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ARTICLE

Tinkering Epistemology with Ontology: Reformulating Popper's Reformulation of the Problem of Induction with Eastern and Western Ontology

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ABSTRACT

Karl Popper thought that he had successfully resolved the philosophical problem of induction by replacing inductive logic with deductive logic in every aspect of the philosophical analysis of science. In examining Popper's approach, it may seem, however, that, instead of resolving the original problem, what he has resolved was a reformulated problem of induction. Nevertheless, by "reformulating" Popper's reformulation by using the relevant ontology from contemporary Eastern and Western philosophers, this paper maintains that this re-reformulated meta-account can be used to argue that the first impression that the problem has not been resolved can be replaced with the idea that Popper's reformulation of the problem of induction into the problem of scientific growth has its meaning in a contemporary context. The key significance of this reformulation is: By examining the paired concepts—such as "inductive inference vs. deductive inference" or "context of discovery vs. context of justification"—from the perspective that "scientific reasoning is to find a stable causal environment or situation to derive regular causal conclusions", we can then maintain that instead of regarding these concepts as mutually exclusive in the "practice of causal inquiry", it is better to assume that they have a complementary relationship—this situation manifests exactly what Popper believed: In the process of scientific inquiry, there is always a dynamic interdependence between conjecture and refutation.

Keywords: The problem of induction, Karl Popper, Ontology, Yuelin Jin, Nicholas Rescher, Nancy Cartwright

1. Introduction

The problem of induction is well-known in Western philosophy history – the Classical empiricist philosopher, David Hume, once used the game of billiards as an example to present the problem in the following way: After repeatedly observing the game of billiards where a white ball hits a coloured ball many times, how do we, as observers, predict that the coloured ball will roll forward in a similar way in a similar situation in the future? According to Hume, the logical answer is that relative to the coloured ball, the white ball has its "causal power", which enables it to push the coloured ball forward; or there is a "necessary connection" or "uniformity of Nature" between the white and coloured balls resulting in the white ball necessarily connecting with the coloured ball in any similar situation. However, as an empiricist, Hume was not satisfied with the idea of "causal power", "necessary connection", or "uniformity of Nature" because these lack the empirical basis of how we experience the existence of the power exerted by "causal power". As finite knowers, how do we experience and assert that causal connections "necessarily" exist or that there is a "uniformity of Nature" which enables the necessary connection between the two balls? In contrast, Hume questioned what it is exactly that is observed during a game of billiards. He maintained that, according to our cognitive experience, what we observe is nothing more than the white ball being spatiotemporally contiguous with the coloured ball; the rolling of the white ball is prior in time to the rolling of the coloured ball; and the rolling of the white ball is "regularly associated" or "constantly connected" with the rolling of the coloured ball in all similar events. However, the three observations mentioned above still seem unable to explain why we have the feeling of "causal power", "necessary connection", or "uniformity of Nature"; or, to put it in another way, where do our sense of "causal power", "necessary connection", or "uniformity of Nature" come from? Hume maintained that this feeling or sense comes from our expectation. The next question is why we have this expectation. According to Hume, we "expect" similar events to happen again at a later moment after observing the many instances of white balls hitting coloured balls. As such, our expectations are then not brought about by causal power, necessary connection, or uniformity of Nature that are imperceptible to sensory experience, but by "custom or habit" that we form according to the constraints of our sensory experience, that is, our custom or habit drives us to "expect" similar events happening again. (Hume, 1978a; Hume, 1978b)

