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Arts: A Science Matter

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The nature and origin of arts, and its relationship to "science" have been under much debate since Plato about 2,400 years ago. Here, a new perspective on these issues is presented. Science is to understand how nature works, while nature consists of (human and nonhuman) living systems and nonliving systems. Consequently all human-dependent matters are part of science—the premise underlying the new discipline called *Science Matters* (SciMat), which covers all topics in humanities and social sciences, arts in particular. (Arts here refer to visual arts, literature, film, performance arts, music, architecture, new media arts and so on.) In fact, arts are a subset of humans' creative activities that aim to excite the receiver's neurons in a certain manner, through that person's senses, with or without significant consequences. The usual kind of "science" is to understand mostly inanimate, simple systems and how the world/universe works; it is part of science in general. Arts as a science matter is to find out everything about arts, including arts' origin and nature, and how and why arts work at both ends of the creator and the receiver. Like physics and any other discipline, arts can be classified into two types—*pure arts* and *applied arts*. Some arts, such as drawing and performance art, could start a million years ago. All arts evolved over time and space, and the contents kept on changing as humans invented language and writing and as they migrated out of Africa and spread over the world; arts contain both global universal elements and local features. Here, all these issues as well as how arts as a science matter could be studied are elaborated, after a brief introduction to SciMat and humans' development history and inheritance mechanism (genes and epigenes) is given.

1.1 Introduction

Arts in this chapter refer to visual arts, literature, film, performance arts, music, architecture, new media arts and so on. The origin and nature of arts, and its relationship to "science"[1] are under much debate.[2] The confusion arises from many factors which will become clear later as our discussion goes along.

Here we will try to clear up these confusions by reexamining the problem and presenting a new perspective on all these issues. We will first clear up the definition of the word science and introduce the new discipline *Science Matters* [Lam, 2008a] within which arts belong (Section 2). Since arts are human activities, it is important to understand where we came from and how we developed evolutionarily (Section 3). The origin and nature of arts are then discussed, respectively, in Sections 4 and 5. Arts as a science matter are presented in Section 6, where the relationship of arts to "science" and how arts could be studied are given. Discussion and conclusion in Section 7 conclude the chapter.

1.2 Science and Science Matters

The scope and nature of science, and the new discipline Science Matters are presented here.

1.2.1 *What Is Science?*

Science is about the study of nature and a means to understand it in a unified way. Nature consists of everything in the universe—all material systems: humans and nonhumans. Consequently, the only logical conclusion about the scope of science is:

$$\begin{aligned} \text{science} &= \text{natural science} \\ &= \text{"physical" science} + \text{social science} + \text{humanities} \end{aligned} \tag{1.1}$$

[1] In this chapter, "science" with quotation marks means the science of mostly inanimate systems (i.e., science in the narrow sense), identical to the conventional usage of the word.
[2] There is a sizable body of literature on these topics. At the entry level, see [Appenzeller, 1998; Brown & Dissanayake, 2009] for arts' origin, [Carroll, 1999; Adams, 1996; Dutton, 2009] for arts' nature, and [Strosberg, 2001; Miller, 1996; Leibowitz, 2008] for arts and "science."

where the three items on the right-hand side of Eq. (1.1) are in decreasing level of scientific development; they are *not* classified according to the nature of the objects under study [Lam, 2008a].

That "everything in nature is part of science" was well recognized by Aristotle and da Vinci and many others. However, it is only recently, with the advent of modern science and experiences gathered in the study of evolutionary and cognitive sciences, statistical physics [Lam, 1998; Paul & Baschnagel, 1999], complex systems [Lam, 1997; 1998] and other disciplines, that we know how the human-related disciplines can be studied scientifically.

1.2.2 *Three Misconceptions about Science*

The contents of science can be divided into two parts: human-dependent and human-independent. The study of the human-dependent part (humanities and social science) was hindered by three misconceptions in science. In fact, the miserable part of human history (e.g., ideological massacre and religious burning at stake) is related to these three misconceptions.

Misconception 1: Natural systems include non-human systems only (i.e., humans are excluded). This misconception started, at least, from the early Greek time some 2,400 years ago. It is wrong because all material systems in nature, humans included, are made up of atoms created in the stars some 300 million years ago [Turner, 2009].

Misconception 2: Physics is about deterministic systems only (i.e., stochastic systems[3] are excluded). This misconception is due to the tremendous success of Newtonian physics in the past 300 years and the ignorance of physics developments (Fig. 1.1).

[3]Stochastic is a technical word in physics, meaning that probability appears somewhere in the process; a random process is a special case [Paul & Baschnagel, 1999].

Fig. 1.1. Two ways to classify the contents of physics: (1) it is made up of deterministic systems and stochastic systems; (2) it consists of simple systems and complex systems.

Misconception 3: Science is about (mostly) simple systems only (i.e., complex systems are excluded). This misconception started from Galileo's time 400 years ago even though science before that actually includes the study of both simple and complex systems (Fig. 1.2).

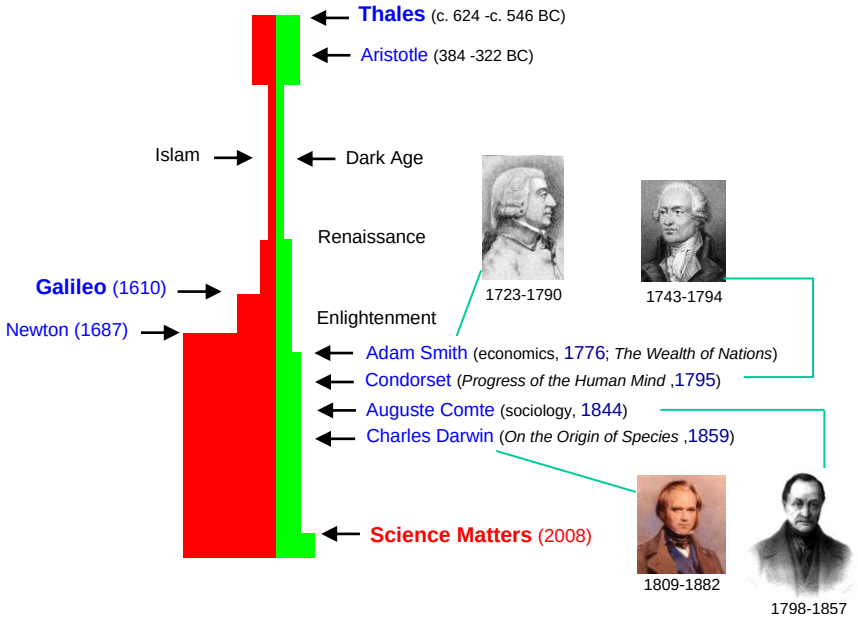

Fig. 1.2. A brief history of science in the last 2,600 years since Thales. The left (right) column corresponds to simple (complex) systems; the column width represents roughly how much the development activity was during different time periods.

