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Cover Picture

A hundred years ago *Nature* was reviewing E. J. Marey's *Animal Mechanism* (page 518, October 29, 1874). These cumbersome mechanisms were soon to be replaced by Muybridge's zoopraxiscope camera. On page 567 we look at a Muybridge sequence and—a century later—what happens when the light is switched on.



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# nature

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## Investigating the paranormal

WE publish this week a paper by Drs R. Targ and H. Puthoff (page 602) which is bound to create something of a stir in the scientific community. The claim is made that information can be transferred by some channel whose characteristics appear to fall "outside the range of known perceptual modalities". Or, more bluntly, some people can read thoughts or see things remotely.

Such a claim is, of course, bound to be greeted with a preconditioned reaction amongst many scientists. To some it simply confirms what they have always known or believed. To others it is beyond the laws of science and therefore necessarily unacceptable. But to a few—though perhaps to more than is realised—the questions are still unanswered, and any evidence of high quality is worth a critical examination.

The issue, then, is whether the evidence is of sufficient quality to be taken seriously. In trying to answer this, we have been fortunate in having the help of three independent referees who have done their utmost to see the paper as a potentially important scientific communication and not as a challenge to or confirmation of prejudices. We thank them for the considerable effort they have put in to helping us, and we also thank Dr Christopher Evans of the National Physical Laboratory whose continued advice on the subject is reflected in the content of this leading article.

A general indication of the referees' comments may be helpful to readers in reaching their own assessment of the paper. Of the three, one believed we should not publish, one did not feel strongly either way and the third was guardedly in favour of publication. We first summarise the arguments against the paper.

(1) There was agreement that the paper was weak in design and presentation, to the extent that details given as to the precise way in which the experiment was carried out were disconcertingly vague. The referees felt that insufficient account had been taken of the established methodology of experimental psychology and that in the form originally submitted the paper would be unlikely to be accepted for publication in a psychological journal on these grounds alone. Two referees also felt that the authors had not taken into account the lessons learnt in the past by parapsychologists researching this tricky and complicated area.

(2) The three referees were particularly critical of the method of target selection used, pointing out that the choice of a target by "opening a dictionary at random" is a naive, vague and unnecessarily controversial approach to randomisation. Parapsychologists have long rejected such methods of target selection and, as one referee put it, weaknesses of this kind reveal "a lack of skill in their experiments, which might have caused them to make some other mistake which is less evident from their writing".

(3) All the referees felt that the details given of various safeguards and precautions introduced against the possibility of conscious or unconscious fraud on the part of one or other of the subjects were unconvincingly vague

(to use one phrase). This in itself might be sufficient to raise doubt that the experiments have demonstrated the existence of a new channel of communication which does not involve the use of the senses.

(4) Two of the referees felt that it was a pity that the paper, instead of concentrating in detail and with meticulous care on one particular approach to extra-sensory phenomena, produced a mixture of different experiments, using different subjects in unconnected circumstances and with only a tenuous overall theme. At the best these were more "a series of pilot studies . . . than a report of a completed experiment".

On their own these highly critical comments could be grounds for rejection of the paper, but it was felt that other points needed to be taken into account before a final decision could be made.

(1) Despite its shortcomings, the paper is presented as a scientific document by two qualified scientists, writing from a major research establishment apparently with the unqualified backing of the research institute itself.

(2) The authors have clearly attempted to investigate under laboratory conditions phenomena which, while highly implausible to many scientists, would nevertheless seem to be worthy of investigation even if, in the final analysis, negative findings are revealed. If scientists dispute and debate the reality of extra-sensory perception, then the subject is clearly a matter for scientific study and reportage.

(3) Very considerable advance publicity—it is fair to say not generated by the authors or their institute—has preceded the presentation of this report. As a result many scientists and very large numbers of non-scientists believe, as the result of anecdote and hearsay, that the Stanford Research Institute (SRI) was engaged in a major research programme into parapsychological matters and had even been the scene of a remarkable breakthrough in this field. The publication of this paper, with its muted claims, suggestions of a limited research programme, and modest data, is, we believe, likely to put the whole matter in more reasonable perspective.

(4) The claims that have been made by, or on behalf of, one of the subjects, Mr Uri Geller, have been hailed publicly as indicating total acceptance by the SRI of allegedly sensational powers and may also perhaps now be seen in true perspective. It must be a matter of interest to scientists to note that, contrary to very widespread rumour, the paper does not present any evidence whatsoever for Geller's alleged abilities to bend metal rods by stroking them, influence magnets at a distance, make watches stop or start by some psychokinetic force and so on. The publication of the paper would be justified on the grounds of allowing scientists the opportunity to discriminate between the cautious, limited and still highly debatable experimental data, and extravagant rumour, fed in recent days by inaccurate attempts in some newspapers at precognition of the contents of the paper.

(5) Two of the referees also felt that the paper should be published because it would allow parapsychologists, and all other scientists interested in researching this arguable field, to gauge the quality of the Stanford research and assess how much of the current publicity to parapsychology

(6) *Nature*, although seen by some as one of the world's most respected journals cannot afford to live on respectability. We believe that our readers expect us to be a home for the occasional 'high-risk' type of paper. This is hardly to assert that we regularly fly in the face of referees' recommendations (we always consider the possibility of publishing, as in this case, a summary of their objections). It is to say that the unusual must now and then be allowed a toe-hold in the literature, sometimes to flourish, more often to be forgotten within a year or two.

The critical comments above were sent to the authors who have modified their manuscript in response to them. We have also corresponded informally with the authors on one or two issues such as whether the targets could have been forced by standard magical tricks, and are convinced that this is not the case. As a result of these exchanges and the above considerations we have decided to publish in the belief that, however flawed the experimental procedure and however difficult the process of distilling the essence of a complex series of events into a scientific manuscript, it was on balance preferable to publish and maybe stimulate and advance the controversy rather than keep it out of circulation for a further period.

