THE JOURNAL OF THE AMERICAN SOCIETY FOR PSYCHICAL RESEARCH

VOLUME 82 JULY 1988 NUMBER 3

Geomagnetic Effects on GESP: Two Studies

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ABSTRACT: Two studies manifesting general extrasensory perception (GESP) at statistically significant levels were analyzed for possible correlations of GESP performance with planetary geomagnetic field (GMF) activity. Adams' (1985) finding of lower values of GMF activity on several days preceding more successful laboratory GESP performance (remote viewing) was generally directionally replicated, although not at a level of clear statistical significance. Schaut and Persinger's (1985) findings of significantly lower GMF activity on days of spontaneous GESP events in their four independent studies were paralleled at a statistically significant level for deliberate laboratory GESP in one study, but not the other. When the present data of that study were more closely analyzed, the GMF/GESP relationship was found to occur when the shielding structure, an intact, solid-wall Faraday cage, was in an electrically floating (with respect to ground) condition, but not when it was electrically grounded. The electromagnetic shielding effectiveness of the Faraday cage was found not to be affected by whether it was grounded or ungrounded in empirical tests, so it is unlikely that the GMF itself was affected by the grounded versus ungrounded condition of the cage. A grounded Faraday cage was associated with significantly higher GESP performance from the percipients, however, so an alternative explanation is that the apparent amplification of GESP performance found in the grounded Faraday cage condition washed out the GMF effect. Although not strongly supported, the possibility of enhancing GESP performance by conducting experiments in grounded Faraday cages and/or in geomagnetically "quiet" weather deserves further investigation.

[1] An earlier version of this paper was presented at the 1986 meeting of the Parapsychological Association at Sonoma State University in Rohnert Park, California. These studies would not have been possible without the diligent efforts of my students: Hector Aponte, Scott Archibold, Amy Callahan, Alan Croft, Bruce Frankel, Annette Fuerstenberg, Laurie Gates, Mark Glatt, Georgette Holezal, William Kincaid, Kurt Kland, David Kraus, Eric Larsen, George Mayweather, Erin McCarthy, Jeffrey Mellin, Frank Menhams, Judi Norquist, Frank Odasz, Lawrence Selbach, Monika Sumi, Gaines Thomas, Paul Tefler, Ryan Unruh, Mark Watts, Wanda Welch, Bruce Westlund, and Elizabeth White. I am also indebted to Jessica Utts for advice on statistical procedures, to Yvette Tazeau for assistance in data analysis, to

Several older theories about the nature of extrasensory perception (ESP) have postulated that it involves some form of electromagnetic carrier for the transmission of information. Insofar as this is true, we would expect ESP to have characteristics similar or identical to those involved in radio communication, such as reliability being dependent on signal strength, carrier detectability by physical instrumentation, and marked attenuation by both distance and electrical shielding. Because the vast bulk of the experimental data has not shown any physically detectable electromagnetic emissions, nor any effects of shielding and distance (other than those attributable to psychological factors), electromagnetic carrier theories have had little useful explanatory power to date. (Further detail on this may be found in Chari, 1977; Tart, 1975; and Tart, Puthoff, & Targ, 1979.)

Some studies in recent years have indicated that biological organisms, including humans, show physiological and psychological responses to low intensity electromagnetic fields at field strengths comparable to those normally found on the planetary surface (Adey, 1981; Becker & Selden, 1985; Persinger, 1979). Thus, even if the transmission mechanism of ESP is not electromagnetic per se, it is possible that naturally varying or artificially varied electromagnetic factors might affect ESP performance by affecting the nervous systems of people involved in using ESP. Such a possibility is strongly suggested by recent studies of Adams (1985), Persinger (1985a, 1985b, 1985c), Persinger and Schaut (1988), Schaut and Persinger (1985), and others of relationships between the earth's magnetic field and general ESP (GESP, i.e., no distinction between telepathy and clairvoyance) performance. This paper will review these studies and present retrospective analyses for geomagnetic field (GMF) effects in two experimental studies.

The Geomagnetic Field

The geomagnetic field has several components. The main one is that created by the earth itself, as if there were a huge bar magnet running through the core of the earth, with its ends at the north and south magnetic poles. The exact intensity and direction of this field undergoes slow variation over a period of years (called secular variation). Regular monthly and diurnal variation occurs from lunar and solar influences, respectively. Irregular variation occurs as a result of weather affecting winds in the electrically charged ionosphere. Major variations result from sunspot activity, creating geomagnetic storms. The aurora borealis is the best known example of charged particles from the sun interacting with the earth's mag-

Marsha Adams, E. Stanton Maxey, and Michael Persinger for providing geomagnetic indices data, and to Irene Segrest and the Bernstein Brothers Parapsychology and Health Foundation for general support of this and other projects. Initial results of this study were presented at the First Archaeus Congress, Santa Fe, New Mexico, in January of 1986.

netic field in the ionosphere. The ionospheric electrical phenomena are modified by the GMF and in turn modify the GMF.

GMF changes can be sudden and unpredictable and may last for minutes to weeks. A day of low amplitude, slow, predictable variation is referred to as a quiet magnetic day, one of sudden and large amplitude changes as a magnetically stormy day. A good analogy can be made to ordinary weather, where we sometimes have calm, clear, sunny days and sometimes windy, stormy days. Just as some people's moods may be affected by the ordinary weather, some evidence suggests that some people's mood (and consequent performance on a variety of tasks) may be affected by the magnetic weather.

Psi Performance and the Geomagnetic Field

Adams (1985) retrospectively analyzed a large database of remote-viewing (RV) trials conducted from 1979 to 1984 as part of several independent experiments at SRI International. The general procedure and results of the SRI and other remote-viewing studies are well described in the literature (see, e.g., Targ & Harary, 1984; Targ & Puthoff, 1977; Tart, Puthoff, & Targ, 1979). Each of the RV trials in Adams' study was rated on a 0–7 scale, with 0 indicating nothing at all in the viewer's description that a rater could relate to the RV target and 7 (a rating almost never used) indicating an almost photographically accurate and correct description of the target, including abstract analytical information such as correct naming of prominent target items. The scale has been fully described in Targ, Targ, and Lichtarge (1985). Adams started with a total of 515 RV trials and selected those that were rated as 5.0 (''Good correspondence with unambiguous unique matchable elements, but some incorrect information'') or greater, or as 2.0 (''some correct elements, but not sufficient to suggest results beyond chance expectation'') or less. This yielded 72 high-performance RV trials and 48 low-performance ones.