1.2.3 *Science Matters*

Science Matters (SciMat) is the new discipline that treats all human-related matters, humanities in particular, as part of science (by avoiding the three misconceptions above) (Fig. 1.3). It was originated by Lam in 2008 [Lam, 2008a; 2008b]. Accordingly, Eq. (1.1) is replaced by

$$\begin{aligned} \text{science} &= \text{natural science} \\ &= \text{nonhuman-related science} + \text{Science Matters} \end{aligned} \tag{1.2}$$

SciMat has a number of important implications [Lam, 2008a]. One of them is that the usual usage of "Science and Art" or "Science and Society" is misleading, since they imply that Science and Art (or Society) are two different things while, according to the reasoning above, art is contained within science.

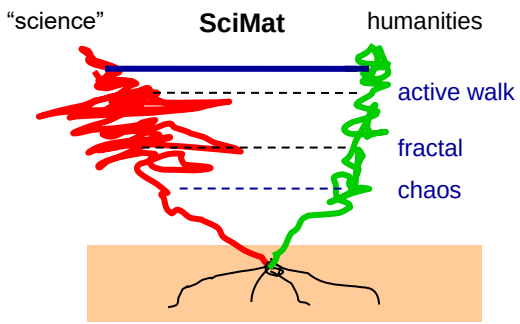

Fig. 1.3. SciMat links up humanities and "science" completely while active walk, fractal and chaos, respectively, does that partially. Humanities and "science" share the same root, growing up like two branches of the same plant.

1.3 Humans

Arts are created by humans. To understand arts we have to understand humans. Here are the basic facts about humans [Hoagland & Dodson, 1998]. A human body is composed of 5×10^{12} cells. Each cell is made up of molecules, a combination of atoms (coming from the stars). One of

these molecules is the DNA molecule which is the same inside each cell. It is the DNA that passes biological information from generation to generation. However, a human being's thinking and behavior are controlled by the 10^{11} neurons in her brain. And the neurons could be influenced by external media (e.g., artwork, sunset) through the bodily sensors or substances (e.g., marijuana smoke) absorbed into the body.

There are several basic facts about human development [Mithen, 1999] that are relevant to the discussion of arts (Table 1.1).

Table 1.1. A brief history of human development. Data source: www.newscientist.com/movie/becoming-human (June 18, 2010).

Years ago	Evolution	Migration	Life style	Art related
6 million	Chimp and human lineages split.			
3.5-1.8 million			First hominids move from forest to savannah; meat eating begins.	
2.5 million	*Homo habilis* appears.			
2 million	*Homo erectus* appears.			
1.8 million		First wave of migration out of Africa begins.		
1.6 million			First use of fire; more complex stone tools created	
400,000			Earliest evidence of cooking.	
195,000	*Homo sapiens* (early modern humans) appears.			
120,000				Pigment use gives first evidence of symbolic culture.
72,000				Clothing invented and earliest evidence of jewelry
60,000		Second wave of migration out of Africa (Fig. 1.4)		
50,000				Cultural revolution: ritualistic burials, clothes-making, invention of complex hunting techniques
35,000				Oldest known cave art (in France, Spain,…)
10,000			Agriculture begins; first villages appear.	
5,500				Bronze Age begins.
5,000				Earliest known writing

Equally important is how humans pass on their genes and the question of "nature vs. nurture" [Ridley, 2003; Moore, 2003]. According

to the British naturalist, Charles Darwin (1809-1882), and putting it in modern language, human inheritance is stored in the genes and passed on from generation to generation. However, *random* mutation of the genes happens from time to time, resulting in the appearance of new species. Different species compete with each other for resources and "the fittest wins." This is called "natural selection" or the evolutionary pressure; the winner keeps the (new) genes that help it win—an adaptive trait in the evolutionary sense. Moreover, the evolutionary process is very slow and continuous; no learned skills can be passed on to the next generation.

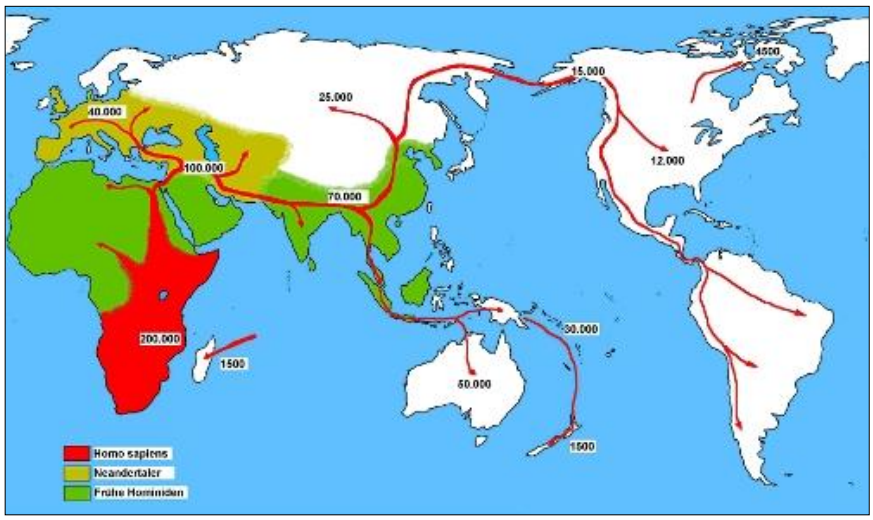

Fig. 1.4. Spreading of *Homo sapiens* out of Africa. (The numbers in this map differ slightly from those in text.) According to this map, the ancestors of the Chinese are Indians who (and everyone else) in turn are descendants of Africans.

The other school of thought was advocated by the French biologist, Jean-Baptiste Lamarck (1744–1829), who proposed that acquired characteristics can indeed be passed on to the offspring. It turns out that both Darwin and Lamarck are partially right (or partially wrong), according to new findings in genetic studies in the last decade [Jablonka & Lamb, 1995; Cloud, 2010].

The present understanding is that although we do inherit stable genes, we also inherit alterable epigenes [Shenk, 2010]. Epigenes are molecules external to the genes that can switch on and off particular genes (Fig. 1.5). More importantly, an epigene's switching state could be influenced by the environment and could be passed on to the next generation, for many generations. For example, this passing-on ability has been demonstrated in fruit flies. When exposed to a drug fruit flies show unusual outgrowths on their eyes that can last through at least 13 generations of offspring when no change in DNA has occurred [Cloud, 2010]. Similarly, experiments on roundworms fed with a kind of bacteria show changes that last at least 40 generations [Jablonka & Raz, 2009].

