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Editorial: Some readers will, no doubt, be a little fed up of all the coverage given in *Anomaly* recently to the theory that magnetic fields may be responsible for certain cases of haunting. However, I make no apology for continuing to cover the topic in depth. The reason is quite simple. After more than a century of serious study of the paranormal, the mechanism behind most of the things we study, like ghosts, poltergeists, precognition, telepathy, etc. remains obscure. Indeed, some people still dispute their very existence. To be able to both scientifically explain, and verify the reality of, one type of haunting, is one of the most exciting developments in our field for decades. Field results are still tantalisingly vague, hence the need for MADS, but they do, so far, support the theory. These are highly exciting developments and ASSAP is at the leading edge.

Magnetic Hallucinations

by Maurice Townsend

There is now so much laboratory evidence in favour of magnetically induced hallucinations that some paranormal researchers are taking it as read that they are the source of certain anomalous experiences, notably some kinds of ghost. However, the field evidence for such magnetic fields is slight at present. But that could soon change as equipment capable of detecting them is now being deployed at haunted locations. If these magnetic fields exist outside the laboratory, what exactly is causing them?

There have been several articles in *Anomaly* recently concerning theories on the true nature of ghosts. In particular, there has been a lot about the possibility that they may be hallucinations induced in susceptible people by suitable ambient magnetic fields. While the results of lab experiments are impressive and compelling, there is still little evidence from the field to back this theory up. Initiatives like MADS (described in *Anomaly* 34) are designed to fill that gap. It will, at last, be simple to measure relevant magnetic fields in allegedly haunted locations.

An important question concerns the detailed nature of any such fields found at haunted locations for MADS to research. They are unlikely to be just like those produced artificially in the laboratory, so we need to investigate what they really 'look' like in the field. Once we know that, we can try to ascertain what aspects are absolutely necessary for strange experiences to occur.

Once such fields, and their principal components, have been identified then the next intriguing question becomes, 'where do they come from'. At first sight, there seem few obvious sources for such fields, perhaps explaining why ghosts are not common. I decided to research the possibilities so that the search could be narrowed down. I hope this will assist investigators when they are researching possible field sources in haunting cases.

Defining the Fields

Before we can identify possible sources of relevant magnetic fields, we need to define exactly what we are looking for. I am indebted to Dr Jason Braithwaite for reviewing the relevant papers (from Persinger *et al*) concerning the laboratory experiments which have induced ghost-like hallucinations.

The best results have come from what could be broadly described as weak, complex, time-varying magnetic fields. Because the nature and potential sources of such fields are difficult to characterise at this stage, Braithwaite introduced the general term Experience-Inducing Fields, or EIFs for short (see the series of previous articles in *Anomaly*). This definition relates to all, or any, fields that could have experience-inducing properties. This distinction is helpful for a number of reasons. Firstly, while not all magnetic anomalies will have implications for experience, some will have the ability to influence equipment (which could be interpreted as paranormal) but will not alter the operation of the brain in any way. Those fields could be characterised as Event-Related Fields (ERFs) as they pertain to a tangible physical event. Secondly, it focuses the researcher theoretically on the potential relevance such fields might have.

There are three main aspects to EIFs that have been demonstrated experimentally to be of crucial importance. The following figures are by no means absolute limits: things might happen outside them. However, experiments within these bounds have produced reliable, strong results. So it makes sense to look for fields within these parameters first, at haunted locations.

At present, the evidence suggests that EIFs are varying magnetic fields with low frequency (approx 0.1 to 30 Hz, and certainly under 50Hz) and a moderate intensity (from 100 to 5000 nT) or amplitude (or, more correctly, flux density). For comparison, the average geomagnetic field, which is not generally considered strong and does not vary greatly over time, is around 50,000 nT. An important point to remember is that EIFs are most likely to overlay whatever ambient static magnetic field is present in the area. This would usually be the geomagnetic field itself. Confusion often arises here because the geomagnetic field is usually described as being 'static' (ie. does not change over time), whereas, in fact, it does change over time, but very slowly (over hours). There might also be other local permanent distortions to the local magnetic field, such as the presence of the mineral magnetite in the geological strata below the site. At present, such permanent static fields are NOT considered important to inducing hallucinations, however. Therefore, EIFs, if present, would most likely appear as fluctuations on top of the local static field (though see discussion below).

There is another important factor that greatly enhances the chance of hallucinations: field complexity. This is more difficult to characterise. As an example, a typical laboratory experiment may use a simple 30 Hz sine wave field but pulse it for, say, 1s every 3s for a period of 30mins (during this time the field may also vary in amplitude across the pulses as well). Thus, the field fluctuates overall, in addition to the fundamental sine wave. Such overall variance could involve any, or all, of the major field variables: amplitude, frequency and direction. Laboratory studies have used amplitude-modulated, frequency-modulated and complex pulse-patterned sequences with great success. Overall field variations might be repetitive, with the field eventually returning to its original state after a certain period, or they may be chaotic with no obvious repetition. The time period over which fields need to vary is probably (from experiments) in the millisecond to multiple minute region. Simple continuous waveforms, like sine waves, are not at all as effective. The reason for this is that such simple fields are considered not to 'contain' the complex information profile that a brain would accept as sensory information. Incidentally, the direction of a magnetic field (which is conventionally said to flow from the north pole of a bar magnet to the south pole) determines which way it will produce a force on another nearby magnetic object.