Hume's approach to "psychologizing causality" is that causality, as urged by human being's custom or habits, does to a certain extent impact the psychologizing of the problem of induction which is the problem closely related to the problem of causality. Karl Popper questioned Hume's approach. According to Popper, Hume's approach does nothing more than formulate the problem of induction into the following traditional philosophical form: "What is the justification for the belief that the future will (largely) be like the past?" (Popper, 1972) However, the problem of induction expressed in this form cannot be answered because it involves a subjective and psychological concept namely, belief. This belief takes into consideration human subjective psychological expectation, custom, or habit and as such, it seems that it is impossible for us to find an "objective" criterion to resolve a "subjective" problem. For this reason, Popper suggested that a non-falsifiable problem of induction with subjective or psychological connotations should, through reformulation, be converted into a falsifiable problem with objective or logical form. Popper's idea is that if a traditional problem of induction involving subjective psychological expectation, custom, or habit can be reformulated into a testable theoretical statement with a specific regularity law, then the theoretical statement can be tested for refutation by the relevant test statement. Accordingly, the problem of induction can then be rephrased as follows: "Can the claim that a general theory with a theoretical statement be true or one that is false be justified by 'empirical reasons' through either test or observation statements?" (Popper, 1972) For Popper, the reformulated problem of induction has an objective or logical form that can be tested on empirical grounds. Furthermore, Popper presumes that there is a principle of transference, that is, the principle that what is true in logic is true in psychology. Therefore, once the reformulated problem with objective and logical form is solved, the solution can then be transferred to the traditional induction problem, which has subjective and psychological implications. In the end, the traditional induction problem can be regarded as being solved. (Popper, 1972)

The contentions of the paper are: Did Popper really solve the traditional problem of induction? Or, did he just solve the reformulated version of the problem, leaving the original version of the problem intact? Or, did Popper solve the traditional problem of induction, but did not clearly state in what sense he did it? By closely examining Popper's approach to reformulating the problem of induction, it may first appear that this approach did not solve the problem as the process seems to replace the original problem with another. And so, it may be argued that solving a different problem does not mean resolving the original problem. This paper maintains that the first impression of the problem not being resolved can be changed if we reformulate Popper's reformulation of the problem of induction by using the relevant ontology from contemporary Eastern and Western philosophers. This re-reformulated meta-account of Popper's approach shows that Popper's reformulation did indeed solve the problem. The key significance of this re-reformulation is that from the perspective that "scientific reasoning is to find a stable causal environment or situation to derive regular causal conclusions" in regards to paired-concept such as "inductive inference vs. deductive inference" or "context of discovery vs. context of justification", we can maintain that these concepts have a complementary relationship instead of being mutually exclusive in the "practice of causal inquiry". The situation manifests exactly what Popper believed: In the process of scientific inquiry, there is always a dynamic inter-dependence between conjecture and refutation.

2. On Popper's Reformulation of the Problem of Induction

Karl Popper, who thought his "peculiar reformulation" of the traditional philosophical problem of induction was "decisive," (Popper, 1972) declared in *Objective Knowledge* that he had resolved the problem of induction and successfully replaced inductive logic with deductive logic in every aspect of philosophical analysis of science. The first part of the paper discusses how well Popper solved the traditional problem of induction and examines whether the elimination of inductive logic in philosophical analysis of science is valid.

Popper acknowledged that while he did not resolve the problem of induction as originally framed by Hume, he had addressed the problem by reformulating it. (Popper, 1972) Reformulation, as Popper emphatically pointed out, was a crucial process in solving the "traditional" problem of induction. Through reformulation, Popper was able to make testable what was previously untestable. (Popper, 1972)

The analysis of Popper's method begins with the historical background of these problems. In *Objective Knowledge*, Popper recalls how Hume raised two problems of induction and gave answers to each: (Popper, 1972)

> A logical problem (H_L): Are we justified in reasoning from [repeated] instances of which we have experience to other instances [conclusions] of which we have no experience?
>
> Hume's answer to H_L: No, however great the number of repetitions.
>
> A psychological problem (H_{PS}): Why, nevertheless, do all reasonable people expect, and believe, that instances of which they have no experience will conform to those of which they have experience? That is, why do we have expectations in which we have great confidence?
>
> Hume's answer to H_{PS}: Because of "custom or habit"; that is, because we are conditioned, by repetitions and by the mechanism of the association of ideas; a mechanism without which, Hume says, we could hardly survive.

These two problems and their answers had an effect on the commonsense problem of induction, which is derived from the commonsense theory of knowledge and its answer: (Popper, 1972)

> Commonsense problem of induction (C_s): How can these expectations and beliefs have arisen?
>
> Answer to C_s: Through repeated observations made in the past.

Hume's criticism on the commonsense problem of induction led to the formulation of the so-called traditional philosophical problem of induction (T_r): (Popper, 1972)

> The traditional philosophical problem of induction (T_r): What is the justification for the belief that the future will be (largely) like the past? Or, perhaps, what is the justification for inductive inferences?

