UNIVERSITY OF CALIFORNIA, SAN FRANCISCO

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO   SANTA BARBARA • SANTA CRUZ

LANGLEY PORTER NEUROPSYCHIATRIC INSTITUTE   SAN FRANCISCO, CALIFORNIA 94143

June 11, 1976

Dr. Harold Puthoff
Mr. Russell Targ
Stanford Research Institute
333 Ravenswood Avenue
Menlo Park, California 94025

Dear Dr. Puthoff and Mr. Targ:

In this letter is a summary of our efforts to refine and replicate your report of EEG response to remote stimulation, published in NATURE in 1975. We have first verified the effect, by playing your previously recorded data tapes through our analysis system. We then designed a new experiment with an EMI-free source, tested the experiment on several of our staff, and, finally we reran your original finding with more extensive data acquisition and improved controls.

I. Reanalysis of previous data.

We played the EEG tapes of Hella Hamid, gathered by Dr. Rebert of SRI, through the following analysis system, whcih can handle a maximum of six channels simultaneously.

DETAILED DESCRIPTION OF EEG PROCESSOR: The channels of EEG signals are taken from the output and lead to the alpha EEG filters. The filters were built by Kinetic Technology, Inc., of Mountain View, California, to high specifications: corner frequencies 9.0 and 12.0 Hz, 48 db down at 8.0 and 13.0 Hz with rejection over the rest of the stop band greater than 30 db, pass band ripple less than 0.2 db p-p. The KTI filters also had a 30-60 mg DC offset. Therefore, a high pass filter with f=8Hz was designed which blocked the DC offset and satisfactorily attenuated the delta contamination, giving adequate comparison to the computer-generated alpha ratios. Alpha levels at the filter output are usually less than 400 mv. Operational amplifiers invert and amplify the filtered alpha (gain=50) to provide optimum (near maximum) input to the squared circuits. The alpha signals are squared by analogue multipliers (Analog Devices #533K) to yield instantaneous power, an approximation to the FFT computation. The transfer function is $X^2/10$, with a maximum of $\pm$ 10V input yielding + 10 V output. After this stage, the signal processing is commanded by a microprogrammed controller, hardwired in TTL logic, except for read-only memories (ROM) which control formatting in the digital printer. A master clock is synchronized with the power line (60Hz).

When the experimenter is ready to begin data acquisition, he selects the summation time (1-99 seconds) with a two digit thumbwheel switch and pushes the START button. In our experiment two four second intervals were chosen. The START function resets the summing integrators, commands the printer to print a line of special characters signifying the beginning of the record, delivers a 50m second pulse to the polygraph marker channel, and connects the outputs of the six squared units to the integrators. Switching is handled by reed relays for lower leakage. Solid state switching devices were used initially, but leakage currents (10^{-9} A) were too high for the accuracy and stability required. The integrators make use of low loss polystyrene capacitors, and FFT-input amps with ultra low (5×10^{-12} A) input offset current. This design makes it possible to use long summing intervals or interrupts with a drift error of no more than 1%.

After the summation time has elapsed, the outputs of the six summing integrators are sequentially connected to the analog to digital converter (ADC) by the analog multiplexer. When each conversion is finished (10 bits BCD) the data is parallel loaded into shift registers. The shift registers are then clocked by the controller to send the data in digit serial form to the printer. This being completed, the next integrator is connected to the ADC and the process repeats. This continues untill all six integrators have been read and the summed power of each EEG lead is printed. The digital printer is a MC4000 Monroe Datalog. A fiberoptic cathode ray tube exposes light sensitive paper quickly and (most important for our research) silently. All standard alphanumeric characters are printable.

Next the controller commands a line feed from the printer. The second line of data for this sample consists of the log ratios of pairs of integrators. The log of the ratio rather than the ratio is desired as it is linear around zero, e.g., a ratio of 2/1=0.301. The analog multiplexer is then commanded to connect the first two integrators to the two inputs of the log ration module. Its output is an analog voltage representing the log ratio of the two channels to a 10 bit BCD number. The printing process is the same with the addition of a polatiry bit indicating which hemisphere has a higher output for the task.

The process is repeated for computation of log ratios of the other two pairs of integrators. After the last data are printed, the controller resets the integrators, then reconnects the squaring units to their integrators. One count is added to the trial display register which tells the experimenter at a glance how many 30 second epochs have been collected. The digitizing, computation and printout takes 2 seconds, primarily due to the switching speed of the relays.

The results of this transcription and analysis are provided below: they show power means at O_z in the null condition greater than that of the 16 Hz condition at greater than .01. This reanalysis confirmed the published effect and also ensured the compatibility of our systems.

