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Science and the Supernatural

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Believers in psychic phenomena—such as telepathy, clairvoyance, precognition, and psychokinesis—appear to have won a decisive victory and virtually silenced opposition. Many other times during the past century such victory has seemed close, as evidence for the supernatural has been produced that has been found convincing by some of the world's leading scientists. But always on previous occasions, other investigators have made criticisms or conducted new tests, thereby demonstrating flaws in the evidence. What is unique about the present is that, during the last 15 years, scarcely a single scientific paper has appeared attacking the work of the parapsychologists.

This victory is the result of an impressive amount of careful experimentation and intelligent argumentation. The best of the card-guessing experiments of Rhine and Soal show enormous odds against chance occurrence, while possibility of sensory clues is often eliminated by placing cards and percipient in separate buildings far apart. Dozens of experimenters have obtained positive results in ESP experiments, and the mathematical procedures have been approved by leading statisticians (*1*).

I suspect that most scientists who have studied the work of Rhine (especially as it is presented in *Extra-Sensory Perception After Sixty Years, 2*) and Soal (described in *Modern Experiments in Telepathy, 3*) have found it necessary to accept their findings. Concerning the latter book, a reviewer (*4*) has written: "If scientists will read it carefully, the 'ESP controversy' will be ended." Against all this evidence, almost the only defense remaining to the skeptical scientist is ignorance, ignorance concerning the work itself and concerning its implications. The typical scientist contents himself with retaining in his memory some criticism that at most applies to a small fraction of the published studies. But these findings (which challenge our very concepts of space and time) are—if valid—of enormous importance, both philosophically and practically, so they ought not to be ignored.

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Practical Applications for Extrasensory Perception

A common belief concerning ESP experimentation is that the results are interesting but are of small importance because of the great inaccuracy of perception. For example, Boring (*5*) writes in a discussion of Soal's work: "You see a 'brilliant' performance in telepathy is not so very striking after all. It is only 7 out of 25 instead of 5 out of 25. When people ask why these able percipients do not get rich by telepathing directors' meetings and playing the stock market with their superior knowledge, they do not know how small an advantage the best available telepathy of the modern age provides."

But card guessing by ESP, inaccurate though it is, nevertheless is a communication system by which information is transmitted. In the terminology of Shannon's "Mathematical theory of communication" (*6*), it is a case of a *discrete communication channel with noise,* "noise" representing whatever it is that causes errors. Information theory is unequivocal in showing that any system that has a finite capacity for transmitting information can (if we employ proper coding) transmit with any degree of accuracy we may desire—say, as accurately as by telegraph, or more accurately—although it may take a long time to transmit a small amount of information with high accuracy.

In an ESP experiment where 6 hits are made in a run of 25, the channel capacity is about 0.0069 bits per trial; while 7 hits corresponds to 0.026 bits per trial, or 0.66 bits for a run of 25 trials (*7*). This means that (if each trial takes only a few seconds) information can be transmitted at a rate of several bits per hour and as accurately as by telegraph. Thus this appears to be a solution to problem No. 449 of the National Inventors Council, which involves "the development of a revolutionary new method of transmitting intelligence." Since ESP is independent of distance and requires no equipment (except possibly a watch for synchronization), it should be a most convenient means for transmitting information from an espionage agent in the Soviet Union directly to Washington or London.

Soal considers that there must be a selected human "sender" to aid in transmitting information, in addition to a selected percipient; but Rhine believes that a good percipient can perceive by clairvoyance in the absence of any sender as well as receive telepathically from virtually any person. Therefore, according to the findings of either Rhine or Soal, the suggestion made in the preceding paragraph is a fully practical one; but if Rhine's work is valid, then there are additional applications of enormously greater importance. In particular, while Soal has evidence that ESP may penetrate a few seconds into the future, Rhine has performed experiments of considerable ingenuity that show (in his opinion) that information concerning ESP cards can be received from as far as 10 days in the future (*8*; *9*, pp. 73–75; *10*, pp. 94 ff.; *11*).

The general means for transmitting information accurately over a noisy channel is to send messages of high *redundancy*; that is, the information is repeated over and over again (in properly coded form) within the message. But events of great importance may be thought of as messages of high redundancy. Thus a nuclear bomb explosion would tell its story with enormous redundancy in terms of each of the hun-

dreds of buildings destroyed and of the thousands of people killed (in excess of normal mortality). This suggests that ESP can be used for such purposes as accurate forecasting of a major catastrophe—assuming that Rhine's findings are valid. And this will be especially true if it is possible to use many percipients working simultaneously to increase accuracy.

Let us design a procedure to give a 10-day warning of a nuclear bomb explosion. ESP card designs are used, to make conditions closely similar to those Rhine employed in his precognition experiments. Cards are prepared that will react to the thermal flash of a nuclear explosion, so that the initial design will be bleached and a second design will develop. The cards are placed inside cameras with open shutters, surrounding a likely target area and directed upon various portions of the area. The cards are guarded and their symbols are kept secret. Each day several thousand selected percipients try to guess card symbols 10 days ahead. Guesses are analyzed in terms of each of the two possible correct symbols for each card.

If card symbols have been properly randomized, then, in the absence of ESP there will be no statistically significant pattern in the relationship between guesses and possible correct symbols. Thus, it will be virtually impossible to have a false alarm if ESP is not operating. Therefore, there will be strong presumption that there should be prompt evacuation, if some day, for cards corresponding to some contiguous area, guesses show a statistically significant relationship to the symbols-to-be-developed, while for the surrounding area there is a similar relationship involving the initial symbols.

Does this suggestion seem absurd? No. If information theory and Rhine's conclusions are both valid, this is a practical suggestion of high importance. Such a warning system would be far more effective and less expensive than radar. To be sure, it is true that Rhine's evidence for precognition is not so much in the form of large numbers of correct guesses, but rather it depends on certain statistical abnormalities in the pattern of correct guesses. But in general, any relationship between cards and guesses that is so highly improbable that it constitutes evidence for ESP can be made use of for transmission of information. And even if there is only 10-percent probability that Rhine's findings are valid, it is still the clear duty of appropriate government officials to investigate this possibility promptly and thoroughly.

Furthermore, contemporaneous clairvoyance can also be put to work in many ways. For example, the arrangement of ore in a vein provides a form of redundancy plus a means of checking against guesses not based on ESP—provided that we exercise a little ingenuity in the way we set up the guessing procedure.

In short, it appears that wherever parapsychology can yield extrachance results, we can find a way to put it to practical use.

Hume's Argument Concerning Miracles

Now it happens that I myself believed in ESP about 15 years ago, after reading *Extra-Sensory Perception After Sixty Years,* but I changed my mind when I became acquainted with the argument presented by David Hume in his chapter "Of miracles" in *An Enquiry Concerning Human Understanding.*

Hume's argument runs as follows: "A miracle is a violation of the laws of nature; and as a firm and unalterable experience has established these laws, the proof against a miracle, from the very nature of the fact, is as entire as any argument from experience can possibly be imagined. . . . no testimony is sufficient to establish a miracle, unless the testimony be of such a kind that its falsehood would be more miraculous than the fact which it endeavours to establish. . . ."