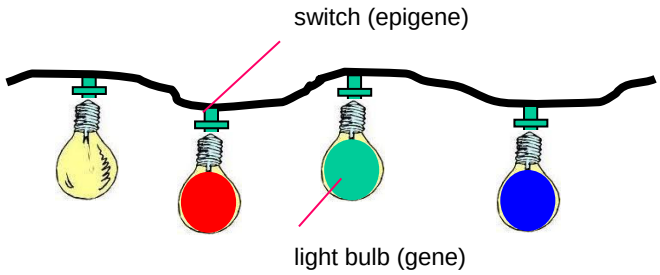

Fig. 1.5. Presently, a DNA chain can be visualized as a chain of light bulbs in different colors plus switches for the light bulbs. The light bulb represents a gene; the switch, an epigene.

What all these imply is that the debate of "nature vs. nurture" is losing its importance since both nature (genes) and nurture (environment acting through epigenes) are both inheritable, with important implication for the origin-of-arts problem (see Section 1.6).

1.4 Origin of Arts

The cave art (Fig. 1.6) 35,000 years ago [Aczel, 2009] is pretty sophisticated and mature, as painting goes, not something you and I can

likely do.[4] The recent discovery of Neandertal[5] jewelry and body paint in Spain suggests that modern human behavior has ancient roots [Wong, 2010]. Even carving of 250,000 years ago had been found [Appenzeller, 1998]. Fire use (starting 1.6 million years ago) and cooking (400,000 years ago), two sophisticated inventions, occurred long before modern humans appeared. All these point to the fact that arts could start a million years ago.

No one could be sure how it happened since there is no record left from that period in time so long ago; moreover, arts like pantomime and dancing would leave no marks. Yet, since evolution happened very slowly, the basic instinct of our ancestors could not differ that much from our own. We could thus guess reasonably. And it could happen like this.

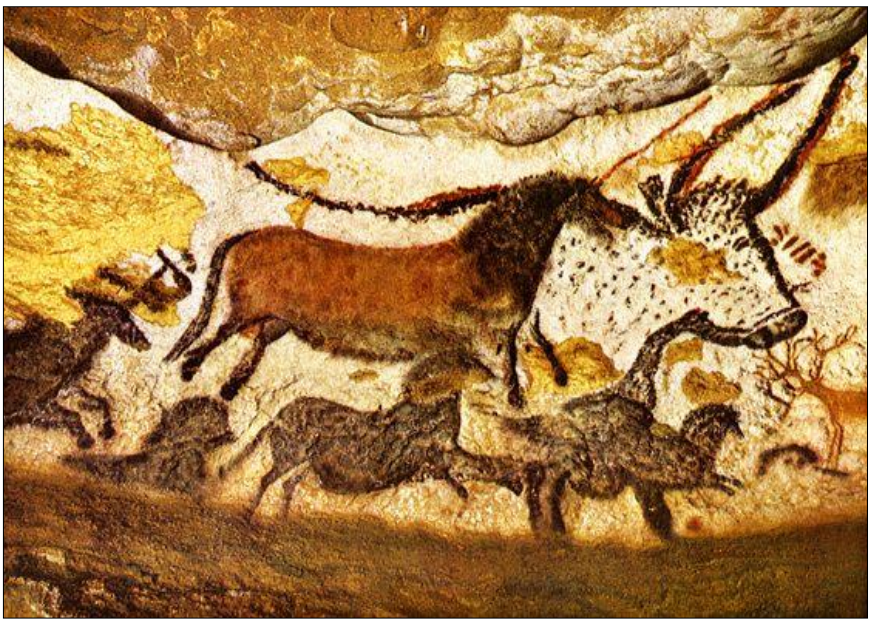

Fig. 1.6. Painting in Lascaux cave, southwestern France (c. 15,000 years ago).

[4] No cave art was found in China. For rock art in China dating to about 10,000 years ago, see [Chen, 2009].

[5] Neandertals, our closest relatives, ruled Europe for 200,000 years, but vanished about 28,000 years ago [Wong, 2009].

Let us say, somewhere in Africa, a community of few or ten people confined to a habitat during a rain of three days and nights, what would they do? And that happened after a good kill; food was plentiful and there was no rush to make preparations for the next hunt. Sex activities could use up just that much time;[6] and pretty soon, all females would be pregnant. So some of them might start doing something purely "useless," just to *kill time*.[7] Someone could be tracing another person's shadow on the soil surface with a piece of stick—early painting, hitting a piece of wood with a stick—early music, telling something with his hands and bodies—pantomime performance, and balancing the body on a piece of wood put on top of a rock—early performance art. Of course, all these could serve as entertainment, too. And it took time to perfect these skills, with more time killed. The ability to handle all these activities is "mimesis," i.e., to mime, imitate, gesture, and rehearsal of skill, which was already there 2 million years ago [Donald, 2006, p. 7]. Or, something like these might happen later, when there were tens or hundreds of persons living together in a larger group.

All these acts were not for sexual selection (which came later), because that was basically a "free sex" community. And they are never about aesthetics alone, since nature provides plenty, and better, aesthetic experiences (like the sunset).

In any case, sooner or later, someone (or a few in the group) would emerge as an expert in something and might become the first

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[6] In a group of ten members, assume that there are two very old members and two child and we are left with eight sexually active members; further assume that four are males and four are females, and they are all heterosexual. Then there are 16 pairing of copulation; if each copulation consumes ½ hour, it will take only two to eight hours for all copulations to finish, depending on whether the copulations take place concurrently or serially.

[7] "Kill time" is a neutral word here, without value judgment; it is short for "spending one's *free* time"; it does not imply the person is bored. In modern society, let us say we work 5 days/week, 8 hours/day; and we sleep 8 hours/day and spend 1 hour traveling between home and work/day. In addition, we have to spend 2 hours/meal (including cooking, eating and washing dishes), 2 meals/day, say. We are left with 24 x 7 – [(8 + 2 x 2) x 7 + (8 + 1) x 5] = 39 hours/week, our free time after work, eat and sleep. A million years ago and before the arts profession appeared, work consisted of hunting, gathering and tool making. How each species spends its free time differentiates one species from the other, and has important consequence in its evolutionary survival.

professional "artist," earning his food by entertaining others and staying at home instead of going out to hunt. In other words, *being an artist was the first safe job in history*. This would happen when the population expanded to a certain point and could afford to keep such an artist in their group. The first expert could be male or female, in principle.[8] The important points are:

1. Being a safe job, competition is keen and innovation was called for in the arts profession from the very beginning.
2. To keep the good job and reduce competition, the first artists would tend to maintain secrecy of their trades, pass their skills to their own sons only,[9] or inject mysterious elements into their practices—giving birth to the new profession of sorcery, perhaps.
3. The market demand and positive-feedback effect guaranteed that arts as a profession, once established, would not vanish.

