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The Significance of Horizon in Scientific Cognitive Activities

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The hermeneutic concept of horizon contributes to the philosophical understanding of scientific cognition. In the context of scientific cognitive practices, the concept of horizon provides a way of understanding the distinctive characteristics of scientific observation and knowing. Horizon is a key factor that facilitates the cognitive subject to select objects and their backgrounds. In order to make new accomplishment in scientific discoveries, it is essential to broaden the horizon and introduce new cognitive instrumentalities and methods. This requires people to be adept at finding out the limitations of their thinking and overcome them consciously. Conscious horizon expansion is essential to the integration of intuition and logical thinking process in scientific cognitive activities, as well as to the establishment of the essential connection/relation between different disciplines and research fields, prompting inter-disciplinary communication and producing methods of thinking. This article is an attempt to explore the significance of horizon for scientific cognition. As we will show, by integrating intuitive thinking and logical thinking through the expansion of horizon, a new cognitive model will be provided.

Keywords: horizon, scientific cognition, intuition, logic

The concept of horizon in hermeneutics has drawn wide interest among academics and is widely employed in hermeneutic and phenomenological research. For example, interpretations of the Bible are undertaken quite differently within the horizons of faith or skepticism. Phenomenological descriptions of aesthetic experience differ from those of politics. And the concept of horizon is also significant in scientific cognition. Not only is it relevant to the scope, profundity, and creativity in science, but it can also contribute to the understanding of the relationship between intuitive thinking and logical thinking. The features of horizon *per se* and its evolution are thus worth exploring.

1. Functions of Horizon in Scientific Cognitive Activities

In hermeneutics, horizon indicates “the framework or field vision within which one understands.” Understanding the history requires a historical horizon, and interpreting through it by historical being *per se* and the horizon of its past tradition instead of the contemporary criteria and prejudice (Bunning and Yu 2001, 447). According to Gadamer, every finite present has its limitations. We define the concept of “situation” by saying that it represents a standpoint that limits the possibility of vision. Hence, the essential part of the concept

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of situation is the concept of horizon. The horizon is the range of vision that includes everything that can be seen from a particular vantage point. A person who has no horizon does not see far enough, and hence overvalues what is nearest to him. On the other hand, “to have a horizon” means not being limited to what is nearby, but being able to see beyond it. Working out of the hermeneutical situation means the achievement of the right horizon of inquiry for the questions evoked by the encounter with tradition (Gadamer 1997, 302). Horizon in hermeneutics and phenomenology is concerned with text meaning with focus on the dynamic feature of horizon, excluding the specific account for the function of horizon in scientific cognitive activities.

With regard to scientific epistemology, not only does the horizon of scientific cognition refer to the range in which scientific observation activities are involved, but also it includes the range of theoretical thinking. It also has a link to objects of scientific cognition and such background elements as objects of scientific cognition including scientific knowledge, research experience, social and cultural environment. Robert Boyle, a British chemist, proposed that the establishment of matters of fact utilizes three technologies, i.e., a material technology, a literary technology as well as a social technology that refers to incorporating the conventions that experimental philosophers should use in dealing with each other and considering knowledge-claims (Shapin and Schaffer 1989, 25). At this point, something in common can be found between the horizon of scientific cognitive activities and that of hermeneutics along with some differences in that the object of the former is objective materials as well as their laws rather than texts in the sense of hermeneutics. The subject of scientific cognition selects its object by means of horizon, and places it in a certain background in order to examine the interrelationship between the object and the background things, and identify the essential features of the object.

