A NEW ROLE OF THE EXPERIMENTER IN SCIENCE SUGGESTED BY PARAPSYCHOLOGY RESEARCH

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I. INTRODUCTION

One of the goals of scientists is to give an objective description of the outside world. This raises the question as to what extent a clear separation between the experimenter and the outside world is in principle possible.

In the framework of classical physics it seemed that the experimenter just played the role of a passive observer who merely had to set the stage for an experiment and could then observe without having to disturb nature in the process. This concept of the experimenter as passive onlooker had to be revised with the advent of quantum theory. Thus it was found, for example, that one cannot study the structure of an atom without rather violently disturbing this atom at the same time. In the further development of quantum theory it became apparent that this disturbance of an atomic system by the act of observation was not just an annoying practical feature, but formed a basic part of the structure of the theory.

New information about the role of the experimenter was provided by experimental parapsychology. In psychokinesis, for example, a new type of coupling between the experimenter and the outside world was discovered. Furthermore, it was seen that this coupling has some non-causal features in the sense that the future acts directly on the present. This non-causality might perhaps be considered the basic feature of psychic phenomena. It leads necessarily to some unusual experimenter-object interaction, and so it appears that the role of the experimenter is quite intricately related to the most basic problems of psi.

II. THE ROLE OF THE EXPERIMENTER IN CLASSICAL AND MODERN PHYSICS

During the development of science nature seemed inclined to be rather friendly toward the experimenter. Thus we were not faced with the whole complexity of nature at once, and in particular we could find in the formalism of classical physics a conceptually and mathematically simple tool to describe nature in a surprisingly good approximation. Only after we had gained experience and confidence in the quantitative mathematical method did we become aware of the necessity to introduce quantum theory with its more complex structure. Furthermore, it was only after quantum theory had been very successfully established that the need for some further modifications was indicated by the results of psi research.

From the viewpoint of the researcher, classical physics had many rather pleasant features. In particular, most of classical physics seemed intuitively plausible. Thus physics appeared as a rather natural quantitative extension of man's everyday experiences. Most phenomena could be understood by reducing them to simpler, more familiar concepts. For example, the complex motion of water waves could be explained in terms of the motions of the individual atoms, which in turn were governed by simple mechanical laws.

Especially helpful for the formulation of mathematically simple physical laws was the finding that the physical forces encountered in nature had a limited range, such that a system under study in the laboratory could in many cases be considered an "isolated system." That is, its interaction with the rest of the world could be ignored. In classical physics it seemed, furthermore, that this isolation could be maintained while the experimenter observed and made measurements "from outside" the system. Thus an ideal separation between experimenter and outside world seemed possible, in the sense that we could conceptualize an independent, physically real outside world that we could just passively observe without having to disturb it in the process.

With the advent of modern physics nature seemed to lose some of these pleasant features.

The theory of relativity, and later quantum theory emphasized rather drastically that our intuitive feelings about nature, which we developed in our sandbox days, need not necessarily be correct. Thus it was found that for systems traveling at very high speeds, our intuitive concepts of space and time had to be modified, and at the atomic level even such intuitive concepts as the position or the velocity of a particle became meaningless. The fact that intuitive feeling and common sense, as developed in everyday life, are not good guides when interpreting completely new phenomena that we can not yet incorporate into our intuition, has brought a shift in what the physicist would define as "understanding" nature. In the absence of any intuitive guidance to tell us what is reasonable, "understanding" becomes synonymous with giving a mathematically simple and self-consistent description of a phenomenon. Thus the experimenter's judgment of plausibility becomes replaced by the mathematical requirements of a physical theory.

Quantum theory brought the role of the experimenter, practically and theoretically, into a new perspective. Practically it was found that in observing physical systems at the atomic level we cannot avoid disturbing the systems in the process of observation. For example, in order to measure the positions of the electrons in an atom we have to shoot light quanta (or other particles) at the atom, and for a good measurement the light quanta must have such high energies that they violently disturb the electrons under study. Thus the experimenter loses his role as a passive spectator.

From the theorist's viewpoint the changes brought about by quantum theory appear still more radical. Not only is the experimenter unable to study an undisturbed system, but the very concept of an absolute physical reality without reference to an observing experimenter loses its meaning, at least at the atomic level.