There are two other important issues concerned in producing magnetic hallucinations, not directly related to the field characteristics. The first is that not everyone is susceptible to hallucinating when subjected to the EIFs outlined above. Current estimates suggest that only around 20 - 30% of the population show a substantially increased susceptibility, due to increased neuronal instability in specific brain regions. Secondly, susceptible people need to be subjected continuously to the EIFs for a significant time, say 20 to 30 minutes, before hallucinations are reported. This applies if the person is static. I will mention people moving around in fields later on. There is, therefore, an important exposure component to EIFs – the effects are not instantaneous.

The hallucinatory phenomenon is thought to arise because the frequency of the external magnetic waves is similar to that used internally by the brain for cognition. This stimulates brain activity, through a process called neural entrainment, which can confuse the brain into producing hallucinations (see 'Magnetic Fields and the Brain', this issue).

The table below summarises the factors involved.

Factor	Magnitude
Magnetic field frequency	0.1 to 30 Hz
Magnetic field amplitude (flux density)	100 to 5000 nT
Time varying ‘complexity’	1ms to 100s+ period
Brain susceptibility	Some 20 - 30% of the population
Length of exposure to EIFs	Over 20 minutes [if static]

Naturally Occurring EIFs

Could fields with the relevant characteristics occur naturally? The first obvious place to look is the geomagnetic field. This is the magnetic field that is constantly present at the Earth’s surface and in which we are all immersed continuously. It is what makes a compass point north. It is caused by a dynamo effect in the molten core of our planet. Though this effect produces a highly stable field, like that of a bar magnet, the field is constantly changing, primarily due to the effects of the sun impinging on it. The sun is constantly bombarding the Earth with the solar wind, which consists of highly energetic, charged particles. These interact with the geomagnetic field and cause changes reflecting the sun’s own activity. Features such as solar flares can have a major effect on the geomagnetic field. The most significant changes to the geomagnetic field take place over periods of hours. Thus, from a human perspective, the geomagnetic field appears relatively stable.

The geomagnetic field might appear, given its slow variations, an unlikely candidate for EIF, at first sight. Having said that, there have been some studies that have reported correlations between geomagnetic activity and the occurrence of spontaneous hauntings. These correlational studies did not involve field investigations and are considered controversial. As any statistician will tell you, a correlation does not always imply a causal link.

There are certain geomagnetic variables that change at frequencies required for EIFs. Unfortunately, it turns out that these variables, though they have relevant frequencies, are far too weak to produce EIFs, as shown in the table (Campbell, 2003).

Factor	**Typical frequency**	**Typical Amplitude**	**Comments**
Pc1 pulsations	0.2 - 5Hz	0.1 nT	Pc = pulsation continuous, caused by magnetosphere processes
Schumann resonances	7.8, 14, 20, 26Hz	0.05 nT	Caused by lightning energy resonating between the earth and ionosphere.
Atmospherics	5 - 100+ Hz	0.05 nT	Caused by distant lightning

Geomagnetic storms can bring larger amplitude changes in the geomagnetic field. A storm is defined as a period (usually of several days) when there is a large reduction in the horizontal component (parallel to the ground) of the geomagnetic field. On average, one big geomagnetic storm per year might bring a field reduction of around 250 nT, but most will be much less (maybe 10 per year bringing about 50 nT reduction). Therefore, only the largest, most infrequent storms have the sort of amplitudes we are looking for in EIFs. However, these changes typically occur over hours, or minutes at the fastest. Even the Pc1 pulsation component of the geomagnetic field, which has the correct frequency, varies only by a maximum amplitude of a few tenths of one nT (Belyaev, 2003). In summary, there are no natural variations of the geomagnetic field that provide both the amplitude and frequency together to be classed as EIFs, even during geomagnetic storms. Indeed, as we will see later, most of us live in an environment where such natural magnetic variations are entirely swamped by more powerful local artificial sources. So the geomagnetic field can, effectively, be dismissed as a likely source of EIFs.

Another natural source of EIFs that has been suggested is tectonic strain. Essentially, the Tectonic Strain Theory (TST) states that stresses within the Earth's crust, less than those required to produce an earthquake, may result in highly localised surface electromagnetic disturbances through piezoelectricity in sub-surface rocks. Piezoelectricity is the phenomenon whereby certain crystals, notably quartz, produce an electric charge across opposite crystal faces when under physical pressure or strain.

The TST is the reason why many ghost researchers these days get excited if a geological fault lies near an allegedly haunted location. A fault is a crack in the Earth's crust. Like any crack in a solid object, it is an indicator of strain, or pressure for movement, in the local area. Strain generally builds up around a fault until it is released through a physical movement (usually) underground, resulting in an earthquake. Thankfully, the vast majority of earthquakes are, in fact, tremors and are so small they are only noticed by seismologists using sensitive equipment.