Based on Norwood Russell Hanson’s ideas of the theory-ladenness of observation (1958), the more rational explanations can be given as to the fact that different subjects have different judgments on the basis of the identical observation materials. However, from the perspective of scientific cognition subjects, the ideas of the theory-ladenness of observation are insufficient to explain individual differences in judging under the same theoretical background. In the scientific world, scientists share their research achievements of theory and experiments with each other. Thus, scientists are able to obtain the latest theoretical development and discoveries from literature and dynamic information, but a few men make great theoretical breakthroughs on the basis of new observations and experiments. A significant reason is that the horizon of scientists is slightly different but significant. Some factors in thinking or psychology limit or broaden their horizon, making them ignore or pay more attention to those theories, hypotheses, or social backgrounds related to observation objects, which leads to the difference in their cognitive results. John Kepler (1958) discovers the law of planetary motion from investigating a huge amount of data in Tycko Brahe. Newton proposes law of gravity by linking the power of astrodome with that of the Earth that drives objects to fall down. Darwin puts forward theory of evolution, which advances predecessors. Their achievements are relevant to their broad horizon (Dampier 1958, 127-8; 153; 276-7). The cognitive function of horizon comes from a long-term accumulation of cognitive activities. It exists before each particular cognitive activity and initiates and becomes the prerequisite of exercising cognitive activities. This is what Martin Heidegger calls fore-structure of understanding (Heidegger 1996, 151). Experiment and observation seems to be objective. However, what comes to scientists’ horizon or what can be associated with the objects, and what background can be the basis for thinking, are all significantly subjective when scientists observe the same phenomenon. Obviously, those have a broad horizon manage to overcome predecessors’ limitations and think over problems by associating the object with more background things, including relevant phenomena, knowledge, research approaches, and even concepts as well as

evaluation standards so as to discern more features and significance of the object. Antoine Laurent Lavoisier is able to resist the effect of the Phlogiston Theory and discover oxygen on the basis of Joseph Priestley's experiments in that he is equipped with a broader horizon. As he said, "to link our knowledge about compounding air or releasing air from substances with other knowledge that has been obtained to form a theory, I have ever suggested all experiments be re-conducted by new effective measures" (Mason 1977, 287). Similarly, Rumford is not swayed by the Caloric Theory, but proposes Mechanical Equivalent of Heat, and this also happened to Einstein who escapes from the effect of the Ether Theory and raises the Theory of Relativity. Both of them have a new horizon that differs from their predecessors', preventing previous theories from setting a limit to the explanation of scientific facts.

Different horizons can influence the understanding of each other. Various cultural environments, life experience, knowledge structures, and psychological features make horizons vary. It seems impossible to understand other people's horizon completely. In many aspects, scientists have a lot in common including the same structure, value standards, and the way of thinking, which makes their horizons partially identical and enables them to reach an agreement on the paradigm of scientific research and on many problems, while the differences in their horizons cannot be eliminated. Some scholars always feel confused when they are discussing about many Western scientists who have religious beliefs. For instance, Newton in his old ages immerses himself in annotating Christian masterpieces. However, religious awareness is an indispensable part of many Western scientists' horizon. Shapin et al., disclose the academic life and horizons of Hobbes and Boyle in their book *Leviathan and the Air-Pump*, restoring the relationship between the polity and scientific experiments as well as the relationship between "philosophical space" and "experimental space," which could be distinct from what modern readers think about pure philosophers and scientists (Shapin and Schaffer 1989, 107; 113). In most cases, there is likelihood that the horizons of those great Western scientists cannot be clarified since our imagination comes from our own horizon.

Horizon regulates the depth and breadth of scientific cognition which is not thoroughly concerned about the objects *per se*, but reflects the process of interpreting the property and significance of cognitive object in a certain horizon. The deepening of understanding indicates how profound the essential association between cognition objects and background is, which requests horizon to be considerably abstract with a general structure. The broadening of understanding indicates how extensive cognitive object and background link with each other. This means that horizon possesses a tremendous thinking space and requires cognitive subjects to own strong associative abilities. The existence of horizon conceals the things outside the horizon, which is often referred to as "unexpected," while horizon experiences continuous changes in thinking process, and those changes can be adjusted consciously. Thus, the changes of horizon are likely to be a process of unconcealing. Due to the introduction of new elements, thinking conflicts in the previous horizon arrive at reasonable explanations, in other words, it comes into the feeling of "I got it." New elements can also generate innovative association and inspiration, discovering the new relationship between things. David Hilbert in his speech of "Mathematical Problem" mentions that the further mathematical theories develop, the more coherent and harmonious mathematical structures will be. And some unexpected relations between consistently isolated branches in this subject will manifest (Reid 1970, 103). To find those relations, it is necessary to have a deep and broad horizon. Although in the research of mathematics and natural sciences, the cognitive results from logical reasoning and scientific experiments are not questionable; neither will they change due to horizon extension. However, viewing the cognitive results that have been achieved in a wider horizon is possible to lead to more general