Publishing in a scientific journal is not a process of receiving a seal of approval from the establishment; rather it is the serving of notice on the community that there is something worthy of their attention and scrutiny. And this

scrutiny is bound to take the form of a desire amongst some to repeat the experiments with even more caution. To this end the *New Scientist* does a service by publishing this week the results of Dr Joe Hanlon's own investigations into a wide range of phenomena surrounding Mr Geller. If the subject is to be investigated further—and no scientist is likely to accept more than that the SRI experiments provide a *prima facie* case for more investigations—the experimental technique will have to take account of Dr Hanlon's strictures, those of our own referees and those, doubtless, of others who will be looking for alternative explanations.

Perhaps the most important issue raised by the circumstances surrounding the publication of this paper is whether science has yet developed the competence to confront claims of the paranormal. Supposedly paranormal events frequently cannot be investigated in the calm, controlled and meticulous way that scientists are expected to work, and so there is always a danger that the investigator, swept up in the confusion that surrounds many experiments, abandons his initial intentions in order to go along with his subject's desires. It may be that all experiments of this sort should be exactly prescribed beforehand by one group, done by another unassociated group and evaluated in terms of performance by the first group. Only by increasing austerity of approach by scientists will there be any major progress in this field.

## For those in peril on the factory floor

*In this article Peter J. Smith argues that a greater commitment (in deed as well as word) to community science by the Scientific Establishment might help the world of science regain some of the public respect it has lost.*

THE question of who speaks, or should speak, on behalf of the scientific community has been debated on many occasions, most often without result. On the face of it, such lack of resolution is hardly unexpected, for scientists and scientific institutions are not noted for their ready ability to achieve consensus. Yet there is no doubt that they can put up a pretty collective front when they feel so moved. The one famous occasion on which a near consensus was reached was when the scientific community saw itself put at risk financially by the Rothschild proposals. Then individuals and institutions miraculously found a common cause of self-preservation.

But when it comes to the defence of less privileged groups it is quite a different story; the voice of the British scientific community is seldom to be heard, whether taking a moral stance, exerting humanitarian pressure, supplying expertise or even simply providing information. A good case in point is provided by a new *Socialist Worker* pamphlet entitled *Asbestos: The Dust that Kills in the Name of Profit*. As

the title hints, the object of *Socialist Worker* is nothing less than the complete overthrow of the capitalist system; and one of the ways of achieving this aim, it seems, is to give strident publicity to defects in the capitalist-industrial system. Fortunately, one can easily avoid a sharp turn to the left and still admit that what some British workers have been subjected to in the name of asbestos production is beyond the limit of acceptability in a humanitarian society.

For what clearly emerges from the rhetoric of the pamphlet in question is a picture of men and women reacting in some bewilderment to the long-term ill effects of a technological activity. The chief consequence is, of course, asbestosis—a killing disease acquired by breathing in asbestos fibres. The bulk of the pamphlet is devoted to case histories of men to whom asbestosis has come as a shock after a decade or so in the industry. But more instructively, there is also a short account of the fight for safety put up by a small group of the 7/162 Glasgow insulation workers' branch of the Transport and General Workers Union against the obstruction of the asbestos companies, the indifference of politicians, the weakness of the Factory Inspectorate, the silence of much of the press, the impotence of health authorities, the equivocal official stance of unions in general, and, last but not least, apathy among many of the

asbestos workers themselves.

And there is certainly something to fight about. According to Patrick Kinnerly (*The Hazards of Work: How to Fight Them*, Pluto Press, 1973), asbestosis is taking an increasing toll: 64 are known to have died in 1965, 107 in 1970 and 113 in 1971. The number of new cases diagnosed rose from 82 in 1965 to 153 in 1970. Moreover, asbestosis is only one of the asbestos-induced diseases. Lung cancer appears to require a smaller exposure to asbestos. There is also another form of cancer known as mesothelioma which involves growths in the linings of the lungs and stomach. Almost all mesotheliomas are caused by asbestos; but no one knows how many workers in Britain are killed by them, partly because they take so long to develop and partly because they are not always identified. The TUC Centenary Institute of Occupational Health has suggested that, 30 years after first exposure, about one in 200 will be found to have died of mesothelioma; but Dr Irving J. Selikoff of Mount Sinai Hospital in New York is apparently more pessimistic. He has recently been quoted as saying that, for every 100,000 workers entering the asbestos industry under the safety standards obtaining in the United States as recently as 1971, he would expect 20,000 to die of lung cancer, 7,000 of mesothelioma and 7,000 of other cancers and asbestosis.

Legon poses, as a challenge to the problem of extracting work from the mixing of two ideal gases in an isolated system of constant total volume. It is elementary that if the mixture is allowed to form by merely withdrawing a partition between the gases we have a good example of a completely irreversible process with maximal entropy creation (+11.53 J K<sup>-1</sup> if we started with 1 mol of each at 300 K) and no performance or storage of work. On the other hand, by introducing into the system a suitable machine, the uniform mixture could be allowed to form in such a way that a weight within the system was raised. (The machine described by Planck (ref. 8, page 219) may be readily adapted for this purpose.) At the end of the latter mixing process the isolated system would accordingly contain more mechanical energy than it did at the beginning. From the First Law it follows that the system must necessarily contain less thermal energy; that is, its temperature must have fallen. In the limit, where the mixing was reversible, the maximum possible work would have been performed and transferred to the weight (2,769 J if the gases were monatomic) and the temperature would have fallen to 189 K. In this reversible case the change in entropy arising from mixing (+11.53 J K<sup>-1</sup>) is exactly counterbalanced by that attributable to cooling (-11.53 J K<sup>-1</sup>): no entropy is created.

At this point it might be objected that the change in the gases is not exactly the same as if they had mixed irreversibly, because their thermal energy and temperature have decreased. This is a simple consequence of the First Law which applies equally no matter whether one is considering an isolated system, a non-isolated one or the whole Universe. If a change is conducted in such a way that a weight is lifted then all the other bodies involved cannot possibly end up in the same state as if the weight had not been lifted.

