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RESEARCH ARTICLE

Magnetic Anomalies and the Paranormal

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Abstract—The current interest in the effects of magnetic fields on the brain was originally stimulated by the identification of correlations between some apparently paranormal events (such as hallucinations) and the occurrence of major disturbances to the magnetic field of the earth. This has led to extensive laboratory-based investigations into the effects of magnetic fields on the brain. Study of the published literature suggests that this work is unlikely to yield meaningful or reliable results, primarily because the investigators seem unaware of a number of salient facts known to physicists, communication engineers, or neurologists. Some of these may be rather recondite but are nonetheless extremely relevant. A few examples are discussed.

Introduction and Philosophy

Although I have been interested in the paranormal (as an amateur) for many years, I have only recently become aware of the current research into a possible relationship between variations in the local magnetic field and the occurrence of apparently paranormal phenomena. As a physicist, I was intrigued by the idea and investigated further by reference to published literature. I came to the conclusion that, whatever may be the truth underlying the original premise, it was most unlikely to be revealed by the methods and procedures described.[1] The fundamental problem appears to be that the majority of the investigators (possibly all of them) do not have sufficient knowledge of the underlying physics.

I find this difficult to accept. The word *paranormal* may be defined as "not susceptible to normal explanation," so a paranormal event can be identified only by reference to what is "normal." For the last three hundred years scientists have labored to establish a set of "Laws" by which the universe operates, and which should therefore define the limits of observable phenomena. To claim to be studying apparent divergences from those limits with no reference to, or knowledge of, how they are defined, established, or operate, would seem an unreasonable process, to say the least. It may (or may not) be possible for psychology to be limited to study of the human mind alone, and as such to take place in an "ivory tower" environment, with no reference to any other sciences. But when the prefix *para* is added, the subject is expanded to include relationships (including possible connections) between three "worlds":

1) The physical "world" as defined and studied by orthodox science;
2) The "world" of the mind (whether or not one considers this to be merely an epiphenomenon of the physical brain).
3) A hypothetical (but insistent) "other world," whether or not one considers this in a spiritist or religious context or as a physical possibility (as suggested by modern theories in quantum physics).

The third point may cause dissension, but science cannot have it both ways. If it claims to have established mathematically and physically that the universe "consists of" more spatial dimensions than three, then *by that fact alone* there can be other three-dimensional "worlds" inaccessible to our senses (Zöllner 1880, Hinton 1904, Ralphs 1992). Any study of the paranormal that dismisses such a possibility a priori and refuses even to consider it, risks being regarded as biased and unscientific—particularly if it claims to be investigating strange and apparently inexplicable *physical* phenomena.

So to do the job properly, psychical research must include full consideration of at least two distinct "hard" sciences, i.e. physics and the *neurology* of the brain. I emphasize the word *neurology*, as it is not enough to consider the brain in purely behavioral terms, as nothing more than a box of mathematical tricks that gives a pre-programmed response to any and every stimulus or combination of stimuli. This inevitably limits a priori any final conclusions to ones that meet orthodox materialist/determinist assumptions—a clear case of throwing out the baby with the bathwater.

It is the purpose of this article to present a few almost random facts that, although possibly specialized and recondite, may be of vital importance in the context of parapsychological research, particularly in the study of possible interaction between magnetic fields and the human brain. It is the author's thesis that any such interaction must ultimately be understood in terms of a physical process, and although the detectable symptoms may initially be studied by psychological methods, these could lead to misleading conclusions if this fact is ignored, and there is every sign in the published literature that this is the present situation.

Magnetism and the Brain

Take as an example the ultimate claim, that individual brain functions may be controlled by suitable waveforms of magnetic field applied to appropriate places on the skull. For this to be taken seriously, it is reasonable to expect at least some suggestion of a feasible explanation as to how this may be achieved. But in the current published literature on parapsychology, while there are frequent references to discoveries by neuropsychologists of the location of particular brain functions, there is an almost complete absence of any reference to discoveries by neurophysiologists on the structure or function of the stream of pulses ("action potentials") that carry the "signal" in the axon of a brain cell—which is the process claimed to be controlled.