Perturbations in the GMF may have subsequent electromagnetic consequences that lag behind the initial perturbations by periods ranging from minutes to several days. Daily planetary GMF indices tend to be highly correlated for 3 days in a row, for example, but relatively independent over longer time periods (Schaut & Persinger, 1986). Consequently, Adams (1985) compared geomagnetic activity on 4, 3, 2, and 1 days before each RV session, as well as on the day of the session, for high- and low-performance RV sessions. She also presented analysis for the 4 days following the RV sessions as a kind of control, but these data showed no effects and will not be further considered here.

Adams found that Sigma K_p, a daily measure of variability of the most unsettled horizontal component of the earth's GMF, was lower (quieter geomagnetic ''weather'') for the days of high-performance RV trials and for the 4 days preceding these trials, compared to low-performance RV sessions. This difference was greatest for 1 day before the RV session, significant at $p < .005$ (two-tailed,[2] comparing means and standard deviations). For this day preceding the RV trial, the low-performance RV days showed about 30% higher GMF activity, judging from Adams' Figure 1. More detailed analysis with 3-hour indices of variations in the GMF also yielded interesting results. Adams' analyses were not corrected for the use of multiple tests on the data, but this is not as important in initial explorations of possibilities as in hypothesis-testing experiments, so we shall let her findings stand for the time being.

Persinger and Schaut (Persinger, 1985a, 1985b, 1985c; Persinger & Schaut, 1988; Schaut & Persinger, 1985), working from a well-developed theoretical model of Persinger's implicating extremely low frequency (ELF) electromagnetic radiation and GMF perturbations as factors affecting human behavior, analyzed three independent samples of spontaneous GESP cases of apparent telepathy or clairvoyance. The first was a rigorous case collection of Stevenson's (1970). Twenty-five cases had sufficient date information for analysis. Using the aa (average antipodal) index of GMF activity developed by Mayaud (1973), Persinger and Schaut found that the mean aa index on the days of these spontaneous cases was significantly lower (mean 10, standard error ± 3.5) than the mean aa for 7 days before or after the experience (mean for all 14 days of 18.45, standard error ± 10, $p < .001$, one-tailed, by both parametric and nonparametric analyses).

Their second sample consisted of 78 old but exceptionally well-verified telepathic or clairvoyant cases from *Phantasms of the Living* (Gurney, Myers, & Podmore, 1886). Again the mean aa index was 10 (± 1.0) for the days of the experiences, significantly lower than the mean value of 15 (± 3.0) for the days preceding or following. As an especially interesting control, Persinger and Schaut similarly analyzed 31 other cases from this collection that showed more discrepancies in verification, and so might not be genuine instances of GESP. The aa values on the days of those cases did not differ significantly from the days preceding or following them.

Persinger and Schaut's third sample consisted of 57 cases of ostensible spontaneous telepathy from *Fate* magazine that were precisely dated. Again the mean aa index was lower on the days of these ostensibly telepathic experiences (13.5 ± 10.9) than on preceding and following days (21 ± 15). As a control, a sample of 56 ostensible *precognition* cases from *Fate*, in which a different psi mechanism might theoretically be involved, did not show such differences. Note that these are large differences, with the aa index being 50% to 80% higher on control days.

The high magnitude of results in these two sets of studies, both reported

[2] In Adams' (1985) paper, this significance level was not specified as one- or two-tailed, but I ascertained this from a personal communication. Also, Figure 1 in her report is accidentally mislabeled, as it is a plot of the planetary A_p index, rather than Sigma K_p.

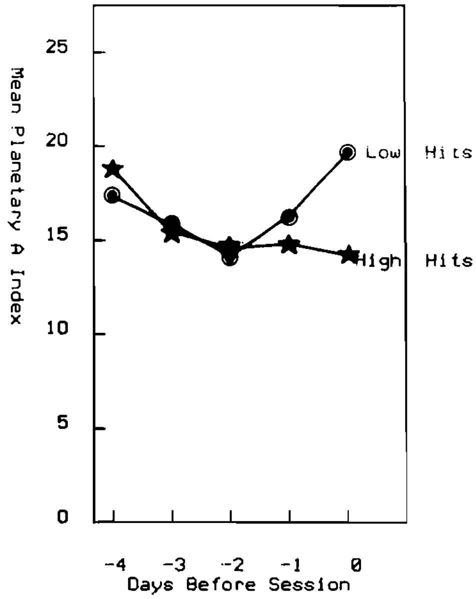

Fig. 1. Geomagnetic field activity as a function of high and low GESP scoring activity, planetary A_p index, irrespective of the electrical condition of the Faraday cage enclosure.

at the 1985 meeting of the Parapsychological Association, inspired me to look for GMF correlates of GESP performance in a recent and a decade-old study my students and I had carried out. This recent Faraday Cage Study seemed of special interest in regard to possible GMF correlates because it involved partial electromagnetic shielding of the percipients by a Faraday cage, which I initially assumed (erroneously) might be expected to affect higher frequency electromagnetic radiation that might be linked to the GMF.

Further studies of the GMF and psi were reported at the 1986 meeting of the Parapsychological Association. Schaut and Persinger (1986) extracted 75 new cases of ostensibly telepathic or clairvoyant spontaneous psychic experiences from their remaining collection of *Fate* magazines. As with their three previous studies, the aa index was significantly lower for the days of the experiences compared to the 3 days before or after. Forty-nine ostensible precognition cases were again used as a control and again showed no significant lowering of the aa index on the day of the experience. This difference is interesting in light of my finding (Tart, 1983) of a major difference in the bit rate of present-time and precognitive GESP laboratory test performance. Further, Schaut and Persinger used 65 cases of ostensible postmortem apparitions as another control, and they also failed to find any lowering of the aa index on the day of the experience. Indeed they note a suggestive (but not statistically significant) trend for the aa index to be higher on the days of both ostensibly precognitive and postmortem experiences.

