A Perceptual Channel for Information Transfer over Kilometer Distances: Historical Perspective and Recent Research

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Abstract—For more than 100 years, scientists have attempted to determine the truth or falsity of claims for the existence of a perceptual channel whereby certain individuals are able to perceive and describe remote data not presented to any known sense. This paper presents an outline of the history of scientific inquiry into such so-called paranormal perception and surveys the current state of the art in parapsychological research in the United States and abroad. The nature of this perceptual channel is examined in a series of experiments carried out in the Electronics and Bioengineering Laboratory of Stanford Research Institute. The perceptual modality most extensively investigated is the ability of both experienced subjects and inexperienced volunteers to view, by innate mental processes, remote geographical or technical targets including buildings, roads, and laboratory apparatus. The accumulated data indicate that the phenomenon is not a sensitive function of distance, and Faraday cage shielding does not in any apparent way degrade the quality and accuracy of perception. On the basis of this research, some areas of physics are suggested from which a description or explanation of the phenomenon could be forthcoming.

I. Introduction

"It is the province of natural science to investigate nature, impartially and without prejudice" [1]. Nowhere in scientific inquiry has this dictum met as great a challenge as in the area of so-called extrasensory perception (ESP), the detection of remote stimuli not mediated by the usual sensory processes. Such phenomena, although under scientific consideration for over a century, have historically been fraught with unreliability and controversy, and validation of the phenomena by accepted scientific methodology has been slow in coming. Even so, a recent survey conducted by the British publication *New Scientist* revealed that 67 percent of nearly 1500 responding readers (the majority of whom are working scientists and technologists) considered ESP to be an established fact or a likely possibility, and 88 percent held the investigation of ESP to be a legitimate scientific undertaking [2].

A review of the literature reveals that although experiments by reputable researchers yielding positive results were begun over a century ago (e.g., Sir William Crookes' study of D. D. Home, 1860's) [3], many consider the study of these phenomena as only recently emerging from the realm of quasi-science. One reason for this is that, despite experimental results, no satisfactory theoretical construct had been advanced to correlate data or to predict new experimental outcomes. Consequently, the area in question remained for a long time in the recipe stage reminiscent of electrodynamics before the unification brought about by the work of Ampere, Faraday, and Maxwell. Since the early work, however, we have seen the development of information theory, quantum theory, and neurophysiological research, and these disciplines provide powerful conceptual tools that appear to bear directly on the issue. In fact, several physicists (Section V) are now of the opinion that these phenomena are not at all inconsistent with the framework of modern physics: the often-held view that observations of this type are *a priori* incompatible with known laws is erroneous in that such a concept is based on the naive realism prevalent before the development of quantum theory. In the emerging view, it is accepted that research in this area can be conducted so as to uncover not just a catalog of interesting events, but rather patterns of cause–effect relationships of the type that lend themselves to analysis and hypothesis in the forms with which we are familiar in the physical sciences. One hypothesis is that information transfer under conditions of sensory shielding is mediated by extremely low-frequency (ELF) electromagnetic waves, a proposal that does not seem to be ruled out by any obvious physical or biological facts. Further, the development of information theory makes it possible to characterize and quantify the performance of a communications channel regardless of the underlying mechanism.

For the past three years, we have had a program in the Electronics and Bioengineering Laboratory of the Stanford Research Institute (SRI) to investigate those facets of human perception that appear to fall outside the range of well-understood perceptual/processing capabilities. Of particular interest is a human information-accessing capability that we call "remote viewing." This phenomenon pertains to the ability of certain individuals to access and describe, by means of mental processes, information sources blocked from ordinary perception, and generally accepted as secure against such access.

In particular, the phenomenon we have investigated most extensively is the ability of a subject to view remote geographical locations up to several thousand kilometers distant from his physical location (given only a known person on whom to target).[1] We have carried out more than fifty experiments under controlled laboratory conditions with several individuals whose remote perceptual abilities have been developed sufficiently to allow them at times to describe correctly—often in great detail—geographical or technical material such as buildings, roads, laboratory apparatus, and the like.

As observed in the laboratory, the basic phenomenon appears to cover a range of subjective experiences variously referred to

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[1] Our initial work in this area was reported in *Nature* [4], and reprinted in the *IEEE Commun. Soc. Newsletter*, vol. 13, Jan. 1975

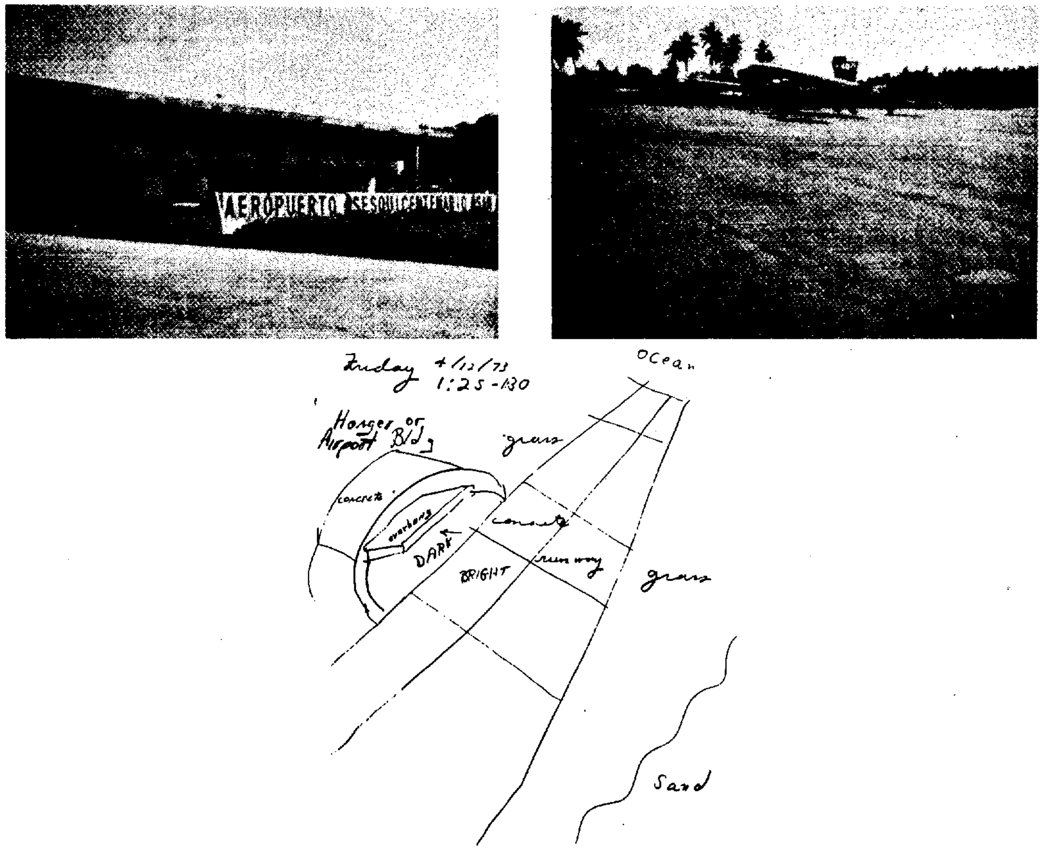


Fig. 1. Airport in San Andres, Colombia, used as remote-viewing target, along with sketch produced by subject in California.

in the literature as autoscopy (in the medical literature); exteriorization or disassociation (psychological literature); simple clairvoyance, traveling clairvoyance, or out-of-body experience (parapsychological literature); or astral projection (occult literature). We choose the term "remote viewing" as a neutral descriptive term free from prior associations and bias as to mechanisms.

The development at SRI of a successful experimental procedure to elicit this capability has evolved to the point where persons such as visiting government scientists and contract monitors, with no previous exposure to such concepts, have learned to perform well; and subjects who have trained over a one-year period have performed excellently under a variety of experimental conditions. Our accumulated data thus indicate that both specially selected and unselected persons can be assisted in developing remote perceptual abilities up to a level of useful information transfer.

In experiments of this type, we have three principal findings. First, we have established that it is possible to obtain significant amounts of accurate descriptive information about remote locations. Second, an increase in the distance from a few meters up to 4000 km separating the subject from the scene to be perceived does not in any apparent way degrade the quality or accuracy of perception. Finally, the use of Faraday cage electrical shielding does not prevent high-quality descriptions from being obtained.

To build a coherent theory for the explanation of these phenomena, it is necessary to have a clear understanding of what constitutes the phenomena. In this paper, we first briefly summarize previous efforts in this field in Section II. We then present in Sections III and IV the results of a series of more than fifty experiments with nine subjects carried out in our own laboratory, which represent a sufficiently stable data base to permit testing of various hypotheses concerning the functioning of this channel. Finally, in Section V, we indicate those areas of physics and information theory that appear to be relevant to an understanding of certain aspects of the phenomena.

First, however, we present an illustrative example generated in an early pilot experiment. As will be clear from our later discussion, this is not a "best-ever" example, but rather a typical sample of the level of proficiency that can be reached and that we have come to expect in our research.

Three subjects participated in a long-distance experiment focusing on a series of targets in Costa Rica. These subjects said they had never been to Costa Rica. In this experiment, one of the experimenters (Dr. Puthoff) spent ten days traveling through Costa Rica on a combination business/pleasure trip. This information was all that was known to the subjects about the traveler's itinerary. The experiment called for Dr. Puthoff to keep a detailed record of his location and activities, including photographs of each of seven target days at 1330 PDT. A total of twelve daily descriptions were collected before the traveler's return: six responses from one subject, five from another, and one from a third.

The third subject who submitted the single response supplied a drawing for a day in the middle of the series. (The subject's response, together with the photographs taken at the site, are shown in Fig. 1). Although Costa Rica is a mountainous country, the subject unexpectedly perceived the traveler at a beach and ocean setting. With some misgiving, he described an airport on a sandy beach and an airstrip with the ocean at the end (correct). An airport building also was drawn, and shown to have a large rectangular overhang (correct). The traveler had taken an unplanned one-day side trip to an offshore island and at the time of the experiment had just disembarked from a plane at a small island airport as described by the subject 4000 km away. The sole discrepancy was that the subject's drawing showed a Quonset-hut type of building in place of the rectangular structure.

The above description was chosen as an example to illustrate a major point observed a number of times throughout the program to be described. Contrary to what may be expected, a subject's description does not necessarily portray what may reasonably be expected to be correct (an educated or "safe" guess), but often runs counter even to the subject's own expectations.

We wish to stress again that a result such as the above is not unusual. The remaining submissions in this experiment provided further examples of excellent correspondences between target and response. (A target period of poolside relaxation was identified; a drive through a tropical forest at the base of a truncated volcano was described as a drive through a jungle below a large bare table mountain; a hotel-room target description, including such details as rug color, was correct; and so on.) So as to determine whether such matches were simply fortuitous—that is, could reasonably be expected on the basis of chance alone—Dr. Puthoff was asked after he had returned to blind match the twelve descriptions to his seven target locations. On the basis of this conservative evaluation procedure, which vastly underestimates the statistical significance of the individual descriptions, five correct matches were obtained. This number of matches is significant at $p = 0.02$ by exact binomial calculation.[2]

The observation of such unexpectedly high-quality descriptions early in our program led to a large-scale study of the phenomenon at SRI under secure double-blind conditions (i.e., target unknown to experimenters as well as subjects), with independent random target selection and blind judging. The results, presented in Sections III and IV, provide strong evidence for the robustness of this phenomenon whereby a human perceptual modality of extreme sensitivity can detect complex remote stimuli.

II. Background

Although we are approaching the study of these phenomena as physicists, it is not yet possible to separate ourselves entirely from the language of the nineteenth century when the laboratory study of the paranormal was begun. Consequently, we continue to use terms such as "paranormal," "telepathy," and the like. However, we intend only to indicate a process of information transfer under conditions generally accepted as secure against such transfer and with no prejudice or occult assumptions as to the mechanisms involved. As in any other scientific pursuit, the purpose is to collect the observables that result from experiments and to try to determine the functional relationships between these observables and the laws of physics as they are currently understood.

Organized research into so-called psychic functioning began roughly in the time of J. J. Thomson, Sir Oliver Lodge, and Sir William Crookes, all of whom took part in the founding of the Society for Psychical Research (SPR) in 1882 in England. Crookes, for example, carried out his principal investigations with D. D. Home, a Scotsman who grew up in America and returned to England in 1855 [3]. According to the notebooks and published reports of Crookes, Home had demonstrated the ability to cause objects to move without touching them. We should note in passing that, Home, unlike most subjects, worked only in the light and spoke out in the strongest possible terms against the darkened seance rooms popular at the time [5].

Sir William Crookes was a pioneer in the study of electrical discharge in gases and in the development of vacuum tubes, some types of which still bear his name. Although everything Crookes said about electron beams and plasmas was accepted, nothing he said about the achievements of D. D. Home ever achieved that status. Many of his colleagues, who had not observed the experiments with Home, stated publicly that they thought Crookes had been deceived, to which Crookes angrily responded:

> Will not my critics give me credit for some amount of common sense? Do they not imagine that the obvious precautions, which occur to them as soon as they sit down to pick holes in my experiments, have occurred to me also in the course of my prolonged and patient investigation? The answer to this, as to all other objections is, prove it to be an error, by showing where the error lies, or if a trick, by showing how the trick is performed. Try the experiment fully and fairly. If then fraud be found, expose it; if it be a truth, proclaim it. This is the only scientific procedure, and it is that I propose steadily to pursue [3].

In the United States, scientific interest in the paranormal was centered in the universities. In 1912, John Coover [6] was established in the endowed Chair of Psychical Research at Stanford University. In the 1920's, Harvard University set up research programs with George Estabrooks and L. T. Troland [7], [8]. It was in this framework that, in 1930, William McDougall invited Dr. J. B. Rhine and Dr. Louisa Rhine to join the Psychology Department at Duke University [9]. For more than 30 years, significant work was carried out at Rhine's Duke University Laboratory. To examine the existence of paranormal perception, he used the now-famous ESP cards containing a boldly printed picture of a star, cross, square, circle, or wavy lines. Subjects were asked to name the order of these cards in a freshly shuffled deck of twenty-five such cards. To test for telepathy, an experimenter would look at the cards one at a time, and a subject suitably separated from the sender would attempt to determine which card was being viewed.

Dr. J. B. Rhine together with Dr. J. G. Pratt carried out thousands of experiments of this type under widely varying conditions [10]. The statistical results from these experiments indicated that some individuals did indeed possess a paranormal perceptual ability in that it was possible to obtain an arbitrarily high degree of improbability by continued testing of a gifted subject.

The work of Rhine has been challenged on many grounds, however, including accusations of improper handling of statistics, error, and fraud. With regard to the statistics, the general consensus of statisticians today is that if fault is to be found in Rhine's work, it would have to be on other than statistical grounds. With regard to the accusations of fraud, the

[2] The probability of a correct daily match by chance for any given transcript is $p = \frac{1}{7}$. Therefore, the probability of at least five correct matches by chance out of twelve tries can be calculated from

$$p = \sum_{i=5}^{12} \frac{12!}{i!(12-i)!} \left(\frac{1}{7}\right)^{i} \left(\frac{6}{7}\right)^{(12-i)} = 0.02.$$

most celebrated case of criticism of Rhine's work, that of G. R. Price [12], ended 17 years after it began when the accusation of fraud was retracted by its author in an article entitled "Apology to Rhine and Soal," published in the same journal in which it was first put forward [13]. It should also be noted that parapsychological researchers themselves recently exposed fraud in their own laboratory when they encountered it [14].

At the end of the 1940's, Prof. S. G. Soal, an English mathematician working with the SPR, had carried out hundreds of card guessing experiments involving tens of thousands of calls [15]. Many of these experiments were carried out over extended distances. One of the most notable experiments was conducted with Mrs. Gloria Stewart between London and Antwerp. This experiment gave results whose probability of occurring by chance were less than 10^{-8}. With the publication of *Modern Experiments in Telepathy* by Soal and Bateman (both of whom were statisticians), it appeared that card guessing experiments produced significant results, on the average.[3]

The most severe criticism of all this work, a criticism difficult to defend against in principle, is that leveled by the well-known British parapsychological critic C. E. M. Hansel [17], who began his examination of the ESP hypothesis with the stated assumption, "In view of the *a priori* arguments against it *we know in advance* that telepathy, etc., cannot occur." Therefore, based on the "*a priori* unlikelihood" of ESP, Hansel's examination of the literature centered primarily on the possibility of fraud, by subjects or investigators. He reviewed in depth four experiments which he regarded as providing the best evidence of ESP: the Pearce–Pratt distance series [18]; the Pratt–Woodruff [19] series, both conducted at Duke; and Soal's work with Mrs. Stewart and Basil Shackleton [15], as well as a more recent series by Soal and Bowden [20]. Hansel showed, in each case, how fraud *could* have been committed (by the experimenters in the Pratt–Woodruff and Soal–Bateman series, or by the subjects in the Pearce–Pratt and Soal–Bowden experiments). He gave no direct evidence that fraud *was* committed in these experiments, but said, "If the result could have arisen through a trick, the experiment must be considered unsatisfactory proof of ESP, *whether or not it is finally decided that such a trick was in fact used*" [17, p. 18]. As discussed by Honorton in a review of the field [21], Hansel's conclusion after 241 pages of careful scrutiny therefore was that these experiments were not "fraud-proof" and therefore in principle could not serve as conclusive proof of ESP.

Even among the supporters of ESP research and its results, there remained the consistent problem that many successful subjects eventually lost their ability and their scores gradually drifted toward chance results. This decline effect in no way erased their previous astronomical success; but it was a disappointment since if paranormal perception is a natural ability, one would like to see subjects improving with practice rather than getting worse.

One of the first successful attempts to overcome the decline effect was in Czechoslovakia in the work of Dr. Milan Ryzl, a chemist with the Institute of Biology of the Czechoslovakian Academy of Science and also an amateur hypnotist [22]. Through the use of hypnosis, together with feedback and reinforcement, he developed several outstanding subjects, one of whom, Pavel Stepanek, has worked with experimenters around the world for more than 10 years.

[3]Recently, some of the early Soal experiments have been criticized [16]. However, his long-distance experiments cited here were judged in a double-blind fashion of the type that escaped the criticism of the early experiments.

Ryzl's pioneering work came as an answer to the questions raised by the 1956 CIBA Foundation conference on extrasensory perception. The CIBA Chemical Company has annual meetings on topics of biological and chemical interest, and that same year they assembled several prominent parapsychologists to have a state-of-the-art conference on ESP [23]. The conference concluded that little progress would be made in parapsychology research until a repeatable experiment could be found; namely, an experiment that different experimenters could repeat at will and that would reliably yield a statistically significant result.

Ryzl had by 1962 accomplished that goal. His primary contribution was a decision to interact with the subject as a person, to try to build up his confidence and ability. His protocol depended on "working with" rather than "running" his subjects. Ryzl's star subject, Pavel Stepanek, has produced highly significant results with many contemporary researchers [24]–[29]. In these experiments, he was able to tell with 60-percent reliability whether a hidden card was green side or white side up, yielding statistics of a million to one with only a thousand trials.

As significant as such results are statistically, the information channel is imperfect, containing noise along with the signal. When considering how best to use such a channel, one is led to the communication theory concept of the introduction of redundancy as a means of coding a message to combat the effects of a noisy channel [30]. A prototype experiment by Ryzl using such techniques has proved to be successful. Ryzl had an assistant select randomly five groups of three digits each. These 15 digits were then encoded into binary form and translated into a sequence of green and white cards in sealed envelopes. By means of repeated calling and an elaborate majority vote protocol, Ryzl was able after 19 350 calls by Stepanek (averaging 9 s per call) to correctly identify all 15 numbers, a result significant at $p = 10^{-15}$ The hit rate for individual calls was 61.9 percent, 11 978 hits, and 7372 misses [31].

Note Added in Proof: It has been brought to our attention that a similar procedure was recently used to transmit without error the word "peace" in International Morse Code (J. C. Carpenter, "Toward the effective utilization of enhanced weak-signal ESP effects," presented at the Annual Meeting of the American Association for the Advancement of Science, New York, NY, Jan. 27, 1975).

The characteristics of such a channel can be specified in accordance with the precepts of communication theory. The bit rate associated with the information channel is calculated from [30]

$$R = H(x) - H_y(x) \tag{1}$$

where $H(x)$ is the uncertainty of the source message containing symbols with *a priori* probability p_i:

$$H(x) = -\sum_{i=1}^{2} p_i \log_2 p_i \tag{2}$$

and $H_y(x)$ is the conditional entropy based on the *a posteriori* probabilities that a received signal was actually transmitted:

$$H_y(x) = -\sum^{2} p(i, j) \log_2 p_i(j). \tag{3}$$

For Stepanek's run, with $p_i = \frac{1}{2}$, $p_j(j) = 0.619$, and an average time of 9 s per choice, we have a source uncertainty $H(x) = 1$ bit and a calculated bit rate

$$R \approx 0.041 \text{ bit/symbol}$$

or

$$R/T \approx 0.0046 \text{ bit/s}.$$

(Since the 15-digit number (49.8 bits) actually was transmitted at the rate of 2.9×10^{-4} bit/s, an increase in bit rate by a factor of about 20 could be expected on the basis of a coding scheme more optimum than that used in the experiments. See, for example, Appendix A.)

Dr. Charles Tart at the University of California has written extensively on the so-called decline effect. He considers that having subjects attempt to guess cards, or perform any other repetitious task for which they receive no feedback, follows the classical technique for deconditioning any response. He thus considers card guessing "a technique for extinguishing psychic functioning in the laboratory" [32].

Tart's injunctions of the mid-sixties were being heeded at Maimonides Hospital, Brooklyn, NY, by a team of researchers that included Dr. Montague Ullman, who was director of research for the hospital; Dr. Stanley Krippner; and, later, Charles Honorton. These three worked together for several years on experiments on the occurrence of telepathy in dreams. In the course of a half-dozen experimental series, they found in their week-long sessions a number of subjects who had dreams that consistently were highly descriptive of pictorial material that a remote sender was looking at throughout the night. This work is described in detail in the experimenters' book *Dream Telepathy* [33]. Honorton is continuing work of this free-response type in which the subject has no preconceived idea as to what the target may be.

In his more recent work with subjects in the waking state, Honorton is providing homogeneous stimulation to the subject who is to describe color slides viewed by another person in a remote room. In this new work, the subject listens to white noise via earphones and views an homogeneous visual field imposed through the use of Ping-Pong ball halves to cover the subject's eyes in conjunction with diffuse ambient illumination. In this so-called Ganzfeld setting, subjects are again able, now in the waking state, to give correct and often highly accurate descriptions of the material being viewed by the sender [34].

In Honorton's work and elsewhere, it apparently has been the step away from the repetitive forced-choice experiment that has opened the way for a wide variety of ordinary people to demonstrate significant functioning in the laboratory, without being bored into a decline effect.

This survey would be incomplete if we did not indicate certain aspects of the current state of research in the USSR. It is clear from translated documents and other sources [35] that many laboratories in the USSR are engaged in paranormal research.

Since the 1930's, in the laboratory of L. Vasiliev (Leningrad Institute for Brain Research), there has been an interest in the use of telepathy as a method of influencing the behavior of a person at a distance. In Vasiliev's book *Experiments in Mental Suggestion*, he makes it very clear that the bulk of his laboratory's experiments were aimed at long-distance communication combined with a form of behavior modification; for example, putting people at a distance to sleep through hypnosis [36].

Similar behavior modification types of experiments have been carried out in recent times by I. M. Kogan, Chairman of the Bioinformation Section of the Moscow Board of the Popov Society. He is a Soviet engineer who, until 1969, published extensively on the theory of telepathic communication [37]–[40]. He was concerned with three principal kinds of experiments: mental suggestion without hypnosis over short distances, in which the percipient attempts to identify an object; mental awakening over short distances, in which a subject is awakened from a hypnotic sleep at the "beamed" suggestion from the hypnotist; and long-range (intercity) telepathic communication. Kogan's main interest has been to quantify the channel capacity of the paranormal channel. He finds that the bit rate decreases from 0.1 bit/s for laboratory experiments to 0.005 bit/s for his 1000-km intercity experiments.

In the USSR, serious consideration is given to the hypothesis that telepathy is mediated by extremely low-frequency (ELF) electromagnetic propagation. (The pros and cons of this hypothesis are discussed in Section V of this paper.) In general, the entire field of paranormal research in the USSR is part of a larger one concerned with the interaction between electromagnetic fields and living organisms [41], [42]. At the First International Congress on Parapsychology and Psychotronics in Prague, Czechoslovakia, in 1973, for example, Kholodov spoke at length about the susceptibility of living systems to extremely low-level ac and dc fields. He described conditioning effects on the behavior of fish resulting from the application of 10 to 100 μW of RF to their tank [43]. The USSR take these data seriously in that the Soviet safety requirements for steady-state microwave exposure set limits at 10 $\mu W/cm^2$, whereas the United States has set a steady-state limit of 10 mW/cm^2 [44]. Kholodov spoke also about the nonthermal effects of microwaves on animals' central nervous systems. His experiments were very carefully carried out and are characteristic of a new dimension in paranormal research.

The increasing importance of this area in Soviet research was indicated recently when the Soviet Psychological Association issued an unprecedented position paper calling on the Soviet Academy of Sciences to step up efforts in this area [45]. They recommended that the newly formed Psychological Institute within the Soviet Academy of Sciences and the Psychological Institute of the Academy of Pedagogical Sciences review the area and consider the creation of a new laboratory within one of the institutes to study persons with unusual abilities. They also recommended a comprehensive evaluation of experiments and theory by the Academy of Sciences' Institute of Biophysics and Institute for the Problems of Information Transmission.

The Soviet research, along with other behavioristically oriented work, suggests that in addition to obtaining overt responses such as verbalizations or key presses from a subject, it should be possible to obtain objective evidence of information transfer by direct measurement of physiological parameters of a subject. Kamiya, Lindsley, Pribram, Silverman, Walter, and others brought together to discuss physiological methods to detect ESP functioning, have suggested that a whole range of electroencephalogram (EEG) responses such as evoked potentials (EP's), spontaneous EEG, and the contingent negative variation (CNV) might be sensitive indicators of the detection of remote stimuli not mediated by usual sensory processes [46].

