Final Report *30 September 1980*

ELECTRONIC SYSTEM PERTURBATION TECHNIQUES (U)

By: EDWIN C. MAY BEVERLY S. HUMPHREY G. SCOTT HUBBARD

SPECIAL ACCESS PROGRAM FOR GRILL FLAME. RESTRICT DISSEMINATION TO ONLY INDIVIDUALS WITH VERIFIED ACCESS.

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Final Report
Covering the Period 6 June 1979 to 2 August 1980

30 September 1980

ELECTRONIC SYSTEM PERTURBATION TECHNIQUES (U)

By: EDWIN C. MAY BEVERLY S. HUMPHREY G. SCOTT HUBBARD
(Consultant)

SRI Project 8585

SPECIAL ACCESS PROGRAM FOR GRILL FLAME. RESTRICT DISSEMINATION TO ONLY INDIVIDUALS WITH VERIFIED ACCESS.

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I OBJECTIVE (U)

(S) The objective of this program is to determine the degree to which selected personnel are able to interact, by mental means alone, with sensitive electronic equipment, and to ascertain how this phenomenon might be utilized for Army-designated applications.

II EXECUTIVE SUMMARY (U)

(U) In this report, we consider the possible production by individuals of physical effects, such as the perturbation of sensitive electronic equipment that appears to be well shielded against, or otherwise inaccessible to, human influence. The precedent for considering whether sensitive electronic equipment can be influenced as a result of a remote perturbation (RP) phenomenon has been established in the open literature in 48 published papers.[1-48*] These reports describe 214 separate experiments, 74 of which show statistical evidence for an anomalous perturbation--a factor of nearly seven times chance expectation.

(U) A representative experiment of this type involves three basic elements:

(1) A source of "true" random electronic output.

(2) A statistical analysis technique.

(3) An individual who attempts to cause, by mental means alone, a change in the random source's output.

(U) Although the data base cited above appears to be quite impressive, a close examination of these studies reveals that they all can be considered incomplete in one or more significant details. For example, 44% of the references report no control tests of any type, and the majority of the studies afford insufficient details about the experimental apparatus to permit assessment of possible environmental influences.

(S) We believe that the serious implications of RP for science in general and for military applications in particular necessitated the

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* (U) References are listed at the end of this report.

(S)

design and execution of a random number generator (RNG) experiment, which attended to these important factors. A one-year, two-phase program was initiated to accomplish this objective.

(U) During Phase I a computer-based binary RNG system was constructed from two isolated sources (noise diode and radioactive β-decay source), an LSI-11 microcomputer, and a video graphics display unit. Pulses from a given random source were used to construct binary sequences. Sequential analysis, a particularly sensitive method of determining whether a given sequence is "random," was applied to this binary output. Finally the results were stored for further analysis and displayed on the video graphics system.

(U) The results of Phase I are described in detail in May and Hubbard[49], but are summarized briefly here. Both sources were investigated for their sensitivity to changes in physical environment, and those parameters that were found to influence them were either controlled by cut-off circuitry or monitored. The sources were shielded, electrically isolated, and coupled to the computer by optical transmission links. Both the sequential analysis program and the sources were modeled by Monte Carlo techniques and found to be well within expected limitations. The entire RNG system was tested by a series of standard fixed-length statistical tests and found to meet all standard criteria for randomness. In addition, the system was checked using the variable-length sequential analysis procedure. The binary sequences also satisfied the criteria set by that technique for randomness.

(U) The requirements and protocol for Phase II are detailed in May et al.[54] During this phase we screened 17 volunteers and selected seven of them to participate in the formal portion of the experiment. We set an a priori criterion that required significant runs from two of the seven subjects to label the entire effort a success. It was also

(U)

predetermined that over a period of three months each subject would complete 100 trials.

(U) A trial is defined as a variable-length sequence terminated by the a priori criteria set by sequential analysis. Only two results are possible from a single sequential analysis trial: the binary sequence is distorted (i.e., the probability of finding a one in a given bit position is either greater than 0.52 or less than 0.48), or the sequence is within chance expectation. These two decisions are made to within a confidence level of 95 percent. For a single subject to contribute a significant result to the overall series, he had to produce 16 or more distorted trials out of his set of 100.

(U) Two types of control trials were taken during the formal portion of Phase II: (1) global trials that usually were generated in sets of 100 each at random times throughout the investigation, and (2) local trials that were taken immediately prior to each subject's period of effort. Both types of controls were generated without personnel in the experimental area. The global trials served as a time-independent check on the parent distribution from which the samples were drawn. The local control trials tested the momentary statistical fluctuations immediately before the formal session.

(U) The results from the study met the preestablished, formal criteria for success:

- Two out of the seven subjects produced significant runs. (The possibility that chance fluctuations alone could produce this result is $p = 0.029$, where p is the probability.)
- Neither type of control run exhibited significant overall deviations from chance expectation.

III INTRODUCTION (U)

(U) Occasionally reports appear of anomalous failures of electronic equipment that seem to be caused by the proximity of certain individuals. Of special interest is a class of phenomena involving perturbation of sensitive equipment isolated from human subjects by distance or shielding. In certain of these instances the generation of such effects appears to be under volitional control of the subjects involved.

(U) Included among the above are experiments in which a subject attempts to perturb the output of an electronic RNG drived by electronic noise or radioactive decay. This kind of RP experiment has an investigative appeal because it involves no subjective interpretation, i.e., the results may be expressed in terms of well-understood statistical theory.

(U) The first such experiment of this type was published in 1970 by Helmut Schmidt.[1] As of December 1979, there have been 47 other papers[2-48] published, mostly in the literature on parapsychology. Almost all of these experiments have two points in common:

- A truely random input device.
- An individual with motivation and intent to have the statistics of the random input device differ from chance expectation during designated periods.

(U) A representative experiment might proceed as follows. A random input device, such as the noise associated with a solid state diode, is used to create a random binary sequence. The accumulated number of ones in the sequence is indicated to the subject by lights connected to the noise source. In a successful experiment the subject is able to enforce an excess number of ones. As in the case of biofeedback research, effects have been demonstrated even when little is known about the mechanism.

(U) We have examined the body of literature spanning the ten years from 1970 to 1979. In this survey, we have only considered the random generator experiments published in the three major U.S. parapsychological journals: The Journal of the American Society for Psychical Research, Journal of Parapsychology, and Research in Parapsychology. This survey, which represents the vast majority of the published RNG studies, is detailed in the Appendix and summarized in Table 1. Forty-eight papers reported a total of 214 individual experiments, 74 of which claimed statistically significant results.* The chance likelihood of such an outcome is approximately 2×10^{-41}.

(U) This impressive statistic must, however, be evaluated with respect to experimental equipment and protocols. All the studies surveyed could be considered incomplete in at least one of the following four areas:

(1) No control tests were reported in more than 44 percent of the references. Of those that did, most did not check for temporal stability of the random sources during the course of the experiment.

(2) There were insufficient details about the physics and constructed parameters of the experimental apparatus to assess the possibility of environmental influences.

(3) The raw data was not saved for later and independent analysis in virtually any of the experiments.

(4) None of the experiments reported controlled and limited access to the experimental apparatus.

(S) We believe that the serious implications of RP for military applications and for science necessitated the design and execution of an RNG experiment that was more complete with respect to the four points enumerated above.

(U) A two-phase program was initiated to accomplish the objective stated at the outset. Phase I aimed to develop a reliable computer-based,

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*(U) $p \leq 0.05$ for any individual experiment.

Table 1

(U) RNG SURVEY SUMMARY

Numbers of References	Year	Number of Experiments	Number of Significant Experiments ($p \leq 0.05$)
2	1970	3	3
3	1971	6	4
5	1972	22	12
2	1973	7	7
3	1974	14	7
6	1975	17	7
10	1976	43	12
9	1977	46	10
6	1978	28	7
2	1979	28	5
48		214	74

(U)

noise-driven RNG system and to certify that the binary bit streams produced by the generator met a number of statistical criteria for randomness. This report recapitulates the detailed Phase-I discussion contained in May and Hubbard[49] and summarizes the experimental modifications that address the above mentioned four areas.

(U) During Phase II, seventeen personnel were screened to select the seven individuals who participated in the formal portion of this Phase. The testing procedure and the results are described in detail below.

IV RANDOM NUMBER GENERATOR SYSTEM (U)

(U) To achieve the objective of this program, we developed a computer-based random number generator. Special efforts were made in two specific areas: First, extensive testing of the true random sources was carried out to study their response to environmental factors. Second, a variety of statistical tests were applied to the complete system to ensure that the output was truly random under experimental conditions.