Hume illustrated as follows the spirit in which he thought his argument should be employed: "You would in vain object to me the difficulty, and almost impossibility, of deceiving the world in an affair of such consequence . . . . with the little or no advantage . . . . from so poor an artifice: all this might astonish me; but I would still reply that the knavery and folly of men are such common phenomena, that I should rather believe the most extraordinary events to arise from their concurrence, than admit of so signal a violation of the laws of nature."

And also: "Where shall we find such a number of circumstances, agreeing to the corroboration of one fact? And what have we to oppose to such a cloud of witnesses, but the absolute impossibility or miraculous nature of the events which they relate? And this, surely, in the eyes of all reasonable people, will alone be regarded as a sufficient refutation."

Long before Hume, a similar point of view was taken by the Greek writer Lucian (*12*): "To defend one's mind against these follies, a man must have an adamantine faith, so that, even if he is not able to detect the precise trick by which the illusion is produced, he at any rate retains his conviction that the whole thing is a lie and an impossibility."

And Tom Paine, a little after Hume, stated the same argument succinctly (*13*): ". . . is it more probable that nature should go out of her course, or that a man should tell a lie?"

Improbability of the Supernatural

My opinion concerning the findings of the parapsychologists is that many of them are dependent on clerical and statistical errors and unintentional use of sensory clues, and that all extrachance results not so explicable are dependent on deliberate fraud or mildly abnormal mental conditions.

The first step in applying Hume's argument would preferably be to make a numerical estimate of the *a priori* improbability of ESP. But unfortunately, it appears that scientific philosophy has not yet developed to the point where this is possible. This is regrettable, yet we should consider that if the problem were so simple as to permit numerical calculation, then this controversy would perhaps never have arisen.

Since I cannot prove, all I can do is try to convince by showing that ESP is incompatible with current scientific theory. It is sometimes asked: With what scientific laws does ESP conflict? But the conflict is at so fundamental a level as to be not so much with named "laws" but rather with basic principles. C. D. Broad has presented an excellent analysis showing that the psi effects are incompatible with nine "basic limiting principles" involving our fundamental concepts of space, time, and causality (*14*). I accept his analysis and incorporate it as part of the present argument.

Broad's discussion is too long to summarize here, so instead I shall list several incompatibilities of psi phenomena, described in a less fundamental manner. (i) ESP penetrates the future even in situations where rational inference is powerless. (ii) ESP is apparently unattenuated by distance. (iii) Psi effects are apparently unaffected by shielding. They come from matter and interact with matter (control of dice in psychokinesis), so why do they not interact with matter in a shield? (iv) Dye patterns on cards are read in the dark: how does one detect a trace of dye without shining light on it? (v) Patterns on cards in the center of a pack are read without interference from other cards. (vi) We have found in the body no structure to associate with the alleged functions. (vii) There is no learning but, instead, a tendency toward complete loss of ability. (So far as I know, there is for this type of behavior no parallel among established mental functions.) (viii) Different investigators obtain highly different results. For example, Soal requires a telepathic sender, but Rhine finds this unnecessary.

The parapsychologists themselves have agreed almost unanimously that psi phenomena are completely incompatible with modern physics. The situation has been analyzed in detail and with excel-

lent logic by both Rhine (*10*, chap. 4; *15*, chap. 12) and Soal (*3*, pp. 303–305). And Rhine has correctly stated (*10*, p. 94) that "Nothing in all the history of human thought—heliocentrism, evolution, relativity—has been more truly revolutionary or radically contradictory to contemporary thought than the results of the investigation of precognitive psi."

To be sure, some scientists have argued that there may be no incompatibility. For example, see a recent paper on "Parapsychology and dualism" by Walker (*16*). And Boring (*5*) writes: "All you have got yet for extrasensory perception is an observed difference between two frequencies, between hits and misses, and a great deal of ignorance as to what causes the difference. Ignorance does not overthrow old concepts." But it seems to me that this is equivalent to arguing: "So you have seen a man turn into a small bat and fly away, and you think that this is evidence for the existence of vampires? Nonsense. All you have got is a difference between two patterns in which photons strike the retina, and a great deal of ignorance as to what causes the difference. Ignorance is not evidence." I feel that R. H. Thouless described matters aptly when he said (*17*): "I suggest that the discovery of the *psi* phenomena has brought us to a . . . . point at which we must question basic theories because they lead us to expectations contradicted by experimental results."

If, then, parapsychology and modern science are incompatible, why not reject parapsychology? We know that the alternate hypothesis, that some men lie or deceive themselves, fits quite well within the framework of science. The choice is between believing in something "truly revolutionary" and "radically contradictory to contemporary thought" and believing in the occurrence of fraud and self-delusion. Which is more reasonable?

But the parapsychologists usually reply that we should accept both science and the supernatural. Although these may not fit together within a single scheme of things, we can imagine two separate systems, each compatible within itself. Why should we not accept dualism? To answer this here, I must try to compress a complex argument into minute space. The answer is: because past experience shows that dualistic reasoning has usually been comparatively unsuccessful in making predictions concerning observable phenomena.

Experience is all we have available as a guide to the future. As Reichenbach has pointed out, even when we consider magic phenomena, we must still base our expectations on inductive reasoning from past experience (*18*). From our experience we have derived certain generalizations concerning observable phenomena. (Some of these we term *laws of science*, while others are so fundamental that we rarely name them.) In addition, we are able to make other generalizations concerning these first generalizations, for an enormous amount of pertinent data has accumulated. Thus, experience shows that scientific laws often fail when they are extended to a new range of size, like atomic size, but scientific laws do not fail in association with particular people.

For example: Suppose a physics student reports that he has found the wavelength of the red cadmium line to be 2 millimicrons greater than the accepted value. Now we cannot in any way at all prove that there do not actually exist some human beings whose presence can cause real, experimentally verifiable changes in physical constants—just as we cannot prove that the universe will not come to an end tomorrow. But our past experience suggests that the most profitable attitude for us will be to assume that the student made an error.

In the same way, we cannot prove that psi phenomena do not occur. Maybe in the presence of a "sensitive" the basic limiting principles no longer limit. But all our experience suggests that it will be more profitable for us to assume that the old generalizations are still valid, and that the findings of the parapsychologists are to be explained on the old, familiar basis of human error.

The Essence of Magic

We now imagine a new critic, who speaks to us as follows: "This is all very well, and I concede that psi phenomena appear to me most strange and improbable, but a half-century ago I would have felt the same way concerning relativity. Does not any radically new complex phenomenon appear as baffling and improbable as ESP?"

What is required is a test to separate reported findings toward which we should be narrow-minded from those toward which we should be receptive. What is the fundamental difference between the natural and the supernatural? What is the essential characteristic of magic?

Let us compare scientific and magical methods of table levitation (*19*). A scientist sits in his living room and says: "Table, rise." His speech pattern is portrayed on the screen of a visible speech apparatus. Phototubes observe the pattern through masks of appropriate shapes. A switch is closed, turning on an enormous electromagnet on the floor above. This attracts an iron plate concealed within the table top, and the table rises to the ceiling.