Early experimentation of this type was carried out by Douglas Dean at the Newark College of Engineering. In his search for physiological correlates of information transfer, he used the plethysmograph to measure changes in the blood volume in a finger, a sensitive indicator of autonomic nervous system functioning [47]. A plethysmographic measurement was made on the finger of a subject during telepathy experiments. A sender looked at randomly selected target cards consisting of names known to the subject, together with names unknown to him (selected at random from a telephone book). The names of the known people were contributed by the subject and were to be of emotional significance to him. Dean found significant changes in the chart recording of finger blood volume when the remote sender was looking at those names known to the subject as compared with those names randomly chosen.

Three other experiments using the physiological approach have now been published. The first work by Tart [48], a later work by Lloyd [49], and most recently the work by the authors [4] all follow a similar procedure. Basically, a subject is closeted in an electrically shielded room while his EEG is recorded. Meanwhile, in another laboratory, a second person is stimulated from time to time, and the time of that stimulus is marked on the magnetic-tape recording of the subject's EEG. The subject does not know when the remote stimulus periods are as compared with the nonstimulus periods.

With regard to choice of stimulus for our own experimentation, we noted that in previous work others had attempted, without success, to detect evoked potential changes in a subject's EEG in response to a single stroboscopic flash stimulus observed by another subject [50]. In a discussion of that experiment, Kamiya suggested that because of the unknown temporal characteristics of the information channel, it might be more appropriate to use repetitive bursts of light to increase the probability of detecting information transfer [51]. Therefore, in our study we chose to use a stroboscopic flash train of 10-s duration as the remote stimulus.

In the design of the study, we assumed that the application of the remote stimulus would result in responses similar to those obtained under conditions of direct stimulation. For example, when an individual is stimulated with a low-frequency (< 30 Hz) flashing light, the 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 [52]. We hypothesized that if we stimulated one subject in this manner (a putative 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 an EEG driving similar to that of the sender, or other coupling to the sender's EEG [53]. The receiver was seated in a visually opaque, acoustically and electrically shielded, double-walled steel room about 7 m from the sender. The details of the experiment, consisting of seven runs of thirty-six 10-s trials each (twelve periods each for 0-Hz, 6-Hz, and 16-Hz stimuli, randomly intermixed), are presented in [4]. This experiment proved to be successful. The receiver's alpha activity (9–11 Hz) showed a significant reduction in average power (−24 percent, $p < 0.04$) and peak power (−28 percent, $p < 0.03$) during 16-Hz flash stimuli as compared with periods of no-flash stimulus. [A similar response was observed for 6-Hz stimuli (−12 percent in average power, −21 percent in peak power), but the latter result did not reach statistical significance.] Fig. 2 shows an overlay of three averaged EEG spectra from one of the subject's 36 trial runs, displaying differences in alpha activity during the three stimulus conditions. Extensive control procedures were undertaken to determine if these

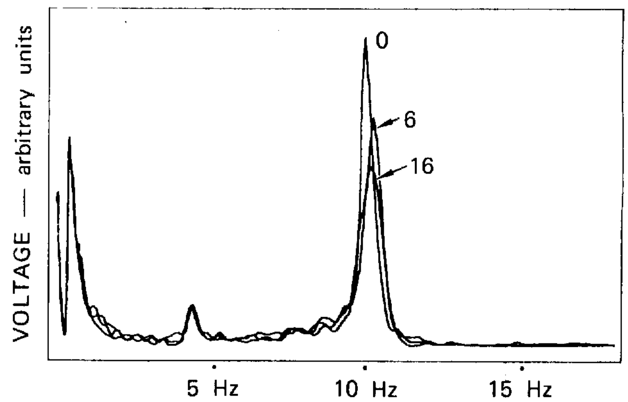


Fig. 2. Occipital EEG frequency spectra, 0–20 Hz, of one subject (H.H.) acting as receiver showing amplitude changes in the 9–11-Hz band as a function of strobe frequency. Three cases: 0-, 6-, and 16-Hz flashes (twelve trial averages).

results were produced by system artifacts, electromagnetic pickup (EMI), or subtle cueing; the results were negative [4].

As part of the experimental protocol, the subject was asked to indicate a conscious assessment for each trial (via telegraph key) as to the nature of the stimulus; analysis showed these guesses to be at chance. Thus arousal as evidenced by significant alpha blocking occurred only at the noncognitive level of physiological response. Hence the experiment provided direct physiological (EEG) evidence of perception of remote stimuli even in the absence of overt cognitive response.

Whereas in our experiments we used a remote light flash as a stimulus, Tart [48] in his work used an electrical shock to himself as sender, and Lloyd [49] simply told the sender to think of a red triangle each time a red warning light was illuminated within his view. Lloyd observed a consistent evoked potential in his subjects; whereas in our experiments and in Tart's, a reduction in amplitude and a desynchronization of alpha was observed—an arousal response. (If a subject is resting in an alpha-dominant condition and he is then stimulated, for example in any direct manner, one will observe a desynchronization and decrease in alpha power.) We consider that these combined results are evidence for the existence of noncognitive awareness of remote happenings and that they have a profound implication for paranormal research.

III. SRI Investigations of Remote Viewing

Experimentation in remote viewing began during studies carried out to investigate the abilities of a New York artist, Ingo Swann, when he expressed the opinion that the insights gained during experiments at SRI had strengthened his ability (verified in other research before he joined the SRI program) to view remote locations [54]. To test Mr. Swann's assertion, a pilot study was set up in which a series of targets from around the globe were supplied by SRI personnel to the experimenters on a double-blind basis. Mr. Swann's apparent ability to describe correctly details of buildings, roads, bridges, and the like indicated that it may be possible for a subject by means of mental imagery to access and describe randomly chosen geographical sites located several miles from the subject's position and demarcated by some appropriate means. Therefore, we set up a research program to test the remote-viewing hypothesis under rigidly controlled scientific conditions.

In carrying out this program, we concentrated on what we considered to be our principal responsibility—to resolve under unambiguous conditions the basic issue of whether or not this class of paranormal perception phenomenon exists. At all times, we and others responsible for the overall program took measures to prevent sensory leakage and subliminal cueing and to prevent deception, whether intentional or unintentional. To ensure evaluations independent of belief structures of both experimenters and judges, all experiments were carried out under a protocol, described below, in which target selection at the beginning of experiments and blind judging of results at the end of experiments were handled independently of the researchers engaged in carrying out the experiments.

Six subjects, designated S1 through S6, were chosen for the study. Three were considered as gifted or experienced subjects (S1 through S3), and three were considered as learners (S4 through S6). The *a priori* dichotomy between gifted and learners was based on the experienced group having been successful in other studies conducted before this program and the learners group being inexperienced with regard to paranormal experimentation.

The study consisted of a series of double-blind tests with local targets in the San Francisco Bay Area so that several independent judges could visit the sites to establish documentation. The protocol was to closet the subject with an experimenter at SRI and at an agreed-on time to obtain from the subject a description of an undisclosed remote site being visited by a target team. In each of the experiments, one of the six program subjects served as remote-viewing subject, and SRI experimenters served as a target demarcation team at the remote location chosen in a double-blind protocol as follows.

In each experiment, SRI management randomly chose a target location from a list of targets within a 30-min driving time from SRI; the target location selected was kept blind to subject and experimenters. The target pool consisted of more than 100 target locations chosen from a target-rich environment. (Before the experimental series began, the Director of the Information Science and Engineering Division, not otherwise associated with the experiment, established the set of locations as the target pool which remained known only to him. The target locations were printed on cards sealed in envelopes and kept in the SRI Division office safe. They were available only with the personal assistance of the Division Director who issued a single random-number selected target card that constituted the traveling orders for that experiment.)

In detail: To begin the experiment, the subject was closeted with an experimenter at SRI to wait 30 min before beginning a narrative description of the remote location. A second experimenter then obtained from the Division Director a target location from a set of traveling orders previously prepared and randomized by the Director and kept under his control. The target demarcation team, consisting of two to four SRI experimenters, then proceeded by automobile directly to the target without any communication with the subject or experimenter remaining behind. The experimenter remaining with the subject at SRI was kept ignorant of both the particular target and the target pool so as to eliminate the possibility of cueing (overt or subliminal) and to allow him freedom in questioning the subject to clarify his descriptions. The demarcation team remained at the target site for an agreed-on 15-min period following the 30 min allotted for travel.[4] During the observation period, the remote-viewing subject was asked to describe his impressions of the target site into a tape recorder and to make any drawings he thought appropriate. An informal comparison was then made when the demarcation team returned, and the subject was taken to the site to provide feedback.

A. *Subject S1: Experienced*

To begin the series, Pat Price, a former California police commissioner and city councilman, participated as a subject in nine experiments. In general, Price's ability to describe correctly buildings, docks, roads, gardens, and the like, including structural materials, color, ambience, and activity—often in great detail—indicated the functioning of a remote perceptual ability. A Hoover Tower target, for example, was recognized and named by name. Nonetheless, in general, the descriptions contained inaccuracies as well as correct statements. A typical example is indicated by the subject's drawing shown in Fig. 3 in which he correctly described a park-like area containing two pools of water: one rectangular, 60 by 89 ft (actual dimensions 75 by 100 ft); the other circular, diameter 120 ft (actual diameter 110 ft). He incorrectly indicated the function, however, as water filtration rather than recreational swimming. (We often observe essentially correct descriptions of basic elements and patterns coupled with incomplete or erroneous analysis of function.) As can be seen from his drawing, he also included some elements, such as the tanks shown in the upper right, that are not present at the target site. We also note an apparent left–right reversal, often observed in paranormal perception experiments.

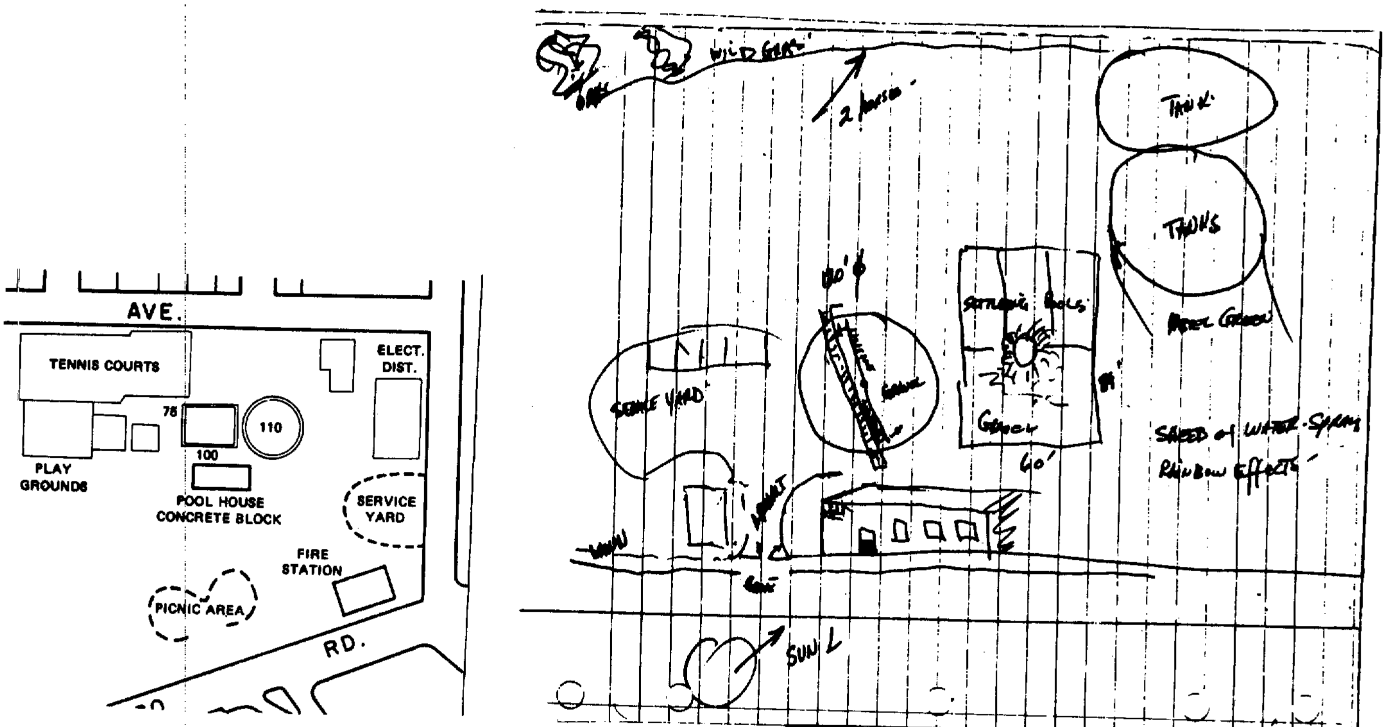
To obtain a numerical evaluation of the accuracy of the remote-viewing experiment, the experimental results were subjected to independent judging on a blind basis by an SRI research analyst not otherwise associated with the research. The subject's response packets, which contained the nine typed unedited transcripts of the tape-recorded narratives along with any associated drawings, were unlabeled and presented in random order. While standing at each target location, visited in turn, the judge was required to blind rank order the nine packets on a scale 1 to 9 (best to worst match). The statistic of interest is the sum of ranks assigned to the target-associated transcripts, lower values indicating better matches. For nine targets, the sum of ranks could range from nine to eighty-one. The probability that a given sum of ranks s or less will occur by chance is given by [55]

$$\Pr(s \text{ or less}) = \frac{1}{N^n} \sum_{i=n}^{s} \sum_{l=0}^{k} (-1)^l \binom{n}{l} \binom{i - Nl - 1}{n - 1}$$

where s is obtained sum of ranks, N is number of assignable ranks, n is number of occasions on which rankings were made, and l takes on values from zero to the least positive integer k in $(i - n)/n$. (Table I is a table to enable easy application of the above formula to those cases in which $N = n$.) The sum in this case, which included seven direct hits out of the nine, was 16 (see Table II), a result significant at $p = 2.9 \times 10^{-5}$ by exact calculation.

In Experiments 3, 4, and 6 through 9, the subject was secured in a double-walled copper-screen Faraday cage. 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. The results of rank order judging (Table II) indicate that the use of Faraday cage electrical

[4] The first subject (S1) was allowed 30 min for his descriptions, but it was found that he fatigued and had little comment after the first 15 min. The viewing time was therefore reduced to 15 min for subjects S2 through S6.



(a) (b)

Fig. 3. Swimming pool complex as remote-viewing target. (a) City map of target location. (b) Drawing by Price (S1).

TABLE I
CRITICAL VALUES OF SUMS OF RANKS FOR PREFERENTIAL MATCHING

Number of Assignable Ranks (N)	Probability (one-tailed) that the Indicated Sum of Ranks or Less Would Occur by Chance													
	0.20	0.10	0.05	0.04	0.025	0.01	0.005	0.002	0.001	0.0005	10^{-4}	10^{-5}	10^{-6}	10^{-7}
4	7	6	5	5	5	4	4							
5	11	10	9	8	8	7	6	6	5	5				
6	16	15	13	13	12	11	10	9	8	7	6			
7	22	20	18	18	17	15	14	12	12	11	9	8		
8	29	27	24	24	22	20	19	17	16	15	13	11	9	8
9	37	34	31	30	29	26	24	22	21	20	17	14	12	10
10	46	42	39	38	36	33	31	29	27	25	22	19	16	13
11	56	51	48	47	45	41	38	36	34	32	28	24	20	17
12	67	61	58	56	54	49	47	43	41	39	35	30	25	22

Note: This table applies only to those special cases in which the number of occasions on which objects are being ranked (n) is equal to the number of assignable ranks (N). Each entry represents the largest number that is significant at the indicated p-level. *Source:* R. L. Morris [55].

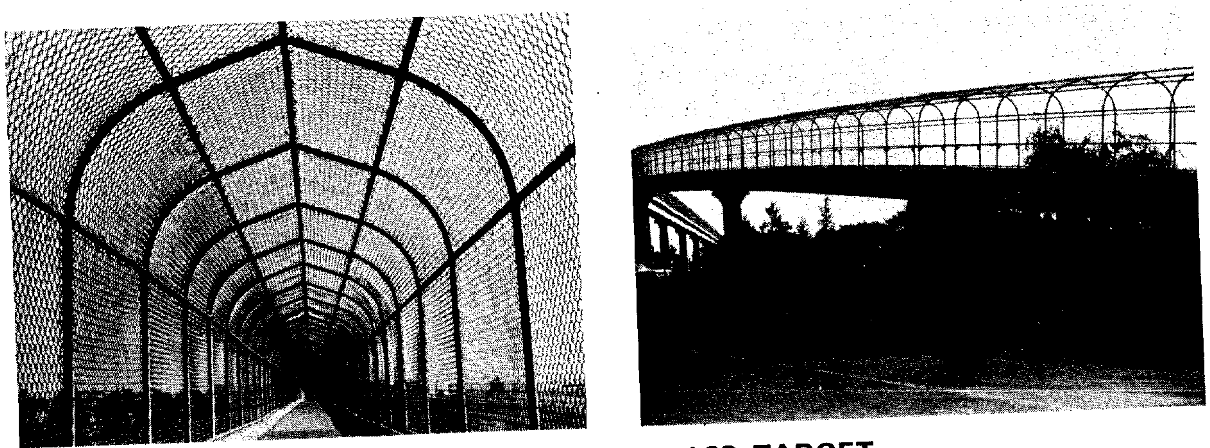
shielding does not prevent high-quality descriptions from being obtained.

As a backup judging procedure, a panel of five additional SRI scientists not otherwise associated with the research were asked simply to blind match the unedited typed transcripts (with associated drawings) generated by the remote viewer against the nine target locations which they independently visited in turn. The transcripts were unlabeled and presented in random order. A correct match consisted of a transcript of a given date being matched to the target of that date. Instead of the expected number of 1 match each per judge, the number of correct matches obtained by the five judges was 7, 6, 5, 3, and 3, respectively. Thus, rather than the expected total number of 5 correct matches from the judges, 24 such matches were obtained.

B. Subject S4: Learner

This experiment was designed to be a replication of our previous experiment with Price, the first replication attempted. The subject for this experiment was Mrs. Hella Hammid, a gifted professional photographer. She was selected for this series on the basis of her successful performance as a percipient in the EEG experiment described earlier. Outside of that interaction, she had no previous experience with apparent paranormal functioning.

At the time we began working with Mrs. Hammid, she had no strong feelings about the likelihood of her ability to succeed in this task. This was in contrast to both Ingo Swann who had come to our laboratory fresh from a lengthy and apparently successful series of experiments with Dr. Gertrude Schmeidler at City College of New York [56] and Pat Price



PEDESTRIAN OVERPASS TARGET

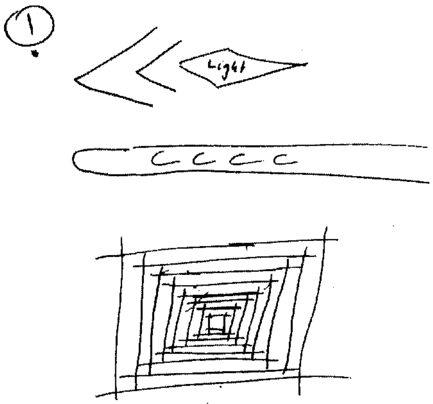


Fig. 4. Subject Hammid (S4) drawing, described as "some kind of diagonal trough up in the air."

TABLE II
DISTRIBUTION OF RANKINGS ASSIGNED TO TRANSCRIPTS ASSOCIATED WITH EACH TARGET LOCATION FOR EXPERIENCED SUBJECT PRICE (S1)

Target Location	Distance (km)	Rank of Associated Transcript
Hoover Tower, Stanford	3.4	1
Baylands Nature Preserve, Palo Alto	6.4	1
Radio telescope, Portola Valley	6.4	1
Marina, Redwood City	6.8	1
Bridge toll plaza, Fremont	14.5	6
Drive-in theater, Palo Alto	5.1	1
Arts and Crafts Plaza, Menlo Park	1.9	1
Catholic Church, Portola Valley	8.5	3
Swimming pool complex, Palo Alto	3.4	1
Total sum of ranks		16 ($p=2.9\times10^{-6}$)

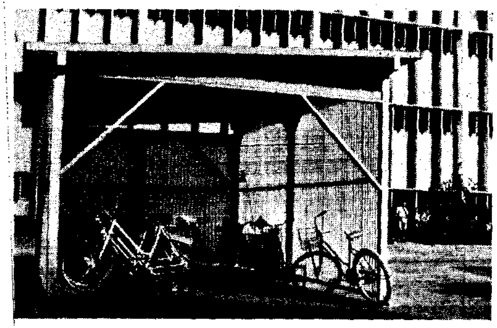
who felt that he used his remote-viewing ability in his everyday life.

In comparison with the latter two, many people are more influenced by their environment and are reluctant under public scrutiny to attempt activities that are generally thought to be impossible. Society often provides inhibition and negative feedback to the individual who might otherwise have explored his own nonregular perceptual ability. We all share an historical tradition of "the stoning of prophets and the burning of witches" and, in more modern times, the hospitalization of those who claim to perceive things that the majority do not admit to seeing. Therefore, as an addition to maintaining scientific rigor, one of our primary tasks as researchers is to provide an environment in which the subject feels safe to explore the possibility of paranormal perception. With a new subject, we also try to stress the nonuniqueness of the ability because from our experience paranormal functioning appears to be a latent ability that all subjects can articulate to some degree.

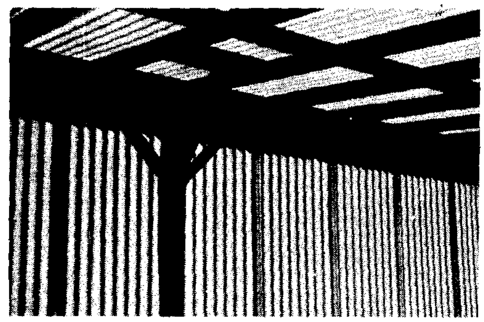
Because of Mrs. Hammid's artistic background, she was capable of drawing and describing visual images that she could not identify in any cognitive or analytic sense. When the target demarcation team went to a target location which was a pedestrian overpass, the subject said that she saw "a kind of trough up in the air," which she indicated in the upper part of her drawing in Fig. 4. She went on to explain, "If you stand where they are standing you will see something like this," indicating the nested squares at the bottom of Fig. 4. As it turned out, a judge standing where she indicated would have a view closely resembling what she had drawn, as can be seen from the accompanying photographs of the target location. It needs to be emphasized, however, that judges did not have access to our photographs of the site, used here for illustrative purposes only, but rather they proceeded to each of the target locations by list.

In another experiment, the subject described seeing "an open barnlike structure with a pitched roof." She also saw a "kind of slatted side to the structure making light and dark bars on the wall." Her drawing and a photograph of the associated bicycle shed target are shown in Fig. 5. (Subjects are encouraged to make drawings of anything they visualize and associate with the remote location because drawings they make are in general more accurate than their verbal description.)

As in the original series with Price, the results of the nine-



BICYCLE SHED TARGET



DETAIL OF BICYCLE SHED

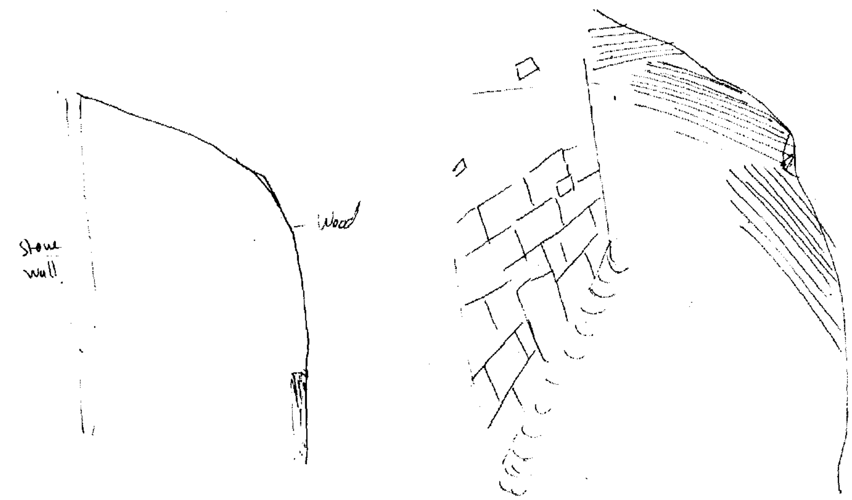


Fig. 5. Subject Hammid (S4) response to bicycle shed target described as an open "barn-like building" with "slats on the sides" and a "pitched roof."

TABLE III
DISTRIBUTION OF RANKINGS ASSIGNED TO TRANSCRIPTS ASSOCIATED WITH EACH TARGET LOCATION FOR LEARNER SUBJECT HAMMID (S4)

Target Location	Distance (km)	Rank of Associated Transcript
Methodist Church, Palo Alto	1.9	1
Ness Auditorium, Menlo Park	0.2	1
Merry-go-round, Palo Alto	3.4	1
Parking garage, Mountain View	8.1	2
SRI International Courtyard, Menlo Park	0.2	1
Bicycle shed, Menlo Park	0.1	2
Railroad trestle bridge, Palo Alto	1.3	2
Pumpkin patch, Menlo Park	1.3	1
Pedestrian overpass, Palo Alto	5.0	2
Total sum of ranks		13 ($p=1.8\times10^{-6}$)

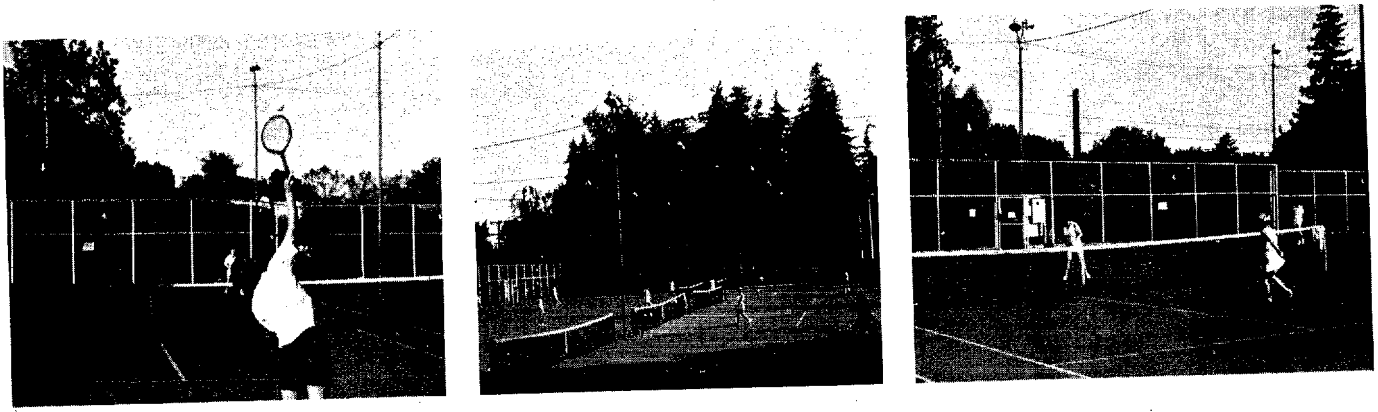
experiment series were submitted for independent judging on a blind basis by an SRI research analyst not otherwise associated with the research. While at each target location, visited in turn, the judge was required to blind rank order the nine unedited typed manuscripts of the tape-recorded narratives, along with any associated drawings generated by the remote viewer, on a scale 1 to 9 (best to worst match). The sum of ranks assigned to the target-associated transcripts in this case was 13, a result significant at $p = 1.8 \times 10^{-6}$ by exact calculation (see Table I and discussion), and included five direct hits and four second ranks (Table III).

