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Analysis of the Fundamental Prerequisites for Scientific Research

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Abstract **Review Article**

Scientific research is a special kind of activity, aimed at understanding the world and exploring the law of things. Therefore, researchers can't do a fruitful job without certain prerequisites: either objective or subjective. The basic objective prerequisite is that researchers must be free both physically and mentally; the subjective prerequisite is that researchers must have the spirit to doubt, the interest in research, wonderful ability to think abstractly and a knowledge structure in T shape.

Keywords: Scientific Research, Freedom, Doubt, Ability to Think, Knowledge.

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INTRODUCTION

From the perspective of the relationship with the thing being discussed, or in terms of form, conditions can be divided into internal conditions and external conditions, while from the perspective of content, they can be divided into subjective conditions and objective conditions. As for conducting research, the external and objective conditions, as well as the internal and subjective conditions, basically overlap, because the subject of studying is humans. This article discusses the objective conditions for conducting research, namely external conditions, while emphasizing the subjective or internal conditions. To put it more clearly, it focuses on exploring the basic psychological qualities, thinking abilities, and knowledge structure that researchers should possess. This article only analyzes the most basic conditions for scientific research to proceed normally and achieve results, without discussing the specific research methods, skills, and academic ethics that researchers should master.

I. Objective Conditions for Doing Scientific Research: Researchers Should Have "Freedom"

The "freedom" that the author talks about here has two meanings. It is not the kind of freedom in the sense of "the understanding of objective inevitability and the transformation of the objective world", but a state that has no worries about food and clothing, is not burdened by livelihood, and does not run about for survival. It is the physiological freedom that the basic life needs of researchers can be satisfied anytime and anywhere, as well as the psychological freedom or ideological freedom that a researcher is not influenced by a specific ideology and can basically maintain value neutrality. Aristotle said that researchers should have "leisure" and "freedom". His so-called "leisure" is not leisure with nothing to do, but leisure after the basic needs of life are met, which is in fact what the author calls physiological freedom; what he called "freedom" is roughly equivalent to freedom of thought.

Before demonstrating that researchers should have 'freedom', we must also make clear the meaning of "research" here. The word research has two meanings. The first meaning is to explore the truth, nature, laws, etc., of things, and the second meaning is to consider or discuss (opinions, questions) [1]. In this paper, the word "research" takes the first meaning mentioned above. In extension, "research" includes scientific research, philosophical research and so on, but their boundaries are also relative.

Generally speaking, research is a kind of human practice. Human beings have all kinds of needs, and need is human nature. In order to meet the needs, human beings must carry out all kinds of practical activities. According to the Marxist point of view, the basic forms

[1] See Dictionary Editing Office, Institute of Linguistics, Chinese Academy of Social Sciences, *Modern Chinese Dictionary*, Beijing: The Commercial Press, 2002, p. 1447.

of human practice are production practice, social communication practice and spiritual and cultural creation practice with scientific experiment as the main content. Production practice is a practical activity for human beings to transform nature in order to obtain material goods; social communication practice is a practical activity for people to transform society to deal with interpersonal relations, which is mainly manifested as the struggle between opposing classes in class society; scientific experiment is a practical activity for human beings to explore the objective laws of nature and human society and to develop science and technology. This is a scientific experiment in a broad sense, which is synonymous with scientific research. Scientific experiment or scientific research is not a production practice, nor is it directly related to the production of material goods that satisfy people's clothing, food, housing and transportation, nor is it social communication practice, so only when the basic life needs of researchers are met and have physiological freedom, will they not be forced to slide from activities mainly engaged in scientific experiments to production practice or social communication practice. Only then is it possible to concentrate on scientific research without distractions, and to produce more results and good results.

The basic purpose of scientific research is to seek truth and to understand the world, so one of its most important characteristics is objectivity. "The objectivity of scientific research means that any researcher, no matter which class, party or religion they belong to, can draw the same conclusion as long as they adopt the same scientific method." [2]. The objectivity of science requires researchers to be based on empirical facts, pay attention to "commitment to evidence", exclude the intervention of subjective factors as far as possible, remain neutral in value, and cannot be based on value judgment. scientific research for the purpose of understanding the world cannot be turned into an activity for the purpose of experiencing the world. Practice has social historicity, so scientific research as practice is not an individual behavior, it is restricted by social and historical conditions and is social. Therefore, in order to ensure the objectivity of scientific research, especially social science research, society should provide a loose and democratic academic atmosphere for researchers, eliminate the soil that produces "academic hegemon", and the state should improve the management system of archives and other first-hand materials. Do not set value orientation for researchers, do not let scientific research fall into an ideological trap, support and encourage academic criticism, and truly let different opinions and findings contend. Make the academic get rid of the passive dependence and obedience to politics, and let the researchers enjoy more full freedom of thought. Of course, the "freedom of thought" mentioned by the author here is only an ideal state, especially for social science researchers. Because, subjectively, there is no final conclusion on the class nature of social science; objectively, because of the heterogeneity and consciousness of its research object, it is generally difficult for researchers to get rid of the influence of ideology as well as their own culture and values. But scientific research procedures and methods can greatly reduce this impact.

