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INNOVATIVE INTERDISCIPLINARY RESEARCH

# Research Bursaries for Hypnotic Susceptibility as a Predictor of Anomalous Cognition Performance and A Random Number Generator Test of The Gradient of Shannon Entropy:

## Final Report

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## Objective

The objective of this paper is to provide a final report with regard to two research bursaries that were awarded to the Laboratories for Fundamental Research by the Fundação Bial.

# Introduction and Executive Summary

The two research bursaries under discussion are:

1. Hypnotic Susceptibility as a Predictor of Anomalous Cognition Performance
2. A Random Number Generator Test of the Gradient of Shannon Entropy

Each of these are discussed in detail in their own sections below and for completeness contain significant overlap with our interim report. A brief description and summary of the results are included in this section.

## *Hypnotic Susceptibility as a Predictor of Anomalous Cognition Performance*

The main goal of this experiment was to see if an earlier laboratory anecdote could be confirmed with a naïve population of subjects. That is, a high percentage of LFR's experienced remote viewers scored 6 or above on the Stanford Hypnotic Susceptibility Scale (SHSS).

One hundred students from a Budapest, Hungary, "new age" college participated in the study. A random half were measured by hypnotic techniques for their SHSS scores before participating in the anomalous cognition (AC) part of the study. The remaining half of the students were measured on the SHSS after their AC participation. Each subject was asked to contribute four AC trials at a rate of approximately one per week.

By rank-order assessment, we found little AC in this population. We observed a mean rank ($n=400$ trials) of 2.998 corresponding to an effect size of 0.002 ($p = 0.482$). There was weak support for some of the students (i.e., 34) who produced possible evidence for AC (i.e., $ES \geq 0.38$) where 30 would be expected ($p = 0.22$).

### Conclusion

The correlation of rank-order with SHSS was 0.003 with 398 degrees of freedom. Our initial main goal was not confirmed. We discuss in the body of this report a number of possible explanations for this apparent null result. We are reanalyzing the AC responses using experienced judges, which we realize is beyond the scope of this bursary, and will include those results in the published form of this report.

# A Random Number Generator Test of The Gradient of Shannon Entropy

The main expectation of this experiment was to explore the binary random number generator hit rate region above 60%. Given the strong and stable correlation of AC with the gradient of Shannon entropy and given the evidence that RNG results arise from AC rather than some force-like interaction, we thought that high gradient binary sequences would be "easier" to obtain in a psi-mediated selection task.

Fourteen subjects participated in formal trials in this study and contributed a total of approximately 4,600 individual trials of 200 binary bits each. We found that the selection of high entropy sequences was no more likely than for low entropy sequences. Thus the initial hypothesis was not confirmed.

However, this experiment indicated an exciting path for a future experiment. In the AC studies that do show a correlation with the gradient of Shannon entropy, the main feature is that feedback to the subject also has the gradient information embedded in the display. We noticed, too late for the experiment, that the feed back of even high gradient sequences was a display who's visual gradient was always quite low. That is a "wiggly" line graph has low visual display gradient regardless of the gradient of the underlying driving sequence. If individuals make psi-like decisions on the bases of the gradient they experience, then we would expect the observed null result.

# Hypnotic Susceptibility as a Predictor of Anomalous Cognition Performance

## *Background*

Since the time of Mesmer, hypnosis has been associated with purported manifestations of so-called psychic ability. In his four-volume classic, Dingwall (1967) compiled anecdotal evidence of this association. Honorton and Krippner (1969) and Schechter (1984) have reviewed experimental work comparing anomalous cognition (AC) performance after hypnotic induction with performance under control conditions. With a total of 25 such comparisons in 20 papers from 10 different laboratories, both reviews found a persistent effect in favor of the hypnotic condition. Yet Palmer and van der Velden (1983) reported a study using AC of magazine pictures in a hypnosis condition. Their study used 150 receivers in groups of 8 to 16 with no waking controls. The found no significant AC-functioning in the hypnosis condition.

The later work conducted at SRI International also produced mixed results. Lantz (1989) designed a pilot study with a single calibrated receiver. A single trial consisted of two 15-minute sessions separated by a 30-minute period during which one of two possible procedures occurred. On a counter-balanced basis either a licensed clinical hypnotist hypnotized the receiver, or the receiver was asked to proofread written material. During the hypnosis condition, the hypnotist implanted a post-hypnotic suggestion, which was keyed to the word "target," to recall as much detail in the second 15-minute AC session that was specifically not mentioned during the first AC session. We emphasize that the AC sessions were conducted in the waking state. The results were that there was significant improvement from AC-session one to AC-session two only in the hypnosis condition. This observation failed to replicate in a follow-on study with two additional receivers.

Lantz (1989) also examined AC performance in a hypnotic trance condition. Two experienced receivers contributed 16 trials each while under a pre-determined level of hypnotic trance. The effect sizes were –0.088 and –0.354, respectively.

A post-hoc analysis showed that the effect size in all of the SRI hypnosis studies qualitatively correlated with the interpersonal interaction of the receiver and the hypnotist. That is, if the receiver "liked" the hypnotist the scores were better than when the receiver "disliked" the hypnotist. Clearly we are unable to draw any conclusions from this observation; however, Bányai informed us that interpersonal relationships of this type are a major concern in hypnosis research today.

As part of the above SRI experiments, the hypnotist administered the Stanford Hypnotic Susceptibility Scale tests to most of the SRI receivers. We found that most of them scored 6 or above on the 12-point scale.