A. Hardware (U)

(U) Figure 1 shows the overall hardware configuration, which consisted of three basic elements: (1) an isolated source of random electronic signals, (2) an analysis and control section, and (3) a graphics display unit. Following the techniques of learning theory, we used the graphics display unit to provide visual feedback of information about the current

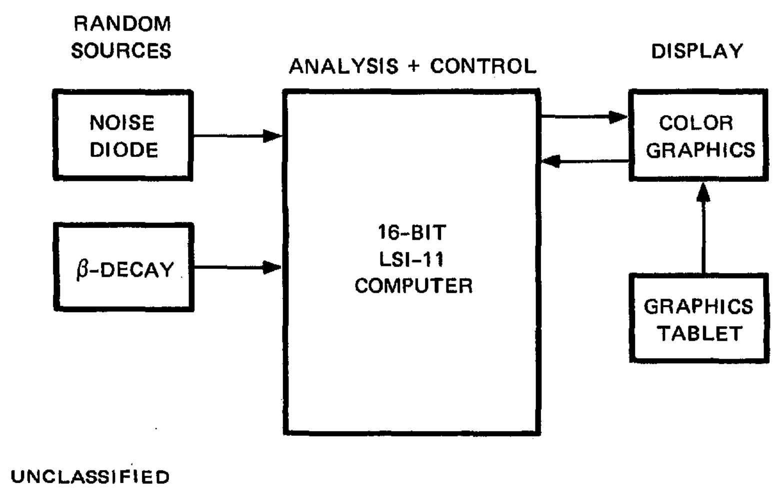


FIGURE 1 (U) BLOCK DIAGRAM OF COMPUTER-BASED RNG SYSTEM

(U)

status of the binary sampling. We hypothesized that in this fashion the subject might learn to influence the sequence more readily.

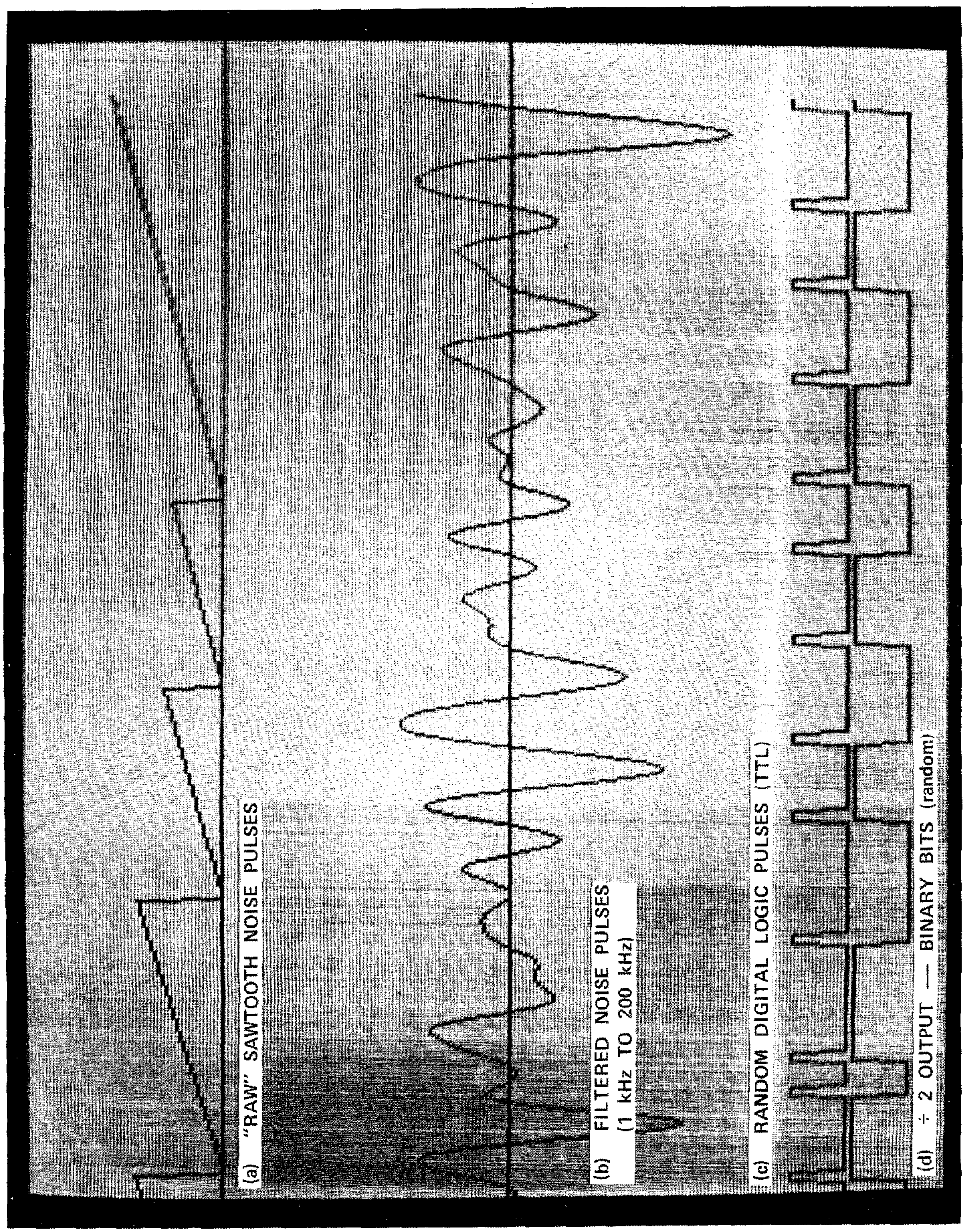
1. Random Sources (U)

(U) The random source elements consisted of a commercially available noise diode and a radioactive source with an appropriate radiation detector.

(U) A Texas Instruments MD-20 planar silicon noise diode was chosen for its large noise output ($\sim 500\ \mu V/\sqrt{Hz}$) and its well-described functional characteristics.[50,51]

(U) ^{147}Promethium (^{147}Pm) was selected as a radioactive source because it is nearly a 100-percent β emitter with essentially no competing decay modes. Detection of the electron continuum was accomplished using a well-understood and reliable ORTEC silicon surface-barrier detector.

(U) Figure 2 shows the process by which a random number was generated from the noise diode source. Random-amplitude 1-MHz sawtooth voltage pulses from the diode, Figure 2(a), were filtered by a bandpass filter, Figure 2(b). At each positive-going zero crossing of the filtered signal a TTL pulse was generated, giving a random digital signal, Figure 2(c). Finally, a divide-by-two circuit changed state at the rising edge of each TTL pulse, yielding a binary bit stream, Figure 2(d) with probability of being in the logical one state of one-half. This bit stream was sampled and shifted into an 8-bit shift register at a 1-kHz rate, so that a random 8-bit number might be selected at intervals greater than 8 ms. A completely analogous process occurred with the β-decay source. The major distinction was that electrons of random energy arrived at a detector where they were converted into electrical signals of random voltage. A low-level discriminator generated a logic pulse whenever the



UNCLASSIFIED

FIGURE 2 (U) PULSE PROCESSING SEQUENCE

(U)

voltage rose above a threshold corresponding to electron energy of 25 keV. From this point the signal processing was the same as described above for Figure 2(c).

2. Analysis and Control (U)

(U) The analysis and control portion of the system consisted of an LSI-11 microcomputer. The LSI-11 was programmed to sample one of the noise sources at a specified rate to obtain its random bits. A sequence of such samples was tested by the LSI-11 for an excess or lack of ones on a continuous basis, using a sequential analysis statistical technique.[52,53]

(U) Sequential analysis is an efficient technique for determining whether the output of a binary random generator contains a distribution of zeroes and ones as expected, or is distorted. The principal advantage of this technique as compared with other methods is that, on the average, fewer bits per final decision are required (roughly 50 percent fewer) for an equivalent degree of statistical reliability.

(U) Before we are able to detect whether the random output of a binary generator has been distorted, we must a priori define criteria as to how much distortion we require, and what statistical risks we are willing to accept for making an incorrect decision. To meet these criteria, sequential analysis demands the specification of four parameters to determine to which binomial distribution a particular data sequence belongs. The four parameters are: (1) p_o, the fraction of ones expected in an undistorted distribution; (2) p_1, a threshold for the fraction of ones assigned to define distorted distributions; (3) α, the assigned acceptable probability for concluding that the random source is perturbed (p_1 distributor or greater) when it is not (Type I error); (4) and β, the assigned acceptable probability for concluding that the random source is

(U)

unperturbed (p_o distribution) when it is (Type II error). With the parameters thus specified, the sequential sampling procedure provides a decision graph as shown in Figure 3. In this figure, the y axis displays the accumulated number of excess ones (number of ones less expected number of ones) as a function of sample number (x axis). Using Figure 3, a decision can be made after the nth sample by applying the following algorithm:

(1) Sample the binary sequence.