The TST looks attractive, in principle, but it does have its critics. I have always had problems understanding it, when considering the physical details of the processes involved. Quartz generally occurs underground within other rocks, like granite, where its crystals are separated by other minerals. If you crush granite, an electric charge will build up across individual quartz crystals. However, since the crystals are orientated randomly, the charges (on opposite sides of each crystal) do not align. Therefore, they tend to cancel each other out rather than combining to form a strong overall electric field. There is a tiny overall field where stressed granite (under strain from lateral stress near a fault) is exposed at the earth's surface, due to the fact that there are no crystals above the surface to completely cancel the field. But it is very small indeed.

Another problem that arises is that any electric field that might conceivably be produced by straining quartz underground will, in any case, be static. There is no movement (except for extremely slow tectonic movement, usually measured in mm per year) in the rocks and so no change in any field produced. This means there could be no magnetic field. In order to get a magnetic field you need to move electric charge through an electric field (such as when current flows down a wire). With no physical movement, there is no magnetic field.

Things change dramatically if the rock fractures, as has been demonstrated in granite crushing experiments (Zhu, 2001). Then, measurable electric (and magnetic) fields can be generated, through both the piezoelectric effect and something called seismoelectric conversion (caused by acoustic waves). The effect is amplified by the presence of water. While this process produces magnetic fields, you have to bear in mind that it involves the rock fracturing, not simply getting strained. There is little or no evidence for underground rock fracturing, even near faults, except during and immediately prior to an earthquake (Robb, 2005).

We do have some measurements of the kind of magnetic fields that might be produced by rock fracturing immediately prior to an earthquake. As a method of predicting earthquakes it is controversial, but the evidence does exist. One of the best known examples was the Loma Prieta earthquake in California in 1989. This was preceded by a weak (up to 60 nT) magnetic field with low frequency (0.01 to 10 Hz) up to 55 km away from the epicentre and three hours prior to the quake. However, even this field is not quite up to the strength required for an EIF and it took a 7.1 magnitude earthquake to generate it.

A further problem with TSTs is the very specific locality of the phenomena they set out to explain. In particular, the phenomena are often restricted not just to a single house but to particular rooms or even parts of rooms (sometimes in upper storeys). Houses nearby are seemingly unaffected. It seems unlikely that widespread tectonic strains could give rise to phenomena localised to just a couple of metres. However, it is possible that environmental factors within a house may amplify (or even attenuate) more widespread field disturbances. Also, a house may appear haunted, though next door does not, merely because an EIF-susceptible person lives in one and not the other.

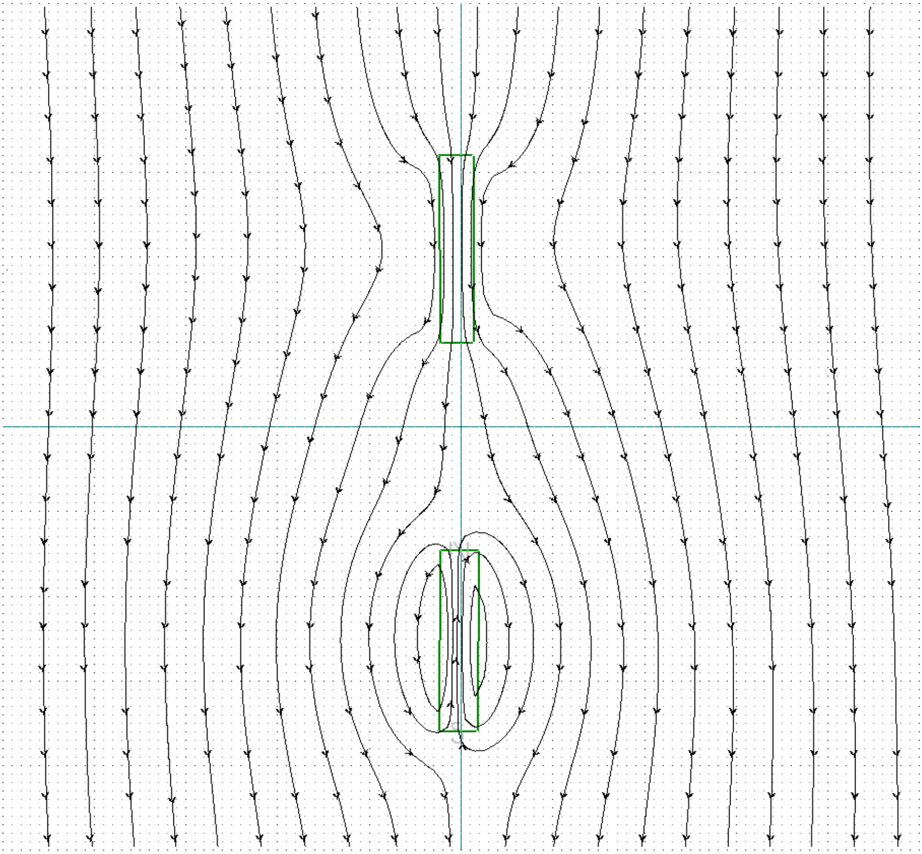
In spite of these problems, I will outline later a variation on the TST that might make it work better than the existing one.