This observation serves as the basis for the hypothesis for the proposed investigation. One of the major problems facing AC researchers today is to identify individuals who possess a strong AC talent. These receivers could significantly increase the "signal" strength in a variety of AC experiments. If it can be shown that AC-performance is correlated with hypnotic susceptibility, then screening for exceptional AC talent can be more readily accomplished.

## *Method of Approach*

We engaged Professor Éva Bányai who is head of the Experimental Psychology Department at Eötvös Loránd University, Budapest, Hungary, to oversee the project in Hungary. Zoltán Vassy, who is recognized as one of the leading experimenters in the study of anomalous cognition, directs the AC part of the project.

### General Protocol Considerations

We asked 100 self-selected students from a "New Age" college in Budapest to participate as receivers in the study. All have been asked to contribute four anomalous cognition trials each at a rate of approximately one per week. A random half of the receivers completed their AC trials before being measured for their hypnotic susceptibility and the remaining half afterward. In general terms, the hypnotic susceptibility, which is an integer in the range 0 to 12, is determined by the successful (or not) completion of 12 tasks while in a hypnotic trance. A score of 12 indicates that all 12 tasks were successfully completed and, therefore, suggests that the person is highly susceptible to hypnosis. The hypnosis was carried out by one of the professors in the Experimental Psychology Department. Vassy and his team carried out the AC trials.

### Set-Up and Training

Beginning in late April 1999, May and McMoneagle spent a week in Budapest working with the AC team to refine the protocol and to demonstrate high-quality AC functioning. May returned to Hungary in mid May through mid June to supervise the data collection and to train the AC analyst.

### Anomalous Cognition Protocol

The collection of anomalous cognition data was accomplished through the use of a computer program that was mostly developed under a previous research bursary from the Foundação Bial[1]

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[1] Based upon this research, a paper (The Correlation of the Gradient of Shannon Entropy and Anomalous Cognition: Towards an AC Sensory System) has been accepted for publication in the Journal of Scientific Exploration.

### ***Anomalous Cognition Program Details***

The data collection part of the code is run through the configuration screen. All data during the course of the trial are preserved in an Access database for later inspection. Figure 1 shows this configuration screen:

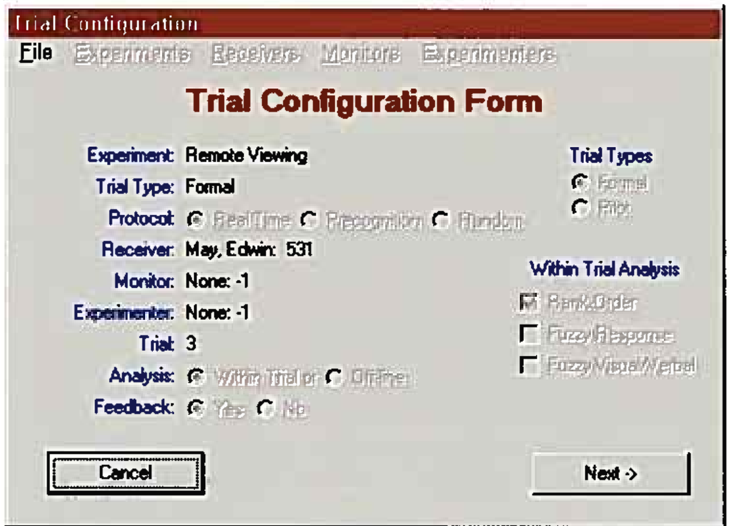


**Figure 1. Configuration Form for AC-data Collection**

Formal trials are set at experiment first-entry time, and the parameters, such as when and what type of feedback, real-time or precognition, and what type of analyses, may all be reconfigured in pilot mode. At this time, it is possible to abort the session without the protocol being violated (see below).

The next screen governs the sessions, and is shown as Figure 2.

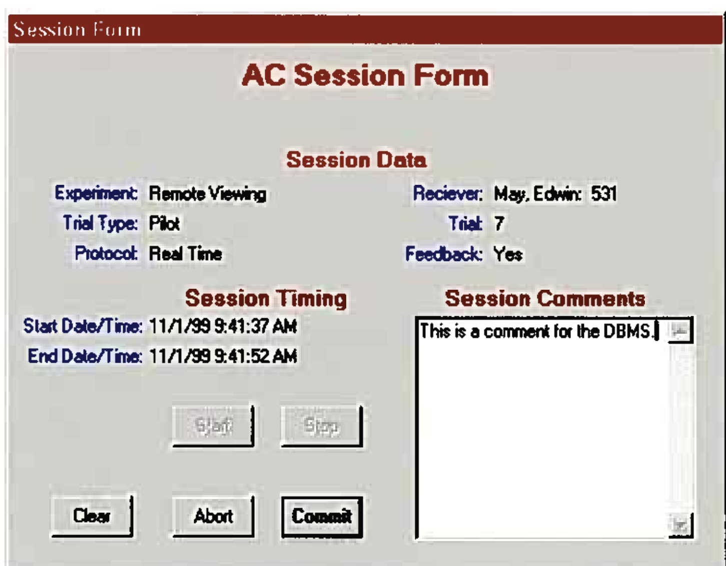


**Figure 2. Session Form**

This screen logs the start and end times of the sessions and any comments by the session monitor. All information is also stored in the database. Because neither the session monitor nor the participant have seen any feedback about the target selection, the session may still be aborted at this stage; however, once the **Commit** button is pressed, the session is formally logged into the database and the analysis must be carried out.