**Failure to apply to nonisothermal systems.** Legon expresses doubts about the validity of the equation for entropy creation (refs 3 and 4) save for "the trivial case for which the temperature *T*<sub>0</sub> of the environment is equal to the temperature *T* of the system throughout the process". On what grounds are these doubts based? Legon does not discuss, let alone dismiss, any of the sources quoted in my article<sup>9</sup>. Other relevant sources which should be considered are Keenan and Hatsopoulos<sup>13</sup> and the classic accounts by Maxwell<sup>10</sup> and by Gouy<sup>14</sup>.

Legon's quotation from Planck (ref. 8, page 104) concerning "dissipated energy" deserves close consideration. It seems to state that the maximum work is a definite quantity only for isothermal processes. If true this would directly contradict the views of Thomson<sup>11</sup> (later Lord Kelvin) "On a universal tendency in Nature to the dissipation of mechanical energy". On pages 113-117 of ref. 8, however, Planck discusses his own statement (ref. 8, page 104) and we see that there is in fact no contradiction. What Planck demonstrates is that although the change in Helmholtz free energy, -dA = -d(U-TS), measures *w*<sub>max</sub> under isothermal conditions, it cannot conveniently be used to determine *w*<sub>max</sub> under nonisothermal conditions because the term *S* d*T* that then appears is frequently indeterminate. The same point has already been made in a footnote by Gouy (ref. 15, page 506) who had also given the correct equation for determining *w*<sub>max</sub> under nonisothermal conditions. Accordingly I find no substance in Legon's objections under this heading.

If it is thought that there is conflict between the 'work' view of thermodynamics and the 'entropy' view it is high time that the idea was abandoned. The two views are different, but symmetrical, aspects of the same reality. Spontaneous processes of all kinds fall somewhere within the pattern shown in Table 1, their position depending on the efficiency of the machinery used for the extraction of work.

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 D. R. WILKIE  
 Department of Physiology,  
 University College London,  
 Gower Street,  
 London WC1E 6BT, UK

Received December 3, 1973; revised June 4, 1974.  
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<sup>14</sup> Gouy, M., *J. de Phys.*, 2<sup>e</sup> serie, t.VIII (Novembre 1889).  
<sup>15</sup> Thomson, W., *Phil. Mag.*, Series 4, 4, 304 (1852); corrections in *ibid*, 5, viii.

### Information transmission under conditions of sensory shielding

We present results of experiments suggesting the existence of one or more perceptual modalities through which individuals obtain information about their environment, although this information is not presented to any known sense. The literature<sup>1-3</sup> and our observations lead us to conclude that such abilities can be studied under laboratory conditions.

We have investigated the ability of certain people to describe graphical material or remote scenes shielded against ordinary perception. In addition, we performed pilot studies to determine if electroencephalographic (EEG) recordings might indicate perception of remote happenings even in the absence of correct overt responses.

We concentrated on what we consider to be our primary responsibility—to resolve under conditions as unambiguous as possible the basic issue of whether a certain class of paranormal perception phenomena exists. So we conducted our experiments with sufficient control, utilising visual, acoustic and electrical shielding, to ensure that all conventional paths of sensory input were blocked. At all times we took measures to prevent sensory leakage and to prevent deception, whether intentional or unintentional.

Our goal is not just to catalogue interesting events, but to uncover patterns of cause-effect relationships that lend themselves to analysis and hypothesis in the forms with which we are familiar in scientific study. The results presented here constitute a first step towards that goal; we have established under known conditions a data base from which departures as a function of physical and psychological variables can be studied in future work.

#### REMOTE PERCEPTION OF GRAPHIC MATERIAL

First, we conducted experiments with Mr Uri Geller in which we examined his ability, while located in an electrically shielded room, to reproduce target pictures drawn by experimenters located at remote locations. Second, we conducted double-blind experiments with Mr Pat Price, in which we measured his ability to describe remote outdoor scenes many miles from his physical location. Finally, we conducted pre-

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liminary tests using EEGs, in which subjects were asked to perceive whether a remote light was flashing, and to determine whether a subject could perceive the presence of the light, even if only at a noncognitive level of awareness.

In preliminary testing Geller apparently demonstrated an ability to reproduce simple pictures (line drawings) which had been drawn and placed in opaque sealed envelopes which he was not permitted to handle. But since each of the targets was known to at least one experimenter in the room with Geller, it was not possible on the basis of the preliminary testing to discriminate between Geller's direct perception of envelope contents and perception through some mechanism involving the experimenters, whether paranormal or subliminal.

So we examined the phenomenon under conditions designed to eliminate all conventional information channels, overt or subliminal. Geller was separated from both the target material and anyone knowledgeable of the material, as in the experiments of ref. 4.

In the first part of the study a series of 13 separate drawing experiments were carried out over 7 days. No experiments are deleted from the results presented here.

