Towards The Physics of Psi:
Correlation with Physical Variables

Edwin C. May
Laboratories of Fundamental Research, Palo Alto, California

Abstract: The evidence for psi has been mounting particularly with the proliferation of free-response methodologies such as ganzfeld, and the technique known as direct interaction with living systems or DMILS. We have identified two physical variables (i.e. the gradient of Shanon entropy and the geomagnetic field of fluctuations) and one orientation variable (i.e. the local sidereal time LST) that significantly correlate with the outcome measures of these methodologies. The trial effect-size is enhanced by a factor of three at 13.30 LST over the mean effect size at other values of LST. We will show the data in support of the correlations and speculate about possible mechanisms.

Before claiming that there are correlations of *psi* with physical variables, it is helpful to examine some of the evidence for an "information transfer anomaly." To do this properly, we provide definitions of the phenomenon, show a sample protocol for data collection and analysis, and give a brief overview of the collected evidence.

Using this as background, we then examine three physical correlates to psi:
1. The Gradient of Shannon Entropy
2. Local Sidereal Time
3. GeomagneticField Fluctuations Ap index

Finally, I will present a few speculations for the future.

Over the years, there have been many changes of terminology for the phenomena generally known as psi. We have added a new one in that we wanted to find a term that was as close to the observable data as possible, but did not have any implication as to possible mechanism. By definition, the classical terms such as ESP, telepathy, and clairvoyance all have mechanisms embedded in their constructs. Telepathy, for example, assumes there is a mind-to-mind communication, whereas what is generally meant is that telepathy *appears* to happen given a particular experimental setup. So we have chosen the term **anomalous cognition***: The acquisition by mental means alone, of information that is blocked from the ordinary senses by shielding, distance, or time.* To experience cognition means to become aware of and anomalous means that awareness does not currently fit into the scientific structure.

A typical protocol for data collection goes as follows. Two people are sequestered in an isolated room. One we call a receiver (i.e., our word for experiment participant or subject) the other is an experimenter who we call a monitor. A third person (or a computer) randomly chooses one photographic image from a pre-defined collection to serve as the target for the session. At this point, although the receiver and the monitor might be knowledgeable of the total collection of photographs, they both are blind the specific one that was chosen.

Schematic AC Protocol
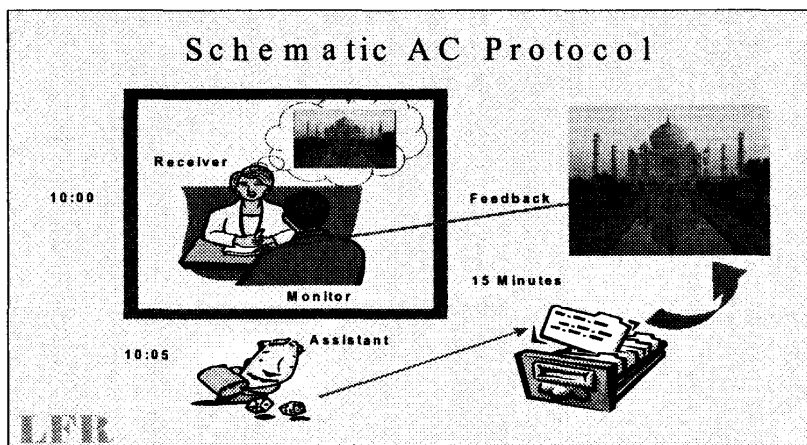
Then for approximately 15 minutes the monitor interviews the receiver with regard to her impressions about the target. She writes and draws her impressions for later analysis. At the close of the session, the data are secured and the receiver and monitor are shown the target for feedback. This feedback does not constitute an analysis.