The next screen is for the fuzzy set encoding of the response, and is shown as Figure 3.

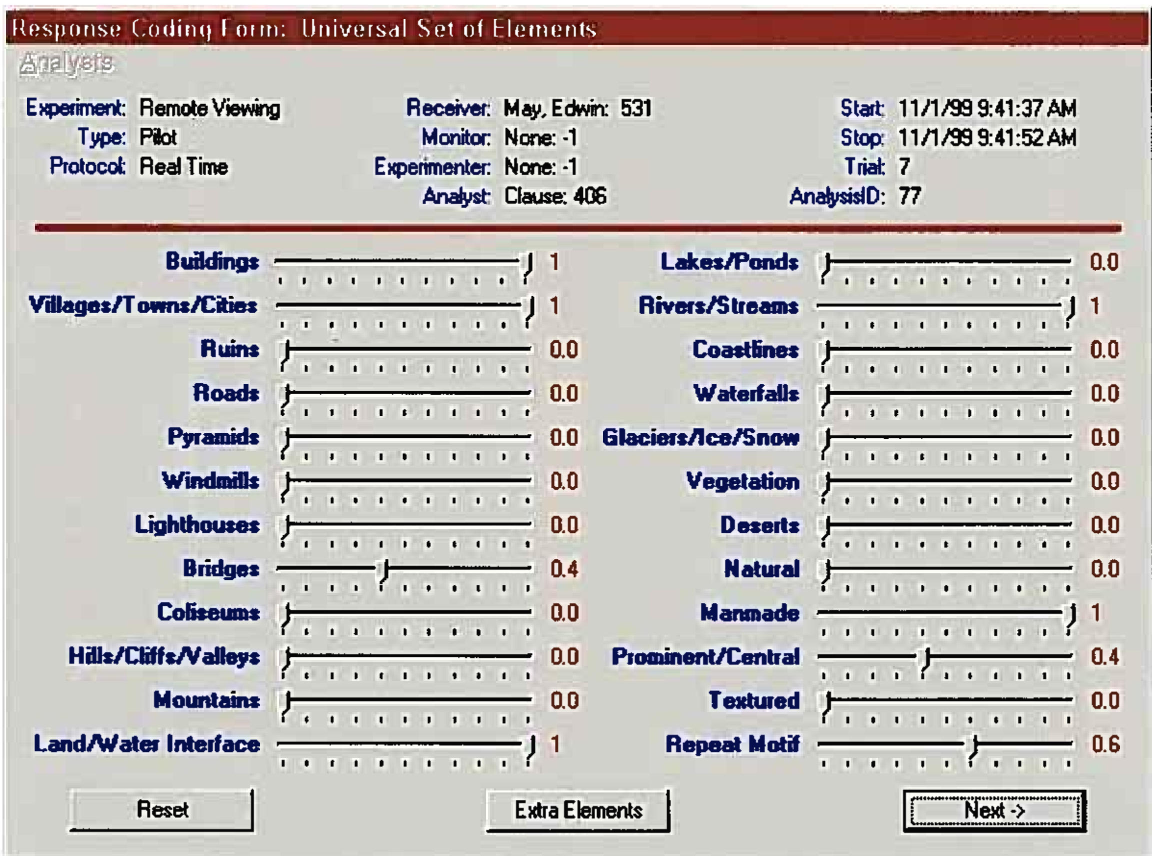


**Figure 3. Fuzzy-Set Encoding Form**

This set of fuzzy elements is a combination of those from an extensive earlier study (May, et al., 1990), and new insights gained from the development of a Foundação Bial funded program (May, et al. 1999). As part of that study, all 300 targets in the target pool were coded with regard to their visual importance on each of the elements shown in Figure 3. This coding was done before any AC data collection.

Without knowledge of the selected target, the session monitor, acting as an analyst, scored each of these elements with regard to the degree to which he/she is was convinced that each element was part of the response. For example, if the response included the word, "City," that element must be scored as a one; however, in this hypothetical example, the session monitor was only 40% convinced that the response contained a

Bridge. Response elements that are not contained in this list may be added by selecting **Extra Elements.**

Traditional rank-order analysis is accomplished in the next screen shown as Figure 4.

