DOES GOD PLAY AT DICE?

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How do the concepts of law and order in nature relate to the ideas of novelty and free choice? Does the will of God allow for freedom in the reality about us?

INTRODUCTION

For most of us there is a tension between the naturalistic and the theistic view of the relations between things and events. For the naturalist the universe is a vast system or process, self-contained and self-consistent, with every thing and every event explicable (in principle) in terms of other things and other events belonging to the system. The theist holds to the idea of a God who is apart from the world and yet on whom the world depends for its existence and to whose will it is responsive. The tension, if I am correct, is part of the cultural heritage of Western man. It is particularly acute for those who subscribe to theism and practice crafts, like those of the scientist or historian, primarily concerned with the development of naturalistic explanations.

Since the seventeenth century the view of the world most frequently held is one that might be called "Newtonian" after its similarity to Newtonian mechanics. In this naturalistic pattern, all future events flow out of the present and are uniquely determined by the present. In a real sense there are no surprises in the Newtonian world since every event follows inexorably from other events.

Laplace expressed the Newtonian idea in a particularly impressive way that has become part of the myth of the original idea. He supposed there was a mathematical demon of infinite computational capacity, something far beyond even the most powerful computers of the present day. He claimed that with such a demon at hand he would only need to know the exact position and velocity of every particle in the universe at a particular instant to be able to determine the state of the universe at any other time, past or future. The entire history of matter is interlocked in such a manner, according to this ideal, that it is inevitably unique. That such a demon could not exist is not an argument against Laplace's idea, as the statement is not about computability but about the relations of determinism.

It is difficult to make the Newtonian model harmonize with the ideas of theism, for a well-determined and self-consistent sequence of events can hardly be influenced from the outside without a serious disruption. And much of the conflict between scientific and religious thinking about the world in the post-Newtonian era can be traced to this difficulty. God can be seen as the creator of this vast machine and even the one who gives it initial direction, but He enters the stream of events only as an alien and a disrupting influence.

The twentieth-century physics of quantum mechanics stands apart from the Newtonian ideal in that the events of the future are not uniquely determined. The potentialities for a variety of futures exist in the present and although the question of God's relation to the whole remains unanswered, it is clear that it must be answered in fundamentally different terms than in an earlier era. It is the purpose of this essay to attempt the expression of the problem in terms and concepts common to twentieth-century physics. It would be optimistic to expect a solution to the fundamental question to result from the change of physical world-view, but refreshing insights may follow from the endeavor.

The first, and I believe the only, person to attack the problem outlined was William Pollard, who in *Chance and Providence* attempted to bring the world-views of theism and quantum physics together. In

what follows I will be depending heavily upon his work. If I take exception to his views at times, I believe I am still within the basic spirit of his approach. The terms used (and to a large extent the categories) are those introduced in his work. "Providence" usually implies a relation between God and the world rather than any specific act. "Chance" as he uses the word describes an event that is not uniquely determined by its antecedents. The "accidental event" is for him one that occurs at the coincidence of two or more causal chains.

What begins as a nuclear physicist qua theist looking at the Biblical view of providence becomes a historiography, where the random events are not those of atoms but of men; but the openness of a world where chance events may occur is required if one is to posit a God active in history.

The key to the Biblical ideas of providence, and therefore to providence in the form in which we as Christians perceive it, is to be found in the appearance of chance and accident in history (Pollard 1958, p. 66).

In Pollard's view what is seen as accidental in the scientific or historical view of reality may with equal validity be seen as providential from the Biblical view and these two apparently contradictory perceptions are two aspects of a single total reality.

THE BIBLICAL VIEW

There are two fundamental concerns of cosmological thought on which the Bible clearly speaks and where its statements guide us in our thinking. The Scriptures are clear in expressing a basic theism in describing God's relation to the world of things. He creates the world from nothing. He passes judgment on it. The world is sustained by Him and is subject to His will both in a general way and in specific cases. It, however, does not reflect His immediate will in all things. Man, as he appears in Scripture, stands between. He is part of the created world of things, but is given responsibilities that transcend the rest of nature. He is able to make judgments and to introduce novelty. He is subject to a world of nature as part of it, but makes choices and takes actions that do not flow uniquely out of the situation. He is held responsible for these actions.