Similarly, the magician says: "Table, rise." And the table rises. The difference is that there is no iron plate, no electromagnet, no switch, and no speech interpretation apparatus.

Now a scientist can accept the absence of the iron plate; it is conceivable that there can exist sharply localized forces attracting wooden objects. He can even accept the absence of the magnet. What he cannot accept is the absence of the speech interpretation apparatus and the switch. New forces can be fitted into a scientific scheme of things. What cannot be made to fit is the *intelligent* manner in which the force is turned on and *directed* to act upon the table.

In the scientific process, each successive detail is provided for. In the magic process, there are just the wish and the result, and all intermediate steps are omitted. The essential characteristic of magic is that phenomena occur that can most easily be explained in terms of action by invisible intelligent beings (*20*). The essence of science is mechanism. The essence of magic is animism. The way of science is to build a television system and a radio-controlled robot manipulator and have the manipulator cut a pack of cards at the 12th card and hold it up to the television camera. The way of magic is to sit in a chair with eyes closed and vaguely wish to know the identity of the 12th card down in a certain pack 100 miles away; and then the answer pops into one's mind.

Suppose that some extraordinary new phenomenon is reported: should we be narrow-minded or receptive? The test is to attempt to imagine a detailed mechanistic explanation. Whenever we can imagine any sort of detailed explanation without introducing incorporeal intelligences, we should be prepared to regard the phenomenon open-mindedly. For this test it is not necessary that our explanation be simple, reasonable, or usable in making predictions. For example, any nuclear physicist could postulate a score of new forces, transition rules, and such, and so produce a complete theory of the atomic nucleus. Such a theory would be scientifically worthless, yet it would still satisfy the proposed test.

But with the phenomena of parapsychology, the situation is entirely different. Suppose that we attempt to describe mechanisms. Let us start with ESP tests at a distance of 100 miles or so, and let us feel free to imagine strange, fantastic forces without limit. Assume that we have under our control an invisible observation device that we can send in any direction at the speed of light. How do we go about locating a pack of cards 100 miles away? Would we guide ourselves by landmarks—or what? And would we not have to perceive with great accuracy in order to find the target? But how can we be accurate in perception of landmarks when we are grossly inaccurate in

reading the target card? And how do we go through this locating process without any consciousness of it?

The special linkage that seems to exist between a percipient and the proper target card or telepathic sender is the sort of linkage that is characteristic of magic. In Greek mythology, the life of Meleager was linked to a piece of wood, and when his mother threw it on a fire, he perished far away. Or an African witch doctor makes a clay image and buries within it nail parings and bits of hair, and when the image is destroyed a man dies in London. Or a curse is uttered, and some magic influence goes to seek a distant victim.

Next, consider the process of "reading down" through a pack of ESP cards. How do we accurately locate card No. 12? How do we tell that we are reading the pattern on the face of card 12 and not confusing it with the back of card 13? How do we detect dye molecules in the dark? Do we subject the electrons to the same transitions that they would undergo in light, or do we employ different means of analysis? And how do we analyze just the dye and not the paper? Imagine anything you wish. Feel free to invent a new topology and a dozen different types of fields. But just describe the process in detail.

For other mental processes, conscious or subconscious, we can describe (or at least imagine) successive steps. We can describe in detail the steps involved in the creation of a great poem (*21*) or a mathematical theory (*22*). We can explain subconscious processes such as the regulation of our heartbeat. Where information is missing, we can guess. But with the supernatural, all is different.

Moreover, how does the information get into a brain? How is it converted into electrochemical changes within neurons? And suppose that translation into neural impulses is already accomplished; then how are these signals to be interpreted? Pitts and McCulloch (*23*) have suggested neural patterns in human brains for interpretation of visual and auditory stimuli—but can anyone describe a conceivable nerve network for interpreting the raw data of ESP?

And finally, what conceivable way is there to explain precognition?

There is no plausible way to explain these details except in terms of special intelligent agents—spirits or poltergeists or whatever one wishes to call them. The proper target card is selected by a spirit. A spirit implants information in the brain in proper electrochemical form. The ability disappears when the spirit tires of working with a particular person. In short, parapsychology, although well camouflaged with some of the paraphernalia of science, still bears in abundance the markings of magic.

To be sure, the world of magic is a lovely world. To make a silent wish—and mysteriously influence the fall of dice. To sit with closed eyes while knowledge of the future strangely floats into the mind. These possibilities have for us the charm of childhood days, when we could fall asleep on Christmas Eve and in the morning find a tree hung with presents—like some Arabian Nights adventurer who fell asleep in a hovel and awoke in an enchanted palace. But the way of science is different. To construct a building, each brick and board must be fitted into place by human beings—not by jinn who answer the rubbing of a lamp. If our soldering is careless, our circuit will certainly be noisy; and if we make our seals poorly, our vacuum system will assuredly leak—and no incantation will help.

Fraud and Error

Following the publication in 1935 of Rhine's first book (*24*), numerous papers appeared in American psychological journals pointing out possibilities of clerical errors and sensory clues and criticizing the statistical methods. These criticisms have been reviewed in detail by Pratt *et al.* (*2*). Later attacks of this sort were made by Nabours (*25*), Skinner (*26*), Rawcliffe (*27*), Brown (*28*), and—most recently and authoritatively—by Soal himself (*3*).

I believe that many of these criticisms were justified, but I am also completely convinced that some of Rhine's work and most of Soal's can be accounted for by no conceivable combination of such explanations.

What about fraud?

The parapsychologists speak of that possibility with utmost scorn: "We have done all that we can when the critic has nothing left to allege except that the investigator is in the trick. But when he has nothing else to allege he will allege that" (*29*). The hypothesis of "extensive and collusory fraud has yet to be responsibly suggested" (*30*). "The notion of such wholesale conspiracy would be to most students more fantastic than the ESP hypothesis" (*2*, p. 166).

Surprisingly, it is not only believers who are reluctant to imagine fraud, but virtually all skeptics as well will prefer almost any other type of explanation. It would be tedious for me to cite statistics to show that "the knavery and folly of men" are indeed "common phenomena," for everyone is aware of this—in an intellectual way. But when we try to imagine knavery and folly in connection with a particular individual, we encounter a surprising emotional blockage, and the possibility seems unreasonable. And thus we find skeptics searching for every other conceivable sort of explanation—proposing absurd systems of involuntary whispering, or indulging in the metaphysical acrobatics of arguing that ESP cannot occur because it involves a "negative hypothesis"—while the one explanation that is simplest and most in accord with everyday experience is dismissed as inconceivable. It is almost as though we give this answer to Paine: "We detest the thought that nature would go out of her course, but we will believe that or anything else rather than believe that a man would tell a lie."

It is particularly difficult for us to conceive of dishonesty in any situation where fraud would have to be complex and daring. For example, most people find it easier to imagine that some assistant may have occasionally cheated in an ESP experiment, than to suppose that a chief investigator could have deliberately designed an entire investigation fraudulently. Similarly, in the field of the "confidence game," the victim might be capable of suspecting one or two of his new "friends" as crooks, except that he cannot imagine that the entire stock exchange or gambling club to which they introduce him is an artifice, with the manager, employees, and even patrons all "in the trick."