(2) Sum the excess number of ones to date.

(3) If the excess sum of ones lies above Line A but not in Region 1, or below Line B but not in Region 2, do Step 1.

(4) If the sum lies in Region 1, stop the sampling and conclude that the binary sequence is derived from a distorted distribution with fraction of ones greater than p_1.

(5) If the sum lies in Region 2, stop the sampling and conclude that the sequence belongs to a distorted distribution with fraction of ones less than $1 - p_1$.

(6) If the sum attempts to cross both Line A and Line B, stop the sampling and conclude that the sequence belongs to the undistorted distribution, p_o.

The detailed analysis and mathematical formulations of sequential analysis can be found in May and Hubbard.[49]

(U) For the experiment described in this report, p_o, p_1, α, and β were fixed at 0.50, 0.52, 0.05, and 0.05, respectively.

3. Display (U)

(U) The computer-driven graphics display system consisted of two independent 19-in. color video monitors, a Grinnell display controller, and a Summagraphics 20-by-20-in. graphics tablet. Using these components,

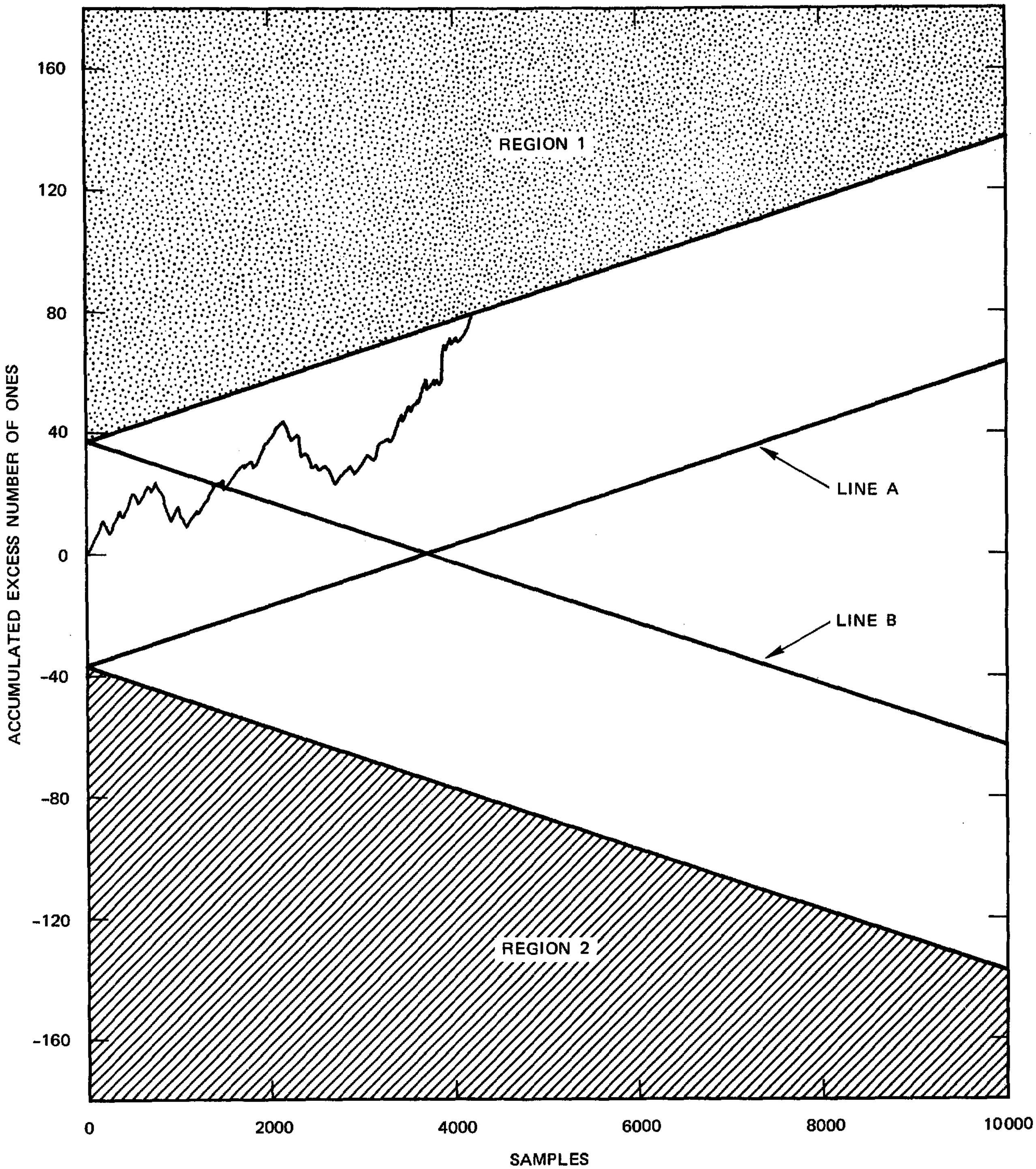


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FIGURE 3 (U) EXAMPLE OF A 2-TAILED SEQUENTIAL SAMPLING PLOT

(U)

data from sequential sampling statistics, pulse height analysis, or any other output could be displayed.

B. System Testing (U)

(U) Noise diodes for use in this system were extensively tested for response to changes in temperature (-40 to +40 C), leakage current (40 μA to 200 μA), and other environmental factors such as a 6000-gauss dc magnetic field and low-intensity radioactive sources (^{241}Am, ^{60}Co, ^{147}Pm). We found that over the range examined for each factor the spectral noise density was flat within ±1 dB for the bandpass of the filter (1 kHz to 200 kHz). Furthermore, the filtered noise followed a Gaussian distribution under all conditions tested as long as the leakage current was 80 to 120 μA. We confirmed the manufacturer's specification for the dependency of the noise power-spectrum on temperature. This change was insignificant for variations of ±5 C near room temperature.

(U) The random emission of electrons from the β decay of ^{147}Pm is independent of known external influences. The sensitive element, the surface barrier detector, was tested for changes in leakage current as a function of temperature. At the maximum temperature tested (~40 C) the noise contribution was caused by the increased current leakage and was eliminated completely with an appropriate low-level discriminator.

(U) We assumed that the TTL logic circuitry of the major system elements (LSI-11, Grinnell controller, and the like) would continue to operate as specified by the vendor, so that extensive environmental testing of these components was not done. Any possible failures of these components would have been observed in the extensive control investigations described below.

C. System Isolation and Interference Protection (U)

(U) To prevent spurious signals from known external influences being incorporated into the random source output, numerous precautions were taken. Each random source was encased in a sealed 0.125-in. thick soft iron box with radio frequency shielding to provide protection against mechanical, magnetic, or rf intrusion. Batteries supplied the electrical power to eliminate ac-line transients and 60-Hz noise. All data output to the LSI-11 occurred via optical transmission links to ensure complete electrical isolation. In addition, the noise diode was monitored continuously with a precision of ±0.2 C to determine any temperature changes.

(U) Fail-safe circuits were included in both random sources so that the units would shut off automatically and require manual reset under the following circumstances:

- The battery supply dropped below a critical point (12 V).
- The electron detector leakage current rose above an acceptable level (2.0 μA).
- The diode current deviated from a narrowly defined current window.

D. System Certification Testing Results (U)

(U) A variety of fixed-length statistical tests were applied to 500,000 sample control runs of random numbers generated by the system described above. In addition, approximately 3×10^6 samples from each source were subjected to sequential analysis. No unexpected deviations from chance expectation were observed in any of these control tests, indicating that the system performed in accordance with design. Complete details of the hardware, computer software, testing procedures, and numerical results can be found in May and Hubbard.[49]

V EXPERIMENT PROTOCOL (U)

(S) A complete experiment protocol was prepared and submitted to the client organization in advance of the formal data-acquisition portion of Phase II. Much of that protocol is repeated here.