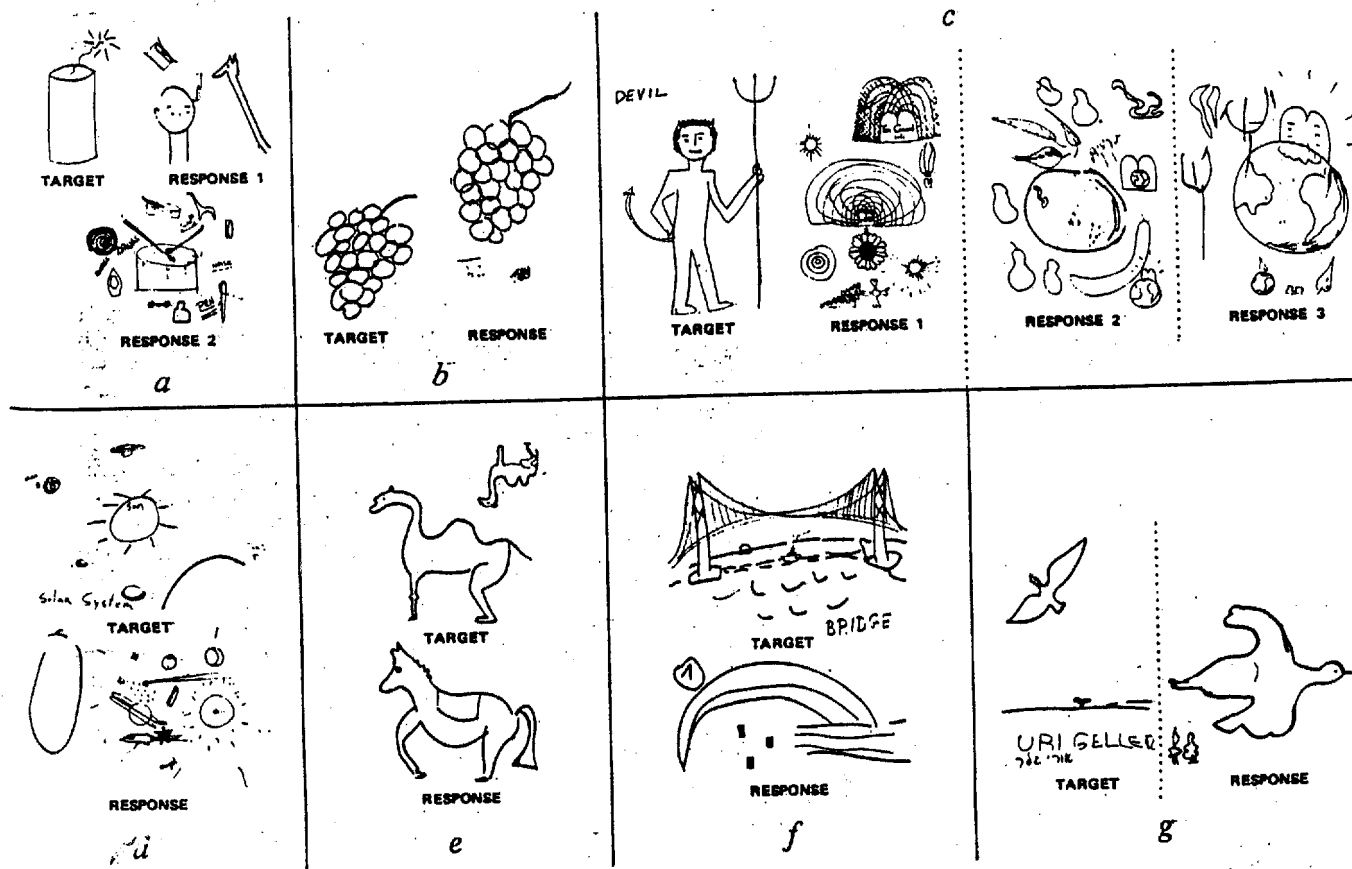
At the beginning of the experiment either Geller or the experimenters entered a shielded room so that from that time forward Geller was at all times visually, acoustically and electrically shielded from personnel and material at the target location. Only following Geller's isolation from the experimenters was a target chosen and drawn, a procedure designed to eliminate pre-experiment cueing. Furthermore, to eliminate the possibility of pre-experiment target forcing, Geller was kept ignorant as to the identity of the person selecting the target and as to the method of target selection. This was accomplished by the use of three different techniques: (1) pseudo-random technique of opening a dictionary arbitrarily and choosing the first word that could be drawn (Experiments 1-4); (2) targets, blind to experimenters and subject, prepared independently by

SRI scientists outside the experimental group (following Geller's isolation) and provided to the experimenters during the course of the experiment (Experiments 5-7, 11-13); and (3) arbitrary selection from a target pool decided upon in advance of daily experimentation and designed to provide data concerning information content for use in testing specific hypotheses (Experiments 8-10). Geller's task was to reproduce with pen on paper the line drawing generated at the target location. Following a period of effort ranging from a few minutes to half an hour, Geller either passed (when he did not feel confident) or indicated he was ready to submit a drawing to the experimenters, in which case the drawing was collected before Geller was permitted to see the target.

To prevent sensory cueing of the target information, Experiments 1 through 10 were carried out using a shielded room in SRI's facility for EEG research. The acoustic and visual isolation is provided by a double-walled steel room, locked by means of an inner and outer door, each of which is secured with a refrigerator-type locking mechanism. Following target selection when Geller was inside the room, a one-way audio monitor, operating only from the inside to the outside, was activated to monitor Geller during his efforts. The target picture was never discussed by the experimenters after the picture was drawn and brought near the shielded room. In our detailed examination of the shielded room and the protocol used in these experiments, no sensory leakage has been found.

The conditions and results for the 10 experiments carried out in the shielded room are displayed in Table 1 and Fig. 1. All experiments except 4 and 5, were conducted with Geller inside the shielded room. In Experiments 4 and 5, the procedure was reversed. For those experiments in which Geller was inside the shielded room, the target location was in an adjacent room at a distance of about 4 m, except for Experiments 3 and 8, in which the target locations were, respectively, an office at a distance of 475 m and a room at a distance of about 7 m.

A response was obtained in all experiments except Numbers 5-7. In Experiment 5, the person-to-person link was eliminated by arranging for a scientist outside the usual experimental group to draw a picture, lock it in the shielded room before Geller's arrival at SRI, and leave the area. Geller was then led



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Fig. 1 Target pictures and responses drawn by Uri Geller under shielded conditions.



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 Table 1. Remote perception of graphic material

Experiment	Date (month, day, year)	Geller Location	Target Location	Target	Figure
1	8/4/73	Shielded room 1*	Adjacent room (4.1 m)†	Firecracker	1a
2	8/4/73	Shielded room 1	Adjacent room (4.1 m)	Grapes	1b
3	8/5/73	Shielded room 1	Office (475 m)	Devil	1c
4	8/5/73	Room adjacent to shielded room 1	Shielded room 1 (3.2 m)	Solar system	1d
5	8/6/73	Room adjacent to shielded room 1	Shielded room 1 (3.2 m)	Rabbit	No drawing
6	8/7/73	Shielded room 1	Adjacent room (4.1 m)	Tree	No drawing
7	8/7/73	Shielded room 1	Adjacent room (4.1 m)	Envelope	No drawing
8	8/8/73	Shielded room 1	Remote room (6.75 m)	Camel	1e
9	8/8/73	Shielded room 1	Adjacent room (4.1 m)	Bridge	1f
10	8/8/73	Shielded room 1	Adjacent room (4.1 m)	Seagull	1g
11	8/9/73	Shielded room 2‡	Computer (54 m)	Kite (computer CRT)	2a
12	8/10/73	Shielded room 2	Computer (54 m)	Church (computer memory)	2b
13	8/10/73	Shielded room 2	Computer (54 m)	Arrow through heart (computer CRT, zero intensity)	2c

\*EEG Facility shielded room (see text).