TRANSCRIPTION OF DR. REBERT'S TAPES
PLAYED THROUGH THE ANALYZER
FROM FEBRUARY 2, 1976 TO
FEBRUARY 6, 1976

ANOVA w/ REPEATED MEASURES   Oz 4-8 SECONDS

		TREATMENT $\bar{\bar{x}}0$	$\bar{x}16$
SESSION	1:1	578	490
	3:1	465	397
	2:1	553	466
	2:3	232	174
	2:4	308	236
	Mean:	427.2	352.6

F-RATIO COMPUTATION

	SS	df	F	P
TREATMENTS	13913	1	169.05	$<.01$
RESIDUAL	82.3	4		

(P, .01=21.2)

II. In pretesting our equipment situation, we ran our experiment using unselected subjects such as laboratory personnel, in order to test the adequacy of the experiment and to determine whether there were any correlated electronic or mechanical discharges from the apparatus. In 20 sessions of data acquisition, of 40 each (800 trials) there were no significant differences between the null and 16 Hz conditions.

III. For the formal replication of the experiment we used a non-radiating electromagnetic source which could be triggered at either 0Hz or 16Hz. This was stationed in a remote room approximately 10 meters from the subject.

The trials in the experimental sessions were triggered by pulses from one of a set of seven tapes so that no human operator was involved in the triggering of the trials in either the 16Hz or the 0Hz condition (once the session had begun). These tapes were made at our laboratory during the month preceding the experiment.

Randomized tables for the tapes were generated with a Texas Instrument SR-51A electronic calculator, which has a random number key. This random number key produces a sequence of two digit numbers (zero superseeded, i.e., if the first digit is 0, the zero does not appear but can be assumed, which is truly random (i.e., not repetitive, and with no seed number) and distributed in a pure rectangular distribution.

Random sequences of +'s (16Hz) and -'s (0Hz) in lengths of 40 were generated, constrained by the requirements that 1) the trials be pseudo-randomized within each block of trials (i.e., groups 1-10, 11-20, 21-30 and 31-40 each contain five of each kind of trial): and 2) not more than three trials in a row of either type be allowed.

The following procedure was used:* +'s and -'s were assigned alternately within each block of 10 trials according to the random sequences of numbers generated by the key. E.G., if the 21-30 block was being filled, and the random sequence of numbers was 14, 38, 45, 27: first a + would go to 1, then a - to 4, then + to 3, - to 8, + to 5, - to 2, + to 7, etc., until the block was filled and then on to the next block (repeated digits were ignored). Further more, each + and the succeeding - was linked in the record for editing purposes (see below).

Blocks of +'s and -'s were discarded if it was clear that they would include sequences of four or more consecutive +'s or -'s; also, if a sequence of four or more +'s or -'s was created from the juxtaposition of two blocks of 10, the latter block was reversed (+'s changed to -'s, and vice versa). A single block of 10 trials was discarded becuase of calculator failure in the middle of generating the block, and another becuase of a possible recording error on the part of the operator, otherwise, each trial that was generated was kept.

---

*When the condition was first turned on each time, the random number key was pressed twice to clear initial entries.

Trials were recorded on a tape with a 4 trace Ampex stereo FM tape deck in direct mode, with pulses of 4-5 on one channel for the 16Hz condition and on another for the OHz condition. The pulses were produced by two Grass stimulators. They were recorded 30 seconds apart, then checked afterward on playback. The inter-trial interval was checked and found to be within 1 second of 30 seconds, consistently, with no detectable systematic difference between conditions. The tapes were played back on a Tandberg 2-track stereo tape recorded into a logic circut which triggered the type of trial corresponding to the channed. There were no failures in trial triggering due to errors in the trial tapes at any point during the experiment.

Trials were deleted after the session for three reasons only: artifact, logic circuit failure resulting in a breakdown in the trial sequence, or abnormal EEG power (under 50 or above 1299 on printout). In each case, the linked trial of any trial discarded was also discarded along with data from all leads for all 8 seconds. If more than 10 trials all together were deleted for any session, the session was deleted. Only in the case where it would make the difference in saying or discarding a session were the tapes of the session played back and reanalyzed at different levels to recover all the epochs. This was done for 3 sessions. The trials were deleted by experimenters blind to the condition.

