Predictability in Science: Accuracy and Limitations
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EPISTEMOLOGICAL STUDY OF THE VOCABULARY OF PREDICTION IN SCIENCE AND THEOLOGY

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Since this symposium is dedicated to the study of predictability, my paper will endeavour to show how the terms used in scientific discussions, in the philosophy of nature and in theology keep interacting. This will go to prove that it is important to be able to mark distinctly the meaning of terms according to the levels of discussion and conceptualisation and thus avoid the misunderstandings which today seem to have caused the dialogue between science and faith to reach a dead end.

1. *The Return of an Old Quarrel*

In Western thought, a clear distinction between scientific knowledge and theological considerations has been the universal rule. It was quite evident that scientific work should not be mingled with religious or ideological considerations. It was a manner of respecting the objectivity of scientific knowledge, built upon the exacting demands of the experimental method – where the subjectivity of the observer must not interfere with the results. Such an attitude was an essential element of the freedom of research.

Now, this situation has drastically changed today through the influence of religious groups which play an important part in North-American society.[1] Their project of reforming society includes religious elements, which is logical, since religious convictions and practices are integral parts of human

[1] The question is complex and one must carefully distinguish between the various trends of ideas or opinions which introduce confusions between religious and scientific discourses. As far as I am concerned, I could not possibly mistake creationism for fundamentalism; or place those in favour of the Intelligent Design in the category of creationists: it would be a way of evading discussion.

identity. What is new, is that in the name of religion, the supporters of *Intelligent Design* claim that they are able to settle questions discussed by scientists: by rejecting the theory of evolution, some of them even claim that they can judge the value of a scientific theory by referring it to biblical texts.

Most scientists have said that such an interpretation has revived the old conflicts between science and faith, since a religious conviction has imposed on scientists what they must think. Since one the elements of the present debate concerns the relationship between chance and finality, it seems to me that this convention concerning scientific predictability is a good opportunity to examine in a balanced way the relationship between science and monotheistic theology: as a matter of fact, one should avoid the simplistic approaches of 'concordism'[2] or 'discordism',[3] when one tries to examine how scientific discourse and theological discourse get on together – and thus denounce the confusions which are caused by those who support *Intelligent Design*, when they oppose divine design and chance in the name of finality.

2. *Causality and Scientific Prevision*

Predictability has always been one of the major concerns of mankind – in order to know in advance about the return of seasons, to evaluate climactic variations or to assess what resources were necessary for survival. Such a requirement was revived at the birth of rational thought in a vision which grants primacy to reason in human actions. This primacy of reason has kept away from the plurality of divine beings that haunt ancient mythology. In order to establish social and political order as well as learning, the Greeks introduced the concepts of law, order and reason – placed under the exacting demand of logical coherence.

Within this framework, Greek thinkers introduced the notion of cause.[4] Hence the need to explain turns facts and events into serial sequences

[2] A posture which claims that the inspired text and the results of science coincide word for word. The Catholic church has challenged this position, which was prevalent at the beginning of the twentieth century.

[3] It is the opposite attitude, which considers that science and faith don't have to mind or worry about each other – even when creation or providence are at stake.

[4] In Greek thought, one talks of science (épistèmè) when the cause (aitia) is known. The concept of cause refers to the fact that a 'being' (in the widest possible sense, meaning an individual, an event, a connection of any sort…) is dependent on another being. The notion of cause refers to the questions 'why?', 'how', 'what is it' or 'what is it made of?'.

which connect to one another with the passing of time. They develop in a mode which is made clear through the tenses of verbs: past, present and future. The present is the outcome of the past and the future is understood as the result of the present action. The link between facts is a causal link. When a cause is established, effects necessarily follow. It cannot be otherwise, as the saying goes: 'the same causes produce the same effects'.

This ideal of perfect knowledge has led scientific thought to introduce a fundamental distinction between predicton and speculation, between science and opinion.

When scientific knowledge is at work, it is possible to foresee what is coming, since the whole process is governed by necessity. For the Ancients, science proceeded through the knowledge of necessity. But there are situations which do not correspond to this ideal requirement. Facts are not necessary, they could be different, they are contingent and no demonstration can be made about them with any certainty. In this case, we are not talking of science, but of opinion: prediction is impossible, only conjecture remains.