A. Definitions (U)

(U) We began the discussion of the Phase II Formal Test Protocol by introducing a set of definitions:

- TARGET BIT — The determined single bit from one of the random sources to be used in the analysis.
- SAMPLE — The acquisition of eight binary bits from the RNG of which the fifth bit is defined as the target bit. (The additional bits are to provide a local temporal history of the bit stream in which the target bit is imbedded.)
- TRIAL — A number of samples comprising a sequence that meet a set of statistical conditions that terminate the sequence.
- RUN — 100 trials
- CONTROL TRIAL — A trial carried out automatically by the computer under the same conditions as the data acquisition session, but with no one present in the session area.
- SEQUENTIAL ANALYSIS — The statistical procedure that provides a decision algorithm for terminating the trial.
- CHANCE DISTRIBUTION — A binomial distribution of binary digits (0, 1) with a mean probability of 0.05 for observing a one as the target bit.
- DISTORTED DISTRIBUTIONS — Binomial distributions with means greater than or equal to 0.52, or less than or equal to 0.48 (a two-tailed test).

(U) Table 2 shows the timing intervals for a sample, trial, and run. It is important to note, that no bits in the binary sequence were lost for a single trial, and that data for each trial was a continuous record of bits collected in 8-bit samples. Thus, the average trial length consisting of 3300 samples was approximately 25 s. All bits from the source that were generated between trials were lost.

Table 2

(U) TIMING INTERVALS

Item	Timing Interval
Sample	8 ms
Trial	~25 s
Run	~3 months

B. <u>Data-Acquisition Session Description</u> (U)

(U) A data-acquisition session was divided into three sections:

(1) Presession

(2) Session

(3) Postsession.

(U) During the presession before the subject's arrival, the hardware was checked for proper functioning, and the set of variables characterizing the session (e.g., time of day, noise source) were entered into the system program. The variables chosen were those specifically determined for that participant during the pilot period. In addition, no less than five control trials were executed with no one present in the session area. These control trials were collected under the same environmental conditions as the

(U)

session trials, except for the absence of putative human intervention. Once the control session was initiated, an automatic trial sequencer cycled through a sequence of trials, spaced apart by random time intervals τ, $0 < \tau < 20$ s. This random spacing insured that the control trials simulated human interaction with the system as closely as possible.

(U) To begin a session, the subject and one monitor entered the session room. The subject took his place in front of the viewing monitor and controlled the start time of the individual trials by means of a start button on a cursor associated with the graphics tablet. This constituted the only form of physical interaction of the subject with the apparatus. The subject's task was to cause mentally either an excess number of ones or an excess number of zeroes in the binary sequence. The session lasted no longer than 30 min. During the session the subject received visual feedback for all trials, and auditory feedback (a bell) for trials that sequential analysis indicated belonged to one of the distorted distributions.

(U) The postsession consisted of a debriefing in which the subject discussed his experience. At the conclusion of the debriefing, there was an additional period during which no less than five more trials were conducted with no one present in the session area. Such postsession trials (not to be confused with control trials) were conducted specifically to investigate the claim that there might be a linger effect associated with putative RP interaction. This linger effect might be compared to the well-understood physics concept of relaxation time. Postsession trials were recorded separately for later analysis.

(U) To allow for a possible linger effect, a minimum of one-hour separation between subjects was generally enforced.

C. Controls (U)

(U) Aside from the presession control trials, a total of 1000 additional control trials were taken in sets of 100 or more for each of the seven participants. These trials were collected at random times on a 24-hour basis to establish the empirical sampling distribution throughout the formal testing period.

D. Test Requirements (U)

(U) The test requirements for a single trial were determined completely by the formulation of the sequential analysis theory. In that analysis a set of decision boundaries completely determines (within the bounds of the Type I and Type II errors specified) from which of the distributions (chance or distorted) a given sequence belongs. Details of this analysis are given in May and Hubbard.[49] For a single trial to be successful, the sequence had to belong to a distorted distribution corresponding either to a mean ≥ 0.52 or ≤ 0.48, with a single-tailed confidence factor of 95 percent. The overall chance likelihood for making a decision in favor of a two-tailed distorted distribution on any given trial was 0.1.

(U) Each subject was required to contribute 100 valid trials.* Of these 100 trials, the number of sequences designated by the sequential analysis as being distorted were tallied by the computer. The probability of obtaining 16 successful events in 100 trials is less than 0.039 (fifteen is greater than $p = 0.05$). The subject therefore had to produce 16 or more successful formal trials out of a total of 100 to have completed a significant run. As during the pilot period, the subject could choose to exercise a pass option before any given trial, in which case it was labeled

*(U) See Part F below for definition of valid/invalid trials.

(U)

as such in the computer record. Regardless of the outcome, a pass did not contribute to the formal series of 100 trials.

(U) For the entire study to have significance, two or more of the seven subjects chosen for the formal study were required to complete significant runs. The probability of obtaining two significant runs out of seven attempts by chance is less than 0.028. The probability of a single significant run is ≤ 0.039.

E. Records (U)

(U) Two types of data recording were utilized during the formal test period:

(1) Recording of summary statistical information.

(2) Bit-by-bit recording of raw data.

For all trials (passes, presession and postsession controls, and the 1000 additional control trials for each participant), a summary statistic was recorded on a single floppy disk. This data included the following:

- Date
- Time of day (to nearest second)
- Temperature of diode (if used)
- Source
- Pass indicator
- Accumulated number of trials
- Accumulated number of successful trials
- Number of samples in the given trial
- Number of ones in that trial
- Sequential analysis decision.

(U) For all trials except the extra 1000 control trials, raw data was recorded on a second floppy disk. These included:

- All the data for each trial from the summary disk (redundancy check).
- All parameters of the sequential analysis used to analyze the trial in question.
- Two bytes of data for each sample, one byte for the random 8-bits acquired for that sample and one byte of count-rate information for secondary analysis (i.e., β-decay rate or the number of voltage zero crossings from the noise diode).
- Target bit position.

F. Trial Invalidation Requirements (U)

(U) The two random sources were equipped with appropriate hardware failsafe circuitry. Nonetheless, to account for possible hardware/software failures, we designated, in advance, the following certain conditions under which data would be rejected as invalid, i.e., not counted as part of the formal series:

- If the battery power supply dropped below a preset level, or various other hardware parameters exceeded their prespecified operating ranges, the source output was inhibited. The system program detected this state and by software forced a "pass" condition for that trial. The trial just prior to system "shut down" was labeled "invalid" regardless of its particular statistic.
- As a further cross-check against possible source hardware difficulty, a trial was labeled "invalid" if the raw data contained five contiguous samples of identical data bytes. The probability of this occurring by chance alone is less than one part in 10^{12}. Because there was no prior evidence that such large-scale effects occur in RNG systems, we concluded that such a sequence of data bytes would most likely have resulted from momentary hardware failure.

G. General Considerations (U)

(S) At no time did the subject have access to the generating hardware, nor was he left unattended in the session area. As a closed, classified area, it is secured by combination and 4-state cipher lock.

(S) The guidelines set forth in May et al[54] with regard to human experimentation were in effect during the course of the experiment.

VI RESULTS (U)

A. Pilot Phase (U)

(U) Seventeen SRI International employees were chosen to take part in the pilot phase of this program. They were selected purely upon their own expressed interest in participating in such a program, rather than on any previous RP experience. During this phase, although the sample rate was fixed at 125 s each subject was allowed to select his favorite time of day, his preferred experimenter, the source which seemed to "work" best for him, and the number of trials he would do at a single sitting.

(U) Two general experimental parameters emerged from the pilot phase. First, it became rapidly apparent to the experimenters that an arbitrary limit of five trials/session seemed optimal. If the subject continued much beyond this limit, he became bored with the task and began to initiate each successive trial in a "mechanical" or rote fashion.

(U) Secondly, we felt that more interesting feedback displays might only serve to divert the subject's attention from the RP task; therefore, we decided not to design alternatives to the display of the sequential sampling decision lines. Neither of these two viewpoints were based on sufficient data to be statistically significant, but the pilot success rate of a number of subjects indicated that these conditions should be included in the formal portion of Phase II.

(U) Because the participants contributed varying numbers of trials, our selection criteria for the formal phase included not only the scoring rate, but also the subject's interest and availability for a three-month period. Table 3 shows the pilot results for each of the seven subjects who were finally chosen for the formal experiment, and an asterisk indicates

Table 3

(U) PILOT PHASE RESULTS

Subject	Source	Trials	Successes†
085	β decay	42	5
130	Diode	115	13
146	β decay	14	2
346	β decay	29	4
531*	β decay	74	16
758	Diode	45	5
827*	Diode	228	31

*(U) Independently significant.

†(U) Probability of a single success of 0.1.