The coded tapes were selected by number with no prearrangement except that a different tape be used for each session in a set until all tapes were used once. Only the operator of the logic equipment had the knowledge of which tape was being used and no person knew before any trial what the trial type would be: that information was coded in the tape. The coded tapes were played back through a conventional tape recorder producing pulses of about 5 volts which, mediated by the digital logic, triggered the appropriate stimulus type for any trial. Intertrial interval was fixed by the spacing of pulses on the tape to be 30± 1 second. The command box of the free photic stimulator, when triggered, produced a one second warning tone to both sender and receiver, then flashed a light for 10 seconds when a 16Hz trial was ordered, or did nothing if a null trial was ordered. The digital logic meanwhile kept track of the events from the tape and command box and sent pulses to turn on and off the analyzer at one and ten seconds respectively from the onset of the trial. For each trial the digital logic generated pulses to be recorded on the Hewlett-Packard tape for use, if necessary, in computer analysis of the data. A 16Hz trial was differentiated from a OHz trial by the presence of an initial .5 volt positive pulse for the 16Hz trial. This was the only electronic event of difference to the conditions that entered the recording area while the experiment was in progress.

The "sender" sat before the photic stimulator* and behind a partition in a separate room from the receiver or the recording equipment, but shared a room with the logic, equipment and monitors. The number of people in the room with the stimulator and the sender varied from one to three. Noise from the street and hallway were also variable.

The "receiver" sat upright in a sound-attenuated darkened room and made no overt responses for set 1, but was required to press a button to indicate her idea of trial type about 12 seconds after the warning tone for set 2. The subject being familiar with the nature of the experiment was not formally instructed for each session.

The EEG output (J6) of the Grass model 7 was sent to our data analysis system, described above and also to a Hewlett Packard FM tape recorder, through a Vetter multiplex system. Our obtained means in arbitrary relative power units are in summary in the table below with those differences significant at greater than .05 starred. A "set" was defined as a 100 acceptable trials to each type. After the first set, minor modifications (such as a button to indicate guesses) were added, and a second set was run. The total number of acceptable trials was 212 of both types, or 424 total.

The previous experiment reported a decrement at O_z-linked mastoids at 16Hz compared with the null condition, in the second four seconds. We did not find this but did find a significant decrement in Oz in the first 4 seconds of the first set. None of the other Oz comparisons attain significance and the combined set 1 and set 2 first 4 seconds is not significant. Therefore we did not directly repeat your earlier findings.

However, the other occipital leads do also show consistent decrements at 16Hz compared with null, and analyzing all the data from O1 on all 424 trials over 8 seconds shows a consistent decrement.

This finding is most encouraging and does lead us to pursue the matter further. There does seem, in these data, an indication of a consistent effect which is difficult to explain by any arbitrary hypotheses

Since these data are so consistent, even though it is only one subject and the possibilities so intriguing, we propose to continue our explorations. Specifically, we would like to explore factors on this experiment such as the dependence of this effect upon the "sender" and to set the experiment so that no one knows during the experiment which trial is which. We would also like to explore more elaborate physiological monitoring of the subject to more precisely determine the locus of the effect (we found significance in this experiment in the occipital but not in the central leads), and its dependence upon site of reference.

We would also like to determine the subject variables such as Ms. Hamid's EEG under our series of hemispheric activation tasks, and other tests of her sensitivity to internal stimuli. If we can develop a workable

* A battery driven CW incandescent lamp, chopped by a continuously rotating apertured disc.