Consider the facts of the structure of the neocortex of the brain. It consists of a layer of neural material about 3 mm thick, each square millimeter of surface covering about 200,000 neurons ("nerve cells"). If the magnetic field from an external electromagnet affects one square centimeter of cortex surface, this includes 2×10^7 (twenty million) cells. These are organized in "columns" of associated neurons about 0.3 mm diameter, so about 1,000 columns are affected, each of which (in principle) can be carrying out a different function (Szentágothai 1989). To apply a magnetic field to one neuron, or a small group, or even a specific column, without affecting other functions, would seem an impossible task.

The "axon" (nerve) of each cell (*whatever its function*) carries a stream of *identical* quasi-electrical triangular pulses of about 1 ms (millisecond, one thousandth of a second) duration (Szentágothai 1989, Ralphs 1995), and it is the "pattern" of bursts of pulses (or, more probably, in the author's opinion, the erratic gaps between bursts) that presumably "carries the message." So, assuming that it was possible to inject an artificial signal into a single axon, what form should it take?

Low-frequency magnetism has virtually no effect on the non-magnetic materials that constitute the human body. For instance, the very strong fields used in MRI scanning have little or no effect. Higher frequency stimulation (such as attempts to duplicate natural neural waveforms) would require very accurate, rapidly changing waveforms to be injected into specific minute structures within the cortex.

At best it may be possible to use strong fields in a purely negative sledgehammer process (just as one can stop a mechanical watch escapement, the spark-ignition system of a car engine, or the conversation on a telephone line by the same means) to disable or corrupt several neighboring functions. As an example, if you could disable the functions of fear, doubt, and worry in the brain, the result would be a feeling of utter peace and security—a true nirvana that, with a little gentle suggestion, could easily be interpreted as an awareness of the presence of angels, or even God himself. This could hardly be called "control," although it is notable that many such claims can be explained in similar negative terms. With such facts in mind, it is evident that attempts to control neural systems by magnetic fields are misplaced, to say the least.

Another error frequently committed is to regard biologically produced electrical fluctuations (such as EEG traces) as potential "electromagnetic (EM) waves." A fluctuating electric current or magnetic field does not immediately produce an electromagnetic wave. At a distance from its source, the electrical and magnetic energies in a true electromagnetic wave are equal, but close to the source one or the other is predominant (depending on the type of source), and the wave must travel for more than half a wavelength before the two energies are within 20% of each other (ITT 1956). Accepting this as a "definition" of a true EM wave, if a wave of frequency "f" KHz is at a distance "s" Km from its source, and f × s is less than 150, it is not yet a true EM wave, merely fluctuating magnetic and/or electrical fields. When you consider that the significant frequencies in an EEG trace are well below 30 Hz (which has a wavelength of 1,000 Km), it evidently fails to qualify as an EM wave at any reasonable range.

Magnetic Storms

The theory that fluctuations in the local magnetic field can cause hallucinations or other mental phenomena seems to have originated in published articles that identified correlations between periods of strong magnetic disturbances and the reporting of hallucinatory visions (Randall & Randall 1991), and poltergeist and other PK phenomena (Gearhart & Persinger 1986), which apparently confirmed that magnetism can affect neural functions. However, it is very probable (and in my opinion almost certain) that this assumption is not so much incorrect as seriously misleading. My reasoning is based on the structure and origin of so-called "magnetic storms" (a subject that seems to have generated a mythology of its own).

It has been known for more than 150 years that the appearance of "spots" on the surface of the sun could be accompanied by inexplicable deviations of a ship's compass, and as a result the strength and direction of the earth's magnetic field is studied internationally and has been continuously monitored and recorded in the UK since 1868, the data being collated nowadays by the British Geological Society. Apart from its interest to scientists, this information is gathered for very practical reasons. Such magnetic surges can induce electric currents of considerable strength into the electrical mains supply network. This would be immaterial, except that control signals between major power stations are passed over the distribution network itself and if these signals are blocked or corrupted, control can be lost or misapplied, causing major failures of electricity supplies. These disturbances follow an eleven-year "sunspot cycle," and those in America during the last sunspot maximum blacked out half the USA (Beamish, Clark, Clarke, & Thomson 2002). The next maximum is due at about the end of 2012.