A good antidote against our curious mixture of credulity and incredulity is to become acquainted with some of the elaborate deceits of the past. Books that describe fraudulent production of supernatural phenomena have been written by Houdini (*31*), Podmore (*32*), Dunninger (*19*), Jastrow (*12*), and Rawcliffe (*27*). Confidence games involving expert understanding of the psychology of credulity are described by MacDonald (*33*). And MacDougall (*34*) discusses the history and psychology of hoaxing.

There is a literature on the supernatural, just as there is a literature of chemistry and physics, and the scientist who ignores this literature and depends on his pure reasoning powers in evaluating reports of psychic phenomena is at a disadvantage. A little acquaintance with the careful studies of men like Podmore and Houdini will give one a broader point of view and a clearer understanding by which to evaluate modern parapsychology. For example, the man who knows that the Davenport brothers employed as many as 10 confederates in a single séance (*31*, p. 23) should not think it unreasonable when I presently suggest that I would want seven or eight confederates in order to imitate 170 Soal sittings. And the reader who finds that he cannot conceive of the possibility that any leading modern parapsychologist could be fraudulent should compare his attitude with certain earlier judgments concerning the honesty of mediums. Consider, for example, Houdini's report that Ar-

thur Conan Doyle told him that "he did not believe any of 'the nice old lady mediums' would do anything wrong and it was just as unlikely for some old gentleman, innocent as a child unborn, to resort to trickery" (*31*, p. 142). Or consider William Crookes's opinion of Daniel Home (*35*): "To those who knew him Home was one of the most lovable of men, and his perfect genuineness and uprightness were beyond suspicion . . . ." (Home was the most brilliant and successful of all mediums, and his patrons included the rulers of France and Russia. He could elongate his body by 11 inches, levitate himself and float around séance rooms near the ceiling, and perform numerous other miracles.)

History shows numerous men of great intelligence victimized by the simplest and most transparent trickery. Therefore, it is wisdom on our part to be aware that the rules by which we actually protect ourselves against dishonesty are little more than rules-of-thumb telling what to do in particular situations ("Don't gamble with strangers." "Know your endorser." "Always have a lawyer read the contract."), while our general principles for detection of dishonesty are mostly prejudices with little value. The courts, as a result of vast experience and utter necessity, have worked out a moderately satisfactory system of rules of evidence; but the psychological theorizing by which in daily life we judge innocence or guilt is valueless when it is applied to the work of a clever deceiver.

There is a certain stereotype of appearance and behavior that we associate with honesty, and a second stereotype that we associate with dishonesty—and successful swindlers are wise enough to imitate the former stereotype. "O what a goodly outside falsehood hath!" And so it is folly for us to survey the actions of a brilliant man and say: "This looks honest. If he were a charlatan, he would have done thus and so." Let us remember that those who seek to deceive us possibly are smarter than we are and probably have had more practice in simulating honesty than we have had in detecting dishonesty.

The wise procedure, when we seek to evaluate probability of fraud, is to try to ignore all vague, psychological criteria and base our reasoning (i) on such evidence as would impress a court and (ii) on purely statistical considerations. And here we must recognize that we usually make a certain gross statistical error. When we consider the possibility of fraud, almost invariably we think of particular individuals and ask ourselves whether it is possible that this particular man, this Professor X, could be dishonest. The probability seems small. But the procedure is incorrect. The correct procedure is to consider that we very likely would not have heard of Professor X at all except for his psychic findings. Accordingly, the probability of interest to us is the probability of there having been anywhere in the world, among its more than 2 billion inhabitants, a few people with the desire and the ability artfully to produce false evidence for the supernatural.

Has There Been a Satisfactory Test?

What is needed is one completely convincing experiment—just one experiment that does not have to be accepted simply on a basis of faith in human honesty. We should require evidence of such nature that it would convince us even if we knew that the chief experimenter was a stage conjurer or a confidence man. Has there been any single ESP experiment that would stand up if it were examined from this point of view?

Had I but space enough, I would analyze here all the major experiments of all the major investigators. But I do not have. I might select Rhine's work for discussion, but it apparently has not impressed critics nearly so much as Soal's. In fact, there are some indications that it has not impressed Soal himself very much (*36, 37*). But Soal's own work has been found convincing by eminent men of great intelligence. G. Evelyn Hutchinson (*38*) wrote concerning the Shackleton experiments that "they appear to be the most carefully conducted investigations of the kind ever to have been made," and that "Soal's work was conducted with every precaution that it was possible to devise." C. D. Broad wrote (*39*): "There was already a considerable mass of quite good experimental evidence for telepathy, e.g. in the work of Dr. Rhine and his colleagues at Duke University, but Dr. Soal's results are outstanding. . . . The precautions taken to prevent deliberate fraud or the unwitting conveyance of information by normal means are described in great detail, and seem to be absolutely water-tight."

So in the next two sections, I shall describe and analyze Soal's experiments. But I hope that readers will not search in these sections for psychological clues with which to bolster skepticism or belief. For example, one may note that Soal was originally himself a partial skeptic and from this conclude that he must be honest. Or conversely, one can reason: "The fact that for the Stewart series Soal altered the position of the screen aperture, raising it to eye level, suggests that he arranged conditions so that he could observe cards reflected in eyeglasses." But the wise course is to try to avoid such ethereal speculations. At best they may be treated as hunches to guide detectives but not as evidence to be presented in court. Such trivia would hardly be considered in a trial of a pickpocket, so they should not be offered as evidence for deciding profound cosmological questions.

This is the type of testimony that impresses a court (*40*): "On April 17, 1910, at a séance given by Eusapia Palladino in New York City at the home of Professor H. G. Lord, I crawled under some chairs and lay with my face on the floor within eight inches of the leg of the table at the left side of the medium, and a foot came from underneath the dress of the medium and placed the toe underneath the left leg of the table, and pressing upward, gave it a little chuck into the air." Since I know of no evidence of this nature showing that Soal did or did not cheat, all that I am trying to do in the next two sections is to demonstrate that Soal *could* have cheated if he wanted to, and that therefore we should demand better evidence than his before we believe in the supernatural.

Soal's Experiments

In his early work as a psychic investigator, Soal published excellent papers reporting negative findings and showed himself to be a meticulous and ingenious experimenter, expert at uncovering trickery (*41*). Then, allegedly, in 1939 he recalculated some old data and found that two people he had tested unsuccessfully for contemporaneous telepathy had actually been making highly significant precognitive scores (*42*). These were Basil Shackleton and Mrs. Gloria Stewart. Shackleton was then studied in 40 sittings dating from January 1941 to April 1943 (*43*). Mrs. Stewart was investigated from August 1945 to January 1950, in 130 sittings (*3*, pp. 199–337; *37*, pp. 34–56; *44*).