As time went by and humans advanced, more varieties of arts were created. For example, with the invention of pigments, we had color painting; with language, singing; with writing, literature. And only with plenty of leisure time and a large enough market that *pure arts* appeared. Before that it was all *applied arts*,[10] which, of course, coexisted with pure arts after that. Here, pure arts mean arts for arts sake, and applied arts are done with some practical applications in mind, such as group dancing in ritual ceremonies which is to increase group adhesion.

Only in the last two hundred years that the word "art" was associated with aesthetics and fine art [Shiner, 2001]. Art in this narrow sense is part of pure arts.

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[8] There is hint that cave arts could be made by women as well as men. See: www.dailymail.co.uk/sciencetech/article-1197680/After-25000-years-scientists-discover-artwork-created-cave-men-AND-cave-women.html##ixzz0rJjXRF3I (June 19, 2010), and [Lane, 2011].

[9] This practice is maintained today in some Asian countries, in the professions such as martial arts and Chinese medicine.

[10] Every discipline can be divided into two parts: pure and applied, like the case in physics and in history [Lam, 2002].

1.5 Nature of Arts

Arts are a subset of humans' creative activities that aim to excite the receiver's neurons in a certain manner, through that person's senses, with or without significant consequences. This is pretty strange, since while good research works in all other disciplines are also creative activities, only arts as a discipline—with the exception of entertainment—aims at someone's neurons. For instance, pure science is to understand how nature works; it does not aim at anybody's neurons; it does not even need anybody out there (apart from the creator) to receive the end results.

1.5.1 *Applied Arts*

Applied arts, by definition, are explicitly useful. For instance, a well-decorated vase will help to sell more of those vases, apart from increasing its aesthetic value when placed in a sitting room. A skillfully written novel could change the worldview of the reader, turning her into a fighter for a noble cause or a revolutionary. Obviously, architecture is one of applied arts. It is pure arts that are puzzling. What are they good for?

1.5.2 *Pure Arts*

As observed by Kant (1724-1804), art is useless [Kant, 2007]. Here, Kant is referring to pure art, and useless does not mean that it is completely void of consequences. A beautiful landscape painting, for example, could put the receiver into a serene mood. Da Vinci's *Mona Lisa* (1503-1506) could jumpstart the receiver's neurons to wonder what that lady is smiling about. Yet, apart from exercising the receiver's brain—perhaps providing pleasure to and stimulating the thinking or creativity of this person—pure arts do not seem to have any important consequences. This is not exactly true (see Criterion 2 below). Here, five criteria on *lasting* pure arts are presented.

Criterion 1: Aim at receiver's neurons

This is the basic characteristic of any art.

Criterion 2: Kill time

An important function of pure arts is to kill time (see footnote 7), the time of the *receiver*.[11] If it is indeed an important piece of art, it is always the case that the receiver has to spend a lot of time contemplating it, while experiencing it and *afterward*. That is what happens to Marcel Duchamp's *Fountain* (1917) (see Fig. 1.7 below), as the receiver is concerned. That is also the case for an art movie or a good play, even though the viewing time of each is about two hours only. In short, pure arts kill time on the part of the receiver; *good pure arts kill a lot of time*. And that is an important criterion on pure arts.

Criterion 3: Kill time gently and harmlessly

But "kill time" by itself is not enough for something to be called pure art. Entertainments and drugs could kill time, too. The difference is that pure arts kill time gently and harmlessly while entertainments such as a World Cup football game jerks your neurons every 10 or 15 minutes if it is good. Similarly, drug effects are usually not gentle and drug use could get you in jail. (Moreover, drugs do not satisfy Criterion 5 below.) By the same reasoning, classical music is art; heavy metal music, bordering on entertainment. My guess is that Napoleon (1769-1821) would not hang *Mona Lisa* in his bedroom, if the smile in the portrait was not that gentle.

In other words, pure arts allow us to kill time in ways that make us feel good, without exciting our neurons too violently, and thus, *encourage us to revisit them frequently*.

Criterion 4: Passivity

It is not true that people want to get involved actively in everything they do. After a day's hard work, most people would like to relax themselves passively by watching TV, for example, and, for those artistically inclined, listen to classical music or doing something, again passively.

[11] Ever since arts became a profession long time ago, perhaps a million years ago, killing time was not the motivation of any *professional* artist. The creative effort in arts, like that in physics, could be hard work [Lane, 2011]. As in any creative profession, the time spent is partly to make a living, but mostly it is to satisfy one's personal urge to create (and ego, for most people).

On the weekend, they might read a book or go to an art museum, enjoying arts passively.

In fact, passivity on the part of the receiver is the signature of all great arts, from painting to literature and to performance arts. All pure arts (and some applied arts) have served the receivers this way in the past many, many years, building up a habit or tradition that we humans still keep. That is why interactive arts never caught on, and perhaps will never be in the future. *Too much interactivity is bad for pure arts*.

Criterion 5: Human creation or intervention

Arts, by definition, have to be something created or intervened by humans. It does not mean that the artists cannot use materials—natural or man-made—or do their work with the aid of machines or computers. Of course, they do, and have been doing it all the time.

By this criterion, a piece of rock lying on the roadside is not a piece of art, no matter how beautiful it is. However, if you take a photo of that rock, the photo could become a piece of art—*photographic art*, because the creation of the photo involves your intervention, assuming that Criterion 1 is also satisfied (which you can help by making the photo interesting, e.g., by bettering the camera angle and using artificial lighting).[12] You might also bring that rock home, put a frame around it and become an artist instantly, because the frame is your way of telling the receiver that you want that person to look at it from a certain angle, a human intervention. Of course, there is no guarantee that this *geographic art* is a piece of great art.

As a result of the tradition a million years in the making, we treasure more those arts that are created with the less external aids. Paintings and sculptures, created practically without external aids, are high on the list. For this reason, we will never consider computer graphics (such as fractals) or ape's "painting" as high art.[13] Similarly,

[12] Such a strategy is employed by Frankel in producing images from science and engineering experiments, making the two disciplines visually informational and accessible to the public and within the research community [Frankel, 2002].

[13] One day, if computers are smart enough to create paintings or write music and novels *all* by themselves (e.g., through genetic algorithm), we may have to differentiate two

mass reproductions of an art piece are considered commercial products but not art pieces because they are too many steps away from the human creator, the artist. That explains why Andy Warhol (1928-1987) reproduced his silk-screen art pieces in a very limited number, and did it with human hands.

In summary, *pure arts are created by humans or with human intervention, to kill time gently and harmlessly, and let the receiver to experience it (preferably) passively*. With this understanding, it is obvious that the content or form of a pure-art piece is secondary;[14] they are there to serve Criteria 2 to 4.