II. The First Subjective Conditions for Doing Scientific Research: Researchers Should Have a Skeptical Spirit

The spirit of doubt has two meanings: first, when something happens, you like to think about what, why, and how, and you like to ask questions; second, you have a certain degree of self-confidence and academic courage, not superstitious about authority, and dare to adopt new perspectives and decisively put forward new ideas.

Science and philosophy are inseparable. Science originally appeared in the form of philosophy or was mixed with philosophy. Later, science was differentiated from philosophy, so the word "science" derived from Japanese means "separate disciplines of learning." Both Plato and Aristotle said that philosophy begins in wonder. Wonder means doubts and questions. To question itself is philosophical. Philosophy is a collection of questions that are inconclusive and have no definite answers. If a certain discipline gives clear answers to questions, its research field will be delineated accordingly, and it will break away from philosophy, gain independence and become science. "The main feature of science, whether it is humanities and social sciences or natural sciences, is to answer questions like 'what is this' or 'what is that'." [3]. Therefore, science stems from problems, and science can only exist if there are problems. Science calls for a spirit of doubt.

The spirit of skepticism has an epistemological and methodological foundation. From an epistemological perspective, any truth is the unity of absolute truth and relative truth. Absoluteness and relativity are two different aspects of the same truth. Although any truth is absolute, that is, it marks the consistency of subjectivity and objectivity, and contains objective content that does not depend on man and man's will, due to the limitations of historical conditions, truth can only be a limited understanding of finite things and limited levels of finite things in the infinite universe, and therefore is concrete, historical, and relative. For example, Lenin's discourse on capitalism can no longer explain the modern capitalist society, and a new theory is needed. The relativity of truth reflects the openness

[2] Yuan Fang, *A Course in Social Research Methods*, Beijing: Peking University Press, 1997, pp. 16-17.

[3] Hu Jun, *What Is Philosophy?* Beijing: Peking University Press, 2002, p. 13.

and self-development requirements of science, which is the vitality and advantages of science.

From a methodological point of view, science "begins with problems and contradictions formed by the interaction between observation and theory," and "the logic of scientific inquiry is: to ask questions → to solve problems → to raise new questions." [4]. Based on this, Pope proposed the famous hypothesis testing method or "trial-and-error method". The hypothesis test can be summarized as follows: P1→TT→EE→P2.... P1 stands for "Problem 1"; TT stands for "Tentative Theory"; EE stands for "Elimination of Error"; P2 stands for Problem 2. This formula was summarized on the basis of his in-depth study of scientific development through the ages. According to Popper, all science is inseparable from four organic links: (1) Science begins with problems, and problems make scientists think persistently; (2) To put forward hypotheses or theories through thinking and bold speculation in response to problems; (3) Fierce competition among hypotheses, criticism of each other, and examination by observation and experiment; On this basis, errors are eliminated and new theories with higher truth degree are selected. (4) Apply new theories to practice and constantly undergo various tests. With the in-depth development of practice and science and technology, new problems will appear, and the original theories cannot solve new problems. In short, the process repeats, and the fourth link seems to return to the first link (question 1), but this is definitely not a simple repetition, but standing on a higher starting point.

In short, science originates from questions, scientific truth is relative and open, and scientific research begins with questions. Therefore, scientific researchers should have the courage to ask questions and doubt boldly to promote the development of science more effectively.

However, the skeptical spirit of science is fundamentally different from extreme skepticism, which can lead to suspicion of everything and close the mind to explore; or deny people's ability to understand the world and the objectivity of scientific knowledge, thus moving towards anti-science. The spirit of scientific doubt is to solve new problems, that is, to "boldly hypothesize, carefully verify" as the inevitable follow-up, and is based on the purpose of innovating the new, developing science, and understanding the world.

III. Subjective Condition Two: The Researcher Should Have Scientific Research Interest and Strong Abstract Thinking Ability

Scientific research is an activity of seeking inevitability from contingency, discovering the essence of things through the phenomena of things, and rising from sensibility to rationality. Things are ever-changing and complex, exploring the law of cause and effect of things, finding or constructing the intrinsic relationship between things is not done overnight, but requires researchers to observe and think continuously for a long time. If the researcher does not have a high enthusiasm and interest in the content of the study, he will not only be a coward in practice but also a lazy person in thought, and he will be very susceptible to external interference and therefore it is difficult to achieve satisfactory research results. "As Einstein said... laws can only be obtained by intuition and the professional passion of the researcher." [5].

