Through the anxious years coming up, man's fitness to survive what already hangs over his head may easily depend on how well and how fast his scientists can think. But who knows what this thinking is worth until it is known—until it is made readily available in the forum, the symposium, and the periodical? It is time, and it is urgent, to borrow from the engineers their successful practice of reaching out for, instead of fending off, novel claims and unorthodox discoveries, of clarifying their status promptly and in general encouraging the creative turn of mind—and to extend this practice to areas beyond that of gadgetry and invention, areas that have to do with the understanding of man and the guiding values of life.

In this last section I have been attempting to say that Price's article is perhaps more revealing with regard to the need in American science for a more tolerant attitude than it is of the status of the struggling young science of parapsychology on which it has made a curious, bludgeoning attack. Parapsychology can now take care of itself, I think, but what about American science?

References and Notes

1. R. Walker, *Sci. Monthly* 79, 1 (1954).
2. E. G. Boring, *Am. Scientist* 43, 109 (1955).
3. I will furnish, on request, a reading list to those who may wish to go over the course more fully.
4. J. G. Pratt and J. L. Woodruff, *J. Parapsychol.* 3, 121 (1939).

Compatibility of Science and ESP

Paul E. Meehl and Michael Scriven

As two of the people whose comments on an early draft of George Price's article on "Science and the supernatural" he acknowledged in a footnote, we should like to clarify our position by presenting the following remarks.

Price's argument stands or falls on two hypotheses, only the first of which he appears to defend. They are (i) that extrasensory perception (ESP) is incompatible with modern science and (ii) that modern science is complete and correct.

If ESP is *not* incompatible with modern science, then the Humean skeptic has no opportunity to insist on believing modern science rather than the reports about ESP. If modern science is *not* believed to be complete or correct, then the skeptic is hardly justified in issuing a priori allegations of fraud about experimenters even when they claim that they have discovered a new phenomenon that requires reconsideration of the accepted theories.

In our view, both of Price's hypotheses are untenable. Whatever one may think about the comprehensiveness and finality of modern physics, it would surely be rash to insist that we can reject out of hand any claims of revolutionary discoveries in the field of psychology. Price is in exactly the position of a man who might have insisted that Michelson and Morley were liars because the evidence for the physical theory of that time was stronger than that for the veracity of these experimenters. The list of those who have insisted on the impossibility of fundamental changes in the current physical theory of their time is a rather sorry one. Moreover, unhappy though Price's position would be if this were his only commitment, he cannot even claim that specifiable laws of physics are violated; it is only certain philosophical characteristics of such laws that are said to be absent from those governing the new phenomena.

It is true that Price attempted to give a specific account of the incompatibilities between ESP and modern science, rather than relying on Broad's philosophical analysis, but here the somewhat superficial nature of Price's considerations becomes clear. Of his eight charges, seven are unjustified.

1) He claims that ESP is "unattenuated by distance" and hence is incompatible with modern science. But, as is pointed out in several of the books he refers to, since we have no knowledge of the minimum effective signal strength for extrasensory perception, the original signal may well be enormously attenuated by distance and still function at long range.

2) He says that ESP is "apparently unaffected by shielding." But shielding may well have an effect: the evidence shows only that the kind of shielding appropriate to electromagnetic radiation is ineffectual; since detectors indicate that no such radiation reaches the percipient from the agent, this is scarcely surprising.

3) He says "Dye patterns . . . are read in the dark; how does one detect a trace of dye without shining a light on it?" The two most obvious answers would be by chemical analysis and physical study of the impression (which is usually different for different colors).

4) "Patterns on cards in the center of a pack are read without interference from other cards." The word *read* is hardly justified in view of the statistical nature of the results; however, this phenomenon is always used by parapsychologists as evidence against a simple radiation theory, which it is. But no simple radiation theory can explain the Pauli principle and one can no more refute it by saying "How could one electron possibly know what the others are doing?" than one can refute the ESP experiments by saying "How could one possibly read a card from the middle of the pack without interference from those next to it?" These questions are couched in prejudicial terms.

5) "We have found in the body no structure to associate with the alleged functions." Even if true, this hardly differentiates it from a good many other *known* functions; and among eminent neurophysiologists, J. C. Eccles is one who has denied Price's premise [originally in *Nature* **168** (1951)].

6) "There is no learning but, instead, a tendency toward complete loss of ability" a characteristic which Price believes has "no parallel among established mental functions." Now it would be reasonable to expect, in a series of experiments intended to show that learning does not occur, some *trial-by-trial* differential reinforcement procedure. Mere continuation, with encouragement or condemnation after *runs of many trials* can hardly provide a conclusive proof of the absence of learning in a complex situation. We ourselves know of *no* experiments in which this condition has been met and which show *absence* of learning; certainly one could not claim that this absence was established. Furthermore, *even if it had been established,* it would be very dan-

Dr. Meehl is chairman of the department of psychology at the University of Minnesota. Mr. Scriven is a research fellow in the Minnesota Center for the Philosophy of Science.

gerous to assert that there is "no parallel among established mental functions." In the psychophysiological field particularly, there are several candidates. Finally, *even if it had been established and there were no parallel among mental functions,* there would be no essential difficulty in comparing it with one of the many familiar performances that exhibit no learning in adults—for example, reflex behavior.