This philosophy of knowledge has a logical aspect, since ideal knowledge rests on the conviction that there must be a relation between things and thought. Logical necessities are necessities of the human being. This entails a theory of demonstration.[5]

Since truth does not reside only in concepts, but in judgements, one must examine the status of propositions. A proposition is true when, if affirmative, it says what is, or if negative, what is not. Hence it follows that propositions concerning present or past things are necessarily either true or false, since they always refer in the present or in the past to something with which they are or are not in agreement. On the other hand, if propositions cannot refer to anything in reality which either confirms or denies them, they are neither true nor false: they are neutral. This neutrality characterises propositions which refer to what is called the 'contingent future'.

The expression applies to what is to come in the future, but does not belong to the field of necessity. For Aristotle, such facts cannot be foreseen, so that the propositions which concern them can neither be true nor false. They are neutral.

Thus, there are two categories of facts: the former concerns what exists according to the necessity of natural laws, or events which have taken place.

[5] See Aristotle, 'Seconds Analytiques', I,2,71b, tr. Jean Tricot, *Organon IV*, Vrin, 1938, pp. 7-8.

The latter concerns facts which occur without reference to necessity. It is possible to assert the truth or untruth of what has happened; but one cannot assert the truth or untruth of what is yet to happen outside the scope of necessity.[6] This does not create any dificulty, as long as one stays at a logical level, since one accepts that there are such things as natural assertions[7] and that there is a limit to human knowledge; but it is of some importance when such a conception of knowledge is made to apply to theology.

3. *Providence and Predestination: Contingent Futures*

The following discussion only concerns monotheistic theology. Acknowledging plural divine beings only means extending what's taking place on earth into heaven. But acknowledging a unique God – as do the philosophers and Abrahamic religions – invites one to reconsider the preceding distinctions in the light of the problems raised by the existence of chance. Chance has been defined as the meeting point of independent causal series.[8] The random character of events follows from their independent causes, which make prediction impossible.

In order to enter the theological debate, it may be appropriate to resort again to a classical example used by philosophy teachers: two slaves are sent by their master on an errand. They start independently from one another, each without knowing what the other has to do. Supposing they meet in the town square; they will say that their meeting was due to chance, and happened at random.From their point of view, their encounter was the result of two series of independent causes. Not so for the master, who – in so far as he has sent them to the same place at the same time, is entitled to believe that they were bound to meet. Their meeting does not have the same nature for

[6] The question has been discussed at length in the Treatise of Interpretation, and illustrated by the example of a naval battle supposed to take place in the future. Because it is not certain that the naval battle will take place at all, since it depends on a number of factors which include human freedom, it is impossible to pass a judgement on the proposition: 'the battle will take place tomorrow'. Since it is a contingent fact, one cannot with any certainty ascertain the truth or untruth of the proposition. Things go differently where a naval battle of the past is concerned: propositions concerning it can be classified into two categories of true and false propositions.

[7] This Aristotelian reserved attitude is rejected by the Stoics, who talk of modal propositions.

[8] Aristotle's definition has been taken up by modern science under the influence of Cournot.

the master and for his slaves. This difference in points of view between master and slaves has been taken up in theology. In the case of a monotheistic confession of faith, the situation of men – caught up as they are in temporality – is different from that of God, who is outside Time. So that the question of chance and predictability has entered Christian theology, which claims, in accordance with the requirements of monotheism, that God sees everything. Therefore, the distinction between past, present and future events is not a radical one: everything is present, for Him. If one takes into consideration only the knowledge which God has of past and present facts, such a theological proposition does not offer any major difficulty. But if one considers that this knowledge can be creative, a difficulty arises: since God knows everything and since nothing can be kept unknown from Him, does it mean that such an action invalidates the contingent character of what it creates?

The answer to such a question has occasioned important research in theology, on the question of what has been called 'contingent futures'. A thorough discussion of this academic disputation[9] is here out of the question. One can however observe that in a monotheistic tradition, two conceptions of divine action are at work.

4. *The Action of God and His Design*

In order to answer the question asked by the supporters of the *Intelligent Design* theory, it is possible to consider two opposite traditions.[10]

According to the first tradition, the notion of omnipotence designates the absolute character of the power God, who is supposedly able to do all that he wants without being stopped by anything. This school of thought stresses the word 'all', which refers both to the universal character of what is, and to the universal character of what could be – and even to what lies outside the scope of human imagination. Nothing can limit the action of God, which evades all rational explanation.