(U)

those who were scoring at a significant rate. The combined score for all subjects using the diode source approaches significance (49 successes for 388 trials, $p \leq 0.054$); the total for the β-decay source is significant (27 successes for 159 trials, $p \leq 4.4 \times 10^{-3}$).

B. Global Control Runs (U)

(U) Global control runs were long sessions of trials generated without intentional influence on the apparatus in the absence of all personnel from the experimental environment. The sessions, which consisted of multiples of 100 trials each, were taken at all times of the day throughout the course of the formal experiment and were designed to monitor the long-term statistical behavior of the random sources. Such long runs average

(U)

over small local deviations and give an accurate measure of the ideal distribution from which the samples are taken (binomial in this case).

(U) The protocol required 1000 trials for each subject. The results of these controls are shown in Table 4 and were analyzed in runs of 100 trials.

(U) The general expression for the expected number of successful runs is:

$$N_s = N_R \times p_s$$

where N_R is the number of runs and p_s is the probability of a single successful run.

(U) The probability of obtaining five or fewer successful trials is ≤ 0.024 (six is not significant). Thus, for this case $N_R = 70$, $p_s = 0.024$ and $N_s = 1.7$. The asterisks in Table 4 indicate those runs with significantly too <u>few</u> successes: The chance probability of this occurring is $p \leq 0.027$.

(U) Similarly, the probability of obtaining 16 or more successful trials is ≤ 0.040 (15 is not significant). Therefore $N_R = 70$, $p = 0.040$, and $N_s = 2.8$. The daggers in Table 4 indicate those runs with 16 or more successful trials: the expected number is three and two were observed (not significant).

(U) In the overall, two-tailed case five runs are expected to show some significant deviation, and seven were observed. This result is not significant and confirms that the long-term parent distribution was binomial.

Table 4

(U) GLOBAL CONTROL RUNS

Set	Subjects						
	085	130	146	346	531	758	827
1	5*	9	8	7	7	12	9
2	14	11	9	10	9	9	10
3	10	10	7	8	12	7	17†
4	12	9	10	7	3*	8	12
5	6	8	6	9	9	6	13
6	11	15	9	13	8	9	6
7	6	6	6	10	10	11	8
8	10	3*	8	11	8	7	7
9	12	5*	7	12	12	9	10
10	13	5*	9	11	19†	10	6

*(U) Significantly too few successes.

†(U) Significantly too many successes.

C. Formal Phase (U)

(U) Each of the seven subjects chosen for the formal phase contributed 100 trials over a 3-month period. Table 5 shows the results of the formal experiment as well as for the local controls and post-session trials.

(U) None of the local control sets before each session were significant for any of the subjects. This indicates that the sources were producing bit streams consistent with the binomial distribution immediately prior to the subject's period of effort.

Table 5

(U) FORMAL PHASE RESULTS

Subject	Controls	Formal Experiment	Post-session
085	8/100	11	5/100*
130	10/105	12	9/100
146	12/105	9	10/105
346	7/85	7	7/75
531*	8/105	17 (p = 0.021)	8/105
758*	9/95	16 (p = 0.040)	9/105
827	9/80	15	5/80

*(U) Independently significant.

(U) A significantly small number of successes was obtained in one postsession run for Subject 085. The remaining postsession runs were within chance expectation.

(U) Subjects 085, 146, 346, and 531 used the radioactive source; Subjects 130, 758, and 827 preferred the noise diode. The formal phase results (Table 5) show that Subjects 531 and 758 produced 17 and 16 successes out of 100 trials, respectively. The odds that chance deviations alone produced this result are greater than 47:1 for 17 successes and greater than 25:1 for 16 ($p \leq 0.021$ and ≤ 0.039, respectively).

(U) The formal requirement, as stated in May et al.[54] was:

> "for the entire study to be significant, two or more of the seven participants chosen for the formal study must contribute significant 100 trial sets (i.e., sets of 16 or more successful trials)."[54]

This requirement has been satisfied. The probability that two or more subjects would produce significant results by chance fluctuations alone is ≤ 0.029.

VII DISCUSSION (U)

(U) The first part of the objective of this program was to determine the degree to which certain selected personnel are able to interact, by mental means alone, with sensitive electronic equipment. To assess the statistical results quoted above properly, we must comment further on the survey results discussed in Section III. One criticism that is levied frequently against such research is the suggestion that the experimenters might only report the good results and ignore the unsuccessful results. Let us suppose, for example, that for every successful experiment reported there were ten other experiments that were both unreported and unsuccessful. If, then, we interpret the survey results in accordance with this hypothesis, the odds are greater than 2500:1 against the chance that the expanded data base would have so many successful experiments. If we consider the complexity and time constraints of the various experiments, it seems unlikely that selective reporting can account for the survey results.

(S) The results might possibly be accounted for by subtle, yet quite ordinary influences. As mentioned in Section II, we noticed four major areas in which the survey was incomplete, which prevented us from properly assessing these influences. The possibility of such influence was one of the principle reasons for repeating the experiment. In our experiment we attended to the insufficiencies as follows:

- As reported in May and Hubbard[49] we performed detailed analyses of the physics associated with the random sources and determined their particular sensitivities to environmental parameters. We noted that the diode was mildly sensitive to temperature, and it was monitored throughout the experiment. (There were no significant correlations of small temperature fluctuations with statistical successes). A quantum

(S)

mechanical model of the diode was developed and found to match direct measurement to within 1 percent error. This model enabled us, by Monte Carlo methods, to simulate temperature fluctuations and assess their influence upon the statistical output. We found that temperature changes of ±20.0 C did not effect the statistical, single bit probability of the binary sequence, which was the expected effect of the 200-kHz bandpass filtering of the diode output. Likewise, large temperature changes in the radioactive source would have added electronic noise to the electron signal, but would not have affected the single bit probability. Considering the isolation precautions and the extensive random source testing described in May and Hubbard,[49] we concluded that the sources were stable against usual and in some cases (magnetic fields, for example), large environmental changes.

- We monitored the output from the sources with global and local control trials throughout the course of the 3-month experiment. Because no long- or short-term statistical changes were observed, we concluded that both sources were stable with time.
- We saved a complete record of the sample-by-sample raw data for both the formal experiment effort as well as for the local control trials. These data were archived with the client organization.
- We conducted the entire experiment in a classified vault: at no time did the subjects have unsupervised access to the room.

(U) The experiment described in this report is more complete with the addition of parameters described above. We have enumerated the individual results for local control, formal, and postsession runs in the previous section. Although the combined results for each of these three categories cannot be reported formally in terms of the protocol,[54] they merit some discussion, nonetheless.

(U) The combined result for the local control runs (63 successes for 675 trials) is not significant, whereas the total across all subjects for

(U)

the formal experiment is. Five of the seven subjects produced runs above chance expectation (ten successes), which contributed to the overall formal score of 87 successes out of 700 trials (p = 0.021). The odds that such a deviation would occur by chance alone are greater than 47:1. Note that none of the formal trials were invalidated under the guidelines of the protocol.

(U) The overall total for the postsession runs is significantly too low (53 successes for 670 trials, p = 0.028). In the protocol we noted that the postsession trials were used as a check on the claim of a linger effect: it has been noted in past experiments that after a significant deviation was observed during a subject's effort period, postsession trials taken just after his effort tended to deviate significantly as well. Usually, these trials would "decay" back to the expected value in a short period of time. We see no evidence of such a correlation in our data, but we note here the significantly low overall result for the sake of completeness.

(U) We conclude that we have observed an anomalous and, as yet, unexplained effect upon an electronic system, which cannot be accounted for easily by simple engineering considerations because

- The magnitude of our results is commensurate with previous reported studies.
- Precautions and controls significantly exceeded any former experiments.

(U) If we assume, then, that we have verified our initial hypothesis that an anomalous RP phenomenon exists, we must then examine the possible mechanisms for this effect.

(U) The first such potential mechanism, and that which is frequently mentioned in the data base, is some form of remote perturbation--that is,

(U)

a physical change in a system that occurs without a subject's physical intervention. In this model, a subject through his volutional control literally "forces" a random source to change its behavior. Although this kind of RP interaction has been reported variously by 5000 years of human culture, it has appeared to be at odds with currently accepted ideas of physics. However, in a recent paper, Y. Aharonov and M. Verdi describe that under specific conditions,

> "... if one checks by continuous observation if a given quantum system evolves from some initial state, to some other final state, along a specific trajectory in Hilbert space, the result is always positive, whether or not the system would have done so on its own accord."[55]

Aharonov's and Verdi's reference to "continuous observation" is a critical point in the paper. They note that to enforce a change of state by continuous observation, the time between successive measurements is many orders of magnitude smaller than is presently possible for real measuring devices. Furthermore, it is a long way from a highly speculative consideration about the nature of a quantum system to a physical explanation for a given experiment. We are not claiming that remote perturbation is the correct or only mechanism for what we have observed in this experiment, but rather that it may have some merit in terms of developing theories in physics.