Researchers must read a large number of books and materials when doing scientific research, but if they do not have strong abstract thinking skills, they will have difficulty truly digesting and absorbing what they read, thus turning the knowledge they have learned into knowledge that is partially understood, which is dangerous. Some people have a lot of knowledge, but because of their poor abstract thinking ability, they do not understand the connections between knowledge, so they can not turn knowledge into power and innovation, but only use it to talk. "Napoleon once said that reading is only to provide us with some material of knowledge, and it is thinking that turns what we read into our own." [6]. The thinking here mainly refers to the use of abstract thinking. Reading books and materials is a silent dialogue process with the author, which is a critical process. It is better to have no books than to believe in all in books. "Real science is essentially critical." [7]. However, criticism, especially criticism of academic works, requires the use of critical thinking. Critical thinking focuses on the analysis of the validity of arguments, so it is essentially abstract thinking. Researchers sometimes have to experiment, observe, but it is more important to think in the process of observation, to raise the perceptual concrete to the abstract thought, and the abstract thought to the concrete thought, because we do not quickly understand what we feel, and only what we understand can we feel well.

The results of the research are usually presented in language in the form of a paper. Language is the externalization of thinking, and thinking plays a leading role in language, so thinking plays a decisive role in

[4] Liu Dachun. General Introduction to the Philosophy of Science. Beijing: China Renmin University Press, 1998, pp. 262-263.

[5] Yuan Fang, *A Course in Social Research Methods*, Beijing: Peking University Press, 1997, p. 100.

[6] Dennis H. Long, *The Wisdom of Power*, Compiled by Wang Xiaodong, Beijing: Democracy and Construction Press, 2002, p. 297.

[7] A. Minor, *Introduction to Methodology*, Translated by Wang Lu, Beijing: Sanlian Bookstore, 1991, p. 63.

research papers. Generally speaking, a good paper should be reasonable, substantial, orderly, and well written. The writing of research papers is generally the last stage of research, so at this time, the idea and the material are basically not a problem, the key is the structure, that is, how to unify the idea and the material, and the key to solving this problem is abstract thinking. What about the issue of literary talent? Although it is said that "writing without literary grace will be difficult to be passed down for a long time", the writing of research papers is completely different from other articles. It is not prose or experience. Too much emphasis on literary grace will make the expression inaccurate or even ambiguous, thereby reducing the scientific nature of research papers. Of course, the language of research papers should not be colloquial. It is true that "a successful (research) paper should have a good foundation in grammar and writing skills, but what is more important is to have profound ideological connotations, detailed scientific textual research, strict logical reasoning and accurate scientific expression." [8]. Therefore, abstract thinking plays a leading role in the writing of research papers.

What is abstract thinking? "Abstract thinking, also known as logical thinking, is a thinking form that reflects the essence, relations and laws of things with abstract language and symbols." [9]. It mainly includes formal logic and dialectical logic, the basic form of which is concept.

Therefore, researchers should have a strong ability of abstract thinking.

IV. Subjective Condition Three: Researchers Should Have a "T" Shaped Knowledge Structure

Although "the core of intelligence is thinking rather than knowledge", [10], having the courage to ask questions, being diligent in thinking, and having strong abstract thinking ability cannot guarantee good thinking effects, and it does not mean that excellent research results will appear for researchers, because abstract thinking solves mostly formal problems, if there is no material or knowledge for content, thinking cannot unfold normally, which is like a clever woman who cannot make a meal without rice. Research is a kind of creative activity, and "experts point out that the efficiency of creative work is proportional to the amount of information obtained and processed" [11]. But do keen thinking and rich knowledge necessarily lead to good research results? In this case, it depends on what kind of knowledge structure the researcher has. Researchers should have a "T" shaped knowledge structure. This actually means that researchers should grasp the relationship between "extensiveness" and "specialization" of knowledge. The horizontal line of "T" means "extensiveness", which means that you must have multi-disciplinary and interdisciplinary selected knowledge; the vertical line means "specialization", which means that you must have in-depth knowledge of a certain profession. As a researcher, rich professional knowledge is essential, because scientific research is a professional activity, whose object is specific and clear. However, it is not enough for a researcher to study only one subject and do nothing else, he must also master a large number of core knowledge that is closely related to his specialty. "Specialization" should be based on "extensiveness", and "extensiveness "should be reflected by "specialization".

