
The Functional-Analogical Explanation in Chinese Science and Technology. A Case Study of the Theory of Yin-Yang and Five Elements

Zhang Huaxia and Zhang Zhilin

China's major Research Base of Philosophy of Science and Technology, Shanxi University, Taiyuan, China, and Department of Philosophy, Sun Yat-sen University, Guangzhou, P.R. China
{hsszhx,hsszhang}@sysu.edu.cn

Summary. Philosophy offers the culture of science and technology a certain research tradition composed of two elements, ontological assumptions and epistemological-methodological principles, which restricts specific explanation model. Through the case study of the theory of Yin-Yang and Five Elements, this paper states the ontological assumptions and epistemological-methodological principles of the research tradition in ancient China, analyzes the functional-analogical explanation model's positive and negative influences on Chinese culture of science and technology, tries to answer the famous "Needham's Problem", and criticizes some trends in the culture of science and technology in contemporary China.

The development of science and technology is dependent on cultural backgrounds. In the view of philosophy, cultural backgrounds offer science and technology ontological assumptions and epistemological-methodological principles which form the research tradition in culture of science and technology [6]. With different ontological assumptions and epistemological-methodological principles, different scientific communities raise different explanation models for understanding experiential phenomena.

The theory of Yin-Yang and Five elements is a fundamental research tradition and explanation model in Chinese culture of science and technology. The authors in this paper hold that the model is one of functional-analogical explanations based on intuition, and that it has profound influences on Chinese culture of science and technology.

1 The Theory of Yin-Yang and Five Elements in the View of the Research Tradition

The term "research tradition" in this paper is from Laudan, who states: "A research tradition is a set of general assumptions about the entities and pro-

cesses in a domain of study, and about the appropriate methods to be used for investigating the problems and constructing the theories in that domain” [6, p. 81]. According to this definition, a research tradition contains two key elements, ontological assumptions and epistemological-methodological principles.

We hold that the research tradition dominating ancient Chinese culture of science and technology can be featured by three key concepts, Qi, Yin-Yang, and Five Elements. Historically, the three concepts have different origins. Once they merged into one, however, it gradually became the research tradition ruling the whole Chinese culture of science and technology. Moreover, we can say that it is a kind of “perpetual philosophy”, in Joseph Needham’s word. The ontological assumptions of this research tradition include the following:

(A) Qi is the noumenon (or first principle) which produces and forms every thing in the world. Chuang Tru states: “It is Qi that unifies the whole world” (*Chuang Tru*, Chapter 22, “Zhibei Travels”). Qi is not like air, one of Four Elements, in Aristotle’s philosophy. It is continuous and permeates the cosmos, and it is invisible. Therefore, Qi is not like the atoms in the eyes of philosophers in ancient Greece, nor is it like their concept of void, for the universe is permeated with Qi, as Wang Fuzhi states: “The Void contains Qi, and Qi is full of the Void. There is no not-being” (*Comment on Zhang Zai’s Correcting Youthful Ignorance*).

(B) From the point of view of a functional analogy, Qi is classified into two kinds, Yin’s and Yang’s, and all the things in the world can be classified in Yin and Yang. Yang originally refers to the part of a mountain facing the Sun, while Yin refers to the part upon which the Sun does not shine. However, using character-imagination and function-analogy, ancient Chinese people infinitely extended the original meanings of Yin and Yang, and thought that every thing can belong to Yin or Yang. For example, the Sun belongs to Yang while the Moon to Yin; brightness to Yang while darkness to Yin; the heaven to Yang while the earth to Yin; South to Yang while North to Yin; Heat to Yang while Cold to Yin; Hardness to Yang while Softness to Yin; movement to Yang while still to Yin; man to Yang while woman to Yin; the back of the human body to Yang while the abdomen to Yin; the five internal organs (heart, liver, spleen, lung, and kidney) to Yang while the six hollow organs (gallbladder, stomach, large intestine, small intestine, bladder, and “saujiao”) to Yin, and so on. Evidently, Yin and Yang are not like the concepts such as the South Pole and the North Pole, positive charge and negative charge, positive particle and negative particle, because the former is based on intuitive imagination and analogy, while the latter is based on logical analysis and experiment. Generally speaking, the moving, the high, the warm, the bright, the ascending, and the external belong to Yang, while the still, the low, the cold, the dark, the descending, the internal, belong to Yin.