Whereas the Biblical views of God and man do not speak directly on our subject, they supply a reference point. They reject what Pollard describes as the tended-machine idea that grows out of Newtonian mechanics and that ends by eliminating the possibility of God acting in the world.

... we have come to think of our world ... as a vast and intricately complex mechanism unfolding inexorably in accordance with fixed and timeless laws defining its behavior down to the most intimate detail. The relation between God and nature, if acknowledged at all, has been reduced to that of the deus ex machina *who, having initially brought the world into existence and endowed it with a certain structure regulated by a complete system of scientific law, has ever since stood wholly apart from it* (Pollard 1958, p. 19).

Against this idea, he expresses the following as the Biblical concept:

The idea of a nature which was capable of running along on her own course apart from God even for a short time is entirely foreign to Biblical thought. Providence in the Bible is a continuous relationship of dependence of both man and nature on God of such mutuality and intimacy that the latter could not continue at all if ever the relationship were broken (Pollard 1958, p. 27).

This latter quotation is an expression of the apostle Paul's "In Him we live and move and have our being" (Acts 17:28). Our immediate interest is to discover compatibility between the Biblical view of God's action and the view commonly held by quantum physicists of the statistical nature of events. The task is undertaken with full confidence in both the basic theistic views and the meaningfulness of scientific and historical activity. The synthesis sought is one that includes a purposive God, ever active in the whole of creation, and that preserves the essential integrity of science.

THE QUANTUM VIEW

In twentieth-century physics a completely new set of ideas associated with quantum mechanics has become dominant, contested from every side, but still the working faith of a large part of the physics community. It is this set of ideas that I will suggest may be compatible with the Biblical view of providence and with God's continued action in a world apart from Him.

Within the theory of quantum mechanics are several features that merit attention. First, there is the basic statistical nature of the event. The consequence of a quantum calculation is always stated in terms of probabilities. The probability of quantum mechanics is not a consequence of complexity or of lack of knowledge, but is fundamental and at the heart of the matter. The consequence of any set of conditions is not uniquely described but always given as a probability statement on a set of possibilities, and there is no set of more precise measurements that is ever going to make it more than this. It follows that the demon could not uniquely specify the future of even the simplest system, but only the possibilities for the future, and this is clearly far from Laplace's ideal, as the future is now open in a real sense. This does not indicate that the future is completely open to any possibility, as a number of rigid conservation rules determines the possibilities and their relative probabilities. They, however, do not determine the specific event that will take place at any instant.

Secondly, the principle of uncertainty (indeterminacy) describes the limitations on the knowledge available about a physical system as a result of any single set of measurements. In physical terms either the energy or the time of the event may be known, but if the energy is specified more precisely, it results in the time being known less precisely. This limitation is also true for knowledge about the position and velocity. This places a fundamental restriction on the knowledge available about the system. Laplace's demon would be hamstrung before commencing his calculation by a lack of complete information.

Taken together, what the statistical event and the uncertainty principle reveal is a world that is open at its most fundamental level in the sense that the future is not uniquely determined by the present state of affairs. This was identified by the term "chance" at the beginning. I cannot emphasize too strongly that this chance is not the same as that experienced in events such as rolling dice, where it is in theory possible to know the outcome, if sufficient care is taken. In this case, the statistical nature of the event is at the heart of the matter.

It is at this point that many persons, including Einstein, reject the statistical interpretation of quantum mechanics. Can the world be statistical and open at its most fundamental level? The question is in a sense still open, for there is not universal agreement about the foundations of physics. But the weight of current evidence and opinion favors a statistical view, which at this level implies an open system. The next question is what this means for our broader world-view.

