varphi$
EX	$\forall x\varphi \to \varphi[x/t]$
GEN	$\varphi \to \psi[x/t] \Rightarrow \varphi \to \forall x\psi$, x not free in φ
ID	$t = t$
FUNC	$t = t' \to (t''[x/t] = t''[x/t'])$
SUBST	$t = t' \to (\varphi[x/t] \to \varphi[x/t'])$

Definition 3.4 [Structure] Consider the following structure $\mathcal{S} = \langle A, W, P_{w_i}, M, D\rangle$:

- $A = \{a, b, c, \dots\}$ is a non-empty finite set of *KEA*,
- $W = \{w_1, \dots, w_m\}$ is a non-empty set of possible worlds ($|W| = m \in \mathbb{N}$),
- $P_{w_1} = \left\{p_{1_{w_1}}, \dots, p_{m_{w_m}}\right\}$ is a non-empty set of propositions $\left(\left|P_{w_1}\right| = m \in \mathbb{N}\right)$,
- $M = \{m_1, \dots, m_m\}$ is a non-empty set of metadata ($|M| = m \in \mathbb{N}$),
- $D = \{d_1, \dots, d_m\}$ is a non-empty set of documents ($|D| = m \in \mathbb{N}$) .

$\mathcal{S}$ is a dynamic structure, a structure in which possible worlds W occur. A is the set of *KEA*, while $P_{w_1}$is the set of epistemic propositions. M is the set of metadata while D is the set of documents.

4. Example of $\mathcal{S}$

Let us now consider two metadata extractions using the CERMINE system. The first extraction w_1 can be defined as a standard extraction as it was performed from born-digital scientific literature, specifically, extraction was

performed on two SARS-CoV-2 (covid-19) studies [9, 12]; on the contrary, the second extraction w_2 can be defined as a *non-standard extraction* since it was performed on a logic [1] and an information science [2] article.

Consider the following structure $\mathcal{S} = \langle A, W, P_{w_i}, M, D \rangle$:

- $A = \{c\}$;
- $W = \{w_1, w_2\}$;
- $P_{w_{1,2}} = \left\{p_{1_{w_1}}, \dots, p_{m_{w_1}}, p_{1_{w_2}}, \dots, p_{m_{w_2}}\right\}$
- $M = \{m_1, m_2, m_3, m_4\}$
- $D = \{d_1, d_2, d_3, d_4\}$

$P_{w_{1,2}}$:

$$\forall_i \in A, \psi_i: \begin{Bmatrix} K_c(E_{d_1}^{m_1}), K_c(E_{d_1}^{m_2}), K_c(E_{d_1}^{m_3}), K_c(E_{d_1}^{m_4}), \\ K_c(E_{d_2}^{m_1}), K_c(E_{d_2}^{m_2}), K_c(E_{d_2}^{m_3}), K_c(E_{d_2}^{m_4}), \\ K_c(E_{d_3}^{m_1}), K_c(E_{d_3}^{m_2}), K_c(E_{d_3}^{m_3}), K_c(E_{d_3}^{m_4}), \\ K_c(E_{d_4}^{m_1}), K_c(E_{d_4}^{m_2}), K_c(E_{d_4}^{m_3}), K_c(E_{d_4}^{m_4}) \end{Bmatrix}$$

$c = Cermine,\ m_1 = Title, m_2 = Abstract,\ m_3 = Author,$
$m_4 = Keywords$
$d_1 = [12], d_2 = [9]$
$d_3 = [1], d_4 = [2]$

$\boldsymbol{w_1}$:

- $K_c(E_{d_1}^{m_1}) = \mathrm{T}$
- $K_c(E_{d_1}^{m_2}) = \mathrm{T}$
- $K_c(E_{d_1}^{m_3}) = \mathrm{T}$
- $K_c(E_{d_1}^{m_4}) = \mathrm{T}$
- $K_c(E_{d_2}^{m_1}) = \mathrm{T}$
- $K_c(E_{d_2}^{m_2}) = \mathrm{T}$
- $K_c(E_{d_2}^{m_3}) = \mathrm{T}$
- $K_c(E_{d_2}^{m_4}) = \mathrm{F}$

In the first extraction w_1, agent *c* correctly extracts seven out of eight

metadata items. In the first paper *c* correctly extracts all metadata. In the second paper, however, it correctly extracts only three metadata: m_4, despite being present in the document, is not captured. This extraction can be represented of the model of Figure 4.1

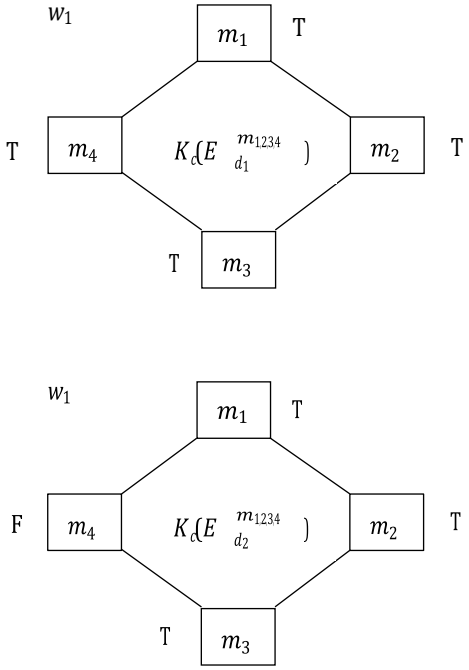

Figure 4.1: The model of $\mathcal{S}$ in w_1

$\boldsymbol{w_2}$:

- $K_c(E^{m1}_{d_3})$ = T
- $K_c(E^{m2}_{d_3})$ = T
- $K_c(E^{m3}_{d_3})$ = T
- $K_c(E^{m4}_{d_3})$ = F
- $K_c(E^{m1}_{d_4})$ = T
- $K_c(E^{m2}_{d_4})$ = T
- $K_c(E^{m3}_{d_4})$ = T
- $K_c(E^{m4}_{d_4})$ = T

In the second extraction w_2 the agent c correctly extracts seven out of eight metadata. In the third document *c* does not report any information about

metadata m_4, although the metadata is present within the article. In the fourth document c correctly extracts all metadata. This extraction can be represented of the model of Figure 4.2