It is still meaningful to state that an experimenter who measured the position of an electron obtained a certain value, but it is no longer meaningful to assume that the electron has a well-defined position if no measurement is made. Such assumptions lead to inconsistencies. Thus the concept of such seemingly simple and intuitive plausible quantities as the position of a particle has no absolute reality. A perhaps more familiar example of the reality problem arises in connection with the old question of whether light consists of particles or waves. It turns out that it makes no sense and leads to contradictions to suppose that light is "really" formed by waves *or* particles. The only meaningful type of statement to be made is one like this: If the experimenter conducts this or that experiment, then he will observe the light quanta as waves or particles.

Among physicists, a more controversial issue arises if one extends the quantum mechanical formalism to macroscopic systems, because then, even in the macroscopic world, physical processes need not have the character of absolute reality unless there is an observer.

This viewpoint would lead to a rather unconventional interpretation of physical events, but it would not be in disagreement with the available experimental evidence. Consider, as an example, an experiment where a die is shaken under a cup and then, still covered by the cup, placed on the table. From the new viewpoint it would appear then that the decision about which side falls on top is not made at the time when the die comes to rest but rather at the moment when the experimenter lifts the cup and looks at the die. I do not want to advocate this extreme viewpoint since physics has provided no means for an experimental check. On the other hand I consider it well possible that parapsychology might help to decide some questions that, in the present state of physics, are purely theoretical issues.

III. THE EXPERIMENTER IN A WORLD WITH PSI

In many psychological tests the outcome depends to some extent on how the experimenter handles the subjects. It is certainly not surprising to find a similar effect in psi tests, particularly since psi is largely a subconscious function which depends critically on subtle factors such as confidence and motivation. This type of experimenter effect plays a very important practical role in parapsychology, but I will not pursue this purely psychological aspect in the present context. Let me rather focus on those aspects of the experimenter effect that are directly related to the operation of psi.

PK research has demonstrated the existence of some possible interaction between the experimenter and the object under study. PK appears in the laboratory as a mental influence on the outcome of random events. These events can be provided by rolled dice, by shuffled cards, or by other means. I will discuss an experiment in which the randomness is furnished by what is perhaps nature's most elementary source of randomness, simple quantum processes. The central part of the test equipment is an electronic binary random number generator —let me call it an "electronic coinflipper"—that can produce, at a typical rate of one per second, a random sequence of "heads" and "tails." The internal mechanism of this generator is, briefly this: An electronic high frequency switch oscillates very rapidly (one million times per second) between two possible positions, a "head" position and a "tail" position. A random number is generated by stopping the oscillating switch suddenly at a random time. These random times are provided by simple quantum processes, radioactive decays. They are the times when electrons from a radioactive source are registered by a Geiger counter. Since from the viewpoint of contemporary physics the decays of the individual radioactive atoms occur in a completely random and unpredictable manner, the sequence of generated heads and tails should also be random and unpredictable.

During the PK test the sequence of generated heads and tails was automatically recorded, and the heads and tails were displayed to the subject not only by the readings of the two counters, but in several other psychologically more attractive ways. A particularly successful display was provided by a circular arrangement of nine lamps, one of which was lit at a time. Whenever the generator produced a head or a tail the light jumped from one step in a clockwise or counterclockwise direction, respectively, performing thus, in the absence of a subject, a random walk among the nine lamps. During the test the subject tried mentally to enforce an overall clockwise motion of the light, corresponding to the generation of more heads than tails.

Table

Formal Precognition Tests Made so far with the Four-Choice Random Number Generator

Test Number	No. of Subjects	Total Trials	Deviation* of scoring rate from 25%	CR†	P‡
1	3	63,000	1.1%	6.4	$<2\times10^{-9}$§
2	3	20,000	2.0%	6.6	$<10^{-10}$
3	2	10,000	−0.3%	not significant	
4	11	10,000	1.4%	3.3	$<5\times10^{-4}$
5	1	1,000	6.4%	4.7	$<2\times10^{-6}$

* Deviations in the desired direction are counted as positive.
† CR = (Deviation)/(Standard Deviation)
‡ P is the probability for obtaining, in a test of specified length, such a high or higher score as the result of chance fluctuation.
§ In the first experiment the number of trials to be made was only specified approximately between 55,000 and 70,000 trials. The given P-value provides an upper limit for obtaining anywhere in this interval the observed or a higher value of CR.