The complex experimental procedure devised by Soal is most conveniently described as a cryptographic process (although Soal himself does not employ this terminology). An original number sequence of 50 terms (randomly selected from the digits 1 to 5) is enciphered by use of a *key* to yield a letter sequence. The latter is transmitted telepathically to a percipient, who records his guesses. This received letter sequence is deciphered by use of the key to yield a second number sequence, which is compared with the original. The cipher system is simple, one-digit substitution, and the key is a permutation of the letters E G L P Z (or other symbols). The total process is illustrated in Table 1, as it might occur with the following key:

1 2 3 4 5
L P Z G E

The steps in the process are carried out

by (i) the "EA" (the *E*xperimenter associated with the *A*gent), who shows the original sequence, one digit at a time, to (ii) the *Agent,* who performs the enciphering and then telepathically transmits to (iii) the *Percipient.* At the close of a sitting, all received sequences are deciphered and then scored for "hits," as is shown in column VI, which indicates postcognitive ("−2" and "−1"), contemporaneous ("0"), and precognitive ("+1" and "+2") hits.

The EA and Agent sit on opposite sides of a small table, separated by a screen with a 3-inch square aperture. (The center of the aperture was 13 inches above the table top in the Shackleton sittings and 18 inches above the table in the Stewart sittings.) Resting in a rectangular box on the table on the Agent's side is a row of 5 *code cards* bearing animal pictures or initial letters (for example, Elephant, Giraffe, Lion, Pelican, Zebra). The open face of the box is toward the Agent, so that the code cards are shielded from the EA and others. The Percipient is in another room.

In a typical experiment, at each trial, the EA displays at the aperture the digit indicated by a random number list (column II), and then he calls out to the Percipient the serial number of the trial (column I). Then the Agent briefly raises and glances at the code card in the indicated position, and the Percipient writes his guess. For example, at trial No. 8 in Table 1, the EA displayed the digit 2 at the aperture and called out "eight." The Agent then raised the card in position 2 (second from the left) and glanced at the picture of a pelican. The Percipient wrote down the letter *G,* which was a "+1" precognitive hit.

Sittings were usually composed of 8 runs of 50 trials. At "normal" rate of calling, each trial required between 2 and 3 seconds. At the start of each run, the Agent or an observer shuffled and arranged the code cards out of sight of the EA, thereby changing the key. After each 50 trials, the code-card order was recorded. Following the last run, the Percipient's guesses were deciphered by the appropriate key, and hits were counted.

There were a number of variations. In most experiments the original sequence was taken from a list provided by Soal, but occasionally lists were computed by outsiders and were given directly to the EA at the start of the experiment. At a few sittings the number sequence was generated by the EA during the run by drawing colored counters from a bag or bowl. Usually the sitting was in the Percipient's home, but occasionally other locations were employed; and in six sittings Mrs. Stewart made her guesses in Antwerp, with Agents in London.

In the Shackleton series, almost all the extrachance results were produced with either "R.E." or "J.Al." as Agent. With the former, most successes were "+1" precognitive hits. In 5367 "+1" trials at "normal" rate of calling with R.E. as Agent, Shackleton scored 1540 "+1" hits, for a mean of 13.77 per run of 50 trials (*45*). Usually, with J.Al. as Agent, both pre- and postcognitive guesses yielded more than 13 hits per run; hits were ordinarily "−1" and "+1," but changed to "−2" and "+2" when the calling rate was doubled. Thirty-one sittings yielded extrachance results, and at all of these both Soal and Shackleton were present, plus at least one of the following: Mrs. Goldney, J.Al., and R.E. In addition, at 23 of the 31, one or more additional persons were present. Usually these took the roles of EP (*E*xperimenter watching the *P*ercipient) or EA, or watched the Agent; but two worked successfully as Agents.

In the Stewart series, 30 persons were tested as Agents, and 15 were successful. Total score for 37,100 trials by standard procedure was 9410 "0" hits, for a mean score of 12.68 hits per run of 50. In these experiments Soal usually took the role of EA. The usual procedure was for the Agent to shuffle the cards and then arrange them face up and stare at them for 30 seconds. Then they were turned over, and during the run the Agent tapped the indicated card on the back instead of lifting it. The cards usually bore initial letters about 2 inches high instead of animal pictures (*46*).

Table 1. An example of the transformations involved in a typical telepathy experiment of the Soal type.

I Trial number	II Original sequence	III Enciphered sequence	IV Received sequence (guesses)	V Deciphered sequence	VI Type of "hit"
1	3	Z	G	4	
2	5	E	E	5	0
3	1	L	E	5	−1, +2
4	4	G	P	2	
5	5	E	L	1	−2, +1
6	1	L	Z	3	
7	2	P	P	2	0, +1
8	2	P	G	4	+1
9	4	G	Z	3	+1
10	3	Z	P	2	−2

Analysis of Soal's Work

Before I continue, it should be clearly understood that I am not here stating that Soal or any of his associates was guilty of deliberate fraud. All that I want to do is show that fraud was easily possible.

I do not claim that I know how Soal cheated if he did cheat, but if I were myself to attempt to duplicate his results, this is how I would proceed. First of all, I would seek a few collaborators, preferably people with good memories. The more collaborators I had, the easier it would be to perform the experiments, but the greater would be the risk of disclosure. Weighing these two considerations together, I'd want four confederates to imitate the Shackleton experiments. For imitating the Stewart series, I'd probably want three or four—although it is impossible to be certain, because the Stewart sittings have not been reported in much detail. In recruiting, I would appeal not to desire for fame or material gain but to the noblest motives, arguing that much good to humanity could result from a small deception designed to strengthen religious belief.

The next step would be to devise procedures. Like a competent medium, I would want several alternatives available, so that any skeptic who suspected one procedure could be confronted by a repetition performed under conditions making the suspected procedure impossible. One main group of procedures would involve matching a prepared random number sequence to a letter or number sequence previously memorized or written out by the Percipient. At about 90 percent of my sittings, the original sequences would be taken from lists provided by me. Here are a few of the possibilities:

Procedure 1. The Percipient and the Agent are "in the trick." The Agent arranges the code cards as previously directed by me, and the Percipient writes down a memorized sequence or takes a list from a drawer if no outsider is watching him. (This would be a preferred procedure in most experiments except when an outsider determined the order of the code cards. It could succeed with outsiders as EA and EP.)

Procedure 2. The Percipient and the Agent (or the EA or an observer) are "in the trick." The code card order is determined by an outsider. The Agent (or the EA or an observer) notes this order, classifies it into 1 of 6 groups, and signals the group number to the Percipient be-

fore or after the run. Only 2.6 bits of information are needed to designate a choice of 1 out of 6. For example, the Agent glances at the backs of the cards and then says: "Ready." "All ready." "Yes, I'm ready." "Yes, ready."—And so forth (*47*). The Percipient then takes from a drawer the designated guess sheet, which is already filled out in his hand writing (*48*). (If the Agent is an outsider, the EA or an observer can note the card order when it is recorded at the end of the run and signal it in the conversation then.)

Procedure 3. The Percipient and the Agent are "in the trick." The Agent notes the card order and signals it (6.9 bits for the 120 possible permutations) before the start of the run. The Percipient has memorized a number sequence, and he uses the card order to encipher each number mentally. (This can work with outsiders watching both the Agent and the Percipient and shuffling the code cards; or if the Agent is an outsider, the signaling can be done by an observer who shuffles the cards.)