Since the system of neurons of human beings is an extremely complex system that is not yet well understood, there are not yet sure ways to create an artwork that would satisfy Criteria 2 and 3, i.e., arousing the interest and getting the repeated attention of the receiver. All feasible ways had been tried by artists, such as appealing to humans' deep emotions about love and motherhood, and religious upbringing. However, since the brain's neuron connections are shaped not just by nature but by culture, something that worked in a previous era may not work for the present generation. What is clear is that pure arts do not always work on people's sense of aesthetics (Fig. 1.7, left); they are also about all kinds of emotions such as fear (Fig. 1.7, upper right) and other things (Fig. 1.7, lower right), too. Just like physics, arts are about the representation, description or interpretation of everything in nature. Sometimes arts abstract the real (Fig. 1.8)[15] or play on people's affinity

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categories of arts: computer arts and human arts. Our bet is that the former will be valued far less than the latter due to Criterion 5.

[14] This does not imply that the content is immaterial. For example, in Duchamp's *Fountain*, the readymade urinal is actually a pretty complicated object with a peculiar shape that invokes all kinds of interesting thoughts, leading to the fulfillment of Criterion 2. If he replaced the urinal with a simple rice bowl, it would not work. Or, if he used a dirty urinal instead of a clean one it would not work either, because that would make the receiver uncomfortable and the resulting work would fail Criterion 3.

[15] Charlene Lam's *Petals* in Fig. 1.8 was made during a dark February in northern Sweden, which is a visualization and representation of the contrast between the region's long, light-filled days of summer and the short days of winter. The lengths of paper used were determined by the actual and predicted lengths of daylight for the first of each

for ambiguity (Fig. 1.9). Apparently, there are endless ways of doing good arts; we just do not know exactly what they are. This problem of arts is both its strength and difficulty, and obviously is an open problem in science.

Fig. 1.7. *Left*: Jean-Auguste Dominique Ingres, *The Spring* (1820-1856). *Upper right*: Edvard Munch, *The Scream* (1893-1910). *Lower right*: Marcel Duchamp, *Fountain* (1917).

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month in 2009. The outer loops of each petal represent the 24 hours in a day; the inner loops represent the hours of daylight. It should be noted that though the length of the materials were determined by scientific data, the resulting visualization is more of an artistic statement about the perception of light available in a given day. More details and additional work can be found at www.charlenelam.com.

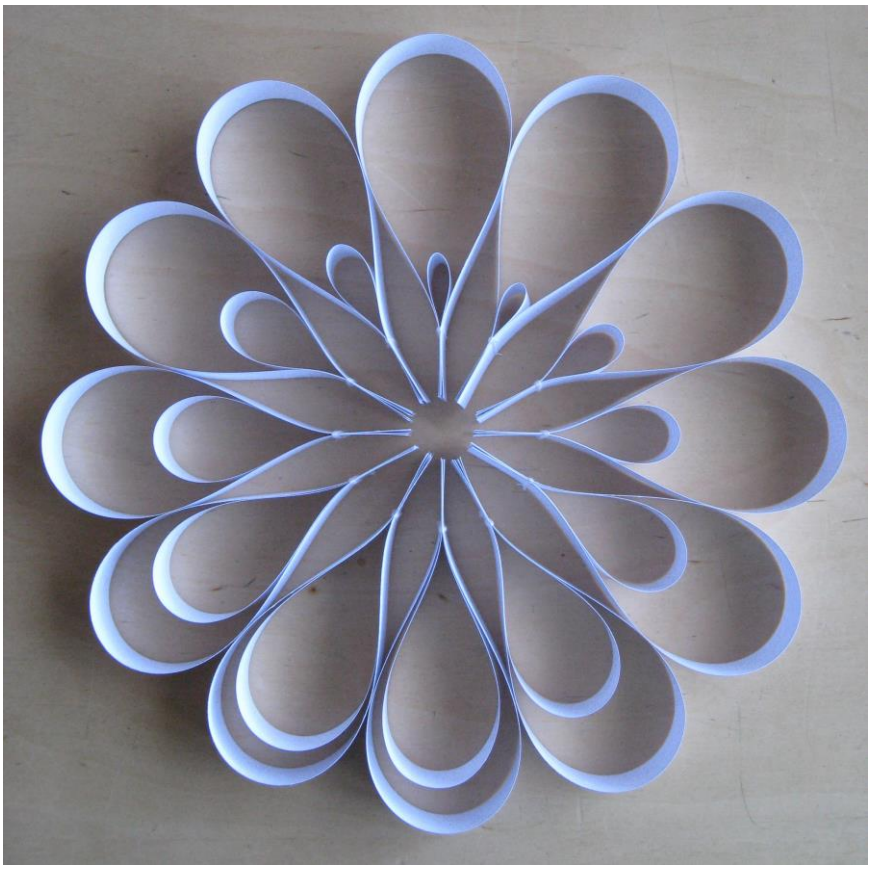

Fig. 1.8. Charlene Lam, *Petals (Longing for Light)* (2009), discarded paper strips and thread, 27 x 27 x 3 cm.

As humans migrated out of Africa 60,000 years ago, the contents of arts assumed local features, in addition to global universal elements developed in Africa. The fact that we treasure artworks (more than old stamps, say) implies that they do touch humans' deep emotions, needs, values, or something uniquely human. This was exemplified clearly in the French's national effort to hide the Louvre's artworks—and not something else—outside of Paris before the occupation of the Germans during World War II [Nicholas, 1995].