When Popper tried to solve the T_r problem, he found it to be insoluble. T_r was wrongly formulated, he argued, because it was framed in subjective or psychological terms. In addition, the problem presupposed that a "regularity" existed. From

Popper's viewpoint, it was impossible to find an "objective" criterion to consider a "subjective" problem. As such, Popper suggested that T_r be treated as a psychological problem concerning the acquisition of knowledge rather than as a problem of logic. (Popper, 1972)

Popper traced the problem of T_r to Hume's H_L and H_{PS} formulations and argued that it was H_{PS} and Hume's answer to it that constituted the insolubility of T_r. (Popper, 1972) Popper decided to ignore H_{PS} and deal only with H_L. He justified abandoning the H_{PS} concept by arguing that if something is true in logic, it is also true in psychology—the so-called principle of transference. (Popper, 1972) Popper reasoned that because there is no way to solve T_r (because of its "subjective, psychological, unjustifiable" nature), he had to go back to its origin—Hume's two problems—to see whether they could be solved. Because H_{PS} is the insoluble essence of T_r, it should be ignored in favour of H_L. If H_L could be solved as Popper believed, the probable answer for H_{PS} would be established through the principle of transference. (Popper, 1972)

While Popper agreed with Hume's answer to H_L, he objected the formulation of H_{PS}. In formulating H_{PS}, Popper argued that Hume presupposed "a process of valid inference" for an unjustifiable problem, "look[ing] upon these as 'rational' *mental processes*." (Popper, 1972) Implicit in Popper's argument is the belief that the formulation of H_L was somewhat influenced by the inherent inclination that human beings have "expectations" as per H_{PS} and its answer. (Popper, 1972) Thus, to lessen the influence of H_{PS} and make H_L testable, Popper "restate[d] Hume's H_L in an objective or logical mode of speech." (Popper, 1972) As a result, we have Popper's engineering of reformulation—an approach to turn an untestable logical problem into one that is testable. (Popper, 1972) Popper renamed this reformulated, testable problem L_1. (Popper, 1972)

> L_1: Can the claim that an explanatory universal theory is true be justified by "empirical reasons"; that is, by assuming the truth of certain test statements or observation statements (which, it may be said, are "based on experience")?

Table 1: Comparison of terms in Hume's H_L or T_r and Popper's L_1 (Popper, 1972)

Hume's H_L or T_r (subjective terms) (before reformulation)		**Popper's L_1 (objective terms) (after reformulation)**
Belief (instances of which we have no experience)	→	Statements, explanatory universal theory
Impression (instances of which we have experience)	→	Observation statement, test statement
Justification of a belief	→	Justification of the claim that a theory

Table 2: Comparison of statements of Hume's H_L and Popper's L_1 (Popper, 1972)

Hume		**Popper**
Instances of which we have experience [impression]	→	Test statements (observation statements, basic statements) = singular statements describing observable events
Instances of which we have no experience [belief]	→	Explanatory universal theories
H_L	→	**L_1**
Are we justified in reasoning from [repeated] instances of which we have experience to other instances [conclusions] of which we have no experience?	→	Can the claim that an explanatory universal theory is true be justified by "empirical reasons"; that is, by assuming the truth of certain test statements or observation statements (which, it may be said, are "based on experience")?
[justification of a belief]	→	[justification of the claim that a theory is true]

From Popper's point of view, H_L had been successfully reformulated into an objectively testable new mode, L_1. However, he noticed that L_1 is a problem that can never be answered because a theory by any number of empirical reasons cannot be "verified" or "confirmed". On the other hand, a theory can be "falsified" by introducing a single contradictory empirical reason. Thus, L_1 can be reformulated into a more general form, L_2. This second reformulation is the so-called problem of induction: (Popper, 1972)

> L_2: Can the claim that an explanatory universal theory is true or that it is false be justified by "empirical reasons"; that is, can the assumption of the truth of test statements justify either the claim that a universal theory is true or the claim that it is false?

We can learn something interesting about L_2 by reviewing Popper's tetradic schema of the growth of scientific knowledge: (Popper, 1972)

$$P_1 \rightarrow TT \rightarrow EE \rightarrow P_2$$

where P_1 = Problem 1, TT = Tentative Theory, EE = Error Elimination, and P_2 = Problem 2, a new problem that arises when TT cannot pass the test during the EE stage.