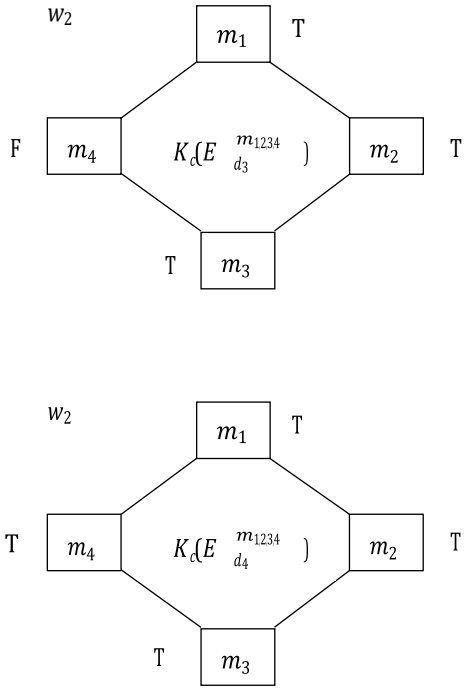

Figure 4.2: The model of $\mathcal{S}$ in w_2

5. Conclusions and future work

The creation of logic models applicable to automatic metadata extraction systems is a new but extremely interesting research topic. In this article we have provided a formalisation of the knowledge extracted by a specific extraction system: CERMINE. The use of formal models in support of data science and knowledge engineering offers many advantages to knowledge managers: *i*) it guarantees a rapid study of the extracted information; *ii*) it allows a comparison between different automatic metadata extraction systems; *iii*) it allows visualising the presence of inconsistent or incomplete metadata. The last point is probably the most challenging aspect of logic research applied to automatic

metadata extraction systems. A possible future development could be: *i*) to study the problem of inconsistent or incomplete metadata in a similar way to how it was treated in inconsistent or incomplete databases; *ii*) the use of polyvalent logics suitable for dealing with vague, imprecise or unreliable data.

References

1. F. Belardinelli, A. Lomuscio. "A quantified epistemic logic for reasoning about multiagent systems". *6th International Joint Conference on Autonomous Agents and Multiagent Systems*. 2007.
2. E. Bottazzi, R. Ferrario. "Preliminaries to a DOLCE Ontology of Organizations". *Int. J. Business Process Integration and Management*. Vol. 4, No. 4, 2009.
3. Bonanno and Battigalli. "Recent results on belief, knowledge and the epistemic foundations of game theory". *Research in Economics*. Volume 53, Issue 2, June 1999, Pages 149-225. 1999.
4. S. Cuconato. "A logical framework for democratic decision-making: epistemic logic and liquid democracy", *Science & Philosophy – Journal of Epistemology, Science and Philosophy*, 2020.
5. R. Fagin, J. Y. Halpern, Y. Moses, M. Y. Vardi. *Reasoning About Knowledge*. The MIT Press: Cambridge, MA. 1995.
6. C. Ha Lee, T. Kanungoa. "The architecture of TrueViz: a groundTRUth=metadata editing and VIsualiZing ToolKit", *Pattern Recognition*, 36 pp. 811 – 825. 2003.
7. J. Hintikka. *Knowledge and Belief: An Introduction to the Logic of the Two Notions*. Second edition, Vincent F. Hendriks and John Symons (eds.), (Texts in Philosophy, 1). London: College Publications. 1962 [2005].
8. H. Hosni, A. Vulpiani, "Data science and the art of modelling", *Lettera Matematica International*. 2018.
9. Li Z, Yi Y, Luo X, Xiong N, Liu Y, Li S, et al. "Development and Clinical Application of A Rapid IgM-IgG Combined Antibody Test for SARS-CoV-2 Infection Diagnosis". *Journal of medical virology*. 2020
10. Ch. Meyer, W. van der Hoek. *Epistemic Logic for AI and Computer Science*. Cambridge University Press. 1995.
11. J. Pomerantz. *Metadata*. MIT Press Ltd. 2015.
12. B. Shanmugaraj, A. Malla, W. Phoolcharoen. "Emergence of Novel Coronavirus 2019- nCoV: Need for Rapid Vaccine and Biologics Development". *Pathogens*. 9(2):148. 2020
13. D. Tkaczyk, P. Szostek, P. Jan Dendek, M. Fedoryszak, Ł. Bolikowski

14. "CERMINE — automatic extraction of metadata and references from scientific literature". *Conference: 2014 11th IAPR International Workshop on Document Analysis Systems*. 2014.
15. D. Tkaczyk, P. Szostek, P. Jan Dendek, M. Fedoryszak, Ł. Bolikowski
16. "CERMINE — automatic extraction of metadata and references from scientific literature", *International Journal on Document Analysis and Recognition (IJDAR)*. Springer. 2015
17. H. van Ditmarsch, W. van der Hoek, B. Kooi. *Dynamic Epistemic Logic*, Synthese Library, Volume 337. Netherlands: Springer. 2007.
18. H. van Ditmarsch, J. Halpern, B. Van Der Hoek, B. Kooi. *Handbook of Epistemic Logic*. College Publications. 2015.

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Society and territory: prevention and social planning.

Roberto Veraldi[1]

Abstract

Prevention and social planning are two terms that bind to the sense of community and identity of a territory, at a time of socio-economic regeneration of the territory itself and resilience to the crises imposed by globalization. The local community is at the center of the processes of renaissance, or at least this is what all decision-makers declare in their planning. In reality, programming (at all levels, from European to local) needs to confront the demands, values, resources and power (even perceived) of change that belong to the local community, as an expression of relationships and power. The relationship between external/internal agents of change is not only limited to policy makers and stakeholders (both of the different levels of programming and of the different sectors of the same local community), but also to the view that they have of the dichotomies (sometimes stereotyped) such as: health/health, well- being/disease, development/protection, investment/cost, participation/delegation.

Keywords: community/society; local/global; social identity/relationships[2]

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Roberto Veraldi

1. Introduction

The word, the feeling, the reaction that unites all of us in this globalized world, is fear. Fear of the foreigner who steals our work, fear of the foreigner who deals drugs on the street, fear of the labour market that selects more and more ruthlessly, fear of companies that can fire at any time by closing an entire plant to move it to another part of the globe, fear of financial speculators who can ruin a nation in a single day.

And all this generates anxiety, the anxiety of recognition and reassurance, anxiety of grandmother to be more accepted within their own experience of relationships, anxiety to slip slowly among the invisible, among the last, between the gap of society, but also anxiety of entire communities that see their places impoverished, denied, compressed by capitalist society and by a lack of planning projected into the future. And all this is expressed through a tension, to use Bauman's words, between individual phenomena and collective phenomena experienced at varying degrees of intensity as threats, such as subsidiaries of the post-modern (I would add that I do not particularly like postmodern adjective. I love more the term of late modernity or second modernity).