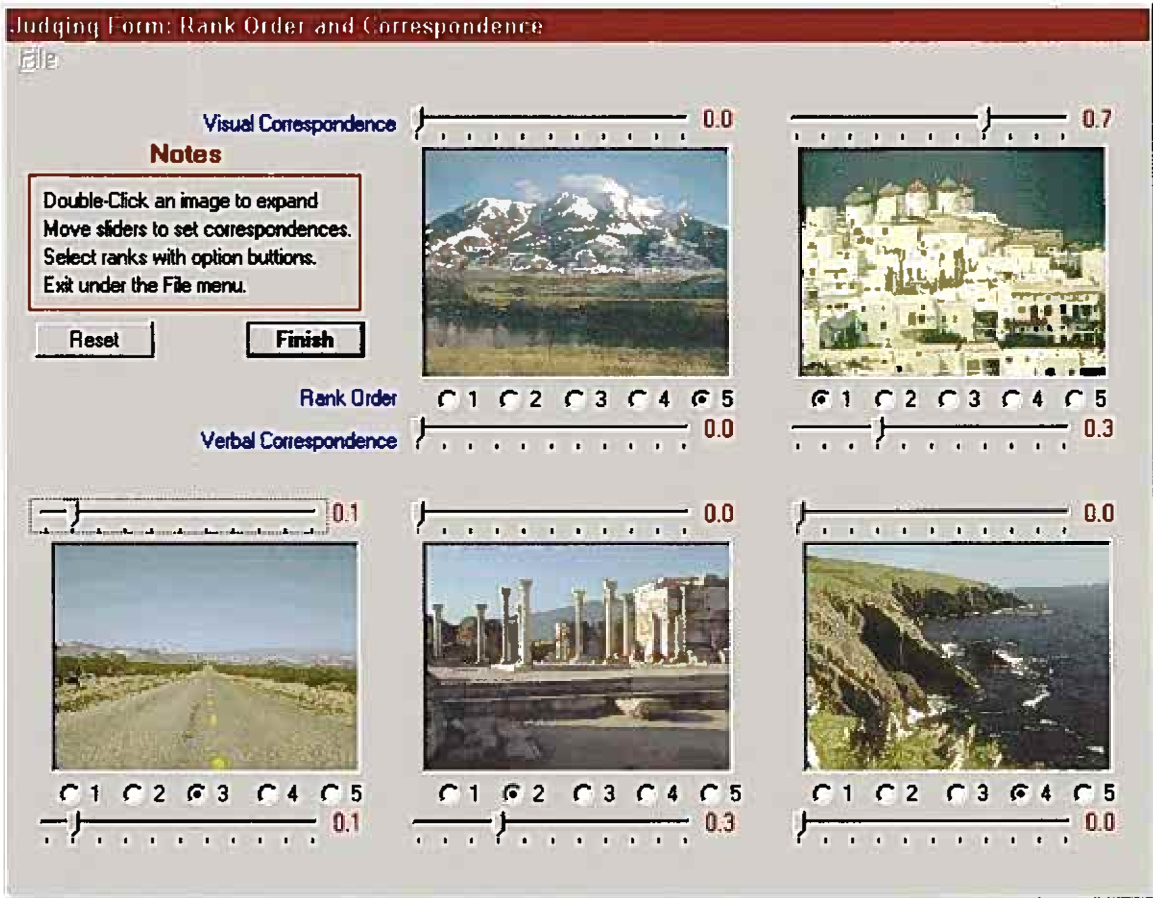


**Figure 4. Rank-Order Form**

The analyst is assured that selected target is one of the five pictures that are displayed in Figure 4. In this example, the analyst chose the city as the best match to the response, the ruins as the second best, the road as third, the coast as forth, and the mountain as fifth. The sliders represent the degree to which the analyst feels each photograph visually and verbally corresponds to the response. Selecting Finish allows the data in Figure 4 to be logged into the database and presents feedback as shown in Figure 5.

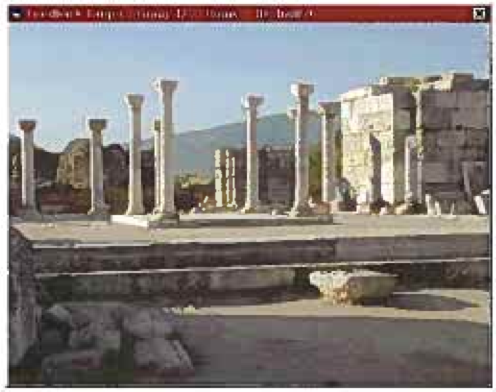

**Figure 5. Feedback of the Selected Target**

In this hypothetical example, a second-place rank is entered into the database.

### *Variations for the Hypnosis Trials*

As the experimenter, Vassy conducted the session much as shown above; however, he did not conduct the fuzzy analysis of the responses. A third individual, who was blind to the experimental conditions, conducted that analysis off-line.

## *Results*

We examine the results from there perspectives–hypnosis AC, and their correlation.

### Hypnosis

Figure 6 shows the distribution of susceptibility scores for the student population in the study.

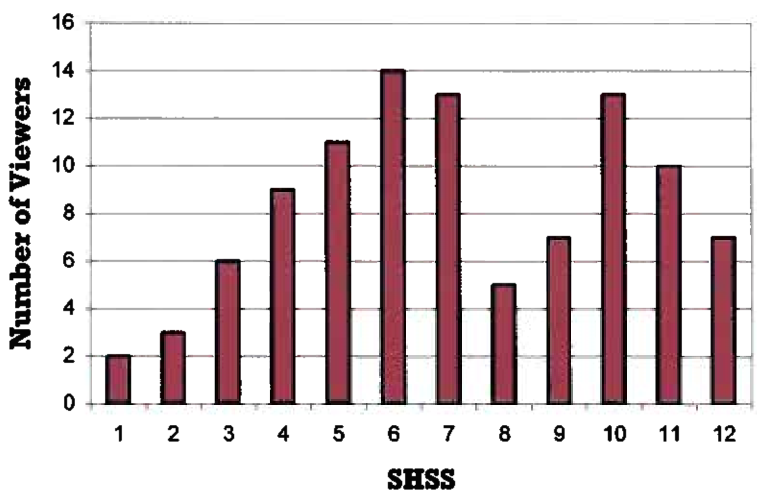


**Figure 6. Distribution of Scores for 100 Student Participants**

We note that participants were not selected on the basis of the SHSS scores.