OTHER SOURCES OF NOVELTY

From the beginning of deterministic modern science there was no suggestion that man was completely determined. Descartes spoke of animals as automatons in the sense of being machine-like, but man was seen as something apart, capable of taking self-generated action. As the ideas of determinism became more thoroughly developed, however, others insisted that man is also part of deterministic nature. We see the culmination of this tendency in the behavioral psychology of the present era. It is, to say the least, ironical to see the result of an *idee fixe*, discarded from the world of physics, held to religiously in a field where there was little reason to adopt it in the first place.

We see no reason to doubt that even though man is subject to a multitude of determining forces and is in many ways determined, he still makes choices, takes action, and is a source of genuine novelty in the world. There is certainly as much empirical evidence for this generalization as for any made in the field of physics. The honest skeptic will continue to raise valid questions, but if he looks critically at the fundamental principles of physics, he will find them at least as dubitable as the ideas that he questions about man. Opposition to the idea of man as an originator of genuine novelty comes from both sides. Believers in deterministic materialism reject it as in some sense placing man outside of an otherwise complete natural world. Those who subscribe to the idea of an omnipotent God reject freedom for man as in some way encroaching on God's prerogatives. The two objections, from opposite poles of thought, are similar in that they each view the idea of man's freedom as a violation of a monolithic view of reality, and we can only ask for a critical, open-minded examination of the evidence in science, in history, and in Scripture.

The comparison between the behavior of physical systems and historical events at the level of man's

action is certainly a giant quantum jump and must not be understood in terms of the latter being derived from the former. If either or both are genuine, they must stand on their own merits. Pollard sees the connection, or parallel, between the two as lying in the irreversibility shared by all events subject to the second law of thermodynamics and the irreversibility of history. He is here relying upon a distinction made by Weizäker between scientific and historic time: "With the second law ... it can be proved that the world is a sequence of events incapable of repetition" (Weizsäker 1951, pp. 49, 50). In this context, the term historic time refers to any irreversible sequence, whether the concern is historic or scientific.

In developing the analogy Pollard depends heavily on Handlin's argument that the development of history is open to chance and accident. To Handlin the chance event or the accident is often the key to "understanding" history, and since he suggests that the workings of providence may "be seen" in these turns of history, the idea is ready at hand for Pollard's use. It should be made clear that he is not suggesting either: 1) at the level of random events, God in some sense mechanically contrives the outcome either for atoms or man, or 2) God manipulates the probabilities so that the outcome is certain or more certain. Although Handlin may in fact be saying something like one of these, what Pollard is saying is more basic and deals specifically with our understanding of events.

In the following quotation the idea of complementarity is evidently applied:

Science deals with repeatable events for which the laws of nature determine probabilities of occurrence. Providence in the Biblical sense deals with isolated singular events apprehended in a given historical context as responsive to God's will. One and the same event can equally well be regarded as under the full sway of all laws of nature and natural causality and at the same time under the full sway of the divine will (Pollard 1958, p. 94).

He clearly believes that to perceive events as the working out of God's will requires the insight of revelation:

The methods of science can never penetrate beyond chance and accident to discover any evidence of providence, and at the same time how and why it should be that the hand of God in history can only be known ... through revelation.... one and the same sequence of events can be apprehended by one observer as merely a remarkable streak of luck while being recognized by another for what it really is: a mighty act of the living God (Pollard 1958, p. 171).

As he describes the two ways of looking at reality, insisting that both are true but neither is truth, it is clear that the idea of complementarity (it may be necessary to look at the same event from two different points of view to extract all its possibilities) is as precious to Pollard as it was to Bohr. The scientific world-view and the theistic world-view are necessary complements to each other.

It is apparent that there are at least three different sources for novelty: God, man, and the quantum event. It remains to explore what the consequences are and what they say about God's relation to the whole.