Again, as a backup judging procedure, a panel of five additional judges not otherwise associated with the research were asked simply to blind match the unedited typed transcripts and associated drawings generated by the remote viewer, against the nine target locations which they independently visited in turn. A correct match consisted of a transcript of a given date being matched to the target of that date. Instead of the expected number of 1 match each per judge, the number of correct matches obtained by the five judges was 5, 3, 3, 2, and 2, respectively. Thus, rather than the expected total number of 5 correct matches from the judges, 15 such matches were obtained.

C. Subjects S2 and S3: Experienced

Having completed a series of 18 remote-viewing experiments, 9 each with experienced subject S1 (Price) and learner S4 (Hammid), additional replication experiments, four with each subject, were carried out with experienced subjects S2 (Elgin) and S3 (Swann) and learners S5 and S6. To place the judging on a basis comparable to that used with S1 and S4, the four transcripts each of experienced subjects S2 and S3 were combined into a group of eight for rank order judging to be compared with the similarly combined results of the learners S5 and S6.

The series with S2 (Elgin, an SRI research analyst) provided a further example of the dichotomy between verbal and drawing responses. (As with medical literature, case histories often are more illuminating than the summary of results.) The experiment described here was the third conducted with this



TARGET—TENNIS COURTS

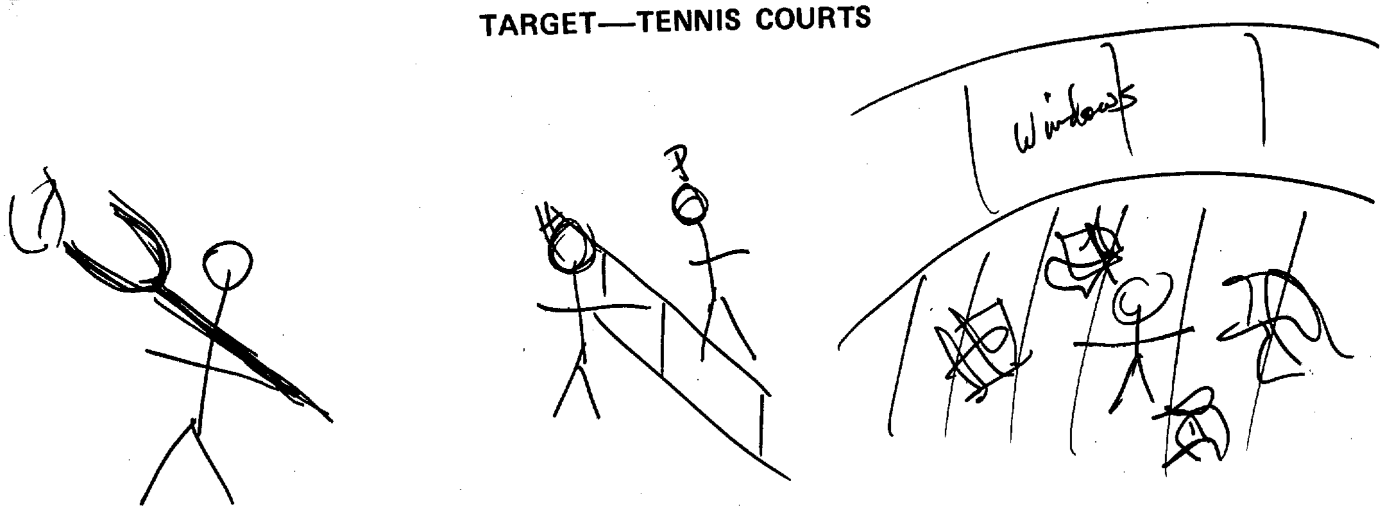


Fig. 6. Subject Elgin (S2) drawings in response to tennis court target.

subject. It was a demonstration experiment for a government visitor who had heard of our work and wanted to evaluate our experimental protocol.

In the laboratory, the subject, holding a bearing compass at arm's length, began the experiment by indicating the direction of the target demarcation team correctly to within 5°. (In all four experiments with this subject, he has always been within 10° of the correct direction in this angular assessment.) The subject then generated a 15-min tape-recorded description and the drawings shown in Fig. 6.

In discussing the drawings, Elgin indicated that he was uncertain as to the action, but had the impression that the demarcation team was located at a museum (known to him) in a particular park. In fact, the target was a tennis court located in that park about 90 m from the indicated museum. Once again, we note the characteristic (discussed earlier) of a resemblance between the target site and certain gestalt elements of the subject's response, especially in regard to the drawings, coupled with incomplete or erroneous analysis of the significances. Nonetheless, when rank ordering transcripts 1 through 8 at the site, the judge ranked this transcript as 2. This example illustrates a continuing observation that most of the correct information related to us by subjects is of a non-analytic nature pertaining to shape, form, color, and material rather than to function or name.

A second example from this group, generated by S3 (Swann), indicates the level of proficiency that can be attained with practice. In the two years since we first started working with Swann, he has been studying the problem of separating the external signal from the internal noise. In our most recent experiments, he dictates two lists for us to record. One list contains objects that he "sees," but does not think are located at the remote scene. A second list contains objects that he thinks are at the scene. In our evaluation, he has made much progress in this most essential ability to separate memory and imagination from paranormal inputs. This is the key to bringing the remote-viewing channel to fruition with regard to its potential usefulness.

The quality of transcript that can be generated by this process is evident from the results of our most recent experiment with Swann. The target location chosen by the usual double-blind protocol was the Palo Alto City Hall. Swann described a tall building with vertical columns and "set in" windows. His sketch, together with the photograph of the site, is shown in Fig. 7. He said there was a fountain, "but I don't hear it." At the time the target team was at the City Hall during the experiment, the fountain was not running. He also made an effort to draw a replica of the designs in the pavement in front of the building, and correctly indicated the number of trees (four) in the sketch.

For the entire series of eight, four each from S2 and S3, the numerical evaluation based on blind rank ordering of transcripts at each site was significant at $p = 3.8 \times 10^{-4}$ and included three direct hits and three second ranks for the target-associated transcripts (see Table IV).

D. Subjects S5 and S6: Learners

To complete the series, four experiments each were carried out with learner subjects S5 and S6, a man and woman on the SRI professional staff. The results in this case, taken as a

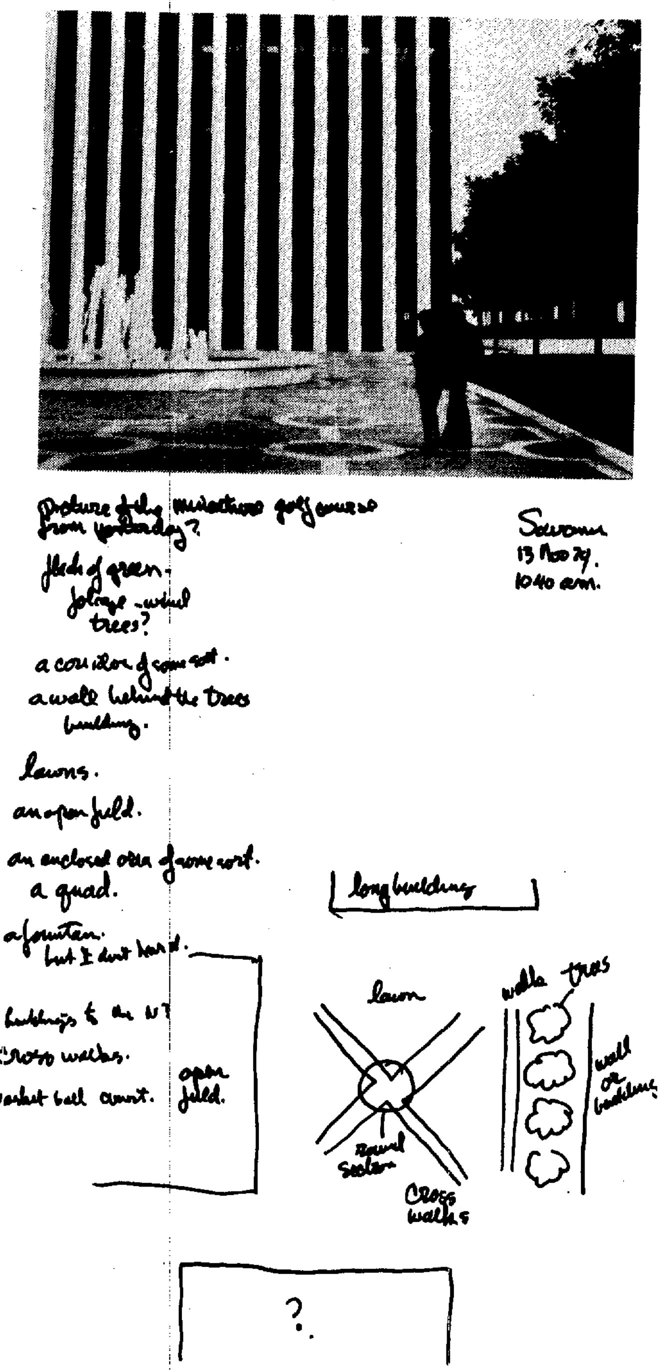


Fig. 7. Subject Swann (S3) response to City Hall target.

group, did not differ significantly from chance. For the series of eight (judged as a group of seven since one target came up twice, once for each subject), the numerical evaluation based on blind rank ordering of transcripts at each site was nonsignificant at $p = 0.08$, even though there were two direct hits and two second ranks out of the seven (see Table V).

One of the direct hits, which occurred with subject S6 in her *first* experiment, provides an example of the "first-time effect" that has been rigorously explored and is well-known to experimenters in the field [57]. The outbound experimenter obtained, by random protocol from the pool, a target blind to the experimenter with the subject, as is our standard procedure, and proceeded to the location. The subject, a mathematician [illegible] who had no pre-

TABLE IV
DISTRIBUTION OF RANKINGS ASSIGNED TO TRANSCRIPTS ASSOCIATED WITH EACH TARGET LOCATION FOR EXPERIENCED SUBJECTS ELGIN (S2) AND SWANN (S3)

Subject	Target Location	Distance (km)	Rank of Associated Transcript
S2	BART Station (Transit System), Fremont	16.1	1
S2	Shielded room, SRI, Menlo Park	0.1	2
S2	Tennis court, Palo Alto	3.4	2
S2	Golf course bridge, Stanford	3.4	2
S3	City Hall, Palo Alto	2.0	1
S3	Miniature golf course, Menlo Park	3.0	1
S3	Kiosk in park, Menlo Park	0.3	3
S3	Baylands Nature Preserve, Palo Alto	6.4	3
	Total sum of ranks		15 ($p = 3.8 \times 10^{-4}$)

TABLE V
DISTRIBUTION OF RANKINGS ASSIGNED TO TRANSCRIPTS ASSOCIATED WITH EACH TARGET LOCATION FOR LEARNER SUBJECTS S5 AND S6

Subject	Target Location	Distance (km)	Rank of Associated Transcript
S5	Pedestrian overpass, Palo Alto	5.0	3
S5	Railroad trestle bridge, Palo Alto	1.3	6
S5	Windmill, Portola Valley	8.5	2
S5, S6	White Plaza, Stanford (2)	3.8	1
S6	Airport, Palo Alto	5.5	2
S6	Kiosk in Park, Menlo Park	0.3	5
S6	Boathouse, Stanford	4.0	1
	Total sum of ranks		20 ($p = 0.08$, NS)

vious experience in remote viewing, began to describe a large square with a fountain. Four minutes into the experiment, she recognized the location and correctly identified it by name (see Fig. 8). (It should be noted that in the area from which the target locations were drawn there are other fountains as well, some of which were in the target pool.) As an example of the style of the narratives generated during remote viewing with inexperienced subjects and of the part played by the experimenter remaining with the subject in such a case, we have included the entire unedited text of this experiment as Appendix B.

E. Normal and Paranormal: Use of Unselected Subjects in Remote Viewing

After more than a year of following the experimental protocol described above and observing that even inexperienced subjects generated results better than expected, we initiated a series of experiments to explore further whether individuals other than putative "psychics" can demonstrate the remote-viewing ability. To test this idea, we have a continuing program to carry out additional experiments of the outdoor type with new subjects whom we have no *a priori* reason to believe have paranormal perceptual ability. To date we have collected data from five experiments with two individuals in this category: a man and a woman who were visiting government scientists interested in observing our experimental protocols. The motivation for these particular experiments was twofold. First, the experiments provide data that indicate the level of proficiency that can be expected from unselected volunteers.

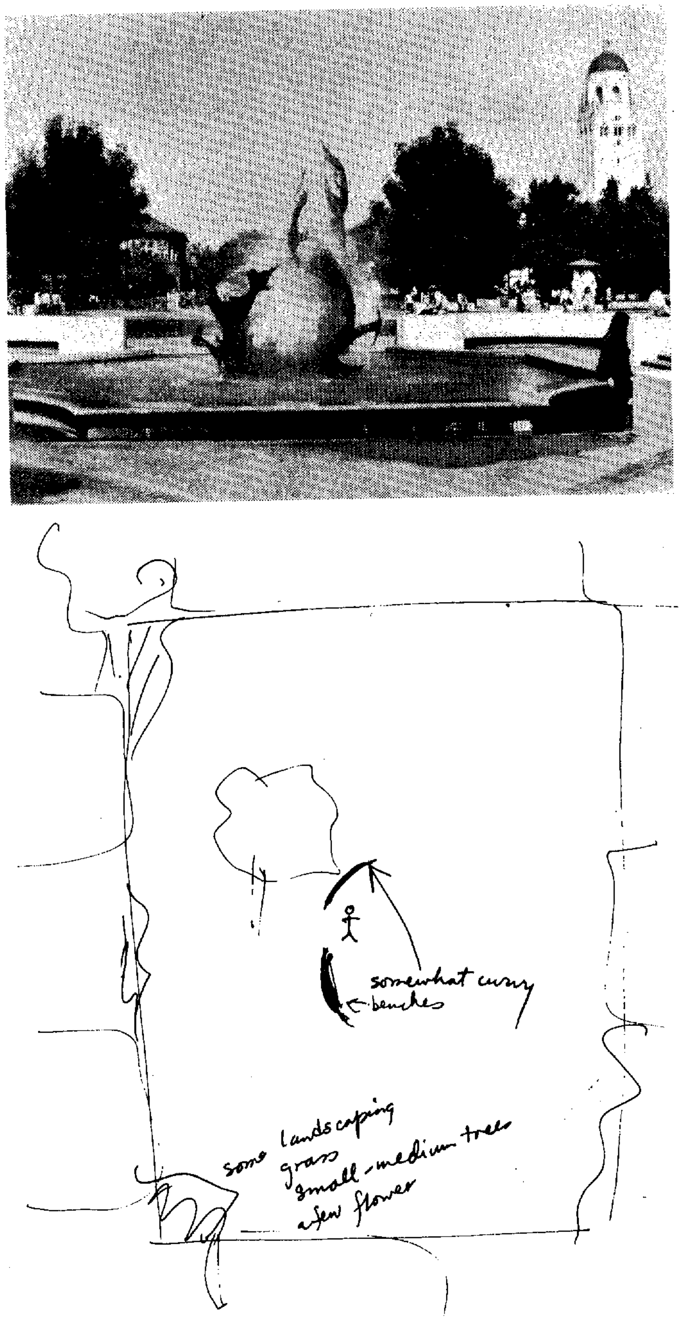
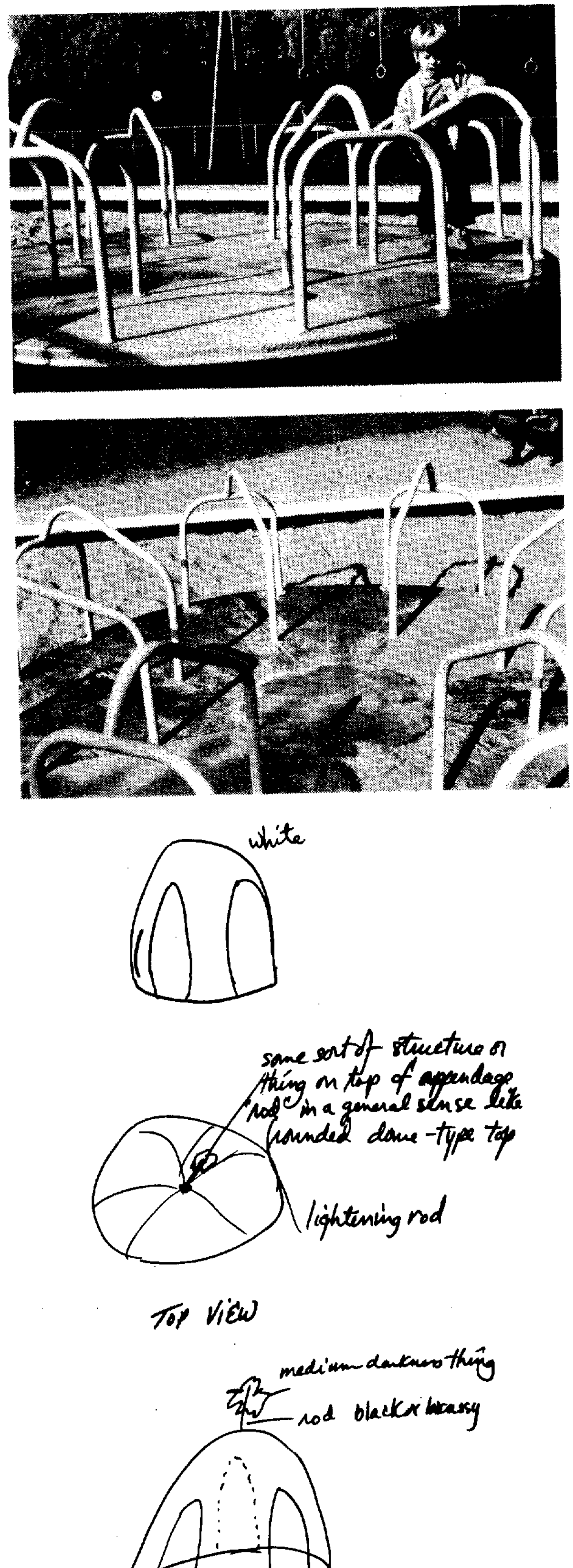


Fig. 8. Subject (S6) drawing of White Plaza, Stanford University. Subject drew what she called "curvy benches" and then announced correctly that the place was "White Plaza at Stanford."



RESPONSES OF VISITING SCIENTIST SUBJECT

Fig. 9. Subject (V1) drawing of merry-go-round target.

Second, when an individual observes a successful demonstration experiment involving another person as subject, it inevitably occurs to him that perhaps chicanery is involved. We have found the most effective way to settle this issue for the observer is to have the individual himself act as a subject so as to obtain personal experience against which our reported results can be evaluated.

The first visitor (V1) was invited to participate as a subject in a three-experiment series. All three experiments contained elements descriptive of the associated target locations; the quality of response increased with practice. The third response is shown in Fig. 9, where again the pattern elements in the drawing appeared to be a closer match than the subject's analytic interpretation of the target object as a cupola.

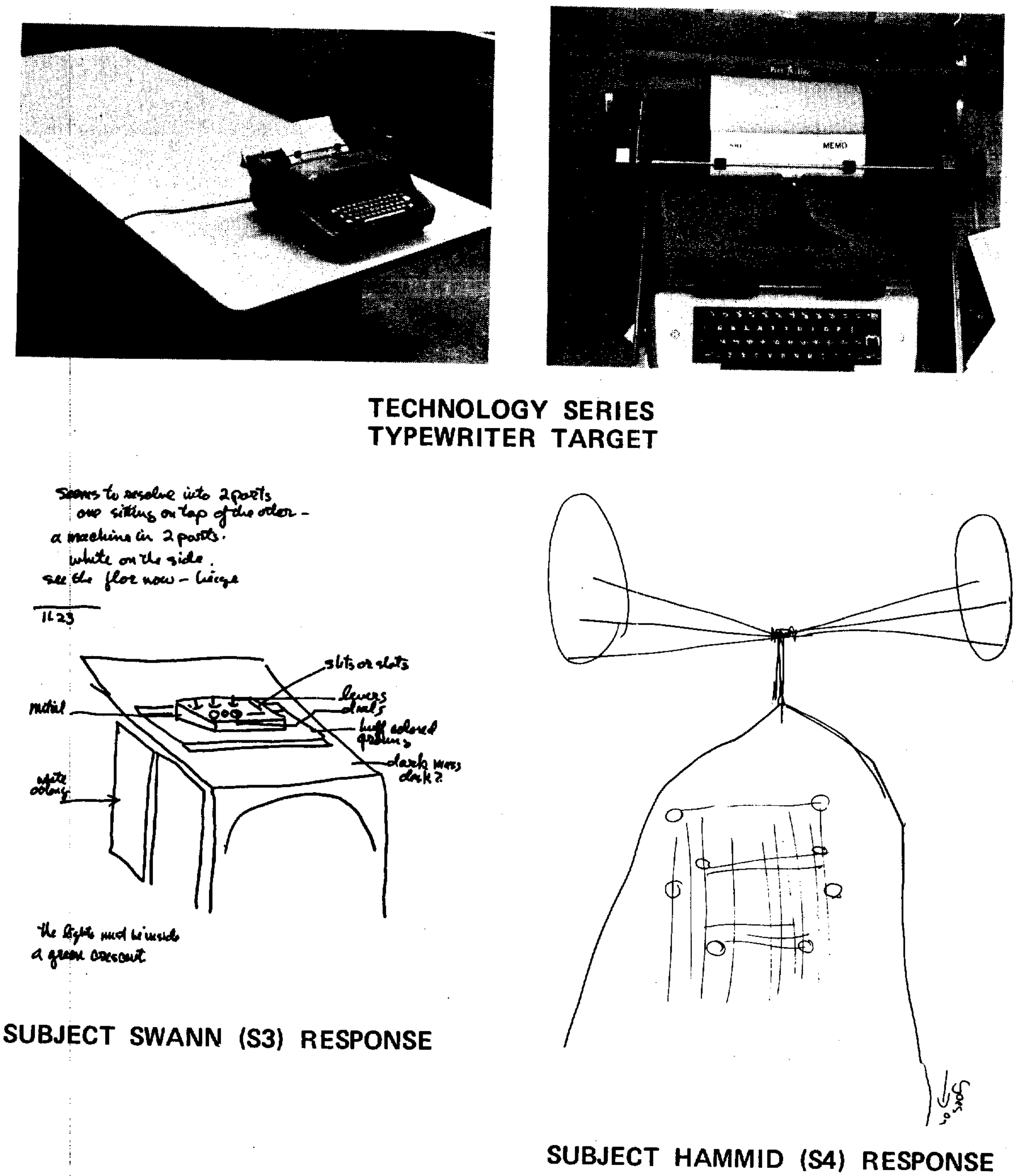


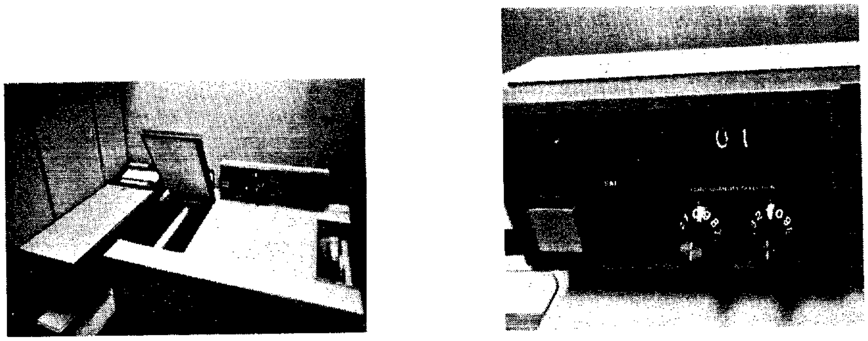
Fig. 10. Drawings of a typewriter target by two subjects.

The second visitor [V2] participated as a subject in two experiments. In his first experiment, he generated one of the higher signal-to-noise results we have observed. He began his narrative, "There is a red A-frame building and next to it is a large yellow thing [a tree–Editor]. Now further left there is another A-shape. It looks like a swing-set, but it is pushed down in a gully so I can't see the swings." [All correct.] He then went on to describe a lock on the front door that he said "looks like it's made of laminated steel, so it must be a Master lock." [Also correct.]

For the series of five–three from the first subject and two from the second–the numerical evaluation based on blind rank ordering of the transcripts at each site was significant at $p = 0.017$ and included three direct hits and one second rank for the target-associated transcripts. (See Table VI.)