### Anomalous Cognition

By rank-order assessment, we found a mean rank of 2.998 where 3.000 is expect by chance. This corresponds to an effect size of 0.002 and a p-value of 0.482. Figure 7 shows the distribution of effect sizes over the 100 participants and four trials each.

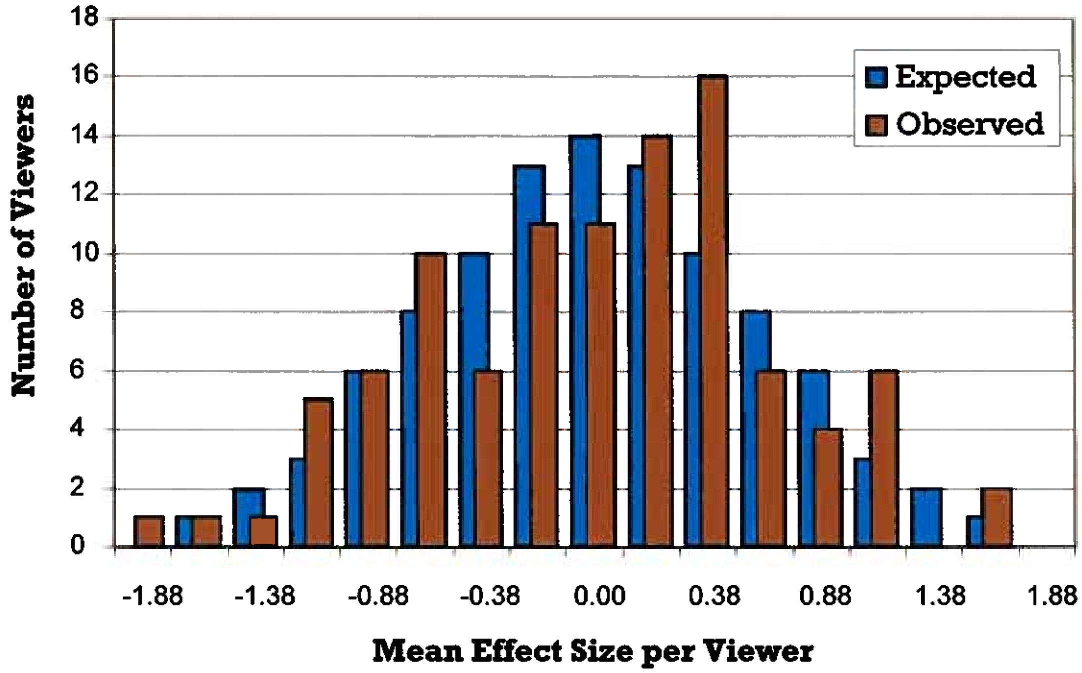


**Figure 7. Distribution of AC Effect Sizes for 100 Participants**

The expected and observed distributions are nearly the same with a slight bias toward more AC (p = 0.33). By this traditional measure, there was little evidence for AC in this study.

### Correlation of SHSS and Anomalous Cognition

The overall correlation of the SHSS with the ranks was 0.006 with 98 degrees of freedom. The overall correlation of the SHSS with the figure of merit absolute measure of AC was –0.027 with 98 degrees of freedom. Neither of these correlations is significant.

However, a more relevant question is to determine if there is a correlation with those participants who actually exhibited AC in their four trials. Post hoc, we found that for subjects who's average rank was 2.5 or less (i.e., ES > 0.35) the correlation was –0.243. With 32 degrees of freedom, this corresponds to p = 0.08. The figure of merit based correlation for this subset was –0.014.

## *Conclusion*

While their may have been a hint at a possible correlation between the participants that scored well in the AC task with their SHSS score ($p = 0.08$), this study failed to show a significant correlation in general. There are a number of factors that could contribute to this finding:

- There actually is no correlation between SHSS and AC ability.
- Novice analysts were used to assess the quality of AC. A sample re-judging by a very experienced AC analyst showed a possible improvement in AC sensitivity. We are continuing to re-analyze the AC responses outside the scope of this bursary, and will include that post hoc judging in the published version of this report.
- The target pool and the fuzzy-set descriptors were designed for an American population. Perhaps there are cross-cultural issues. One such example occurred in training the fuzzy-set analyst. The Hungarian word for mountain and hill is the same word, *hegy*. Our fuzzy universal set of elements contains both hills and mountains, which American analysts have a clear understanding of the difference. But what should a Hungarian analyst do with the response word *hegy*?
- Since there appeared to be very little AC in the study, it may be expected that there would not be a correlation.

# A Random Number Generator Test of The Gradient of Shannon Entropy

## *Background*

The entropy random number generator (RNG) experiment was designed to assess the degree to which the gradient of Shannon entropy of a sequence allows for better hitting in an RNG study which appears to the operator to be a "classical" RNG protocol. In a classical study, an operator presses a button to initiate a trial of *n* binary samples usually drawn from a hardware random device (e.g., radioactive decay or a noise diode). The outcome is measured by a standard z-score, which assumes a normal approximation to a binomial distribution:

$$z = \frac{(p_1 - p_0)\sqrt{n}}{\sqrt{p_0(1-p_0)}},$$

where $p_0$ is the expected hit rate (e.g., 0.5 in a binary situation) and $p_1$ is the observed hit rate.