The world is universally connected, parts can be well understood only when they are placed in the whole, and professional knowledge can be well mastered and flexibly applied only when it is connected and compared with other knowledge. A thing is well explained only in relation to its kind and to the species to which it belongs. "Godel proved the theorem that the coordination and completeness of an axiomatic system must be proved by means of a more general system." [12].

With the development of modern science, there are many interdisciplinary disciplines, the links between disciplines are closer, and the boundaries between them are more blurred. In terms of research methods, interdisciplinary phenomena have also emerged, such as using natural science methods to study social science problems, using sociology, economics, psychology and other disciplines to study political science problems, using biological methods to study historical problems. The deeper the degree of "specialization", the more things that originally belonged to "extensiveness" need to be transformed into "specialization".

"The purpose of science is to discover, anticipate, and establish the real and possible interactions of objective things." [13]. Extensive knowledge is

[8] Tan Peiwen, Qiu Yongtian, Zhang Peiyan, *Writing Philosophical Essays*, Nanning: Guangxi People's Publishing House, 2000, p. 1.
[9] Zhang Min, *Thinking and Wisdom*, Beijing: China Machine Press, 2003, p. 42.
[10] Xia Xiao, *Thinking Training Course*, Beijing: China Machine Press, 2004, p. 1.
[11] Liu Shanxun, *Learning to Learn: Tips for Improving Performance*, Beijing: The Commercial Press, 2001, p. 113.
[12] Zheng Xiangfu and Hong Wei, *The Spirit of Science: A Study of Epistemological Problems in Contemporary Western Scientific Philosophy*, Shanghai: Shanghai Sanlian Bookstore, 2001, p. 169.
[13] Zheng Xiangfu and Hong Wei, *The Spirit of Science: A Study of Epistemological Problems in Contemporary Western Scientific Philosophy*, Shanghai: Shanghai Sanlian Bookstore, 2001, p. 61.

conducive to researchers to promote the development of internal contradictions of concepts through thinking, to form reasoning and demonstration, and to show the intrinsic connection between things. Extensive knowledge can stimulate the inspiration and wisdom of researchers, broaden their horizons of understanding, open their analytical ideas, and thus accelerate the process of problem solving and promote the development of science. "There is evidence that the fundamental reason why outstanding scientists and successful people have strong analytical and problem-solving skills is that they have abundant knowledge." [14].

If a researcher's knowledge is too narrow, then he may be rigid in thinking and stick to rules, and his existing knowledge will become his preconceptions when observing and analyzing problems. Therefore, he not only lacks the ability to raise high-level new questions, but also tends to get excited or surprised easily due to a lack of knowledge background. He may misunderstand as wrong what others are right, and even arrogantly "correct" them, making some worthless, seemingly profound but actually superficial arguments and publishing them as "scientific research achievements".

But "extensiveness" requires us to focus on key points, not to grasp everything at once, not to try to learn everything, but to read more high-quality works closely related to our profession. "Feuerbach says: 'Thomas Hobbes (1588-1679) read only very distinguished works, so that he read very few books, and he often even said that if he had read as many books as the other scholars, he would have been as ignorant as them'." [15]. "Extensiveness" also requires that researchers pay attention to knowledge updating, always pay attention to and grasp the new cutting-edge knowledge at any time, and strive to keep up with the pace of knowledge development.

V. CONCLUSION

Liu Zhiji, a famous historian in the Tang Dynasty, said: "People who write history books must have three specialties: talent, knowledge and courage. Few people in the world can have the three, so there are few people who study history very well." [16]. While this applies to the study of history, it also applies to doing research in general. The three subjective conditions for doing scientific research mentioned above are similar to what he calls courage, talent, and knowledge. The skeptical spirit is equivalent to "courage", the ability of abstract thinking is equivalent to "talent", and the "T"-shaped knowledge structure is equivalent to "learning". Liu Zhiji immediately talked about the relationship between "courage" "talent" and "learning", and believed: "A man who has learning but no talent is like a foolish fellow who controls gold and cannot grow goods; a talented man without learning is like a skillful craftsman who has no tools to build a house. Good and evil must be written, so that arrogant kings and their evil ministers can be afraid, which is the best." Here, he also advocated that history should be based on straight writing, not concealing evil or vain beauty. He emphasized the courage of history writers and seemed to require "courage" for scientific researchers. Yuan Mei, a Qing Dynasty man, also talked about the relationship between the three: "Learning is like a bow, and talent is like an arrowhead. Only by courage which leads an arrowhead can you be won."

[14] Rovding, *Training in Super Analysis*, Translated by Xu Shiming, Harbin: Harbin Publishing House, 2004, p. 35.

[15] Wang Zikun, *A Treatise on Scientific Discovery*, Shanghai: Shanghai People's Publishing House, 1978, p. 44.

[16] See *New Book of Tang*, Volume 145, Biography 57.