I would then like to focus briefly on this state of fear: if we think of unemployment, new miseries, daily precariousness, and this just to stay in the local, we see how all these aspects become phenomena that give full hands insecurity, doubt, distrust, risks. The generalized precariousness, the urban insecurity, the migrants who push at the borders, the illegal immigrants who steal our women's work, the violence that the ecosystem suffers from the consequent climate changes, the destruction of the forests, the poisoning of the seas, do nothing but give an obscure existential representation, bearer of threats that have now become systemic and that represent scenarios unable to build handholds to which I can cling to in its increasingly frantic search for points of reference.

And the uncertain forms that the contemporary world takes on today, can be considered the mirror of the slipperiness and ambiguity of the forms of identity of the citizens of this century: the figure of the uncertain (and widespread uncertainty) is about to be one of the dominants of the present and the immediate future. Perhaps we could add that, net of any play on words, perhaps what we are most afraid of today is just not knowing what to be afraid of.

The third world, for example, appears to be absorbed for better or for worse in the complex economic, social and political dynamics of globalization, with a significant increase in the distance between a few developed nations, most of which are afflicted by the dramas of poverty, hunger, underdevelopment, and political unrest. We must add that the very bad habit of defining developing countries as the Third World hides the bonds of dependence on Western countries; bonds that are very strong both from the times of colonialism and from today's globalized neo-colonialism.

In all this, Europe shows a profound inability to assume its responsibilities, denying its historical and cultural matrix, avoiding being inspired by principles of justice, fair distribution of resources, the fight against hunger, and leaving room only for the heartless and depersonalizing economy. What comes out of this description in gloomy colours: it discerns a tear in social networks and a weakening of the welfare state that gives way to the war between goods and labour, on the one hand, and the community on the other... the effects of this war could somehow once have been cured

in the backyards of affections and family ties or social networks, today these backyards are increasingly undermined by weak and temporal ties; solid networks then give way to mobile networks.

And it is no coincidence that he has repeatedly used the word network. It is a word that refers to a protective and reassuring dimension, but also a coercive dimension; its conceptual evocation allows us to approach and keep together a system of binomials and antinomies that would otherwise conflict. The network allows us to work with e between the formal and the informal, the community of the individual, the right and solidarity, money and the free, the public and the private, the ego and the other.

Above all, however, what stands out most is the attempt to break up even the remaining links between weak networks because of the increase in complexity in the E social context, because of the ambivalence present in it: It is under the eyes of all how the new constraints, the new steel cages, given by today's social structure harness the life of all (living a hectic and hyper-organized time, deny the fragility to always be prepared and ready to compete, delude themselves that they can have endless potential to awaken And become aware that this is not the case, build as people in a context that is increasingly without models and protective nets especially for young people).

And again, there seem to be evident known aspects of daily life: a) the appearance of a new individualism that overshadows groups, organizations, intermediate social bodies that have produced a dynamic reading of the situations and problems that people live (even if there are examples not exciting, in fact of new forms of associationism that are neither spontaneous nor full of content); b) also, another useful element for reflection, the loss of the desire to relate (as a result of what was said above). The alternative seems to be the construction of instrumental (interested) social bonds that generate what is defined as liquid modernity, as a new form of communal modernity as a refuge from an insecure world.

2. Prevention and social planning

It is clear that all this makes it difficult to promote interventions of prevention and social planning; also because some have thought of putting prevention as a player at a personal level or at most between two institutions; In reality, it must be understood as a process that brings into play in the local community many actors who are called to put themselves into the network to develop an idea of prevention as a time to seek new social meanings, new social coexistence, new visions of the social world to relaunch social ties and implement new forms of construction of the common good. However, it is no longer possible to experiment with new forms at random, but neither should we try to bridle reality by lowering, from above and in an a-contextual manner, behavioural models, rules of conduct, when instead a prevention is needed that is designed, centred on the Person as a resource and not as a problem, and that involves the whole community.

Prevention that does not impose models but the dialogue with the situations, that reads the specific situations and declines interventions in a perspective of support and change within the processes participated with the protagonists of the prevention. Planning prevention means translating an intentionality, linked to values and premises often implicit, it means seeing what you want to do, what you can do, what you do. In a word it means awareness. Through a conscious vision of the choices that are made and what happens, the design process takes a direction, a guide. Through design, the values that animate the subjects in the field are translated into objectives and therefore become goals, the realization of which can be evaluated.

It must also be engaging and have an impact on everyday life contexts. But it must also be an act of continuity that concerns families, peer groups, schools, sports organizations, religious or cultural groups. In this sense, those who promote prevention are placed in the perspective of promoting the network of social ties and use as a resource the group and its potential both systemic and ethical: this also means promoting social capital, such as the set of relational elements that can enhance the social rationality itself; therefore, social capital is characterized by the presence of relationships of trust, cooperatives, in which the meso dimension (between macro and micro) of families, groups, organizations that the prevailing individualism has mortified is recovered. And social capital then becomes a sort of resource for the community, as it puts people in a position to act together for the achievement of a common goal, even in the absence of particular constraints.

And so all this means putting relations back at the center, that is, rediscovering that bonds are a resource as well as a bond: they can be generated and regenerated in the family but also in the community, the world of work, in the world of associationism, as well as in politics. To do this we need to get out of the false dichotomy between the individual and society, to recognize that the encounter, the crossbreeding, between the individual and society always sees the presence of multiple mediations, whether they are groups or organizations, artificial or natural, and that all are combined with the promotion of quality of life. It is, therefore, necessary to promote and support the capacities of individuals and groups to generate and regenerate bonds and improve the quality of life, which in any case lead to the promotion of networks and dynamism in local communities.

Prevention means building and rebuilding as well as relaunching social ties; prevention and caring for the ties, of people, of the community. In this perspective, taking care takes the form of accompanying in paths of reconstruction and regeneration of bonds, the laughed meaning of events, of assuming responsibility towards oneself and others: in these cases what counts is the search for meaning, a search that implies the relationship with the other, but also doing something for the relationship, that is, for the bond. And it is also a search for new affiliations, new mutual recognition, new pacts of social coexistence, and participation for a new season of self-organization as a promotion of community development.

It would not make sense, however, if we did not connect everything, not only to the construction of social bonds but also to the idea that all the actors put in place and called to collect, to the need that they are not passive recipients or users of rigid and standardized services, but active protagonists (or if you like, co-actors) of possible responses in a perspective of strengthening the Welfare State.