Rank-Order Analysis: Single Trial

● Target is Selected Randomly from a Set of 300
  12 Groups of 5 Categories Each   Group Chosen First
  The Target is Randomly Selected from within a
  Randomly Selected Category
  After the Trial, 4 Decoys are Randomly Selected
    One each from the remaining 4 Categories

● Analyst's Task
  Determine Which of the 5 Targets Best Matches the Response
  Second Best Matches, and so on

The current target pool consists of a total of 300 photographs organized into 12 groups consisting of 5 orthogonal categories each of which contain 5 similar photographs. A target is chosen by first randomly choosing a group, then a category, and finally a target. After the session, each of the four remaining categories in the selected group are accessed to randomly select one target from within each of them. The result is 5 photographs--4 decoys and 1 intended target--to be used by the analyst.

The analyst's task for a given response, is to select the photograph that best matches the response, second best matches the response, and so on until all 5 targets have been ranked according to their correspondence with the response. The statistical outcome for the trial is a single rank number corresponding to the place that the analyst put the intended target. In the example shown in the slide, the correct target was number 4. The analyst placed it second best, so the output rank is 2. On the average over many such trials, the null hypothesis is that the mean rank should be, in this case, 3.0.
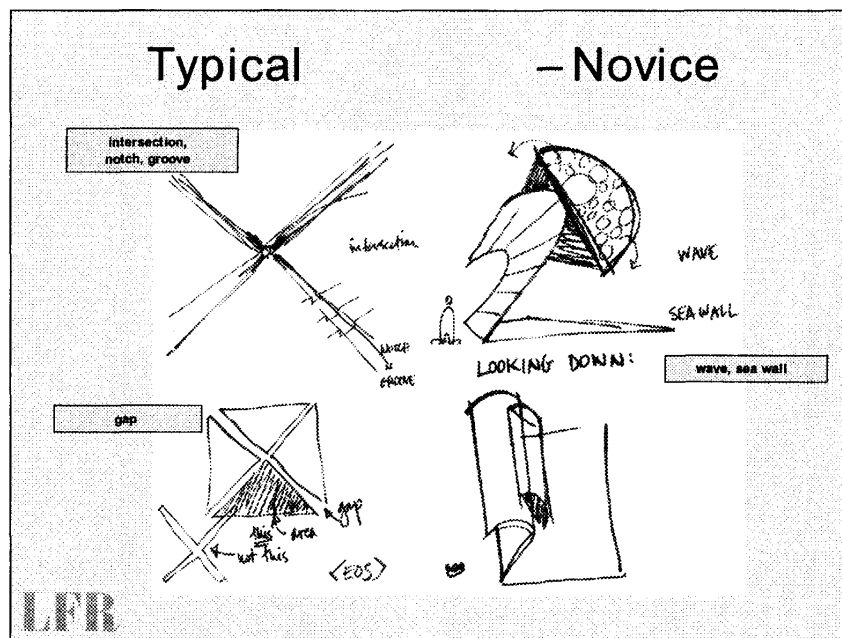
Statistics for Rank Order

● Continuity-Corrected Effect Size:
Where
    n = Number of Possible Ranks
    R_{ave} = Observed Average Rank
    M = Number of Trials

$$ES = \frac{\frac{n+1}{2} - R_{ave} \pm \frac{0.5}{M}}{\sqrt{\frac{n^2-1}{12}}}$$

● After M Trials, Z-Score is Given by: $z = ES \times \sqrt{M}$

LFR

This above formula shows the continuity-correct expression for the effect size computed over M trials and its associated z-score.