(U) A second possible mechanism, which was mentioned in Schmidt[1] entails some form of psychoenergetic data selection (PDS). In this mode of operation, the subject scans the unperturbed binary sequence ahead in time and selects the proper time to initiate the trial. This strategy enables him to take advantage of an unperturbed, yet significantly deviant subsequence and achieve a success for that trial. At first thought, this idea also seems inconsistent with current thinking in

(U)

physics because it involves obtaining information about a future state of a random system with virtually an infinite number of possible future states available.

(U) Many physicists have speculated upon the time-reversed information flow for quantum systems, but the most detailed discussion has been presented by O. Costa de Beauregard[56,57]. He shows, by using strict covariant formalism, that advanced probability waves can carry information from some future state of a system backward in time to the present. De Beauregard concludes:

> "... what would the phenomenology of advanced waves, decreasing probability, blind statistical retrodiction, and information as organizing power, look like? Exactly to what parapsychologists call precognition and/or psychokinesis. Logically these phenomena should show up, no less than thermodynamical progressing fluctuations--which indeed they are."[57*]

Within the physics community the concept of gaining information from future events may not be inconsistent with current ideas of quantum physics. Even if such physics speculations of de Beauregard should prove to be true, there are many unanswered questions: how does the subject "receive" such information and in what manner does this information reach the subject's conscious awareness? We must emphasize here that de Beauregard's hypothesis should not be regarded as proof of mechanism, but only as interesting speculation.

(U) In our experiment, it was premature to attempt to determine what mechanism was involved. The first part of the objective simply entailed the verification of the existence of the phenomenon under nearly ideal conditions. Since this objective was met, future work in the area should

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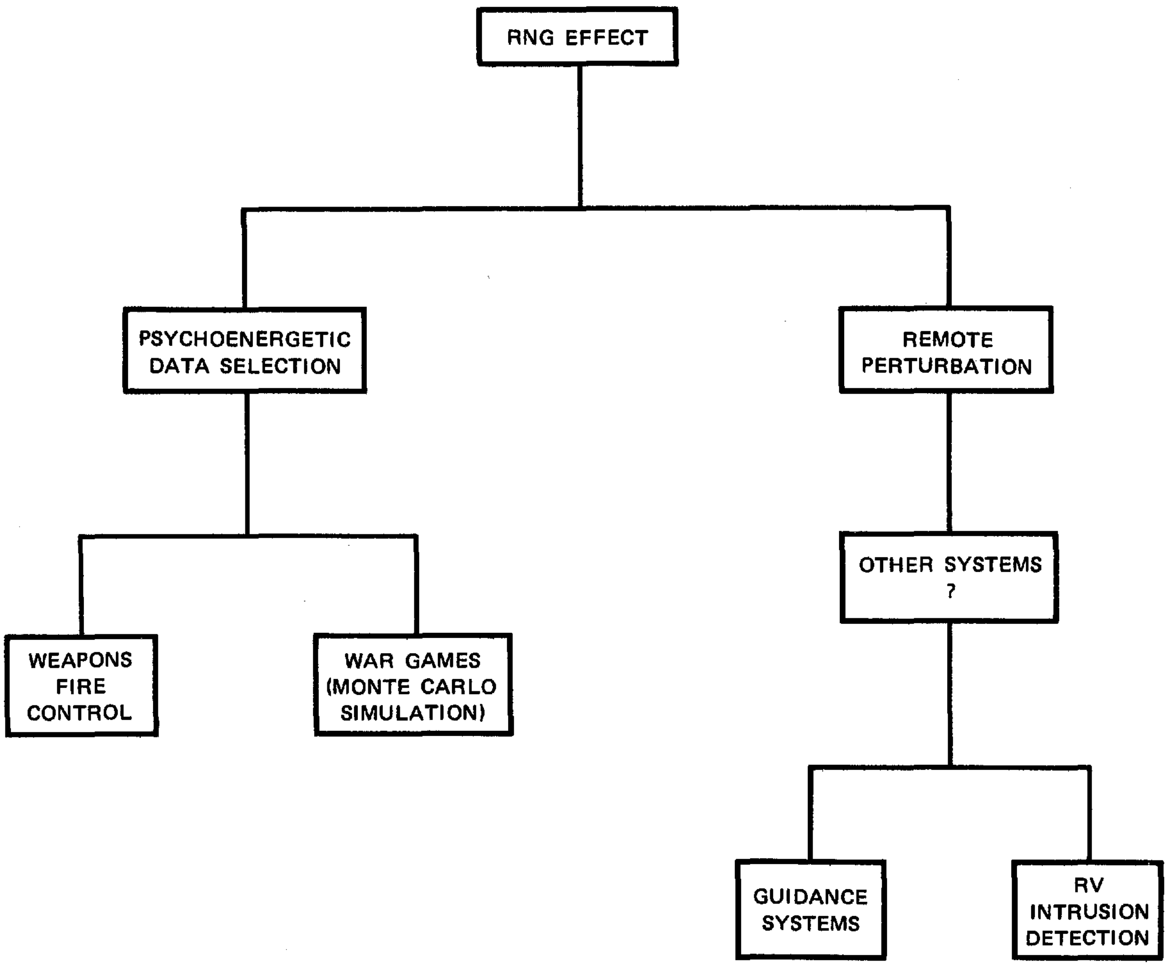
* (U) The emphasis is de Beauregard's.

(U)

focus attention in differentiating between these two possible mechanisms and in searching for others.

(S) The second part of the program objective was to determine how the RP phenomenon might be utilized for Army-designated applications. A particular application potential depends on the type of RP mechanism, and the degree to which Army personnel can be trained to use that mechanism. Figure 4 shows a number of possible application areas that might be considered under each of the two main hypotheses described above.



SECRET

FIGURE 4 (S) RP APPLICATION POTENTIAL

(S) If the phenomenon is mediated by PDS then any situation that entails human-initiated events in random or pseudo-random environments can be considered. We have shown two such possibilities in Figure 4.

(S) In those situations that involve weapons fire control, an individual is responsible for either the actual firing of the weapon, or for the initialization of an automatic fire-control sequence. Trained personnel could significantly increase the kill probability of the particular weapons system by "psychoenergetically selecting" the optimum time to initiate the fire sequence. A PDS ability would be particularly valuable for antiaircraft personnel in a combat situation.

(S) Because PDS does not require some form of physical interaction, it is possible to consider pseudo-random environments, as well. Thus, as shown in Figure 4, any Monte Carlo simulation situation such as war games, must be considered as susceptible to PDS. For example, in assessing strategies by war game techniques, pseudorandom algorithms are consulted to assess weapons performance. If PDS is the mechanism that predominates in RP interactions, it is possible that an operator might bias the results toward a favored strategy by PDS, leading to a misassessment of its effectiveness.

(S) If the phenomenon is mediated by genuine remote perturbation interactions, and systems other than electrical random number generators can be influenced, a different category of applications must be considered. Two such applications are indicated in Figure 4.

(S) First, there are subcomponents to guidance systems that might be particularly sensitive to RP. For example, the electromechanical restoring circuitry contains elements that have appeared to be influenced by RP in quasi-laboratory experiments. If these results were confirmed in controlled laboratory studies, even weak RP, judicially applied, could alter a trajectory to a very significant degree.

(S) Finally in Figure 4, we consider a remote viewing (RV) intrusion detection system. Evidence in the parapsychology literature[58,59] has indicated that RV phenomena are accompanied by associative RP effects. In those experiments, assumed sensitive "detectors" (e.g, a strain gauge[58]) appear to change concomitantly with RV efforts. In the experiment described in this report, it was the subjective assessment of the three best-scoring subjects, that at least part of the effect they were observing, was caused by their ability to focus their attention on the actual generating hardware. Thus, we can conceive of a multifaceted intrusion "detector" consisting of a variety of electronic components. Some or all of those components would have demonstrated susceptibility to RP in laboratory situations. Considering the current ability of our own remote viewers to penetrate secure facilities, we feel that it is important to develop such a detector system.