In general, magnetism originates from a permanent magnet or an electrical device generating a magnetic field. In either case the source has two opposing "poles." "Lines of Magnetic Force" leave the source from its North pole and take the shortest route open to them (subject to certain "laws") to re-enter the source at the South pole. This means that it is essentially a short-range phenomenon, limited to five or six times the distance between the two poles. This applies to magnetic storms on the sun, just as much as to a pocket magnet. Therefore any magnetic field on the surface of the sun will not reach the earth, and another mechanism to explain the observed correlations is necessary.

The "mechanics" of such storms were established by the study of "cosmic rays" in the early twentieth century (Millikan 1939). They were found not to be "rays" in the normal sense of the word, but dense streams of electrically charged particles—bits of smashed-up nuclei of atoms—but the title is still used. They are continuously emitted by the sun (and other sources in space), but in massive quantities from a sunspot, which can be imagined in terms of a gigantic volcanic eruption ejecting millions of tons of this electrically charged "dust" at speeds in excess of four million miles per hour [sic!] (a Coronal Mass Ejection (CME)). As they approach the earth, these particles are deflected by the earth's magnetic field toward the poles, creating the beautiful Northern Lights (Aurora Borealis), but this deflection is not complete, and more than 70% of the stream reaches earth, even at the magnetic equator. [Ryan's description of "an electrically charged gas" (Ryan 2008) is extremely misleading, but understandable, since the term *plasma* is often applied to a cloud of electrically charged particles, and some dictionaries define the word as "a hot gas." In this case the difference is vital.]

The effects of these particles on earth must be considered with reference to their ability to penetrate deeply into material objects. Every human head in the world has more than a hundred of them travelling right through it every minute, and the more powerful particles can go through several centimeters of lead or about ten meters of sea water. Each particle is so small that only one in several million will actually collide with the nucleus of an atom, but when it does, it can split it into two or three parts (Millikan 1939:53ff). A particle can "zap" a transistor (being the only known "wear-out" mechanism for the computers in a spaceship and so of great interest to NASA). So one would expect it to be quite capable of affecting a cell in the human body or brain, either by physically damaging it, or by passing so close to an axon as to set up a large (but extremely brief) magnetic pulse in it.

Alternative Explanations

When an electrical charge moves, it generates a ring of magnetic force around its path with a strength depending on the strength of the charge and the speed at which it is moving. The quantity and velocity of cosmic rays means that they can generate quite appreciable magnetic fields at the surface of the earth. So the two phenomena, the electrical charges and the magnetic field they generate, are correlated. It is not surprising that a correlation exists between severe magnetic activity and some mental factors (including ESP), but ***it is a distinct possibility—indeed, a definite probability—that the active agent in most such cases is NOT the magnetic fluctuations themselves, but the cosmic rays that cause them***. For instance, the electricity supply problem is attributable to the former, while the considerable effects on the earth's ionosphere are predominately due to the latter. In the days of Short-Wave (HF) signalling, an SID (Sudden Ionospheric Disturbance) could disrupt long-range communication for a period from half an hour to half a day by particles destroying the ionospheric layers over a very wide area.

Magnetism is relatively easy to generate, to control, and to measure; while charged particles are far less amenable. Inevitably in virtually all studies (in all fields) it is customary to refer to magnetic measurements and to ignore or forget the particle aspect. The fact that there is a close correlation between the two, the particles generating the magnetism, makes this unimportant in most cases, but in the case at issue the distinction is vital. All laboratory investigations on the lines indicated by Persinger and others (Persinger, Tiller, & Koren 2000) apply magnetic fields alone to the brain, so only one of the active agents is being replicated. If, as I suggest, the charged particles in a magnetic storm may be equally or even more effective, any results, positive or negative, could be seriously misleading.

Physiological Correlations

Because of the regularity of the eleven-year sunspot cycle and the existence of detailed medical records over many years, it is relatively easy to trace correlations between magnetic storms and a number of physiological variables, including:

Positive Correlation: Suicides, depression and mental disorders, heart rate and high blood pressure, SIDS (Sudden Infant Death Syndrome).

Negative Correlation: Melatonin secretion in the pineal gland, circadian rhythm, sensitivity to light, fatal heart attacks, etc. (Ward & Henshaw).

It follows that, while correlation between magnetic anomalies and various aspects of ESP is a reasonable assumption, it is far from exclusive, and the wide range of effects suggests that the basic mechanism is almost certainly mechanical or electrical at the cell level, with no explicit paranormal associations. It follows that theories postulating precisely defined complex "magic wiggles" of magnetism generating hallucinations by performing specific functions in the brain (Braithwaite 2004, Persinger, Tiller, & Koren 2000) are not only unjustified and unsupported, but may be considered as bordering on the tendentious.