principles and laws.

The previous research into scientific cognition has not attached enough importance to horizon, as the major method adopted in the research of scientific epistemology is logical analysis which is generally a process of making the particulars revealed or dividing into particulars (Prigogine and Stengers 1984, 5), where cognitive objects increasingly shrink at the spatial scale, and are investigated independently apart from the background. Horizon is changed accordingly simultaneously, and the main tendency is being narrowed constantly. There could be horizon broadening due to the introduction of new concepts, theories, and methods from other subjects and discovering new relations with other subjects. In this case, broadening horizon is restricted by the need of sharp logical reasoning, and the change of horizon does not serve as the prominent element in cognitive activities. The change of horizon is often influenced by non-logic cognitive elements, for instance, sub-consciousness, emotion, intentionality and intuition, which are seldom involved in the cognitive framework of logical analysis. Nevertheless, horizon plays a vital role at the original stage of scientific cognition, since it to a certain extent determines the direction and development space of scientific cognitive activities, and consequently influences the success or failure of scientific exploration. Therefore, the features of its evolution should be highly valued.

2. Evolution of Horizon in Science

The evolution of horizon in scientific cognitive activities includes broadening, contracting, transferring, and fusing. The broadening of horizon means taking the factors that have been never thought over before into consideration and finding out new relationships with the original cognitive object. The contracting of horizon is to rule relevant factors once taken into account out of horizon, narrowing down thinking scope consciously or unconsciously. The transferring of horizon means shifting from the original one to the new one. And the fusing of horizon is to combine the original horizon with the new one, which either comes from the horizon of predecessors or adopts coetaneous one. The fusing of horizon is also considered to be a sort of expansion in terms of thinking space. The change of horizon indicates that scientists as the cognitive subjects vary their horizons simultaneously along with the change of starting points and perspectives of their thinking. Newton’s famous saying “If I have seen a little further, it is by standing on the shoulders of giants,” implies the fact that only by accurate grasping the research starting point of cognitive object, its background factors and conscious adjustment research perspective can horizon achieve rational revolution in scientific cognitive activities.

The evolution of horizon in scientific cognitive activities has a close link with research experience and knowledge accumulation. As research experience and knowledge are increasingly abundant, people’s horizon broadens gradually. However, the piling up of experience and knowledge does not necessarily result in horizon broadening since the key point is whether experience and knowledge background can be related to the present cognitive objects in order to truly change the process and outcome of cognitive activities. The broadening of horizon to some extent depends on whether obstacles for broadening can be overcome consciously. Many a factor is thought to cause horizon fossilization, such as superstition on traditional ideas, the blind obedience to authorities, being accustomed to the isolated, static, and one-sided way of viewing problems, sticking to previous experience and methods and so forth. What can be taken into the horizon is what is expected to see, while what is unwilling to see is always neglected. Intentionality can define or intensify the horizon. Emotion and mental status can influence the horizon broadening. Although scientists are highly rational, they cannot avoid the impact of intentionality and emotional factors on the horizon. The history has seen some scientists

who defend pseudo-science or events for political reasons, which violates their wills, but accords with their horizons that they are in. The difference in horizon also has an effect on the public understanding of science. In the early 1970s, China experienced the farce of "criticizing" relativism of modern physics. The fact is that the scientific knowledge at that time was limited to the scope of classical mechanics without understanding of relativism at all. And their supporters' knowledge horizon was much narrower (Yan 1993, 194; 436-76). Similar criticism happened to "academic authorities" at that time is also due to the problem of horizon.