TABLE VI
DISTRIBUTION OF RANKINGS ASSIGNED TO TRANSCRIPTS ASSOCIATED WITH EACH TARGET LOCATION FOR VISITOR SUBJECTS V1 AND V2

Subject	Target Location	Distance (km)	Rank of Associated Transcript
V1	Bridge over stream, Menlo Park	0.3	1
V1	Baylands Nature Preserve, Palo Alto	6.4	2
V1	Merry-go-round, Palo Alto	3.4	1
V2	Windmill, Portola Valley	8.5	1
V2	Apartment swimming pool, Mountain View	9.1	3
	Total sum of ranks		8 (p=0.017)



TARGET LOCATION: XEROX MACHINE (TECHNOLOGY SERIES)

TO ADD INTEREST TO TARGET LOCATION EXPERIMENTER WITH HIS HEAD BEING XEROXED

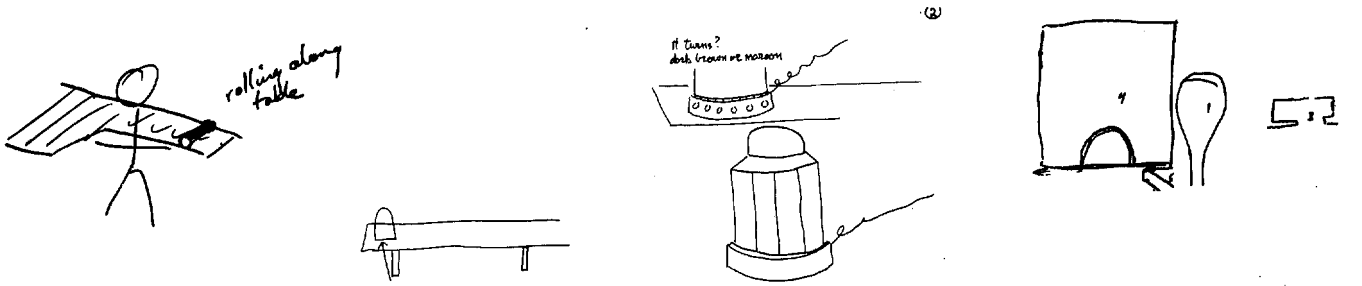


Fig. 11. Drawings by three subjects (S2, S3, and V3) for Xerox machine target. When asked to describe the square at upper left of response on the right, subject (V3) said, "There was this predominant light source which might have been a window, and a working surface which might have been the sill, or a working surface or desk." Earlier the subject had said, "I have the feeling that there is something silhouetted against the window."

Observations with unselected subjects such as those described above indicate that remote viewing may be a latent and widely distributed perceptual ability.

F. Technology Series: Short-Range Remote Viewing

Because remote viewing is a perceptual ability, we considered it important to obtain data on its resolution capabilities. To accomplish this, we turned to the use of indoor technological targets.

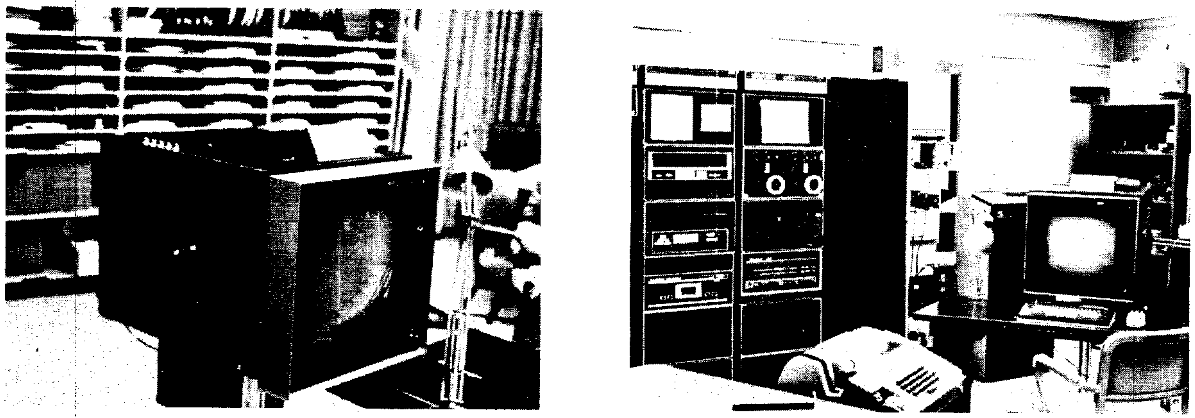
Twelve experiments were carried out with five different subjects, two of whom were visiting government scientists. They were told that one of the experimenters would be sent by random protocol to a laboratory within the SRI complex and that he would interact with the equipment or apparatus at that location. It was further explained that the experimenter remaining with the subject was, as usual, kept ignorant of the contents of the target pool to prevent cueing during questioning. (Unknown to subjects, targets in the pool were used with replacement; one of the goals of this particular experiment was to obtain multiple responses to a given target to investigate whether correlation of a number of subject responses would provide enhancement of the signal-to-noise ratio.) The subject was asked to describe the target both verbally (tape recorded) and by means of drawings during a time-synchronized 15-min interval in which the outbound experimenter interacted in an appropriate manner with the equipment in the target area.

In the twelve experiments, seven targets were used: a drill press, Xerox machine, video terminal, chart recorder, four-state random number generator, machine shop, and typewriter. Three of these were used twice (drill press, video terminal, and typewriter) and one (Xerox machine) came up three times in our random selection procedure.

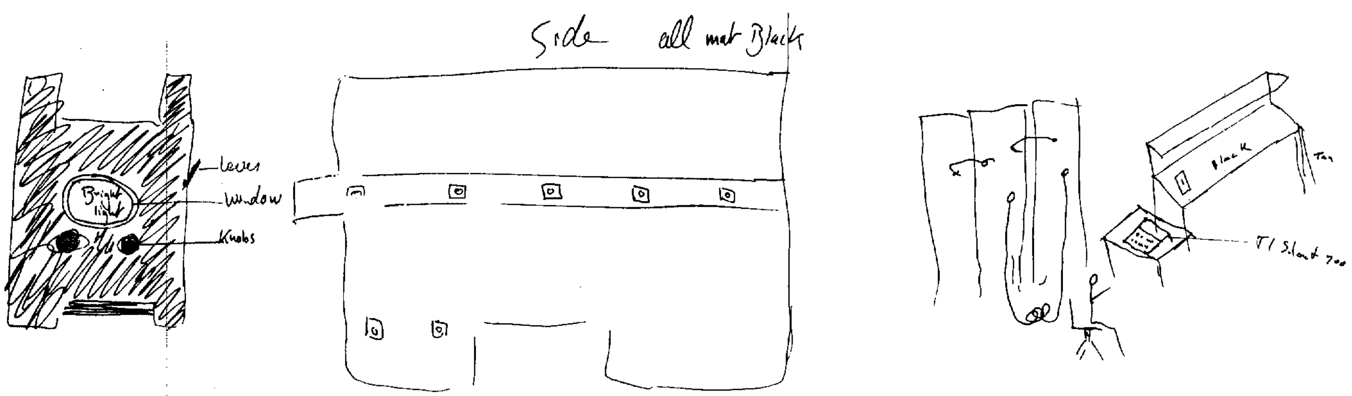
Comparisons of the targets and subject drawings for three of the multiple-response cases (the typewriter, Xerox machine, and video terminal) are shown in Figs. 10, 11, and 12. As is apparent from these illustrations alone, the experiments provide circumstantial evidence for an information channel of useful bit rate. This includes experiments in which visiting government scientists participated as subjects (Xerox machine and video terminal) to observe the protocol. In general, it appears that use of multiple-subject responses to a single target provides better signal-to-noise ratio than target identification by a single individual. This conclusion is borne out by the judging described below.

Given that in general the drawings constitute the most accurate portion of a subject's description, in the first judging procedure a judge was asked simply to blind match only the drawings (i.e., without tape transcripts) to the targets. Multiple-subject responses to a given target were stapled together, and thus seven subject-drawing response packets were to be matched to the seven different targets for which drawings were made. The judge did *not* have access to our photographs of the target locations, used for illustration purposes only, but rather proceeded to each of the target locations by list. While standing at each target location, the judge was required to rank order the seven subject-drawing response packets (presented in random order) on a scale 1 to 7 (best to worst match). For seven targets, the sum of ranks could range from 7 to 49. The sum in this case, which included 1 direct hit and 4 second ranks out of the 7 (see Table VII) was 18, a result significant at $p = 0.036$.

In the second more detailed effort at evaluation, a visiting scientist selected at random one of the 12 data packages (a drill press experiment), sight unseen and submitted it for independent analysis to an engineer with a request for an esti-



TARGET: VIDEO MONITOR FOR TEXT EDITING (TECHNOLOGY SERIES)



(a) (b)

Fig. 12. Drawing by two subjects of a video monitor target. (a) Subject (S4) drawing of "box with light coming out of it . . . painted flat black and in the middle of the room." (b) Second subject (V2) saw a computer terminal with relay racks in the background.

TABLE VII
DISTRIBUTION OF RANKINGS ASSIGNED TO SUBJECT DRAWINGS ASSOCIATED WITH EACH TARGET LOCATION

Subject	Target	Rank of Associated Drawings
S3, S4	Drill press	2
S2, S3, V3	Xerox machine	2
S4, V2	Video terminal	1
S3	Chart recorder	2
S4	Random number generator	6
S4	Machine shop	3
S3, S4	Typewriter	2
	Total sum of ranks	18 (p=0.036)

TABLE VIII
SUMMARY: REMOTE VIEWING

Subject	Number of Experiments	p-Value, Rank Order Judging
With natural targets		
S1 (experienced)	9	2.9×10^{-5}
S2 and S3 (experienced)	8	3.8×10^{-4}
S4 (learner)	9	1.8×10^{-6}
S5 and S6 (learners)	8	0.08 (NS)
V1 and V2 (learners/visitors)	5	0.017
With technology targets		
S2, S3, S4, V2, V3	12	0.036

mate as to what was being described. The analyst, blind as to the target and given only the subject's taped narrative and drawing (Fig. 13), was able, from the subject's description alone, to correctly classify the target as a "man-sized vertical boring machine."

G. Summary of Remote Viewing Results

1) Discussion: The descriptions supplied by the subjects in the experiments involving remote viewing of natural targets or laboratory apparatus, although containing inaccuracies, were sufficiently accurate to permit the judges to differentiate among various targets to the degree indicated. A summary tabulation of the statistical evaluations of these fifty-one experiments with nine subjects is presented in Table VIII. The overall result, evaluated conservatively on the basis of a judging procedure that ignores transcript quality beyond that necessary to rank order the data packets (vastly underestimating the statistical significance of individual descriptions), clearly indicates the presence of an information channel of useful bit rate. Furthermore, it appears that the principal difference between experienced subjects and inexperienced volunteers is *not* that the latter never exhibit the faculty, but rather that their results are simply less reliable, more sporadic. Nevertheless, as described earlier, individual transcripts from the inexperienced group of subjects number among some of the best obtained. Such observations indicate a hypothesis that remote viewing may be a latent and widely distributed perceptual ability.

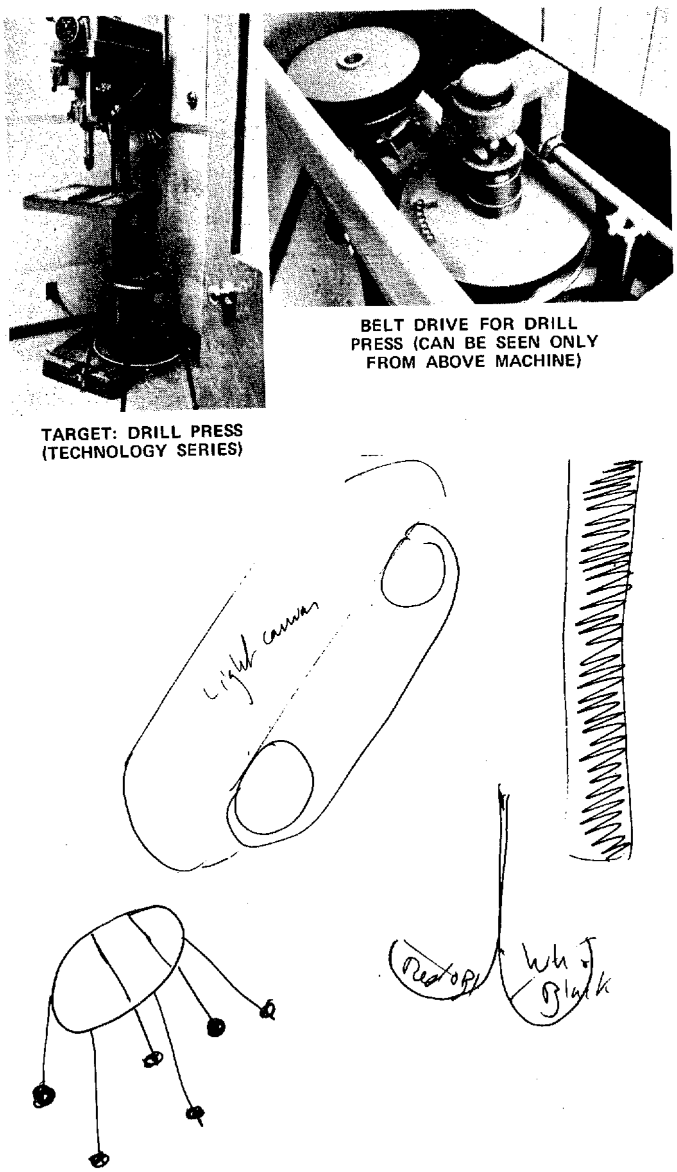


Fig. 13. Subject (S4) drawing of drill press showing belt drive, stool, and a "vertical graph that goes up and down."

Thus the primary achievement of the SRI program was the elicitation of high-quality remote viewing from individuals who agreed to act as subjects. Criticism of this claim could in principle be put forward on the basis of three potential flaws. 1) The study could involve naiveté in protocol that permits various forms of cueing, intentional or unintentional. 2) The experiments discussed could be selected out of a larger pool of experiments of which many are of poorer quality. 3) Data for the reported experiments could be edited to show only the matching elements, the nonmatching elements being discarded.

All three criticisms, however, are invalid. First, with regard to cueing, the use of double-blind protocols ensures that none of the persons in contact with the subject can be aware of the target. Second, selection of experiments for reporting did not take place; every experiment was entered as performed on a master log and is included in the statistical evaluations. Third, data associated with a given experiment remain unedited; all experiments are tape recorded and all data are included unedited in the data package to be judged and evaluated.

In the process of judging—attempting to match transcripts against targets on the basis of the information in the transcripts—some patterns and regularities in the transcript descriptions became evident, particularly regarding individual styles in remote viewing and in the perceptual form of the descriptions given by the subjects. These patterns and the judging procedure are discussed below.

a) Styles of response: The fifty-one transcripts were taken from nine different subjects. Comparing the transcripts of one subject with those of another revealed that each pattern tended to focus on certain aspects of the remote target complex and to exclude others, so that each had an individual pattern of response, like a signature.

Subject S3, for example, frequently responded with topographical descriptions, maps, and architectural features of the target locations. Subject S2 often focused on the behavior of the remote experimenter or the sequence of actions he carried out at the target. The transcripts of subject S4, more than those of other subjects, had descriptions of the feel of the location, and experiential or sensory gestalts—for example, light/dark elements in the scene and indoor/outdoor and enclosed/open distinctions. Prominent features of S1's transcripts were detailed descriptions of what the target persons were concretely experiencing, seeing, or doing—for example, standing on asphalty blacktop overlooking water; looking at a purple iris.

The range of any individual subject's responses was wide. Anyone might draw a map or describe the mood of the remote experimenter, but the consistency of each subject's overall approach suggests that just as individual descriptions of a *directly* viewed scene would differ, so these differences also occur in *remote*-viewing processes.

b) Nature of the description: The concrete descriptions that appear most commonly in transcripts are at the level of subunits of the overall scene. For example, when the target was a Xerox copy machine, the responses included (S2) a rolling object (the moving light) or dials and a cover that is lifted (S3), but the machine as a whole was not identified by name or function.

In a few transcripts, the subjects correctly identified and named the target. In the case of a computer terminal, the subject (V2) apparently perceived the terminal and the relay racks behind it. In the case of targets which were Hoover Tower and White Plaza, the subjects (S1 and S6, respectively) seemed to identify the locations through analysis of their initial images of the elements of the target.

There were also occasional incorrect identifications. Gestalts were incorrectly named; for example, swimming pools in a park were identified as water storage tanks at a water filtration plant (S1).

The most common perceptual level was thus an intermediate one—the individual elements and items that make up the target. This is suggestive of a scanning process that takes sample perceptions from within the overall environment.

When the subjects tried to make sense out of these fragmentary impressions, they often resorted to metaphors or constructed an image with a kind of perceptual inference. From a feeling of the target as an "august" and "solemn" building, a subject (S4) said it might be a library; it was a church. A pedestrian overpass above a freeway was described as a conduit (S4). A rapid transit station, elevated above the countryside, was associated with an observatory (S2). These responses seem to be the result of attempts to process partial information: similarly, this occurs in other parapsychological experiments. These observations are compatible with the hypotheses that information received in a putative remote-viewing mode is processed piecemeal in pattern form (consistent with a low bit rate process, but not necessarily requiring it); and the errors arise in the processes of attempted integration of the data into larger patterns directed toward verbal labeling.

When the subjects augmented the verbal transcripts with drawings or sketches, these often expressed the target elements more accurately than the verbal descriptions. Thus the drawings tended to correspond to the targets more clearly and precisely than the words of the transcript.

The descriptions given by the subjects sometimes went beyond what the remote experimenter experienced, at least consciously. For example, one subject (S4) described and drew a belt drive at the top of a drill press that was invisible even to the remote experimenter who was operating the machine; another subject (S1) described a number of items behind shrubbery and thus not visible to members of the demarcation team at the site.

Curiously, objects in motion at the remote site were rarely mentioned in the transcript. For example, trains crossing the railroad trestle target were not described, though the remote experimenter stood very close to them.

Also in a few cases, the subject descriptions were inaccurate regarding size of structures. A 20-ft courtyard separating two buildings was described as 200 ft wide, and a small shed was expanded to a barn-like structure.

c) Blind judging of transcripts: The judging procedure entailed examining the transcripts for a given experimental series and attempting to match the transcripts with the correct targets on the basis of their correspondences. The transcripts varied from coherent and accurate descriptions to mixtures of correspondences and noncorrespondences. Since the judge did not know *a priori* which elements of the descriptions were correct or incorrect, the task was complicated, and transcripts often seemed plausibly to match more than one target. A confounding factor in these studies is that some target locations have similarities that seem alike at some level of perception. For example, a radio telescope at the top of a hill, the observation deck of a tower, and a jetty on the edge of a bay all match a transcript description of "looking out over a long distance." A lake, a fountain, and a creek may all result in an image of water for the subject. Therefore, in several cases, even correct images may not help in the conservative differential matching procedure used.

According to the judge, the most successful procedure was a careful element-by-element comparison that tested each transcript against every target and used the transcript descriptions and drawings as arguments for or against assigning the transcript to a particular target. In most cases, this resulted in either a clear conclusion or at least a ranking of probable matches; these matches were subjected to the statistical analyses presented in this paper.

2) Summary: In summary, we do not yet have an understanding of the nature of the information-bearing signal that a subject perceives during remote viewing. The subjects commonly report that they perceive the signal visually as though they were looking at the object or place from a position in its immediate neighborhood. Furthermore, the subjects' perceptual viewpoint has mobility in that they can shift their point of view so as to describe elements of a scene that would not be visible to an observer merely standing at ground level and describing what he sees. (In particular, a subject often correctly describes elements not visible to the target demarcation team.) Finally, motion is seldom reported; in fact, moving objects often are unseen even when nearby static objects are correctly identified.

A comparison of the results of remote viewing (a so-called free-response task) with results of forced-choice tasks, such as the selection of one of four choices generated by a random number generator [58], reveals the following findings. From a statistical viewpoint, a subject is more likely to describe, with sufficient accuracy to permit blind matching, a remote site chosen at random than he is to select correctly one of four random numbers. Our experience with these phenomena leads us to consider that this difference in task performance may stem from fundamental signal-to-noise considerations. Two principal sources of noise in the system apparently are memory and imagination, both of which can give rise to mental pictures of greater clarity than the target to be perceived. In the random number task, a subject can create a perfect mental picture of each of the four possible outputs in his own imagination and then attempt to obtain the correct answer by a mental matching operation. The same is true for card guessing experiments. On the other hand, the subject in remote viewing is apparently more likely to approach the task with a blank mind as he attempts to perceive pictorial information from remote locations about which he may have no stored mental data.

Finally, we observe that most of the correct information that subjects relate to us is of a nonanalytic nature pertaining to shape, form, color, and material rather than to function or name. In consultation with Dr. Robert Ornstein of the Langley–Porter Neuropsychiatric Institute, San Francisco, CA, and with Dr. Ralph Kiernan of the Department of Neurology, Stanford University Medical Center, Stanford, CA, we have formed the tentative hypothesis that paranormal functioning may involve specialization characteristic of the brain's right hemisphere. This possibility is derived from a variety of evidence from clinical and neurosurgical sources which indicate that the two hemispheres of the human brain are specialized for different cognitive functions. The left hemisphere is predominantly active in verbal and other analytical functioning and the right hemisphere predominates in spatial and other holistic processing [59], [60]. Further research is necessary to elucidate the relationship between right hemisphere function and paranormal abilities. Nonetheless, we can say at this point that the remote-viewing results of the group of subjects at SRI have characteristics in common with more familiar performances that require right hemispheric function. The similarities include the highly schematicized drawings of objects in a room or of remote scenes. Verbal identification of these drawings is often highly inaccurate and the drawings themselves are frequently left–right reversed relative to the target configuration. Further, written material generally is not cognized. These characteristics have been seen in left brain-injured patients and in callosal-sectioned patients.

As a result of the above considerations, we have learned to urge our subjects simply to describe what they see as opposed to what they think they are looking at. We have learned that their unanalyzed perceptions are almost always a better guide to the true target than their interpretations of the perceived data.

IV. Considerations Concerning Time

If the authors may be forgiven a personal note, we wish to express that this section deals with observations that we have been reluctant to publish because of their striking apparent incompatibility with existing concepts. The motivating factor for presenting the data at this time is the ethical consideration that theorists endeavoring to develop models for paranormal functioning should be apprised of all the observable data if their efforts to arrive at a comprehensive and correct description are to be successful.

During the course of the experimentation in remote viewing (Section III), subjects occasionally volunteered the information that they had been thinking about their forthcoming participation in a remote-viewing experiment and had an image come to them as to what the target location was to be. On these occasions, the information was given only to the experimenter remaining at SRI with the subject and was unknown to the outbound experimenter until completion of the experiment. Two of these contributions were among the most accurate descriptions turned in during those experiments. Since the target location had not yet been selected when the subject communicated his perceptions about the target, we found the data difficult to contend with.

We offer these spontaneous occurrences not as proof of precognitive perception, but rather as the motivation that led us to do further work in this field. On the basis of this firsthand evidence, together with the copious literature describing years of precognition experiments carried out in various other laboratories, we decided to determine whether a subject could perform a perceptual task that required both spatial and temporal remote viewing.

It is well known and recently has been widely discussed that nothing in the fundamental laws of physics forbids the apparent transmission of information from the future to the present (discussed further in Section V). Furthermore, there is a general dictum that "in physical law, everything that is not forbidden, is required" [61]. With this in mind, we set out to conduct very well-controlled experiments to determine whether we could deliberately design and execute experiments for the sole purpose of observing precognition under laboratory conditions.

The experimental protocol was identical to that followed in previous remote-viewing experiments with but one exception. The exception was that the subject was required to describe the remote location during a 15-min period beginning 20 min before the target was selected and 35 min before the outbound experimenter was to arrive at the target location.

In detail, as shown in Table IX, each day at ten o'clock one of the experimenters would leave SRI with a stack of ten sealed envelopes from a larger pool and randomized daily, containing traveling instructions that had been prepared, but that were unknown to the two experimenters remaining with the subject. The subject for this experiment was Hella Hammid (S4) who participated in the nine-experiment series replicating the original Price work described earlier. The traveling experimenter was to drive continuously from 10:00 until 10:30 before selecting his destination with a random number generator. (The motivation for continuous motion was our observation that objects and persons in rapid motion are not generally seen in the remote-viewing mode of perception, and we wished the traveler to be a poor target until he reached his target site.) At the end of 30 min of driving, the traveling experimenter generated a random digit from 0 to 9 with a Texas Instruments SR-51 random number generator; while still in motion, he counted down that number of envelopes and proceeded directly to the target location so as to arrive there by 10:45. He remained at the target site until 11:00, at which time he returned to the laboratory, showed his chosen target name to a security guard, and entered the experimental room.

TABLE IX
Experimental Protocol: Precognitive Remote Viewing

Time Schedule	Experimenter/Subject Activity
10:00	Outbound experimenter leaves with 10 envelopes (containing target locations) and random number generator; begins half-hour drive
10:10	Experimenters remaining with subject in the laboratory elicit from subject a description of where outbound experimenter will be from 10:45-11:00
10:25	Subject response completed, at which time laboratory part of experiment is over
10:30	Outbound experimenter obtains random number from a random number generator, counts down to associated envelope, and proceeds to target location indicated
10:45	Outbound experimenter remains at target location for 15 minutes (10:45-11:00)

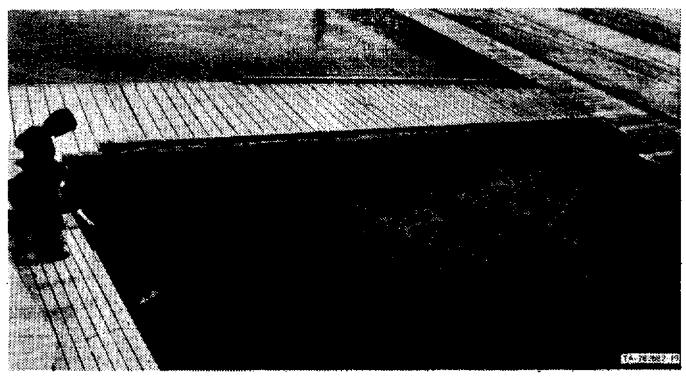


Fig. 14. Subject Hammid (S4) described "some kind of congealing tar, or maybe an area of condensed lava . . . that has oozed out to fill up some kind of boundaries."

During the same period, the protocol in the laboratory was as follows. At 10:10, the subject was asked to begin a description of the place to which the experimenter would go 35 min hence. The subject then generated a tape-recorded description and associated drawings from 10:10 to 10:25, at which time her part in the experiment was ended. Her description was thus entirely concluded 5 min before the beginning of the target selection procedure.

Four such experiments were carried out. Each of them appeared to be successful, an evaluation later verified in blind judging without error by three judges. We will briefly summarize the four experiments below.

The first target, the Palo Alto Yacht Harbor, consisted entirely of mud flats because of an extremely low tide (see Fig. 14). Appropriately, the entire transcript of the subject pertained to "some kind of congealing tar, or maybe an area of condensed lava. It looks like the whole area is covered with some kind of wrinkled elephant skin that has oozed out to fill up some kind of boundaries where (the outbound experimenter) is standing." Because of the lack of water, the dock where the remote experimenter was standing was in fact resting directly on the mud.