Persinger and Krippner (1986) analyzed the relationship of GMF activity to degree of success in the Maimonides dream telepathy experiments. Their analysis is somewhat complex, involving four categories of hit rates. Results seem to provide at least partial confirmation of the finding of lower aa indices with more successful GESP, but my interpretation of this is only tentative, as fuller details of the procedure need to be published.

Adams (1986) reported some quite complex analyses of GMF correlates of 130 Ganzfeld sessions at the Psychophysical Research Laboratories in Princeton, NJ. Post hoc and rather theoretical transformations of data were apparently required to find some correlations of GESP performance with another aspect of the GMF, Pc_1 micropulsations, so it is best to consider this study exploratory rather than confirmatory of earlier findings.

Nelson and Dunne (1986) looked for GMF correlations in three psi databases collected at the Princeton Engineering Anomalies Research unit at Princeton University, without finding any. The first database was their Precognitive Remote Perception trials. A lack of correlation of GMF activity with precognitive ESP would, of course, parallel Persinger and Schaut's findings for spontaneous cases in the two *Fate* studies outlined above. A question of mine to Nelson at the presentation of the paper revealed, however, that the adjective "Precognitive" in the name of the database is misleading: Some of the RV trials were precognitive, but others were not. A reanalysis, separating these cases, is required before the findings can be considered meaningful.

Nelson and Dunne's other two databases were PK experiments, one with electronic random generators and the other with a mechanical cascade device. They found no correlations between PK hit rate and GMF activity. This search for GMF correlates with a different form of psi is to be commended, but it raises an important methodological point.

Detectability of Relationships

If some variable, X, is genuinely correlated to another variable, Y, that does not mean we will have a high likelihood of detecting this correlation in any real experiment where our sampling of X and Y is a small fraction of the natural variation and manifestation of X and Y. Our likelihood of detecting the true relationship will be positively correlated with the size of the true relationship. That is, if X and Y have, for example, a .90 correlation in nature, we are much more likely to detect it in a small experiment than if their true correlation is more like .08. Further, our likelihood of detecting the true correlation is inversely related to the range of variation of X and Y in our study. If both vary over a small range, we may not detect the relationship even though it is there in nature.

This point does not seem to be generally understood by parapsychologists. Low-level manifestations of psi make it very unlikely that we would detect a correlation of it with some other variable even if the correlation exists. Almost all studies of psi versus personality factors, for example, have involved low-level manifestations of psi, so it is not surprising that this research area is characterized by unstable findings. In the case of the Nelson and Dunne PK databases, my impression is that we are dealing with quite low-level manifestations of PK. Because they comprise enormous numbers of trials, they are very significant *statistically*, but the effect level seems to be quite low. So even if there is some relationship between PK and the GMF, it is not surprising that it is not detectable in these two studies.

Any psi-missing in a database would further complicate the detectability of a genuine correlation.

Someone with appropriate mathematical skills would do a service to the field by putting the above argument in mathematical terms and providing some practical guidance charts that would estimate sample sizes and effect ranges necessary to detect true correlations of various magnitudes.

Applying this reasoning to the studies of GMF activity and psi available to date, we should note that both Adams' (1985) first study of RV activity and Persinger and Schaut's (Persinger, 1985a, 1985b, 1985c; Persinger & Schaut, 1988; Schaut & Persinger, 1985, 1986) studies dealt with relatively high level manifestations of GESP. In Adams' 1985 study, the percipients had generally been selected and trained for high-level remote-viewing performance. The apparent magnitude of GESP in spontaneous cases that are interesting enough to be published, as in Persinger and Schaut's studies, seems to be quite high compared to typical laboratory performance. To introduce new terminology analogous to that currently being used in PK studies, Schaut and Persinger (1985, 1986) in particular and Adams (1985) (sometimes) were dealing with manifestations of *macro-ESP*. The typical forced-choice laboratory GESP or PK study, on the other hand, has much lower level results. Typically, a group of percipients might average 51% success on a binary guessing task, and over many trials this might be *statistically* significant, but unlikely to impress ordinary people who are not versed in the abstract reasoning of statistical tests. Thus, most laboratory work deals with *micro-ESP* or *micro-PK*.

Possible relationships of GESP and GMF activity, then, seem to have emerged in at least four studies involving macro-ESP, but the relationship is ambiguous or missing with studies involving micro-ESP or micro-PK.

Turning to the two GESP studies conducted at the University of California at Davis (UCD) that I will analyze for GMF correlates in this paper, the Faraday Cage Study showed micro-ESP effects, so any link between GESP performance and GMF factors would probably have to be strong to emerge. The First Training Study showed substantially stronger, but still low, ESP effects.

The UCD Faraday Cage Study

The Faraday Cage Study was inspired by some little-known work of Andrija Puharich (1957, 1962). His studies employed percipients preselected for high-level, demonstrated psychic ability: They could usually score statistically significantly above chance on a forced-choice GESP test conducted under ordinary room conditions, often showing statistically significant scores in a single run. Puharich found that the electrical treatment conditions of a solid-wall Faraday cage varied without the percipients' apparent knowledge, markedly altered their GESP performance. Under both the grounded (cage connected to earth) and charged (cage 15,000 volts DC negative with respect to ground) cage treatment conditions, their scores were much higher than their already significant ordinary room performance. Under an electrically floating condition (cage not electrically grounded to earth), their scores fell to chance. This latter finding suggested active inhibition of ESP abilities, because these percipients could usually score significantly under ordinary room conditions. My UCD Faraday Cage Study was an initial attempt to test Puharich's basic findings, comparing GESP performance in a Faraday cage under grounded and floating conditions.

Faraday Cages

Because shielded enclosures are not familiar to most parapsychologists, I will briefly describe them in nontechnical language.