From a semantic point of view, L_2 obviously falls into the TT → EE stage, whereas T_r or Hume's H_L is in the initial stage, that is, P_1 → TT. It appears that Popper moved the (original) problem (of induction) from the P_1 → TT stage (the traditional problem of induction) to the TT → EE stage (what Popper called "the problem of induction"). Then, the immediate question is: why did Popper do this?

Recall that Popper had repeatedly claimed that the formulation of the problem of induction (L_2) was different from that of the traditional problem of induction (T_r) or Hume's H_L. We already understood that L_2 and T_r were derived from Hume's H_L. As such, we hold the idea that L_2, T_r, and H_L represent the same problem in different formulations.

In order to answer as to why Popper moved the problem of induction from the P_1 → TT stage to the TT → EE stage, let us return to Table 2, paying particular attention to the three underlined terms: "instances of which we have no experience," "belief," and "explanatory universal theories." In Popper's view, an untestable, subjective problem should be reformulated into a testable, objective problem. Thus, "instances of which we have no experience" in H_L should be replaced by "explanatory universal theories" in L_2. (Popper, 1972) In addition, Popper argued that the term "belief" in T_r (as seen in Table 1) equalled to "instances of which we have no experience" in H_L. As such, based on Popper's thinking, if we can solve L_2, then there will be no problem in H_L, and through the principle of transference, the answer to H_{PS} will be valid and T_r will no longer be a problem. (Popper, 1972)

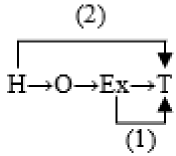
How well did Popper solve the traditional problem of induction? If we accept Popper's idea of reformulation, it's fair to say that he did indeed resolve the problem of induction. He transformed Hume's H_L into L_1 (verification form) and L_2 (falsification form) and asserted that if we could resolve L_2, then Hume's H_L would be resolved. Popper did provide the answer to the problem of L_2 because we can falsify any theory that contradicts empirical cases. In this sense, we can say that Popper's strategy did solve the problem of induction in his well-designed problem-resolving structure.

3. From the Method of Learning by Repetition of Observation to the Method of Learning by Trial and Error

Although Popper's strategy seems to have solved the problem of induction in his well -designed problem-solving structure, the first impression of Popper's approach is that it did not solve the problem. This is because the function of the reformulation process is to change the original problem into another one. As such, it can be argued that solving a different problem does not help in resolving the original one. In order to defend the adequacy of Popper's approach in resolving the problem, we then need to come up with a meta-account in order to be able to interpret and justify that Popper's approach did indeed solve the problem.

In order to develop a meta-account that can be used to reinterpret and justify what Popper did in his engineering of reformulation, let's return to Popper's tetradic schema of the growth of scientific knowledge: $P_1 \rightarrow TT \rightarrow EE \rightarrow P_2$. Popper noticed that his schema could not explain the dynamics of stage $P_1 \rightarrow TT$. Therefore, he expressed a strong attitude against inductive inference: "As against all this, I happen to believe that in fact we *never* draw inductive inferences or make use of what are now called 'inductive procedures'… …The method of learning by trial and error has been mistaken for the method of learning by repetition." (Popper, 2015) Thus, Popper refused to accept inductive inference as a probable method of acquiring knowledge at the $P_1 \rightarrow TT$ stage and wanted to replace inductive logic with deductive logic instead. (Popper, 1972)

Popper offered two reasons for this. First, he wanted to replace the unsound, closed system of inductive inference. Popper pointed out that "experience results from learning through repeated observation—[it] is a closed system of prejudices where critical examination is usually resisted and often resented.” (Popper, 2015) Popper’s viewpoint of the traditional inductive schema can be illustrated as follows:



(1) Verification (confirmation)
(2) A theory-pregnant process (we can treat it as the traditional problem of induction)

Figure 1: Traditional Inductive Schema

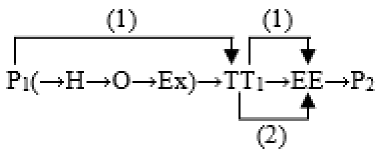
where H = Hypothesis, O = Observations, Ex = Experiments, and T = Theory established. Note that this model includes verification or confirmation and that the process is “theory-pregnant.” We can treat it as the traditional problem of induction.