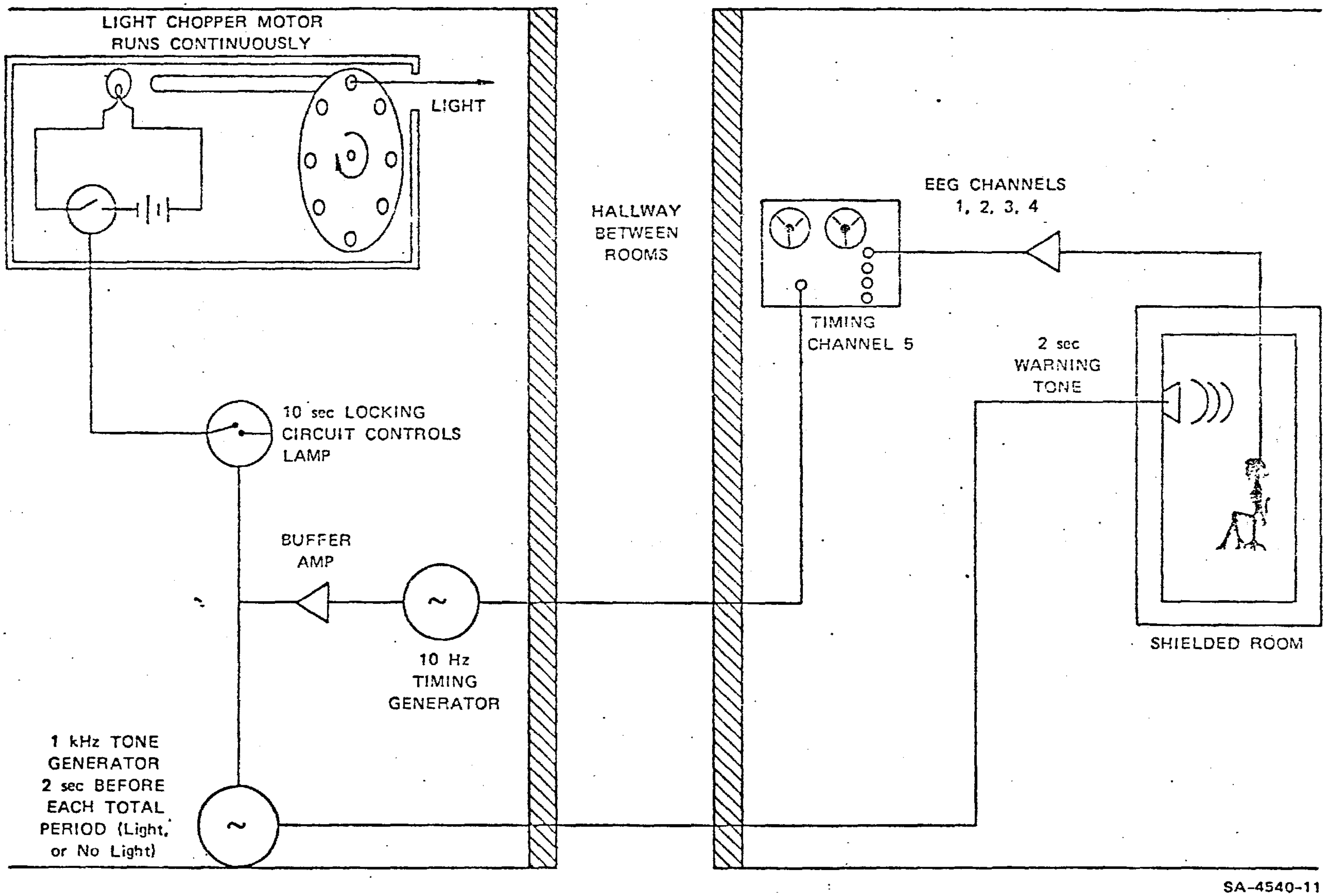

FIGURE 1 REMOTE SENSING EEG EXPERIMENT

SET I

	C3	C4	01	02	0z
0-4 sec.	276 / 261	276 / 245	353 / 305*	425 / 336**	419 / 352*
4-8 sec.	284 / 267	268 / 249	358 / 347	415 / 413	420 / 413
0-8 sec.	560 / 528	544 / 494	711 / 655	841 / 749	839 / 765

COMBINED: 01 ONLY

0-4 sec.	411 / 383
4-8 sec.	419 / 383*
0-8 sec.	830 / 766*

Set II

0-4 sec.	305 / 288	389 / 386	469 / 461	534 / 536	532 / 563
4-8 sec.	303 / 274	411 / 371	479 / 419*	511 / 477	484 / 516
0-8 sec.	608 / 562	800 / 757	948 / 880	1045 / 1013	1015 / 1079

null

16Hz

*sign at <.05
**sign at <.01

experimental paradigm through these further tests and extensions of the method, we would then be in a position to test many subjects in this situation and so begin to determine the generality and distribution of the effect on the population.

Robert E. Ornstein
Langley Porter Neuropsychiatric Institute

POSSIBLE EEG CORRELATES TO REMOTE STIMULI UNDER CONDITIONS OF SENSORY SHIELDING

E. C. May,* Russell Targ, and H. E. Puthoff
Stanford Research Institute, Menlo Park, California 94025

ABSTRACT

We have investigated the ability of certain individuals to perceive remote (faint) stimuli at a noncognitive level of awareness. To investigate this we have looked for systematic changes in a subject's brainwave (EEG) production occurring at the same time as light flashes are generated on a random schedule in a remote laboratory. Although we have found in this investigation that significant correlations appear to exist between the times of light flashes and the times of brainwave alterations, we consider these data to be only suggestive, with a definitive result requiring further experimentation.

INTRODUCTION

In a number of laboratories evidence has been obtained indicating the existence of an as-yet-unidentified channel wherein information is coupled from remote electromagnetic stimuli to the human nervous system as indicated by physiological response, even though overt responses such as verbalizations or key presses provide no evidence for such information transfer. Physiological measures have included plethysmographic response[1] and EEG activity.[2,3] Kamiya, Lindsley, Pribram, Silverman, Walter, and others have suggested that a whole range of EEG responses such as evoked potentials (EPs), spontaneous EEG, and the contingent negative variation (CNV) might be sensitive indicators of the detection of remote stimuli not mediated by usual sensory processes.[4]

A pilot study was therefore undertaken at SRI to determine whether EEG activity could be used as a reliable indicator of information transmission between an isolated subject and a remote stimulus. Following earlier work of others, we assumed that perception could be indicated by such a measure even in the absence of verbal or other overt indicators.