(C) Yin and Yang are not only used to classify all things in the world, they are also used to express the mechanism of the interactions. Zhang Zai says, “Yin’s and Yang’s are cyclical and alternate, get together and separate,

ascend and descend, interact, attract each other and repel each other” (*Correcting Youthful Ignorance*). When Yin (or Yin’s) and Yang (or Yang’s) are in the state of dynamic equilibrium, everything is stable, while everything is turbulent when they are not in such a state. In *Guoyu, Zhouyu* it is stated: “In the second Year of Youwang (Zhou Dynasty), there was an earthquake. Boyang Fu said, ‘Zhou Dynasty would perish. Qi in the world shall be in order’; if it is not, there will be people’s turbulence. The earthquake comes from disorder of Yin and Yang”. Here, disharmony of Yin and Yang explains both the natural phenomenon (earthquake) and the social phenomenon (people’s turbulence), and it is predicted that Zhou Dynasty would perish on the basis of the disharmony. In *Yellow Emperor’s Inner Classics*, a famous work on Chinese medicine, there is another statement concerning harmony and disharmony: “The key of Yin and Yang is the harmony of the two. If they are in disharmony, it is the same as that there is the spring without the autumn, or that there is the winter without the Summer. It is the best to make disharmony of Yin and Yang become harmonious. Therefore, if Yang is excessive, Yin will perish; if Yin and Yang are cooperative, it is healthy; if there is only Yin without Yang or is there is only Yang without Yin, man will die”.

(D) The procedure of mutual promotion and restraint among five elements shows the process in which Yin (or Yin’s) and Yang (or Yang’s) are cyclical and alternate, and both interact and check each other. Classical statements about Five Elements (Wu Xing) are the following: “There are Five Elements: Water, Fire, Wood, Metal, and Earth. The nature of Water is to moisten and descend; of Fire, to burn and ascend; of Wood, to be crooked and straight; of Metal, to yield and to be modified; of Earth, to provide for sowing and reaping. What moistens and descends produces saltiness; what burns and ascends produces bitterness; what is crooked and straight produces sourness; what yields and is modified produces acidity; what provides for sowing and reaping produces sweetness” (*Book of History*, “*Great Norm*”). The Chinese character, “Xing”, means movement, change, process, function, etc. Strictly speaking, “Wu Xing” should be translated into “five movements” “five changes”, “five processes”, or “five functions”. However, since water, fire, wood, metal and earth are indeed common materials or elements in our daily life, there are reasons to translate “Wu Xing” into “five elements”. Surely, the following passages support this translation: “Water and fire are used to cook; metal and wood are used to build; earth is used to plant. Therefore, they are all useful to human beings” (*Book of History*, “*Great Biography*”, “*Zhou Biography*”). The early Kings mix earth, metal, wood, water, and fire to produce various things” (*Guoyu Zhengyu*).

Thinking of the quotations, and considering the common translation in the long history of combination between Chinese culture and the Western one, we have chosen the translation of “Five Elements”. At the same time, we do not neglect the meanings of “movement”, “change”, “process”, and “function”. These meanings fully show Chinese intuitive-analogical-thinking perspective, by which everything in the world – and its natures – belongs to one of Five

Element. According to this perspective, the classification of all things can be made on the basis of Five Elements (see Table 1).

There are two basic interactions, “Sheng” and “Ke”, among the five. “Sheng” means that one thing can promote, produce, cause, and push another thing, while “Ke” means that one thing can restrain, win, and conquer another thing. The sequence of “Sheng” is that wood promotes fire, which promotes earth, which promotes metal which promotes water, which promotes wood. It can be expressed as shown in Figure 1.

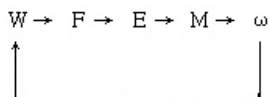


Fig. 1. The sequence of promotion among Five Elements.

The sequence of “Ke” is that wood restrains earth, which restrains water, which restrains fire, which restrains metal, which restrains wood. Cf. Figure 2:

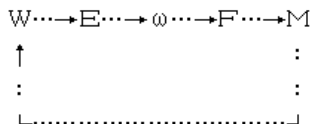


Fig. 2. The sequence of restraint among Five Elements.