In our study, we differ from the classic example in two important ways. First, we use a computer algorithm for the source of random binary bits, and secondly we use the number of times a hit rate is selected as the dependent variable rather than the hit rate itself. Figure 8 shows a schematic representation of the protocol for a single trial

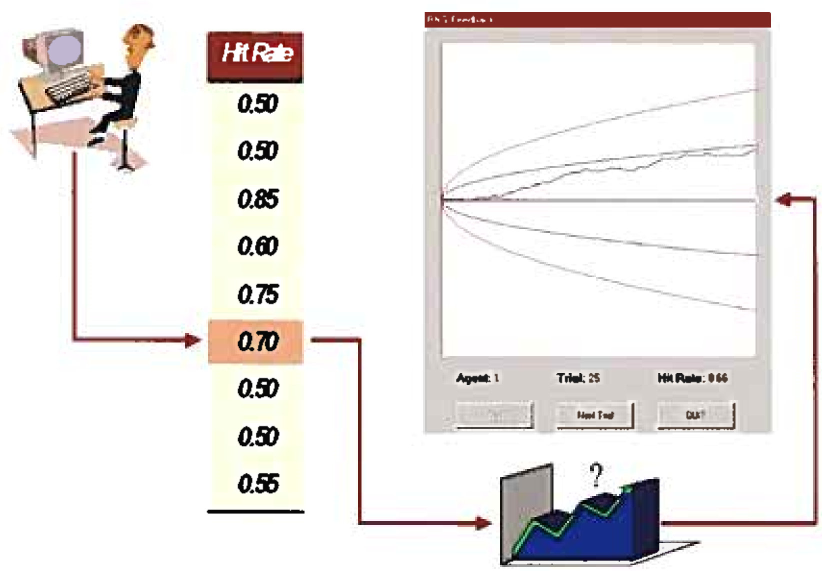


**Figure 8. Schematic Trial Protocol for the Entropy RNG Experiment**

The operator presses a button that accesses the system clock to obtain a seed for a computer-based random number generator (Marsaglia, 1987). Under the null hypothesis, the seeded generator provides a uniform access into a large array of pre-specified hit rates. One half of this array contains a 0.50 hit rate, one quarter contains 0.25, one eighth contains 0.125, and so one up to a hit rate of 0.9. Let $N_a$ be the size of the hit rate array. Then the number of cells that contain hit rate $h$ is given by $h \times N_a$.

The selected hit rate is used to set the probability of a binary one in the Marsaglia fair random number generator. A single trial consists of 200 binary bits.

The hypothesis under question, however, is that a sequence that contains a higher gradient of Shannon entropy will be "easier" to sense with anomalous cognition and thus allow operators to selected the higher hit rates more often than by chance (May, et al., 1994).

The gradient of Shannon entropy per bit for a sequence of length, $n$, is given by:

$$\frac{\Delta S}{n} = 1 + p_1 \log_2 p_1 + (1 - p_1)\log_2(1 - p_1).$$

where $p_1$ is the selected hit rate (May, et al., 1995). Figure 9 shows that expected hit rate selections under the null and test hypotheses.

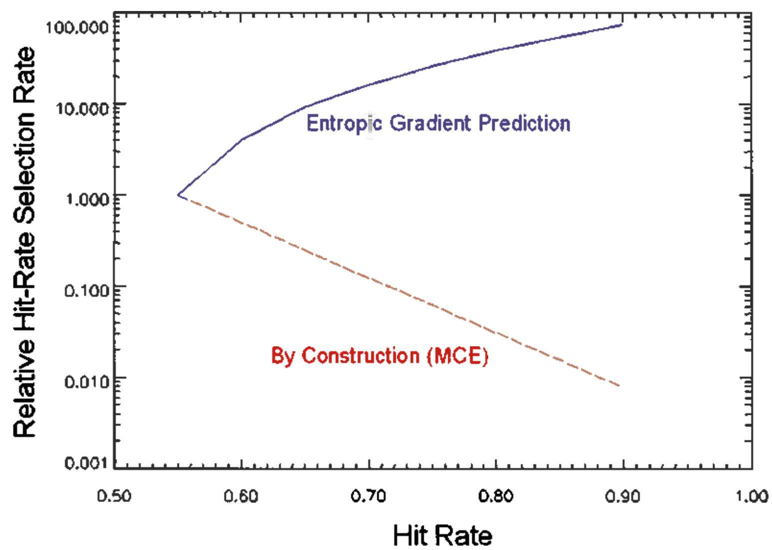


**Figure 9. Chance and Test Hypotheses**

Normalized at a hit rate of 0.55, we expect to realize a gain of $10^4$ at a hit rate of 0.9 over what we would expect under the null hypothesis.

## *Methodology*

We have written a Visual Basic based computer code that allows an experimenter to configure and run the experiment.

Upon invoking the program a registration form will be displayed and is shown as Figure 10.