Next consider some of the procedures that could be used even when the number sequence was not known to me in advance:

Procedure 4. The Percipient and the Agent are "in the trick." They have copied or memorized the same lists of letter symbols. During the run the Agent records (concealed by the box) the numbers corresponding (precognitively) to the letters that he knows the Percipient is guessing, and at the end he rearranges the code cards to give the desired degree of success. For example, with a record like that shown in Fig. 1, the Agent could see that card arrangement LEGZP will yield a large number of hits. (This procedure would be particularly useful when the EA was an outsider.)

Procedure 5. The Percipient and the EA are "in the trick." The EA learns the order of the code cards and signals information to the Percipient during the run. The Percipient has memorized a random sequence of letter symbols. The EA, in calling out the serial numbers, slightly alters his voice or timing a few times during each run (5 times per 50 trials to give 14 hits). Ordinarily the Percipient is to guess at random, but at each signal he writes down the next letter on the memorized sequence. (I would use this method particularly in experiments when an outsider who wore glasses served as Agent. Then the preferred experimental arrangement would be that in which the cards are turned face up for 30 seconds, the screen aperture would be located as it was in the Stewart sittings, and the lighting would be so arranged that the EA could see the cards by reflection in the Agent's glasses.)

Procedure 6. The Percipient plus the EA, the *Recorder,* or the Agent are "in the trick." In runs where the number sequence is generated by counters, I would have the EA draw counters of the needed color at particular points, or the Recorder could keep false records of counters drawn. And in some experiments, procedures, 1, 4, or 5 could be used.

The procedures that could give the highest degree of success, and that thus would be chosen when I wanted simultaneous "– 1" and "+ 1" or "– 2" and "+ 2" successes, are procedures 1 and 3. Any of the others would be more than adequate for scores of 12.68 hits per run of 50, or 13.77 hits in 48 trials. For long-distance experiments, procedures 1 and 4 would work. Or I could employ procedure 2 by telephoning the Percipient after the sitting to tell him which lists to mail in.

Many other procedures are possible. The six chosen for description were selected as samples of what can be done by simple means. Mental abilities required are similar to those needed for playing bridge competently, except that some collaborators would need a little memory training. Use of special apparatus or of collaborators with the abilities of a good stage conjurer would open up numerous new possibilities. Thus it should be clear that Soal's work was *not* conducted "with every precaution that it was possible to devise." The work would have been enormously more nearly fraudproof if Soal, instead of employing his highly complex arrangement, had simply had many different Agents "send" directly from lists prepared by outsiders and given directly to the Agent at the start of each run. And the examples to be given presently will show what precautions can be devised if one really wants to devise precautions.

Why Has There Been No Satisfactory Test?

Both Soal and Rhine have demonstrated ESP before intelligent "open-minded" outside observers, but what is needed is something that can be demonstrated to the most hostile, pig-headed, and skeptical of critics. Why has there been no such demonstration? Because when onlookers are hostile, "sensitives" allegedly lose their paranormal abilities. This excuse is an old one, long employed by spiritualist mediums, but contemporary parapsychology has modernized it with a touch of poetry. Thus Rhine asks (*15,* p. 246): "Would you expect, if we had a young poet here, that we could send him up to your university to write some poems for you while your committee sat staring fixedly at him to see that he did not slip them from one of his pockets?" And Soal argues (*3,* pp. 51 f.): "But one would not expect even a poet to produce a good poem if he were surrounded by people who, he felt, viewed his activities with half-concealed scorn or humorous contempt. The best he could do would be to churn out a few passable verses from which the informing spirit of poetry would be absent."

There are two replies to this excuse. The first is that it is false. It appears plausible to us because nowadays we tend to regard poets as rather erratic, neurotic beings. But in other periods, when it was expected of every educated man that he be able to write competent poetry, such reasoning would not have seemed convincing. Of course there are poets who require solitude for work, just as there are bridge players who are upset by kibitzers; but one would hardly imagine, say, Sidney or Raleigh or Byron suddenly starting to write like Edgar Guest because people were staring at him.

Poetic creation, as analyzed by John Livingston Lowes in his monumental study of Coleridge (*21*), is strikingly similar to mathematical creation, as described by Jacques Hadamard in his brilliant little book on *The Psychology of Invention in the Mathematical Field* (*22*). We expect a young mathematician to be able to do creative mathematical thinking before a hostile examining committee, and a poet or any other kind of thinker can do as well. Rhine writes (*9,* p. 141): "All the fickleness and skittishness of ESP and PK will find their counterparts in the fine arts, in the realm of the Muses." But this is not correct. There is no established human ability whatsoever that shows the fickleness of ESP.

Such is the first reply to the excuse of Rhine and Soal. And the second reply is that it is perfectly possible to set up fraudproof tests permitting "sensitives" to work anywhere they wish, completely alone or with whatever company they desire, and yet with the experiments subject to the most searching scrutiny at all essential points.

In other days, numerous "sensitives"

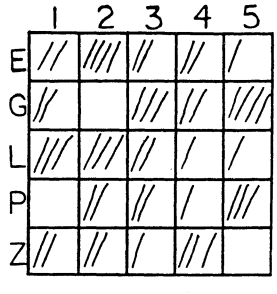

Fig. 1. Type of record to be kept by an Agent employing procedure 4 for simulating telepathy. If the number sequence "12345" is replaced by the letter sequence "LEGZP," it will be seen that arranging the code cards in this order will result in 16 "hits."

willingly demonstrated their marvels before critical examining committees. In the 1870's, Daniel Home submitted to painstaking investigation by William Crookes. In the 1880's, a number of mediums appeared before the Seybert Commission of the University of Pennsylvania. Later, the British and American Societies for Psychical Research continued the type of investigations that had been started by the Seybert Commission. And from about 1880 to 1910, the great Eusapia Palladino made a specialty of holding séances before committees of scientists.

But a change came. Although scientists were often easily fooled, conjurers proved to be able foes of mediums. Houdini devoted the last years of his life to exposing mediums, and then this work was continued by Dunninger, who for many years defended the *Science and Invention* awards of $21,000 for physical spirit manifestations that he could not duplicate by scientific means (*49*). So effective has such work been that nowadays we hear very little of the olden wonders like materializations or elongations, levitations or transportations. Such tricks are too risky, too easily exposed by skeptics with flashlights. Instead, today we are expected to marvel at vague statistical effects, minutiae that a conjurer would scorn to imitate on a stage. So little is claimed, and this little is demonstrated only to such restricted audiences and under such carefully controlled conditions and with so many excuses for failure available that it is quite difficult to prove that the little is actually nothing. Yet this can be done, I think.

Design of a Satisfactory Test

As scientists, what sort of evidence for ESP should we demand? This sort: one test of such nature that fraud or error would seem to us as improbable as the supernatural. Let us somewhat arbitrarily think of a committee of 12 and design tests such that the presence of a single honest man on the "jury" will ensure validity of the test, even if the other 11 members should cooperate in fraud either to prove or disprove occurrence of psi phenomena. Assume that the committee includes two experimental psychologists, two experimental physicists, one statistician, and three conjurers or other experts on trickery—all prominent men and all strongly hostile toward parapsychology, with that "adamantine faith" that Lucian recommended (*50*). Then probably most scientists would have confidence in the committee and would be prepared to believe in psi phenomena in preference to believing that the entire committee was dishonest or deluded. In addition, so that results would be acceptable to parapsychologists, the chairman of the committee should be a person with a record of successes in psi experimentation, for it is claimed by West (*51*) and Soal (*3*, pp. 388 f.) that the personality of the chief experimenter may in some psychic manner determine success or failure in a psychic experiment.