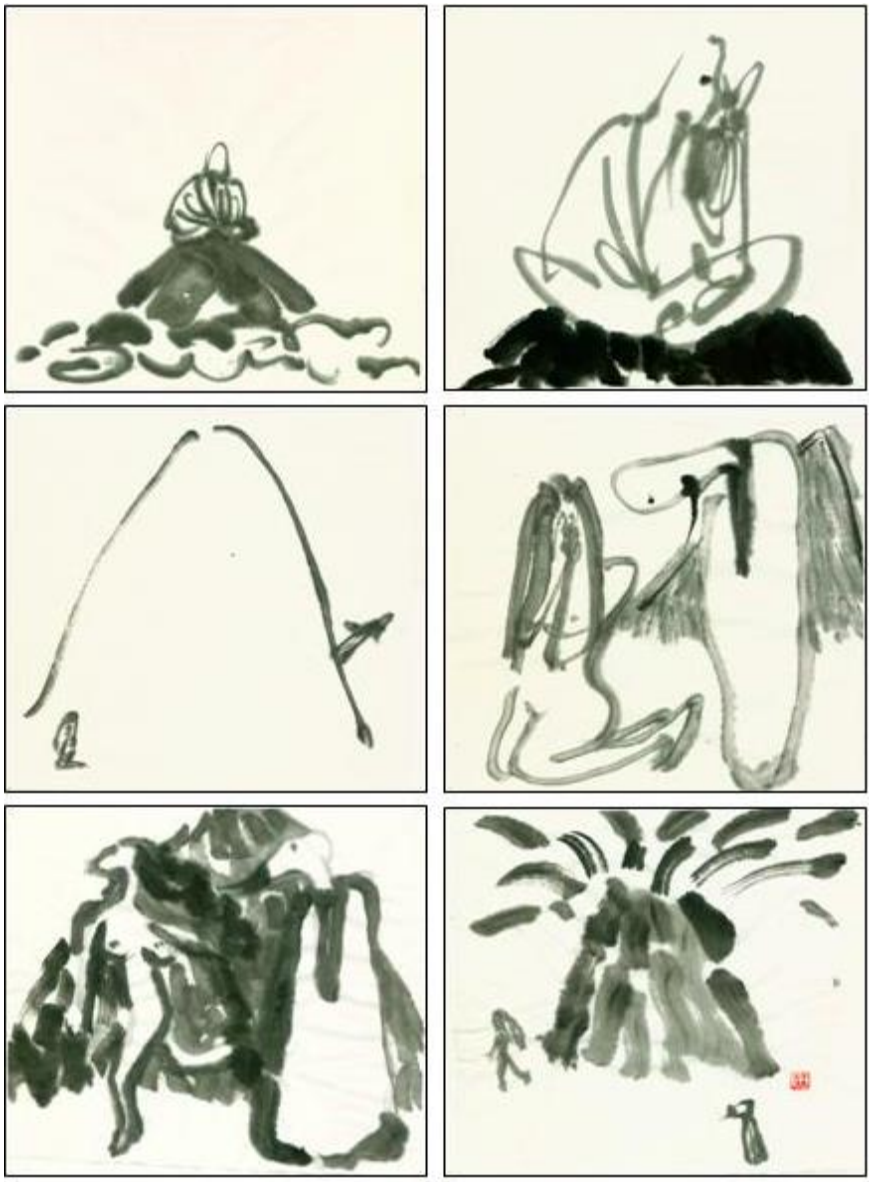

Fig. 1.9. Zhuang Wei-Jia, *Guru and the Little Woman* (2010), ink on rice paper, 22 x 24 cm each. Story unfolds from left to right, top to bottom.

1.6 Arts as a Science Matter

Arts, a part of science and a topic in SciMat, can be and should be studied scientifically. To study something is to understand it as thoroughly as possible, with all possible methods and using all appropriate tools. Therefore, knowledge and experiences from other disciplines could be borrowed; theoretical and experimental approaches are both allowed.

1.6.1 *Three Lessons from Physics*

There are three lessons that physics can offer to arts:

1. How to define a field

The domain of physics keeps on changing. For example, presently, the matured Newtonian dynamics drop out of physics and are picked up by engineering; new subdisciplines such as econophysics [Mantegna & Stanley, 2000], histophysics [Lam, 2002; 2008c] and complex systems [Lam, 1998] are added. To accommodate this ever shifting scene, *Physics Today*, the monthly magazine published by the American Physical Society, cleverly defines physics like this: "Physics is what physicists do" [Lubkin, 1998, p. 24]. Arts, with its content and form ever changing due to cultural and technological advancements, are like physics in this regard. It is thus not surprising that efforts to find the necessary and sufficient definition of arts all fail [Carroll, 1999].[16]

2. The existence of subdisciplines

In physics, different aspects of the same material are studied in different subdisciplines. As an example of the latter, for solids, we have Optics of Solids, Mechanics of Solids, Thermodynamics of Solids, etc. Every such subdiscipline can describe only certain properties of solids. They complement each other; when combined, a full understanding of solids is

[16] Noël Carroll's practical reason [1999, p. 207] that we need to define art precisely so an artwork such as Brancusi's abstract sculpture *Bird in Flight* can be imported to the U.S. duty free, is not strictly valid. This practical problem can be solved in the same way that we handle pornography, i.e., to be decided by a committee of local residents.

achieved. When viewed this way, the different approaches in art studies (such as Marxism, feminism, biography and autobiography, semiotics, psychoanalysis and aesthetics) [Adams, 1996] are actually studies at the phenomenological level (see below); each approach is a subdiscipline that specializes on a narrow aspect of arts. No one should expect that any one of them to be encompassing and be able to tell the whole story.

3. There are three levels of study

In *any* scientific study, after observing and collecting data, and analyzing the data, there are three approaches or levels—empirical, phenomenological and bottom-up—that one can adopt to go further [Lam, 2002]. These three approaches in the cases of physics and arts are sketched in Table 1.2. Empirical studies always happen first. Phenomenological studies are done without knowing the mechanism underlying a phenomenon; they are very powerful and sometimes undervalued. Fundamental understanding of a phenomenon is reached through the bottom-up studies in which the mechanism will reveal itself and become understood.

Table 1.2. The three approaches in the study of physics (gas as an example) and arts.

Approach	Gas	Arts
Empirical	Gas law	Empirical rules discovered by artists; empirical studies by art critics/historians/ scholars; fractal analysis of paintings and music by physicists
Phenomenological	Navier-Stokes equation	Interpretations of nature of art by art philosophers/ historians/scholars; evolutionary arguments via Darwin
Bottom-up	Molecular picture (called microscopic method)	Studies through biology: evolution theory (genetics), cognitive science, neuroscience; through physics: statistical analysis

1.6.2 *Arts Studies in Three Approaches*

Here examples of arts studies done with the three approaches are given.

1. Empirical

In arts studies, at the empirical level, there are various empirical rules worked out by the artists and empirical analyses due to arts scholars. An

example of the latter is the work by André Leroi-Gourhan (1911-1986); he regarded *all* the signs *and* animals depicted in the prehistoric cave paintings as sex symbols and classified them as either female or male (e.g., bison for female, horse for male), reflecting the supposed worldview that the world is divided into two types or two kinds of things, two genders, akin to the Chinese's yin-yang philosophy (see [Aczel, 2009]). Another example is Taylor's fractal analysis [2002] of the dripping paintings of Jackson Pollock (1912-1956), and the fractal studies of music (see [Barrow, 1995]). The third example is the statistical analyses of literature by Gottschall and his coworkers [Gottschall, 2008]; e.g., romantic love is shown to be a literary universal by counting the number it occurs in folktales from different cultures.

2. Phenomenological

At the phenomenological level, apart from the different interpretations of arts such as those summarized in Adams' book [1996] mentioned above, the origin of arts was studied by Dissanayake [1988] through Darwin's evolution theory. Here, arts are argued to be an adaptive behavior that benefits humans' survival, passing from generation to the next through the genes. The problem with this approach is that, in view of the new findings in epigenetics (Section 1.3), it is not clear that the genetic route is at all necessary. Maybe the cultural effects on arts could be inherited too, through the epigenes; or both. The crucial problem is that unless there is experimental proof of the adaptive nature of arts, such a conjecture remains a conjecture. Similar considerations plague the debate of the nature vs. culture origin of arts. Further examples of the phenomenological approach are the evolutionary study of literature by Carroll [2004] and of film by Anderson [1996].