Appendix (U)

CHRONOLOGICAL LITERATURE SURVEY (U)

Appendix (U)

CHRONOLOGICAL LITERATURE SURVEY (U)

(U) This Appendix chronologically displays a collection of the random number generator (RNG) experiments published during the past ten years in the three major U.S. parapsychological journals: Research in Parapsychology, The Journal of Parapsychology, and The Journal of the American Society for Psychical Research.

(U) In most cases a single reference contains several "separate experiments." We have defined any major change in experimental protocol or variable (e.g., a change of experimenter, type of feedback, etc.) as a separate experiment. A numerical p value is listed in the "Statistics" column for each experiment that is significant at the $p \leq 0.05$ level; an "n.s." indicates "not significant" for all others.

(U) If an experiment (or group of experiments) was published in more than one journal, only one reference--typically the most comprehensive--is cited in the survey.

Appendix I

Table A-1

(U) RNG STUDY SURVEY

Year	Title	Author	Comments	Statistics*
1970	PK Experiments with Animals as Subjects[1]	H. Schmidt	Cat experiment Cockroach experiment	1.60×10^{-2} 1.00×10^{-4}
	A PK Test with Electronic Equipment[2]	H. Schmidt		1.00×10^{-3}
1971	A PK Experiment Comparing Meditating Versus Nonmeditating Subjects[3]	F. Matas L. Pantas	Meditating Nonmeditating	2.00×10^{-2} n.s.
	PK Scoring Under Preferred and Nonpreferred Conditions[4]	L. Pantas	Preferred condition Nonpreferred condition	1.00×10^{-2} n.s.
	Psi Tests with Psychologically Equivalent Conditions and Internally Different Machines[5]	H. Schmidt L. Pantas	Precognition Psychokinesis/precognition	1.00×10^{-2} 1.70×10^{-2}
1972	PK Conditioning[6]	B. Camstra	I. Auditory feedback a. Subjects asked to concentrate b. Subjects asked not to concentrate II. Enhanced feedback: auditory and visual	 n.s. "significant" n.s.

*Equal to or less than the probability that the observed effect occurred by chance deviation alone.

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Table A-1 (continued)

Year	Title	Author	Comments	Statistics
1972	PK Performance with Waking Suggestions for Muscle Tension Versus Relaxation[7]	C. Honorton W. Barksdale	I. Passive concentration/muscle tension	2.00×10^{-3}
			Active/tension	n.s.
			Passive/relaxation	n.s.
			Active/relaxation	n.s.
			II. Replication using individual subjects (not group PK)	
			Passive/tension	n.s.
			Active/tension	n.s.
			Passive/relaxation	n.s.
			Active/relaxation	n.s.
			III. Replication using single subject	
			Tension	5.00×10^{-5}
			Relaxation	5.00×10^{-4}
	Confirmation of PK Action on Electronic Equipment[8]	E. André	I. Experiment 1	
			Morning sessions	3.00×10^{-3}
			Afternoon sessions	n.s.
			II. Experiment 2	
			Morning sessions only (strong decline effects observed)	5.00×10^{-3}
	Psi Tests with Internally Different Machines[9]	H. Schmidt L. Pantas	I. Experiment 1: Groups	
			Precognition	1.00×10^{-2}
			PK	5.00×10^{-4}

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Table A-1 (continued)

Year	Title	Author	Comments	Statistics
1972			II. Experiment 2: single subject	
			Precognition	5.00×10^{-5}
			PK	5.00×10^{-3}
	A Subject's Efforts Toward Voluntary Control[10]	E. F. Kelly B. Kanthamani	Four-button machine	1.00×10^{-9}
			Noise source (two subjects combined)	5.00×10^{-3}
1973	PK Tests with a High-Speed Random Number Generator[11]	H. Schmidt	Slow/visual	1.00×10^{-2}
			Slow/acoustical	1.00×10^{-2}
			Fast/visual	1.00×10^{-2}
			Fast/acoustical	1.00×10^{-2}
	PK Effect on Random Time Intervals[12]	H. Schmidt	Several subjects	2.67×10^{-5}
			One subject	1.45×10^{-4}
			Brine shrimp	1.37×10^{-3}
1974	Psychokinetic Influences on an Electromechanical Random Number Generator During Evocation of "Left-Hemispheric" Versus Right-Hemispheric Functioning[13]	K. Andrew	"Right hemispheric tape"	2.00×10^{-2}
			"Left hemispheric tape"	1.10×10^{-2}
	Observation of Subconscious PK Effects with and without Time Displacement[14]	H. Schmidt	I. Present time	1.00×10^{-3}
			II. Prerecorded test	1.00×10^{-3}
			Prerecorded control	n.s.

Table A-1 (continued)

Year	Title	Author	Comments	Statistics
1974	Comparison of PK Action on Two Different Random Number Generators[15]	H. Schmidt	I. Five subjects/200 trials each	
			Simple generator	5.11×10^{-3}
			Complex generator	n.s.
			Simple generator "inactive"	n.s.
			II. Ten subjects/100 trials each	
			Simple generator	6.74×10^{-3}
			Complex generator	n.s.
			Simple generator "inactive"	n.s.
			III. Twenty subjects/50 trials each	
			Simple generator	3.57×10^{-2}
			Complex generator	n.s.
			Simple generator "inactive"	n.s.
1975	PK Experiment with Repeated, Time Displaced Feedback[16]	H. Schmidt	Present time	5.00×10^{-2}†
			Prerecorded	5.00×10^{-4}†
	Volitional Control in a PK Task with Auditory and Visual Feedback[17]	C. Honorton E. C. May	High aim	9.00×10^{-3}†
			Low aim	n.s.
	A Dynamic PK Experiment with Ingo Swann[18]	E. C. May C. Honorton	PSIFI	1.10×10^{-2}
	A Preliminary PK Experiment with a Novel Computer-Linked High-Speed Random Number Generator[19]	B. Millar R. Broughton	I. RNG 1: 1000/s	n.s.
			II. RNG 2: 100/s	n.s.
			III. RNG 3: 10/s	n.s.
			IV. RNG 4: 1/s	n.s.

†One-tailed.

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Table A-1 (continued)

Year	Title	Author	Comments	Statistics
1975	Psychokinetic Influences on Random Number Generators During Evocation of "Analytic" Versus "Nonanalytic" Modes of Information Processing[20]	W. Braud G. Smith K. Andrew S. Willis	I. (see RIP, 1974, p. 58)	
			II. Physiology monitored/ Experienced monitor	
			Nonanalytical mode	2.50×10^{-2}†
			Analytical	n.s.
			III. No physiology/naive monitor	
			Nonanalytical mode	n.s.
			Analytical	n.s.
	Psychokinesis as Psi-Mediated Instrumental Response[21]	R. Stanford R. Zenhausern A. Taylor M. A. Dwyer	Experimenter 1: conscious PK	n.s.
			Experimenter 1: unconscious PK	n.s.
			Experimenter 2: conscious PK	5.00×10^{-2}
			Experimenter 2: unconscious PK	1.00×10^{-2}
1976	A Test of Intentional Versus Unintentional PK[22]	B. Millar	Intentional condition	n.s.
			Unintentional condition	n.s.
	Effects of Meditation and Feedback on Psychokinetic Performance: A Pilot Study with an Instructor of Trancendental Meditation[23]	C. Honorton	I. Premeditation feedback	
			High-aim	n.s.
			Low-aim	n.s.
			II. Meditation without feedback	
			Theta-alpha	n.s.
			Outside theta-alpha	n.s.
			III. Postmeditation feedback	
			High-aim	2.40×10^{-2}

†One-tailed.