To test Rhine's "sensitives," the simplest procedure is to prepare sealed packages of cards and mail them to Duke University to be examined by clairvoyants at any time and place they select, and then have them mailed back along with records of guesses. In preparing the packages, cards would be shuffled automatically by a series of machines and placed within opaque containers in such manner that no one could possibly have seen any card from the beginning of the shuffling. A good procedure for insuring against opening would be to place each set of cards in a small metal container, weld on a cover, and take photomicrographs of the weld—for it is probably impossible to counterfeit microscopic details. When the cards were returned, first the seals would be checked, and then packages would be cut open and cards fanned out by machine, with the jury watching and with a motion-picture camera recording everything.

For the type of findings made by Soal, the simplest and most fraudproof type of test would make use of the precognitive ability that Shackleton allegedly showed most of the time and that Mrs. Stewart allegedly showed for a brief time. With precognition, the only safeguards needed are that the "message" be generated in a way not subject to ordinary human control or prediction, and that guesses be recorded before the message is displayed. Imagine a radioactive sample of high activity, plus a scintillation counter with ring-of-five scaling circuit and indicator lamps corresponding to Soal's five animal symbols. An accurate timing circuit turns off the counter at set intervals. The circuitry is wired in such open fashion that inspection is easy. The apparatus is battery-powered and is placed in a shielded case, with nothing penetrating through the shield except windows to show the indicators. The percipient and the telepathic sender can be wherever in the world they wish, together or far apart, in the same room with the apparatus or across the ocean from it, alone or with whatever company they want. The guesses of the percipient (transmitted via radio or cable, if necessary) are indicated in some visible form, and a single motion-picture camera records both guesses and subsequent "calls" of the number generator.

It is also simple to test psychokinetic control of dice. While a motion-picture camera records everything, one or more dice are placed at the top of a chute or in a throwing machine. Then a ring-of-six random number generator tells the psychic controller what number to wish for, and a few seconds later the dice are automatically released. The psychic controller can be in the same room, or anywhere in the world where telephone or radio can reach him.

For testing contemporaneous telepathy, symbols to be transmitted should be controlled by a random number generator, and the percipient could be anywhere in the world except close to the sender. However, it is exceedingly difficult to guard against all known communication means, especially since only a few bits of information need be transmitted per 25 trials in order to give extrachance results. For example, the sender might signal to a member of the committee by means of slight motions of his body, and the committee member could use a pocket radio transmitter to relay the information. I have worked out several procedures that appear to be reasonably fraudproof, but the required precautions are quite elaborate, and I am not sure that others cannot think of much simpler procedures, so I prefer not to take the space to describe my ideas here. No doubt clairvoyance, precognitive telepathy, and psychokinesis should be examined first, since it is so easy to test them. Then—if anyone is still interested in the question — contemporaneous telepathy can be tested.

Even now in 1955, paranormal findings continue to be published in England (*52*) and America (*53*), so it is reasonable for us to expect that both the British Society for Psychical Research and the Duke University Parapsychology Laboratory will gladly offer "sensitives" to be tested.

Conclusion

What sort of reply will the parapsychologists make to these criticisms? I have read answers they have made to others, and on that basis I might expect some of the following.

1) "Some interesting suggestions for further demonstrations of ESP have recently been made, but we consider that ESP was demonstrated beyond any reasonable doubt many years ago, and it is a waste of time to keep proving the same thing over and over again. However, there is much need for additional workers in the field, so we hope that Price will try his suggestions himself."

2) "Standards of experimentation in psi research are already far higher than those in most fields of science, so it is absurd to seek further inprovement. Science would have made little progress if every chemistry and physics experiment had had to be performed before wit-

nesses and with numerous other precautions."

3) "A foolish attack has recently been made by an incompetent man who, to the best of our belief, has never published a single experiment in the field of parapsychology." (*54*)

4) "Unfortunately, I can furnish no one right at present for demonstrating ESP. However, I proved everything conclusively, with odds against chance of 10^{237} to 1, back in 19—."

But the only answer that will impress me is an adequate experiment. Not 1000 experiments with 10 million trials and by 100 separate investigators giving total odds against change of 10^{1000} to 1—but just one good experiment. And until such a demonstration has been provided, I hope that my fellow-scientists will similarly withhold belief. (*55*).

References and Notes

1. See, for example, the press release by B. H. Camp, president of the Institute of Mathematical Statistics, quoted in the *New York Herald Tribune*, 16 Jan. 1938, sect. II–IV, p. 6.
2. J. G. Pratt, J. B. Rhine, B. M. Smith, C. E. Stuart, J. A. Greenwood, *Extra-Sensory Perception after Sixty Years* (Holt, New York, 1940).
3. S. G. Soal and F. Bateman, *Modern Experiments in Telepathy* (Yale Univ. Press, New Haven, Conn., 1954). I cite this book as "Soal," rather than as "Soal and Bateman," since large portions of it are taken almost unchanged from papers by Soal alone or by Soal and Goldney.
4. R. A. McConnell, *J. Parapsychol.* 18, 245 (1954).
5. E. G. Boring, *Am. Scientist* 43, 108 (1955).
6. C. E. Shannon, *Bell System Tech. J.* 27, 379–423, 623–656 (1948).
7. Channel capacity is given by:

   $$\text{Bits/trial} = \log_2 5 + (N/25)\log_2(N/25) + 4[(25-N)/100]\log_2[(25-N)/100]$$