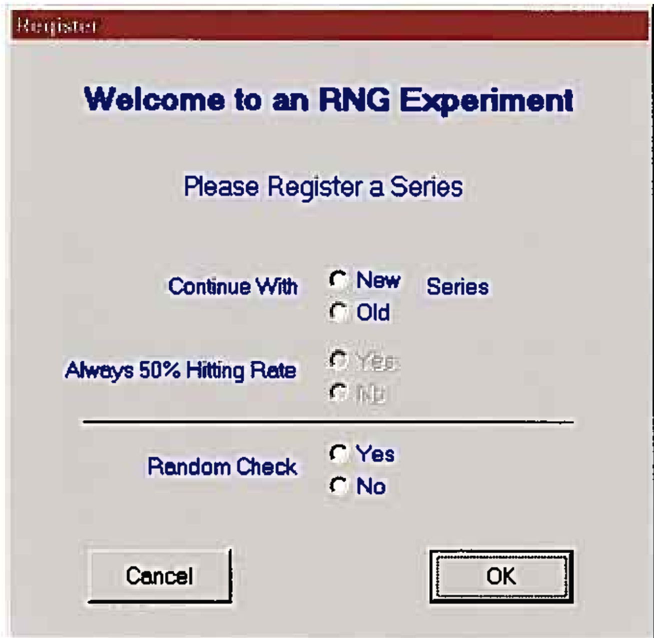


**Figure 10. Registration Form**

To continue a series that is in progress, then **Continue With Old**, is selected, otherwise **Continue With New** is selected. The next choice concerns if the run is for screening (i.e., **Always 50% Hitting Rate**). A **No** selection is for the formal test.

The **Random Check** selection may be used to check if the random number generator is functioning properly. Usually this is set to **No.**

When these choices have been set, the experimenter presses OK.

After the file names have been set or selected the operator sees the screen, which is the heart of the experiment, shown as Figure 11.

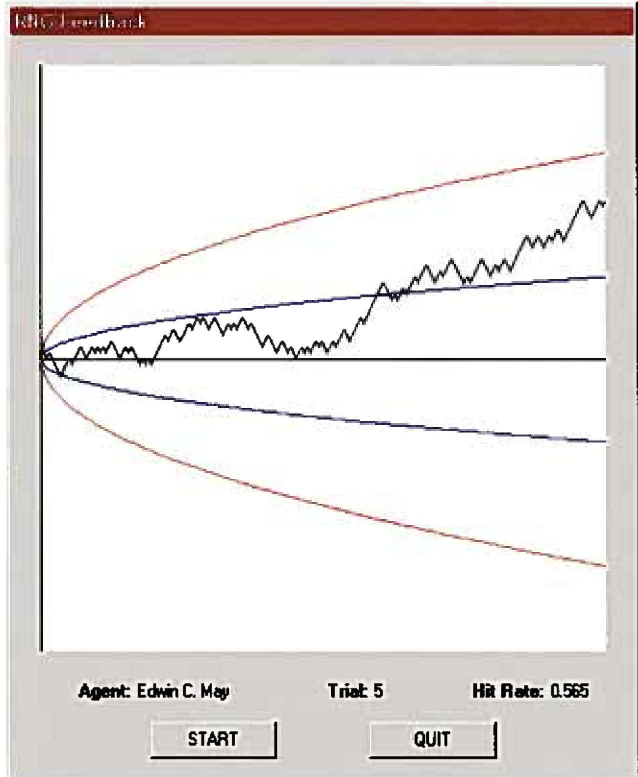


**Figure 11. Run and Feedback Display Form**

The operator, the current trial number and the resulting hit rate are displayed above the buttons. When the **Start** button is pressed, a wobbly line will begin to move to the right. The more binary ones in the sequence, the more the line moves up. The more zeros in the sequence, the more the line moves down.

The goal is to "force" the moving line to go up as far as possible. If the line ends as shown, that is above the blue line, the trial is especially good (i.e., $Z \geq 1.0$). If the line ends up above the red line, then the trial is very good (i.e., $Z \geq 2.0$).

The operator may quit at the end of any trial. The series may be continued later by selecting the appropriate file name in the registration phase of the program.

All results are saved in a form that may be read by a standard Spread Sheet program.

## *Results*

The results involve both screening for talent and the formal test of the hypothesis.

### Screening

We screened as many people as possible to search for individuals who possess a skill in RNG tasks. A screening run consists of 100 trials during which the hit rate at which the Marsaglia generator is biases is always constrained to be 0.50. The dependent variable is the observed hit rate from which and effect size is calculated as:

$$ES = \frac{(p_1 - p_0)}{\sqrt{p_0(1-p_0)}},$$

where $p_0$ is the expected hit rate and is equal to 0.50 in the screening runs. A Z-score can be computed for each run is given by $10 \times ES$.

The Laboratories for Fundamental Research have screened nine individuals five of whom produced and absolute effect size greater than 0.009.[2] One such individual (i.e., operator 531) has a long history of producing good results in RNG tasks. This operator produced and overall Z-score of 2.62 with an associated ES = 0.018. Figure 12 shows the expected and observed Z-score distribution for this operator.

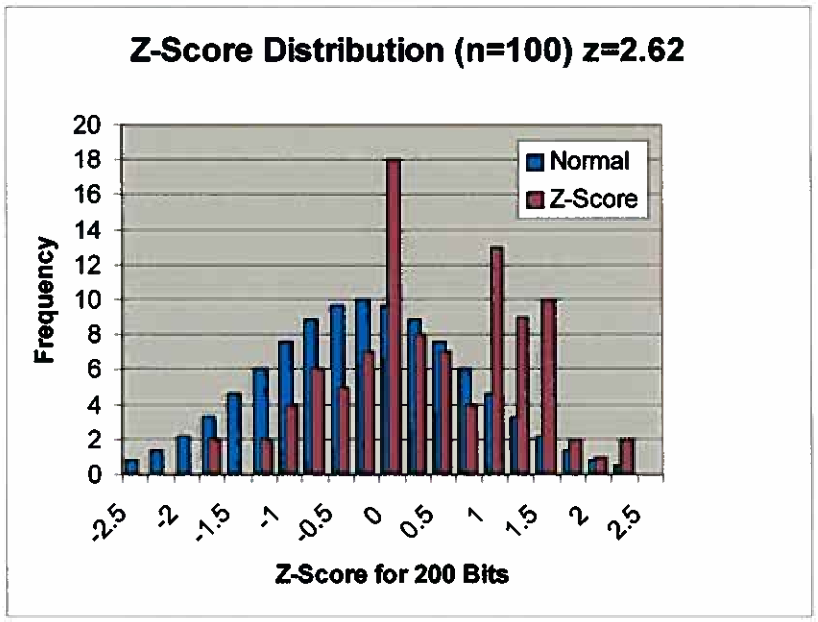


**Figure 12. Significant (p=0.004) Screening for 531**

The level of skill that we have seen in the screened individuals so far is consistent with published results (Radin and Nelson, 1989).