The first test with this arrangement was done with a group of the most easily available subjects. A preliminary study showed that these people as a whole had a negative scoring tendency. When they tried for heads they obtained an increased number of tails. In order to study the reality of the negative scoring the nine most negatively scoring subjects were selected for a formal test. To preserve the negative scoring tendency, the experimenter displayed a rather pessimistic attitude toward the test, and some subjects were instructed to consciously associate feelings of failure with the test.

The formal test, consisting of $2^{15}=32768$ trials, confirmed the negative scoring tendency. In only 49.1% of the random events did the light move in the desired clockwise direction. Such a large deviation would occur as a result of chance in less than one in a thousand such experiments. ($P<10^{-3}$, Table, Test 1.)

After this experiment, a man with more pronounced negative scoring tendencies was located, and the effect could be verified in the second formal test (Table, Test 2). Finally a strong positive scorer, an outgoing girl, was found. Again the following formal test (Table, Test 3) confirmed the reality of the effect. Another test was made with this same girl several months later. In this test a more complex random generator was used, obtained by mixing the output of two of the previously described generators. The score was again significantly positive (Table, Test 4). In particular, the increased complexity of the generator did not change the magnitude of the effect.

This PK experiment shows, like many of the earlier experiments, not only that PK exists, but also that a considerable number of people, with proper motivation, are able to display PK abilities. Furthermore, it is seen, for example from the group of negative scorers mentioned above that PK is subject to conscious control only to a limited degree. Faced with this situation we cannot exclude the possibility that any experimenter may have some mental influence on the outcome of any subtle statistical experiment. Consider, for example, the case where a physicist tries to obtain information about some elementary particle by taking and analyzing a small number of cloud chamber pictures. Then it might well be possible that the physicist uses his PK force subconsciously in such a way as to obtain an increased number of statistical events in his pictures that would support any theory he might favor.

This possibility of experimenter PK, which we can neither control nor shield, is more than an academic problem, for example in PK tests involving animals. Suppose we want to investigate whether or not animals can exert a PK effect on their surroundings. For this purpose we might couple an animal to the electronic coinflipper in such a way that whenever a head is produced the animal receives a certain stimulus whereas a tail generated provides no stimulus. Then, if the animals have some PK ability and can use it to their advantage, one might expect that the PK coupling causes the generator to produce an increased or decreased generation rate of heads, depending on whether the stimulus is a pleasant or unpleasant one.

The first indication of an effect was obtained from a cat that was kept in a cold room and exposed to a pleasant stimulus in the form of the short lighting of a heat lamp whenever a head was produced. Under these conditions the generator produced more heads than tails. A formal repetition of the test gave a statistically moderately significant confirmation, but a later attempt to reproduce the result brought only chance scores. Since then, several significant PK series with animals have been obtained by several researchers, but some rather similar tests gave only chance results. Through a better understanding of the animals involved the biologist might try to design better reproducible effects.

On the other hand we cannot yet exclude the possibility that it was the experimenter's desire to obtain a particular result rather than the animal's participation that was instrumental in unbalancing the number generation rates. In this case even the biologically most expert design of a test would not guarantee its repeatability. Further tests in which biological conditions and experimenters are systematically changed might clarify the role of the experimenter.

The first PK experiments with dice seemed to suggest some similarity between PK and other physical forces such as are found in electricity, magnetism, or gravitation. A different aspect of PK gradually emerged, however, when it became apparent that PK can operate unlike these other forces in a purposeful manner in the sense that it can complete seemingly very complicated tasks. One such example is provided by the experiments reported. From our everyday viewpoint the subject's task was a very complicated one. In order to succeed the subject had to cause the electrons from the radioactive decays to arrive at the Geiger counter just at the time when the high frequency oscillator was in the right phase. And when in the last test the task was made seemingly twice as complicated by combining two of the original random generators, this increased complexity did not lower the PK scores.