EEG and MEG

A second serious criticism of many experiments is the total reliance on EEG and MEG (magnetoencephalogram) recordings. The fact that such waveforms do not represent any functional neural activity anywhere in the brain is generally ignored.

The basic "action pulse" which is the carrier of neural information throughout the whole of the human nervous system is a symmetrical triangular ("isosceles") pulse with a base width of about 1 ms, and each is followed by a chemical "dead time" of about 1 ms, during which another pulse cannot be generated. So in theory the fastest pulse stream which can be generated has a period of about 2 ms, at a frequency of about 500 Hz. The information seems to be carried by short and long bursts of pulses at something like this frequency. (The signals recorded from individual nerves in a rabbit (Barlow 1987) show some single pulses, but many bursts of 20 to 100 successive pulses at a frequency of about 100 Hz.) So one would expect a Fourier analysis of the signal in a single human neuron to show a broad maximum somewhere below 500 Hz (Appendix 1).

In contrast, EEG recordings show no pulses, but an irregularly varying voltage at much lower frequencies, with nothing significant above 30 Hz. They are generated by a "clearing-up" process in the brain. Transfer of electrical pulses along nerves inevitably affects the distribution of electric charges in the brain, and the resulting imbalances are corrected by normal electric currents flowing back through any available return path, such as blood vessels or bone. This includes the bone structure of the skull, which allows them to be detected by EEG electrodes. Their characteristics vary according to the ***level of neural activity*** in the area of the electrodes, which makes them invaluable to neurophysiologists ***in diagnostic and "brain-mapping" work***, but if the stimulus is unknown there is no information in the waveform itself on the actual neural process being carried out or its significance.

This is particularly true of the MEG, as a study of the generation of an action potential pulse establishes that in theory it creates no magnetic field at all. The extremely low level of field detected in practice supports the view that this is created by fortuitous epiphenomena (secondary divergences from the mathematical model), which are unlikely to carry much more useful information than the EEG. It should also be noted that normal Faraday screening is ineffective against low-frequency magnetic fields, as correctly noted by Ryan (2008). He also notes that:

> ELF [Extremely Low Frequency] spherics (the standing waves surrounding the earth, continuously powered by lightning strikes) in the 5–50 Hz frequency range are known to be disrupted by GMA [Geomagnetic activity]. (Ryan 2008)

This author would question this concept. Two magnetic fields from independent sources can add only vectorially and arithmetically. Lightning static is not affected appreciably by cosmic rays, or vice versa, and is virtually continuous at all times all over the earth. It acquires characteristic changes to its frequency structure by repeated travel around the circumference of the globe (allied to the so-called Schumann Resonances). Major solar flares can generate considerably higher levels of magnetism, but with totally different characteristics. It may make the smaller signal more difficult to observe, but this is irrelevant.

It is extremely rare for this distinction to be mentioned in parapsychological literature. Braithwaite (2004) for instance recorded signals with all the known characteristics of lightning static, but still (wrongly) attributed them to possible solar hallucination-generating anomalies. It is a reasonable conclusion that he is not alone, and many analyses by parapsychologists of suspected magnetic disturbances fail to distinguish between the two (which, since lightning static is not correlated to sun-spot activity or vice versa, could throw doubt on some conclusions from the correlation studies mentioned above).

Conclusions

This article is intended to be helpful and informative, but by implication the underlying state of affairs described is not encouraging. It suggests that the academic study of parapsychology is being carried out in an introspective and self-satisfied manner by specialists who cannot or will not recognize that, whether they like it or not, study of the paranormal by modern means must eventually involve sophisticated electronic equipment carrying out physical measurements of physical quantities that obey physical laws. B. F. Skinner and computerized statistics cannot provide all the answers.

Note

1 Note that I am not suggesting that there is no correlation between magnetic fields and the paranormal (indeed, I consider it quite possible), but I doubt the ability of present-day techniques in academic parapsychology to investigate the matter effectively.

References

Barlow, H. (1987). *The Biological Role of Consciousness.* In C. Blakemore & S. Greenfield (Editors), *Mindwaves*, Oxford: Basil Blackwell, p. 362.