On the basis of the discussion above, to broaden the horizon consciously, it is essential to be adept at finding thinking limitations and surmount them consciously. An important method of overcoming thinking limitations is to inquire the unreasonable, illogical part in cognitive achievements. People sometimes feel confused something that should not have happened take place eventually, or something that should have happened does not occur, which is possibly due to the problem of observing horizon. Thus, it is suggested to discover the factors that have never been thought over before in favor of horizon extension. Some theoretical systems have intrinsic contradictions, which fails to be explained reasonably. And it is much likely that some deep and pressing problems have not been resolved. Hence, it is necessary to adjust research horizon so as to seek out a deeper and broader framework of interpretation. To reach a reasonable explanation by positive searching for relevant factors apart from horizon naturally leads to horizon extension. The ability of broadening horizon in some sense can be trained. People working for the same scientific research institution or team have different horizons due to the important influence of that subjective initiative. The horizon is probably confined to their knowledge structure and work scope, which can be gradually broken through by knowing more about the knowledge and information outside. The real extension of horizon depends on external stimuli, including the understanding of key information, the advice from others, and the inspiration from related areas. An important role that academic communication plays is to promote the broadening of scientific researchers' horizon. Undoubtedly, the broadening of horizon cannot be casual. The broadened horizon ought to be necessarily correlated to the object, and the discovery of its new significance and values can be achieved indeed. Casual broadening horizons cannot generate any meaningful result.

What is also worth noticing is that sometimes it is necessary to shrink or move the horizon consciously. Remaining in outdated, backward, and narrow horizons fossilizes scientists' thoughts, and finalizes their academic life. In terms of the "knowledge aging" discussed often, knowledge *per se* cannot be "aging;" "aging" merely happens to horizon. The innovation of horizon resembles the process of metabolism. Virtuous broadening of the horizon ought to be open, vigorous, and sustainable.

The revolution of horizon in scientific cognitive activities is similar to the scientific view of social constructivism in terms of thinking characteristics. Specifically, sociocultural factors are introduced into interpreting the process of constructing scientific theory by changing researching starting points and research perspectives to gain the new understanding of scientific essence and its influence on the society, such as feminist epistemology of science, Rorty's science view of post-modernism and virtue epistemology, virtue epistemology and so on and so forth. However, the evolution of horizon in scientific cognitive activities is related to the exploration of objective scientific knowledge alone, and thus, it has universal significance in "scientific community" without causing multi-understanding and value judgment on science *per se*.

3. Horizon as the Mediation between Intuition and Logic

Another aspect of horizon in scientific cognitive activity is that it works as the intermediary of intuition

and logic, and plays a role in integrating these two kinds of thinking process to achieve complementary advantages. The investigation into this function of horizon contributes to transplantation and penetration of thinking methods between different subjects, which further develops the creative abilities of science.

In the scientific cognitive activities, intuition and logic have long been viewed as two distinct thinking processes, and can be incommensurable. “Intuition” originally refers to the thinking activity that depends on looking into the essence of things straightforward instead of logical deduction. Not a few authorities consider intuition thinking to be non-logical, thus, it cannot be analyzed by logical thinking. Intuition, as a mysterious and psychological activity, generates creative ideas, although it is implicit. Many scientists have ever discussed the significance of intuition thinking in their scientific studies. As Einstein says, “There is no logical way to the discovery of these element laws. There is only the way of intuition, which is helped by a feeling for the order lying behind the appearance and this *Einfuehlung* is developed by experience” (Xu et al., 2009, 10). However, how to cultivate intuition thinking and make use of intuition thinking are always subjective without any relation to logic. This is due to the fact that the intermediary connecting of these two thinking ways was neglected in the past, that is, the change of horizon in cognitive activities.