Typical   – Novice

intersection, notch, groove

gap

WAVE

SEA WALL

LOOKING DOWN:

wave, sea wall

⟨EOS⟩

LFR

This figure is the complete response for a novice participant. He said *intersection, notch, groove, wave, sea wall, gap, and looking down.* In addition, he drew a number of items. This response is typical of a novice participant.
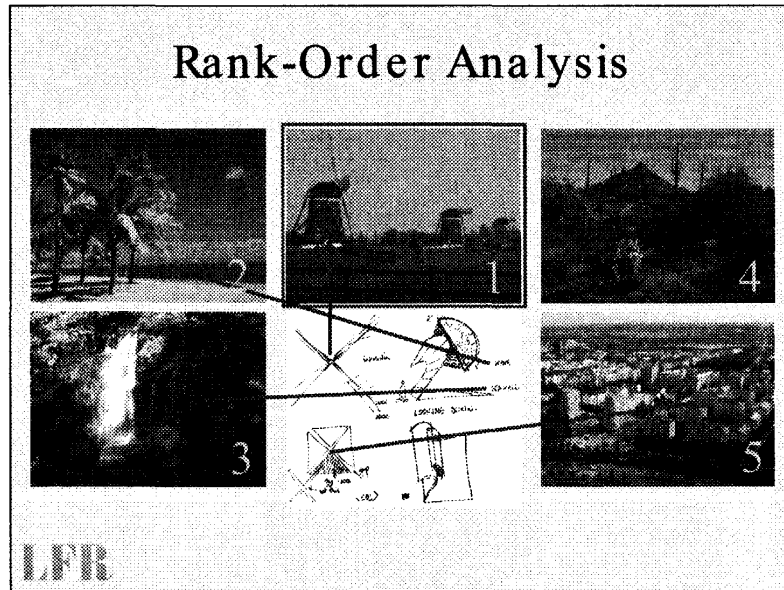
The above picture displays the target pack for ranking, given the response. The arrows indicated that elements of the response can be found in different pictures--a situation that is typical in such analysis. The large numbers in each photograph show the analyst's opinion as to the ranking. In this case the correct answer is the windmill, so the rank number for this session is one. The previous example was just one drawn from a formal study of 24 trials that were conducted in an industrial setting in California. The overall effect size is rather large and the study was significant at p = 0.0046. One of the three participants produced an independently significant result in 8 trials for an effect size of 0.619.


Professor (Statistics--University of California at Davis) Jessica Utts has published a meta-analysis of the "free response" database. After normalizing the data into a 1-in-4 choice analysis set, she finds overall that the hit rate is 0.33 where 0.25 is expected by chance. The approximate effect size is 0.22 leading to a p-value of 6 × 10^{-23}. The *Statistical Sciences* paper discusses a broad range of alternatives, which in

the end are rejected. Utts and the discussants in the paper agree that the null hypothesis must be rejected

We now move on to show correlations of anomalous cognition (AC) with various physical variables. The first of these is the gradient of **Shannon entropy**. The above list is a quick review of a few concepts about entropy. Thermodynamic entropy is a measure of disorder. The change, or gradient, of its information theoretic equivalent is related to information.


Typical Target Photograph
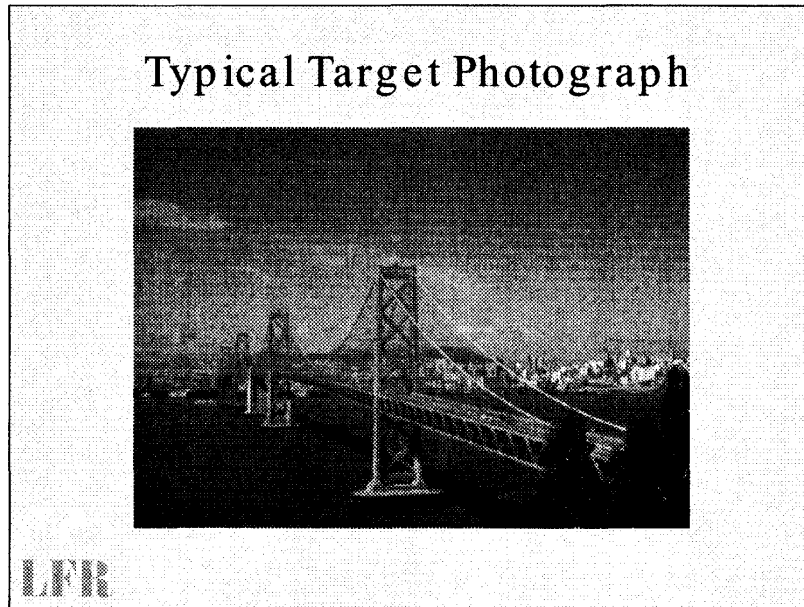
A typical target photograph--the Bay Bridge in San Francisco. This digital photograph contains 8-bits of color information for each of three primary colors, red, blue and green.