The Faraday cage is named after the British physicist Michael Faraday and is routinely used in various types of physics experiments. It operates on the principle that like electrical charges repel each other. In the case of a solid container whose surface is an electrical conductor, such as copper, if a static electrical charge is applied to its surface, the mutual repulsion of the electrons will move the electrical field to the outermost surface of the Faraday cage. The electrical charge does not penetrate to the interior of the cage.

Alternating electrical fields, such as radio waves, are also attenuated by a Faraday cage but in a more complex way. Attenuation is a combined function of (a) the degree to which the incident radio waves are reflected from the outer surface of the cage skin, (b) the degree to which those not reflected are attenuated within the cage skin; and (c) the degree to which those traveling through the cage skin are reflected back into the skin when they contact the boundary formed by the inner surface of the skin. For a single-wall Faraday cage, attenuation is generally in the order of 60 decibels or more for 10 kHz and higher frequencies. Simply illustrated, if a portable radio is carried inside a Faraday cage and the door is shut, reception will cease and only the white noise inherent in the receiver circuitry will be heard.

This describes an ideal Faraday cage. In practice, very high radio signal strength will allow some signal to penetrate inside the cage so a radio broadcast can be heard, especially with the great sensitivity of modern radio receivers. Slight cracks around doors or other openings may create some leakage. Penetration of radio waves is also inversely proportional to the frequency, so a Faraday cage adequate to completely shield out a high-frequency broadcast may not shield a low-frequency one too well. Although substantially reduced, the electrical shielding effect at frequencies of biological interest is not negligible, though, as evidenced by the widespread use of Faraday cages in EEG work to shield out 60 Hz interference from power lines.

Extremely low frequency (ELF, 3 Hz to 3 kHz) and ultra low frequency (ULF, less than 3 Hz) waves, as well as magnetic fields, will penetrate any feasible Faraday cage with almost no attenuation. A submarine deeply submerged in electrically conductive sea water, for example, is the most effective Faraday cage that can be constructed, but ELF waves can be used to communicate with it. A copper Faraday cage has almost no effect on magnetic fields, which pass right through it.

Method

Because the original study has been described in detail elsewhere (Tart, 1988), I shall only summarize the procedure here, except where details may be important in understanding possible GMF effects.

Percipients and experimenters in the UCD Faraday Cage Study were undergraduate psychology majors at the Davis campus of the University of California. Each student was paired with another student, and they alternated in the roles of agent/experimenter and percipient. Both agent/experimenters and percipients were blind as to Faraday cage electrical treatment conditions until the end of data collection.

GESP data were collected under two randomly varied experimental conditions, the electrically grounded Faraday cage condition and the electrically floating (with respect to ground) condition.

The UCD Faraday Cage

The Faraday cage in my laboratory is an 8-foot hollow cube. It is built with a ¾″ outer plywood skin over ordinary 2″ × 4″ studs, with a plywood inner wall covered with sound-absorbing acoustical tile on walls and ceiling and a rug on the floor. A battery-operated lighting system furnishes illumination, and it is quiet and comfortable inside.

The outer plywood skin is covered with a special tar-impregnated roofing paper that has a thin (0.005 inch, 3 oz. of copper per square foot) layer of copper plated onto it. All joints are continuously soldered. The door edges are covered with tensioned fingertip strip for tight electrical connection. No wires or ventilating openings break the electrical integrity of the cage.[3] Because atmospheric ions can selectively enter a non-airtight Faraday cage and have physiological and psychological effects on percipients, the agent/experimenter completely sealed the edges of the cage door with masking tape after the percipient had entered for each experimental run. The air supply sealed in the cage was more than adequate for the brief time (15–20 minutes at most) a percipient was inside to carry out a run.

This cage shows the usual shielding effect when carrying a portable radio inside: Almost all stations become undetectable on both the standard AM and FM broadcast bands. The inside of the UCD cage was not free of radio frequencies, however, due to the presence of a high-powered (5,000 watts) FM station on campus whose transmitting antenna was located about 100 meters away.

The UCD Faraday cage is mounted on rubber automobile tires, laid horizontally on the floor. This provides both mechanical isolation from floor and building vibrations and electrical insulation. The resistance to ground through these tires is about 10^{10} ohms. The switch on the apparatus in the nearby equipment rack (about 6 feet away) connected the Faraday cage to or disconnected it from a heavy conductor that joined a corner of the cage to a copper grounding rod driven deep into the ground below the second-floor room of the laboratory where the cage was located. The electromagnetic properties of the cage have been described in detail by Hubbard and Vincent (1988).

GESP Test Procedure

For assessing GESP performance, we used the Circular Matching Abacus Test (CMAT). This consists of two matching sets of 10 transparent plastic boxes, each with a different picture inside. The 10 picture boxes in the agent's target set were randomized as to order. The percipient had to arrange his or her set to match the order of the agent's set. The target cards in the CMAT boxes were Tarot cards, selected for their psychological appeal. Mean chance expectancy on this test is one hit per run, and the distribution is well approximated as a Poisson with mean and variance of one (Feller, 1957; Tart, 1988).

The percipient entered the Faraday cage with his or her CMAT response board. The agent/experimenter then taped the cage door shut, turned on the Faraday cage treatment apparatus, took the top card from a set of randomized conditions cards, set the appropriate dial and switch settings, and then shouted to the percipient through the wall of the Faraday cage that sending would start in about 2 minutes.

The agent then left the room containing the Faraday cage, locked its

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[3] This same cage has been used in other ESP experiments (Tart, 1975, 1976, 1978; Tart, Chambers, & Creel, 1981; Tart, Palmer, & Redington, 1979a, 1979b, 1979c), but it was not then functioning as an electrically intact Faraday cage because numerous wires for signals and power ran through openings in its walls, and there were ventilation openings, although these were covered with copper mesh screen. All wires were removed and all openings were covered with copper sheet and soldered for this study.

door, and entered a locked room across the hall. He or she then thoroughly shuffled a deck of ordinary playing cards from which the face cards had been removed. The first 10 cards from this deck that did not repeat were then used to randomly arrange the 10 plastic boxes containing the target cards on the agent's circular layout board.