As any hypothesis is proposed with a problem in mind, I suggest that we place P (problem) before H in the schema. Thus, the complete schema will look like this:

$$P \rightarrow H \rightarrow O \rightarrow Ex \rightarrow T$$

This schema is a restatement of a part of Popper’s schema—namely, the $P_1 \rightarrow TT$ stage. Popper argued that this part of his schema was established through a process of confirmation that lacks an objective criterion, which is impossible to attain, to test its validity. As such, the validity of this entire “theory-pregnant” process cannot be justified, and the growth of knowledge impossible. It is thus a close-ended system. (Schilpp, 1974)

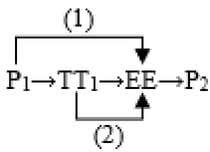
Popper’s second reason was that if inductive inference was rejected, an open-ended growth theory of scientific knowledge would then be possible. Popper said that “if we [give up the justification of inductive inference], we also become aware of the logical gap between induction by repetition and method of trial and error.” (Popper, 2015) He concluded that “since reason and logic tell us that, rationally, that there is no induction nor justification, only criticism and elimination, it is then a good idea to see whether those facts of scientific discovery cannot be interpreted—or perhaps, better interpreted—as procedures of trial and error.” (Popper, 2015) With these statements, Popper technically transferred the problem from stage P_1 → TT to stage TT → EE. As such, T_r was avoided, and Popper’s tetradic schema completed—ruled by deductive inference, that is, by critical rational approach. (Popper, 2015; Popper, 1972) Contrast in Popper’s tetradic schema:



(1) Deductive inference
(2) Falsification

Figure 2: Popper’s Tetradic Schema

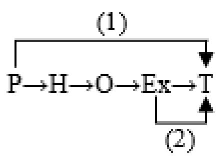
Or concisely,



(1) Deductive inference
(2) Falsification

Figure 3: Condensed Popper’s Tetradic Schema

with an inductivist’s schema:



(1) Deductive inference
(2) Falsification

Figure 4: An inductivist’s Schema

It is clear that Popper was smart enough to manipulate the appearance of T_r, or

Hume's H_L, by his own admissible technique, that is reformulation, in order to reach his soluble conclusion. In addition, Popper maintained that the justification problem of inductive inference should not be regarded as a psychological and historical question, but instead be regarded as a logical, methodological question of validity. (Popper, 1972) Thus, he was able to ignore inductive inference, replace it with deductive inference, and complete his schema of the growth of scientific knowledge. (Popper, 1972)

Popper's attitude toward T_r is acceptable because we cannot establish whether inductive inference is valid. The concept of falsification at the TT → EE stage, of which Popper emphasized, is an important part of scientific research as it plays a critical role in the trial-and-error process. Popper's rejection of the inductive method may, however, invoke criticism that his rejection does not consider the real situation of scientific research.

Defenders of the inductive method may maintain that what is certain is that an inductive conclusion inferred from true premises can neither be justified as true nor false. However, it generally provides more information than only premises. For example, a set of data about the movement of a planet cannot, by itself, give us any ideas about the phenomenon. However, with an explanatory universal theory about the revolving behaviour of the planet based on the operation of inductive inference, scientists will not only be able to explain the phenomenon but also predict the planet's future behaviour. For these defenders, this is the function of inductive inference, that is to expand our knowledge and predict an event in the future. As there is no guarantee that the newly established theory is true, we must test our theory against the empirical phenomena. It is through this testing procedure of trial and error, as maintained by Popper, our knowledge can be developed steadily.

The concept of falsification at the TT → EE stage, which Popper emphasized, is an important part of scientific research as it plays a critical role in the trial-and-error process. Despite this important contribution, Popper's rejection of inductive inference is, however, dubious. For the defenders of inductive method, Popper's rejection may be a "confusion of context of discovery and context of justification." (Reichenbach, 1963) It is generally claimed that deductive inference (or falsification) is important in the context of justification, whereas inductive inference (or confirmation) is crucial in the context of discovery. Therefore, there should not be any substitution between deductive inference (or falsification) and inductive inference (or confirmation), rather these two inferences should be regarded as being supplementary to each other. Our immediate query then is: Did Popper's rejection of inductive inference depict his confusion between context of discovery and context of justification? Or, is it possible that a new meta-account can be provided so that Popper's rejection of inductive inference can be reinterpreted as having its pivotal function in constructing his image of scientific reasoning and the growth of scientific knowledge?