All this is not second-line sociology; the path that this community is following (for some time now) is the proof of involvement of rational social actors, within their social arena of reference (work, the world of associations, the religious world, the peer group, the family, relations in general), who want to decline their life experience into a new dimension, more dialoguing, more open to participating and building reflection. A reinterpretation of the territory, then, that passes through a reinterpretation of Politics and Politics for what Don Milani often mentioned: going out of problems alone is greed, going out together is politics.

In a certain sense, it is the era (and I say this as a provocation) of community utopia, of the now lost hope of a good society inhabited by better people. And if Hannah Arendt speaks to us of politics as love for the world, Ulrick Beck - lucid in his looking at the horizons of everyday life and a future still waiting for radical changes - spurs us on to look for new paths for Politics as love towards the human race and towards the community, towards the sense of community.

3. Conclusion

The local community is at the center of the processes of renaissance, or at least this is what all decision-makers declare in their planning. In reality, programming (at all levels, from European to local) needs to confront the demands, values, resources, and power (even perceived) of change that belong to the local community, as an expression of relationships and power. The relationship between external/internal agents of change is not only limited to policymakers and stakeholders (both of the different levels of programming and the different sectors of the same local community), but also to the view that they have of the dichotomies (sometimes stereotyped) such as: health/health, well- being/disease, development/protection, investment/cost, participation/delegation. A delicate and important role then belongs to all of us called to combine, catalyze and facilitate the processes that respond to a sort of institutional mandate but above all to the demands of the community.

References

1. Arendt, H. (2004). *Politique et pensée*. Paris: Payot & Rivages.
2. Beck, U., Beck, U., Sociologist, G., Beck, U. and Beck, U. (2008). *Costruire la propria vita: quanto costa la realizzazione di sé nella società del rischio*. Bologna: Il mulino.
3. Biorcio, R. and Vitale, T. (2016). *Italia civile: associazionismo, partecipazione e politica*. Rome: Donzelli.
4. D'Alessandro, R. (2010). *La società smarrita. Quattro letture del presente fra paure, crisi e migrazioni*. Milano: FrancoAngeli.

5. Gallino, L.(2005). *Globalizzazione e diseguaglianze*. Roma-Bari: Laterza.
6. Gallino, L. (2006). *Dizionario di sociologia*, Vol. 1 e 2, Rome: Gruppo Editoriale L'Espresso.
7. Giddens, A., (2004). *Le conseguenze della modernità*. Bologna: Il Mulino.
8. Mastropasqua, I. (2004). *Architettura delle reti sociali: teorie, luoghi, metodi*. Roma: Carocci Faber.
9. Pratola, V. a cura di. (1998). *Educazione, scuola e disadattamento : riflessioni e proposte*. Pescara: Libreria dell'Universita Editrice.
10. Veraldi, R. (1999), *Analisi di processi socio-culturali attraverso la scelta emozionale e la dinamica dei gruppi*. Firenze: AIDA.
11. Veraldi, R. (2007). *Globalizzazione e società locale: case studies sulla realtà giovanile abruzzese*. Romane: GAIA srl-Edizioni Univ.
12. Veraldi, R. a cura di. (2008) *Analisi dei dati 2000-2007 sulle cause di morte, infortuni e malattie professionali nel lavoro in Abruzzo : rapporto finale di analisi secondaria*. Roma: EUR.
13. Veraldi, R. ed. (2017). *Mundos sociológicas y campos de acción*. Romane: Edizioni universitarie.

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Il ruolo delle variabili culturali nel processo di modernizzazione del Giappone

Simonetta Secondini[1]

Abstract

The present work aims to underline the role played by cultural variables on the development of social processes, both at micro and macro-social level. Specifically, I want to focus on the role played by the philosophical current of Confucianism in the process of modernization of Japan, which shows how the cultural aspects, both in terms of internalized values, both in the form of cultural norms and models approved by the group have influence on the development of social processes.

Japanese society has succeeded in reconciling the fundamental elements of the Confucian tradition with the modernization, elements that represent a variable that has turned out to be of significant importance in the process of development of Japan

Key words: Cultural factors; Correlation of cultural variables and modernization process; Japanese modernization process; Philosophical current of Confucianism[2]

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1. Introduzione

Il presente saggio vuole porre l'attenzione sul ruolo svolto dalle variabili culturali, nello specifico dalla corrente filosofica del Confucianesimo, nel processo di modernizzazione del Giappone, basandosi sull'assunto che fattori culturali specifici costituiscono una variabile in grado di spiegare, anche a livello macro, alcuni andamenti complessivi, quali, ad esempio, lo sviluppo economico di un determinato Paese.

Così come affermato da Sciolla (2012), si vuole sottolineare l'influenza degli aspetti culturali sull'agire sociale sia sotto forma di valori interiorizzati individualmente sia sotto forma di norme e modelli culturali approvati e validati all'interno di un gruppo. Questo, nella considerazione che, comunque, le relazioni e le azioni sociali hanno determinanti che si intrecciano con quelle culturali. Importante, al proposito, è la tesi di Weber secondo il quale «gli interessi (materiali e ideali) non già le idee dominano immediatamente l'agire dell'uomo, ma le immagini del mondo create attraverso idee hanno molto spesso determinato le vie sulle quali la dinamica degli interessi continuò a spingere avanti l'agire». (Weber 1965, 245). Ciò significa che, pur riconoscendo l'importanza degli interessi materiale ed immediati, ritiene che essi si esprimano attraverso sistemi di idee che rappresentano, quindi, la guida dell'agire. Lo stesso Weber identificò la causa dello spirito capitalistico in Occidente nella configurazione di idee e valori propri dell'etica protestante, sottolineando, quindi, la forte relazione tra religione e sviluppo economico.

Anche altri studiosi hanno individuato variabili culturali che si sono rilevate determinanti nel processo di sviluppo economico. Tra questi, Fukuyama ha sottolineato il ruolo della "fiducia" come disponibilità alla cooperazione, fondata nel tessuto associativo e parte integrante della tradizione culturale di molti paesi dell' Asia medio- orientale. Secondo questo Autore, infatti, la fiducia è «the expectation that arises within a community of regular, honest and cooperative behaviour, based on commonly shared norms, on the part of other members of that community» (Fukuyama 1995, 26).

Le variabili culturali, e nello specifico la fiducia, costituiscono il fondamento della cooperazione e della condivisione di valori tra gli individui della stessa comunità. Le comunità a cui Fukuyama si riferisce sono organizzazioni intermedie, non familiari e non governative, di cui un esempio è dato dal Giappone. All'interno di tali tipologie associative, il capitale sociale si sviluppa solo attraverso l'interazione tra i membri e non anche attraverso decisioni di investimento razionali.