†Perceiver-target distances measured in metres.

‡SRI Radio Systems Laboratory shielded room (see text).

by the experimenters to the shielded room and asked to draw the picture located inside the room. He said that he got no clear impression and therefore did not submit a drawing. The elimination of the person-to-person link was examined further in the second series of experiments with this subject.

Experiments 6 and 7 were carried out while we attempted to record Geller's EEG during his efforts to perceive the target pictures. The target pictures were, respectively, a tree and an envelope. He found it difficult to hold adequately still for good EEG records, said that he experienced difficulty in getting impressions of the targets and again submitted no drawings.

Experiments 11 through 13 were carried out in SRI's Engineering Building, to make use of the computer facilities available there. For these experiments, Geller was secured in a double-walled, copper-screen Faraday cage 54 m down the hall and around the corner from the computer room. The Faraday cage provides 120 dB attenuation for plane wave radio frequency radiation over a range of 15 kHz to 1 GHz. For magnetic fields the attenuation is 68 dB at 15 kHz and decreases to 3 dB at 60 Hz. Following Geller's isolation, the targets for these experiments were chosen by computer laboratory personnel not otherwise associated with either the experiment or Geller, and the experimenters and subject were kept blind as to the contents of the target pool.

For Experiment 11, a picture of a kite was drawn on the face of a cathode ray tube display screen, driven by the computer's graphics program. For Experiment 12, a picture of a church was drawn and stored in the memory of the computer. In Experiment 13, the target drawing, an arrow through a heart (Fig. 2c), was drawn on the face of the cathode ray tube and then the display intensity was turned off so that no picture was visible.

To obtain an independent evaluation of the correlation between target and response data, the experimenters submitted the data for judging on a 'blind' basis by two SRI scientists who were not otherwise associated with the research. For the 10 cases in which Geller provided a response, the judges were asked to match the response data with the corresponding target data (without replacement). In those cases in which Geller made more than one drawing as his response to the target, all the drawings were combined as a set for judging. The two judges each matched the target data to the response data with no error. For either judge such a correspondence has an *a priori* probability, under the null hypothesis of no information channel, of  $P = (10!)^{-2} = 3 \times 10^{-7}$ .

A second series of experiments was carried out to determine whether direct perception of envelope contents was possible without some person knowing of the target picture.

One hundred target pictures of everyday objects were drawn by an SRI artist and sealed by other SRI personnel in double

envelopes containing black cardboard. The hundred targets were divided randomly into groups of 20 for use in each of the three days' experiments.

On each of the three days of these experiments, Geller passed. That is, he declined to associate any envelope with a drawing that he made, expressing dissatisfaction with the existence of such a large target pool. On each day he made approximately 12 recognisable drawings, which he felt were associated with the entire target pool of 100. On each of the three days, two of his drawings could reasonably be associated with two of the 20 daily targets. On the third day, two of his drawings were very close replications of two of that day's target pictures. The drawings resulting from this experiment do not depart significantly from what would be expected by chance.

In a simpler experiment Geller was successful in obtaining information under conditions in which no persons were knowledgeable of the target. A double-blind experiment was performed in which a single 3/4 inch die was placed in a 3 × 4 × 5 inch steel box. The box was then vigorously shaken by one of the experimenters and placed on the table, a technique found in control runs to produce a distribution of die faces differing non-significantly from chance. The orientation of the die within the box was unknown to the experimenters at that time. Geller would then write down which die face was uppermost. The target pool was known, but the targets were individually prepared in a manner blind to all persons involved in the experiment. This experiment was performed ten times, with Geller passing twice and giving a response eight times. In the eight times in which he gave a response, he was correct each time. The distribution of responses consisted of three 2s, one 4, two 5s, and two 6s. The probability of this occurring by chance is approximately one in 10<sup>6</sup>.

In certain situations significant information transmission can take place under shielded conditions. Factors which appear to be important and therefore candidates for future investigation include whether the subject knows the set of targets in the target pool, the actual number of targets in the target pool at any given time, and whether the target is known by any of the experimenters.

It has been widely reported that Geller has demonstrated the ability to bend metal by paranormal means. Although metal bending by Geller has been observed in our laboratory, we have not been able to combine such observations with adequately controlled experiments to obtain data sufficient to support the paranormal hypothesis.

#### REMOTE VIEWING OF NATURAL TARGETS

A study by Osis<sup>6</sup> led us to determine whether a subject could describe randomly chosen geographical sites located several miles from the subject's position and demarcated by some

appropriate means (remote viewing). This experiment carried out with Price, a former California police commissioner and city councilman, consisted of a series of double-blind, demonstration-of-ability tests involving local targets in the San Francisco Bay area which could be documented by several independent judges. We planned the experiment considering that natural geographical places or man-made sites that have existed for a long time are more potent targets for paranormal perception experiments than are artificial targets prepared in the laboratory. This is based on subject opinions that the use of artificial targets involves a 'trivialisation of the ability' as compared with natural pre-existing targets.

In each of nine experiments involving Price as subject and SRI experimenters as a target demarcation team, a remote location was chosen in a double-blind protocol. Price, who remained at SRI, was asked to describe this remote location, as well as whatever activities might be going on there.

Several descriptions yielded significantly correct data pertaining to and descriptive of the target location.