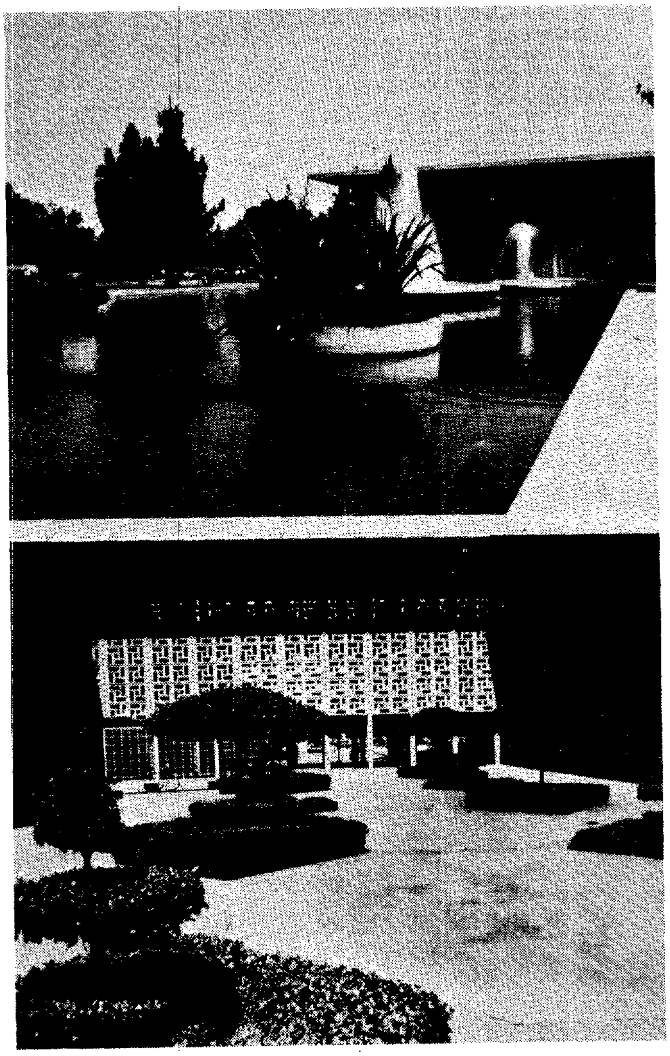


Fig. 15. Subject (S4) described a formal garden "very well manicured" behind a double colonnade.

Note that the subject has learned not to rush into interpretation as to the nature or purpose of the place. This is a result of our cautioning based on the observation that such efforts tend to be purely analytical and in our experience are almost invariably incorrect. If a subject can limit himself to what he sees, he is often then able to describe a scene with sufficient accuracy that an observer can perform the analysis for him and identify the place.

The second target visited was the fountain at one end of a large formal garden at Stanford University Hospital (Fig. 15). The subject gave a lengthy description of a formal garden behind a wall with a "double colonnade" and "very well manicured." When we later took the subject to the location, she was herself taken aback to find the double colonnaded wall leading into the garden just as described.

The third target was a children's swing at a small park 4.6 km from the laboratory (Fig. 16). The subject repeated again and again that the main focus of attention at the site was a "black iron triangle that the outbound experimenter had somehow walked into or was standing on." The triangle was "bigger than a man," and she heard a "squeak, squeak, about once a second," which we observe is a match to the black metal swing that did squeak.

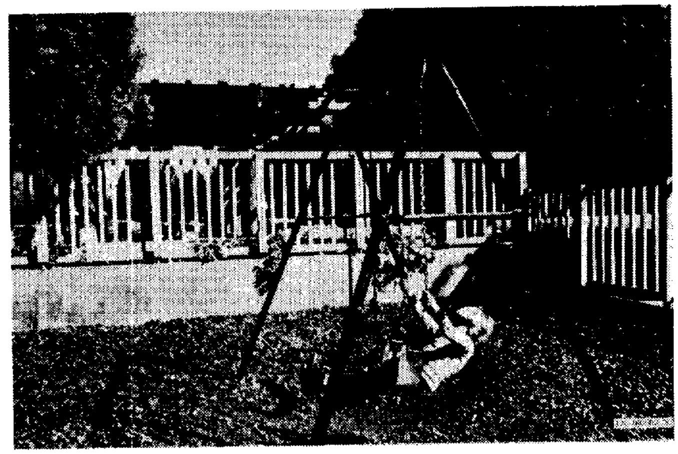


Fig. 16. Subject (S4) saw a "black iron triangle that Hal had somehow walked into" and heard a "squeak, squeak, about once a second."

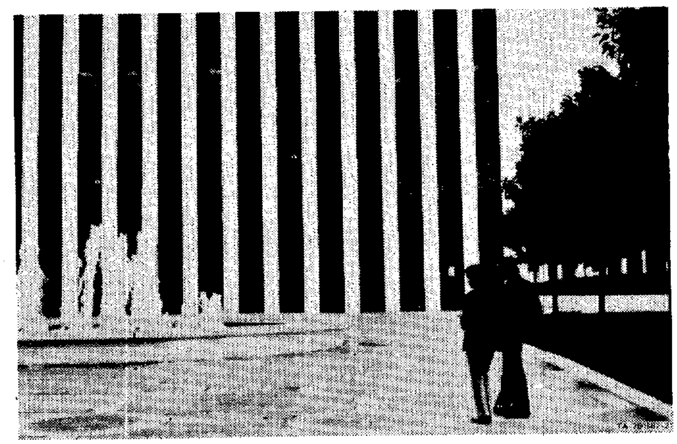


Fig. 17. Subject (S4) described a very tall structure located among city streets and covered with "Tiffany-like glass."

The final target was the Palo Alto City Hall (Fig. 17). The subject described a very, very tall structure covered with "Tiffany-like glass." She had it located among city streets and with little cubes at the base. The building is glass-covered, and the little cubes are a good match to the small elevator exit buildings located in the plaza in front of the building.

To obtain a numerical evaluation of the accuracy of the precognitive viewing, the experimental results were subjected to independent judging on a blind basis by three SRI scientists who were not otherwise associated with the experiment. The judges were asked to match the four locations, which they visited, against the unedited typed manuscripts of the tape-recorded narratives, along with the drawings generated by the remote viewer. The transcripts were presented unlabeled and in random order and were to be used without replacement. A correct match required that the transcript of a given experiment be matched with the target of that experiment. All three judges independently matched the target data to the response data without error. Under the null hypothesis (no information channel and a random selection of descriptions without replacement), each judge independently obtained a result significant at $p = (4!)^{-1} = 0.042$.

For reasons we do not as yet understand, the four transcripts generated in the precognition experiment show exceptional coherence and accuracy as evidenced by the fact that all of the judges were able to match successfully all of the transcripts to the corresponding target locations. A long-range experimental program devoted to the clarification of these issues and involving a number of subjects is under way. The above four experiments are the first four carried out under this program.

Currently, we have no precise model of this spatial and temporal remote-viewing phenomenon. However, models of the universe involving higher order synchronicity or correlation have been proposed by the physicist Pauli and the psychologist Carl Jung [62].

> ACAUSALITY. If natural law[5] were an absolute truth, then of course there could not possibly be any processes that deviate from it. But since causality[5] is a *statistical* truth, it holds good only on average and thus leaves room for *exceptions* which must somehow be experienceable, that is to say, *real*. I try to regard synchronistic events as acausal exceptions of this kind. They prove to be relatively independent of space and time; they relativize space and time insofar as space presents in principle no obstacle to their passage and the sequence of events in time is inverted so that it looks as if an event which has not yet occurred were causing a perception in the present.

We shall see in the next section that such a description, though poetic, has some basis in modern physical theory.

V. DISCUSSION

It is important to note at the outset that many contemporary physicists are of the view that the phenomena that we have been discussing are not at all inconsistent with the framework of physics as currently understood. In this emerging view, the often-held belief that observations of this type are incompatible with known laws *in principle* is erroneous, such a concept being based on the naive realism prevalent before the development of modern quantum theory and information theory.

One hypothesis, put forward by I. M. Kogan of the USSR, is that information transfer under conditions of sensory shielding is mediated by extremely low-frequency (ELF) electromagnetic waves in the 300–1000-km region [37]–[40]. Experimental support for the hypothesis is claimed on the basis of slower than inverse square attenuation, compatible with source-percipient distances lying in the induction field range as opposed to the radiation field range; observed low bit rates (0.005–0.1 bit/s) compatible with the information carrying capacity of ELF waves; apparent ineffectiveness of ordinary electromagnetic shielding as an attenuator; and standard antenna calculations entailing biologically generated currents yielding results compatible with observed signal-to-noise ratios.

M. Persinger, Psychophysiology Laboratory, Laurentian University, Toronto, Canada, has narrowed the ELF hypothesis to the suggestion that the 7.8-Hz "Shumann waves" and their harmonics propagating along the earth–ionosphere waveguide duct may be responsible. Such an hypothesis is compatible with driving by brain-wave currents and leads to certain other hypotheses such as asymmetry between east–west and west–east propagation, preferred experimental times (midnight–4 A.M.), and expected negative correlation between success and the U index (a measure of geomagnetic disturbance throughout the world). Persinger claims initial support for these factors on the basis of a literature search [63], [64].

On the negative side with regard to a straightforward ELF interpretation as a blanket hypothesis are the following: a) apparent real-time descriptions of remote activities in sufficient detail to require a channel capacity in all probability greater than that allowed by a conventional modulation of an ELF signal; b) lack of a proposed mechanism for coding and decoding the information onto the proposed ELF carrier; and c) apparent precognition data. The hypothesis must nonetheless remain open at this stage of research, since it is conceivable that counterindication a) may eventually be circumvented on the basis that the apparent high bit rate results from a mixture of low bit rate input and high bit rate "filling in the blanks" from imagination; counterindication b) is common to a number of normal perceptual tasks and may therefore simply reflect a lack of sophistication on our part with regard to perceptual functioning [65]; and counterindication c) may be accommodated by an ELF hypothesis if advanced waves as well as retarded waves are admitted [66], [67]. Experimentation to determine whether the ELF hypothesis is viable can be carried out by the use of ELF sources as targets, by the study of parametric dependence on propagational directions and diurnal timing, and by the exploration of interference effects caused by creation of a high-intensity ELF environment during experimentation, all of which are under consideration in our laboratory and elsewhere.

Some physicists believe that the reconciliation of observed paranormal functioning with modern theory may take place at a more fundamental level—namely, at the level of the foundations of quantum theory. There is a continuing dialog, for example, on the proper interpretation of the effect of an observer (consciousness) on experimental measurement [68], and there is considerable current interest in the implications for our notions of ordering in time and space brought on by the observation [69], [70] of nonlocal correlation or "quantum interconnectedness" (to use Bohm's term [71]) of distant parts of quantum systems of macroscopic dimensions. The latter, Bell's theorem [72], emphasizes that "no theory of reality compatible with quantum theory can require spatially separated events to be independent" [73], but must permit interconnectedness of distant events in a manner that is contrary to ordinary experience [74]–[75]. This prediction has been experimentally tested and confirmed in the recent experiments of, for example, Freedman and Clauser [69], [70].

E. H. Walker and O. Costa de Beauregard, independently proposing theories of paranormal functioning based on quantum concepts, argue that observer effects open the door to the possibility of nontrivial coupling between consciousness and the environment and that the nonlocality principle permits such coupling to transcend spatial and temporal barriers [76], [77].

Apparent "time reversibility"—that is, effects (e.g., observations) apparently preceding causes (e.g., events)—though conceptually difficult at first glance, may be the easiest of apparent paranormal phenomena to assimilate within the current theoretical structure of our world view. In addition to the familiar retarded potential solutions $f(t - r/c)$, it is well known that the equations of, for example, the electromagnetic field admit of advanced potential solutions $f(t + r/c)$—solutions that would appear to imply a reversal of cause and effect. Such solutions are conventionally discarded as not corresponding to any observable physical event. One is cautioned, however, by statements such as that of Stratton in his basic text on electromagnetic theory [78].

[5] As usually understood.

> The reader has doubtless noted that the choice of the function $f(t - r/c)$ is highly arbitrary, since the field equation admits also a solution $f(t + r/c)$. This function leads obviously to an advanced time, implying that the field can be observed before it has been generated by the source. The familiar chain of cause and effect is thus reversed and this alternative solution might be discarded as logically inconceivable. However, the application of "logical" causality principles offers very insecure footing in matters such as these and we shall do better to restrict the theory to retarded action solely on the grounds that this solution alone conforms to the present physical data.

Such caution is justified by the example in the early 1920's of Dirac's development of the mathematical description of the relativistic electron that also yielded a pair of solutions, one of which was discarded as inapplicable until the discovery of the positron in 1932.

In an analysis by O. Costa de Beauregard, an argument is put forward that advanced potentials constitute a convergence toward "finality" in a manner symmetrical to the divergence of retarded potentials as a result of causality [77]. Such phenomena are generally unobservable, however, on the gross macroscopic scale for statistical reasons. This is codified in the thermodynamic concept that for an isolated system entropy (disorder) on the average increases. It is just this requirement of isolation, however, that has been weakened by the observer problem in quantum theory, and O. Costa de Beauregard argues that the finality principle is maximally operative in just those situations where the intrusion of consciousness as an ordering phenomenon results in a significant local reversal of entropy increase. At this point, further discussion of the subtleties of such considerations, though apropos, would take us far afield, so we simply note that such advanced waves, if detected, could in certain cases constitute a carrier of information precognitive to the event.

The above arguments are not intended to indicate that the precise nature of the information channel coupling remote events and human perception is understood. Rather, we intend to show only that modern theory is not without resources that can be brought to bear on the problems at hand, and we expect that these problems will, with further work, continue to yield to analysis and specification.

Furthermore, independent of the mechanisms that may be involved in remote sensing, observation of the phenomenon implies the existence of an information channel in the information-theoretic sense. Since such channels are amenable to analysis on the basis of communication theory techniques, as indicated earlier, channel characteristics such as bit rate can be determined independent of a well-defined physical channel model in the sense that thermodynamic concepts can be applied to the analysis of systems independent of underlying mechanisms. Furthermore, as we have seen from the work of Ryzl discussed in Section II, it is possible to use such a channel for error-free transmission of information if redundancy coding is used. (See also Appendix A.) Therefore, experimentation involving the collection of data under specified conditions permits headway to be made despite the formidable work that needs to be done to clarify the underlying bases of the phenomena.

VI. Conclusion

For the past three years we have had a program in the Electronics and Bioengineering Laboratory of SRI to investigate those facets of human perception that appear to fall outside the range of well-understood perceptual or processing capabilities. The primary achievement of this program has been the elicitation of high-quality "remote viewing"—the ability of both experienced subjects and inexperienced volunteers to view, by means of innate mental processes, remote geographical or technical targets such as roads, buildings, and laboratory apparatus. Our accumulated data from over fifty experiments with more than a half-dozen subjects indicate the following. a) The phenomenon is not a sensitive function of distance over a range of several kilometers. b) Faraday cage shielding does not appear to degrade the quality or accuracy of perception. c) Most of the correct information that subjects relate is of a nonanalytic nature pertaining to shape, form, color, and material rather than to function or name. (This aspect suggests a hypothesis that information transmission under conditions of sensory shielding may be mediated primarily by the brain's right hemisphere.) d) The principal difference between experienced subjects and inexperienced volunteers is *not* that the latter never exhibit the faculty, but rather that their results are simply less reliable. (This observation suggests the hypothesis that remote viewing may be a latent and widely distributed, though repressed, perceptual ability.)

Although the precise nature of the information channel coupling remote events and human perception is not yet understood, certain concepts in information theory, quantum theory, and neurophysiological research appear to bear directly on the issue. As a result, the working assumption among researchers in the field is that the phenomenon of interest is consistent with modern scientific thought, and can therefore be expected to yield to the scientific method. Further, it is recognized that communication theory provides powerful techniques, such as the use of redundancy coding to improve signal-to-noise ratio, which can be employed to pursue special-purpose application of the remote-sensing channel independent of an understanding of the underlying mechanisms. We therefore consider it important to continue data collection and to encourage others to do likewise; investigations such as those reported here need replication and extension under as wide a variety of rigorously controlled conditions as possible.

Appendix A

Signal Enhancement in a Paranormal Communication Channel by Application of Redundancy Coding

Independent of the mechanisms that may be involved in remote sensing, observation of the phenomenon implies the existence of an information channel in the information-theoretic sense. As we have seen from the work of Ryzl discussed in Section II,[6] it is even possible to use such a (noisy) channel for error-free transmission of information if sufficient redundancy coding is used [30], [31]. Following is a general procedure that we have used successfully for signal enhancement.

We shall assume that the "message" consists of a stream of binary digits (0,1) of equal probability (e.g., binary sort of green/white cards as in Ryzl's case, English text encoded as in Table X and sent long distance by strobe light on/off, and so on). To combat channel noise, each binary digit to be sent through the channel requires the addition of redundancy bits (coding). Efficient coding requires a compromise between the desire to maximize reliability and the desire to minimize re-

[6] See also the note added in proof on the successful work done by Carpenter.

TABLE X
5-BIT CODE FOR ALPHANUMERIC CHARACTERS

E	00000	Y	01000
T	11111	G,J	10111
N	00001	W	01001
R	11110	V	10110
I	00010	B	01010
O	11101	∅	10101
A	00011	1	01011
S,X,Z	11100	2	10100
D	00100	3	01100
H	11011	4	10011
L	00101	5	01101
C,K,Q	11010	6	10010
F	00110	7	01110
P	11001	8	10001
U	00111	9	01111
M	11000	.	10000

Note: Alphabet characters listed in order of decreasing frequency in English text. See, for example, A. Sinkov [79]. (The low-frequency letters, *X*, *Z*, *K*, *Q*, and *J*, have been grouped with similar characters to provide space for numerics in a 5-bit code.) In consideration of the uneven distribution of letter frequencies in English text, this code is chosen such that 0 and 1 have equal probability.

dundancy. One efficient coding scheme for such a channel is obtained by application of a sequential sampling procedure of the type used in production-line quality control [80]. The adaptation of such a procedure to paranormal communication channels, which we now discuss, was considered first by Taetzsch [81]. The sequential method gives a rule of procedure for making one of three possible decisions following the receipt of each bit: accept 1 as the bit being transmitted; reject 1 as the bit being transmitted (i.e., accept 0); or continue transmission of the bit under consideration. The sequential sampling procedure differs from fixed-length coding in that the number of bits required to reach a final decision on a message bit is not fixed before transmission, but depends on the results accumulated with each transmission. The principal advantage of the sequential sampling procedure as compared with the other methods is that, on the average, fewer bits per final decision are required for an equivalent degree of reliability.

Use of the sequential sampling procedure requires the specification of parameters that are determined on the basis of the following considerations. Assume that a message bit (0 or 1) is being transmitted. In the absence of *a priori* knowledge, we may assume equal probability ($p = 0.5$) for the two possibilities (0,1). Therefore, from the standpoint of the receiver, the probability of correctly identifying the bit being transmitted is $p = 0.5$ because of chance alone. An operative remote-sensing channel could then be expected to alter the probability of correct identification to a value $p = 0.5 + \psi$, where the parameter ψ satisfies $0 < |\psi| < 0.5$. (The quantity may be positive or negative depending on whether the paranormal channel results in so-called psi-hitting or psi-missing.) Good psi functioning on a repetitive task has been observed to result in $\psi = 0.12$, as reported by Ryzl [31]. Therefore, to indicate the design procedure, let us assume a baseline psi parameter $\psi_b = 0.1$ and design a communication system on this basis.

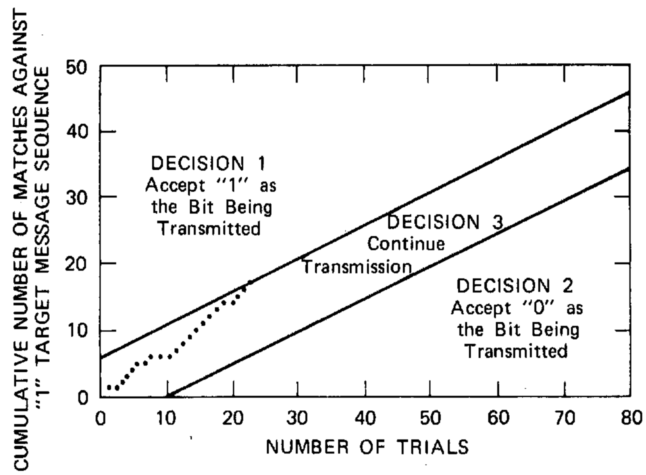


Fig. 18. Enhancement of signal-to-noise ratio by sequential sampling procedure ($p_0 = 0.4, p_1 = 0.6, \alpha = 0.01, \beta = 0.01$).

The question to be addressed is whether, after repeated transmission, a given message bit is labeled a "1" at a low rate p_0 commensurate with the hypothesis H_0 that the bit in question is a "0," or at a higher rate p_1 commensurate with the hypothesis H_1 that the bit in question is indeed a "1." The decision-making process requires the specification of four parameters.

- p_0 The probability of labeling incorrectly a "0" message bit as a "1." The probability of labeling correctly a "0" as a "0" is $p = 0.5 + \psi_b = 0.6$. Therefore, the probability of labeling incorrectly a "0" as a "1" is $1 - p = 0.4 = p_0$.
- p_1 The probability of labeling correctly a "1" message bit as a "1," is given by $p_1 = 0.5 + \psi_b = 0.6$.
- α The probability of rejecting a correct identification for a "0" (Type I error). We shall take $\alpha = 0.01$.
- β The probability of accepting an incorrect identification for a "1" (Type II error). We shall take $\beta = 0.01$.

With the parameters thus specified, the sequential sampling procedure provides for construction of a decision graph as shown in Fig. 18. The equations for the upper and lower limit lines are

$$\sum\nolimits_1 = d_1 + SN$$

$$\sum\nolimits_0 = -d_0 + SN$$

where

$$d_1 = \frac{\log \frac{1-\beta}{\alpha}}{\log \frac{p_1}{p_0} \frac{1-p_0}{1-p_1}} \qquad d_0 = \frac{\log \frac{1-\alpha}{\beta}}{\log \frac{p_1}{p_0} \frac{1-p_0}{1-p_1}}$$

$$S = \frac{\log \frac{1-p_0}{1-p_1}}{\log \frac{p_1}{p_0} \frac{1-p_0}{1-p_1}}$$

in which S is the slope, N is the number of trials, and d_1 and d_0 are the y-axis intercepts. A cumulative record of receiver-generated responses to the target bit is compiled until either

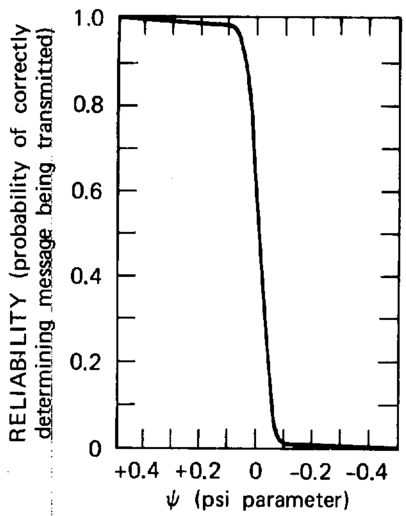


Fig. 19. Reliability curve for sequential sampling procedure ($p_0 = 0.4$, $p_1 = 0.6$, $\alpha = 0.01$, $\beta = 0.01$).

the upper or the lower limit line is reached, at which point a decision is made to accept 0 or 1 as the bit being transmitted.

Channel reliability (probability of correctly determining message being transmitted) as a function of operative psi parameter ψ is plotted in Fig. 19. As observed, the sequential sampling procedure can result in 90 percent or greater reliability with psi parameters on the order of a few percent.

Implementation of the sequential sampling procedure requires the transmission of a message coded in binary digits. Therefore, the target space must consist of dichotomous elements such as the white and green cards used in the experiments by Ryzl.

In operation, a sequence corresponding to the target bit (0 or 1) is sent and the cumulative entries are made (Fig. 18) until a decision is reached to accept either a 1 or a 0 as the bit being transmitted. At a prearranged time, the next sequence is begun and continues as above until the entire message has been received. A useful alternative, which relieves the percipient of the burden of being aware of his self-contradiction from trial to trial, consists of cycling through the entire message repetitively and entering each response on its associated graph until a decision has been reached on all message bits. The authors have used this technique successfully in a pilot study, but a discussion of this would take us beyond the intended scope of this paper.

From the results obtained in such experiments, the channel bit rate can be ascertained for the system configuration under consideration. Furthermore, bit rates for other degrees of reliability (i.e., for other p_0, p_1, α, and β) can be estimated by construction of other decision curves over the same data base and thus provide a measure of the bit rate per degree of reliability.

In summary, the procedures described here can provide for a specification of the characteristics of a remote-sensing channel under well-defined conditions. These procedures also provide for a determination of the feasibility of such a channel for particular applications.

Appendix B

Remote-Viewing Transcript

Following is the unedited transcript of the *first* experiment with an SRI volunteer (S6), a mathematician in the computer science laboratory, with no previous experience in remote viewing. The target, determined by random procedure, was White's Plaza, a plaza with fountain at Stanford University (shown in Fig. 8). As is our standard protocol, the experimenter with the subject is kept ignorant of the specific target visited as well as the contents of the target pool. The experimenter's statements and questions are italics.

Today is Monday, October 7th. It is 11:00 and this is a remote viewing experiment with Russ Targ, Phyllis Cole, and Hal Puthoff. In this experiment Hal will drive to a remote site chosen by a random process. Phyllis Cole will be the remote viewer, and Russ Targ is the monitor. We expect this experiment to start at twenty minutes after eleven and run for fifteen minutes.

It is just about twenty minutes after eleven and Hal should be at his target location by now.

Why don't you tell me what kind of pictures you see and what you think he might be doing or experiencing.

The first thing that came to mind was some sort of a large, square kind of a shape. Like Hal was in front of it. It was a . . . not a building or something, it was a square. I don't know if it was a window, but something like that so that the bottom line of it was not at the ground. About where his waist was, at least. That's what it seemed to me. It seems outdoors somehow. Tree.

Does Hal seem to be looking at that square?

I don't know. The first impression was that he wasn't, but I have a sense that whatever it was was something one might look at. I don't know if it would be a sign, but something that one might look at.

Can you tell if it is on the ground or vertical?

It seemed vertical.

I don't have a sense that it was part of anything particular. It might be on a building or part of a building, but I don't know. There was a tree outside, but I also got the impression of cement. I don't have the impression of very many people or traffic either. I have the sense that he is sort of walking back and forth. I don't have any more explicit picture than that.

Can you move into where he is standing and try to see what he is looking at?

I picked up he was touching something—something rough. Maybe warm and rough. Something possibly like cement.