These two sequences can also be expressed by Figure 3. Tong Zhongshu explains: “Broken lines represent ‘Ke’, while unbroken lines represent ‘Sheng’”.

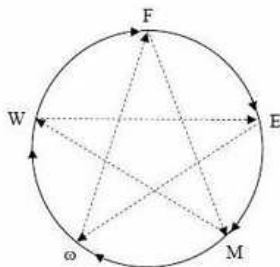


Fig. 3. The broken line represent restraints while the unbroken line represent promotion.

We have described above the ontological assumptions of Chinese research tradition. Let us now turn to its epistemological-methodological principles:

- (a) Everything in the world is composed of Qi which has two kinds, Yin's and Yang's. The principle which make us able to study all problems and to explain all phenomena is that we have to recognize whether Yin's and Yang's are in the state of dynamic equilibrium and harmony or not. This principle is manifested in the sequences of "Sheng" and "Ke" among Five Elements.
- (b) Therefore, the intuitive relationship and functional analogy between the Five Elements and all things in the world is the principle that make us able to explain all experiential phenomena.
- (c) "Sheng", among the Five Elements, shows a positive relationship. Looking at the Figure 1, the more strongly Wo acts on F, the more strongly F acts on E; the more weakly Wo acts on F, the more weakly F acts on E. The other positive relationships are the same. As a result, "Sheng" among Five Elements forms a circle of positive feedbacks.
- (d) "Ke", among the Five Elements, shows a negative relationship. Looking at the Figure 2, the more strongly Wo acts on E, the less weakly E acts on Wa; the less weakly Wo acts on E, the more strongly E acts on Wa. The other negative relationships are the same. Therefore, "Ke", among the Five Elements, forms a circle of negative feedbacks.
- (e) The relationship between "Sheng" and "Ke" is negative. Looking at the Figure 3, the more strongly Wo acts on F, the less weakly Wa acts on F; the less weakly Wo acts on F, the more strongly Wa acts on F. The other relationships between "Sheng" and "Ke" are the same. Therefore, both the circle of positive feedbacks and the circle of negative feedbacks form a system of dynamic equilibrium.

These epistemological-methodological principles have been showed at work in medicine, astronomy, alchemy, etc. We will only describe some example coming from medicine in ancient China. In *Yellow Emperor's Inner Classics*, there are many interesting statements: "Qi is the substance of life", "man's essence of life, energy, saliva, fluid, blood, and pulse all can be reduced into Qi", "If various kinds of Qi fit each other, human body is in a harmonious state; if not, man is ill". In the perspective of Chinese medicine, health is dependent on harmony of Qi, while illness is dependent on disharmony of it. Therefore, The essence of therapy is the adjustment of Qi. The adjustment actually consists in adjusting the relationship between Yin and Yang. For "excess of Yin or Yang means illness", "excess of Yang leads to Yang's illness, and excess of Yin leads to Yin's illness", "when a good diagnostician observes patient's face and feels the pulse, he should make a judgement on the classification of patient's illness at first (Does it belong to Yin's illness, or to Yang's one?)" "Those who know Yang should know Yin, and those who know Yin should know Yang".

The coordination of Yin and Yang is reflected in the dynamic equilibrium of the Five Elements' "Sheng" and "Ke". The classification of five viscera into Five Elements is based on the intuitive imagination of functions and analogy

Heaven (Nature)						Five Elements		Human (Society)					
	Taste	Colors	Development	Weather	Cardinal Points	Seasons		Viscera		Sense organs	Body	Affective State	Dynasty
Yin-Yang									—				
Lessor Yang	Sour	Green	Birth	Wind	East	Spring	Wood	Liver	Gall	Eye	Muscles	Anger	Xia
Yang	Bitter	Red	Growth	Heat	South	Summer	Fire	Heart	Small intestine		Pulse (blood)	Joy	Zhou
Equal balance	Sweet	Yellow	Chang	Wet	Center	August	Earth	Spleen	Stomach	Mouth	Flesh	Think (desire)	Yellow Emperor
Lessor Yin	Acrid	White	Reaping	Dry	West	Autumn	Metal	Lungs	Large intestine	Nose	Skin & hair	Sorrow	Shang
Yin	Salt	Black	Storing	Cold	North	Winter	Water	Kidney	Bladder	Ear	Bones (marrow)	Fear	Qin