A PURPOSEFUL WORLD

Is there any way in which the history of such a statistical world, or the world itself, can be described as purposeful? To answer the question we must first explore the idea of purpose for its meaning. If "purpose" means an inexorable movement toward some unique end, it appears that the openness of the statistical event denies that possibility. If purpose attaches to things rather than to events (e.g., the watch marks time for man, the purpose of the sun is to warm the earth, etc.), it is not clear that the statistical concept has anything particular to say about it. Things may, or may not, have unique functions that serve some central purpose.

Let it be assumed, however, that the statistical nature of events itself serves some general purpose. A case can be made for this in the following way. Suppose that the purpose is not in the end, but in the doing. It is possible from this point of view to see within the statistical world opportunity for purpose to be achieved. If to provide a future open to novelty, to have a world with a rich variety of possibilities and situations, to allow opportunity for creatures to act responsibly serves a purpose, then it appears that the statistical world can be thought of as fulfilling this purpose.

In this connection Bronowski distinguishes systems as topologically open or closed, bounded or unbounded:

A bounded plan is a rational sequence of instructions which have been framed to reach an announced end. If the end state is the same as the state at the beginning, the bounded plan is also closed; but in either case, so long as the end state is fixed in advance, the plan has the finite and prescribed character that makes it equivalent to an instruction (Bronowski 1969, p. 73).

A topologically open and unbounded plan is one in which the end state is not unique nor are the steps by which the end is attained completely specified. In his view there are degrees of both openness and boundedness from the simplest physical systems, to the world of man. "Unbounded" as used here is equivalent to the "open" that we used earlier. In Bronowski's words the world as we perceive it is following an open, unbounded plan. "Only unbounded plans can be creative," for the bounded plan is always the solution to a specific problem. The case being made is that the unbounded character of the world is founded on its basic statistical character. No one is suggesting either complete unboundedness or complete openness. There remain within quantum mechanics, as in history, impossibilities as well as possibilities. In physics it is a striking fact that the strongest laws are statements of impossibility, "the postulates of impotence." Systematic formulation of the impotence postulates for men does not exist, but we are all conscious of our impossibilities. Open-unbounded plans may still have a structure, but it appears as a structure on the statistics.

Neither is it being claimed that randomness at the quantum level is the basis for the randomness at higher levels. This may or may not be true. The assertion that we are making is less than that of Bronowski who sees novelty at all levels, but is compatible with it. The claim is only that there is reasonable evidence for novelty at at least three levels and that this openness to novelty is perceivably purposeful.

OBJECTIONS

Einstein's profound dissatisfaction with the statistical view of quantum theory and his numerous attempts to break the Copenhagen-Born interpretation and to produce an alternative are well known and reminds us of his question of whether God plays at dice: "Der Herr Gott würfelt nicht." He was, and is, not alone in his feeling about the theory, and others continue to challenge the statistical view. If, in fact, the statistical view and the uncertainty principle are valid, and if at the other end of the spectrum man does act freely, it is clear that in a sense God does play at dice, i.e., the outcome of things is not uniquely determined by His will and that He relates to a world open to chance or novelty.

The concern of Einstein appears to stem from devotion to the idea of an ultimate single equation describing all physical reality. Several fundamental contributions to statistical physics and early quantum theory were made by him, but after his work on general relativity and when it became clear where quantum physics was headed, he consistently opposed its statistical interpretations.

Others have different reasons for concern. Is the order perceived at the level of our senses consonant with the disorder or chaos that follows from the statistical event? Is it possible for an overall purpose to be achieved, or for order to result from statistical events? I have spoken of a purpose to be achieved in producing a milieu for free action, but is that enough, for does the Biblical view not see the world as moving toward an end, and is this possible in a statistical world?

There are two approaches to the first question, and the second of these suggests the possibility of a response to the second question. Statistical mechanics, the mechanics of large numbers of atoms, molecules, or anything, is a well-developed branch of deterministic physics. Starting from simple statements about probabilities and proceeding in a straightforward manner it concludes with what appear to be deterministic equations governing the behavior of the system. Laboratory measurements to verify these equations give consistent results. Ought there not to be large fluctuations on any single prediction if the fundamental event is random? No, not so, for there is a central tendency in the statistics, and for large numbers this is extremely sharp and the fluctuations relatively small. The result is that the behavior of a physical system consisting of a large number of elements is predictable. The order is well defined even though it rests on a fundamental disorder. Order does, in fact, emerge from chaos as a result of the central tendency of the statistics of large numbers.