In the experiments a set of twelve target locations clearly differentiated from each other and within 30 min driving time from SRI had been chosen from a target-rich environment (more than 100 targets of the type used in the experimental series) prior to the experimental series by an individual in SRI management, the director of the Information Science and Engineering Division, not otherwise associated with the experiment. Both

the experimenters and the subject were kept blind as to the contents of the target pool, which were used without replacement.

An experimenter was closeted with Price at SRI to wait 30 min to begin the narrative description of the remote location. The SRI locations from which the subject viewed the remote locations consisted of an outdoor park (Experiments 1, 2), the double-walled copper-screen Faraday cage discussed earlier (Experiments 3, 4, and 6-9), and an office (Experiment 5). A second experimenter would then obtain a target location from the Division Director from a set of travelling orders previously prepared and randomised by the Director and kept under his control. The target demarcation team (two to four SRI experimenters) then proceeded directly to the target by automobile without communicating with the subject or experimenter remaining behind. Since the experimenter remaining with the subject at SRI was in ignorance both as to the particular target and as to the target pool, he was free to question Price to clarify his descriptions. The demarcation team then remained at the target site for 30 min after the 30 min allotted for travel. During the observation period, the remote-viewing subject would describe his impressions of the target site into a tape recorder. A comparison was then made when the demarcation team returned.

Price's ability to describe correctly buildings, docks, roads, gardens and so on, including structural materials, colour, ambience and activity, sometimes in great detail, indicated the functioning of a remote perceptual ability. But the descriptions contained inaccuracies as well as correct statements. To obtain a numerical evaluation of the accuracy of the remote viewing experiment, the experimental results were subjected to independent judging on a blind basis by five SRI scientists who were

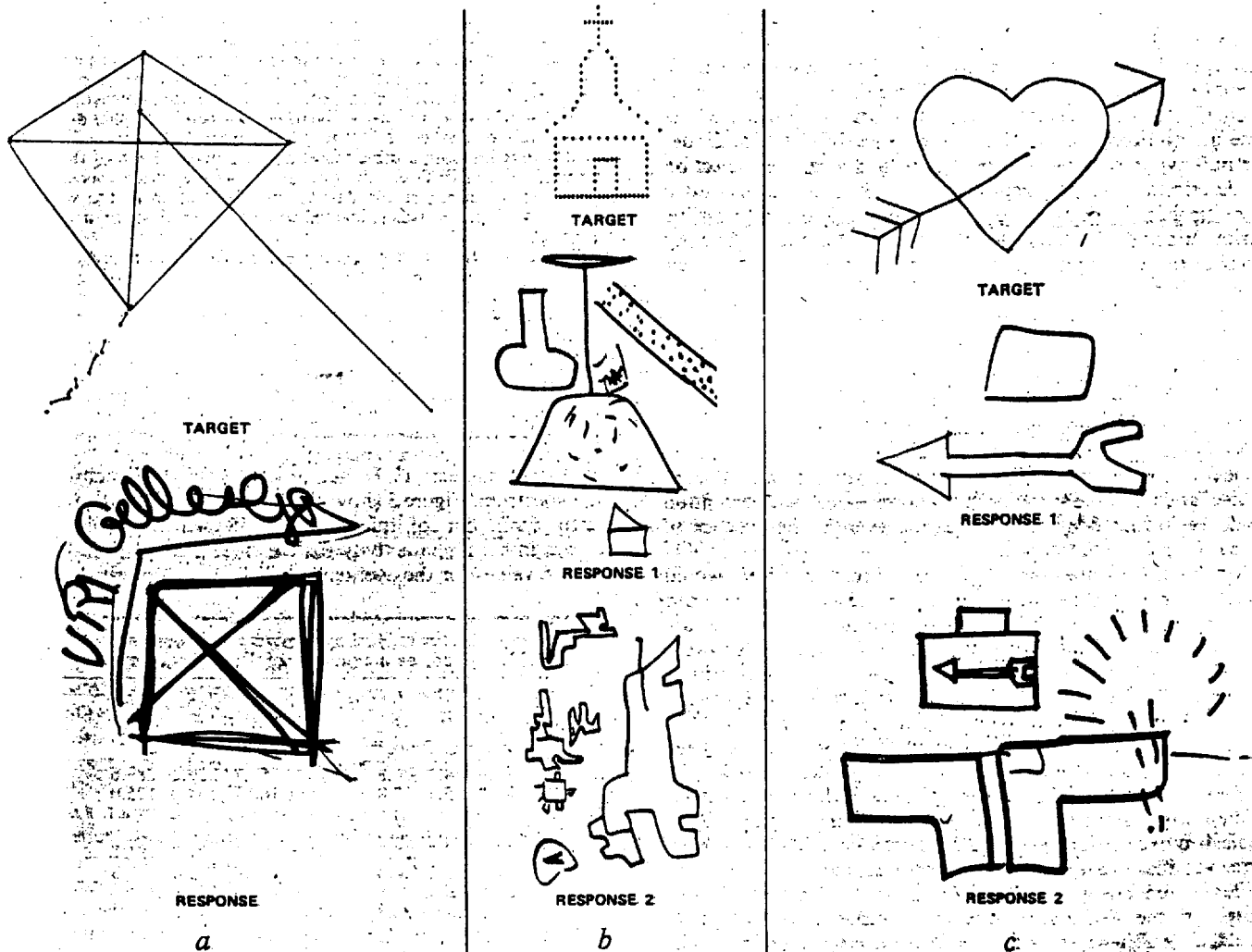


Fig. 2. Computer drawings and responses: a, computer drawing stored in computer memory only; b, computer drawing stored on video display with zero intensity; c, computer drawing stored on video display with zero intensity.