Table 1. The five elements and their correlations

(cf. Table 1). Therefore, the mythological principles of Five Elements “Sheng” and “Ke” are useful in Chinese medicine. For example, if a patient coughs, has soft phlegm, and has no appetite, his illness is diagnosed as energy deficiency in spleen, which leads to that saliva and fluid cannot circulate efficiently, thus causing Sheldon drop of vital energy in lung, and causing cough. In this case, the cause of the illness is the obstruction of the movement of spleen’s energy to lung (obstruction of the wood promotion of metal). The therapeutical method is to enrich the energy of spleen and lung (to aid earth and then metal).

2 The Theory of Yin-Yang and Five Elements and the Functional-Analogical Explanation

What is an explanation? Nagel says: “Explanation is to answer the ‘why’-questions” [7, p. 15]. In other words, an explanation is a way of saving the phenomena, to provide reasons for the statements which we want to understand, and to answer our question, why would matters be like what the statements state?

How does the theory of Yin-Yang and Five Elements answer the question of “why”? Let us look at the following examples.

Question 1: Why has Zhou Dynasty as a unified dynasty been displaced by Qin Dynasty?

Scholars in ancient China answer the question on the basis of the classification of Dynasties in accordance to the classification of Five Elements. According to the Figure 2, they make the following conclusion:

Qin Dynasty (Water) – Zhou Dynasty (Fire) – Shang Dynasty (Metal)
– Xia Dynasty (Wood) – Yellow Emperor (Earth)

In Lu’s *Spring and Autumn* it is stated: “When a new emperor is going to appear, there must be auspicious signs. At the time of the Yellow Emperor, there appeared the biggest earthworm and the mole cricket. The emperor said that Earth dominates the world. Because of that, Yellow was regarded as the best color, and Earth as the most important. At the time of Yu (the emperor of Xia Dynasty), trees and grasses did not wither in fall and winter as usual. Yu said that Wood dominates. Because of that, green was regarded as the best color, and Wood as the most important. In time of Tang (the emperor of Shang Dynasty), Sword jumped from water. Tang said that Metal dominates. Because of that, White was regarded as the best color, and Metal as the most important. In time of Wenwang (the emperor of Zhou Dynasty), birds keeping red books on their mouth gathered at Zhou’s altar. Wenwang said that Fire dominates. Because of that, Red was regarded as the best color, and Fire as the most important. The replacement of Fire would be Water, and Water would dominate. Because of that, Black would be regarded as the best color,

and Water as the most important. And the next turn would be for Earth.” We can see that the statement of “Water conquers Fire” is applied to answer the question 1; and we shall note that it is predicted that the replacement of Qin Dynasty must belong to Earth. It is equivalent to Boyang Fu’s prediction of Zhou Dynasty’s perishing on the basis of the disorder of Yin and Yang. The logical structure of the explanation is the following:

Explanans:

1. The classes of functions: Water, Fire, Metal, Wood, Earth.
2. The relations between classes: Water conquers Fire.
3. What class the events belong to: Qin Dynasty belongs to Water, and Zhou Dynasty belongs to Fire.

Explanandum:

4. Qin Dynasty replaced Zhou Dynasty and became the ruler of China.

According to the covering-law model of scientific explanation [4], if we take the statement, “Water conquers Fire” as a universal law, the explanation described above obeys to the D-N model (deductive-nomological model); if we take the statement as a statistical law, the explanation obeys to the I-S model (the inductive-statistical model). However, it is questionable to consider a statement like “Water conquers Fire” in the theory of Yin-Yang and Five Elements a “law”. If you state that all the things belonging to Water have the function to conquer Fire only on the basis of the observation that Water can extinguish Fire, without analysis or tests through experiments, it will be difficult to say that your statement is qualified to be considered a universal law, needless to say, a universal law in terms of a relationship between cause and effect. Furthermore, in both D-N explanation and I-S explanation, the explanans should contain statements about the experiential conditions under which the laws holds.