This situation suggests that psi may, perhaps, not be properly understood in terms of some causal mechanism by which the mind makes the electron hit the Geiger counter just at a cleverly calculated time, but that it may be more appropriate to see PK as a goal-oriented principle in the sense that it aims successfully at a final outcome, no matter how intricate the intermediate steps are. The existence of a goal-oriented principle could be interpreted as a direct action of the future on the present. The electron arrives at the right time at the counter because this event is later displayed to the subject as a hit.

The coupling between future and present suggested by PK has been studied previously in precognition tests. In a typical precognition experiment the subject tries to predict the outcome of a later random event that can be provided for example by the shaking of a die, the shuffling of cards, or by a quantum process. A large number of experiments have shown that such a prediction is possible, to a small but statistically significant degree, thus already indicating a direct action of the future on the present. The outcome of the future random events affects the present state of the subject so as to enable him to make a correct prediction. Precognition and PK seem to be experimentally and conceptually very closely related. In a "precognition" test we cannot distinguish whether the subject just predicts the future random event or whether, with the help of PK, he forces the random event to conform to the prediction. Thus it might be best for the present to consider PK and precognition as outcomes of one universal psi process that is characterized by a non-causal goal-oriented interaction between future and present.

IV. THE EXPERIMENTER IN A GOAL-ORIENTED WORLD

The finding that, somewhere in nature, we can encounter a non-causal principle might have a rather stimulating effect on theoretical physics. The general study of non-causal world models lies well within reach of the methods of physics, but it has so far been a rather unexplored field because there seemed to be no practical need for it and because the related mathematical problems are considerable.

The main mathematical difficulty arises from the fact that in a non-causal world, it is no longer permissible to consider an "isolated system" as a good approximation to a real system, because a presently isolated system will at some later time interact with the outside world, and this later interaction can affect the present behavior of the system. Furthermore, the experimenter can no longer be considered an outsider with an independent power to make decisions. These mathematical difficulties are the obvious counterparts of the corresponding difficulties in experimental parapsychology.

It appears, thus, that for the physicist a very natural approach toward the theoretical understanding of psi would be provided by a systematic mathematical study of general non-causal systems. As a first step the physicist would probably investigate very simple, nearly trivial models, and after he has gained some feeling for the cause-effect structure in such systems he might get bold enough to search for a specific non-causal principle which could account for the observed psi effects.

I will not go into further mathematical details, but rather, with the help of two examples, discuss some of the typical features of goal-oriented systems. The possibility of some goal-oriented principle has been mentioned occasionally in biology in connection with the evolution of species. It has been argued that chance mutations in connection with natural selection may not be efficient enough to account for the rather rapid process of evolution, and that there might be some principle that favors, in violation of pure chance laws, such mutations as can best serve some final goal. I do not want to advocate this particular idea. I just use it to illustrate the nature of a goal-oriented law.

Let me first point out that such a new principle need not violate the established physical conservation laws such as those for energy and momentum. It need affect only the frequency of statistical processes that are responsible for the occurrence of mutations. According to the statistical interpretation of modern physics the future of the world is not causally determined. There are, rather, many possible future world histories, and it is just a matter of chance as to which one of the many possible future paths history actually realizes. The goal-oriented principle might just help nature to select one out of the many possible world histories. Such a goal-oriented principle might not quite satisfy our desire to understand intuitively how nature works, because we could not point out a specific mechanism in terms of cause-effect notions that would produce mutation rates deviating from the conventional statistical predictions. But it may be impossible to reduce all new phenomena to the level of our everyday intuition. "Understanding" may perhaps just be equivalent to the successful formulation of a simple mathematical formalism which describes the phenomenon accurately.

The particular example mentioned is much too complicated for a detailed study. A better starting point for the discussion of non-causal systems and the role of the experimenter in these systems might be provided by extremely simplified world models such as, for example, the following:

Consider a "world" which consists of:

a) an animal

b) a binary random generator

c) an experimenter

For the sake of our qualitative discussion make the following assumptions:

a) The experimenter has the freedom, the only freedom, to turn the generator on and off during a one-hour period.

b) The generator, when turned on, produces a sequence of heads and tails at the rate of, say, one per second.

c) Animal and generator are coupled in such a way that with each generated head the animal receives an unpleasant stimulus.

d) In this model "world" there exists some goal-oriented principle which favors those world histories for which the animal receives a small number of unpleasant stimuli during the test hour.