Entropy of a Large Patch

$$s = -\sum_{j=0}^{255} p_j \log_2 p_j$$
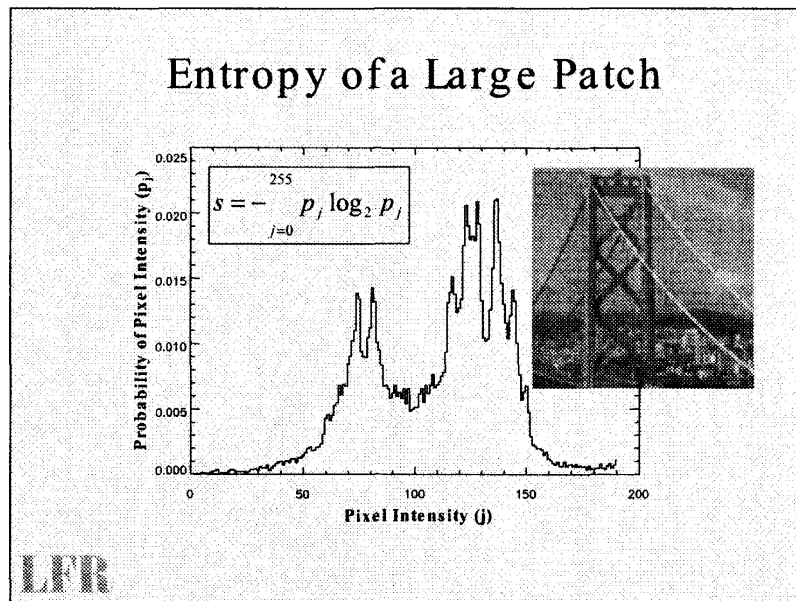
Consider a patch of the target photograph as shown in this figure. The actual patch is usually much smaller, but here it is large to demonstrate that it come from the

preceding photograph. For one of the colors, say green, each pixel may have a value from 0 to 255. For a given patch there is an associated pixel density shown in the graph. The density also is equivalent to the probability of finding a pixel with intensity "j." The formula is a logarithmic average of the intensity distribution for this patch. The total entropy for this patch is the sum of the entropies for each of the three primary colors.
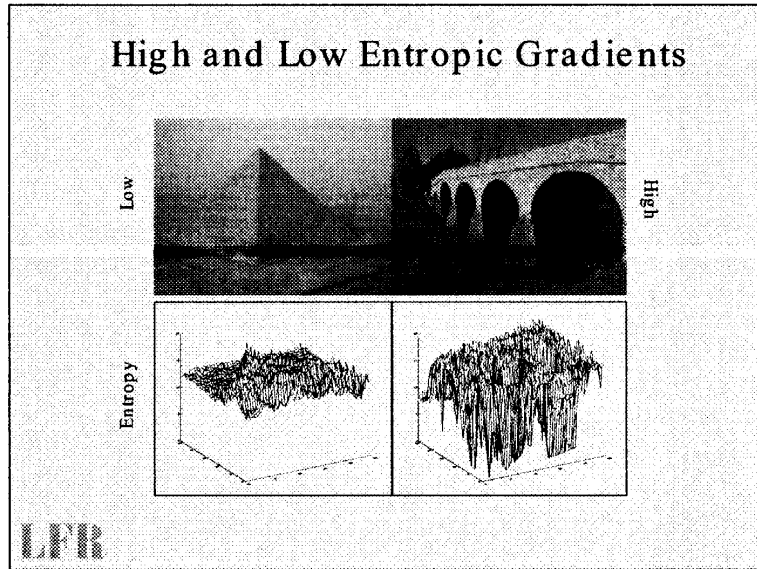