Artificially Occurring EIFs

In a paper on the electromagnetic environment around Moscow (Belyaev, 2003), it was found that the magnetic fields at frequencies around 1 Hz were around 10 times higher in the suburbs, and 100 times higher in the city centre, compared to the countryside. In the city centre fields up to 250 - 300 nT at a frequency of 0.5 Hz were measured. These are strong enough to constitute EIFs. The fields were attributed, unsurprisingly, to electrical equipment in the city. This indicates, quite eloquently, that we should probably look first for artificial sources of EIFs in investigations before looking for, generally weaker, natural alternatives.

Artificial sources contribute significantly to the magnetic fields in a domestic environment, as a quick survey with an EMF meter will show. However, the 0.1 to 30 Hz frequency range of varying fields is generally quiet. This is because most electrical and electronic devices operate using a mixture of DC (for motors, electronic power supplies, etc.), mains frequency (50/60 Hz) and higher. The DC (static) element is rarely pure, being derived from mains supply with rectifiers (often accompanied by transformers). The resultant DC current has a slight voltage ripple on it. However, due to the way rectifiers are designed, this ripple will typically be at mains frequency or above and so not contribute to EIFs. Similarly, the mains supply itself can be distorted by the electrical loads placed on it by various bits of electrical equipment. This gives rise to harmonics but these, too, have a higher frequency and lower amplitude than the mains fundamental frequency. So most domestic electrical appliances, as well as the mains supply itself, will not contribute to EIFs.

Probably the most important source of low frequency magnetic fields is the simple movement, or mechanical vibration, of magnetic materials. By magnetic materials I mean metals with a high magnetic permeability. This means that magnetic fields prefer to flow through them, rather than through the air. Common examples include objects made of iron and steel. The object itself does not



An unmagnetised HMP (top) distorts the geomagnetic field nearly as well as a weak magnet

have to be magnetised, so long as it has high permeability. You can test if an object is highly permeable by seeing if a magnet is attracted to it. It may, or may not, be able, in turn, to attract other bits of unmagnetised steel (eg. paper clips) to itself. All objects with high magnetic permeability (let's call them HMPs, for short), whether magnetised or not, distort the earth's magnetic field around them. In the accompanying figure you will see two objects, one weakly magnetic, the other merely highly permeable. Both distort the surrounding geomagnetic field dramatically. When such objects are vibrated, they drag the magnetic field distortion around with them.

To produce an EIF frequency disturbance in the ambient magnetic field, all we need to do is vibrate an HMP at a rate of between once every ten seconds (0.1 Hz) and thirty times a second (30 Hz). It doesn't need to be a constant frequency motion since, as we have seen, varying fields actually work better! The distortion to the ambient magnetic field will move in sympathy with the movement of the HMP, so inducing an EIF frequency change.

The possible examples of such moving HMPs in the domestic environment are almost endless. A sheet of corrugated iron vibrating in the wind, an iron bedstead shaken by nearby heavy traffic, a steel filing cabinet in a seaside office swayed gently by the crashing surf. Anything made of a suitable metal, whether magnetic or not, vibrated at a suitable frequency, will give us the EIF frequency disturbance. Whether it attains a suitable amplitude for an EIF depends on the degree of vibration of the object and the amount of distortion the HMP brings to the ambient field.

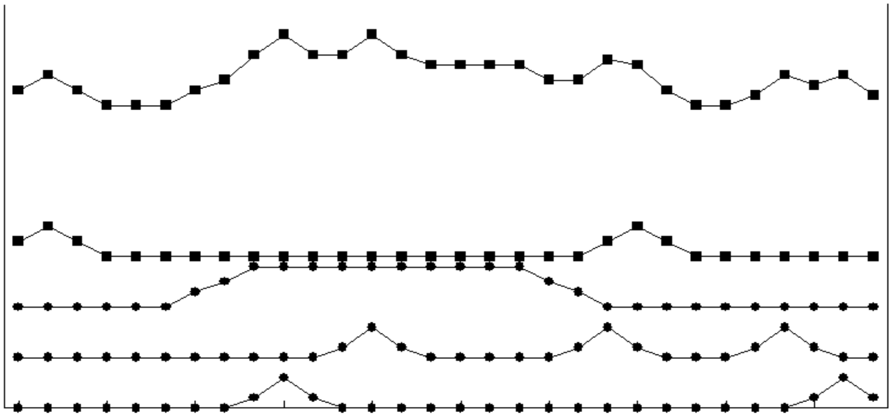
As well as bits of metal, there are also machines that can act as moving HMPs. An electric motor can be imagined as a permanent magnet being rotated, pole over pole, between the opposing poles of two other permanent magnets. In the real world, all the magnets are electromagnets but the effect is the same. A rotating magnetic field will be produced with a frequency reflecting the rotation rate of the motor's armature. Most motors in domestic use are likely to produce rotating fields at EIF frequencies. That's because few will go round faster than 1800 rpm, which equates to 30 Hz. In addition, DC motors may spark where brushes meet the commutator. This would introduce a sharply pulsed field, at twice the frequency of rotation, which might still be low enough to contribute to an EIF.

There are many motors used in the domestic environment. They commonly occur in such things as pumps (central heating, fridges, air-conditioning), fans (computers, air-conditioning, some ovens), washing machines, vacuum cleaners, even hi-fi equipment and hair dryers. Such appliances can produce quite powerful rotating magnetic fields.