[2] This value is approximately three times the observed hit rate at the Princeton Engineering Anomalies Research laboratory (May, et al., 1995).

### Formal

Between the Rhine Research Center and the Laboratories for Fundamental Research, we tested 14 out of the planned 20 formal participants. These people were selected by the screening procedure outlined above. They contributed 4,600 200-bit trials. Figure 13 shows the results combined across participants.

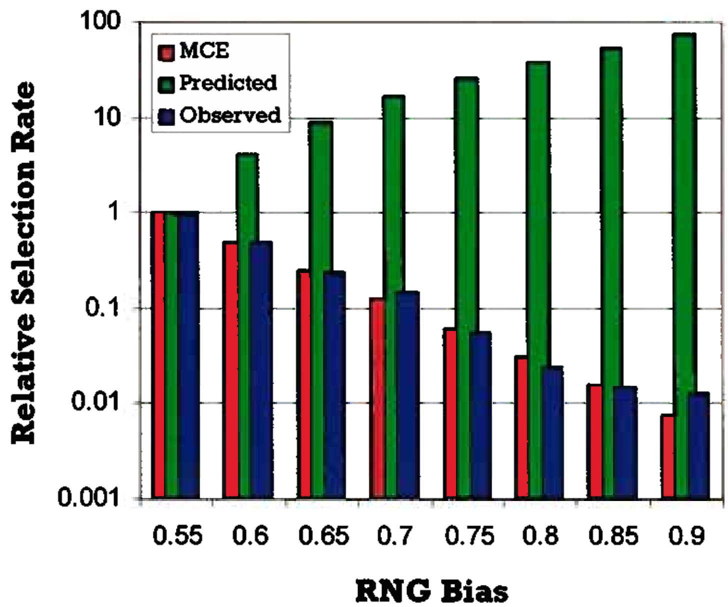


**Figure 13. Formal Results for the Entropy RNG Experiment**

The experiment was terminated prematurely because it is clear from the data shown in Figure 13, that the entropy RNG hypothesis–high gradient binary sequences will be selected more often than chance–was not and would not be confirmed with additional trials.[3] The difference of MCE and Observed is not significant at any RNG bias nor are they different for the high scoring individuals from the pilot phase.

## *Discussion and Conclusion*

This result was surprising given the statistical stability of both the Decision Augmentation Theory description of the historical RNG database and the continued replication of AC ability is significantly correlated with the gradient of Shannon entropy of the target. In conducting the analyses for this experiment we realized a major, and perhaps, important difference between the traditional AC trials an those conducted in this study.

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[3] Please note that the y-axis scale in Figure 13 is logarithmic. Thus, for example, the data misses the entropic prediction at 85% hit rate by a factor of approximately 8,000.

In all of the traditional AC studies, feedback of the photographic target is given at the end of each trial. So too is that true for this experiment. However, in the AC studies the gradient information is maintained in the physical display; whereas, in our RNG study, there was no or little correlation between the physical display (as shown in Figure 11) and the gradient of the underlying binary sequence. Regardless of the sequence gradient the display is just a thin wiggly line in an otherwise constant display. The robust success of the AC experiments and the failure to reach significance in this study strongly suggest that the information on which AC-mediated decisions are based upon the future feedback information.

This hypothesis is relatively easy to test in a future experiment. All that is needed is a display modification to the above protocol. That is, we design, say a fractal based display, whose pictorial entropic gradient is proportional to the binary entropic gradient of the selected sequence.

As is often the case, our knowledge can be as enhanced by the "failed" experiments as by the "successful" ones. This is certainly true in this case.

# Financial Considerations

## *Hypnosis*

In our interim report, we stated that because we experienced an intense effort and travel in setting up the hypnosis project we were somewhat overspent. By experiment's end we were approximately 11% over budget because of an unscheduled return the Budapest near the end of the experiment. The Laboratories for Fundamental Research has made up for the short fall of expenses.

The bursary was for $37,554 and $25,000 was awarded to Hungary for the major portion of the work. The award to our Hungarian colleagues was a firm fixed price. Of the remaining $12,554 we had budgeted $2,225 for travel. Because of the extra person (Mr. McMoneagle) and extra trip, that actual travel was $4,131 leading to the 11% over budget. All other labor and indirect costs met budget constraints.

## *Entropy*

The bursary for this project was $44,608 where $22,026 was portioned to the Rhine Research Center. The reduction of labor time because of not including seven planned participants was counterbalanced by one round trip to the Rhine Research Center by one Laboratories for Fundamental Research representative. Including all costs, we were under budget by $322. Out plan is to apply this small excess to publishing this result in a peer-reviewed journal.

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