In order to demonstrate some experimenter effect in this model, let me discuss two test situations that show that the experimenter, just by operating the on-off switch of the generator, can influence the relative frequencies of generated heads and tails.

a) Assume first that the experimenter decides in advance to leave the generator running during the whole test hour. Then the goal-oriented principle should favor histories of this world that contain a smaller relative frequency of heads than the 50% expected by conventional statistics.

b) Assume next that the experimenter decides in advance on the following test procedure: The generator is turned on for the first ten minutes, and the number of heads and tails are counted. The test is continued (by turning the generator on for the rest of the hour) only if, during the first ten minutes, there was an excess of tails, i.e., if the animals were "successful" in keeping the relative stimulus frequency below 50%.

Since the assumed goal-oriented principle aims at a minimal total number of stimuli generated during the whole hour, this goal can now be attained best by "fooling" the experimenter, by the generation of more than 50% stimuli in the first ten minutes, which makes the experimenter discontinue the test. Thus the generation rate of heads in the first ten minutes of the experiment depends on the experimenter's plans for the rest of the test hour. For a more quantitative discussion, it would be necessary to formulate the goal-oriented principle in a quantitative way, and one would have to use some specific model for the experimenter.

V. CONCLUSION

Psi research has shown a new type of coupling between the experimenter and the outside world and has thus again focused attention on the role of the experimenter. Previously, the experimenter became a topic of intensive study with the development of quantum theory. This theory showed that the experimenter can by no means be considered as an uninvolved spectator. Furthermore, it was seen that the experimenter plays a vital part for the interpretation of the theory. Some of the corresponding questions in quantum theory still wait for a satisfactory solution.

The experimenter effect in parapsychology seems also intricately related to the basic problems of psi. It appears specifically as a necessary consequence of the non-causal or goal-oriented effects observed in precognition and PK tests. It is the non-causal aspect of psi which distinguishes it clearly from current physics and which at the same time leads automatically to a much more drastic experimenter involvement than is encountered in quantum theory. The findings of parapsychology may suggest to the theoretical physicist a systematic study of non-causal world models. Such a study seems well possible within the mathematical formalism of physics, but so far it has been neglected since there seemed to be no practical need for it.

DISCUSSION

TARG: I think I understand the valuable point that you are making with regard to contamination in experiments with animals. There were very serious problems. I also think that it is important to realize that precognition experiments can be contaminated by PK effects. I do not, however, understand how PK effects are contaminated by precognitive phenomena. You seem to say that when a person is trying to control the outcome of your random generator, the experiment is somehow contaminated or ambiguous with precognition.

SCHMIDT: Yes. This is a one-way process. If you think you do a precognition experiment, then you have two possibilities: the subject just guesses or the subject makes up his mind and uses PK to make the prediction. And so you cannot completely separate precognition and PK.

TARG: I thought you worried about some future effect contaminating the PK experiments.

SCHMIDT: Your question about my statement would be: can you do a pure precognition experiment since PK comes in, at least in the statistical experiments. As for whether spontaneous cases are different, let us leave that open for the moment. "Can you do a pure PK experiment?" might indeed be your question. And you might feel more confident. However, there is still the possibility that, if we do a PK experiment with dice, we try to get a six. Then by a waiting strategy, you might wait for a good time. You see, if you are here and you wait, the six is produced, physically speaking, by the interaction of the dice with the table with the thermal fluctuations that are very rapid. If you just wait a second, the whole set-up is different. And so, if you are a good prophet you might say, "No, it is not a good time to try for a six," and do it later. How seriously we take it is another matter.

CAHN: The notion of a goal-oriented process or a non-causal process is, of course, one that has been raised by many people, especially in biology. I would like to ask you, Dr. Schmidt, as a physicist, what you think the possible influence of such a notion might be on the recently described experiments on the radiation of Cobalt 60. There is the supposed preferred directional radiation of Cobalt 60 suggesting—depending on how you interpret it—that it is a property of space or time. How might this possibly, in your opinion, relate to the existence of a goal-oriented process in nature?

SCHMIDT: I think it would not be directly related. In the anisotropy of time you are mentioning, perhaps, in the very basic laws of physics, one direction of time is preferred.

CAHN: But thermodynamically.