To aid in selecting a stimulus, we noted that Silverman and Buchsbaum attempted, without success, to detect EP changes in a subject in response to a single stroboscopic flash stimulus observed by another subject.[5] 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.[6] Therefore, in our study we chose to use repetitive light bursts as stimuli.[7-9]

PILOT STUDY AT SRI

In the design of the study it was assumed that the application of remote stimuli would result in responses similar to those obtained under conditions of direct stimulation. For example, when normal subjects are stimulated with a flashing light, their EEG typically shows a decrease in the amplitude of the resting rhythm and a driving of the brain waves at the frequency of the flashes.[10] 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 (8-13 Hz) activity, and possibly EEG driving similar to that of the sender, either by means of coupling to the sender's EEG, or by coupling directly to the stimulus.

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

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

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

On each trial, a tone burst of fixed frequency was presented to both sender and receiver and was followed in one second by either a 10 s train of flashes or a null flash interval presented to the sender. Thirty-six such trials were given in an experimental session, consisting

*Consultant to SRI.

of 12 null trails--no flashes following the tone--12 trials of flashes at 6 f.p.s. and 12 trials of flashes at 16 f.p.s., all randomly intermixed, determined by entries from a table of random numbers. Each of the trials consisted of an 11-s EEG epoch. The last 4 s of the epoch were selected for analysis to minimize the desynchronizing action of the warning cue. This 4-s segment was subjected to Fourier analysis on a LINC 8 computer.

Spectrum analyses gave no evidence of EEG driving in any receiver, although in control runs the receivers did exhibit driving when physically stimulated with the flashes. But of the six subjects studied initially, one subject showed a consistent alpha blocking effect. We therefore undertook further study with this subject. Of our six subjects, this one had by far the most monochromatic EEG spectrum. Figure 1 shows a typical occipital EEG spectrum of this subject.

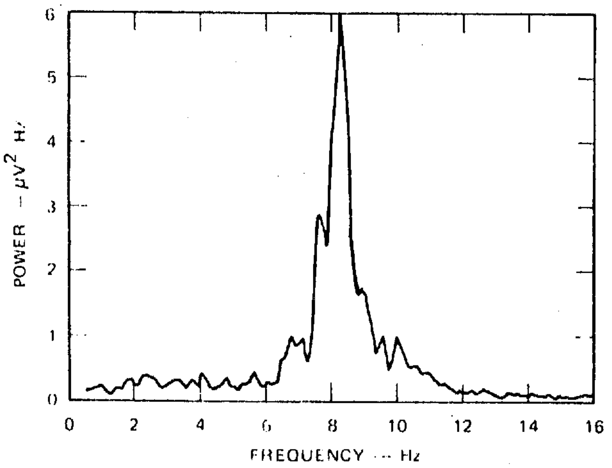

FIGURE 1 TYPICAL POWER SPECTRUM AVERAGED OVER TWENTY 8-SECOND EPOCHS

Data from seven sets of 36 trials each were collected from this subject on three separate days. This comprised all the data collected to date with this subject under the test conditions described above. The alpha band was identified from average spectra; then scores of average power and peak power were obtained from individual trials and subjected to statistical analysis. The final analysis showed that power measures were less in the 16 f.p.s. case than in the 0 f.p.s. in <u>all</u> seven sets of peak power measures and in <u>six</u> out of seven average power measures.

Siegel's two-tailed t approximation to the nonparametric randomization test[11] was applied to the data from all sets, which included two sessions in which the sender was removed. Average power on trials associated with the occurrence of 16 f.p.s. was significantly less than when there were no flashes ($t = 2.09$, d.f = 118, $P < 0.04$). The second measure, peak power, was also significantly less in the 16 f.p.s. conditions than in the null condition ($t = 2.16$, d.f. = 118, $P < 0.03$). The average response in the 6 f.p.s. condition was in the same direction as that associated with 16 f.p.s., but the effect was not statistically significant.

As part of the experimental protocol the subject was asked to indicate conscious assessment for each trial as to which stimulus was generated. The guess was registered by the subject via one-way telegraphic communication. An analysis of these guesses has shown them to be at chance, indicating the absence of any supraliminal cueing, so arousal as evidenced by significant alpha blocking occurred only at the noncognitive level of awareness.

Several control procedures were undertaken to determine if these results were produced by system artifacts or by subtle cueing of the subject. Low level recordings were made from saline of 12 kΩ resistance in place of the subject, with and without the introduction of 10 Hz, 50 μV signals from a battery-operated generator. The standard experimental protocol was adhered to and spectral analysis of the results were carried out. There was no evidence in the spectra associated with the flash frequencies, and the 10 Hz signal was not perturbed.