Order comes out of chaos also in quite another way in the growth of a crystal and in the nourishment of a

living cell. In each of these the random motion of molecular events is a necessity if the process is to continue, i.e., for the crystal to grow or for the cell to continue function.

To develop the idea of a developed order in spite of a basic randomness, consider an analogy. In sending a message by telephone or in recording a scene with a photograph, it is interesting to note that the basic element in each case is a random event. The emission of an electron from a hot filament and the photon striking a silver halide crystal are alike in that there is no way of determining when the electron will be emitted or where the photon will strike. The sound of electrons leaving a filament is quite like the sound of rain on the roof and the statistics of photons striking film the same as that of raindrops hitting pavement. By modulating these events, in time for electrical signal and in space for the optical, the result is a coherent message and a replica of a scene. From this it is clear that order and useful ends can be achieved starting from random events. The analogy is applied by supposing that something like modulation occurs in the world as a result of God's action. Without changing the statistical character of the free act or the quantum event, the overall pattern of events is ordered and purposeful. What is required to achieve that modulation when the effective agent is God's will is not clear nor is it expected that it will ever be clear to us. It appears wise to stay completely away from any attempt to construct a mechanism and ask only if the ideas are self-consistent.

CONSISTENCY

If the ideas that have been developed are to be tested against Scriptural concepts, the best that we can expect is a general harmony. Certainly the Bible doesn't speak on the interpretations of quantum mechanics but it does on the affairs of men and history.

Accidents do occur, are recorded, and accounted for as accidents in Scripture. "Time and chance" are part of the view of the world, and the Bible clearly indicates that to think of God as directly involved in directing each of life's events is improper. To explain, as we often do, that "God permits" is to speak for a world that does not always follow a unique purpose and direction and is consistent with the concept of chance events. There is insufficient Biblical evidence to explain, as some do, that all events not under God's immediate direction are being directed by the power of Satan, although the world described by writers of Scripture certainly allows for direct acts of intervention both by God and Satan. "In Him we live, and move, and have our being" (Acts 17) is a statement about the most basic relation of all being. Beyond this, and after allowing for acts of intervention, the world appears to be given, by its creator and sustainer, the power of autonomy to continue as a self-functioning, self-consistent thing.

It is significant to note that something has happened to our view of God as this idea has developed. If God is omnipotent and if He creates things to which power is given, He is then no longer (as the one who objected to man as a source of novelty realized) omnipotent in the original sense. He has given up, apparently of His own volition, part of His power as a gift to the creation. In another sense it is still His, for it is held, by the other, subject to His will. The Scriptural view of the generous, loving, giving God is consistent with this act of sharing.

If the future is truly open as would be suggested by both the statistical understanding of the quantum event and the concept of men who make bona fide choices, then again God has given up the unique knowledge of all future events we often attribute to Him. In giving to atoms their quantum nature and to man the power to choose and act, He has allowed creative acts, of which He is the sustainer, that introduced genuine novelty into the world. Within this view God still knows the future in that He knows what He plans; but His plans are often conditional, dependent upon the creation. This is certainly a conclusion consistent with Scripture. The conclusion appears to be superior to any view that starts from a thorough determinism in that it allows God to act in the world in a way consistent with the potentialities of the world as an autonomous creation completely dependent upon Him for its continued being. It appears to speak of the largeness of a God who is willing to take risks with His creation so that what is lost in power and knowledge by the gifts He has given may return as greatness of heart.

Furthermore, a question that has been waiting to be answered from the first may now be clearly answered in the affirmative. The activities and explanations of the scientist and the historian are bona fide. Their endeavors have at least the possibility of producing a genuine, although possibly not a complete, understanding.

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