Vibrating HMPs may produce the right frequencies, but will they give us the right amplitudes for people nearby? It comes down to your physical distance from the source of the field disturbance. Assuming the amplitudes exceed minimum EIF level at their source, there is bound to be some critical distance, or zone, away from the source where the field amplitude will be correct. All you have to do is stay in that critical area for long enough and, if you are susceptible and the field varies enough over time, you may well get hallucinations. It is difficult to predict how far such a zone would extend without doing experiments. Magnetic fields decline quickly away from their source, falling with the inverse square law. As a guess, I would say EIFs would probably extend no further than a metre or two from a source likely to be encountered in a domestic situation, assuming the average geomagnetic field as a background. If there was a higher than usual ambient magnetic field, the range would decrease. Conversely, in an area of lower than usual ambient field, the range would increase. One might reasonably ask, how can you live in an area of lower than normal geomagnetic field? HMPs can distort the local magnetic field, as we have seen, and create areas where the local magnetic field is actually lower than average. Such HMPs would, obviously, not need to be moving to produce such an effect. This is the principle behind magnetic shielding. The magnetic field is 'dragged' into the HMP, so attenuating the ambient field around it. A place where the ambient field is low could be particularly promising, as it would require less of a field distortion to produce an EIF.

Interestingly, the degree of distortion caused by HMPs to ambient fields depends on such things as the shape of the source and its angle to the field, as well as the permeability and magnetisation of the metal. Long thin HMPs (like sheet metal) and curved ones (think of a horshoe magnet) disrupt the local magnetic field more than short, fat ones. Also, HMPs aligned with the ambient field will produce a larger effect than those at right-angles to it. Note, also, that the presence of vibrating HMPs would mean that hallucinations would only be experienced in quite small areas inside a house. This would fit in with the often observed fact that only certain rooms, or even particular spots, regularly produce ghosts.

Another possible source of EIFs is combined magnetic transitions in mains frequency equipment. There are many pieces of electrical equipment that can produce such magnetic transitions. Though transitions are not EIFs in themselves, if you get enough of them in a small area, over a short period of time, they could have the same effect. By a transition, I mean a significant, slow (by electronic standards) change in the mains frequency magnetic field produced by electrical equipment. This would appear to a DC magnetometer (insensitive to mains-frequency) as a pulse. A transformer, for instance, though it operates at mains-frequency, takes time to become fully energised or drained (because the magnetic field induced is resisting the current change) when it is switched on or off. This produces a change in the magnetic field slow enough to be 'seen' by a DC magnetometer. Another example is a relay, which contains an electromagnet. When a relay is switched on or off, a static magnetic field will either rise or fall, producing a magnetic transition. Transformers and relays are common in the supply and switching sections of domestic electrical, and particularly electronic, equipment. Electrical house wiring may also show transitions (though not as powerfully) when equipment downstream is switched on or off or has a changing load.



Transformers and a relay (middle curve) combine transitions to produce seemingly chaotic fluctuations (top curve)

In the accompanying illustration you can see three imaginary transformers powering on and off, as well as a relay being operated once. The transformers only produce brief pulses, as explained above. The relay, by contrast, maintains a steady magnetic field, while on. The picture shows the way a DC magnetometer would 'see' the resultant magnetic fields. The top line shows the net fluctuations in the ambient static (DC) field. It looks, more or less, chaotic and could, with suitable frequency and amplitude, constitute an EIF.

In a house with lots of electrical equipment in use there may sometimes be enough pulses, close enough together, both in space and time, to constitute EIFs. If there are a few vibrating HMPs about as well, so much the better. It might seem unlikely that you would get enough pulses to constitute an EIF this way. But consider this, you only need one 100 nT pulse every ten seconds to qualify! As more and more electrical devices are operated in a house at once, the combined fluctuations will show a rise in amplitude and frequency as well as appearing increasingly chaotic.

Another important, though rarer, possible artificial source of EIFs is malfunctioning electrical equipment. This could include the mains supply itself. There are only a few ways most bits of electrical equipment can operate correctly, but any number in which they can malfunction. Therefore it is difficult to list particular examples of malfunctioning equipment producing EIFs. In general, though, accidental capacitances and inductances could possibly, in certain circumstances, give rise to low frequency currents (and hence magnetic fields). Fields can leak, unintentionally, from electrical equipment to nearby conductors (such as water pipes) through induction. Though these would be at the mains frequency, there might be resonances set up by the plumbing configuration that could be at a different frequency, possibly lower. Earthing problems are another possible source of unintentional fields. As I said before, it is difficult to come up with a concrete example, but it might happen and should be considered.

Of course, you may just happen to live in a magnetically dense area. As we saw with the unfortunate inhabitants of central Moscow, some places may be bathed perpetually in a sea of fields that qualify as EIFs. There may be nearby industrial users, such as factories, that could produce EIFs through HMPs and densely packed electrical equipment. So artificially produced EIFs may be outside the premises that are allegedly haunted. You should not assume EIFs are produced naturally just because they have no obvious source inside a house.

Another interesting source of EIFs is human movement! Although you may not have any moving fields within your home, you might move through reasonably strong, complex static fields sufficiently often to produce an EIF in your brain. If you think about it, walking between two areas of high magnetic field, with a low area in between, is no different from having a varying field pass through your head as you sit still. Given that you need to be exposed to such varying fields for some time, however, it might involve a lot of walking! It should be considered, however, particularly in a workplace that might well combine a lot of walking and a complex static magnetic environment.