[9] It is not possible to reproduce the debates here, but suffice it to say that the discussions have encouraged research concerning precise vocabulary and definition of concepts. The debate has been most sharp at the University of Louvain about what is known as 'the quarrel of contingent futures'. See Leon Baudry, *La Querelle des futurs contingents (Louvain 1465-1475)*, Paris, Vrin, 1950. Throughout the debates, academics have distinguished what they call in Latin *de re*, in other words what refers to things, from *de dicto*, namely words, a current discussion in the debates concerning quantum physics.

[10] See the anthology by Olivier Boulnois, *La Puissance et son ombre, de Pierre Lombard à Luther*, Paris, Aubier, 1994.

According to the second tradition, the action of God cannot be dissociated from the notion of wisdom. This implies that the order of elements and the proportion between causes and effects are also taken into consideration. Thus, God's will is motivated by Good and regulated by the notions of order and coherence.

The first tradition, for which the power of God is absolute, does not take into consideration the demands of coherence between natural phenomena. The contingent quality of the facts of nature is an irreducible factor, because God's interventions are limitless. He is free from any restraint arising from reason.

The second tradition, on the other hand, makes the power of God subservient to His wisdom. Then things are proportionate to one another, and the links between causes and effects are well-ordered. Such a conception does away with the notion of God's arbitrary behaviour. It gives sense and meaning to the expression: 'divine design'. But again, the interpretation of such an expression calls for proper judgment.

In the first perspective, the divine design can be recognized only if it cancels the contingent nature of facts or natural events. The notion of divine design clashes with the recognition of chance. In the second perspective, by favouring wisdom and therefore reason, contingency is not invalidated by the recognition of God's action. In fact, phenomena occur according to their nature. In such a perspective, the notions of creation, divine design and providence do make sense. Chance and God's action are not antinomic, because the latter does not distort natural events and respects the rules of the possible. As far as I am concerned, I see no reason why one should oppose chance and God's design.

This respect for the nature of things by the Creator means that if an event is contingent, it does not stop being so because it is willed by Him whose action is at the very source of being.[11] It is willed as such, contin-

[11] The notion of contingency implies that all that god has created does not necessarily partake of the absolute or necessary nature of His being. Thus, in a well directed human action, he who acts adjusts his forces to what he is doing. He does not use all his potentialities to achieve what he is in the act of doing. Thus, an action does not always involve the same resources. Practical wisdom consists in adapting one's efforts to the work in progress. This remark could apply (by carefully respecting the differences between God and man) to divine action. When we describe it as supreme, we do not mean that the whole divine power is engaged to do away with contingency, and therefore with the random nature of phenomena. Here again, the notion of wisdom, which adapts causes to effects, must be favoured. Divine action respects the singularity of human beings and their links.

gent as it is. There is therefore no reason to oppose providence and the chance happenings of life, chance and God's design. Nor is there any reason to oppose the notion of creation to the synthetic theory of evolution. The action of God respects the laws of Nature. How could he do violence to the laws He himself has established? Creative action develops within the framework of time. It takes place through evolution. The general term of evolution has taken a particular meaning in science, when used to designate chance mutations.

The philosophy which we are expounding here discards any explanation referring to special interventions of God, which would distort the normal course of nature. It might be called the 'autonomy of creatures'. The theology which we are promoting rests on the conviction that God's action does not alter natural phenomena and leaves science totally free in its quest for explanations.

5. *Creative Action and the Autonomy of Creatures*

By admitting that God's action is not an intervention which alters the course of natural phenomena, we leave science in its own place. Of course, science does not know everything. But facing the unknown, and the enigma created by the emergence of life and the apparition of mankind, it is erroneous to appeal to an intervention of God which would alter the natural course of things. It is enough to realise that our knowledge is still limited. The theory of evolution accounts for what has been observed. It is open to new discoveries. It looks forward to them. It will renew itself thanks to discoveries to come, unforeseeable in the present state of our knowledge. But such a revision will not repudiate what is today established and verified; it will be a re-interpretation in a wider framework, through a more widely encompassing theory. The opposition between the synthetic theory of evolution and Christian faith is without foundation.

God's action respects the laws of Nature. God's action does not do violence to the rules which He himself has established. God's action then operates through the mechanisms revealed by the theory of evolution. Does creative action take place within the framework of time? It takes place through evolution. It is a general concept. It does away with an explanation which would allow special interventions by God, which would distort the normal course of nature.

At this stage, it is necessary to add a few refinements. First concerning creative action.