The plots are a representation of the entropy/per patch for each of the two photographs. They are plotted on the same vertical scale for easy comparison. We note that the pyramid is much "flatter" in entropy space than is the bridge. The dependent variable is the average gradient computed over the photograph. As it turns out, the bridge possesses about a 300% higher average gradient over that of the pyramid.
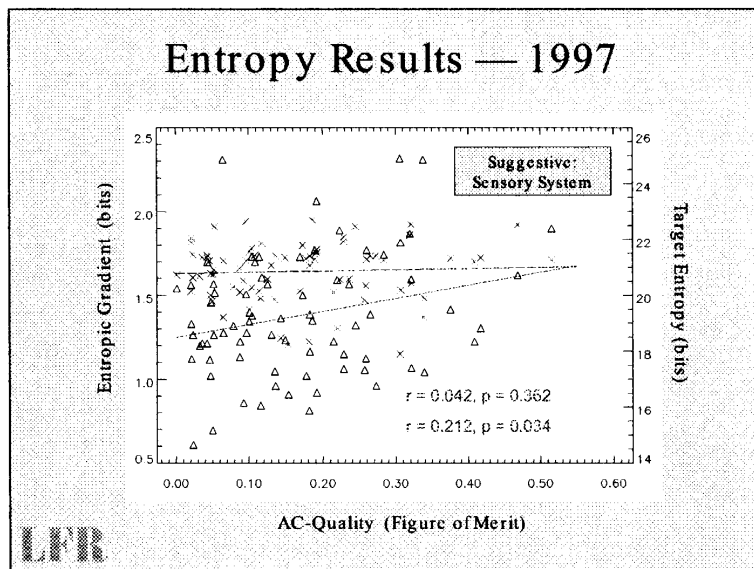

This scatter plot is typical of now 5 different experiments. Shown as black triangles are the points corresponding to 75 trials. The value on the left axis is the

gradient of Shannon entropy for the trial and the x-axis represents the quality of the anomalous cognition for the trial. The sloping line is the correlation of the entropic gradient with the AC quality. The ''s represent the values for the entropy (rather than its gradient) which can be read on the right scale. There is virtually no correlation of anomalous cognition with the entropy of the target. Given that there is a correlation with the gradient and not with the entropy, these results are suggestive of a sensory system. All of the known senses are more sensitive to changes at their "front ends" than they are to the steady state.
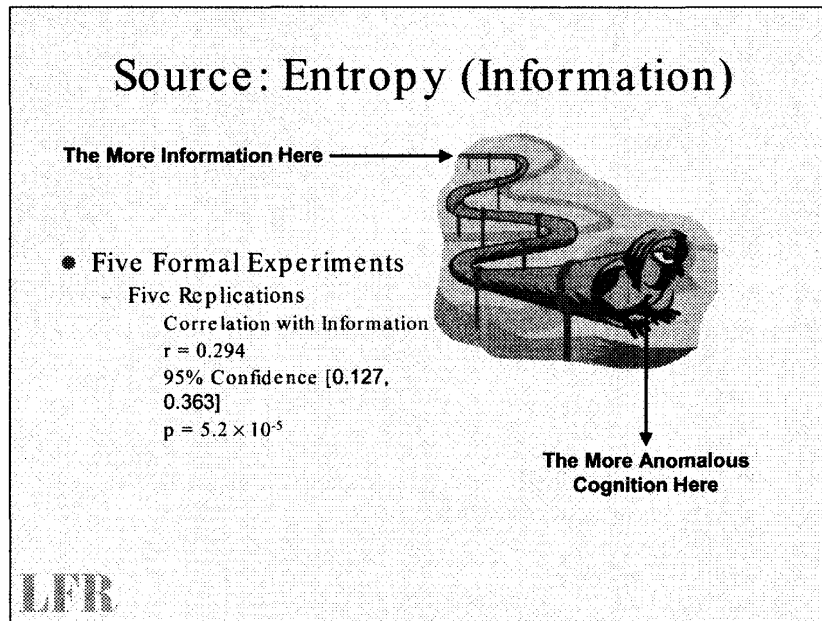