Inglehart (1997) ha messo in evidenza come fattori culturali, quali, ad esempio, la motivazione al successo, intesa come sottoinsieme di valori ben definito cui vengono o non vengono educate le nuove generazioni, risulta strettamente correlata allo sviluppo economico, dal momento che è maggiormente presente nei paesi più sviluppati.

Anche il concetto di *reputazione*, utilizzato da Smith, nella sua opera *La Teoria dei Sentimenti Morali*, il cui andamento è correlato positivamente con quello del livello di fiducia all'interno di una rete di relazioni (Bruni, Sugden 2000, 16), è molto utile all'interno dell'analisi della relazione tra etica confuciana e sviluppo in termini di modernizzazione del Giappone (nella considerazione di quanto l'aspetto della reputazione all'interno della società nipponica fosse una delle preoccupazioni più rilevanti derivanti dai valori dell'etica confuciana). Smith, pur convinto che non sia possibile dissociare l'interesse individuale dallo scopo per cui si mettono in atto determinati comportamenti, abbandona il fine puramente economico del profitto, per sottolineare quanto sia importante la finalità di guadagnare approvazione, e quindi, la reputazione, all'interno di una società.

2. Il ruolo della dottrina confuciana come variabile culturale nel processo di modernizzazione del Giappone

Il processo di modernizzazione del Giappone, processo rigidamente guidato «dall'alto» dalle élite politiche, che parte dal secolo XVI fino al XX secolo, vede negli anni compresi tra la metà del XIX e la fine del XIX secolo i momenti più significativi. La trasformazione sociale in termini di modernizzazione è stata reso possibile anche dal ruolo svolto dal confucianesimo (principalmente, e, marginalmente, da altri movimenti religiosi), i principi del quali erano assimilati, accettati e messi in pratica dai membri della società giapponese.

Durante l'era Tokugawa (1600-1835), ci furono intense trasformazioni sociali, culturali ed economiche ed è proprio in quell'epoca che sono andate maturando in Giappone, autonomamente e prima che si facesse sentire l'influenza europea, le condizioni per la sua trasformazione in Paese moderno (Borsa 1977, 576).

Iniziò a svilupparsi una classe borghese urbana, composta da mercanti ed agricoltori, che tanta parte ha avuto (insieme alla classe samuraica) nel processo di trasformazione della società giapponese (Barrington Moore 1969, 263) modificando, tra le altre iniziative, un'economia agricola di sussistenza in un'economia fondata sullo scambio, sulla moneta, sul credito e quindi nella formazione di un mercato nazionale e che condusse ad un'ampia diffusione delle istituzioni. Secondo Huntingon (2000) ciò fu una delle variabili che facilitò il processo di modernizzazione, sempre nella considerazione del ruolo svolto dall'identità culturale del popolo nipponico in tale processo. In questo periodo, si formò anche una classe dirigente di samurai e mercanti con buone capacità manageriali.

Tokugawa Yoshinobu, l'ultimo shogun, ebbe un ruolo fondamentale nel processo di modernizzazione del Giappone, considerando che fu proprio lui a desiderare una riforma in senso moderno del sistema feudale e a non voler ostacolare la modernizzazione. L'incalzare degli eventi e la pressione dei feudi alleati e l'Imperatore, che in realtà avrebbe preferito una soluzione non radicale, non poté evitare un rinnovamento così immediato.

Dal lato del regime Tokuwaga, si cercò una giustificazione storica, basata anche sul concetto di legittimazione del potere per via divina. A tal proposito, si sviluppò lo studio della tradizione antica, incluso il Confucianesimo, oltreché il Buddhismo e Shintoismo, proprio con il fine di conferire maggiore legittimità al potere dei Tokugawa. Il Confucianesimo, come etica dei rapporti sociali, ed il razionalismo, nello specifico, costituivano la base dell'istruzione. Si sviluppò il *KokugaKu*, lo studio del Giappone tradizionale, che promosse l'approfondimento della tradizione antica, incluso il Confucianesimo (Inumaru 2008, 165). Il tentativo di stabilire una connessione tra funzionamento dello Stato, organizzazione dell'economia e tradizione culturale è molto presente all'interno del dibattito sul capitalismo asiatico e chiama in causa l'influenza del Confucianesimo (Trigilia 2019, 110).

Gary Hamilton, nella sua riflessione sui percorsi di industrializzazione nei paesi del sud est asiatico, è giunto alla conclusione che sono delle specificità della sfera istituzionale, economica, sociale e politica alla base di tale espansione. Queste sono dovute a diversi modelli di legittimazione del potere, rispetto a quelli occidentali e rimandano ad alcuni tratti culturali diffusi in una vasta area che «rinviano a delle visioni del mondo che hanno

una matrice originaria nell'influenza di grande religioni, cioè al concetto di civiltà. In particolare, per il capitalismo asiatico è importante il ruolo del confucianesimo» (*ivi*, 111). All'interno del quadro di riferimento del Confucianesimo, Hamilton sottolinea quei tratti che hanno rappresentato le risorse per lo sviluppo capitalistico nel sud est asiatico: la forte insistenza culturale sugli obblighi di appartenenza alla rete familiare, parentale, comunitaria e politica più ampia. «I rapporti di autorità sono determinati in relazione a una visione armonica del mondo in cui la posizione dell'individuo è definita dal contributo atteso al mantenimento di tale integrazione» (*ivi*, 112). Ciò porta a principi organizzativi sociali e relazionali piuttosto che individuali e giuridici, come in Occidente. Da ciò si possono meglio comprendere le forme di legittimazione del potere politico basate su un forte senso dell'obbedienza all'autorità, tratto che dà una importante risorsa di manovra alle istituzioni statali per politiche dirigiste di promozione dello sviluppo. Dall'altra parte, gli obblighi tradizionali che legano gli individui alle famiglie e alla comunità locale hanno costituito una risorsa cruciale per il dinamismo economico[3]

L'economista giapponese Michio Morishima stabilisce un nesso tra mentalità nipponica e processo di sviluppo economico, processo che ebbe la sua massima espansione con la restaurazione Meiji. Sulle tracce dell'opera di Max Weber, *L'Etica protestante e lo Spirito del capitalismo*, egli sostiene che i valori base del Confucianesimo ebbero nel processo di modernizzazione del Giappone un ruolo simile a quello svolto dall'etica protestante nell'affermazione del capitalismo in Europa e nel Nord America. L'Autore ritiene che se i Giapponesi non avessero accettato l'idea della frugalità, che è uno dei prerequisiti del capitalismo, il capitalismo moderno non avrebbe potuto affermarsi in Giappone. Inoltre, afferma che l'enfasi confuciana sulla fedeltà ai genitori, agli anziani ed allo Stato fu un fattore molto importante nella promozione della cooperazione tra gli imprenditori ed il governo.