The agent/experimenter concentrated on sending the order of the target arrangement for 10 minutes (using a timer) and then wrote down the order on the agent's data sheet. He or she then reentered the room containing the Faraday cage and shouted only that the session was finished. The percipient, who had meanwhile been arranging the target boxes on his or her response board to try to match the order on the agent's target board, now wrote down their order and then left the cage. The number of hits (identical card in identical position) was then counted, and the response order was also copied onto the agent's target order sheet. If time allowed, a second or sometimes a third run would be carried out. Because the analysis for GMF correlates of GESP performance had not been conceived of at the time the study was carried out, the number of times that experiments were run could have had no intentional relationship to GMF variables.

GMF Results of the Faraday Cage Study

Faraday Cage Effects on GESP Performance

As reported earlier (Tart, 1988), there was a significant difference in GESP performance for the grounded and floating Faraday cage conditions. The mean hit rate per run in the grounded condition was 1.224, whereas that in the floating condition was 0.905, a difference significant by the Mann-Whitney *U* test ($p = .03$, one-tailed). This followed the prediction based on Puharich's (1957) original work.

The hitting in the grounded cage condition (93 hits in 76 runs) was independently significant by an exact Poisson test ($p = .032$, one-tailed), with chance results in the floating condition (67 hits in 74 runs).

Analysis for Geomagnetic Effects

I followed Adams' (1985) analytic procedure of dividing the data into high- and low-GESP performance runs. High performance was here defined as a run score of three or more hits ($p \leq .08$, one-tailed), whereas low performance was defined as a score of zero hits. This division was decided on prior to inspecting the GMF data.

The Mann-Whitney *U* Test was used to compare daily GMF values for the planetary A_p index, a daily average measure of the range of variation of the horizontal components of the GMF. A_p values were used for primary analysis because of the two geomagnetic data sets initially available from Adams, A_p had a numerical range more suitable for plotting on my graphics plotter than Sigma K_p. Subsequent analysis of the A_p index

(Adams), the Sigma K_p index (Adams), and the aa index (Persinger & Schaut) for the 24 days in which data were collected in the present study showed that they were essentially interchangeable, however, with rank order correlations between them ranging from a low of .94 to a high of .97.

The *U* test and Spearman rank order correlations were used in preference to parametric statistics as inspection showed that the distributions of A_p values in this study departed markedly from the normal. A methodological paper by Hubbard and May (1986) further shows that parametric statistics are generally inappropriate for current GMF indices. Persinger and Schaut used parametric statistics, but first transformed the indices to normalize their distributions. The Mann-Whitney and Spearman tests assume only that the indices are ordinal scales, that is, that a higher number is greater than a lower number, not that the intervals between numbers are equal (Siegel, 1956). A high (20+) A_p index represents a "stormy," highly variable geomagnetic day, according to Adams (personal communication, November 26, 1985), whereas a low A_p index represents a "calm" day.

Adams (1985) found significantly quieter GMF activity in both A_p and Sigma K_p on the day immediately preceding a more successful remote-viewing session and generally (but not significantly so) quieter GMF activity for the day of the session and the fourth, third, and second days preceding the session. Similarly, I analyzed the 4 days preceding and the day of my percipients' GESP sessions.

Figure 1 shows the mean A_p values for high- and low-scoring GESP runs mixed through both electrical conditions of the Faraday cage. As with Persinger and Schaut's findings with the aa index and spontaneous cases, I found high GESP performance days associated with quieter GMF activity than low-performance days on the day of the GESP test ($U = 363.00$ with $n_1 = 18$, $n_2 = 54$, $Z = 1.593$, $p = .056$, one-tailed).

None of the 4 days preceding the GESP runs showed significant differences in geomagnetic activity between high- and low-scoring runs, in contrast to Adams' (1985) finding.

At biologically active frequencies of 10 Hz or less, the UCD Faraday cage would be essentially completely transparent to electromagnetic radiation, that is, it would be expected to have no shielding effect at all, whether grounded or ungrounded. But because the electrical condition of the Faraday cage, grounded or floating, affected GESP scoring, I separately carried out the same analyses as above for the grounded and floating conditions. I also did this because I thought that there might be high harmonic components of the GMF that might be affected by the Faraday cage, a line of reasoning I later realized was quite speculative. The results are shown in Figure 2 and Figure 3.

The relationship of GMF activity with GESP run performance falls to small, nonsignificant differences when the Faraday cage is in its more psi-conducive mode, that is, grounded. When it is electrically floating, in its less psi-conducive mode, however, the effect of lower GMF activity

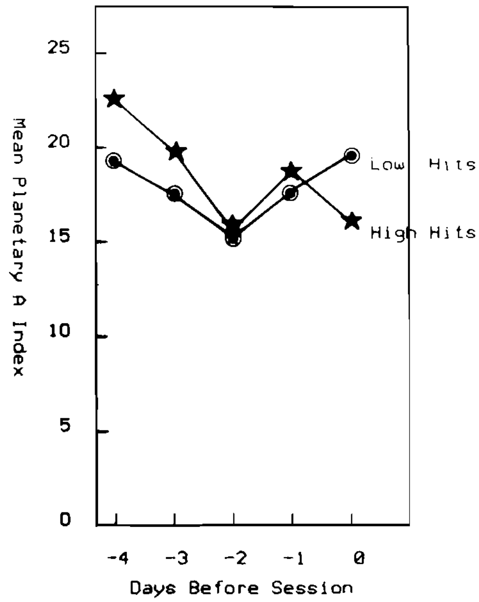

Fig. 2. Geomagnetic field activity as a function of high and low GESP scoring activity, planetary A_p index, in the electrically grounded (GESP-conducive) condition of the Faraday cage.

being associated with higher GESP performance reappears (U = 72.50 with n_1 = 7 and n_2 = 33, corresponding Z = 1.531, p = .063, one-tailed) for the day of the tests. A similar and more significant effect appears for the geomagnetic effect three days prior to the tests (U = 47.50 with n_1 = 7, n_2 = 33, with a corresponding Z = 2.420, p = .008, one-tailed). The reversals of direction and lack of significance 1 day prior to the trials is not very consistent with Adams' (1985) finding of generally lower GMF activity for several days prior to more successful remote-viewing experiments, significant on day −1.