Perhaps anomalous cognition is either mediated through some combination of the known sensory systems or by an additional one as the name "extrasensory perception" suggests.All formal entropic gradient experiments to date have produced significant correlation with the anomalous cognition. The 95% confidence interval suggests that the actual correlation is in the range of 0.127 to 0.363.In words, these results suggest that the more native information you place in one of the *psi* channel the more *psi* you get out of it

We now move to the second physical variable--**local sidereal time.** In general, it takes two angular numbers to locate a point on a sphere. On the Earth, for example, these are called longitude and latitude. Likewise it takes two numbers to locate a star in the celestial "sphere". There are called right ascension and declination. Right Ascension is similar to longitude and is measured in hours, minutes, and seconds, and declination is similar to latitude and is measure in degrees. The local sidereal time is, by definition, the right ascension value of the meridian arc that is directly over head at each instant

Local Sidereal Time: The

- Local Sidereal Time
  - Right Ascension Value of the Stars that are on Meridian, that is, Directly Overhead on North-South Direction
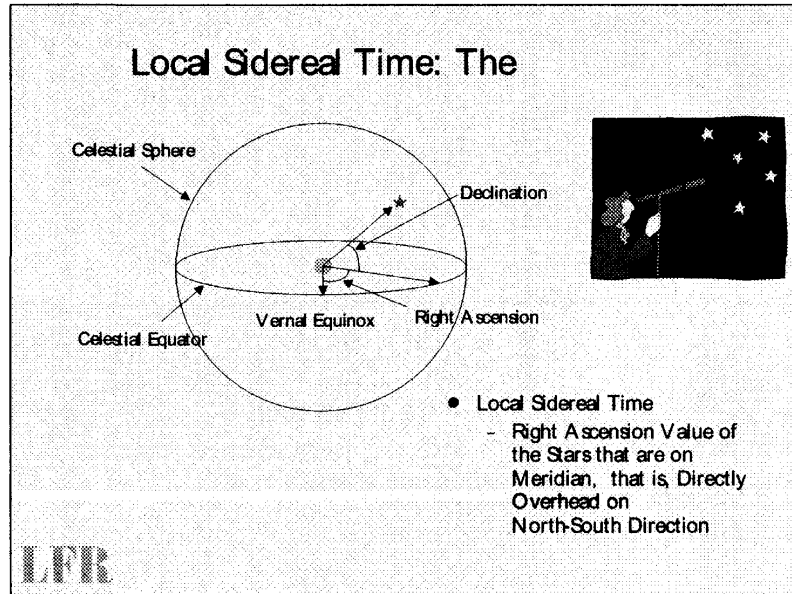
This value depends upon where one is on the surface of the earth and where the earth is in its orbit. If one were to conduct an experiment, say at 10:00 each day for year, that fixed clock time would sweep out 24 hours in local sidereal time.