Il Confucianesimo, sistema etico più che religioso, fu diffuso profondamente tra il popolo nipponico dalla politica culturale del governo Tokugawa. Come verrà specificato ed ampliato nelle pagine successive, tale sistema enfatizzava il rispetto dello Stato e dell'autorità, la lealtà, l'importanza dell'educazione, l'armonia, il gruppo, sviluppando una concezione gerarchica dei rapporti personali tramite il cosiddetto codice dei doveri morali. Inoltre, il Confucianesimo era anche intellettuale e razionale, pertanto molto compatibile con la scienza moderna.

Indirizzi di studio sviluppatisi intorno al 1960 (Eisenstadt 1968), che testimoniano l'importanza dell'opera di Weber per l'analisi dei processi di sviluppo, sono volti ad individuare "equivalenti funzionali" dell'etica protestante nel tessuto sociale dei paesi orientali. Dal punto di vista metodologico, la grande intuizione di Weber consiste nell'aver saputo cogliere come forza dinamica importante «nel processo storico di una determinate società le connessioni (senza cadere in una concezione deterministica) tra religione ed economia: religione intesa come la sede propria del carisma, e quindi ciò che è straordinario; economia intesa come la sede propria della quotidianità, e quindi di ciò che è ordinario» (Mazzei 1982, 6).

La ricerca di equivalenti funzionali dell'etica protestante, in varie parti dell'Asia, ha portato alla formulazione di ipotesi interpretative sulla natura del Capitalismo asiatico, isolando alcune variabili che attengono alla sfera culturale e che si rileveranno molto utili nella spiegazione del processo di sviluppo tumultuoso dei decenni successivi (Regini (a cura di) 2007).

Eisenstadt, allievo di Buber (filosofo e Professore all'Università ebraica di Gerusalemme) sottolinea come egli, con i suoi studi, abbia contribuito alla comprensione del ruolo specifico del carisma nei processi sociali nei suoi aspetti tanto distruttivi quanto costruttivi (Eisenstadt 1997, 17). E' da qui che Eisenstadt pone l'attenzione al concetto di carisma, e più in generale, alla dimensione simbolica della realtà sociale, sottolineando l'importanza del ruolo della relazione tra cultura, struttura ed ordine sociale nel percorso di sviluppo di alcuni Paesi asiatici.

In Giappone, il Confucianesimo, ebbe un ruolo così importante da non poterlo non considerare come equivalente funzionale dell'etica protestante e, quindi, come variabile necessaria per comprendere il processo di modernizzazione in questo Paese. Nello specifico, all'interno di questa corrente filosofica, l'idea di lealtà si ritiene sia uno dei fattori che hanno guidato il cambiamento sociale del Giappone (Beasly 1973, 12).

Un altro studioso, Rober Bellah ha mostrato come l'etica del lavoro dei giapponesi può essere ricondotta a talune forme religiose di questo popolo che possono essere consideratte l'equivalente funzionale del calvinismo. Tra queste, la setta buddhista dello Jodo Shinshu ("Terra pura") predicava l'onestà, la frugalità, il lavoro sodo ed un atteggiamento ascetico in fatto di

[3] Ciò contrasta le ipotesi della prima teoria della modernizzazione che considerava tali fattori ostacoli allo sviluppo economico

consumi e legittimava anche la ricerca del profitto (Fukuyama 1992). Un altro movimento, quello dello Shingaku di Ishida Baigan, pur avendo meno influenza dello Jodo Shinsu, predicava una sorta di misticismo terreno enfatizzando l'economia e la diligenza e minimizzando i consumi (*ibidem*). Egli asseriva, inoltre, che le attività volte al profitto e quelle di risparmio al fine di accumulare capitale, mediante la frugalità, non erano affatto meschine[4].

Questi movimenti religiosi combaciavano perfettamente con l'etica *bushido* della casta dei samurai, ideologia di guerrieri aristocratici, anche se non ebbero, sulla società giapponese, la stessa influenza che appartiene, invece, alla dottrina confuciana.

3. I punti chiave della dottrina confuciana influenti sul processo di modernizzazione del Giappone

Come già accennato precedentemente, la dottrina filosofica ed etica confuciana, dalla quale la tradizione culturale dell'estremo oriente trae le sue origini, viene considerata una variabile che ha avuto un gran peso nel processo di modernizzazione del Giappone. Creatasi più di un millennio prima di Cristo, principalmente in Cina (poi esportata in tutto il continente ed in Giappone) fu portata avanti successivamente da uno dei più grandi pensatori asiatici di tutti i tempi, Confucio (e dai suoi discepoli) (Pira 2016, 2).

In Giappone, fino dagli albori dell'epoca Tokugawa (o, periodo Edo, 1603-1867), l'etica ebbe le sue radici e sanzioni più che nella fede del Buddhismo (che conobbe grande fortuna sin dall'epoca di Nara, 710-794) nel sistema filosofico–religioso confuciano. La grande diffusione del Confucianesimo durante il dominio della famiglia

[4] E' da sottolineare, che la classe borghese, emersa negli ultimi anni del governo Tokugawa, era in grado di interessarsi solo dei profitti scarsi e personali provenienti dal commercio interno, e non avevano quel coraggio necessario per intraprendere rapporti commerciali con l'esterno. Pertanto, questa classe si ritrovò ovviamente tagliata fuori dalla rivoluzione Meiji, compiuta dai samurai di rango inferiore e dai membri dell'Intellighenzia che comportava proprio l'espansione delle relazioni economiche all'esterno del paese (Giardina, Sabbatucci, Vidotto 2016)

Tokugawa e la sua penetrazione in tutte le classi, specialmente in quella dei *samurai*, portò fin d'allora, ad un distacco dell'etica dalla sua matrice religiosa e ad un suo sviluppo autonomo su basi filosofiche (Calzolari 2015, 1). I valori ideali proposti e diffusi all'interno di tutte le classi, e nello specifico, in quella dei samurai (élite di guerrieri che, all'epoca, governava in Paese) furono confuciani e laici: *jin*, la benevolenza verso gli altri, *Gi*, la giustizia, *Rei*, la ritualità e i modi civili, *Chi*, il sapere, *Shin*, la lealtà, la fedeltà, primariamente verso il sovrano e poi nei riguardi di tutte le altre autorità nella complessa rete delle gerarchie vigenti.