In another control procedure a five foot pair of leads was draped across the subject's chair (subject absent). The leads were connected to a Grass P-5 amplifier via its high impedance input probe. The bandwidth was set 0.1 Hz to 30 kHz with a minimum gain of 200,000. The output of the amplifier was connected to one input of a C.A.T. 400C "averager." Two-second sweeps, triggered at onset of the tone, were taken once every 13 seconds for approximately two hours, for about 550 samples. No difference in noise level between the foreperiod and the onset of flicker was observed.

REPLICATION STUDIES AT LANGLEY PORTER

The next effort was directed toward replication by an independent laboratory of the original SRI study of EEG response to remote strobelight stimuli. Arrangements for replication were made with the Langley Porter Neuropsychiatric Institute, University of California Medical Center, San Francisco.

As a special precaution against the possibility of system artifacts in the form of electromagnetic pickup from the strobelight discharge or associated electronic equipment (e.g., through the power lines), SRI developed an entirely battery-operated package for use as a stimulus generator for the EEG experimentation. It consists of a battery-driven incandescent

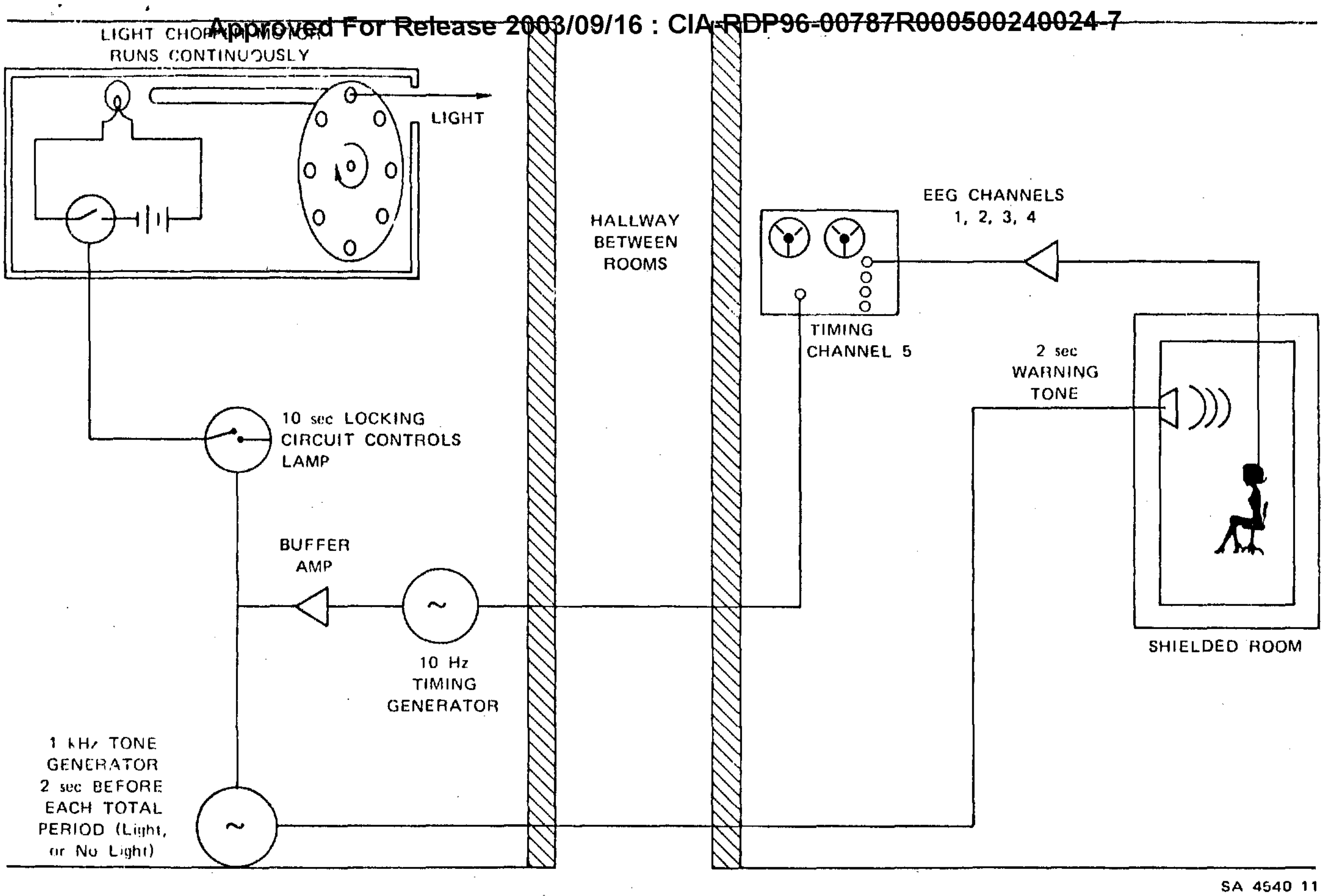

FIGURE 2 SCHEMATIC OF THE REMOTE SENSING EEG EXPERIMENT

lamp, whose CW output passes through a mechanical chopper continuously driven by a battery-driven motor as shown in Figure 2. A 10-Hz timing generator (computer triggered) controls the generation of a 1-kHz warning tone two sec before onset of the experimental period, and also drives a locking circuit that determines the presence or absence of the ten-sec light stimuli, again all battery operated. Thus everything on the left of the diagram of Figure 2 is battery operated and therefore independent of the power line system. Further, replacement of the arc-discharge strobelamp by an incandescent lamp eliminates the possibility of direct subliminal pickup of audio or electrical signals from possible transients associated with the arc discharge or associated electronics.

Description of the EEG Processor

A hardware single channel power spectrum analyzer was constructed from a commercial band-pass filter with corner frequencies of 9.0 and 12.0 Hz, and 48 dB down at 8.0 and 13.0 Hz. Analog multipliers convert the filter output to a signal proportional to in-band power. To confirm that this system is equivalent to the standard FFT analysis used in the pilot study, the analog data of the pilot study was reanalyzed, and the result was found to be consistent with the earlier analysis.

Experimental Protocol

Each experimental session consisted of 40 trials, 20 each for the 0 (no light) and 16 f.p.s. of the remote light stimulus. A trial is defined as a warning tone followed by a 10 second period consisting of a 2 second wait, and two 4 second data collection periods. The trial rate was one trial every 30 ± 1 seconds. The trial sequence was randomized subject to the following conditions: (1) in each group of 10 trials there were equal numbers of each condition, and (2) no more than three in a row of a single type were allowed. Seven 40 trial sequences were made according to this prescription and recorded separately on audio