However, in the above structure of explanation, the explanans does not contemplate a “law-like” statement like “Water conquers Fire”. On the basis of “intuitive imagination and functional analogy”, the man who makes the explanation holds: (1) everything in the world can be classified into five kinds (Five Elements); (2) there is a relationship between Water and Fire: Water can conquer Fire; and (3) Qin Dynasty belongs to Water, while Zhou Dynasty to Fire. Then he assumes these statements as the explanans for the explanandum: (4) Qin Dynasty replaced Zhou Dynasty. There is neither analysis of causation on Zhou Dynasty’s perishing and Qin Dynasty’s rise, nor explanation of purpose. What he offers is the functional-analogical explanation which has two characteristics: 1) explanans include no laws in strict sense, but functional classes and their relationship; and 2) the relationship between explanans and explanandum is not deductive or inductive, but analogical. It presents a low probability. In other words, the quality of the explanation is

very low. In addition, we should note that it is an *ad hoc* explanation. In order to explain Qin Dynasty's rise, the Dynasty must be classified as Water.

Question 2: Why do I often have hectic fever in the afternoon, feel upset, and have a red face, emaciation, night sweat, dryness in my mouth and throat, red tongue with little coating, and weak pulse?

On the basis of the theory of Yin-Yang and Five Elements, Chinese medicine offers an explanation: it is because of deficiency of Yin in kidney. It is a functional-analogical explanation which is different from that given in Western medicine. The latter uses tests (of blood, urine, X-ray, etc.) to detect the cause of the disease (for example, the effects of bacteria, virus, etc.), and to ascertain the focus for example of an infection. In the light of certain medical causal laws (e.g., under certain condition, certain kind of bacteria would certainly causes certain kind of disease), certain boundary conditions, and the particular statements from the tests about the patient, western doctors can logically explain the whole symptoms in Question 2: we hypothesize a Chronic nephritis, or a pulmonary tuberculosis, or a diabetes, etc. On the other hand, doctors in Chinese medicine probe neither substantial causal relationship, nor the focus of disease (infection, for example). They only make functional classification, beginning with classifying human body into five internal organs (liver, heart, spleen, lung, kidney) on the basis of the Five Elements.

It is very important to note that the organs, in the perspective of Chinese medicine, are different from those in the perspective of Western medicine: the former is functional while the latter is "substantial" and anatomical [15]. In order to make a more plentiful and complex classification of diseases, doctors in Chinese medicine add the Eight Concepts of Yin-Yang, exterior-interior, chills-fever, and void-solid, taking Yin-Yang as the key. Matching five internal organs with the Eight Concepts, there can be totally 80 basic functional kinds of diseases. Considering the degrees of every kind of diseases and their combination, there are surely more than one million logically possible kinds of diseases. Chinese medicine's explanation of symptoms actually is related to the classification into different functional sets. Of course, the task of making the classification is not a simple job. It needs technical knowledge and expertise also related to the suggestion of the therapy. Again, we can see that the model of functional-analogical explanation is applied to explain the symptoms in questions. The process can be summarize in the following way:

Explanans:

1. The classes of functions: a system of classification of diseases is related to the pathological changes of man's five internal organs and six hollow organs and the Eight Concepts mentioned above.
2. The characters of the class: the disease of deficiency of Yin in kidney has symptoms stated in question 2.

3. The characters of the individual in question: I have most of the symptoms stated in question 2.

Explanandum: Therefore, I have the disease of deficiency of Yin in my kidney.

If I ask the Chinese doctor a question, “What on earth is my disease?” I will get no answer. Because he does not have empirical tests and universal “causal” laws, and he consequently cannot make D-N or I-S explanation for my symptoms. In the end, the doctor writes out a prescription of “Liuwei dihuang Wan”, and tells me the daily dosage.

Question 3: Why can the medicine of “Liuwei dihuany Wan” cure my disease of deficiency of Yin in my kidney?

The explanation is based on the theory of Yin-Yang and Five Elements. According to the theory, Chinese doctor classifies medicinal herbs into two kinds (Yin’s on Yang’s), five kinds (Five Elements), and four kinds (the ascending, the descending, the floating, the sinking) and so on. Then, after having ascertained the classification of the medicine as “Linwei dihuang wan”, he states that the medicine has the effect to nourish Yin and to enrich the energy in kidney. Because of “Sheng” and “Ke” among the Five Elements, the medicine which I have taken can help my body recover dynamic equilibrium.