Come evidenziano gli studiosi Franco Mazzei e Vittorio Volpi, lo stesso concetto di armonia nel mondo culturale confuciano, è estremamente importante: «Il Confucianesimo enfatizza l'importanza dell'armonia, dell'ordine sociale che nello stesso tempo è anche morale: un ordine consistente in un sistema gerarchizzato sulla base delle "cinque relazioni" (sovrano-popolo, padre-figlio, marito-moglie, fratello maggiore-fratello minore, amico-amico). Da queste relazioni derivano regole morali di tipo comunitaristico, che ubbidiscono non tanto alla coscienza individuale, la quale è scarsamente sviluppata, ma al giudizio della società, del gruppo d'appartenenza.» (Mazzei, Volpi 2010, 291).

I punti chiave della dottrina confuciana sono rilevanti per comprendere quale fosse l'atteggiamento derivante e come potesse quindi guidarne il comportamento conseguente. Tali punti sono: la riflessione filosofica, l'agire in funzione della società, degli amici e della famiglia secondo norme di comportamento legate al senso di giustizia (*Yi*) e al rispetto dei rituali (*Li*), avendo fiducia verso il prossimo (*Xin*) e onorando la propria e l'altrui saggezza (*Zhi*). Considerando che, per il Confucianesimo, la natura umana risulta essere fondamentale buona, tutti gli uomini, in linea di principio, possono essere in grado di essere governati dai *li* (rituali) attraverso la pratica del continuo autoperfezionamento (Mazzei 1982, 30).

Altro punto importante, ai fini della formazione di quel particolare atteggiamento che ha permesso, insieme ad altre variabili, di dirigere il Giappone verso la modernizzazione, è il ruolo cruciale che la collettività riveste all'interno della società confuciana. All'interno di essa, ciò che prevale è la netta appartenenza alla società, alla comunità che è considerata una grande famiglia da rispettare e da migliorare costantemente. Nel ragionamento collettivistico orientale non trova spazio l'individualismo e l'azione del singolo è messa in secondo piano rispetto all'agire sociale, alle decisioni e ai risultati del gruppo. Ciò rende la collettività incline a rispettare ciò che viene deciso dall'alto per il bene collettivo. Influenza questo

atteggiamento anche il profondo rispetto e considerazione dell'autorità. Ciò che umilia chi appartiene a questo tipo di società è la vergogna su base sociale, è la vergogna di fronte alla collettività.

Come sottolinea nuovamente lo stesso Mazzei: «Questo atteggiamento, per forza di cose tendente al conformismo inteso positivamente come tensione morale per garantire l'armonia del gruppo, spinge il confuciano a una partecipazione sociale attiva giocando al meglio il proprio ruolo (di sovrano o di suddito, di padre o di figlio ecc) » (Mazzei, Volpi 2010, 291).

Relativamente all'aspetto attinente al rispetto e considerazione per l'autorità, (atteggiamento che, come già affermato, ha avuto un importante ruolo nel processo di modernizzazione, in quanto ha permesso che la società accettasse le decisioni dall'alto finalizzate al benessere e alla crescita sociale del Paese), è importante sottolineare la diffusione, nel mondo asiatico estremo orientale, di due variabili, quali la pietà filiale, consistente nel rispetto e nella massima obbedienza all'autorità genitoriale ed il rapporto padrino-figlioccio, che vedeva la sottomissione ad una figura (paterna o non) più esperta, dispensatrice di precetti ed ordini al figlioccio il quale obbedisce e ripone in tale figura una fiducia quasi illimitata: ciò ha creato, in Giappone, quel modello che viene definito del capitalismo *comunitaristico*[5]

Negli insegnamenti morali di Confucio, la pietà filiale, intesa come rispetto ed affetto, ha un posto particolarmente rilevante. Nei *Dialoghi*, si sottolineava di quanto fosse improbabile che un uomo pieno di pietà filiale verso i membri del gruppo familiare (e non solo) potesse essere propenso all'insubordinazione nei confronti dell'autorità così come fosse altamente improbabile che fomentasse una ribellione. Inoltre, si affermava di quanto il rispetto per i genitori e per gli anziani fosse alla base della benevolenza e come la pietà filiale fosse alla radice del *ren* (benevolenza)[6]

[5] Nell'impresa-comunità di marca giapponese invece, il soggetto forte è l'impresa in sé: «L'impresa è definita in primo luogo come un ente a dimensione sociale, di cui fanno parte tutti gli individui, che lavorano "in" esso (piuttosto che "per" esso) a tempo pieno» (Dore 1990, 82); quindi i partecipanti all'impresa «formano una "comunità" e sono legati gli uni agli altri da vincoli di interesse condiviso nel destino della comunità, da obblighi di collaborazione, di fiducia reciproca e dalla condivisione dei rischi» (Dore 1993, 929). Di qui deriva il forte senso di appartenenza dei lavoratori, la loro dedizione al lavoro, il forte commitment e l'atteggiamento responsabile che è molto noto in Occidente, destando sentimenti contrastanti di ammirazione ma talvolta anche di ironia.

[6] Del termine *ren* si sono proposte varie traduzioni, ma, come afferma Scarpari (1991, 35) qualsiasi resa finora proposta rimane ovviamente lontana dal descriverne l'intraducibile ampiezza.

L'influenza sulla società nipponica dell'etica confuciana modificò quindi anche i più piccoli nuclei familiari all'interno dei quali la pietà filiale rese stabile una struttura ben definita di tipo gerarchico (Hendry 1987). Inoltre, al fine di assicurare la successione familiare, ogni nucleo familiare ha recepito il concetto, tipicamente feudale, di *ichizoku roto*, gruppo allargato, che consiste nell'accogliere in casa un numero imprecisato di vassalli che assicuravano fedeltà al buon padre di famiglia (Nakane 1992, 66). In tal modo, un nucleo familiare diviene una organizzazione nella quale i rapporti umani assumono una rilevanza tale da mettere in ombra i legami biologici. La necessità di ricambiare la benevolenza ricevuta spinge il *Kobun* a stringere un legame di fedeltà e lealtà con il suo *oyabun* e ad agire sempre nell'interesse del suo superiore che si riversa in quello del gruppo[7] (Takeo 1991, 33-40].

E' dunque questo il clima sociale e politico in cui si instaurerà lentamente la classe dei samurai ed emergerà con forza la tradizione del rapporto padrino-figlioccio giapponese. In seguito alla Restaurazione Meiji (1866-1899) il ceto dei samurai venne abolito ma le relazioni parentali e quelle di fedeltà tra padrone e subordinato, continuarono a rivestire un ruolo fondamentale nella vita quotidiana. Quella base culturale che plasmò l'atteggiamento verso l'autorità e la collettività resterà sempre come base delle relazioni sociali e della gestione del lavoro, in forme certamente più evolute e dinamiche dell'antico vincolo che univa l'*oyabun* al *kobun*.