4. An Ontological Meta-Account for Reinterpreting Popper's Reformulation: Reformulating Popper's Reformulation with Eastern and Western Ontology

Although Popper's rejection of inductive inference from scientific research may seem dubious, his way of re-characterizing the nature of scientific reasoning is insightful, in that it may bring up an ontological implication. What then is the ontological implication? Recall that Popper pointed out that if scientific reasoning was to be characterized as an inductive inference, which in turn is to be characterized as a method of learning by repetition, we never conduct scientific inference. According to Popper, the method which is adopted to conduct scientific reasoning should in fact be regarded as a method of learning by trial and error. By re-characterizing the nature of scientific reasoning in this way, scientific reasoning is no longer to be regarded as a closed system with theory-pregnant prejudices where critical examination is usually resisted. It is, instead, to be regarded as an open-ended process of theory growth.

It may seem that it is Popper's methodological insistence in holding that scientific reasoning is a method of trial and error which brings him to the conclusion that the development of scientific knowledge is an on-going, open-ended process. Our immediate query is: In addition to this, is there an ontological background or reason to further support this conclusion? In the following section, we show that some contemporary Chinese and Western philosophical ideas about the ontological structure of the world can be of help in providing such support.

Let's first examine how Yuelin Jin, a prominent Chinese philosopher in the twentieth century, applied an ontological approach when commenting on Hume's solution to the problem of induction, which is the origin of Popper's criticism.[1] (Chen, 2020) According to Jin's analysis, when Hume encountered the problem of inconsistency between the conclusion of inductive inference and facts, he did not return to the "assumptions" in the premises of inference to solve the problem. Instead, he resorted to the "habit" to solve the problem. However, the reason as to why Hume replaced the "principle of the uniformity of Nature" with "habit" as the key premise of inductive inference is mainly because Hume, when discussing the "necessary connection," did not distinguish between the theoretical and empirical realms. From a theoretical realm perspective, premises and conclusions are concepts set by the theory using assumptions and hypotheses. Therefore, the "connection" between premises and conclusion is inevitable and necessary because of the theoretical settings. Meanwhile, from an empirical realm perspective, we regard the premises as cause and conclusion as effect. As such, the connection between premises and conclusion can be regarded as the process of cause and effect, which can also be considered in terms of "the flow of time," especially "time with content". Since "time with content" contains various "particular changes" and "movements of all things," the relationship between cause and effect has no necessity, and neither does the relationship between the premises and conclusion of inductive inference. It is because of the uncertainty of the premises and conclusion of inductive inference in the empirical realm that made Hume, an empiricist, reject the "principle of uniformity of Nature" as it lacks empirical content as the premise of inductive inference, instead replacing the principle with "habit," which is derived from experience. With respect to this, Jin mentioned: "If anything characterizes Hume's philosophy, it is that he emphasizes theory, while at the same time not considering his philosophy to be rational. When Hume encountered difficult problems, rather than returning to assumptions as a way of solving the problems, he introduced 'habit', which lacks any theoretical basis." (Jin, 2005)

Jin's idea that Nature contains various "particular changes" and "movements of all things" and as such, the inductive inference of Nature's operation is very often inaccurate is echoed by contemporary Western philosopher Nicholas Rescher. According to Rescher, there are two opposite ontic status: (1) Nature is always

[1] Some of the ideas expressed here about Yuelin Jin's criticism of Hume's solution to the problem of induction refer to and are paraphrased from the author's previous article. (Chen, 2020)

changing; and (2) Nature is not actively changing, but human explorers are not exploring it thoroughly and thus gradually reveal the full picture in the step-by-step exploration. No matter which status Nature is in, it seems to constrain the development of science, making the situation point to "the imperfection of science" which is believed to come from "human cognitive incompleteness" that can be traced back to "inexhaustibility of Nature". In response to this, Nicholas Rescher commented in his 2000 book, *Nature and Understanding: The Metaphysics and Method of Science*, "A Law of Natural Complexity so operates as to render nature pervasively complex and inexhaustible in its details. And this means that our characterization of the world's make-up and modus operandi can never be carried through to completion. Our attempts at description can never exhaust the realm of natural fact. Nor can we manage to arrive at a final and definitive account of the law structure of the world." (Rescher, 2000)