Original Data Set: Results
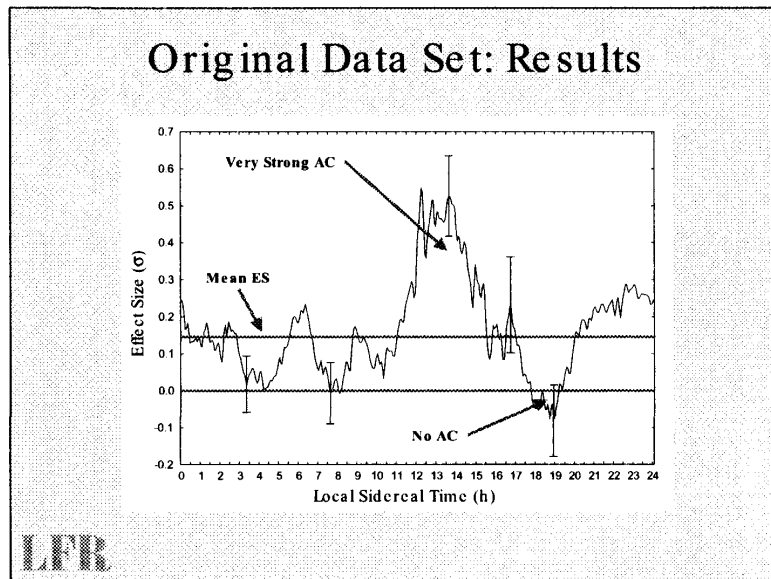
This work is mainly due to James Spottiswoode. He examined approximately 1,500 free-response trials conducted over 20 years in many different laboratories by many different investigators working with many different participants. The curve shown in this slide is a sliding average of the effect size for each trial versus the local sidereal time at the onset of the trial. The mean effect size is approximately 0.15 and 0.0 represents the mean chance expectation. Two strong features stand out. There is a hole at approximately 18 h. local sidereal time (LST). That is over many hundreds of trials during this time there was no evidence of anomalous cognition. But at 13 h LST there is about a 300% improvement over the mean effect size. We spent many months examining potential artifacts but could not explain away this structure.

Original and Confirmation Data Sets
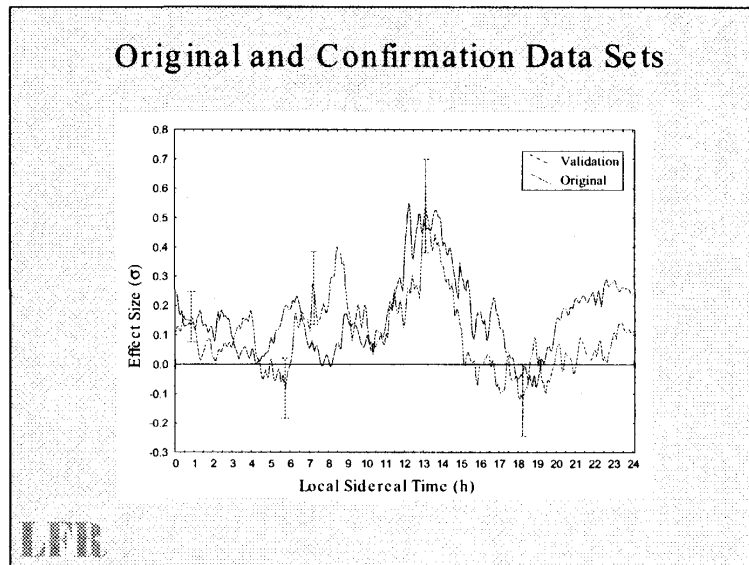
We asked our colleagues to provide us with additional data that were not in the original dataset as part of an independent retrospective test. The blue curve represents the first 1,500 trials which acts as a hypothesis. The red curve is the result of approximately 1,500 additional free response trials. The basic structure (i.e., peak near 13 h and hole near 18 h) was replicated.