The 1974 Training Study

My students and I carried out the First Training Study to ascertain the effects of immediate feedback on GESP performance at UCD in 1974. Methods and results have been described in detail elsewhere (Tart, 1975, 1976, 1979), thus only a brief description is given here.

In accordance with my theory (Tart, 1966, 1977) that immediate feedback of results on a GESP test should allow percipients *who already had enough demonstrable GESP talent to begin with* to improve their performance with practice, rather than, as is common, decline with practice, talented percipients were given feedback training. To locate student percipients with demonstrated GESP ability, a two-stage screening procedure

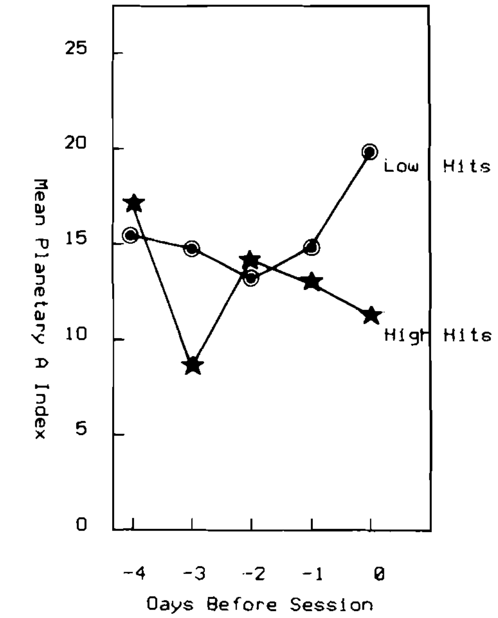

Fig. 3. Geomagnetic field activity as a function of high and low GESP scoring activity, planetary A_p index, in the electrically floating condition of the Faraday cage.

was carried out, beginning with group tests (the Selection Study) and, for those who showed probable GESP talent in those tests, six individual runs (the Confirmation Study) of 25 trials each on either a four-choice GESP test device (the Aquarius model 100) or a 10-choice trainer (the TCT). Percipients who continued to show significant results in the Confirmation Study, and who wished to continue participation, went on to complete a nominal 20 runs on the machine of their choice in the Training Study. Each percipient received full, immediate feedback as to what the correct target had been immediately after making a response, so they could compare various internal strategies and see which yielded the best GESP scoring. Overall GESP scoring in the Training Study was highly significant: For the Aquarius, $p = 4 \times 10^{-4}$, one-tailed, and for the TCT, $p = 2 \times 10^{-25}$, one-tailed.

In late 1985, when I decided to look for possible GMF/GESP correlates in this Training Study, the original data sheets containing the date and time of each run had been discarded for all of the Training Study data collected on the TCT, but data sheets for 12 of the 15 percipients who worked with the four-choice Aquarius machine were available.[4]

[4] Using the designations of the original study, the original data sheets for E6S1, E6S20, and E6S21 were missing.

The 12 percipients scored 1,656 hits in 5,976 trials where 1,494 hits were expected by chance, yielding an overall Z score of 4.84, $p < 10^{-6}$, one-tailed. This is quite *statistically* significant over this large number of trials, but not very strong in absolute terms, corresponding to a mean of 27.7% hits instead of the 25% expected by chance, a psi quotient of 0.04 (Timm, 1973). This is good for psi experiments in general but probably a definitely lower performance level than that represented in the Adams (1985) or Schaut and Persinger (1986) studies.

GMF Results of the First Training Study

Available data were collected from January 25th to April 10th of 1974. The aa index, more easily available to me for that period than any other GMF measure, was used for analysis of planetary GMF activity on a given day, averaging the north and south values of the index. The aa measurements ranged from a low of 5.00 to a high of 85.50.

Previous studies have divided GESP performance into high GESP and no GESP categories and then compared GMF values in those two categories. Because the number of runs per percipient per daily session varied considerably in the present study, no simple value for a session score being above some threshold indicating statistically significant GESP performance could be computed. Thus, mean hit rate for all of a single percipient's Aquarius runs on a given day was used as the measure of session GESP activity. These hit rates ranged from a low of 4.50 to a high of 9.50, with MCE being 6.25. I used the upper and lower quarters of the distribution of 41 mean GESP scores (mean session score ≥ 7.66 or ≤ 6.25, respectively) as an approximate definition of "GESP present" and "GESP absent" categories. Because 41 does not divide evenly into quarters, the upper and lower quarter was taken to mean the 10 highest and 10 lowest scores.

Following Adams' method, the relationship between GESP scoring and GMF was looked at for the day of each session and the preceding 4 days. The results are shown in Figure 4. Mann-Whitney U Tests were used in all the comparisons reported below because of the non-normality of the distributions, and the Z score reported is derived from the U value.

There is slightly higher GMF activity associated with higher GESP scoring for the day of the sessions, but the difference falls far short of significance ($U = 54.500$, $n_1 = 10$, $n_2 = 10$, $Z = 0.340$, n.s.), failing to support Schaut and Persinger's (1985) findings or my findings in the Faraday Cage Study. Lower GMF activity is associated with higher GESP scoring for the 4 days preceding the sessions. This difference is significant for 3 days before the sessions ($U = 28.000$, $n_1 = 10$, $n_2 = 10$, $Z = 1.625$, $p = .052$, one-tailed) and suggestive for 1 and 2 days preceding the sessions ($U = 32.500$, $n_1 = 10$, $n_2 = 10$, $Z = 1.323$ and $U =$

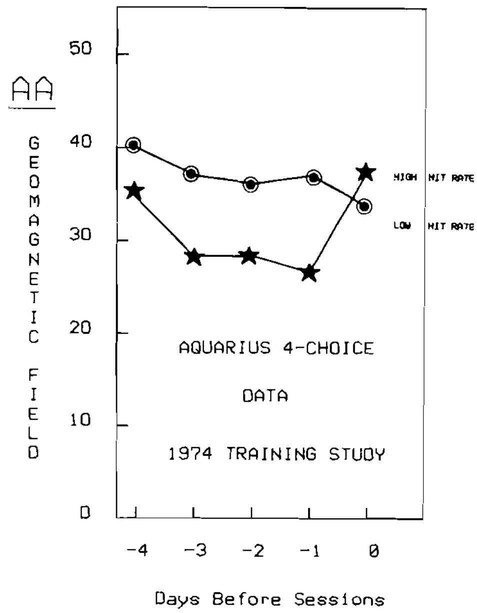

Fig. 4. Geomagnetic field activity as a function of high and low GESP scoring activity, planetary *aa* index, in the four-choice Aquarius data of the First Training Study.