In Rescher's statement above on the relationship between "(the inquirer's) understanding (of Nature)" and "Nature" is that when our understanding of Nature does not align with the related phenomena that Nature manifests, it would be better to reflect on what Nature, with its infinite possibilities of change, is telling us instead of just blaming it on the inaccuracies of inferential accounts used to understand Nature, in order to further explore what is currently dealt with and what can be revised in terms of inferential accounts of the real case. If "understanding Nature" is interpreted as "understanding Nature with theory", then what is the "dynamic development" of the extremely complex mutual relationship between "theory" and "Nature" that Rescher envisages? In his revised edition book, *The Limits of Science*, in 1999, Rescher described the dynamic development as follows: "Scientific theorizing is an inductive projection from the available data. But data availability is bound to improve with the changing state of the technological art—engendering a dynamism that ongoingly destabilizes the existing state of science so as to engender greater sophistication. The increasing complexity of our world picture is a striking phenomenon throughout this process. It is so marked, in fact, that natural science has in recent years been virtually disintegrating before our very eyes. And this phenomenon characterizes all of science—the human sciences included. Indeed, complexification and its concomitant destabilization are by no means phenomena confined to the domain of science—they pervade the entire range of our knowledge." (Rescher, 1999)

Do continuous interactive dialogue and dynamic dialectical development of theories (or inferential accounts) and Nature mean that a theory (or an inferential account) of Nature can never be judged as appropriate because of the extreme uncertainty of the state of Nature and the inexhaustibility of its changing states? Based on this, Jin suggested that any solution to the Humean problem of induction, or the problem of inductive inference in general, should use ontological thinking. In Jin's ontological magnum opus, *On Dao*, Jin provided an ontological principle for explaining the change of an individual, which in turn can be used to resolve the Humean problem of induction: "In the changes and movements of individuals, regularity is certain, and the situation in process has no necessary point of arrival." (Jin, 1987; Zinda, 2012) According to this principle, Jin points out that "regularity is certain" meaning that there is always a regularity between two relevant objects or two events—let's call it the regularity between cause and effect. The term "regularity in certain" means that no matter what *concrete content* the relation between cause and effect *would happen to* possess, the *abstract* regular relationship of "cause and effect happen one after another" *would necessarily* remain regardless of the situation. What then does Jin mean by "the situation in process has no necessary point of arrival"? For Jin, it is *likely* that while Nature will bring about certain situations in the process of things in operation and change, the situation is *not necessarily* to arrive. Once the situation does arrive, with the help of the situation, it can achieve the generation of a "regularity". What kind of situation in the process can achieve the generation of the "regularity"? A "stable situation or environment" is the guarantee that a "regular relationship," that is a "regularity," can be generated.[2] (Chen, 2015)

Jin's conception of the situation in process is echoed by contemporary Western philosopher of science Nancy Cartwright. In her 2021 book, (Cartwright, 2019) Cartwright, like Jin, also believed that the nature of Nature is fickle and capricious, but she maintained that while Nature itself has a changeable character, Nature is also an artful modeler. Cartwright argued that the key to understanding Nature is

[2] The concept of "a stable situation or environment" is similar with what French sinologist François Jullien called "shi"—a Chinese ontological concept about condition, circumstance, power, and potential. According to Jullien, shi means, on the one hand, the disposition of things—it refers to the condition, position, circumstance, configuration, arrangement, or structure of things. On the other hand, it also means force, power, potential, and the movement of things. It is obvious that, by this characterization, shi carries both static and dynamic connotations.

that Nature itself exhibits stable phenomena which allows us to recognize it. How can Nature manifest these stable phenomena? While Nature encompasses everything, the existence of these phenomena seems to be chaotic and haphazard. Nevertheless, if these phenomena remain in a stable environment, they will develop a stable mutual relationship between them, that is, under a stable environment, the causal relationship between phenomena can be generated. It is through this that Cartwright sees Nature as an artful modeler as Nature is able, with an artisan-like proficiency, to take what it has "within a certain range" and use the "well-shielded" method to arrange things in an ingenious way, thus allowing them to create repetitive phenomena that we perceive to be repeatable and reproducible without the interference of other things. Here, the so-called "a certain range" refers to a certain domain of Nature where certain things are arranged in a clever way in this specially shielded and stable domain. It is obvious that what Cartwright called the stable environment is in fact Jin's stable situation in process.