SCHMIDT: No, at the atomic level really, at the microscopic level. That is a question of time and variance whether nature, at the microscopic level, distinguishes one time direction. That is one question that would be rather independent, if it still would be a causal world. It need not be non-causal.

ORME: I am a bit puzzled by this use of the words *causal* and *non-causal*. I admire physical science immensely and think that all science ought to end with some nice mathematical formulations. But I always understood that, even in physics, the cause is not out there. It is in the interpretation one puts on physical events. And indeed I understood that people like Hume, 200 or 300 years ago, argued forcefully for this view. If this is so, of course it makes it difficult to maintain a distinction between physical causes and other events that one is trying to keep outside this framework. Now, if in fact a causal view of anything is worth having, it does not really matter what one is considering. Whether this is goal-directed or something that, in fact, is acting outside some accepted physical view, I would have thought that whatever one was doing, one was after a causal explanation.

SCHMIDT: So, if you had a mathematical formalism, you would say the behavior of a system is a cause of this formalism, then you could call it causal. But if you define causality in such terms that you can split events into cause and the later effects in a reasonable way, then it would be a non-causal effect, like the signals going into the past. That is an exaggeration of terminology, but I would call this non-causal because I have this time-order destroyed.

ORME: I appreciate that this is important, but, again, I thought it was quite respectable in physics these days, to talk about time reversal effects.

SCHMIDT: But that may not be a non-causal thing. The time reversal would mean that if the moon can travel one way around the earth, then it could go the other way as well; it would also be consistent with physical laws. This would be the time reversibility of physical laws, which is different from signals into the past.

ROGO: Dr. Schmidt, concerning the patterns found in PK results after the experiments had been run, such as the Forwald experiments, do you think that such results are free from the experimenter effect?

SCHMIDT: I can only give a personal, unscientific judgment. I say we have to consider it as a serious possibility. Perhaps I am too extreme, but I want to keep this possibility open.

ROGO: Possibility of what?

SCHMIDT: The possibility that the wish of the experimenter to get good results may, ten days later, be fulfilled. This has been my observation.

KOESTLER: Sidney Hook, professor of philosophy at New York University, once said that our categories of thinking are projections of the Greek language into the universe. I think there is a great deal of truth in it, because if you try to argue with an intelligent Hindu philosopher-theologian, you will find that it is not only a question of translating words or grammar. The categories of thought are different. The Easterners have never projected the Greek language and Aristotelian logic. So we are getting the game bogged down again. If an event is non-causal, what causes it? This is a stalemate, a dead end. The phenomena are there. The difficulties of PK, the logic difficulties in terms of Greek categories, with which PK and precognition are faced, are no greater and no smaller than the difficulties that confront a quantum physicist who denies ESP. It can easily be shown that he comes up against the same conceptual difficulties with which the ESP technician is dealing. So let us get rid of that inferiority complex. The quantum physicists are just as guilty of going against common sense as the ESP technicians are.

SCHMIDT: The difference is that in quantum theory, physicists have an appropriate known language in the form of mathematics. We do not yet know the language of parapsychology.

BELOFF: I am interested in Dr. Schmidt's goal-oriented process. I believe this is a very fruitful notion and hope it will not be swept aside. But I want to understand more clearly why he introduces it and what he intends by it. Does he conceive of it as something occurring just because a human being is involved in the process, or would he not be surprised if some parallel goal or entropy process were produced in the ordinary realm of physics that is not directly linked up with what I would call mind influences?

SCHMIDT: I would primarily start with a general system, not assuming any living organisms. Then, eventually start to explore the internal consistency of such a thing. In physics, it is a standard method to start with a formalism and then see later what it means.

POYNTON: I have been having a feeling, in this discussion on causality, that we are tending to confuse two things that might be separate.

Perhaps Professor Flew might comment on the fact that all scientific discovery depends on assertical causes. This is quite a different thing from necessarily believing in a universal causal law.

SCHMIDT: This is an unfortunate double use of the word *cause.* I would say if I have a mathematical theory that describes the results properly, then I have a cause, in the sense of explanation.

POYNTON: There are two contexts: one, just an ordinary, practical context, the other, a metaphysical context; the idea of some universal causality as opposed to the autocratical, assertical causes that characterize normal scientific discovery.