It is twenty-four minutes after eleven.

Can you change your point of view and move above the scene so you can get a bigger picture of what's there?

I still see some trees and some sort of pavement or something like that. Might be a courtyard. The thing that came to mind was it might be one of the plazas at Stanford campus or something like that, cement.

Some kinds of landscaping.

I said Stanford campus when I started to see some things in White Plaza, but I think that is misleading.

I have the sense that he's not moving around too much. That it's in a small area.

I guess I'll go ahead and say it, but I'm afraid I'm just putting on my impressions from Stanford campus. I had the impression of a fountain. There are two in the plaza, and it seemed that Hal was possibly near the, what they call Mem Claw.

What is that?

It's a fountain that looks rather like a claw. It's a black sculpture. And it has benches around it made of cement.

Are there any buildings at the place you are looking at? Are there any buildings? You described a kind of a courtyard.

Usually at some places there should be a building, large or small that the courtyard is about. Look at the end or the sides of the courtyard. Is there anything to be seen?

I have a sense that there are buildings. It's not solid buildings. I mean there are some around the periphery and I have a sense that none of them are very tall. Maybe mostly one story, maybe an occasional two story one.

Do you have any better idea of what your square was that you saw at the outset?

No. I could hazard different kinds of guesses.

Does it seem part of this scene?

It . . . I think it could be. It could almost be a bulletin board or something with notices on it maybe.

Or something that people are expected to look at. Maybe a window with things in it that people were expected to look at.

What kind of trees do you see in this place?

I don't know what kind they are. The impression was that they were shade trees and not terribly big. Maybe 12 feet of trunk and then a certain amount of branches above that. So that the branches have maybe a 12 foot diameter, or something. Not real big trees.

New trees rather than old trees?

Yeah, maybe 5 or 10 years old, but not real old ones.

Is there anything interesting about the pavement?

No. It seems to be not terribly new or terribly old. Not very interesting. There seems to be some bits of landscaping around. Little patches of grass around the edges and peripheries. Maybe some flowers. But, not lush.

You saw some benches. Do you want to tell me about them?

Well, that's my unsure feeling about this fountain. There was some kind of benches of cement. Curved benches, it felt like.

They were of rough cement.

What do you think Hal is doing while he is there?

I have a sense that he is looking at things trying to project them. Looking at different things and sort of walking back and forth not covering a whole lot of territory.

Sometimes standing still while he looks around.

I just had the impression of him talking, and I almost sense that it was being recorded or something. I don't know if he has a tape recorder, but if it's not that, then he is saying something because it needed to be remembered. *It's 11:33. He's just probably getting ready to come back.*

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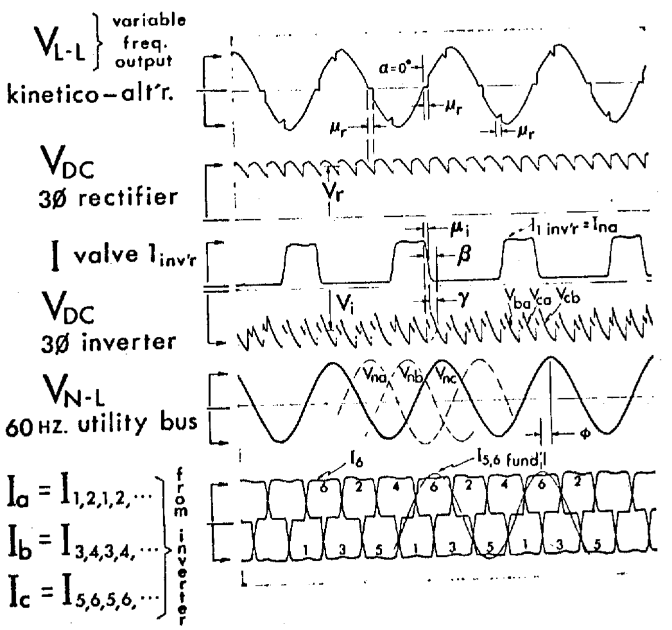

Fig. 2. Waveforms of voltages and currents along the asynchronous link. Case I: Kinetico-alternator speed ≈ 1.0 pu. $V, I, P, \approx 1.0$ pu.

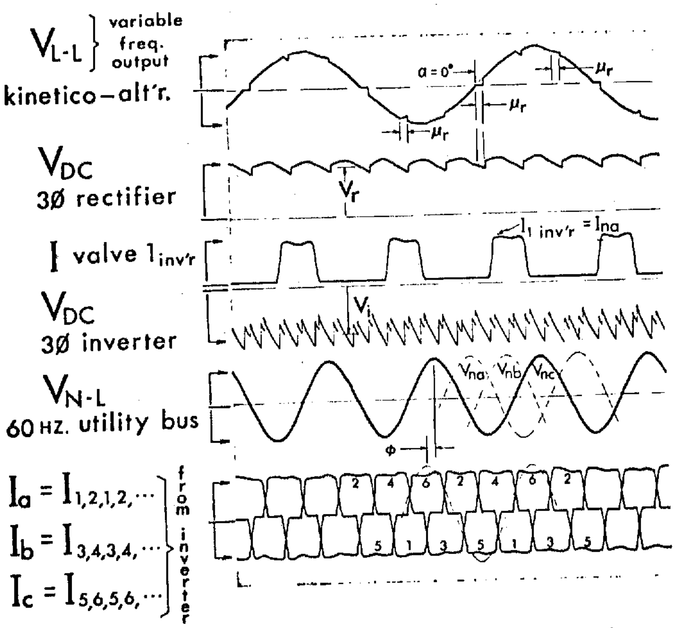

Fig. 3. Waveforms of voltages and currents along the asynchronous link. Case II: Kinetic-alternator speed ≈ 0.44 pu. $V, I, P, \approx 1.0$ pu.

rated charge—the frequency converter thereby supplying losses.) b) At full charge and superwheel rated speed, CB3 can be closed, with CB1 and CB2 open. At this point the controlled firing-angle β (with constant-extinction-angle, CEA, override) of the inverter valves is automatically adjusted to "float" the rectifier-inverter combination by equating the average dc output V_r of the rectifier with the average counter dc, V_i of the inverter. This free-wheeling is maintained until power is desired from the superwheel, whereupon β is increased lowering $V_i < V_r$ to yield the desired $P_{3\phi}$ into the utility as depicted on Figs. 2, 3, and 4. After drawdown the charge-up sequence is repeated during an off-peak time period.

Thus this ac/dc/ac transmission link obviates the "usual" frequency droop and provides smooth energy flow from the kinetic storage to the fixed-frequency utility grid with little limitation on the variable-speed drive.[1] As such this link can be considered one general approach to many problems of variable-speed input to some form of fixed output

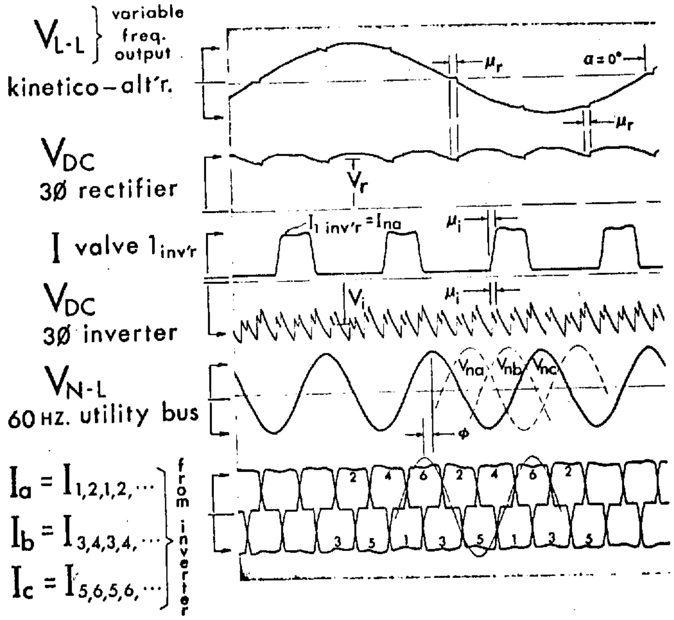

Fig. 4. Waveforms of voltages and currents along the asynchronous link. Case III: Kinetico-alternator speed ≈ 0.28 pu. $V, I, P, \approx 1.0$ pu.

and has related application in areas such as wind-energy conversion systems, dynamic stabilization of system power-transients, recovery of slip-frequency power from the rotor of induction machines operating sub- or suprasynchronously, and others.

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A Confirmatory Remote Viewing Experiment in a Group Setting

ARTHUR C. HASTINGS AND DAVID B. HURT

Abstract—A remote viewing experiment was conducted with a group of 36 persons who successfully identified, without apparent sensory communication, a target location chosen randomly and visited by two observers ($p = 6 \times 10^{-7}$). Success is partly attributed to procedures designed to facilitate remote viewing abilities: asking participants to give themselves permission to have the ability, forming the group into two-person teams of viewer and coach, discussing resistances, and giving instructions on generating mental imagery and impressions.

In response to the call for studies relating to the paper by Puthoff and Targ[1] on information transfer via "remote viewing" and other modes, we wish to report an experiment with a large number of participants in a group setting.

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The authors are with the Parapsychology Research Group, Inc., Stanford, CA 94305.

[1] H. E. Puthoff and R. Targ, "A perceptual channel for information transfer over kilometer distances: Historical perspective and recent research," *Proc. IEEE*, vol. 64, pp. 329–354, Mar. 1974.

[1] Extensive grateful credit must be given to Doctoral Candidate Bernard T. Merritt for his irreplaceable aid in setting up the equipment and instrumentation of this project.

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The authors followed the protocol, with some modifications, established by Puthoff and Targ in their SRI remote viewing experiments. Prior to the meeting of the group, and unknown to them, we selected six target sites, wrote their names on cards, and sealed them in envelopes. These were randomly numbered, so no one, including us, knew the number of any target location.

The group consisted of 36 people, men and women, mostly professional, who met with the understanding that an experiment in ESP would be conducted. At the time of the experiment (8:30 PM, March 16), and in the presence of the group, one envelope was randomly selected by throwing a die. D. H. and a companion who was selected from the group then left with the sealed envelope. They opened the envelope in D. H.'s car and drove to the target site, timing their travel to arrive exactly ten minutes after their departure. At the site they observed and interacted with the location for ten minutes, then returned to the group meeting place.

During the time the remote team was at the target, the members of the group attempted to generate information about the target site, making notes and or drawings of their impressions. At the end of this ten minute period, but before the return of the remote team and still ignorant of the target location, the participants were allowed to complete their notes. Then A. H., who had directed the group procedure, named the six locations in the target pool and described them briefly. (A. H. knew the target sites in the pool, but not which one was randomly chosen.) The participants were asked to infer what the target was, based on the information they had generated during the target period.

Of the 36 participants, 20 "voted" for one site, a playground area with a log structure in a nearby park. The remote team returned a short while after the vote was taken, handed over their envelope, and reported that the playground area was indeed the target location.

Statistically, chance expectation (a null distribution) would allot six votes out of 36 to each of the six locations in the target pool. A t-test (one tailed) for the 20 votes actually given to the correct target gives a Z score of 5.22, with a probability of less than 6×10^{-7}.

We do not wish to be blasé; frankly, we were astonished by the high level of success of the participants.

The target was a circular play area, filled with sand, and containing a log structure with chains hanging from it and a slide on one side. The remote team climbed up the structure, stood on the platform, slid down, and took off their shoes in the sand. There were swings next to the play area, and a jungle gym alongside the sidewalk.

Perceptions of the participants in the group included mental pictures of swings, trees, park lights, sand, and the log structure (seen as logs, vertical columns, a balcony, etc.). Two participants reported images of the remote team taking off their shoes. One participant drew a circle and wrote "playground" in it; D. H.'s companion reported that at the location she had drawn a circle in the sand and had written "playground" in it. One participant reported the correct name of the park. Other descriptions included items outside the immediate area but which the travelers had observed: the jungle gym, swings, lighted windows of houses surrounding the park, a soft drink can on the ground.

The other five target locations were a children's play tunnel into which the remote team was to crawl, an orchard of flowering trees, a busy bar and restaurant, an ice cream parlor, and a post office building. In studying the SRI remote viewing results we concluded that the target locations should vary widely along certain dimensions, particularly indoor/outdoor locations and dominant mood, and the sites in the pool were chosen to be three indoor and three outdoor locations, with each location distinct in mood from the others.

We think that the effectiveness of the experiment was partly due to the way we conducted it. We began by commenting that success in remote viewing seems to be helped by three conditions: 1) Accepting that remote viewing is possible and agreeing that you can do it; 2) Turning your attention away from external perceptions and to inner pictures, experiences, and thoughts; and 3) Receiving feedback as soon as possible.

Regarding the first condition, we stated that remote viewing appeared to be a latent ability that could be developed, and that everyone who agreed to do remote viewing under the SRI conditions had succeeded. We asked everyone in the group to give themselves permission to have "ESP" or remote viewing ability. We then held a brief group discussion on reluctance and resistance to this ability, hoping in this way to relieve emotional blocks or intellectual rejection. For those who had hesitations, we suggested that they give themselves permission for the limited time and place of this experiment.

Regarding the allocation of attention, we used quiet periods in which the participants sat with their eyes closed in silence, and became aware of inner images and thoughts. We had a practice period of one–two minutes before the experiment to facilitate this mode of attention.

To generate information about the remote target, we advised the participants to clear their minds and "request" information about the location, then to observe what information came. We commented that they might expect it to be in the form of pictures, images, moods, and other perceptions. They were instructed not to be judgmental, i.e., not to edit, reject, or ignore impressions, but to remember and report as much as they could, even if fragmentary or apparently nonsensical. They were not to interpret what they perceived. We hoped these instructions would facilitate an openness to internal impressions that would enable the remote viewing information to emerge above the noise level of the usual thinking, judging, and interpreting.

For the actual remote viewing procedure we asked participants to form into pairs, with one person acting as percipient (viewer) and the other acting as a coach. During the first five minutes of the target period both remained silent, eyes closed. Then the percipient, still with eyes closed, reported his or her information to the coach, who wrote down all the description. Near the end of the ten minute target period the coach could ask general questions, such as, "Is the location indoors or outdoors? Are there other people present?"

Coaches were primarily intended to support and assist the viewer, but they could also try remote description themselves if they wished. Our earlier statistics were based on total votes for target sites, combining viewers and coaches. We did not record the two groups separately, though apparently most coaches' votes agreed with their partner. If we assumed that only viewers voted, and cast 10 out of 18 votes for the correct target, the Z score would be reduced to 4.43, giving a probability score of 6×10^{-5}.

With the large number of persons, it was necessary to go through the schedule as a group, rather than having individuals set their own pace. It was important to have one person to conduct the experiment, announce quiet periods, times of viewing, and keep the proceedings relaxed within the protocol.

Feedback was provided on the return of the remote team, who described where they were, details of the location, and their activities. The group asked them questions to check their remote viewing descriptions, and many participants later went to the target site to view it directly. The remote team made written notes and drawings of what they did, and in the future we would suggest tape recording and Polaroid photographs to add to the immediate feedback given to the viewers.

We would also note some improvements that could be made in our procedure. In the results we relied on the viewer's own judgment to identify the correct target; it would be better to have the remote viewing descriptions also judged by outside referees. The target pool should be made up by someone not at the experiment. And we would want to clarify whether the coaches should vote on the basis of their viewer's information or with consideration for information they themselves have generated.

In conclusion the results of this test indicate that remote viewing did occur under controlled conditions in a group setting. We believe this justifies further exploration of this mode of information transfer.

Comments on "A Perceptual Channel for Information Transfer over Kilometer Distances: Historical Perspective and Recent Research"

Comments[1] by R. A. McConnell[2]

The contribution of Puthoff and Targ in their paper[3] seems to me to be two-fold.

For a long time the enigma of extrasensory perception has been needing the pressure of fresh minds with broad backgrounds. In bringing to bear the viewpoint of engineering science, these authors have emphasized informational, quantum mechanical, and thermodynamic aspects of the research that have been largely ignored by most of those who call themselves parapsychologists.

[1] Manuscript received May 6, 1976.
[2] R. A. McConnell is with the Life Sciences Department, University of Pittsburgh, Pittsburgh, PA 15260.
[3] H. E. Puthoff and R. Targ, *Proc. IEEE*, vol. 64, pp. 329-354, Mar. 1976.

Secondly, they have developed a new and promising procedure called "remote viewing," which may bring us closer to the ideal of an experiment "repeatable by prescription."

In a paper reporting a particular set of experiments the authors could not hope to convey the full scope of the existing literature. Their references, although well chosen for their purpose, do not provide a busy, sceptical engineer with many toeholds into the critical literature. Some of their experimental references are primarily of historical interest because there is no satisfying way to assess credibility from a distance in time. They cite several modern papers of good quality, but the reader has no way of spotting these from among others that are important for conceptual exposition but fail to meet the highest standards of evidentiality.

In connection with a course that I teach to natural science university students, I have prepared an annotated "evidential bibliography of parapsychology" and a companion "sociological bibliography" (dealing with the taboo against parapsychology). I shall be glad to send a copy[4] of each to any reader who wonders how best to try to resolve feelings of uncertainty engendered by the findings of the Puthoff and Targ paper.

Comments[5] *by William A. Harris*[6]

You have opened Pandora's box by publishing the paper by Puthoff and Targ,[1] and I assume you will have to publish a considerable number of discussions as a consequence. I personally would like to comment on two examples used in the above paper.

1) Subject Hella Hammid (S4) had initially demonstrated apparent noncognitive communication (pp. 334 and 336). A possible scenario: S4 unconsciously identifies one of the envelopes at approximately 10:00 and causes the target experimenter to override the TI-55 and select the chosen card. No misdirection is implied. S4 directs the future instead of predicting it.

2) S4 described a part of a drill press not visible to the experimenter (p. 346) lending credence to the possibility that she could have "seen" the contents of a sealed envelope. Invocation of "advanced potentials" as an explanation is subject to the criticism of too-close identification of a model with reality (see Slepian's paper "On Bandwidth," in the same issue).

Comments[7] *by C. A. Musès*[8]

In connection with the article on parapsychology by Puthoff and Targ,[1] there is a historical anecdote, furnishing some relevant lessons on electronics vis-à-vis the mooted subject of "psi."

When Puthoff visited my math lab and stayed overnight at my home some four years ago, I pointed out to him among other things that while retarded electromagnetic field potentials furnished the Lorentz transformations, the mathematically equally admissible advanced potentials were being neglected, and I gave him the Julius Stratton reference which he cited in your issue mentioned above.

However, Puthoff rushed into print too soon, forgetting that I had also told him that whatever use they were, advanced potentials could have *no* bearing whatsoever on precognition. Yet that they do was the main and really only electronic point of his and Targ's article (pp. 349–350).

The reason they do not is very simple. If one studies Maxwellian potential theory one soon learns that the time-advance in the case of advanced potentials amounts to r/c, where r is the distance between event and observer. The maximum distance between any two points on earth is one circumference of the planet or about 25 000 miles. Even with this distance the time advance of any "precognition" on this basis could be at best less than 0.0001 second!

Since any precognition worthy of the name must antedate the event precognized by at least 15 minutes, it is clear that advanced potential theory's ability to explain precognition fails by a factor of about a million.

We can only conclude that either Puthoff and Targ have not read their Maxwell lately, or else that they had so much desire to explain precognition in print that they sort of forgot their physics in their enthusiasm.

As to the telepathy (remote viewing) experiments, similar procedures, with even better results in graphic form, were performed and published by the French engineer René Warcollier in the 1920's and 1930's. Warcollier, who anticipated the Puthoff–Targ findings by decades, is unfortunately omitted by them from their long list of "references."

On all counts, then, this letter of rectification is due your readers, with a kudo to that one engineer of yours who cannily distrusted that particular piece.

Comments[9] *by Sid Deutsch*[10]

Publication of the paper on extrasensory perception by Puthoff and Targ[1] shows that, in addition to a shortage of electrical power, we are now suffering from a shortage of editorial restraint (scanning the issue, p. 291). This diversion into parapsychology was tolerable in a day when energy and paper were plentiful, but today man lives more and more by bread alone. It is immoral to devote 24 percent of the technical content of the March 1976 PROCEEDINGS to the dignification of ESP when, ironically, the March 1976 *Spectrum*[11] bemoans the shaky financial state of the IEEE and is softening us up for an increase in dues.

Martin Gardner recently exposed the weaknesses in the Puthoff–Targ ESP research.[12] He showed that the small amount of statistical "evidence" for ESP can be accounted for by bias on the part of the human experimenters. When one substitutes computer score-keeping for the human brain, the statistical evidence vanishes. But one cannot disprove the existence of ESP, and most people (including engineers and scientists) have an emotional need for this sort of thing. We can confidently expect, therefore, that ESP research will be one of our permanent acquisitions.

One can understand how the NASA personnel could approve $80 000 of public funds for an ESP project.[12] At the very least it paid for some equipment that Stanford Research Institute could eventually employ in the public interest. One can only regret that the creativity of some obviously intelligent and skilled engineers and scientists was not directed into more socially useful channels.

There are several scientific arguments against ESP. First, with our present-day sophisticated equipment, we cannot detect any forces beyond the four fundamental forces of physics—gravitational, electromagnetic, the "weak" force, and the "strong" force. Second, we understand quite well the gross operation of an individual neuron, and no one seriously proposes that there is anything here but electrochemical phenomena. Briefly and approximately, a neuron fires, or generates a narrow 100-mV pulse, when the algebraic summation of incoming stimuli or their equivalents exceeds 20 mV. The firing rate generally has a strong noise-like component, but this can be traced to thermal noise (around 60 μV for a myelinated fiber), to the fact that there are many inputs (sometimes as many as 100 000), and not to extrasensory ectoplasm.

The human brain contains some 100-billion neurons. With 100-billion neurons one can do research in ESP, and even write irate letters to the Editor. But the logical conclusion is that the future state of the human brain (and of everything else, for that matter) is predetermined by the present state of the universe. The behavior of the brain is stereotyped in the sense that two or more identical brains, given identical initial conditions, would yield identical outputs at $t = 0+$. In other word, "free will" is an illusion.

From another viewpoint, the computer of today was encoded in the genetic potential of the DNA molecule of its designers 40 years ago. The DNA molecule is synthesized out of only four nucleotide bases (abbreviated *A*, *C*, *G*, and *T*) each of which is a relatively simple assemblage of atoms. Except for identical twins, each of us is the developmental result of a chemically unique DNA molecule. The information content of the DNA molecule—10-million bits based on subsequent protein structures[13]—must be equal to or greater than that needed to "construct" the newborn infant. At what point, as the child develops,

[4] His offer may be accepted by a postcard to him at the above address.

[5] Manuscript received March 25, 1976.

[6] W. A. Harris is a retired engineer formerly with the RCA Corporation.

[7] Manuscript received April 6, 1976.

[8] C. A. Musès is with the Research Centre for Mathematics and Morphology, Santa Barbara, CA 93108.

[9] Manuscript received May 4, 1976.

[10] S. Deutsch is with the Rutgers Medical School and Rutgers University, Piscataway, NJ 08854.

[11] E. Rubinstein, "IEEE: another AMA?" *IEEE Spectrum*, vol. 13, pp. 64–69, Mar. 1976. Also, same issue, E. Rubinstein, "Pres. Dillard on the budget," pp. 70–73.

[12] M. Gardner, "Mathematical games," *Scientific American*, vol. 233, pp. 114–118, Oct 1975. Also, "Letters," *Scientific American*, vol. 234, pp. 6–8, Jan. 1976.

[13] S. Deutsch, *Models of the Nervous System*. New York: Wiley, 1967, p. 57.

do "free will" and ESP enter the picture? And why, if all men are created approximately equal, are some of them blessed with ESP while others are doomed to a more mundane existence?

It is difficult to contemplate a beautiful mathematical result, or the intricacies of a computer, and believe that it is all the predetermined outcome of ensembles of 100-billion neurons that are interacting with each other and with the environment. As a consequence, the IEEE has more than its share of egocentrics. To most of us the world is still flat, we reside at the center of an admiring universe, and the brain is greater than the sum of its 100-billion parts. The great Laplace, on the other hand, more humble than most of us, preached determinism.

Today, when we know so much more, quantum mechanics and the uncertainty principle are routinely invoked to prove that free will does, indeed, exist. The latter assertion is based on a distortion of the uncertainty principle. The principle does *not* state that the small-scale movements of an individual electron do not obey, say, $F = ma$; it only implies that the human experimenter, regardless of how sophisticated his measurements and apparatus become, cannot determine precisely the state of the electron. In any event, quantum mechanics is of negligible significance at the millivolt levels at which a neuron operates.

The writing of this letter, and the decision as to whether or not it will be published, are all predetermined. If it *is* published, it will be fascinating to read the predetermined comments of readers who are convinced, without the slightest uncertainty, that they are writing letters out of their own free will. My point is that whatever they write, once it is published, *had* to be published that way.

Comments[14] *by James L. Calkins*[15]

Puthoff and Targ have undertaken a series of potentially significant studies[1] utilizing what *appears* to be appropriate techniques taken from the scientist's arsenal of objective methodologies, many of which the authors have previously distinguished themselves using in research in the natural sciences. It is certainly an understatement to say that such a controversial topic as ESP requires extraordinarily precise and careful methods, especially well suited to exclude the basis for all those nagging criticisms often irreverently hurled at the parapsychologist—fraud, inadaquate controls, imprecise and imcomplete reporting of essentials and details in their studies, improper statistics, and, especially, the presence of numerous confounding variables. Indeed, the authors themselves apparently set out to achieve this goal, what they refer to as their "principle responsibility—to resolve under unambiguous conditions the basic issue of whether or not this class of paranormal perception phenomenon exists" (pp. 334-335). Unfortunately, the model for their study follows the traditional stratagems of the parapsychologists in the United States and Europe, rather than the method they no doubt otherwise use in their non-behavioral research (and I might add that is largely followed in experimental psychology). As we shall indicate, the consequence of this is that they must necessarily fall far short in fulfilling their stated "principle responsibility."