33.000, $n_1 = 10$, $n_2 = 10$, $Z = 1.247$, $p = .093$ and $p = .107$, one-tailed, respectively), which gives some support to Adams' findings.[5]

Discussion

Because several investigators are in the process of comparing GESP data in older experiments with GMF variables, a much larger database will soon be available to study. Therefore, I shall be brief and tentative in presenting conclusions here.

Support for GMF Effects

The present results provide some support for others' general findings of quieter GMF "weather" on or immediately preceding an experiment associated with superior GESP performance. This is encouraging but not conclusive support, due to the use of multiple analyses. Five statistical tests (for day −4 to day 0) were carried out in each of my studies, with two being significant at the .05 level.

[5] I have used the normal approximation for assessing the Mann-Whitney test results here because the tables available to me do not cover the exact *U* values found here.

The weak level of psi in the present two studies and the small sample sizes, on the other hand, compared to Adams' and Persinger and Schaut's original studies, may have led to failure to adequately detect GESP/GMF relationships. Further, assuming there is a real relationship, because GMF fluctuations may have consequents for days afterward, we need a much larger database to see just what the exact time relationship between GMF activity and GESP performance is.

Given my data and those of others that is available to date, I would conclude that a GMF/GESP relationship is suggested, but not established. Because such a relationship would be of considerable theoretical and practical interest, however, in order to stimulate research, the remainder of this discussion will assume that it is likely.

GMF Variation and Other Variables

Although the present results might conceivably lend some support to an ELF carrier hypothesis for GESP information, it is more likely that we are dealing with general GMF effects on biological life processes and neurophysiological brain processes that are mediating variables that then affect percipients' and/or agents' minds and their consequent GESP performance. Thus, GMF variables are probably similar to mood, instructional set, and experimenter effect variables. Whether they are of larger magnitude and greater reliability than these psychological variables will be determined as new analyses of other studies come in.

Should We Experiment in Stormy Geomagnetic Weather?

If the GMF effects on GESP turn out to be of large magnitude and are reliable, we may have a practically useful way of significantly boosting GESP performance. Cancel the experiment if the GMF factors are poor the day (or several previous days) the experiment is scheduled, carry out experiments on quiet GMF days.

As an initial look at this possibility, Figure 5 shows another analysis of the Faraday Cage Study data in which the primary data classification is into high and low days of GMF activity. The distribution of the A_p index for the day of each GESP run and the preceding 4 days was examined and divided into approximate upper (noisy) and lower (quiet) quartiles of activity for each day. Mean GESP performance was then plotted. Note that this involves a somewhat different selection of data points from the total data than the main selection based on higher and lower GESP performance, so we should not expect results to be exactly the same.

For the day of each run, mean GESP performance in the Faraday Cage Study averaged 1.12 hits/run on geomagnetically quieter days compared to a mean of 0.84 hits/run on geomagnetically noisier days. The difference is suggestive but not statistically significant ($U = 410.00$ with $n_1 = 26$, n_2

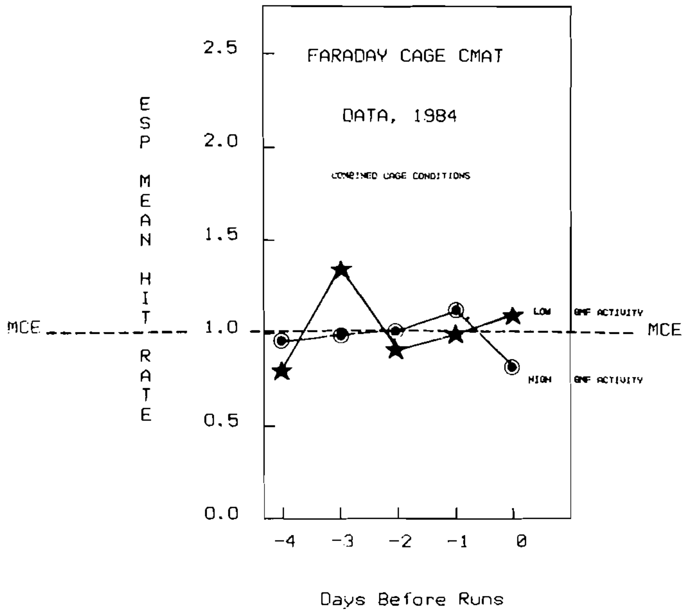

Fig. 5. GESP scoring as a function of noisy GMF activity versus quiet GMF activity in the Faraday Cage Study.

= 38, Z = 1.141, p = .127, one-tailed). The difference is also suggestive for 3 days prior to the day of performance (U = 551.50, n_1 = 35, n_2 = 38, Z = 1.253, p = .106, one-tailed).

A similar analysis was carried out for the First Training Study data. For the day of a session and for the 4 preceding days, the distribution of aa values was divided, with the upper quarter of the distribution designated as "noisy" and the lower quarter designated as "quiet." This was done separately for each day so that, ideally, the upper and lower 10 aa values could be used thus providing enough data for analysis. The procedure involved some approximation, due to the fact that occasionally moving up or down one aa value did not allow for exactly 10 data points. The actual threshold values used ranged from 16.0 to 25.5 for designating quiet days and from 41.0 to 48.0 for designating noisy days. Thus, the minimum difference was 15.5. As in the Faraday Cage Study, this analysis procedure results in a slightly different data selection than the original analysis, so results may not be exactly parallel.