The Tectonic Strain Theory Revisited

A scientist called Friedemann Freund (of San José State University in California) has suggested that electric charges could be induced to flow by applying unusual pressure (through tectonic stress) to igneous rocks (normally insulators), turning them temporarily into semi-conductors (Enriquez, 2003). He has done experiments, crushing rocks, to demonstrate this effect. When the rocks are turned temporarily into semiconductors, holes (positively charged discontinuities) can flow rapidly through the rocks and might even reach the surface. The charges are conducted underground both by rocks, in their semi-conductor state, and by water.

Such moving charges would generate magnetic fields. It is thought these would be low-frequency fields, though there is no prediction, as yet, concerning exact intensity or frequency. The whole idea is still very new, but it could possibly result in natural EIFs near tectonically strained areas around geological faults. The strengths of the theory are that the electric charges are not cancelled out and that they move around (unlike the piezoelectric theory), so producing magnetic fields. The theory is still being developed, but it looks promising. Researchers should still, therefore, investigate local geology (particularly the presence of faults and igneous rocks, such as granite, diorite, gabbro, basalt, etc.) thoroughly in their investigations and see if any EIFs detected can be traced to an underground source.

Detecting EIFs

Unfortunately, the equipment required to detect EIFs satisfactorily is not cheap. That explains the lack of convincing field evidence to date. To have a chance of detecting EIFs, you will need a sensitive magnetometer capable of giving a flat response to fields from 0 to 30 Hz. You will also need to be able to sample the field sufficiently frequently to capture waves up to 30 Hz (requiring 60 samples a second). In practice, it would be better to sample waves up to, say, 100 Hz to include mains frequency (50 Hz). So a sample rate of 200/s or better is required. You will need to sample for extended periods of time (hours) to capture any time variance in the field. The magnetometer should be sensitive to changes down to 50 nT (and preferably 1 nT) to capture waveforms accurately. In addition, it should measure over three axes simultaneously. This allows the whole field to be sampled accurately.

A suitable setup would be a tri-axial, fluxgate magnetometer linked directly to a computer recording device. Fluxgates are most suitable and typically operate from DC upwards and give a good, flat response at low frequencies. In fact, you'll need something very like the MADS system. Unfortunately, many of the cheaper EMF meters on the market are not suitable for scientific measurement of EIFs. Many are deliberately frequency-biassed towards mains frequency as they are designed to measure electromagnetic pollution. They rarely cover the sub-mains frequencies accurately. Some only register changes in the ambient magnetic field and so do not allow absolute amplitudes to be measured. In addition, few such meters respond quickly enough to field changes or allow attachment to a computer.

Once you have such a system, capable of making useful measurements, you can compare places where ghosts have been reported with others nearby where they have not. Assuming you find an EIF, you can then attempt to identify its, or their, source(s) by doing a survey, plotting readings obtained over a grid layout.

The detectors used on the MADS system may be within the financial reach of enthusiastic groups or individuals. In fact, the company that makes the MADS sensors also produce another suitable sensor at a considerably cheaper price with a slightly lower specification. Anyone obtaining such an instrument could greatly help in serious research in an, as yet, poorly explored area. Such field investigations are incredibly simple to set up (it's all done by computer) and non-technical researchers should not be put off, as ASSAP will provide support with these studies. If you are thinking of obtaining your own MADS system, please get in touch beforehand as each unit is custom-built and you will need details for appropriate settings. These settings are permanent to the sensor and cannot be altered after manufacture, so do get in touch beforehand. Please email the *Anomaly* editor for details.

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Northern Haunting

by Christopher J Huff

Chris Huff continues his series of investigations into lesser-known hauntings in the north of England. This case is particularly interesting because it has elements that Chris believes may be explicable by magnetic fields, but others he feels are not.

A visit to Wearvale Hall (pseudonym) on 17 May 2001 revealed that within the last year two materialising ghosts had been witnessed, as well as a plethora of supporting phenomena to suggest that the building is truly haunted. The hall is impressive, massive and brooding, and yet strangely welcoming in atmosphere. The interior is as medieval in aspect as could be demanded by the most fervent of film directors: thick stone walls that are bare of any covering apart from metal shields, replete with heraldic devices, weaponry, old paintings and large standards. If the hall did not have a ghost in residence one would have had to be imported.

The hall is situated in the foothills of the Pennines, near Durham. It is a large and imposing structure, lately divided into two properties. It is an architecturally interesting house, which was much remodelled and added to in the Elizabethan or Jacobean periods. The origins of the hall are medieval, circa 12th century AD. Interesting features are to be found at the west end of the property where the earliest part of the structure undoubtedly is to be located. This façade has a buttress and a row of corbels at first-storey height, which Pevsner suggests may have supported either an oriel or chimney.