tape. During the session, trials were generated from one of these tapes and the sequence was unknown to the experimenters since the sequence tapes were generated one month in advance of the experiments. As in standard EEG protocol, and in accordance with preestablished criteria, certain trials were deleted after the session for three reasons only: artifact, logic circuit failure, or abnormal EEG power. If a trial was rejected, a trial of the opposite stimulus condition was rejected at random from the particular set of 10 trials in question. If more than 10 trials of a given type were rejected from a session, the entire session was deleted. (This occurred twice in each experiment.)

Six channels of EEG and one logic channel taken from the sequence tape were recorded on a multiplexed FM analog tape recorder. The logic on the tape differentiated the trials between flashing and nonflashing conditions.

In pretesting the equipment, we ran the experiment using unselected subjects such as laboratory personnel, in order to test the adequacy of the experiment and to determine whether there were any correlated electronic or mechanical discharges from the apparatus. In 20 sessions of data acquisition, of 40 each (800 trials) there were no significant differences between the null and 16 Hz conditions.

RESULTS

Using the above protocol, two experiments were conducted during a three-month period. For half of the sessions, the subject was asked to press a button when she felt the light was flashing. For the six sessions (105 trials each for the 0 and 16 f.p.s. conditions when she was not asked to overtly indicate her feelings about the light, there was a slight decrease of in-band EEG power measured over the left occipital region of the brain. Similarly, for the six sessions (107 trials each for the 0 and 16 f.p.s. conditions) when she was asked to respond overtly, there was this time a significant decrease of in-band EEG power ($p \leq 0.037$, using an F ratio test derived from a two-way analysis of variance). In considering the experiment as consisting of the combined 212 trials in each stimulus condition regardless of the overt response contingency, we find a statistically significant decrease in in-band EEG power ($p < 0.011$, using F ratio test as above).

During the second experiment, three months later, a different contingency was added to determine if a "sender" was necessary to produce the effect we had observed earlier. For a given session, a random procedure (with equal trials) was used to determine if a person (called the "sender" person) would be looking at the photo-simulator. There was no one present with the photo-stimulator otherwise. For the 7 "non-sender" sessions (121 trials each for the 0 and 16 f.p.s. conditions) we find a statistically significant increase of in-band EEG power measured over the mid-occipital region of the brain ($p < 0.039$ using an F ratio test as above). During the "sender" sessions (123 trials in each stimulus condition) there was a slight increase of in-band EEG power. All together, there was a statistically significant increase of in-band EEG power when the 244 trials were analyzed regardless of "sender" condition ($p < 0.008$ using an F ratio test as above), and there was no significant difference found between "sender"/"no-sender" conditions.