   where N is the mean number of "hits" per 25 trials ($N \geqq 5$). (This formula applies strictly only to cases where in each trial there is equal probability of selecting any of the five symbols; thus it applies strictly to most of Soal's work but will be slightly in error for most of Rhine's work.)
8. J. B. Rhine, *J. Parapsychol.* 6, 111 (1942); 9, 264 (1945).
9. ———, *The Reach of the Mind* (Sloane, New York, 1947).
10. ———, *The New World of the Mind* (Sloane, New York, 1953).
11. B. M. Humphrey and J. B. Rhine, *J. Parapsychol.* 6, 190 (1942).
12. Quoted by J. Jastrow in *Wish and Wisdom* (Appleton-Century, New York, 1935), p. 25.
13. T. Paine, *Age of Reason*; the quotation comes a few pages before the end of part I.
14. C. D. Broad, *Philosophy* 24, 291 (1949).
15. J. B. Rhine, *New Frontiers of the Mind* (Farrar and Rinehart, New York, 1937).
16. R. Walker, *Sci. Monthly* 79, 1 (1954).
17. Quoted in reference 3, p. 357.
18. H. Reichenbach, *The Theory of Probability* (Univ. of California Press, Berkeley, 1949), p. 476.
19. I refer here to genuine magic, not the deceptions of mediums and stage conjurers. Five methods of table levitation employed by mediums are disclosed by J. Dunninger in *Inside the Medium's Cabinet* (David Kemp, New York, 1935).
20. I am using *magic* in a particular sense, defining it in terms of what *can* be explained in a certain way—without regard to how those who attempt to practice it actually do try to explain it. Actions that overtly resemble magic ceremonies and yet are based on mechanistic reasoning (like much of alchemy), I would call not magic but gropings toward science.
21. J. L. Lowes, *The Road to Xanadu* (Houghton Mifflin, Boston, 1927).
22. J. Hadamard, *The Psychology of Invention in the Mathematical Field* (Princeton Univ. Press, Princeton, N.J., 1945).
23. W. Pitts and W. S. McCulloch, *Bull. Math. Biophys.* 9, 127 (1947).
24. J. B. Rhine, *Extra-Sensory Perception* (Humphries, Boston, 1935).
25. R. K. Nabours, *Philosophy of Science* 10, 191 (1943).
26. B. F. Skinner, *Am. Scientist* 36, 456, 482 ff. (1948).
27. D. H. Rawcliffe, *The Psychology of the Occult* (Ridgway, London, 1952). I think that most of Rawcliffe's ideas are correct, but that his explanation of Soal's work in terms of involuntary whispering is implausible.
28. G. S. Brown, *Nature* 172, 154 (1953). I think that Brown's criticism has been adequately refuted by Soal in reference 3.
29. H. Sidgwick, *Proc. Soc. Psychical Research* 1, 7 (1882).
30. W. W. Carington, *ibid.* 46, 265 (1940).
31. H. Houdini, *A Magician among the Spirits* (Harper, New York, 1924).
32. F. Podmore, *Modern Spiritualism* (Methuen, London, 2 vols., 1902); *The Newer Spiritualism* (Holt, New York, 1911).
33. J. C. R. MacDonald, *Crime Is a Business* (Stanford Univ. Press, Stanford, Calif., 1939).
34. C. D. MacDougall, *Hoaxes* (Macmillan, New York, 1940).
35. W. Crookes, *J. Soc. Psychical Research* 6, 341 (1894). Dissenting opinions concerning Home have been written by Podmore (*32*), Houdini, and R. Browning. Houdini (*31*, p. 49) states that "His active career, his various escapades, and the direct cause of his death all indicate that he lived the life of a hypocrite of the deepest dye." (Houdini does not name the cause of Home's death, although he does quote this sentence from Madame Blavatsky's *Key to Theosophy*: "This Calvin of Spiritualism suffered for years from a terrible spinal disease, brought on through his intercourse with the 'spirits,' and died a perfect wreck.") And Browning, in "Mr. Sludge, 'the Medium,' " gives this picture of Home: "Now, don't sir! Don't expose me! Just this once!/ This was the first and only time, I'll swear,—/Look at me,—see, I kneel,—the only time,/I swear, I ever cheated,—yes, by the soul/Of Her who hears—(your sainted mother, sir!)/All, except this last accident, was truth—"
36. S. G. Soal, *Proc. Soc. Psychical Research* 50, 67 (1953), especially pp. 84, 94.
37. ———, *The Experimental Situation in Psychical Research* (Society for Psychical Research, London, 1947), pp. 25 f.
38. G. E. Hutchinson, *Am. Scientist* 36, 291 (1948).
39. C. D. Broad, *Philosophy* 19, 261 (1944).
40. Paraphrased from a report by J. F. Rinn, published by J. Jastrow in *Collier's Weekly* 45, No. 8, 21 (14 May 1910).
41. S. G. Soal, *Proc. Soc. Psychical Research* 40, 165 (1932); *J. Soc. Psychical Research* 30, 55 (1937); *Preliminary Studies of a Vaudeville Telepathist* (Univ. of London Council for Psychical Investigation, London, Bull. III, 1937).
42. ———, *Proc. Soc. Psychical Research* 46, 152 (1940).
43. ——— and K. M. Goldney, *ibid.* 47, 21 (1943).
44. F. Bateman and S. G. Soal, *J. Soc. Psychical Research* 35, 257 (1950); S. G. Soal and F. Bateman, *J. Parapsychol.* 14, 168 (1950).
45. Since there was a pause at the middle of each run, and pre- and postcognitive hits occurring across this gap were not scored, there were 48 "+ 1" trials per run of 50.
46. This description of Soal's experiments omits details not relevant to my argument. For example, I have said nothing concerning precautions taken against tampering with the records. Therefore, readers previously unfamiliar with Soal's work should be cautious in deciding that they have found a flaw in it.
47. Houdini states: "Regarding the possibility of using codes and cues before others without being detected I can say positively that it is not only possible but simple and practical" (reference 31, p. 259). And Soal in several different places discusses auditory codes and other signaling means: for example, in reference 3, pp. 104, 117.
48. A variety of ways are available for setting up such a system. In one of these, 22 prepared guess sheets can suffice for a sitting of 8 runs, and simple, short-cut methods are available for quickly preparing the lists of guesses.
49. Of the $21,000, $1000 was offered by *Science and Invention* magazine, $10,000 by Dunninger, and $10,000 by the same J. F. Rinn who observed Palladino's footwork at close range. Further details are given in reference 19, and in J. Dunninger, *Houdini's Spirit Exposés from Houdini's Own Manuscripts, Records and Photographs* (Experimenter Publ., New York, 1928). Of course, no medium ever won the $21,000. No doubt, if any one of them had been clever enough to devise a trick that Dunninger could not duplicate, that person would not have been a medium, for he would probably have preferred to make an honest living as a conjurer.
50. Strong hostility toward supernaturalism is desirable as a safeguard, even though it is not absolutely essential. To be sure, Houdini had strong yearning to find evidence for the supernatural, and yet he was a most effective exposer of psychic fraud, but such a combination is exceedingly rare.
51. D. J. West, *J. Soc. Psychical Research* 37, 323 (1954).
52. G. W. Fisk and D. J. West, *ibid.* 38, 1 (1955).
53. G. L. Mangan, *J. Parapsychol.* 19, 35 (1955); H. Forwald, *ibid.* 19, 45 (1955).
54. Soal (*36*), in replying to criticism by Rawcliffe (27), writes: "All Mr Rawcliffe's knowledge is derived from books; to the best of our belief he has never in his life published a single experiment in the field of parapsychology." Also, Soal writes (*3*, pp. 23 f.); "It would be interesting to meet the psychiatrist or psychologist who has perused every page of the 49 volumes of the *Proceedings* of the Society for Psychical Research, and who remains a complete sceptic." It would be interesting indeed.

55. For reading early drafts of this paper and making numerous helpful suggestions, I am greatly indebted to Herbert Feigl, Bernard Gelbaum, Gerhard Kalisch, Leo Marx, Paul Meehl, and Michael Scriven, all of the University of Minnesota, and to Claude Shannon of Bell Telephone Laboratories. However, this must not be taken as implying that these men or the Department of Medicine, University of Minnesota, necessarily endorse my views.

A textbook must be exceptionally bad if it is not more intelligible than the majority of notes made by students. . . . The proper function of lectures is not to give a student all the information he needs, but to rouse his enthusiasm so that he will gather knowledge himself, perhaps under difficulties.—J. J. THOMSON.