3. Bottom-Up

The bottom-up approach in the study of physics of materials is to start from the molecular description and work out the macroscopic properties; that is because molecules are at the lower level of materials. The case in humanities is more complicated and slightly different. Even though the immediate lower level of a human body is consisting of cells, no one ever tried to understand humans by considering trillions of cells together.

Instead, the bottom-up approach in the humanities starts from a much lower level, from either the neurons or the genes. The former leads to *neurohumanities*, with subdisciplines such as neurophilosophy and neurotheology, and, for arts, neuroesthetics [Skov & Vartanian, 2009], neuromusicology, neuroarthistory [Onians, 2007] and neurocinematics [Hasson et al, 2008]; this rapid development of neuro-based studies is sometimes called the Neuro Revolution [Lynch, 2009]. The latter leads to the genetic study of humanities and is less developed.

That neuroscience and cognitive science [Turner, 2006] are important in arts studies is not at all surprising, since the brains of the artists and the receivers are obviously important in the creation and appreciation of artworks. And neuroscience helps us to understand what makes the human brain unique [Gazzaniga, 2008]. Yet, in the neuro-studies of arts, some progresses are made but success is limited, perhaps due to the fact that the development in neuroscience and cognitive science [Kolak et al, 2006] is still in its infancy. More nontrivial results are needed to get the attention of the artists.[17]

Apart from the books mentioned above, neuroscience in connection with literary studies is discussed in [Hogan, 2003a; 2003b]. Applications of neuroscience in movie (and advertisement) studies are reported in [Hamzelou, 2010]. Examples of specific works connected with global art history [Onians, 2011] and the paintings of Su Dong-Po and Paul Cézanne [Lam & Qiu, 2011] as well as other topics can be found in the book *Arts: A Science Matter* [Burguete & Lam, 2011].

1.7 Arts and "Science"

The issue of arts and "science" (see footnote 1) is of great interest to many people. What this actually means is that whether there is any connection between the arts and the study of the physical world, since both are creative processes. Unfortunately, there exist a lot of confusion concerning this issue, due mainly to the misunderstanding of the domain

[17] In physics, e.g., the nontrivial result that maximum range of a projectile is achieved with a throwing angle of 45^o is taught in high school. This knowledge is used by the teenager in the movie *Aliens in the Attic* (2009) in hitting the alien with a dart and thus saving the world!

of science, and the origin and nature of arts. Our takes on this issue are summarized in Table 1.3.

Table 1.3. Comparison between arts and "science."

Characteristics	Arts	"Science"
Both are part of science	Arts are part of science.	"Science" (mostly about nonliving systems) is also part of science.
Different aims	Arts aim at receiver's neurons.	"Science" aims to understand how nature works.
Receiver	Arts need a receiver to appreciate the artwork.	"Science" needs no receiver (but has to compare with nature, the ultimate judge).
Different history	Arts started at least 35,000 (and could be a million) years ago.	"Science" started about 2,600 years ago since Thales (c. 624-c. 546 BC), after the invention of language and writing.
Relationship between arts and "science"	• Both involve creative process (for different reasons)—but same in many other human activities. • Arts are humans' creation, reflecting on the world of human and nonhuman systems; the principles governing this world are the same principles (e.g., symmetry, spontaneous symmetry breaking, fractal, chao, active walk) studied by "scientists." • Progress in "science" (and related technology) advances the development of arts; e.g., pigments→color painting, film/camera→photographic art, electricity→cinema, laser→photon art, computer→digital art.	

Furthermore,

1. There is a common misunderstanding on how artists and "scientists" use their brains. The truth is that these two kinds of professionals both use intuitions and rational thinking in their trades [Lam, 2004]; they use both their left and right brains. Real-time brain scans using fMRI (functional Magnetic Resonance Imaging, started in 1990) could help to clarify this issue.
2. Since artists, painters in particular, quite often depict the world as it appears to them, the same physical principles that govern the

working of the physical world could show up in the artists' works. This is indeed the case; some of these principles such as symmetry and broken symmetry are discussed in [Leibowitz, 2008].

3. Occasionally, artists are inspired by "science" in creating their work (see Fig. 1.10 and [Lam, 1998, p. 19; Burguete, 2011]). The reverse case is discussed in [Burguete, 2011].
4. For artists and scientists living in the same era, will their works influence each other? There is no direct evidence that this happened, but they, like Picasso and Einstein, certainly were aware of each other's work [Miller, 1996; 2001].
5. Since artists are those with supreme bodily sensors [Lam, 2008a] and using them everyday, they could know something empirically on how the brain works, long before the "scientists" find it out in their labs. Examples on this are given in [Strosberg, 2001; Lehrer, 2008]; see also [Gardner, 1993].
6. Examples are given by Edwards [2008] that some people can cross the boundary between art and "science," and achieve breakthroughs in both. Discussions on the link between "science" and culture are given in [Slingerland, 2008; Galison et al, 2001].
7. Selected artists and "scientists" like to present their effort as the search for "truth, virtue and beauty." But this claim could not be universally true, for the following reasons: (1) Truth is a fuzzy concept [Godfrey-Smith, 2003]. (2) No virtue could be found by naturalists in their study of how insect parasites feed on their hosts;[18] virtue is claimed mostly by theoretical physicists. (3) As shown in Fig. 1.7, arts are not always about "beauty"; some physicists found Newton's second law of motion, $F = ma$, beautiful (or elegant), but that is because a lot of messy details are hidden from this expression.[19]

[18] For example, predatory wasps paralyze the host insect by stinging and lay eggs on it. The larvae feed on the paralyzed host and killing it in the end (http://en.wikipedia.org/wiki/Entomophagous_parasite, Nov. 1, 2010).

[19] For instance, this law is about non-existent point particles which have mass but zero size; $F = ma$ is only a special case (when m = const) of the second law which states that $\boldsymbol{F} = \mathrm{d}(m\boldsymbol{v})/\mathrm{d}t$, a vector equation involving differential calculus; two quantities, force F and

8. Some arts are known to have healing effects [McCaffrey, 2007]; it links arts to medical science.

Further discussions on the issue of arts and "science" are provided in [Jaroszynski & McNeil, 2000; Rodgers, 2002; Shahn, 2002; Crease, 2003; Hidetoshi & Rothman, 2008; Lucibella, 2010], and references therein.