It is the essence of the *experimental* method—in contrast to naturalistic observation, the survey technique, correlational procedures, field studies, and so on, to in fact *create* the conditions necessary for "unambiguous" resolution of fundamental questions since *only* this method permits manipulation and control of potentially confounding variables by the eminently sensible method of *varying* the critical factors under study, and systematically observing their effects upon other selected and measurable variables while holding potentially confounding variables under tight control via such techniques as randomization, constancy, counterbalancing, matching, etc. The manipulated variables are called independent variables (IV's), and the variables sensitive to the effects of the IV are called dependent variables (DV's). This has been expressed quite eloquently by Ebbinghaus[16] in his incorporation of this *experimental* method into his researches into human memory, a successful effort which went far in illustrating in 1885 the *power* of this method in scientifically understanding human behavior, including I might pointedly add, the study of human perception:

> We all knew of what this method consists: an attempt is made to keep constant the mass of conditions which have proven themselves causally connected with a certain result; one of these conditions is isolated from the rest and varied in a way that can be numerically described; then the accompanying change on the side of the effect is ascertained by measurement or computation.

The simplest and most unambiguous experiments, therefore, are those employing but a single IV and a single DV, and, in the fundamental situation in which an effort is being made to demonstrate the *sheer existence* of a phenomenon (as in the present study, without inquiring further into its composition and contingencies), the two basic values or levels or variates of the IV may be simply designated the "experimental" (i.e., the factor *appears*—operationally defined—in some amount) and "control" condition (i.e., the factor actually *empirically* appears as a "zero" level, something on the order of a "placebo" condition in a drug study).

Unfortunately, in the present study, the basic procedure described was carried out with *all* the subjects (six in number for Section III studies through subsection "D," two more in subsection "E," and five more in subsection "F"; we limit our critique to the more detailed accounts given in subsections A-D rather than the very eketchy material in subsections E and F, although all these studies used essentially the same procedure and varies mainly on the basis of subject characteristics). That is, *all the subjects were administered*, as it were, *the same basic treatment condition*, and were thus all part of the same "clairvoyant" or "remote-viewing" group, consisting essentially in the *S*'s making an effort to somehow envision a remote target. There did not appear to be, therefore, any variations of this critical factor, as Ebbinghaus and experimental logic requires.

Actually, all we know of the instructions to the *S*, so critical in determining the operational definition of this variable (not to mention making the study replicable!) is that the "remote-viewing subject was asked to describe his impressions of the target site into a tape recorder and to make any drawings he thought appropriate (p. 335)," since the authors do not give us the actual instructions.

Unfortunately, there are also fundamental problems in the very definition of the DV, at the heart of which is confusion over the *nature* of the so-called "target." Specifically, the judge for a given *S*'s performance for a given "target" was successively driven to each geographical location previously visited by the peripetetic *E*'s. Since we do *not* know precisely *what aspects* of the geographical location constituted a "target" in the original "experiment" when the demarcation team was present, and since it is even more ambiguous now what the *judge was viewing*, as well as what he was *supposed* to be looking at while he reviewed the *S*'s packages of 9 descriptions, we seem in this procedure, therefore, to actually be dealing with at least three recognizably distinct categories of "targets": one is constituted by the perceptions of the demarcation team; a second by the perceptions of the judges; and a third by direct physical aspects of some geographical location (photographs are used in the report and labelled "target" to further complicate target specification—e.g., their Fig. 4). It is difficult to evaluate how potentially dissimilar these various "targets" were in the absence of clarifying and detailed accounts of the specific instructions to the teams and to the judge. Since these judgements define the essence of a "hit," the fundamental datum of the DV in this report, we are led logically to doubt the validity of this DV and suspect it is also very unreliable (no reliability measures are presented to reassure us on this point).

To summarize our concerns with the DV, we may say, first, it appears to need considerable specification, a detailed operational definition; second, its reliability should be ascertained, and doubt that it is inherently very unreliable removed; third, it should be used for determining experimental condition ("clairvoyance") hit rates in the matching task, as well as for appropriate control conditions' (e.g., "No clairvoyance," "No clairvoyance and no demarcation team," and so on) hit rates, so that an appropriate statistic *based on the net differences in "hit rates"* could be tested for the degree to which this *difference* measure is statistically significant.

This latter point reminds us to comment on the essential experimental invalidity of this parapsychological tactic of comparing their so-called "experimental data" to some hypothetical "chance" level *in the absence of experimental empirical control conditions*. This point is perhaps most clearly illustrated in the psychokinetic ("mind over matter") literature. In those studies, classically championed by Rhine some years age [17] (e.g., 1947), and reviewed up to 1962 in an excellent report by Girden[18], a tumbler might toss out onto a table some 600 dice; the *S* being evluated for his alleged "psychic" skills makes some effort to mentally or "psychically" influence each die and have, say, as many 5's turn up as he can. A tabulation is made, and it is found that, say,

[14] Manuscript received May 3, 1976; revised June 22, 1976.

[15] J. L. Calkins is with the Department of Psychology and Sociology, Drexel University, Philadelphia, PA 19104.

[16] H. Ebbinghaus, *Memory: A Contribution to Experimental Psychology*. New York: Dover Publications, 1964 (original: 1885).

[17] J. B. Rhine, *The Reach of the Mind*. New York: W. Sloane Associates, 1966.

[18] E. Girden, A Review of Psychokinesis (PK), *Psychol. Bull.*, vol. 59, pp. 353-388, 1962.

235 5's have indeed turned up—a startling result, indeed, especially when it is considered that only 100 should have so turned up by "chance," as dictated by purely *theoretical* (not experimental) considerations. The problem with this interpretation is the same as that in the present "remote-viewing" study. This "chance level" is a theoretical, mathematical abstract model of the behavior of 600 ideal dice, not necessarily related to the dice actually being used in the study at all, not to mention to the procedures and physical conditions operating in actually using and tossing them. An *empirical* control condition is necessary to obtain this standard for comparison, one representing the behavior of actual, physically existent and manipulated concrete dice used in the study and accounting for such potentially confounding variables influencing the throw such as non-horizontal tables, leaded dice, etc. This control condition would *exactly duplicate* the experimental condition, save only for the omission of some critical factor under study in the experiment—such as psychokinesis, or, in the present instance, "remote viewing." We *must* run a non-PK or nonremote viewing condition!

How could this be accomplished? For objective experimental purposes, "remote viewing" may be operationally defined either by specifying instructions to a subject concerning his potential task of envisioning distant objects, or by controlling the very existence of a target to be seen "remotely" (or any other way for that matter). Therefore, each of these procedural details can serve as an IV in a well-controlled 2-factor design. For the "target" IV, we would seem to need only the two basic levels of this IV, namely, a condition in which a remote target is available for alledged "remote viewing," hypothetically facilitated in some inscrutable fashion by a "demarcation team" actively observing the target according to explicit, replicable directions, and a condition in which no such remote target or team exists. The former instance would theoretically permit clairvoyance to operate (if it exists), since one's reported imagery could be matched or compared to the actual selected target; the latter control condition would not, since there would be no selected target to see clairvoyantly or otherwise.

Furthermore, on the basis of an operational definition of "remote-viewing" in terms of the instructions to *S* establishing his remote-viewing task (our second IV), we can proceed to require him to draw pictures or verbally describe *anything* he can imagine, but in the experimental condition further telling him to attempt to view a remote target.

Procedurally, this would mean we begin by creating a large pool of nearby geographical sites to function as potential "targets" (this is an attempt to perserve the authors' procedures wherever feasible, since it would hardly otherwise be very advisable to use such complex stimuli as these targets in preference to simpler, ideally quantifiable "targets"), and then randomly assign targets to the 4 cells of our 2 by 2 factorial experimental design until, say, each cell as five (5) targets.

As for the sequence to be followed in actually running *S*'s through these different treatment combinations, a simple randomized arrangement would suffice. Later, the judge can in random sequence consider one cell of descriptions and targets after the other, until all four cells have been "matched," where naturally the judge is not informed of the treatment combination condition. Hit rates are determined, for example, and then appropriate statistical tests for simple effects, main effects and possible interactions determined.

It may be true, as the parapsychologists claim, that ESP is real and represents a great latent power of the human mind, one day to emerge in full recognition by science as another momentous step in the evolution of man and his mind; but its truth remains to be demonstrated through use of the experimental method, and until it is, in the same way as Ohm's Law or Pavlov's conditioned reflex paradigm, parapsychologists ought not consider psychologists and other scientists and engineers calcified conservatives blindly refusing to see the obvious "fact" that ESP, etc., exists, because the parapsychologists themselves, just as in the present study, seem to virtually *intentionally* avoid using the only techniques which in the long run will prove persuasive to the scientific community, and those are *objective experimental* procedures, even through it may *appear* such a convincing logic exists by virtue of the use of scientific jargon, description of scientific equipment, mathematical and information theory models, and so on.

Indeed, the perseverance of belief in ESP, and the reinforcement it does and will continue to receive from such publications as evaluated in this present critique, indicates to this writer that we are dealing more with a social movement or *cult* than with a future discipline in empirical science as Hoffer might put it (1964).[19]

[19] E. Hoffer, *The True Believer.* New York: New American Library, 1964 (original: 1951).

Replies[20] *by Harold E. Puthoff and Russell Targ*[21]

To begin, we appreciate the remarks by McConnell, and we are grateful to him for his offer to make available annotated bibliographies on paranormal studies, including the sociological issues. As researchers publishing in the field, we learned early that sociological factors appear to play an especially significant role in this field, both in carrying out research and in disseminating results.[22]

In response to the comments of Harris, we too have considered the possibility that an alternative explanation for apparent successful precognition in our experiment could involve a concatenation of telepathy, remote viewing, and remote psychokinesis. Although there is no evidence to rule out such a possibility, we prefer the simpler explanation as a working hypothesis. The idea of subject-caused paranormal events leading to apparent precognition, although within the realm of possibility, would seem to be less viable, if one is to give credence to any of the more dramatic cases in the anecdotal literature (disaster prediction, etc.). Harris' comment that the "advanced potential" hypothesis may be too parochial is well taken. We cited it only as a possibility that exists within the present scientific framework, and which we think should be examined before ad hoc theories are introduced.

However, the objection to advanced potentials raised by Musès (precognitive "advantage" restricted to one nanosecond-per-foot) is overcome if one considers not just plane waves propagating at the velocity of light, but rather traveling-wave interferograms (i.e., slowly moving standing wave patterns). In this case information propagates at the velocity of the interference pattern in the wake of the passing waves, rather than at the velocity of the waves themselves. The group velocity of a signal would under these conditions be slower than the phase velocity c, thus allowing for a longer precognition time interval.[23] We wish to emphasize again that we are not putting this forward as *the* explanation for precognition, but rather only as an example that modern theory does not absolutely forbid such modeling, as shown in our Stratton reference.[24] In passing, one of the authors (HP) does acknowledge the conversation on this topic referred to by Dr. Musès, but must point out that the original source of this concept in our work lies in an earlier paper published by one of the authors (RT).[25]

With regard to the Warcollier reference pointed out by Muses, we are familiar with Warcollier's work in remote picture drawing,[26] which is similar to the more easily available material in the book by Upton Sinclair (with preface by Einstein), *Mental Radio*;[27] we are not familiar, however, with any work by Warcollier in our format (remote viewing of natural targets). For the latter a good early reference we have come across since publication of our paper is a chapter by Sir Oliver Lodge in *An Outline of Science.*[28]

Deutsch's first argument against ESP ("with our present-day sophisticated equipment, we cannot detect any forces beyond the four fundamental forces of physics . . .") indicates that, at least with regard to our paper, he has missed one of our major points—that it is not necessary to go outside of present-day physics in order to begin to model so-called paranormal perception. His comments on brain functioning, neuronal firing, and the uncertainty principle, although not directed toward our paper *per se*, nonetheless inspire us to point out that the leading neurophysiologists of our time have taken a position directly counter to that of Deutsch. For example, the eminent neurophysiologist, John C. Eccles, in discussing a neurophysiological hypothesis of will in his book *Facing Reality*, comments at length on the possibility of neuronal firing patterns being controlled by quantum processes at the level of the uncertainty principle.[29] Be that as it may, it would

[20] Manuscript received June 30, 1976.

[21] The authors are with the Electronics and Bioengineering Laboratory, Stanford Research Institute, Menlo Park, CA 94025.

[22] Bicentennial Conference on America in the Information Age, sponsored by the American Society for Information Science; Panel on "Science and unexplained phenomena," Washington, D.C., Apr. 12-14, 1976.

[23] H. E. Puthoff and R. Targ, "Psychic research and modern physics," in E. D. Mitchell's *Psychic Exploration—A Challenge to Science*, J. White, Ed., New York: Putnam's 1974, ch. 22.

[24] J. A. Stratton, *Electromagnetic Theory.* New York: McGraw-Hill, 1941.

[25] R. Targ, "Precognition and everyday life: A physical model," in *Proc. 15th Int. Conf. Parapsychology* (Amsterdam, The Netherlands), Aug. 1972.

[26] R. Warcollier, *Mind-to-Mind*, New York: Creative Age Press, 1948.

[27] U. Sinclair, *Mental Radio.* New York: Collier Books, 1971.

[28] Sir Oliver Lodge, "Psychic science," in *The Outline of Science*, J. A. Thompson, Ed. New York: Putnam's, 1922.

[29] J. C. Eccles, *Facing Reality*, New York: Springer-Verlag, 1970, ch. 8.

appear to us that the "free-will-versus-determinism" issue is separate from and irrelevant to the ESP issue, since even in a deterministic universe there is no strong argument against the occurrence of a completely predetermined event that, because of its characteristics, would be considered "paranormal."

With regard to Deutsch's trust in the Martin Gardner attempt to "expose the weaknesses" of our research with a random number generator, such trust is misplaced. Our rebuttal to Gardner points out that Gardner's major criticism of our experiments was based on his misconception of the manner in which data were collected by an automated system.[30]

In Calkins' letter we find a detailed presentation of the elements of an experiment, definitions of independent and dependent variables (IV's and DV's); a detailed description of a particular factorial experimental design standardly used in certain specialized studies (e.g., drug/placebo treatment of animals), and so on; all of which, taken in proper context, we have no quarrel with. Unfortunately, intertwined with this discourse is the claim that since our experimental design differs from the paradigm he advocates, we have failed to follow accepted methodology (as he narrowly interprets it) in experimental psychology. He would have the reader believe that, as a consequence, our experimental and control conditions, and our IV's and DV's were ill-defined, and perforce our results necessarily ambiguous. Although on the surface his criticism might appear to be both sophisticated and substantive, careful examination of his remarks point by point reveals a basic misinterpretation of our experiment; and also a basic misunderstanding of the roles that different experimental paradigms play in eliciting data of interest in complex and subtle behavioral experimentation. As a result we find his evaluation inaccurate and his conclusions invalid.

To handle the general argument first, obviously there is no single research strategy or experimental design that can be applied in cookbook fashion to all research issues. The designs available within the arsenal of experimental psychologists range from naturalistic observations, through systematic assessment with controlled stimuli, and finally to experimental manipulation.[31] The key distinctions among the strategies involve the degree of experimental control that is exercised, and the amount of artificiality or bias that is introduced. Each strategy has an appropriate function, application, strength, and shortcoming, and, as Scott and Wertheimer point out, "any particular project may well combine features of each strategy."[31]

At an early stage of research, the investigator must find procedures that will minimize ambiguity by controlling unwanted influences, while avoiding the rigidity, artificiality, masking, and biasing effects that premature overrefinement of procedures might introduce. It would be in our opinion premature and imprudent, for example, during the initial stages of an investigation when much remains unknown about the mechanisms and factors involved, to follow Calkins' suggestion to specify precisely on which stimuli within a target area a subject or judge is to concentrate. As Scott and Wertheimer caution, "experimental manipulation may provide such refined control over the situation in which a relationship is established that the generality of the results becomes questionable. Precision of control is not the only consideration in designing a research project. Generality and applicability of the conclusions are others . . . The problem facing the investigator is to find an appropriate compromise that will afford control over certain unwanted influences, while at the same time adequately representing the complex interplay of circumstances he is trying to find out about."

In the design of our remote-viewing protocol, we took into account the advice of Anderson as given in his discussion of what he calls a "natural experiment."[32] "In the early stages of research . . . it is good strategy to observe the operations of variables in their natural settings to obtain some estimate of the relative importance of these variables." We therefore incorporated into our overall strategy certain elements of a "natural experiment" such as the use of targets defined by the "natural" process of site visitation by a demarcation team with unspecified instructions, and the use of "free-response" questioning.

In keeping with accepted methodology in experimental psychology we emphasized rigid control over variables that might have introduced bias into our results. For instance, double-blind protocol was used in all procedures involving the generation and presentation of the stimuli (target site visitations by demarcation team); the analysis of responses (*S*-generated transcripts and drawings) was carried out by a judge blind as to the correct stimulus-response pairs. A series of independent variables (IV's) that Calkins chooses to ignore (target-site characteristics such as distance, elevation, presence or absence of water, etc.) were manipulated by random selection, and a well-defined DV was obtained from the judged accuracy of *S*'s oral and graphic description of target location as represented by rank-order number. Among other things the precise time of stimulus presentation was controlled and *S*'s were uniformly instructed to provide a detailed description, by word and drawing, of their impression of the target area. In short, precise experimental control was used where appropriate to eliminate ambiguous conditions, independent variables were systematically manipulated and presented under suitably controlled conditions, and measurement was made of the effects of the changed stimuli. Thus, the vital elements of an experiment as defined in experimental psychology were present. (For definitions of the elements of an experiment, see footnotes.[31-37])

There is insufficient space to answer in detail each of the specific criticisms made in Calkin's comments (for example, the effort to invalidate our statistical procedure by erroneous extrapolation of the biased-die fallacy). However, a few important points need to be made.

1) Calkins suggests that the two-factor design he advocates is a superior experimental design, in part because of the introduction of control conditions such as: (i) there is an experimental target demarcated by the target team as in our usual experimental condition, but *S* is told to think of "anything he can imagine" (his "do-not-remote-view" condition), and (ii) there is no target, but *S* is asked to carry out a remote viewing anyway. In the first case *S*'s might imagine remote scenes, might focus on close relatives or friends, doodle or simply think of anything at random. It is not at all clear that a meaningful comparison can be made between the output of this exercise and a genuine effort at remote viewing. This would be similar to comparing apples with an entire fruit stand. For case (ii) it is not clear how the absence of a target would be generated. How, for example, does one effectively send a target team "nowhere"? If there is a target team, the members must be somewhere, and thereby would provide some basis for remote viewing. (Our best effort in this direction [p. 340, Table IV, 2nd target site] was to lock the target team up in a shielded room, instead of sending them out to an outdoor target.) If, on the other hand, there is no designated target team, this situation is so dissimilar to the putative remote-viewing situation under study that *S* responses would be open to serious question with regard to the basis for making meaningful comparisons. In sum, Professor Calkins has not shown how his approach is better, if indeed it is as acceptable as that which was used. It would seem, rather, that the recommended approach would introduce more ambiguity into the experimental design than it would resolve, making the results extremely difficult to interpret. One must not abjure common sense in an effort to follow a particular favorite procedure which might recommend itself theoretically.

2) Perhaps the most valid criticism in Calkins' comments, center on our not detailing information about the reliability of the judging process. Although the data are contained within the paper, clarification is in order.

As indicated in Sections A and B, pp. 335–338, two judging procedures were used. In the first, panels of 5 independent judges analyzed the first and second experiments. From this one could obtain the reliability of rankings by several judges (inter-rater agreement) as measured by the coefficient of concordance *W*. However, in the present study a judgment consisted of the matching of descriptive transcripts and drawings to actual sites, and therefore the accuracy of matching provides an empirical measure of judge reliability. The best judge obtained seven matches out of nine cases in the first experiment, five out of nine in the second, setting at least an empirical standard for quality of judging. This procedure amounted to a pre-testing of potential judge reliability. A sixth judge was then obtained who independently rank-order judged the same two experiments. Since he also indepen-

[30] R. Targ and H. Puthoff, Letters, *Scientific American*, vol. 234, Jan. 1976.
[31] W. A. Scott and M. Wertheimer, *Introduction to Psychological Research*. New York: Wiley, 1962, pp. 69–77.
[32] B. F. Anderson, *The Psychology Experiment. An Introduction to the Scientific Method, 2nd ed.* Belmont, CA: Brooks/Cole Publishing Co., 1971. pp. 36–41.
[33] H. B. English and A. C. English, *A Comprehensive Dictionary of Psychological and Psychoanalytic Terms.* New York: McKay, 1958.
[34] B. J. Underwood, *Experimental Psychology, 2nd ed.* New York: Appleton Century Crofts, 1966.
[35] D. T. Campbell and J. C. Stanley, *Experimental and Quasi-Experimental Designs for Research*, Chicago, IL: Rand McNally, 1963.
[36] G. McCain and E. M. Segal, *The Game of Science*, Belmont, CA: Brooks/Cole 1969.
[37] A. Chapanis, *Research Techniques in Human Engineering.* Baltimore, MD: The Johns Hopkins Press, 1959.

dently obtained the same 7 and 5 direct matches as the best judge, we at least had a measure that indicated that with regard to the data generated in our first two experiments, the better judges were in accord, indicating a high degree of reliability, inter- and intra-judge. This sixth judge was therefore used for all the subsequent judging in the paper, and thus the rank-order judging of all the experiments in the paper was carried out by a single judge whose degree of reliability was estimated on the basis of a comparison with the results of judging panels. The authors do recognize, however, that the analysis of free-response material is difficult at best and further work is being pursued in the hope that subjective judging procedures can be replaced altogether by a more quantified form of content analysis.

With regard to Calkins' closing remarks on cultism versus empirical science, it is our understanding that the key distinction between the two is that cultism consists of belief, in the absence of observation or experimentation, whereas those who follow the emirical method can be found in the laboratory formulating hypotheses and designing and carrying out experiments. It would appear to us that it is those who carry out experiments and report results (see other replication studies, this issue), rather than many of their critics, who are true to the canons of empirical science.

Preliminary Experiments in Group "Remote Viewing"

THOMAS W. WHITSON, DAVID N. BOGART, JOHN PALMER, AND CHARLES T. TART

Abstract—**In preliminary research designed to test the "remote viewing" paradigm of Puthoff and Targ, two university art classes drew their impressions of an unknown, randomly determined location. Based on the drawings, independent judges attempted to select the correct locations from among ten slides. The results ($P = 0.03$), although not conclusive, were encouraging.**

The experimental findings of Harold Puthoff and Russell Targ at Stanford Research Institute (SRI) suggest that it is possible to obtain descriptive information about remote locations through an unidentified perceptual channel. Here we report two preliminary experiments performed at the University of California, Davis, to check on the validity of "remote viewing."

We wanted to test the hypothesis that "remote viewing" of natural objects may be a latent and widely distributed ability. We used students in a university art course as percipients. None of them were known to possess extraordinary psychic abilities and none reported having prior experience in describing unknown remote locations. The percipients were practiced art students quite willing to draw and describe their visual images.

Unlike the experiments at SRI, this study was a group experiment, i.e., all percipients present simultaneously. The percipients produced their drawings individually, with no discussion between one another.

For the first experiment, thirty target locations were selected by the experimenters, all within ten minutes driving time from the Davis campus. Of these thirty, ten locations clearly differentiated from each other by visual criteria were chosen as the target pool. A few examples of the target pool are: a palm tree, a Hammond organ, a bike underpass tunnel, and a gravestone statue of an angel. A color slide of each site was sealed in an envelope together with traveling instructions from the university to the location pictured. Before meeting with the class, $E1$ (Whitson) randomized the envelopes while $E2$ (Bogart) was not present.

The experimenters decided to introduce the nature of the experiment at the beginning of the class and then carry out the procedures after the percipients had been drawing for two hours. We felt that the percipients' visual imagery would be more activated at this time than at the beginning of class.

On arriving, the experimenters introduced themselves and the experiment to the percipients. They described the studies performed at SRI and emphasized that the earlier experiments suggested "remote viewing" might be a widely distributed perceptual ability. They then informed the percipients of the procedures that were to be followed two hours later, i.e., that $E2$ would travel to a remote location and view the site for fifteen minutes. Upon leaving, $E2$ selected one of the envelopes from the randomized target pool, without telling $E1$ what it was, and traveled to the chosen site. $E1$ returned to the art class to be present while the percipients attempted to visualize the remote location that $E2$ was viewing. The experimenters had synchronized the fifteen minute interval so that $E2$ and the percipients were "viewing" at the same time. After the percipients had attempted "remote viewing," they were asked by $E1$ to produce a drawing of the images that corresponded to the remote site. $E1$ then collected the drawings and told the percipients the results would be discussed at a later class meeting.

$E2$ returned to a designated room, removed the slides from the envelopes, and randomized them a second time with target slide included. $E1$ was not present at the time the target site envelope was selected or rerandomized. $E1$ then proceeded with the method of evaluation, but being ignorant of the target identity he could not bias the results.

The judge for the first experiment was an employee of the U.C. Davis art department. He was asked to match a first and second choice of the ten possible target slides to each drawing. At the time of the judging, he was not aware that it was an ESP experiment. Using an overhead projector, the ten slides were projected on a screen simultaneously. The judge could then readily distinguish the differences in each location and make the decision for each drawing. After the judging $E2$ revealed the target site to everyone concerned.

The results of the judging were as follows (Table I), with first and second choices counted as hits, a procedure decided upon before the analysis.

Although we were not able to apply a formal statistical test to this single session, we nevertheless were impressed that the correct target received almost twice as many matches as the next most frequently chosen slide (11 versus 6). On the other hand, we were aware that if, by chance alone, the selected remote location happened to meet a predominant drawing bias in the percipients, the results would be artifactually inflated. Therefore we conducted a second remote viewing experiment, with mixed motivation. Partly we wanted to see if we could again obtain positive results, partly we wanted to see if images of tunnels (the target in Experiment One) occurred frequently when it was not the target.

TABLE I

	1st	2nd	Total
ANGEL	1	3	4
BANJO	1	4	5
BEAN POLE	3	2	5
BIKES	3	3	6
BIKE TUNNEL*	5	6	11
DIRT MOUNDS	3	2	5
LOGS	4	0	4
ORGAN	3	2	5
PALM TREE	1	3	4
TRACTOR	3	1	4

Number of Drawings - 27 — 1 2nd choice not given
*ACTUAL TARGET SITE

TABLE II

	1st	2nd	Total
ANGEL	0	0	0
BANJO	3	3	6
BEAN POLE	1	2	3
BIKES*	3	1	4
BIKE TUNNEL	1	0	1
DIRT MOUNDS	0	2	2
LOGS	2	1	3
ORGAN	4	4	8
PALM TREE	0	0	0
TRACTOR	0	1	1

Number of Drawings - 14
*ACTUAL TARGET SITE

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Experiment Two used essentially the same procedure as Experiment One except that a new art class and a new judge, a graduate student in the art department, were used. The bike tunnel was precluded as a possible target, although it was included in the judging pool. Finally, $E1$ noted before the data were analyzed that this class seemed less interested and involved in the experiment than did the first class. Table II gives the results.