Un altro aspetto rilevante della dottrina confuciana, atto a sottolinearne la sua influenza sia sull'atteggiamento verso l'autorità sia su quello dell'autorità stessa, è la considerazione della politica intesa non come scienza autonoma e a sé stante. Per Confucio, la politica e l'etica procedono insieme perché l'una procede logicamente dall'altra. Un cuore pieno di benevolenza si tramuta necessariamente in una attività politica di amore per la comunità umana ed essa è la realizzazione pratica di uno dei quattro germogli(virtù basilari) della dottrina confuciana, la benevolenza (*ren*). Dalla benevolenza deriva la convinzione che governare è un atto di amore e di servizio verso la comunità (Bresciani 2014, Cap.28)

[7] Il rapporto *oyabun-kobun*, che vive ancora oggi, riguarda anche l'antico vincolo samuraico. I samurai, detti anche *bushi*, che si affermarono dalla fine del XII secolo, erano legati ai grandi signori terrieri (*daymo*) da un giuramento di fedeltà e da un rapporto di dedizione, beneficiando di titoli, onori e possedimenti. Il loro compito era quello di proteggere ed espandere le terre dei loro signori (Enciclopedia Treccani: www.treccani.it , 26/05/2016). Per il samurai il suo servizio al padrone non era considerato un duro lavoro, ma un onore ed un sacrificio necessario per il bene della sua nuova, grande famiglia e, in conseguenza di ciò, la concezione giapponese del lavoro risulterà essere molto diversa da quella occidentale anche al giorno d'oggi.

4. Conclusioni

Dal 1868 il Giappone intraprese la via della modernizzazione non perdendo mai di vista quel principio catalizzatore (fortemente voluto dai vertici della dinastia imperiale) del *Wakon* e *Yosai*, che condussero il Giappone a riuscire nell'impresa della modernizzazione a carattere occidentale e nell'industrializzazione forzata del paese. Questi due fattori costituivano un incitamento allo sviluppo, il primo, relativo al mantenimento del rispetto delle tradizioni e dell'etica nipponica, il secondo relativo all'apertura di una nuova via legata alla modernizzazione attraverso tecniche specificatamente occidentali.

Come afferma anche Antonietta Pastore «dal dopoguerra in poi, all'interno di un processo particolarmente tumultuoso di trasformazione del sistema economico e produttivo, la popolazione giapponese continua a mantenere intatta sul lavoro la mentalità di abnegazione e fedeltà proprie del precedente rapporto feudale servo- padrone» (Pastore 2004, 204). La società nipponica è riuscita, quindi, a conciliare gli elementi fondamentali della tradizione confuciana con la modernizzazione, elementi che rappresentano una variabile che è risultata essere di rilevante importanza nel processo di sviluppo del Giappone.

Bibliografia:

Barrington M. jr. (1969) *Origini sociali della dittatura e della Democrazia*, Torino, Einaudi

Borsa G. (1977) *La nascita del mondo moderno in Asia Orientale. La penetrazione europea e la crisi delle società tradizionali in India, Cina e Giappone*, Milano, Rizzoli

Bresciani U. (2014) *Il primo principio della filosofia confuciana*, Gaeta (LT), Passerino editore

Bruni L., Sugden R. (2000) *Moral canals: trust and social capital in the work of Hume, Smith and Genove*si, in Economics and Philosophy (April 2000), Volume 16, Issue 1, pp. 21-45

Calzorali S. (2015) *Religione e secolarizzazione nel mondo moderno:ilcaso del Giappone*, https://silviocalzolari.org/religione- e-secolarizzazione-nel-mondo-moderno-il-caso-giapponese

Dore, R. (1990) *Bisogna prendere il Giappone sul serio. Saggio sulla varietà dei capitalismi*, Bologna, Il Mulino

Dore, R. (1993) *Davvero troppo diverso, il Sol Levante?,* in «Il Mulino», n. 5, pp. 928- 938

Eisenstadt S. N. (a cura di) (1968) *Max Weber on Charisma and Istitution Building*, Chicago, University of Chigaco Press

Fukuyama F. (1992) *La fine della storia e l'ultimo uomo*, Milano, Utet Fukuyama

F. (1995) *Trust: the social values and the creation of Prosperity*, New York, Free Press

Giardina A., Sabbatucci G., Vidotto V. (2016) *Storia più. Vol.2. Il Settecento e l'Ottocento,* Milano, Laterza

Huntington, S. (1993) *The Clash of Civilizations*?, in Foreign Affairs. Vol. 72. n. 3, pp. 22-49

Huntington S. (2000) *The clash of Civilizations and the Remaking of World Order*, Milano, Garzanti

Hendry J. (1987) *Understanding Japanese Society*, New York, Crom Helm.

Inglehart R. (1997) *Modernization and Postmodernization: Cultural, Economic, and Political Change in 43 Societies,* Princeton University Press

Regini M. (a cura di) (2007) *La Sociologia economica contemporanea*, Milano, Laterza.

Pastore A. (2004) *Nel Giappone delle donne*, Torino, Einaudi Editore, collana ETli

Pira C. (2016) *Oriente Vs Occidente: Sviluppi Separati ma Destini Incrociati*

Mazzei F., Volpi V. (2010) *La rivincita della mano visibile. Il modello economico asiatico e l'Occidente*; Università Bocconi Editore, Collana Itinerari

Mazzei F. (1982) *I problemi della modernizzazione: conflitto e interazione tra cambiamento e tradizione. Il caso del Giappone e della Cina. Etica economica e spirito del capitalismo nella modernizzazione del Giappone*; Vol.22, Istituto Italiano per l'Africa e l'Oriente (IsIAO)

Nakane C. (1992) *La Società Giapponese*, Milano, Raffaello Cortina Editore

Scarpari M. (1991) *La concezione della natura umana in Confucio e Mencio*, Venezia, Cafoscarina

Sciolla L. (2012) *Sociologia dei processi culturali*, Bologna, Il Mulino

Takeo Doi (1991) *Anatomia della Dipendenza*, Milano, Raffaello Cortina Editore

Trigilia C., *Sociologia economica. II. Temi, e percorsi contemporanei*, Il Mulino, Bologna, 2019

Weber M, *L'etica protestante e lo spirito del capitalismo*, trad. it. Sansoni, Firenze, 1965

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