From the perspective of horizon change, both intuition and logic have a link with horizon. But they represent different change tendencies of horizon separately. The former continues to expand, while the latter is relatively stable with constant contraction. They are directed at the understanding of the essence of things with disparate occasions and functions. The logical thinking in scientific cognitive activities pursues stringency and accuracy, requiring the synthetic understanding of the details of objects along with rigorous reasoning. The horizon of logical thinking in most cases remains relatively steady in which horizon contracts unceasingly in the process of logical analysis. Intuition thinking shows its value without direct use of logical analysis. In the preliminary stage of scientific cognitive activities, it fails to fully obtain the information about objects, and it is difficult to grasp the attribute and development tendency accurately and judge the significance and value exactly. In order to propose scientific hypothesis timely, determine the research direction, and arrive at the essential property of things as soon as possible, it is essential to employ intuition thinking. Although intuition thinking does not rely on explicit logical analysis and deduction, it seems to accomplish within seconds. Rather, it is a considerably complex process, which can only be detected by observing its horizon change.

Intuition thinking needs sufficient knowledge reserve. In different horizons, objects, and relevant backgrounds have different relations to various significance and values presented. The essential property of these relations serves as the materials of intuition thinking that are stored in people’s experience and knowledge accumulation. When intuition thinking is employed to interpret and judge unknown objects, these cognitive materials will be selected, connecting the information and knowledge about unknown things. And the concept model for interpreting the essential property of unknown things is constructed rapidly and modified constantly, which obviously demands the sustainable extension of horizon. Many authorities have stated the importance of utilizing metaphor and analogy. The function of metaphor and analogy can be seen from appropriate selection of the property of object that is similar to that of unknown object in order to construct the concept model for interpreting the essential property of unknown things (Guo 2007, 55-56). After all, the essential property between analogous things in most cases is significantly similar. Thus, metaphor and analogy are employed to establish and improve the interpretation model of cognitive objects, which allows us to approach the understanding of the essential property of things as soon as possible and leads to noticeable improvement of thinking efficiency. The key of intuition rests in whether objects are situated in an appropriate horizon, whether

previous thinking resources are fully used and the appropriate adoption of metaphor and analogy are picked up swiftly to construct and improve interpretation model, which symbolizes the levels of intuition thinking.

Many scientists trust their intuition concerning scientific assumptions and hypotheses, and they do not take it as an absolutely reliable basis. Since intuition thinking can lead to creative assumptions, as well as bias and fallacies, the horizon of intuition thinking is uncertain in the beginning, so things can only be considered in certain aspects with its properties in certain conditions and situations in certain temporal periods. This is likely to trigger one-sided generalization or intrinsic contradiction involved in achievements that is often covered by emotionalized intentionality. At the moment, thinking cannot go smoothly, which calls for adjusting the way of thinking and changing metaphor and analogy in order to eliminate shortcomings of interpretation model. Here, it is the implicit function of logic thinking that normally cannot be detected.

In the course of intuition thinking, one may be aware of “contradiction,” “problems,” and “cruxes,” which implies logical conflicts or the reflection of logical link lost. The effort to adjust ideas, change horizon, and modify the model just ensures the logical compatibility. The conceptual model that is finally constructed by intuition thinking should not consist of contradictions and conflicts in it. It can be immersed in the knowledge system that can grasp essential features of things in a larger horizon to reach full understanding of essential features and significance of things at present. Lizhi Xu, a Chinese mathematician, sums up three types of perception, that is, discrimination of perception, associated perception, and aesthetic perception, all of which present a hierarchical relation (Xu 2001, 646-9). This classification can also be adopted in scientific intuition in the general sense. It is their hierarchical relation that reflects the feature of horizon broadening in the intuitional thinking process.