Table 2 Distribution of correct selections by judges A, B, C, D, and E in remote viewing experiments

Descriptions chosen by judges	Places visited by judges								
	1	2	3	4	5	6	7	8	9
Hoover Tower	<b>1</b>				<b>D</b>				
Baylands Nature Preserve	2	<b>ABC</b>					<b>D</b>		<b>D</b>
Radio Telescope	3		<b>E</b>		<b>BE</b>				
Redwood City Marina	4		<b>ACD</b>		<b>ABDE</b>	<b>E</b>		<b>DCE</b>	
Bridge Toll Plaza	5		<b>CD</b>			<b>ABD</b>			<b>E</b>
Drive-In Theatre	6			<b>B</b>		<b>C</b>			
Arts and Crafts Garden Plaza	7						<b>ABCE</b>		
Church	8				<b>C</b>			<b>AB</b>	
Rinconada Park	9		<b>CE</b>						<b>AB</b>

Of the 45 selections (5 judges, 9 choices), 24 were correct. Bold type indicates the description chosen most often for each place visited. Correct choices lie on the main diagonal. The number of correct matches by Judges A through E is 7, 6, 5, 3, and 3, respectively. The expected number of correct matches from the five judges was five; in the experiment 24 such matches were obtained. The *a priori* probability of such an occurrence by chance, conservatively assuming assignment without replacement on the part of the judges, is  $P = 8.10^{-10}$ .

not otherwise associated with the research. The judges were asked to match the nine locations, which they independently visited, against the typed manuscripts of the tape-recorded narratives of the remote viewer. The transcripts were unlabelled and presented in random order. The judges were asked to find a narrative which they would consider the best match for each of the places they visited. A given narrative could be assigned to more than one target location. A correct match requires that the transcript of a given date be associated with the target of that date. Table 2 shows the distribution of the judges' choices.

Among all possible analyses, the most conservative is a permutation analysis of the plurality vote of the judges' selections assuming assignment without replacement, an approach independent of the number of judges. By plurality vote, six of the nine descriptions and locations were correctly matched. Under the null hypothesis (no remote viewing and a random selection of descriptions without replacement), this outcome has an *a priori* probability of  $P = 5.6 \times 10^{-4}$ , since, among all possible permutations of the integers one through nine, the probability of six or more being in their natural position in the list has that value. Therefore, although Price's descriptions contain inaccuracies, the descriptions are sufficiently accurate to permit the judges to differentiate among the various targets to the degree indicated.

EEG EXPERIMENTS

An experiment was undertaken to determine whether a physiological measure such as EEG activity could be used as an indicator of information transmission between an isolated subject and a remote stimulus. We hypothesised that perception could be indicated by such a measure even in the absence of verbal or other overt indicators.<sup>4,7</sup>

It was assumed that the application of remote stimuli would result in responses similar to those obtained under conditions of direct stimulation. For example, when normal subjects are stimulated with a flashing light, their EEG typically shows a decrease in the amplitude of the resting rhythm and a driving of the brain waves at the frequency of the flashes<sup>8</sup>. We hypothesised that if we stimulated one subject in this manner (a sender), the EEG of another subject in a remote room with no flash present (a receiver), might show changes in alpha (9-11 Hz) activity, and possibly EEG driving similar to that of the sender.

We informed our subject that at certain times a light was to be flashed in a sender's eyes in a distant room, and if the subject perceived that event, consciously or unconsciously, it might be evident from changes in his EEG output. The receiver was seated in the visually opaque, acoustically and electrically shielded double-walled steel room previously described. The sender was seated in a room about 7 m from the receiver.

To find subjects who were responsive to such a remote stimulus, we initially worked with four female and two male volunteer subjects, all of whom believed that success in the experimental situation might be possible. These were designated

'receivers'. The senders were either other subjects or the experimenters. We decided beforehand to run one or two sessions of 36 trials each with each subject in this selection procedure, and to do a more extensive study with any subject whose results were positive.

A Grass PS-2 photostimulator placed about 1 m in front of the sender was used to present flash trains of 10 s duration. The receiver's EEG activity from the occipital region (Oz), referenced to linked mastoids, was amplified with a Grass 5P-1 preamplifier and associated driver amplifier with a bandpass of 1-120 Hz. The EEG data were recorded on magnetic tape with an Ampex SP 300 recorder.

On each trial, a tone burst of fixed frequency was presented to both sender and receiver and was followed in one second by either a 10 s train of flashes or a null flash interval presented to the sender. Thirty-six such trials were given in an experimental session, consisting of 12 null trials—no flashes following the tone—12 trials of flashes at 6 f.p.s. and 12 trials of flashes at 16 f.p.s., all randomly intermixed, determined by entries from a table of random numbers. Each of the trials generated an 11-s EEG epoch. The last 4 s of the epoch was selected for analysis to minimise the desynchronising action of the warning cue. This 4-s segment was subjected to Fourier analysis on a LINC 8 computer.

Spectrum analyses gave no evidence of EEG driving in any receiver, although in control runs the receivers did exhibit driving when physically stimulated with the flashes. But of the six subjects studied initially, one subject (H. H.) showed a consistent alpha blocking effect. We therefore undertook further study with this subject.

Data from seven sets of 36 trials each were collected from this subject on three separate days. This comprises all the data collected to date with this subject under the test conditions described above. The alpha band was identified from average spectra, then scores of average power and peak power were obtained from individual trials and subjected to statistical analysis.

Of our six subjects, H. H. had by far the most monochromatic EEG spectrum. Figure 3 shows an overlay of the three averaged spectra from one of this subject's 36-trial runs, displaying changes in her alpha activity for the three stimulus conditions.

Mean values for the average power and peak power for each

Table 3 EEG data for H.H. showing average power and peak power in the 9-11 Hz band, as a function of flash frequency and sender

Flash Frequency	Average Power			Peak Power		
	0	6	16	0	6	16
Sender						
J.L.	94.8	84.1	76.8	357.7	329.2	289.6
R.T.	41.3	45.5	37.0	160.7	161.0	125.0
No sender (subject informed)	25.1	35.7	28.2	87.5	95.7	81.7
J.L.	54.2	55.3	44.8	191.4	170.5	149.3
J.L.	56.8	50.9	32.8	240.6	178.0	104.6
R.T.	39.8	24.9	30.3	145.2	74.2	122.1
No sender (subject not informed)	86.0	53.0	52.1	318.1	180.6	202.3
Averages	56.8	49.9	43.1	214.5	169.8	153.5
	-12% -24% (P < 0.04)			-21% -28% (P < 0.03)		

Each entry is an average over 12 trials

of the seven measures we even peak power meas which the s Run 3). It or this run ension abo this is in co of informe Siegel's two tion test? w ssions in wh associated wi hen there v ond measu onditions th ne average r on as that as nificant. Spectrum a kΩ resista on of a 10 ealed no in 0 Hz signal. stem artefa lency energ Subjects w al as to wh own to the n analysis o dication the a nced by sign level of aware We hypoth seful as a so the general



Fig. 3 Occ... acting as r... band as a f...