The hall was bought by the current owners as a restaurant and guesthouse, about a year ago, since which time they have witnessed a surprising number of phenomena. Most of these have manifested in the area which must have once been the medieval hall, now subsumed into the larger, later house. Two areas for the haunting have been identified as being more concentrated in atmosphere than others. On the first day at the hall, Edith (pseudonym), standing outside, looked up at the windows in this part of the building and saw a female face peering down at her. The window was identified as belonging to a guest room. The whole area of the top corridor, a part of the old attic converted into accommodation, which leads past the guest rooms, has been described as feeling creepy or spooky. Everyone questioned admitted that they pass through this area quickly.

The second area that has an atmosphere is the private lounge, beyond the restaurant/bar area to which the customers have access; this has been the focus for one particular activity. Peter (pseudonym), Edith and Jacob (pseudonym) all attested that the temperature in this particular room has regularly been noticed to drop from about 10 pm onwards. Even with a fire in the grate, thick curtains across the windows and the central heating on, Peter has measured the temperature in the room with a thermometer and recorded a drop from 20˚ to 16˚ centigrade, although, he asserts, it feels much colder. Peter has checked the room for draughts using the simple test of a lighter's flame. He did not find any strong draughts that could account for the dramatic temperature change.

From the private lounge there is a corridor, at the end of which is a curious window opening into the restaurant / bar area. Peter, while looking through this opening from the corridor after the hall had closed for business, saw a fleeting figure which he described as 'a young female aged about 19 or 20 who had long blonde hair which reached down to her waist'. The only item of her clothing that he could identify was a frilly neckline, which he later agreed was a ruff. That a ruff is identified is an important clue to the period to which the apparition belongs; they were usually white in colour and worn by both men and women from the mid-16th into the 17th century. The ruff was first worn with a supporting wire frame, to give it structure, but later became heavily starched. By the end of the 16th century, the ruff had been largely superseded by other types of collars. This particular apparition is identified as having been the face seen by Edith on their first day at the hall, looking out of a window in the attic. This young lady has been affectionately named Elizabeth.

Perfume

After one week in residence, the smell of perfume in rooms and the upstairs corridors was noted. Edith, while in bed, noticed this concentrated smell in the room around her, then again slightly later in the corridor outside. All have smelt this perfume at some time during their first year. It is described as intensely flowery and a strong scent of freesia and lavender. The smell apparently moves about, getting stronger and weaker as though someone first walked towards and then away from the observer.

The same bedroom also has a cold spot, and the family dog periodically doesn't like the room and tries to get out of there. Sometimes the dog is seen watching something invisible and on rare occasions he has been found hiding.

In the corridor outside the room, while Edith was walking through it, she had the flashing vision of the top half of a man in front of her. So vivid was this encounter that Edith has clearly remembered what she saw and has painted the remembered image. On other occasions, the last a few days before my visit, Edith has sensed the figure around the hall, usually through a distinct mood of sadness pervading the otherwise calm and friendly atmosphere of the building.

The man was described to me as being fairly short and slight of build. His face was long and he had lank, dark shoulder-length hair. He had a thin moustache, which, shaped like an upside-down U, surrounded his mouth and extended a short way beyond his chin. His remembered garments consisted of a thin leather jerkin, beige in colour, which was round-necked and sleeveless. This garment had coarse, dark or black coloured blanket-stitching visible around the neck and the armholes and was clearly a very poor article of clothing. In a room off this same corridor a female guest was kept awake all night by the sense of a presence in the room with her, and at one point distinctly felt the bedclothes tugged.

Kinetic Activity

There has been kinetic activity witnessed at the hall, the latest a few days before my visit. On this occasion, while tables were being set for a formal reception occurring later the same day, one of the side plates levitated off a table and smashed onto the floor nearby. The plate in question was not near the edge of the table at the time, neither was it near any of the people present, and so cannot have been accidentally nudged. Adding a bizarre twist to the account was the discovery that these particular side plates were not needed for the function later in the day and were removed by the staff soon after the event.

In the bar area, adjoining the restaurant, a two armed candlestick was witnessed launching off its customary place on the top of a speaker, itself on a tabletop close to the doorway. The atmosphere in the hall that day was tense as a burglary had taken place and many items had been taken. The event occurred as Edith was talking to the insurance agent in the area of the bar and both witnessed the candlestick violently launch off the speaker towards the door. The candles, separating from the candlestick in flight, went through the doorway and landed in a different room.

In one of the toilets, a problem developed with the flushing mechanism. This was located behind a sealed panel and set into the wall and so a plumber was called out. Upon his inspection it was discovered that a pipe had been disconnected from its coupling, something which he asserted could not have happened by accident and he enquired as to who had been playing. Neither the staff nor customers at the hall could have tampered with the pipe, since it was sealed in the manner described above.

In addition to the above kinetic activity, artefacts have disappeared, often to be found later in impossible places. On the list of disappearances are tools, documents and, recently, the pin code for a bank account which was temporarily left in the lounge area. This turned up later, in an antique book that had been in storage. The pin code emerged from the book when it was taken out of storage and opened.

Conclusions

Wearvale Hall is one of those rare gems, an apparently haunted house in an idyllic setting where the general public may gain entrance. It has not previously been studied and its stories not so far retold through a succession of Chinese Whisper twists and turns and thereby corrupted by individuals adding to the story.