Figure 6 plots the mean GESP performance rates associated with noisy and quiet GMF activity in the First Training Study. Higher GESP performance is always associated with quieter GMF activity for the 4 days preceding and the day of GESP sessions. This difference is significant by Mann-Whitney U Test for 3 days preceding a session (Z = 1.821, p = .034, one-tailed) and suggestive for 4 days preceding a session (Z = 1.398, p = .082, one-tailed).

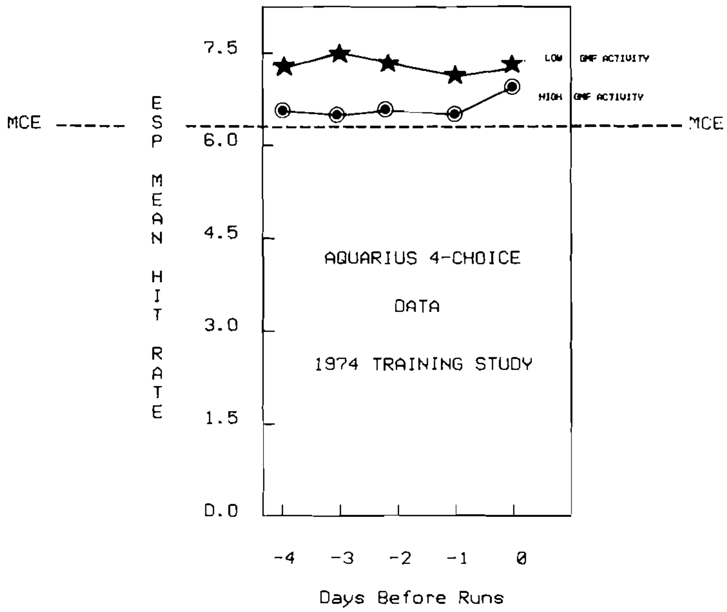

Fig. 6. GESP scoring as a function of noisy GMF activity versus quiet GMF activity in the First Training Study.

General Research on GMF Effects Needed

Assuming the reality of the GMF/GESP correlation, the mechanisms by which the GMF affects percipients need thorough investigation. Many general investigations of the effects of GMF factors on biological, psychological, and behavioral processes will be necessary. This is a new field of science, and it will probably be many years before these mechanisms are understood.

How Does the Faraday Cage Affect GESP Performance?

We need to research the mechanisms by which the Faraday cage apparently affects GESP performance. Does the grounded condition boost GESP performance enough so that the geomagnetic effect, while still actually present, is covered up enough to be undetectable in this study? Does the cage actually shield a percipient from relevant factors (such as higher frequency correlates, if they exist) of the GMF? This second line of speculation seems unlikely, however, given Hubbard and Vincent's (1988) empirical tests of the UCD Faraday cage, showing its electromagnetic shielding effects to be essentially unchanged in the grounded and ungrounded conditions over a very wide frequency range.

Can We Boost GESP With a Combined Method?

Could the apparent Faraday cage effects be combined with more favorable geomagnetic weather to further enhance GESP performance?

As an illustration of potential, Figure 7 compares mean GESP performance under presumably optimal conditions (grounded Faraday cage, geomagnetically quieter day) and presumably worst conditions (floating Faraday cage, geomagnetically noisier day).

As can be seen, GESP performance is uniformly higher and above chance expectation in the grounded cage condition with geomagnetically quieter days during and for the 4 days prior to such runs. For the day of the experiment, we see a mean hits/run value of 1.27 in favorable conditions compared with a value of 0.91 in the unfavorable conditions, a 40% improvement. I shall not present any statistical tests of this, as we are pushing the data somewhat beyond reasonable bounds, but Figure 7 does illustrate some interesting possibilities.

CONCLUSIONS

Hubbard and May (1986) and Adams (1986) have provided an excellent survey of methodological problems in correlating planetary GMF indices with GESP performance. Their papers are required reading for anyone contemplating further research in this area. They mention that the evi-

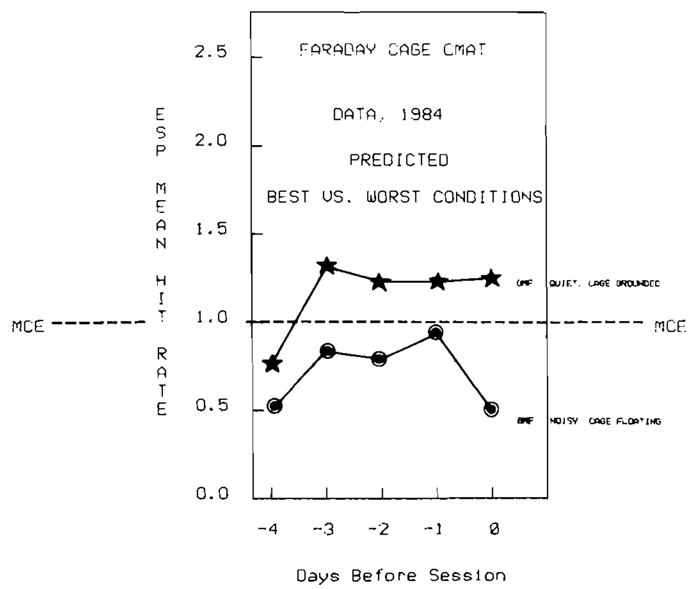

Fig. 7. GESP scoring in predicted optimal conditions (Faraday cage grounded, quiet GMF activity) and nonoptimal (Faraday cage electrically floating, noisy GMF activity).

dence for general GMF effects on biological organisms is regarded as quite controversial by some investigators, they note the statistically peculiar nature of published GMF indices, and they observe that local GMF factors at a given location may be poorly correlated with published planetary GMF measures. Local measures of GMF variables are now technically feasible and should be employed whenever possible in future studies. In spite of these technical problems I believe there is still considerable use for retrospective studies correlating past GESP performance with GMF variables, especially if local GMF measurements show that published indices have a reasonable correlation with local variables for a given laboratory. In addition to encouraging future research, then, I encourage other investigators who have psi databases to carry out retrospective analyses of them.

Some exciting research remains to be done!

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