Regardless of Cartwright or Jin, it seems that as long as we, as limited cognisors, still have access to the operation of Nature, then it is for us to explore the causal structure which is constituted by various relevant things and is stable enough to produce regular causal laws. How can we then proceed with such exploration? We should emulate Nature by making exquisite models that imitate Nature to produce causal phenomena that we can recognize. The objective is to reproduce Nature's causal structures that give birth to stable causal phenomena in these well-made models, after which we can then further test whether these models that are loaded with information about the causal structure can lead to identifiable causal phenomena (or causal laws). If the models lead to identifiable target phenomena, then the models are appropriate, and the related theory that implies the models is also considered appropriate. In short, the way we understand Nature is just as Cartwright advocated: we humans, as limited cognisors, should learn to understand Nature by "modelling Nature artfully", because Nature itself is an artful modeler.

How then are the discussions on Jin's idea about stable causal structure, Rescher's idea about the inexhaustibility of Nature's complexity, and Cartwright's idea about Nature as an artful modeler relevant to Popper's reformulation of the problem of induction? According to Popper, the main content of the reformulated problem of induction is the issue of testing whether an explanatory universal theory with a theoretical statement of the phenomenon in question is true or false in the face of an empirical evidence phrased into a test statement. The theoretical statement of a theory is generally, as maintained by Jin, derived from a well-contrived theoretical model that mimics the causal structure of a specific part of the world from which the phenomenon in question is from. If the result is that the theoretical statement is congruent with the test statement, then the explanatory universal theory is tentatively accepted. Conversely, if the result is that the theoretical statement is incongruent with the test statement, the theory is falsified. In the former case of theory-acceptance, the causal structure specified in the theoretical model can be regarded as truly capturing the genuine causal structure in question, then the theory containing such a causal structure is accepted. In the latter case of theory-falsification, the causal structure specified in the theoretical model does not capture the genuine causal structure and the theory containing such a causal structure is thus rejected. In both cases, it all shows that Popper's deductive account can do justice to a theory by referring to empirical evidence. However, as maintained by Rescher, Nature is always changing or is too complicated to be comprehended all at once. Therefore, our attempts at describing it never exhausts the realm of natural fact. What we can do is, as was indicated by Popper, to then keep on using the method of trial and error to conduct a series of piecemeal tests to try identifying the underlying causal structure of a phenomenon in question. And, yes, as maintained by Cartwright, if we are lucky enough, we will be able to hit the targeted causal structure from which we learn how to model Nature artfully.

5. Conclusion

Referring to Jin's criticism of Hume's solution to the problem of induction, the key point is that Hume did not distinguish between the theoretical and empirical realms of his discussion when he discussed about why there is no necessity between the premises and conclusion of inductive inference. Due to this negligence, Hume could only resort to the "habit" to solve the problem of induction, which is exactly the reason that triggered Popper to proceed with his reformulation engineering to replace inductive inference with deductive inference in scientific reasoning. However, the reality is that we develop our theories by inductive inference, and we justify them by deductive inference. As such, we need both inferences in the construction of our theories. When we are in the empirical realm, it means that we face the chaotic Nature and thus need to apply inductive inference to *conjecture* what Nature's causal structure is. Conversely, when we are in the theoretical realm, it means that we are fortunate enough to mimic Nature's exact causal structure so as to smoothly derive the causal relation from the structure to *justify* whether the derived relation is the right conclusion. In any scientific or everyday endeavour, we make progress through *conjecture*, which is characterized by the process of hypothesis, observation, experiment, and confirmation. We *refute* mistaken conjecture via the process of falsification. Our system of knowledge is established through the interaction between induction and deduction, which are, once again, to borrow Popper's words, conjecture and refutation.

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