Putting a phenomenon into a certain class, and then using the universal characters of the class to explain or predict characters of the phenomenon, was a common way to understand the world in early human history. And it also existed later on in other historical times. The value of this kind of explanation depends on whether the classifications are proper, and whether the supposed universal characters of a class are applicable to all the individuals. If they not, it will be dependent on the degree of the applicability, and on whether the phenomenon to be explained belongs to the class. The key problem is how to make classifications, and what is the role of the functional classification in various classifications.

Let us consider the following three kinds:

1. Natural Kind/Class. It is a set of elements which have common characters, P_1, P_2, \dots, P_n , checked through analysis and experiment. Separated, each of the characters is necessary for the set, while united, the whole of them is sufficient for the set and having all of them is a sufficient condition for the elements to belong to the set. Therefore, the common characters can be used to define the class. Certain atoms, certain molecules, or certain species can all be taken as natural kinds. For example, all molecules of water (H_2O) have the same basic properties under the same conditions. The statement, “All water freezes at $0^\circ C$ ”, can explain the phenomenon, “Today water in this lake freezes”. For natural kinds, classification explanation is actually a form of the D-N model. The explanation is deductive.

2. Class through Family Resemblances. The concept of “family resemblances” is due to Wittgenstein [14]. According to him, the members in a “family” have no common characters, but there is a complex net of overlap of similarities. For example, mixture, earth, furniture, ship, and the most typical one “game” are all concepts belonging to such classes. Zhang Zhilin, one of the authors in this paper, finds out something similar to “essences” (it is better to call them “quasi-essences”) from Wittgenstein’s concept of family resemblances. They are common characters of most members in the same “family”, or characters in the core of the net of family resemblances [16, p. 46]. Because of the quasi-essence in the class with family resemblances, when someone gives a family resemblance explanation to the characters of certain phenomenon, he cannot deduce the characters of the phenomenon from characters of the class. However, he can use induction with high probability to support his explanation. For example, when he explains somebody’s death, he states that because the person had a serious disease he died. Such a serious disease is a class with family resemblances, and most members in the class have a common character of death. Many of I-S explanations belong to the explanation of class with family resemblances.
3. Functional Class through Intuition. Because the class is based on intuition, analogy, and conjecture, it is not at the same level as the natural kinds. In this class, there are no common characters for all of its members, or for most of them. As a result, the ability of explanation based on functional class is not high. In comparison with the above two explanations, this one only has supports from weak induction and reasoning from analogy. This is why using the theory of Yin-Yang and Five Elements to explain Qin Dynasty’s victory is farfetched. However, before people can make D-N and I-S explanations, the explanation based on functional class through intuition is a primary alternative of explanation after all.

3 The Explanation Based on Yin-Yang and Five Elements

How to value the rule of functional-analogical explanation based on Yin-Yang and Five Elements in the development of Chinese science and technology is a big problem. In this paper we try to answer Joseph Needham’s famous difficult question, and criticize some trends in the Chinese culture of science and technology.

1. The model of functional-analogical explanation has both positive and negative effects on Chinese science and technology. Chinese people have accumulated vast knowledge about nature and technology in the history of civilization. At some stage of the development of knowledge, theoretical explanations

have to be formed. As a system of analogy, classification and arrangement of phenomena, the research tradition of Yin-Yang and Five Elements was and is very helpful for Chinese people to systematize their experiences and knowledge, and to accumulate and develop them. For example, when people applied the theory of Yin-Yang and Five elements to make pills of immortality, their actions unintentionally lead to the invention of powder. The theory is also essential for Chinese medicine. It seems that up to now, no alternative can be found to replace the classification system of Yin-Yang and Five Elements which can classify both diseases and traditional Chinese medicine to make appropriate and effective correspondence between the two and produce the effect that traditional medicine can not go beyond. Furthermore, the research tradition of Yin-Yang and Five Elements has the advantage to offer a philosophy of nature in terms of wholeness and of dynamic equilibrium. This holistic perspective is helpful from many respects.