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of the seven experimental sets are given in Table 3. The power measures were less in the 16 f.p.s. case than in the 0 f.p.s. in all seven peak power measures and in six out of seven average power measures. Note also the reduced effect in the case in which the subject was informed that no sender was present (Run 3). It seems that overall alpha production was reduced for this run in conjunction with the subject's expressed apprehension about conducting the experiment without a sender. This is in contrast to the case (Run 7) in which the subject was not informed.

Siegel's two-tailed *t* approximation to the nonparametric randomisation test<sup>9</sup> was applied to the data from all sets, which included two sessions in which the sender was removed. Average power on trials associated with the occurrence of 16 f.p.s. was significantly less than when there were no flashes ( $t = 2.09$ , d.f. = 118,  $P < 0.04$ ). The second measure, peak power, was also significantly less in the 16 f.p.s. conditions than in the null condition ( $t = 2.16$ , d.f. = 118,  $P < 0.03$ ). The average response in the 6 f.p.s. condition was in the same direction as that associated with 16 f.p.s., but the effect was not statistically significant.

Spectrum analyses of control recordings made from saline with a 12 k $\Omega$  resistance in place of the subject with and without the addition of a 10 Hz, 50  $\mu$ V test signal applied to the saline solution, revealed no indications of flash frequencies, nor perturbations of the 10 Hz signal. These controls suggest that the results were not due to system artefacts. Further tests also gave no evidence of radio frequency energy associated with the stimulus.

Subjects were asked to indicate their conscious assessment for each trial as to which stimulus was generated. They made their guesses known to the experimenter via one-way telegraphic communication. An analysis of these guesses has shown them to be at chance, indicating the absence of any supraliminal cueing, so arousal as evidenced by significant alpha blocking occurred only at the noncognitive level of awareness.

We hypothesise that the protocol described here may prove to be useful as a screening procedure for latent remote perceptual ability in the general population.

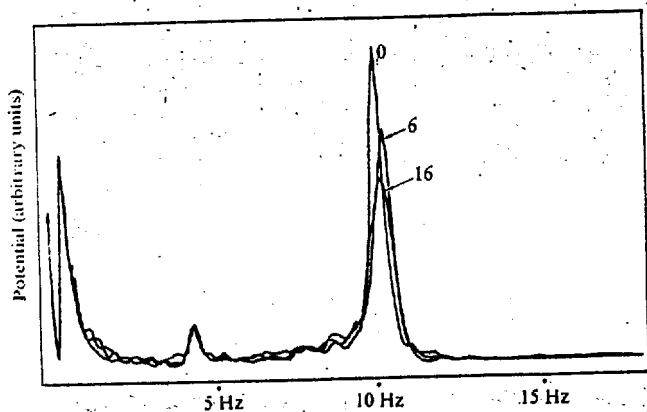


Fig. 3 Occipital EEG spectra, 0-20 Hz, for one subject (H.H.) acting as receiver, showing amplitude changes in the 9-11 Hz band as a function of strobe frequency. Three cases: 0, 6, and 16 f.p.s. (12 trial averages).

### CONCLUSION

From these experiments we conclude that:

- A channel exists whereby information about a remote location can be obtained by means of an as yet unidentified perceptual modality.
- As with all biological systems, the information channel appears to be imperfect, containing noise along with the signal.
- While a quantitative signal-to-noise ratio in the information-theoretical sense cannot as yet be determined, the results of our experiments indicate that the functioning is at the level of useful information transfer.

It may be that remote perceptual ability is widely distributed in the general population, but because the perception is generally below an individual's level of awareness, it is repressed or not noticed. For example, two of our subjects (H. H. and P. P.) had not considered themselves to have unusual perceptual ability before their participation in these experiments. Our observation of the phenomena leads us to conclude that

experiments in the area of so-called paranormal phenomena can be scientifically conducted, and it is our hope that other laboratories will initiate additional research to attempt to replicate these findings.

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RUSSELL TARG  
HAROLD PUTHOFF

*Electronics and Bioengineering Laboratory,  
Stanford Research Institute,  
Menlo Park, California 94025*

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## The stability of a feasible random ecosystem

THE weight of the evidence, and the beliefs of most biologists, seem to support the view<sup>1</sup> that ecosystems tend to be more stable, the larger the number of interacting species they contain. It is puzzling, therefore, that a variety of mathematical models of complex ecosystems appear to give the contrary answer: that complexity makes for instability<sup>2</sup>.

Prominent among such models is the complex system with random interactions, studied in various forms by Gardner and Ashby<sup>3</sup> and May<sup>4</sup>; but their results cannot be applied as they stand to ecological systems. In an ecosystem, the interacting variables are species populations (or species biomass) which cannot take on negative values. Thus, for example, the equilibrium population values must be positive, and it is convenient to denote this necessary property of an ecosystem model by saying that it must be 'feasible'.

The work referred to imposed no such constraint on equilibrium populations in the samples considered. It is of some interest, therefore, to examine the stability of a random model capable of representing ecosystems, by imposing the restriction that the sample be feasible.

I report here the results of computer calculations on such a model. The interaction equations were of the well-known quasi-linear type, in which the rate of fractional increase of a species population is a linear function of the current populations in all *T* species. That is, the number  $N_i$  in the *i*th species obeys

$$dN_i/dt = N_i (b_i + \sum_j a_{ij} N_j).$$

where the  $b_i$  were taken as 1, and the self-regulating coefficients  $a_{ii}$  as  $-1$ . The feasibility requirement was that the