The implicit role of logical thinking that intuition thinking plays is human thinking instinct. And more powerful logical thinking means higher level and effectiveness of intuition thinking. In the history of science, the scientists who have great accomplishment by virtue of intuition are often those who have extremely strong logical thinking. The intuition of the people whose logical thinking is weak is often unreliable. In other words, from the perspective of horizon change, intuition thinking and logical thinking have an internal and interdependent relationship. In the course of continuous extension of intuition thinking horizon, logical thinking focuses on details in a hidden way, constructs the rational relationship in each part of horizon and guarantees the integrity and order of intuition thinking by reverse trend of thinking activity. Integral horizon extension and partial horizon contraction unite organically. Logic plays a role in correctly guiding horizon change in the process of intuition thinking, which is indispensible to improve accuracy, comprehensiveness, and profundity of intuition. For this reason, the achievement of intuition thinking comes from non-logical path, but it does not violate logical rules, and can be proved by logical deduction and scientific experiments designed by logical relation.

It should also be noticed that it is essential to take the advantage of logical thinking to improve the ability and level of intuition, and this is the explicit function of logical thinking. In scientific cognitive activities, many mistakes and logical shortcomings may be involved in the preliminary stage of intuition. If they were not eliminated in time, it would be likely to deviate understanding from the right path. This requires investigating and questioning the achievement of intuition thinking in a logical way. Before the final scientific achievements are obtained, the elements of intuition thinking are involved in understanding some specific problems of science. Particularly, the field of social science has witnessed more standpoints and arguments on the basis of intuition. To eliminate its mistakes and logical shortcoming, it is more essential to conduct logical examination

and question spontaneously. Some achievements of intuition thinking seem illogical, or there exists the procedure loss in thinking, which could be due to the inappropriate use of horizon and conceal certain key factors. Questioning intuition thinking achievement can provide the motivation and direction of intuition horizon extension. Not only is it the need of deepening intuition thinking, but also it caters for the demand of idea innovation.

The integrity of intuition thinking and logical thinking by horizon offers a novel cognitive model, which consists of four procedures in a continuous cycle:

(1) Questioning the achievement of intuition thinking to find out the contradiction in it;

(2) Introducing new relevant factors by broadening horizon and clearing away logical contradiction by new interpretations;

(3) Investigating these cognitive achievements to find out its new significance and value in a new horizon;

(4) On the basis of the procedures above, carrying out new studies by employing intuition thinking in order to reach new cognitive achievements.

As the intermediary of intuition and logic, horizon demonstrates mutual complementation and interpenetrative relations of them, which leads to deeper understanding of intuition thinking. Disclosing the meaning of horizon in scientific cognitive activities and integrating intuition and logic also contribute to inter-discipline transplantation and penetration of thinking methods. One significant feature can be seen from the boom of interdisciplines and boundary disciplines, and one of the modern scientific education tasks is to enable students majored in science subjects to be equipped with open horizon and profound base of knowledge that cannot be turned into creative abilities of scientific research consciously. In this process, the intermediary function of horizon between intuition and logic needs fully exerting. And further exploration of science can be promoted by the organic combination of intuition thinking and logical thinking.

4. Conclusion

The significance of horizon in scientific cognitive activities lies in its influence on the scope, profundity and creativity. Horizon serves as the key factor when the cognitive subject is positively selecting the cognitive object and its background. It combines the relevant knowledge, research experience, social cultural background and other factors, on the basis of which the integral thinking obtain new findings continuously.

The scientific cognitive activities request the extension of horizon positively with new cognitive tools and methods so as to have a theoretical breakthrough. To broaden horizon positively, it is critical to find out thinking limitations and overcome them consciously. The evolution of horizon reflects the change of scientists' starting pointing and perspectives of thinking, which happens within scientific community on the basis of scientific paradigm.

The conscious broadening of horizon helps integrate intuition and logical thinking in scientific cognitive activities, find out the essential link between research objects and research fields, and prompt the transplant and penetration of scientific thinking methods in different fields. In this sense, logical inquire into intuition thinking is considered unavoidable and logical contradiction can be eliminated by new relevant factors in horizon broadening in order to find out new property, significance and value of research objects.

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