1. What is ordinarily meant by creation, is the very first moment of the temporal history of beings – normally represented by point zero on the standard cosmology timeline. It is in this perspective that the arguments of the supporters of Intelligent Design normally develop, on 'fine tuning' and the opposition between microevolution and macroevolution. According to them, God can only intervene without our knowing, or even counter to the natural course of things, in order to bring new solutions, orientate, maybe redress.

This narrow conception is not that of the Christian tradition, for which creation is an act of the present, always present. Providence is a quality of creative action, whose completion is inscribed within a temporal framework.

2. God's action must not be conceived as an intervention on subjects which is meant to orientate those subjects in a way which would not correspond to their being. It should be thought of as the gift of being to what is singular and makes up a whole – the world. It is a universe in the eyes of the scientist, in the sense that phenomena occur according to laws. It is called 'creation' from a theological point of view, when one realizes that it conveys one unique will. This approach lays stress on its unity and on the dynamic movement which drives it towards an accomplishment of some sort, without anything being distorted or the interaction of elements between themselves where chance has a part to play.

6. *The Question of Sense and Reality*

In this perspective, one can say that the question of sense is being raised within the process of evolution, without it being necessary to deny the random nature of singular occurrences by supposing that an intervention of God has somehow filled a gap of some sort.

Does the admission of contingency compel us to give up the possibility of speaking of a divine design? In order to do so, it is not enough to consider singular occurrences. One must consider the whole vital process described by the theory of evolution. It is a fresh way of looking at things. It takes the whole process into consideration and acknowledges its coherence. This is where the followers of *Intelligent Design* start from.

a) In the first place, those in favour of *Intelligent Design*, in taking note of the fact that the universe is in expansion,[12] address the question of sense,

[12] See Rodney D. Holder, *God, the Multiverses and Everything, Modern Cosmology and the Argument from Design*, Hampshire G.B. Ashgate, 2004.

passing from what deals with the direction of a movement to its meaning.[13] The anthropic cosmological principle extends this consideration and refines it, by considering that the universe is orientated towards the emergence of human consciousness.

b) Then, the supporters of the *Intelligent Design* develop the meaning of the word 'program'. They extract the term from the context of a mechanistic conception and make it apply to an intelligence at work at the beginning as well as at the end of the process.

c) If there is for them the possibility of an optimal solution starting from elementary conditions, it proves that there is an internal guidance which uses the openings of the possible for an optimal result, which goes beyond what scattered elements could produce at their own level.

This argumentation unfortunately rests on the opposition between chance and God's design. It ignores an essential point, concerning the nature of the theory of evolution. That theory makes it possible to retrace the history of life. It is voiced by those who are at the end of the process at work. They see links between the forces of nature and occurrences. They offer explanations which extend from the limited field of their studies to the whole phenomenon of life. It is important to admit that it is a retrospective vision. By placing oneself ideally at the beginning, it is not fair to say that one could foresee what happened. It is not pointless to foresee the future evolution of life, but those predictions are of random phenomena – the farther one goes from the present to look into the future, the less one can foresee what will come, as we well know if we think of the determinist chaos. Facing the unknown, it is important to admit that the existence of divine interventions is yet to be proved – and therefore one must avoid appealing to them.

Thus, in order to speak of a divine design in theology, we have shown that it is not necessary to oppose God and chance. The concept of chance is unfortunately too large. On must show that chance is not only a zone of 'unknowing', but that there are laws which make it possible to deal with it. We need to go through a last stage in our argument and consider philosophy immanent to mathematical probabilities.

[13] See John Polkinghorne, *Science and Creation*, London, SPCK, 1988; *Science and Providence*, London, SPCK, 1989; *Science and Christian Belief*, London, SPCK, 1994.

7. *The Notion of Probability*

The current reflexion of the more sensible supporters of *Intelligent Design* takes its roots in a reflexion on conditional probabilities.[14] It is by analysing the way in which an argument concerning conditional probability functions, that the supporters of *Intelligent Design* favour the existence of an intelligence at work in the world.[15]

Concerning this point, it is important to see that the reference of science to probabilities introduces a new perspective. The Ancients gave to the notion of Cause an ontological value. Modern science has abandoned this philosophy, considering that one should not reason in ontological terms. Before being used by sciences, the notion of probability was made clearer through debates concerning the relationship between science and opinion.[16] Whereas science proceeds in a demonstrative way and leads to certitude, the word probable qualifies opinion. The adherence to what is probable has been the object of interest of moralists, concerned as they were with actions corresponding to the standards of truth and rectitude, and of jurists, who had to take decisions in muddled situations. For want of turning to experience and demonstration, a probable opinion was a judgment approved by autority or by the testimony of respected judges. Probable opinion referred to plausibility.