For both experiments, we considered in-band EEG power for the 0-4 second and 4-8 second time periods independently to determine if the effects were time dependent. Although some of these isolated sub-intervals were statistically significant, no systematic relationship emerged. Thus the effect appears to be cumulative over the 8 seconds. The 0-8 second results are summarized in Table 1.

Table 1

SUMMARY OF RESULTS OF THE REPLICATION EXPERIMENTS SHOWING POWER MEANS AND STATISTICAL RESULTS FOR THE VARIOUS EXPERIMENTAL CONDITIONS

	Experiment I			Experiment II		
	Guessing Sessions	Non-Guessing Sessions	Combined	Sender Sessions	Non-Guessing Sessions	Combined
No light flash	957	704	832	854	766	810
Light flash	873	647	761	860	844	852
F ratio	4.39	2.20	6.47	0.017	4.33	7.03
df_1; df_2	1; 202	1; 198	1; 400	1; 232	1; 228	1; 460
$p \leq$	0.037	0.14	0.011	0.90	0.039	0.0083

DISCUSSION

Although our pilot experiment and the two replication studies all showed significant changes in EEG production correlated with the presence or absence of a remote light stimulus, the sign of the systematic change in power in the third study was opposite to that of the first two. We therefore undertook a detailed frequency analysis of the EEG data tapes from the last two experiments, since the pilot experiment had already been subjected to fast-Fourier-transform (FFT) analysis. We conjectured that the observed power change in these experiments might be the result of a very small frequency shift, which could become translated into a large amplitude change due to discriminator action of the alpha-band filter. In a chapter on alpha blocking, Kooi, in his Fundamentals of Electroencephalography says, for example, ". . . attentiveness is associated with a reduction in amplitude and an increase in average frequency of spontaneous cerebral potentials. . . The center frequency of the alpha rhythm may be influenced by the type of ongoing mental activity. Shifts in frequency may be highly consistent as two different tasks are performed alternately." The FFT analysis for the second experiment showed that the average peak EEG power occurred most often near 8 Hz, and thus fell slightly below the hardware summing window (±3 dB at 8.7-12.4 Hz) enhancing a possible discriminator effect. The FFT analysis further showed that there was an overall increase in frequency of peak power but the shift was statistically nonsignificant. This slight shift of 0.11 Hz could possibly account for the observed power increase due to the highly, nonlinear discriminator effects. In examining other portions of the spectrum for further effects, we found that systematic amplitude changes are highly dependent upon where in the frequency spectrum the power sum is taken. This is to be expected since almost all EEG phenomena are known to be strongly frequency dependent.

In the pilot study the frequency region for analysis was centered about the subject's dominant EEG output frequency with bandpass determined by the full width ten-percent power points. In the two replication studies we used hardware filters at this same frequency. FFT analysis showed clearly that if other filter bands had been chosen, significant correlations would not have been found. Thus, although our filter selection was made before the collection of any data, other experimenters might have reasonably chosen other criteria for frequency selection. Therefore, although we have found statistically significant evidence for EEG correlates to remote light flash stimuli, we consider these data to be only suggestive, with a definitive result requiring further experimentation.

REFERENCES

1. E. D. Dean, Int. J. of Neuropsychiatry, Vol. 2, p. 439, 1966.
2. C. T. Tart, Int. J. of Parapsychology, Vol. 5, p. 375, 1963.
3. T. D. Duane and T. Behrendt, Science, Vol. 150, p. 367, 1965.
4. R. Cavanna, Ed., Psi Favorable States of Consciousness. New York: Parapsychology Foundation, 1970.
5. Ibid., pp. 143-169.
6. Ibid., pp. 158-159.
7. R. Targ and H. Puthoff, "Information Transmission Under Conditions of Sensory Shielding," Nature, Vol. 252, No. 5476, pp. 602-607, October 18, 1974.
8. C. Robert and A. Turner, "EEG Spectrum Analysis Techniques Applied to the Problem of Psi Phenomena," Physician's Drug Manual, Vol. 5, Nos. 9-12, Vol. 6, Nos. 1-8, pp. 82-88, January-December 1974.
9. H. Puthoff and R. Targ, "A Perceptual Channel for Information Transfer Over Kilometer Distances: Historical Perspective and Recent Research," Proc. IEEE, Vol. 64, No. 3, pp. 329-354, March 1976.
10. D. Hill and G. Parr, Electroencephalography: A symposium on its Various Aspects. New York: MacMillan, 1963.
11. S. Siegel, Nonparametric Statistics for the Behavior Sciences. New York: McGraw-Hill, 1956, pp. 152-156.