Beamish, D., Clark, T. D. G., Clarke, E., & Thomson, A. W. P. (2002). Geomagnetically induced currents in the UK; geomagnetic variations and surface electric fields. *Journal of Atmospheric & Solar–Terrestial Physics*, *64*, 1779–1792.

Braithwaite, J. J. (2004). Variances associated with "haunt-type" experiences: A comparison using time-synchronised baseline measurements. *European Journal of Parapsychology*, *19*, 3–28.

Gearhart, L., & Persinger, M. (1986). Onset of historical poltergeist episodes occurred with sudden increases of geomagnetic activity. *Perceptual & Motor Skills*, *62*, 463–466.

Hinton, C. H. (1904). *The Fourth Dimension.* London: George Allen & Unwin.

ITT (1956). *Reference Data for Radio Engineers.* New York: International Telephone & Telegraph Corp. p. 663.

Millikan, R. A. (1939). *Cosmic Rays.* Cambridge University Press.

Persinger, M. A., Tiller, S. G., & Koren, S. A. (2000). Experimental stimulation of a haunt experience and elicitation of paroxysmal electroencephalographic activity by transcerebral complex magnetic fields: Induction of a synthetic "ghost"? *Perceptual & Motor Skills*, *90*(2), 659–674.

Ralphs, J. D. (1992). *Exploring the Fourth Dimension.* UK: Foulsham, 0-572-01624-7. US: Llewellyn.

Ralphs, J. D. (1995). Assessment of factors affecting the detectability of thermal radiations from the neural system of the brain. *Medical & Biological Engineering & Computing*, *33*(3), 264–270.

Randall, W., & Randall, S. (1991). Solar wind and hallucinations. *Bioelectromagnetics*, *12*, 67.

Ryan, A. (2008). New insights into the links between ESP and geomagnetic activity. *Journal of Scientific Exploration*, *22*, 335–358.

Szentágothai, J. (1989). The "Brain–Mind" Relation: A Pseudo-Problem? In C. Blakemore & S. Greenfield (Editors), *Mindwaves*, Oxford: Basil Blackwell, pp. 323–336.

Ward, J. P., & Henshaw, D. L. *Geomagnetic Fields, Their Fluctuations and Health Effects.* Jonathan.ward@Bristol.ac.uk

Zöllner, J. C. F. (1880). *Transcendental Physics.* London: W. H. Harrison.

Appendix 1
Fourier Analysis of Brain Axon Activity

Consider a stream of symmetrical triangular pulses of amplitude A and base width = 2t, repeated at time intervals T. The Fourier Analysis of this pulse stream (ITT 1956:1019 Figure 6b) gives a stream of sinusoidal components of amplitude Cn.

$$Cn = 2Av\,[(\mathrm{Sin}\ x) / x]^2$$

where: Av = Average Value, $x = (nt/T)\pi$, and n is any integer.

Now consider the repetition time T to be freely variable.

The smaller T, the higher the pulse repetition frequency, so more pulses per second and the larger the Average Value.

If (nt/2T) is an even integer, Sin x = 0 and Cn = 0.

If (nt/2T) is an odd integer, Sin x = 1, its maximum value, and Cn is then proportional to $(1/n)^2$.

So one would expect the largest component to occur when n = 1 and T = 2t, but, in fact, this cannot happen. The pulse is about 1 ms duration at base, so t = 0.5 ms and there is a chemical "dead period," slightly longer than a millisec, after the pulse, in which it is difficult (impossible?) to trigger a second pulse (Szentágothai 1989). So T cannot be less than about 2 ms or 4t. So I would expect a strong component at about n = 5, making T about 2.5 ms and frequency about 400 Hz, modulated by quasi-random variations with roughly a Sin distribution. In fact, recordings (in animals) of single nerve patterns often show bursts of pulses at about the maximum frequency, so the noise component may often be lower. I have no knowledge as to whether such measurements have been carried out (or are possible?), and have been out of touch with the field for more than twenty years.

As discussed in this article, the acceptance of EEG traces as representing neural signals is completely misleading, since they are the result of a "clearing up" process which is restoring the electrical balance in the brain by returning electrical charges that have been moved in the normal neural processes. No EEG trace bears the slightest resemblance to any signal in a neural axon.