Galactic Structure in the AC Data?
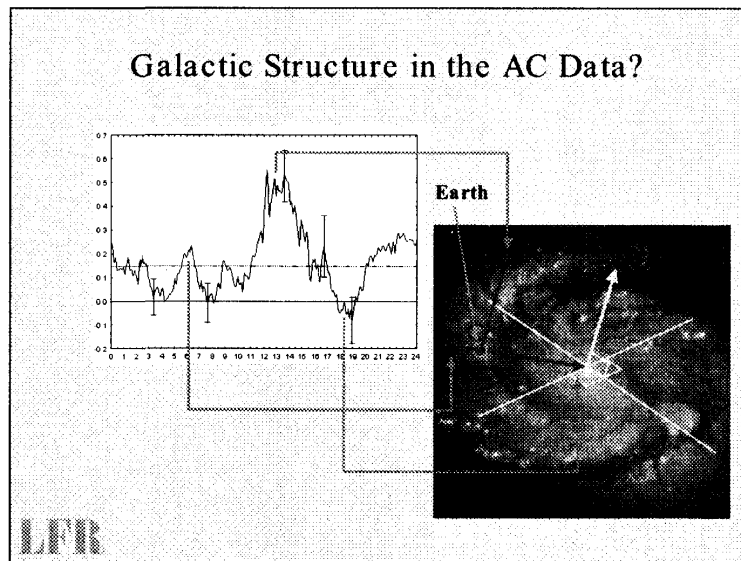
One speculation is that some kind of radiation emanating from the Milkyway galaxy is either disrupting the brain of receivers or is, somehow, adding noise to a putative anomalous cognition channel. That is, when most of the Milkyway is hidden below the horizon, the AC is at a maximum, and the converse is true. When the galactic center is overhead, then AC vanishes. *We wish to emphasize at this time this correspondence is extremely speculative.*

Correlation to the Geomagnetic Field Index: Ap
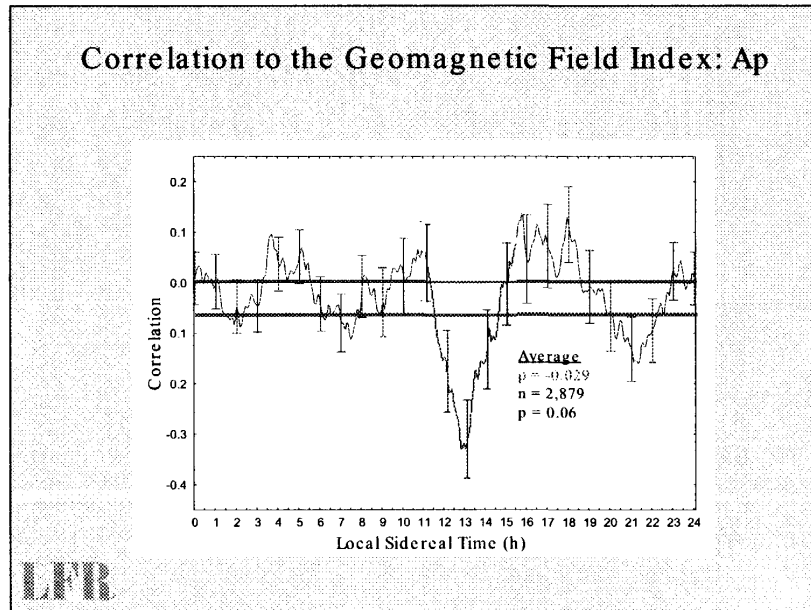
The third physical variable, is the correlation of anomalous cognition with the fluctuating **geomagnetic field** as described by the Ap index. The blue curve shows a sliding average of the correlation as a function of LST. Overall the correlation is quite small, but at 13 hours LST it is decreased by over a factor of 10. The green curve is a plot of the effect size as a function of LST to illustrate that when anomalous cognition is maximized so also the negative effect of a large geomagnetic fluctuation.

C o n c l u s i o n s

* Strong Evidence for an Information Transfer Anomaly
* Clues that it is Mediated via a Sensory-Like System
* Phenomenon may be Modulated by Subtle Environmental Factors

In conclusion, there is incontrovertible evidence for a statistically based information transfer anomaly we call anomalous cognition. It appears to be mediated by some sensory system and is modulated by some subtle environmental factors.