Tunnel-like images that would be matched with the slide of the bike tunnel were quite rare, so we consider the possibility of artifactual inflation of the results of Experiment One to be unlikely. The results of the second experiment were not as impressive as those of the first although the target slide did receive the third highest number of matches out of ten. Of all possible target pairs in both sessions combined, the total number of matches assigned to the actual target pair was the third highest of the 90 possible pairs. This is associated with a one-tailed probability of 0.033.

These initial experimental excursions into the investigation of "remote viewing" offer modest support to Puthoff and Targ's results. Given the theoretical significance of the phenomenon, we intend to do further studies.

Remote Viewing Experiments Through Computer Conferencing

JACQUES VALLEE, ARTHUR C. HASTINGS, AND GERALD ASKEVOLD

Abstract—A series of remote viewing experiments were run with 12 participants who communicated through a computer conferencing network. These participants, who were located in various regions of the United States and Canada, used portable terminals in their homes and offices to provide typed descriptions of 10 mineral samples. These samples were divided into an open series and a double-blind series. A panel of five judges was asked to match the remote viewing descriptions against the mineral samples by a percentage scoring system. The correct target sample was correctly identified in 8 out of 33 cases; this represents more than double the pure chance expectation. Two experienced users provided 20 transcripts for which the probability of achieving the observed distribution of the percentage score by chance was 0.04.

These results confirm earlier reports of successful remote viewing experiments while extending them to cases in which participants were thousands of miles away from each other and in which the targets were mineral samples of potential economic significance, with control of communications provided by a computer network.

In a recent article,[1] Puthoff and Targ have stated the case for the existence in humans of the ability to perceive objects and scenes at a distance through an apparently unknown information channel. In this note, we report a series of experiments that appear to confirm their work while extending it to cases in which the participants were several thousand miles away from each other, with control of sensory conditions automatically and unobtrusively provided by the medium of communication, and in which the targets were mineral samples of potential economic significance.

The experiments were conducted via a computer teleconferencing system, which has been described elsewhere.[2] This system is implemented on a computer network and allows each participant to type comments at any time. All comments are immediately printed by the computer on the terminals of any participants who are currently logged in (or are stored for later retrieval). Twelve persons, in New York, Florida, Quebec, and California, were supplied with computer terminals in their homes or offices. The conference was sponsored by a communications company, and participants made their personal time available for the project on a voluntary basis.

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[1] H. E. Puthoff and R. Targ, "A Perceptual channel for information transfer over kilometer distances: Historical perspectives and recent research," *Proc. IEEE*, vol. 64, no. 3, Mar. 1976.

[2] See, in particular, the articles "Network conferencing," *Datamation*, May 1974, and "The Computer conference, An altered state of communication?," *The Futurist*, June 1975.

REMOTE DESCRIPTION			PANEL SELECTION AND SCORES AMONG THE 10 POSSIBLE TARGETS					ACTUAL TARGET WAS:
No.	Open/ Blind	Author	Best Match	2nd Match	3rd Match	4th Match	5th Match	
1	Open	I.S.	J (134)	F (60)	Ⓒ (50)	G (44)	D (30)	C
2	Open	A.H.	A (100)	I (60)	F (52)	H (50)	Ⓒ (45)	C
3	Blind	I.S.	Ⓕ (212)	G (50)	C (10)	D (10)	H (10)	F
4	Open	I.S.	J (100)	E (76)	F (55)	K (30)	A (10)	G
5	Blind	A.H.	K (70)	H (62)	G (60)			D
6	Blind	R.B.	Ⓓ (284)	J (10)				D
7	Blind	R.T.	A (205)	I (90)	G (80)			D
8	Blind	I.S.	I (210)	J (40)				D
9	Open	A.H.	H (150)	F (70)	J (50)	C (20)		I
10	Open	I.S.	D (50)	J (50)	K (50)	E (48)	C (30)	I
11	Open	R.B.	Ⓘ (208)	D (30)	C (20)	H (20)		I
12	Open	A.H.	F (45)	Ⓔ (20)	D (17)			E
13	Open	R.B.	F (188)					E
14	Blind	R.B.	K (110)	D (56)	J (30)			H
15	Blind	A.H.	A (180)	D (10)	F (10)			H
16	Blind	I.S.	Ⓗ (166)					H
17	Open	R.B.	D (100)	Ⓕ (90)				F
18	Open	I.S.	Ⓕ (246)	D (120)	I (20)			F
19	Open	I.S.	G (104)	C (100)	Ⓙ (84)			J
20	Open	A.H.	F (30)	K (20)	D (6)			J
21	Open	R.B.	Ⓙ (56)	I (50)	D (30)	A (10)	C (10)	J
22	Blind	R.B.	H (62)					K
23	Blind	A.H.	D (52)	G (10)				K
24	Blind	J.B.	C (40)	D (14)	J (10)			K
25	Open	R.B.	Ⓓ (72)	J (10)				D
26	Open	A.V.	J (80)	Ⓓ (25)				D
27	Open	A.H.	Ⓓ (55)	E (5)	F (5)	K (2)		D
28	Open	R.B.	D (126)					H
29	Open	A.H.	D (222)	F (10)	Ⓗ (22)	A (10)	I (10)	H
30	Open	I.S.	J (58)	C (30)				H
31	Blind	A.H.	H (32)	E (30)	G (10)	I (6)		A
32	Blind	R.B.	C (130)	G (124)	J (15)	K (6)		A
33	Open	R.B.	I (60)	D (16)				A

Fig. 1. Total panel results for each remote description (correct matches are circled).

The primary purpose of the experiments was to test "remote viewing" under the altered state of communication enabled by computer teleconferencing—in which participants are individually isolated, communicating with each other only in the printed mode, but often in real time. We further wished to confirm that the use of the teleconferencing system would supply accurate and unobtrusive recording of the data and would prevent collusion or subliminal cuing to a degree not found in most parapsychological experiments.

Over the period of 14 June to 8 July 1975, the participants discussed current issues in psychic research. The formal experiments lasted five days, from 29 June to 3 July, and were conducted as follows: Ten mineral samples selected from geological collections were assigned a label and enclosed in sealed envelopes. The specimens were the rare mineral bastnosite, a vein filling of galena and quartz, opal, gold ore, halite, cinnabar, magnetite, realgar, barite, and cobaltite. The participants were told only that the targets were mineral samples from North America. Five of the samples were enclosed in larger envelopes and randomly labeled "Sunday" through "Thursday" to compose a "double-blind" pool. The other samples constituted an "open" pool.

Each day at 7:30 a.m. and 7:30 p.m. Pacific Daylight Time, a geologist sitting at his home terminal took one of the envelopes from the open pool, extracted the sample, and held it in his hand. Anyone logged into the conference at that time could volunteer a remote viewing description. Such descriptions were recorded and printed by the computer with a date and time stamp. After all descriptions were in, the geologist entered a brief description of the specimen to provide feedback for the participants. This sample was then removed from the open pool.

Similarly, each morning the envelope for the day was taken from the double blind pool and placed at a designated office location where it was a target for remote viewing for eight hours. Anyone logging into the conference during that time could type in a description of the sample contained in that envelope. At the end of the day, the envelope was taken to the geologist, who added the sample to the open pool. No feedback was given for the double blind targets.

Upon completion of the experiments, we had obtained 33 descriptions of the ten samples from six people. Thirteen of these descriptions were under double blind conditions and 20 under open conditions. Four specimens had been run under both conditions.

Inspection showed what appeared to be successful descriptions of several samples, but in order to objectively evaluate the accuracy of the remote viewing descriptions, we asked outside judges to match the 33 descriptions against the mineral samples. Five judges who had no prior knowledge of the correct pairings (a sociologist, an editor, a physicist, a secretary, and a librarian) were given transcripts of the descriptions (without time, date, or author identification) and the geological specimens. Their instructions were to assign one or more specimens to each description. We consider the method of judging to be a critical factor. While Puthoff and Targ used a ranking system, we used a percentage scoring system. Each specimen assigned to a given description was allotted a percentage score which reflected the judge's certainty of the "match." The total of 100 percent could be divided among any or none of the specimens. We then totaled all five judges' assignments for each description to find which specimens scored the highest for each description. The results are shown in the accompanying table.

The corrrect target sample was assigned the highest score (that is, "correctly" identified) in 8 out of 33 cases on the basis of the remote viewing description. This frequency is more than double a pure chance expectation of 3.3 and would occur less than once in 100 trials by chance. For a more detailed analysis, which accounted for the distribution of percentages among several targets for each description, the percentage scores were computer processed with the Statistical Package for the social sciences. A one-tailed T-test was used to determine the probability that the assigned percentage scores for correct and incorrect targets were due to chance. For all 33 transcripts, the probability of achieving the observed distribution of the percentage scores by chance was 0.08. For transcripts provided by participants I. S. from New York and R. B. from Orlando, Florida (9 and 11 transcripts, respectively), the T-test indicated a 0.04 probability score.

Following are some descriptions of the target specimens taken from the remote viewing transcripts:

> Target *F* was halite, which is NaCl (salt). It consisted of two, almost transparent, intergrown crystals. Transcript #18 said, "crystal, crystal ball, glass, crystal, clear crystal . . . formed by dripping and evaporation . . . acquired by mining but found quite near surface . . . Northern Nevada." (Actual origin was Southern Nevada.) Transcript #17 referred to supersaturated salt solutions, and Transcript #3 said, "white thing like a coral . . . will crumble if treated hard . . . more than one part . . . it grew."
>
> Target *D* contained blue-green and milky-white opal clusters in a brown pyramidal silica rock. Transcript #25 said, in part, "Why do I keep getting GREENS? I see a medium size green wedge . . . flecked with brown rock color . . . I don't see a pure green emerald crystal . . . it is flecked and connected to a coarse rock edging . . . It looks to me like it was poured, a heavy liquid green plastic (the green becoming blue-green at the edges of the sample), and if it is fractured it would be in one clean smooth break of glassine purity."

About two-thirds of the transcripts contained descriptive elements that corresponded with the correct target specimen, but often these were mixed with noncorresponding elements, and it was not possible to reduce the information to a coherent single identification. The characteristics most often identified correctly were the color of the sample, the shape, relative weight, presence of crystals, type of material (e.g., metallic), and geological formation process (e.g., volcanic). Attempts to specify location were usually in error as were descriptions of the size of the samples and their exact substance. We do not know if these patterns are due to the participants or to the nature of the information transfer process. We suggest that further studies should select targets that are easily discriminated (i.e., widely different) along these "most perceived" characteristics.

We were encouraged by these results. Accurate and significant remote perception occurred under test conditions that placed the most successful participants 2500 M away from the targets. Also of interest is the result that the double blind conditions provided equally correct descriptions, suggesting that the ability under study also functions on information not known to others. The computer conference system allowed control of the test conditions, with complete recording of all messages among participants.

The fact that several of the specimens were composite and contained mixed materials made this an especially complex (though realistic) test situation, perhaps more demanding than the conditions that prevailed in the SRI studies, at least for non-geologists. Our results tend to validate Puthoff and Targ's experiments and indicate that remote viewing techniques are deserving of further attention.

The conference and experiments were made possible by Mr. A. Katz of Deer Communications, Inc., San Francisco. We also express our gratitude to Messrs. Hudson and Wilson for their assistance in carrying out and analyzing the experiments. Our special thanks go to the five judges: Ms. Amara, Ms. Chula, Dr. Johansen, Dr. Lipinski, and Ms. Spangler.

Book Reviews

The following reviews were selected from those recently published in various IEEE TRANSACTIONS *and Group/Society Newsletters. They are reprinted here to make them conveniently available to the many readers who otherwise might not have ready access to them. Each review is followed by an identification of its original source.*

Design of Systems and Circuits for Maximum Reliability or Maximum Production Yield—P. W. Becker and F. Jensen (Lyngby, Denmark: Polyteknisk Forlag, 1974, 347 pp., $16.00). *Reviewed by Harold K. Knudsen, University of New Mexico, Albuquerque, NM.*

The main thrust of this exceptional book is the development of methods of computer-aided design which results in circuits and systems of maximum drift reliability or maximum production yield. The book has an excellent exposition. The authors express themselves with candor and give a full and nonpedantic development of their material. The material is presented at a level which assumes a modest knowledge of probability theory (e.g., conditional probability, continuous density functions, functions of random variables, etc.). This book would be suitable for a graduate level course, or for self-study in computer-aided design and reliability.

The main body of the text develops fundamental reliability concepts, the formulation of suitable mathematical models, and optimization methods. This material is applied in the design of example circuits of reasonable complexity.

The reliability concepts which are defined and/or developed include: the definition of the reliability function, properties of the reliability function, combinational reliability, and system reliability as a function of time; chapters on design and philosophy, the rule of preliminary design in model formulation, feasible solutions, the development of a mathematical model of yield or of drift reliability, and methods for computing the probability of system or circuit success. The chapter on optimization reviews methods for searching for unconstrained maxima and for formulating performance indices which lead to feasible solutions. Finally, circuit examples consisting of one-transistor and three-transistor amplifiers are used to illustrate the methods which were developed. The appendices provide valuable extensions to the text materials. There is also an extensive bibliography.

This preliminary edition, although excellent in exposition and content, does have some areas in which it could be improved. There is no concluding chapter as a summary of the methods developed and estimates for the costs of applying these methods to more complex systems. A few exercises are scattered throughout the book; but these are insufficient for self-instruction, or for a class, unless supplemented by the instructor. Finally, the equations occasionally contain symbols which are not adequately defined in the text (e.g., P_{ij} on p. 46).

The above shortcomings in the preliminary edition detract very little from the overall book which is an excellent tutorial presentation of the techniques of reliability optimization in the design phase of circuits and systems.

Reprinted from the *IEEE Circuits and Systems Society Newsletter*, February 1976.

dissertation, ETS. Ing Telecomunicación, Madrid, 1973.
[3] S. Yoshizawa, "Some properties of randomly connected networks of neuron-like elements with refractory period," *Kybernetik*, vol. 16, pp. 173-182, 1974.
[4] S. Amari, "A method of statistical neurodynamics," *Kybernetik*, vol. 14, pp. 201-215, 1974.

Comments on "A Perceptual Channel for Information Transfer over Kilometer Distances: Historical Perspective and Recent Research"

LEON D. HARMON

There are many ways in which to comment upon the above paper.[1] I imagine that PROCEEDINGS readers will provide a fine variety of feedback. My own reaction, however, is very simple.

If one takes the trouble to categorize roughly the contents of this ramble, the sequence looks like this:

Topic	Number of Pages
1) Introduction	1
2) Informal anecdotal assertions	$1\frac{1}{2}$
3) Historical background	$3\frac{1}{4}$
4) Main study: Introduction, procedures, controls	$\frac{3}{4}$
5) Results, gratuitous editorial comments, anecdotal procedure citation	$5\frac{1}{4}$
6) Informal presentations and discussions of further experiments	10
7) Analysis	$1\frac{3}{4}$
8) Raw data transcript	1
9) Bibliography	$1\frac{1}{2}$

The central issue in a deeply controversial and highly suspect topic such as telepathy, clairvoyance, time reversal, etc., is whether one is prepared to accept as true what is offered in evidence. Notice that in the rough categorization of the article's contents, above, *only three-quarters of one page* (p. 335) in a 26 page paper is concerned with the critical issue of rigorous experimental protocols and controls. And much of that slim section is cursory and anecdotal.

We can keep our eyes on the ball by examining *solely* the relevant three paragraphs on page 335 of the Puthoff and Targ paper (par. 3, 4, 5). All the rest—background, anecdotes, drawings, discussion, and other (less formal) experiments, delightful as they may be—can be set aside while we peer closely at what must ultimately supply reasonable satisfaction regarding credibility.

The signal-to-noise ratio of this article improves markedly when 26 pages of meander are replaced by three paragraphs of explicit relatively formal description of experimental procedure.

We are told the following.

1) The experiment was double blind.
2) The "transmission" experimenters were given "target" locations and proceeded to the target while the "reception" experimenter was kept ignorant of the target.
3) Experimenters were with the "transmitting" subject at all times during the "transmission."
4) An experimenter was with the "receiving" subject at all times during data taking.

The entire business now hinges on the reader's accepting on faith that no information was transmitted conventionally at any time from, say, the transmission experimenters to the receiving experimenter or to the subject. But no controls are cited; no safeguards are described; no neutral watchdogs are mentioned.

Further, this was *not* a true double-blind experiment as claimed, since at least one of the researchers had *a priori* knowledge of the presumed occult data. We are asked to believe that no conceivable communication channel existed between "transmitter" and "receiver" other than by some exotic attenuationless seemingly magical information propagation.

I feel certain that your readers can conceive of many possible alternative conventional channels. Both electronics engineers and magicians, for example, will be at no loss to suggest many.

It is comforting to know that the Editor and Reviewers of the PROCEEDINGS recommended publication of this preposterous material. At least they are open-minded—which is a good thing. But then, too much open-mindedness is a hole in the head.

Manuscript received March 15, 1976.
The author is with the Department of Biomedical Engineering, Case Western Reserve University, Cleveland, OH 44106.
[1] H. E. Puthoff and R. Targ, *Proc. IEEE*, vol. 64, pp. 329-354, Mar. 1976.

Reply[2] by Harold E. Puthoff and Russell Targ[3]

We would like to comment on the points raised in Harmon's letter in response to our article.

In his introductory remarks, Harmon makes a reference to "less formal" experiments. It is important to state at the outset that there were no such experiments. In every experimental series, from the Costa Rica pilot study to the verification study with visiting government scientists, and resolution study with technology targets, a rigid formal protocol was followed. This required that the experimenter with the subject always be kept ignorant of the chosen target and that the analysis (judging) of the experiment be done in a blind fashion by an individual who did not know which response was associated with which target.

Harmon suggests that the reader of our paper must accept *on faith* that there was no conventional communication channel from the target site to the subject, since "no controls are cited, no safeguards are described, no neutral watchdogs are mentioned." In fact, if Harmon will examine p. 335, he will find that the entire experiment had multiple controls, safeguards, and watchdogs every step along the way.

With regard to control over target selection at the beginning of the experiment:

> Before the experimental series began, the Director of the Information Science and Engineering Division, not otherwise associated with the experiment, established the set of locations as the target pool which remained known only to him. The target locations were printed on cards sealed in envelopes and kept in the SRI Division office safe. They were available only with the personal assistance of the Division Director who issued a single random-number selected target card that constituted the traveling orders for that experiment .... The experimenter remaining with the subject at SRI was kept ignorant of both the particular target and the target pool so as to eliminate the possibility of cueing, overt or subliminal ....

When it came to the departure of the target team, an experimenter plus one to three "watchdogs" assigned by SRI management were handed the travel orders, left SRI, got into an automobile, opened the orders, and then proceeded to the site indicated. As stated in the paper, "The target demarcation team, consisting of two to four SRI experimenters, then proceeded by automobile directly to the target without any communication with the subject or experimenter remaining behind." We find it remarkable for Harmon to read that the target demarcation team consisted of two to four experimenters, and yet argue that perhaps they were not vigilant with regard to the possibility that one of their members might try to communicate back to the subject. In addition, numerous of these experiments were observed by visiting government scientists, outside consultants, SRI management, etc. The roles of the two main experimenters were often reversed as to who remained with the subject and who accompanied the outbound team. The composition of the outbound team was changed, and many times did not include either of the main experimenters. In short, as stated on p. 335:

> At all times, we and others responsible for the overall program took measures to prevent sensory leakage and subliminal cueing and to prevent deception, whether intentional or unintentional. To ensure evaluations independent of belief structures of both experimenters and judges, all experiments were carried out under a protocol ... in which target selection at the beginning of ex-

[2] Manuscript received April 9, 1976.
[3] H. E. Puthoff and R. Targ are with The Electronics and Bioengineering Laboratory, Stanford Research Institute, Menlo Park, CA 94025.

periments and blind judging of results at the end of experiments were handled independently of the researchers engaged in carrying out the experiments.

Harmon goes on to comment that "this was not a true double-blind experiment as claimed, since at least one of the researchers had *a priori* knowledge of the presumed occult data." This is in error. Neither the experimenter with the subject nor the judge who evaluated the data, the two individuals in principle capable of affecting the outcome, had any knowledge of the true correspondences, and thus the experiment *was* double blind. The fact that experimenters sent to the target site knew where they were is irrelevant, since they did not have any opportunity to interact with subjects or judges.

With regard to the mechanisms involved in remote viewing, Harmon states, "We are asked to believe that no conceivable communication channel existed between 'transmitter' and 'receiver' other than by some exotic attenuationless seemingly magical information propagation." We wish to indicate to Harmon that the two mechanisms discussed by the authors, extremely low frequency (ELF) electromagnetic propagation and quantum correlation, though they may seem exotic and magical to him, are well understood phenomena in the engineering and scientific community, both theoretically and experimentally.

Finally, as we indicated in some detail on pp. 340–343, the watchdog aspect was carried to the extreme, by having visiting government scientists who were interested in observing our experimental protocols be subjects themselves in an effort to detect whether chicanery was involved. In the process of trying to account for their own good results on the basis of other than paranormal functioning, they expressed concern that perhaps the experimenter might be cueing them subliminally. This was countered by eliminating the inbound experimenter and having the visitor remain alone in the lab throughout the duration of the experiment. They then conjectured that perhaps after the experiment they were being taken to a place that sounded like their description, even though that may not have been the place where the outbound experimenters had gone. This was countered by having the outbound experimenters make a tape while at the site and turning it over to the subject–critic at the same time that he turned over his own tape describing the remote scene. In such fashion every criticism was met. Thus, although Harmon suggests that "both electronics engineers and magicians" will be at no loss to suggest many possible alternative conventional channels, we find that, to the contrary, both electronics engineers and professional magicians, who have consulted on this project have in fact *not* found any viable alternative to fault the SRI experiments. We therefore consider it important to continue data collection and to encourage others to do likewise.

Further Comments[4] by Leon D. Harmon

I was delighted to see the nature of Puthoff and Targ's response to my letter. The only rebuttal needed is to invite the reader to examine the article and both letters with care and then to judge whether or not my criticisms were responded to.

A similar example of nonresponsive obfuscation by these gentlemen can be found on pages 6 and 8 of *Scientific American* for February 1976.

I tried on two separate occasions to get permission from them to visit and see for myself, preferably with a neutral but hard-nosed observation team of my choice. The requests were met with point-blank refual. Tch!

Further Reply[5] by Harold E. Puthoff and Russell Targ

We agree with Harmon that it is very desirable that interested readers examine with care the article and letters to which he refers, and come to their own conclusions with regard to the points he raises.

We understand Harmon's desire to visit SRI to "see for himself" experiments in progress. As we are sure Harmon can appreciate, he is one of more than fifty who have made similar requests in the past year. We have therefore out of necessity limited such observation to contract monitors and their consultants, potential sponsors, and researchers involved in serious attempts at replication of our work.

If Harmon is genuinely interested in determining whether the experiment works as reported, we would suggest that he try the experiment himself under his own conditions as many others have done. Such independent observations are much to be preferred, if for no other reason than on the issue that an experiment that is not replicable from lab to lab would be more of an art than a science. However, as we have indicated in our response to Harmon's first letter, it is the robustness and independence of environment or subject that characterizes this particular experiment. Therefore, although a demonstration at SRI would be satisfying to Mr. Harmon and to those who know and trust him, we think it would be a mistake for the field. That kind of experiment is basically to provide testimony, but science goes forward on the basis of independent experimentation and replication, not testimony.

[4]Manuscript received April 15, 1976.
[5]Manuscript received April 21, 1976.

Adaptive Monopulse Beamforming

LLOYD J. GRIFFITHS

Abstract—**A new receive-array adaptive beamformer configuration is presented. The array output signal consists of the difference between a conventionally weighted beam and an adaptive beam that is constrained to have a spatial null in the direction of interest. Adaptation then provides minimum total array output power.**

Adaptive receiving arrays have been extensively discussed in the literature [1]–[4] and have been shown to provide significant interference rejection properties. In most of these systems, the arrival direction and/or temporal properties of the signal of interest are assumed to be known *a priori*. If the specification of these properties is inaccurate, the actual desired signal may be treated as interference by the adaptive beamformer and thus may be rejected to some degree by the processor. For this reason, practical adaptive beamformers are generally operated in parallel with a conventionally formed array output which has fixed prespecified mainlobe and sidelobe characteristics. Comparisons between the adapted and conventional outputs can then be conducted to ensure that the desired signal-to-noise and interference ratio is indeed being enhanced by the adaptive beamformer.

The array processor suggested in this letter incorporates a conventionally weighted beam as an integral part of the total beamforming structure, as depicted in Fig. 1. In this figure, Z is used to denote the K-dimensional vector of received array-element signals and G is a fixed prefilter, which ensures that the system is steered in the direction of interest. Thus G is either a set of bulk time delays (for broad-band systems) or a network of phase shifters (for narrow-band arrays), which ensures that the desired signal portion of the K-dimensional vector X is in phase at all components. Equivalently, for a digital beamformer,

$$X(k) = s(k)\mathbf{1} + N(k) \tag{1}$$

where $s(k)$ is the kth sample of the desired signal, $\mathbf{1}$ is a constant vector of ones, and $N(k)$ is the sampled vector of noise and interference terms.

The adapted beam output signal $y_A(k)$ is formed using a system of tapped delay lines, one for each received component, as discussed in [1]–[3]. For a system with L taps per delay line, $y_A(k)$ may be expressed as

$$y_A(k) = \sum_{l=0}^{L-1} X^T(k-l)\, W_{Al}(k) \tag{2}$$

where T denotes transpose and $W_{Al}(k)$ is the lth column of delay-line coefficients employed at the kth sampling instant. A conventional output $y_C(k)$ is formed using a vector of fixed coefficients W_C, which are applied to the input data after a suitable delay, corresponding to the midpoint of the delay lines in the adaptive processor. Thus

$$y_C(k) = X^T(k-n)\, W_C \tag{3}$$

where $n = (L-1)/2$ when L is odd and $n = L/2$ or $(L/2) - 1$ when L is even.

Manuscript received January 19, 1976.
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A PERCEPTUAL CHANNEL FOR INFORMATION TRANSFER OVER KILOMETER DISTANCES: HISTORICAL PERSPECTIVE AND RECENT RESEARCH

H. E. Puthoff and R. Targ

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