7) "Different investigators obtain highly different results." This is the most distressingly irresponsible comment of all. ESP is a capacity like any other human capacity such as memory, in that it varies in strength and characteristics from individual to individual and in the one individual from one set of circumstances to another. The sense in which Rhine and Soal (Price's example of "different investigators") have obtained "highly different results" is when they have been dealing with different subjects or markedly different circumstances—for example, different agents; and exactly the same would be true of an investigation of, for example, stenographers' speed in taking dictation or extreme color blindness.

There remains only statistical precognition, which is certainly not susceptible to the types of explanation currently appropriate in physics: but then it is not a phenomenon in physics. Even if it were, it is difficult to see why Price thinks that we properly accommodated our thought to the distressing and counterintuitive idea that the earth is rotating whereas we should not accept precognition. His test for distinguishing new phenomena from magic is hopeless from the start ("The test is to attempt to imagine a detailed mechanistic explanation") because (i) it is of the essence of the scientific method that one should have means for establishing the facts *whether or not* one has already conceived an explanation and (ii) it would have thrown out the Heisenberg uncertainty principle and action across a vacuum—that is, nuclear physics and the whole of electricity and magnetism—along with ESP.

Finally, Price's "ideal experiments" are only Rube Goldberg versions of the standard tests plus a skeptical jury. The mechanical contrivances would be welcome if only parapsychologists could afford them, and the jury is obviously superfluous because, according to Price's own test, we should rather believe that they lie than that the experiments succeed. However, in our experience, skeptics who are prepared to devote some time and hard work to the necessary preliminary study and experimenting are welcome in the laboratories at Duke and London. Without the training, one might as well have (as Price would say) 12 clergymen as judges at a cardsharps' convention.

The allegations of fraud are as helpful or as pointless here as they were when they were made of Freud and Galileo by the academics and others who honestly believed that they *must* be mistaken. They are irresponsible because Price has not made any attempt to verify them (as he admits), despite the unpleasantness they will cause, and because it has been obvious since the origin of science that any experimental results, witnessed by no matter how many people, *may* be fraudulent.

Probability, Logic, and ESP

P. W. Bridgman

The recent article by G. R. Price in *Science* [**122**, 359 (26 Aug. 1955)] entitled "Science and the supernatural" directs renewed attention to a situation that doubtless has given many people, including myself, a feeling of discomfort, to say the least. My own attitude was expressible in a paraphrase of Price's quotation from Hume to the effect that he would be unwilling to accept such phenomena as those claimed for extrasensory perception (ESP) unless he could be convinced that their genuineness would be less miraculous than the occurrence of fraud somewhere.

My own attitude did not seize on the possibility of fraud, although it seems to me that Hume's position is irrefutable; it seized, rather, on the way in which contemporary arguments for ESP depend on considerations of probability. I felt somewhat vaguely that I would rather think that my understanding of probability is faulty than believe in the genuineness of ESP. My scruples against the use of probability arguments had nothing to do with the details of the calculation of the enormous numbers that represent the odds against the scores obtained in ESP tests. I was willing to take the word of the many technically competent persons involved that the grinding of the machinery by which these numbers were obtained had been according to Hoyle. My scruples went much deeper and were concerned with the logic of the application of probability concepts to concrete events.

It has long been apparent that there is something "funny" about the probability situation. Probability rigorously applies to no concrete happening. If we calculate that the chance of throwing a 6 with a die is one-sixth, and throw the die and obtain a 6, there is no method whatever by which it may be shown that the chance "actually" was one-sixth. Yet the phenomena to which the probability calculations justifying ESP are applied are concrete actual happenings, many of them a matter of record in black and white.

My old feeling that the logical situation should be further explored was fortified by a recent occurrence that is the immediate occasion for this note. I was reading in *Science* [**122**, 471 (9 Sept. 1955)] a review of the recently published collection of 1 million random numbers, when it burst on me in a flash of illumination that random numbers cannot be published. For a set of random numbers is a set in which it is impossible to predict any subsequent number from the preceding numbers, or in which there is no connection between the different numbers. But the subsequent numbers may be predicted, if the set is published, merely by reading the published list, and all the numbers of the set are connected by being written together on paper. A list of numbers *obtained* by a random *process* might perhaps be published if we could answer the question, What is it that

The author is emeritus professor of physics at Harvard University.