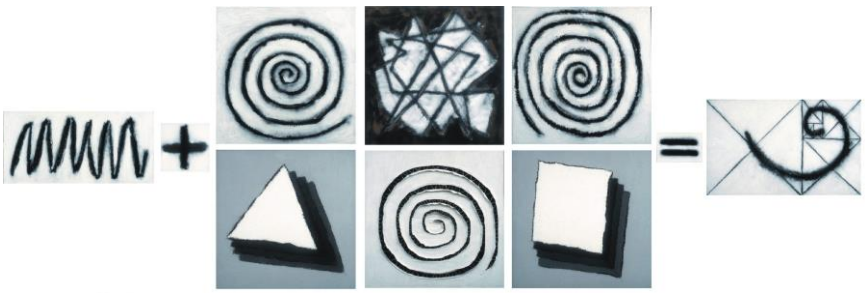

Fig. 1.10. George Cladis, *Line Revisited*, 10 acrylic and stitching on linen, 146" x 472" installation. The complete absence of color in this installation idealizes the heft and vastness of the conscious domain (for more information, see "Patterns of Mind" in http://alct.com/gCladis/AbstractCD/2abs.htm).

1.8 Discussion and Conclusion

The nature and origin of arts is a 2,400-years-old unsolved puzzle dating to Plato's time. In this chapter, an answer to this puzzle is attempted.

In previous sections, we point out that arts consist of applied arts and pure arts. Applied arts could start a million of years ago, while pure arts emerged later when the community is large enough to support pure artists. Being an artist was the first safe job in human history. The nature of arts is then discussed; five criteria on pure arts are given. Our understanding of arts is based on a global and historical perspective; it differs from the conventional wisdom popularized by the West [Shiner, 2001, p. 6] or existing in the East. Yet, reasonable this story of arts is, it has to be substantiated by more works. Here are further discussions.

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mass *m*, are defined with this one equation, which is completely illogical [Wilzeck, 2004].

1. In a way, arts are like driving. Driving is to move a vehicle from point A to point B and deliver something. The motivation of the driver is irrelevant here; the type of vehicle used is secondary. Similarly, the essence of arts is to have the artwork created in the artist's brain (point A) and delivered to the receiver's neurons (point B). It will only confuse the issue if you search for the artist's motivation (which could be a mixture of curiosity, fame and making a living—same as for scientists [Tsui & Lam, 2011]).[20] And the content and style of the artwork, like the vehicle in driving, is secondary as long as they sit well with the receiver's neurons.

2. Historically, the development of arts is from applied to pure (Section 1.4), similar to the case in science's early development which is from technology to applied and to pure. (The reverse order is mostly true in science today.)

3. The key to understand arts is to understand arts (and not just art) as a whole, both historically and globally, and not merely the small part of it existing in Europe. In fact, the latter has a short history of only two thousand years or so, including the last two hundred years of fine arts [Hoppe, 2011].

4. It seems that women fall easily for male artists, but female artists do not attract men, at least not to the same degree. If this is true, it can be explained by our surmise that arts was the first safe job in prehistory. According to the evolution theory, women tend to choose capable men who would and could stay around to protect the mother and child. In this respect, an artist father would be favored over a hunter father, and this preference could be carried over to the present day. More research on this issue is warranted.

5. In the West, arts (and "science") were derived from the "liberal arts" some 2,000 years ago and the ideal of liberal arts—designed for free men—was the pursuit of universal knowledge [Wu, 2011]. On the other hand, artworks in Europe until a few hundred years ago was operated within the commission/patronage system; the artist was not

[20] Einstein's explanation for people's motivation in doing art and science is that "[to] escape from everyday life with its painful crudity and hopeless dreariness" [Einstein, 1982, p. 225].

completely free in choosing his topics, not even Michelangelo or da Vince [Shiner, 2001, p. 18]. Surprisingly, great arts were produced. There were two factors that made this possible: (1) the artist was given enough artistic freedom in executing the project, and, more importantly, (2) the person who had the final say, the patron, possessed a high enough level of sophistication or artistic taste. That the artistic sophistication of the "authority" is crucial is reflected in the uniform style of the tall buildings built in Beijing, China, within a couple of years about a decade ago. They all wear a "hat"—the Chinese way of blending the Western and Chinese styles of architecture at that time; an example is shown in Fig. 1.11. Even in the last two hundred years when there has been a free market for artworks, in a certain sense, artists are still not completely free. The art creating process is constrained by the human nature of the artist and the receiver, and by the principles underlying nature.

Fig. 1.11. Pacific Digital City, a "hat"-wearing building at Peking University, Beijing, China.

6. Neuroscience in arts studies could involve the use of fMRI scan and optogenetics [Deisseroth, 2010], applied to the brains of the artist and the receiver. In the optogenetic experiments, light-responsive opsin genes are inserted into the cells of the brain. Specific neurons can then be triggered to fire by a flash of light, providing precision down to the neuron level.

7. In arts studies, no matter how useful the bottom-up neuro approach (theoretically and experimentally) is, it should not be the only method one relies on in understanding arts. Empirical and phenomenological approaches as well as *common sense* should not be forgotten. The situation is like that in physics. After quantum mechanics was invented about 100 years ago, there was a rush to do quantum theory of everything interesting. However, if one wants to understand the flow of water, the advice is to start from the phenomenological Navier-Stokes equation and not quantum mechanics, because it is unnecessary and impractical to do so. In the study of complex systems (and in any other discipline), the appropriate research tool should be selected according to the level at which the property under study emerges [Lam, 2002].

8. In [Dutton, 2009, pp. 52-59], 12 features of art are listed: direct pleasure, skill and virtuosity, style, novelty and creativity, criticism, representation, special focus, expressive individuality, emotional saturation, intellectual challenge, art traditions and institutions, and imaginative experience. Unfortunately, it seems that all these features are shared by the other creative discipline called physics, and hence are not unique to art.

9. The monetary value of an art piece fluctuates in time. It has more to do with the uniqueness of the artwork, like a large piece of diamond or rare stamps, than to do with the artistic nature of the artwork itself.

10. Religion and "science" have been called the two pillars of Western civilization by the Nobel laureate in physics, Richard Feynman (1918-1988).[21] Since religion is not a prime element in societies like China, it could be said that *it is arts and "science" that are the two*

[21] "The Relation of Science and Religion," the transcript of a talk given by Richard Feynman at the Caltech YMCA Lunch Forum on May 2, 1956 (http://calteches.library.caltech.edu/49/2/Religion.htm, June 18, 2010).

pillars of any *civilization*. That is, arts are more basic than religion as civilization is concerned.

11. In principle, all modern creations by humans—like cell phones and air conditioning—could be given up and (most if not all) humans would still survive. However, without these creations, life would become very inconvenient and many people would suffer. In contrast, if *Mona Lisa* was gone, only the Louvre museum would suffer, materially speaking. In this sense, and only in this sense, arts are inessential and "useless." Otherwise, arts are most valuable! No one should live in a world without arts, and they can't.

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