Table A-1 (continued)

Year	Title	Author	Comments	Statistics
1976	Effects of Meditation and Feedback on Psychokinetic Performance: Results with Practitioners of Ajapa Yoga[24]	R. Winnett C. Honorton	I. Premeditation feedback	
			High-aim	n.s.
			Low-aim	5.00×10^{-3}
			II. Meditation without feedback (no physiology)	n.s.
			III. Postmeditation feedback	
			High-aim	n.s.
			Low-aim	n.s.
	The Performance of Healers in PK Tests with Different RNG Feedback Algorithms[25]	D. Bierman N.V.T. Wout	Experiment I	
			Group A: false feedback	
			Fast RNG	n.s.
			Slow RNG	n.s.
			Group B: true feedback	
			Fast RNG	n.s.
			Slow RNG	n.s.
			(RNGs used separately)	
			Experiment II	
			Group A: false feedback	
			Fast RNG	n.s.
			Slow RNG	n.s.
			Group B: true feedback	
			Fast RNG	n.s.
			Slow RNG	n.s.
			(RNGs used simultaneously)	

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Table A-1 (continued)

Year	Title	Author	Comments	Statistics
1976			Experiment III	
			Group A: false feedback	
			Fast RNG	n.s.
			Slow RNG	n.s.
			Group B: true feedback	
			Fast RNG	3.16×10^{-2}
			Slow RNG	3.16×10^{-2}
			(RNGs used separately)	
	PK Effects by a Single Subject on a Binary Random Number Generator Based on Electronic Noise[26]	S. Hill	One subject	1.60×10^{-3}†
	A PK Experiment with a Covert Release-of-Effort Test[27]	R. Broughton	Overt trials	n.s.
			"Release-of-effort"	n.s.
	Search for a Relationship Between Brainwaves and PK Performance[28]	H. Schmidt, J. C. Terry	Alpha/enhancement	1.93×10^{-3}
			Beta/enhancement	1.93×10^{-3}
			Alpha/suppression	n.s.
			Beta/suppression	n.s.
	A Covert PK Test of a Successful Psi Experimenter[29]	B. Millar	Altered χ^2 values	n.s.
	An Investigation of the Psi Enhancement Paradigm of Schmidt[30]	B. Millar, R. Broughton	I. Experimenter 1	
			Present time	n.s.
			Prerecorded	n.s.

†One-tailed.

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Table A-1 (continued)

Year	Title	Author	Comments	Statistics
1976			II. Experimenter 2	
			Present time	n.s.
			Prerecorded	n.s.
	PK Effect on Prerecorded Targets[31]	H. Schmidt	I. Experiment 1	
			Present time	1.00×10^{-3}†
			Prerecorded	1.00×10^{-3}†
			II. Experiment 2	
			Present time	5.00×10^{-2}
			Prerecorded	5.00×10^{-3}
			III. Experiment 3	
			Prerecorded	5.00×10^{-2}
			"Easy" trials	n.s.
			"Difficult" trials	n.s.
1977	Conscious and Subconscious PK Tests with Prerecorded Targets[32]	J. Terry H. Schmidt	I. Total "conscious"	5.00×10^{-3}
			II. Total "unconscious"	n.s.
	A PK Investigation of the Experimenter Effect and Its Psi-Based Component[33]	R. Broughton B. Millar J. Beloff K. Wilson	Sixteen experimenters using prerecorded targets (reported as 16 different experiments)	n.s.
	Psychokinetic Effects upon a Random Event Generator under Conditions of Limited Feed-back to Volunteers and Experimenter[34]	L. Braud W. Braud	I. Experimenter trial-by-trial feedback	
			Subject/feedback	n.s.
			Subject/nonfeedback	5.00×10^{-2}

†One-tailed.

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Table A-1 (continued)

Year	Title	Author	Comments	Statistics
1977			II. Experimenter/global feedback	
			Subject/nonfeedback	5.00×10^{-2} †
	Computer Controlled Random Number Generator PK Tests[35]	R. Jungerman J. Jungerman	I. $p_o = 1/2$	4.00×10^{-2}
			II. $p_o = 1/8$	n.s.
	A Test of the Schmidt Model's Prediction Concerning Multiple Feedback in a PK Task[36]	J. Dauts M. Morrison	Direct	n.s.
			Delay one	n.s.
			Delay four	n.s.
	Plant PK on an RNG and the Experimenter Effect[37]	H. Edge	I. Growth in darkness	
			Plants absent	n.s.
			Plants present	n.s.
			II. Plants light-starved	
			Plants absent	n.s.
			Plants present	n.s.
			III. Growth in darkness/addition of florescent light	
			Plants absent	n.s.
			Plants present	1.70×10^{-6}
			IV. Same as III above	
			Plants absent	n.s.
			Plants present	3.60×10^{-2}

† One-tailed.

Table A-1 (continued)

Year	Title	Author	Comments	Statistics
1977	Allobiofeedback: Immediate Feedback for a Psychokinetic Influence Upon Another Person's Physiology[38]	W. Braud	I. (Experimenter effecting subject GSR)	(1.0×10^{-2})
			II. Effect on RNG with respect to experimenter feedback	
			A. Audible	n.s.
			B. Inaudible	5.00×10^{-3}†
	Electronic Random Number Generator Operation Associated with EEG Activity[39]	G. Heseltine	Experiment I	
			High tone	n.s.
			Low tone	1.50×10^{-2}
			Nonfeedback	n.s.
			Experiment II	
			Low tone	5.00×10^{-4}
			Nonfeedback	n.s.
	A Take-Home Test in PK with Prerecorded Targets[40]	H. Schmidt	I. Experiment 1 Prerecorded high tone and prerecorded low tone combined result	1.00×10^{-3}
			II. Experiment 2	
			Group/inspected	n.s.
			Group/not-inspected	n.s.
			Individual/inspected	n.s.
			Individual/not-inspected	n.s.

†One-tailed.

Table A-1 (continued)

Year	Title	Author	Comments	Statistics
1978	Electronic Random Generator Operation and EEG Activity: Further Studies[41]	G. Heseltine	I. Series 3	
			Left hemisphere/feedback	2.00×10^{-2}
			Left hemisphere/nonfeedback	n.s.
			II. Series 4	
			Right hemisphere/feedback	n.s.
			Right hemisphere/nonfeedback	n.s.
			III. Series 5	
			Left hemisphere/feedback	n.s.
			Left hemisphere/nonfeedback	n.s.
	Psi Correlates of Volition: A Preliminary Test of Eccles' "Neurophysiological Hypothesis" of Mind-Brain Interaction[42]	C. Honorton L. Tremmel	I. Experiment 1	
			Gated EEG/feedback	2.00×10^{-3}
			II. Experiment 2	
			Gated EEG/feedback	5.00×10^{-3}†
			Ungated EEG/feedback	n.s.
			Gated/nonfeedback	n.s.
			Ungated/nonfeedback	n.s.
	Search for Psi Fluctuations in a PK Test with Cockroaches[43]	H. Schmidt	Algae	n.s.
			Yeast and chlorella	n.s.
			Wingless fruit flies	n.s.
			Cockroach replication	n.s.
	Use of Stroboscopic Light as Rewarding Feedback in a PK Test and with Prerecorded and Momentarily-Generated Random Events[44]	H. Schmidt	I. Section 1	
			Prerecorded/ON	3.73×10^{-3}
			Prerecorded/OFF	n.s.

†One-tailed.

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Table A-1 (continued)

Year	Title	Author	Comments	Statistics
1978			II. Section 2	
			Real time/ON	1.93×10^{-3}
			Real time/OFF	n.s.
	PK with Immediate, Delayed and Multiple Feedback: A Test of the Schmidt Model's Prediction[45]	M. Morrison J. Davis	Direct	n.s.
			Delay one	n.s.
			Delay four	n.s.
	Intentional Observer Influence upon Measurements of a Quantum Mechanical System: A Comparison of Two Imagery Strategies[46]	R. Morris M. Nanko D. Phillips	I. Study 1 (all subjects used both imagery)	
			Goal-oriented	1.00×10^{-2}
			Process-oriented	n.s.
			II. Study 2 (all subjects used both imagery)	
			First session:	
			Goal-oriented	n.s.
			Process-oriented	n.s.
			Second session (subject's imagery choice):	
			Goal-oriented	1.00×10^{-3}
			Process-oriented	n.s.
1979	The Influence of Imagery and Feedback on PK Effects[47]	A. Levi	Goal-oriented/feedback	5.00×10^{-2}
			Goal-oriented/nonfeedback	4.50×10^{-2}
			Process/feedback	n.s.
			Process/nonfeedback	n.s.
			Control/feedback	n.s.

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Table A-1 (concluded)

Year	Title	Author	Comments	Statistics
1979			Control/nonfeedback (Subject or experimenter start in each case above proved insignificant; reported as 12 separate experiments)	n.s.
	An Investigation into the use of Aversion Therapy Techniques for the Operant Control of PK Production in Humans[48]	R. Broughton B. Millar M. Johnson	I. Subject 1	
			A	n.s.
			B	n.s.
			A	n.s.
			Release-of-Effort	n.s.
			II. Subject 2	
			A	5.00×10^{-2}
			B	n.s.
			A	n.s.
			Release-of-effort	n.s.
			III. Subject 3	
			A	n.s.
			B	n.s.
			A	n.s.
			Release-of-effort	n.s.
			IV. Subject 4	n.s.
			A	n.s.
			B	n.s.
			A	n.s.
			Release of effort	n.s.

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