However, the research tradition, on the whole, is out of date, for it is intuitive and not experimental, synthetical and not analytical, conjectural and not logical. The concepts of Yin, Yang, and Five Elements all are intuitive, they have no clear definition, and even they cannot be defined. For example, the concept of "Metal" refers to metals, gold, autumn, and dryness, etc. It has so many different meanings that you cannot define it. How to use logic with these ambiguous concepts? Reasoning in this tradition depends on conjectures and imagination, and it is neither inductive nor deductive. Why does liver belong to Wood? How can you infer that "liver produces veins" from "Wood's ability to grow"? Why do we say it belongs to Wood? Is not there wood which is sweet or bitter? The theory of Yin-Yang and Five Elements cannot answer these questions. Because of the lack of conformity to logical requirements, it may more easily lead to absurdities such as seeking human body's immortality and practicing divination. Moreover, as we already said, all the basic theories of Chinese medicine based on the ideas of Yin-Yang and Five Elements are not set up by experimental methods. Because Chinese medicine cannot explain how moisture reaches bladder through intestines, it has to fabricate the organ of "Sanjiao" as a passage. And it states that there are "Jing" and "Qi" breathed in and out the human body, and that some part of them circulates through all internal organs and the other part circulates in the whole body through fictitious channels. All these have not been verified by experiments.

We can conclude that the lack of analytic spirit and the lack of experimentation is the fatal disadvantage of the research tradition and the explanation model of Yin-Yang and Five Elements. "Lack of analytic spirit" means lack of methods of analysis and induction to discover true laws in terms of cause and effect. "Lack of experimental spirit" does not mean that Chinese philosophers of nature and technicians do not have anything to do with experimentation and empirical results. Indeed, it is well known that in order to ascertain the healing properties of various herbs, Shen Nong ate them and was poisoned by toxic herbs for seventy times in a day. In Tang Dynasty, alchemists who

tried to make pills of immortality did a plenty of experiments, and having blown up many people and buildings, they unintentionally invented powder. Shen Nong and these alchemists are all good experimentalists. However, the non-experimental and anti-experimental spirit represented by the theory of Yin-Yang and Five Elements is: (i) There is no such systematic experimental approach to reveal causation, by which scientific experiments can be designed and done; (ii) theories are not designed to be testable or falsifiable; and (iii) experimentation is not taken as the criterion of truth even if propositions and theories can withstand empirical tests. In this sense, we hold that the research tradition lacks the experimental spirit. What they do at most belongs to the context of discovery, but not to the context of justification.

2. Joseph Needham's difficult question may be answered by checking Chinese research tradition. In his study of the history of Chinese science and technology, Needham in 1938 raised a question which afterward was expressed in the following way: "Since Chinese people made so many achievements of science and technology in early time, why did not they develop modern science?" [10]. We hold that the Chinese research tradition for a long time was too indifferent to scientific experiments, to analytical and inductive methods, and to strict logical reasoning. In China there is no sufficient changes in scientific methodology able to create and promote a full interest in experimental method, in analysis, and in mathematical and logical tools. It is well known that modern science in Europe began with a "revolution" in which the experimental method, the practice of induction and deduction, and the exploitation of mathematical tools, became central. Galileo, Bacon, and Descartes violently discussed the cognitive value of the Aristotelian tradition and the kinds of "explanations" related to it.

On the other hand, the Chinese research traditions is specifically stubborn. Although some thinkers, such as monists in pre-Qin Dynasty and Wang Chong in Han Dynasty, were skeptical about it, no new research traditions had been set up. Intuitive-functional-analogical method and explanation model may be helpful for science research, but if this method and this model stay at the core of the research tradition, there is no room for modern science. Therefore, we think that the following Einstein's statement is the correct answer to Needham's difficult question, "The development of Western Science is based on two great achievements, the system of formal logic invented by ancient Greek philosophers (in Euclid's geometry) and the possibility to find out relationships between cause and effect through systematic experiments (on the period of the Renaissance). In my point of view, it is not surprising that Chinese sages do not step into the two" [2, p. 574]. It shall be noted that the reason why the sages cannot do that task is that because their minds are dominated by the research tradition of Yin-yang and Five Elements.