The situation changed in the 17th century, when calculations were made to determine what was the most probable. Pascal's findings were resumed by Leibniz, who was the first to suggest the use of calculation in order to measure the degree to which a proof was valid.[17] At the end of the

[14] This theme has been dealt with at some length by Michael Behe, *Darwin's Black Box*, New York, Free Press, 1996. On this point, see the review by Eliott Sober, 'Intelligent Design and probability reasoning', *International Journal for Philosophy of Religion*, n. 52, 2002, pp. 65-80.

[15] See the book by one of the supporters of *Intelligent Design*, William A. Dembski, *The Design Inference. Eliminating Chance through small Probabilities*, Cambridge / New York: Cambridge University Press, 1998. On this question, see John Forster, *The divine Law-Maker, Lectures on Induction, Laws of Nature and the Existence of God*, Oxford, Clarendon Press, 2004.

[16] Ian Hacking, *The Emergence of Probability*, Cambridge University Press, 1975. Trad. Fr. *L'Emergence de la Probabilité*, Paris, Ed. du Seuil, 2002.

[17] This research shows how a new science benefits by the conceptual contributions of other fields; here, the science of action in the fields of morality, justice, and the management of goods.

17th century, Bernoulli synthetised those results and formulated a theory proposing a global vision of the notion of probability linked with a mathematical expression in the shape of a theorem.[18] Ever since, scientists have invented more powerful mathematical tools and, in so doing, have changed the nature of scientific work.

For the Ancients, at the school of Plato or Aristotle, the link between a cause and its effect is of an ontological nature, it is necessary. The mathematical expression is then a source of certitude. The consideration issuing from the development of a science founded on probabilities is quite different. By using no longer what is certain but what is probable as a support for its demonstration, science no longer says *what is*, but *what happens most often*. The questions asked by Hume express this change. Abstraction is replaced by induction. In the classical sense of the word, abstraction catches the essence of a phenomenon, and separates it from adventitious elements; in the modern sense of the word, induction is a generalisation which remains in the field of the probable. The words *law* and *cause* do not have the same meaning. In current science, the notion of predactibility has broken away from the deterministic vision whose ambition is to account for everything by necessary reason, without leaving anything outside of its scope.[19] A classical example of this is to be found in the preface by Laplace to his *Treatise on Probabilities*.

The notion of predictibility has radically changed. For that reason, the transfer made by the supporters of *Intelligent Design* from science to theology is not a rigorous step, because it does not respect the orders of knowledge: it unduly introduces theological developments within scientific discourse. It has been our concern to honour philosophy by talking of contingency and science by talking of random phenomena.

Conclusion

At the close of this rapid analysis, I would like to introduce a distinction between three ways of considering the action of God the Creator. One way seems to me quite traditional: the world has been created by God. The cre-

[18] On the question of probabilities, see the fundamental study by Jean Largeault, *Hasard, Probabilités, Inductions*, Toulouse, Université du Mirail, 1979.

[19] See Alexandre Kojève, *L'idée du déterminisme dans la physique classique et dans la physique moderne*, Paris, Librairie Générale française, 1990.

ating act does not consist in establishing a universe, which God would have then abandoned. It is a permanent presence.

A second approach strikes me as inadequate: I will describe it as apologetic, because it uses the inadequacies and uncertainties of science to propose an intervention of God. It is improper, because if and when we eventually understand, God becomes an 'unnecessary hypothesis'.

A third attitude seems to me unacceptable: it consists in finding arguments in the Bible to challenge or refute the scientific explanations which do not use word for word the biblibical text. Here is there a misunderstanding of the nature of the biblical text.

At the end of this paper, I would like to remark that these difficulties arise from a too narrow conception of the action of God. If you make God into an actor like other actors, you have to push God aside so that nature can act, and nature must be purely passive in order to obey God.

We have a different conception of God. The acknowledgment of his sanctity allows for the autonomy of his creatures and the play of nature's laws. Such a position is rooted in revelation. Revelation, far from limiting scientific activity, founds it by showing that God is greater than what religions and philosophies ordinarily admit. Revelation, far from giving ready-made answers to human research, underscores the importance of man's freedom, circumscribed as he is in a nature which has its own coherence and richness.

Those elements apply to nature; they could also be used to build a theology of human freedom. The more we acknowledge the greatness of grace, the better we understand that nature is at work according to its capacities in the adventure of salvation.