The Needham's question presents another aspect. Since modern science only developed in European civilization, but not in Chinese culture, why was

Chinese civilization much more effective in obtaining knowledge of nature and applying it to human practical needs in the period from 100 B.C. to 1400 A.D.? [9]. Since we are not historian of science, we cannot use many historical facts to answer the question. But we can suggest some remarks. When it is said that Chinese science and technology surpassed Western counterparts, this mainly refers to technology, such as in the case of the invention powder, compass, and printing. Although there is a close relationship between scientific and technological knowledge, they are two different ones at all, they often had and independent life. Knowing how without knowing why is certainly possible. Chinese traditional focus of science and technology on practical results is related to disregard the theoretical aspects of science. This is the reason why modern science did not appear in China. However, it is not surprising that the focus on practical aspects generated those many results of Chinese technology that surpassed Western ones before the fifteenth century.

3. We do not think we have to give up the functional-analogical explanation model of Yin-Yang and Five Elements. What we have stated above does not mean that the model has to be eliminated. What we mean is that the model is a primitive or auxiliary way to know the world, and that it cannot occupy the key position in a modern system of science. We strongly maintain that the research tradition of Yin-Yang and Five Elements should have space to continue to develop freely. It is still helpful to diagnose and to choose and make therapies in Chinese medicine. We think that three kinds of medicine, Western (modern), Chinese (traditional), and the combination of the two should be developed at the same time. In the combination of the two traditions, the Chinese one can be a great treasure.

However, we should distinguish between the medical technical knowledge on hers, acupuncture, qigong etc. and its philosophical basis, the explanation model of Yin-Yang and Five Elements. Furthermore, we disagree with the obscure statement that Chinese medicine is holist while Western one reductive. Finally, we certainly also disagree with Qian (1996), who thinks it is necessary to abandon the science of life based on modern Western medicine, and focus on a Chinese theory of medicine enhanced by Marxist philosophy in a core position. He thinks this can reestablish a correct science of human body, which he calls "Somatic Science". Furthermore, he also maintains that the research of Qigong and extrasensory perception is the key to open the door of science of human body, and that this research can lead to a new scientific revolution. Of course we are not opposed to the freedom to make research on this "science of human body". It is a pity that we could not discover the publications in the field.

Acknowledgement. The research work of this paper is supported by China's major Research Base of Philosophy of Science and Technology, Shanxi University, Taiyuan, China (No. 04JZD0004).

References

1. Dupré, J.: Natural Kinds. In W.H. Newton-Smith, ed., *A Companion to the philosophy of Science*. Blackwell Publishers (2000)
2. Einstein, A.: *Einstein's Works*, Vol. 1. Business Press, Beijing (1976)
3. Feng, Y.: *New History of Chinese Philosophy*, Vol. 1. People's Press, Beijing (1983)
4. Hempel, C.G.: *Aspects of Scientific Explanation and Other Essays in the Philosophy of Science*. The Free Press, New York (1965)
5. Hou, W., Zhao, J., Du, G.: *History of Chinese Thought*. People's Press, Beijing (1957)
6. Laudan, L.: *Progress and Its Problems: Towards a Theory of Scientific Growth*. University of California Press, Berkeley (1977)
7. Nagel, E.: *The Structure of Science*. Hackett Pub. Co., Indianapolis (1979)
8. Needham, J.: *Science and Civilization in China*, Vol. II. Caves Books. LTD. (1985)
9. Needham, J.: Science and society in the East and the West. *Magazine of Nature* **12** (1990)
10. Needham, J.: Preface. In G. Wang, *Needham and China*. Shanghai's Popular Science Press, Shanghai (1992)
11. Qian, X.: *Free Talk about Science of Human Body and Development of Modern Science and Technology*. People's Press, Beijing (1996)
12. Ren, Y., Liu, C., eds.: *Collected Essays on Inner Classics*. Hubei People's Press, Wuhan (1982)
13. Wang, G.: *Needham and China*. Shanghai's Popular Science Press, Shanghai (1992)
14. Wittgenstein, L.: *Philosophical Investigations*. Translated by G.E.M. Anscombe, Basil Blackwell, Oxford (1967) 3rd Ed.
15. Yin, H., ed.: *The Fundamental Theory of Chinese Medicine*. The Science and Technology's Press of Shanghai, Shanghai (2000)
16. Zhang, Z., Chen, S.: *Anti-essentialism and The Problems of Knowledge*. Guangdong People's Press, Guangzhou (1995)