Of the phenomena witnessed at the hall, I will concede that some may indeed be caused by the electromagnetic fields so favoured by Dr Jason Braithwaite, especially the physical manifestation of the upper torso of a man in the corridor, and the apparition of the young woman. They might even account for the antics of the family's pet dog allegedly "seeing" things. Suffering from migraines myself, I am very aware of the aura which often accompanies them. In this state visual and olfactory hallucinations may occur and have done to me personally. I am therefore aware that magnetic fields could be a cause, but with a very strong caveat that this is definitely not the only method by which these phenomena may be produced.

To digress briefly from the haunting at Wearvale Hall, my articles to date show my clear bias towards the existence of an afterlife and the possibility, if not probability, of the interaction between it and the physical. I have also propounded the ideas that there are two distinct types of hauntings, the sentient (the aware) and the non-sentient (the recording). Of the two, I believe that Dr Braithwaite's theories may indeed account for the latter, the classic hauntings by non-sentient apparitions who merely appear to re-enact something from the past, those oft seen phantoms who drift from one room to another without the slightest hint that there is any form of consciousness about them.

The stone tape theory, often offered to account for these non-sentient types, suffers from a number of problems, one of the main ones being exactly how the image records itself onto the structure or landscape. Paul Lee's article on Ghosts in *Anomaly* 34 discusses the topic clearly and logically, and I shall not elaborate the point further. However, going outside of the box, so to speak, if the element of an electromagnetic field is introduced into the scenario, influencing the brain and thereby producing an internalised phenomenon, it may account for a non-sentient ghost.

This has some interesting potential, a non-sentient could be produced almost anywhere, even on the moon, should the correct conditions for the production of that apparition be met. The analysis to be performed therefore is, rather as Jason is doing with his MADS system, to analyse the electromagnetic fields in the so-called haunted locations throughout the country. Once the science behind the production of this particular phenomenon is understood, we can make progress towards better understanding the more rewarding and more elusive second type of ghost, the sentient, which I believe is not an internalised phenomenon at all.

I am not convinced that Jason's electromagnetic fields can be responsible for the kinetic effects witnessed at the hall, the problems with the toilet system and the translocation of objects. These various phenomena from the hall seem to suggest that there is an intelligence behind them, especially the shattering side plate the piece of crockery which was not needed for the function later in the day, and the toilet-flushing mechanism located behind a sealed panel where a pipe had been disconnected from its coupling, something which the plumber asserted could not have happened by accident.

If I had the time, free rein of the building, several volunteers and, latterly, the inclination to do so, I would favour Wearvale Hall as a venue for both a mediumistic interface and Jason's scientific studies. All I have succeeded in doing is bringing the haunting of Wearvale Hall to the attention of the members of this society, and content myself that yet another case with first-hand accounts has been documented in a respectable journal.

Magnetic Fields and the Brain

by Dr Jason Braithwaite

The idea that certain weak magnetic fields could be responsible for haunt-type experiences is gaining currency. There have been several investigations recently that have produced field evidence in favour of the theory. This does not mean that the method of producing such hallucinations is understood. In this article, Jason Braithwaite outlines some of the neurological problems involved in understanding how such a phenomenon might work.

Recent laboratory studies have revealed that human exposure to low-frequency complex electromagnetic fields (EMFs) can induce strange and exceptional hallucinatory experiences under controlled conditions. The implication from these laboratory studies is that such EMFs could underlie spontaneous instances of anomalous cognition that occur in the natural setting. However, although the laboratory-based studies show convincingly that magnetic fields can disrupt neural firing patterns, it is less well known exactly how this actually happens. Indeed, there is an emerging debate directed specifically at how these low-amplitude fields could have any implication for neural processing. In this brief paper I outline just a few of my concerns from the perspective of neuroscience.

Over the average 24-hour daily cycle multiple sources of magnetic and electromagnetic fields (EMFs) bombard our brains and our bodies. Although still a contentious areas of research, field studies, correlational and epidemiological studies are now highlighting a link between EMFs and changes in human biology, neurophysiology and behaviour. In the laboratory neuroscientists can now artificially induce all manner of hallucinations by applying relatively weak low-frequency and low-amplitude magnetic fields to the outer cortex of the brain (see Persinger, 1999, 1988; Persinger & Koren, 2001; Persinger, Koren & O'Connor, 2001; Persinger &

Richards, 1994; Persinger, Richards, & Koren, 1997). What these studies seem to suggest is that certain magnetic fields may have implications for cognition and behaviour. Although the effect of EMFs on neurophysiology is in little doubt, it is less clear exactly how these low-amplitude EMFs can actually stimulate the brain at all. Regular readers of *Anomaly* will note that I do generally support the suggestion for a role of EMFs in some haunting / apparitional experiences. However, this does not prevent me from continuing to ask specific questions about how such an account actually works at the neuronal level. That is to say, although I accept that the magnetic fields and EMFs account has a great deal of merit as a useful framework for understanding some strange experiences, that does not mean it is without a need for further detail.

Magnetic stimulation and the brain

There are two well-known methods of magnetic brain stimulation: Transcranial Magnetic Stimulation (TMS: see Walsh & Pascual-Leone, 2002) and Transcerebral Magnetic Stimulation (TCS: see Persinger, 1999, 1988; Persinger & Koren, 2001). At the neuronal level, the biophysics of TMS are relatively well known. TMS involves the use of an intense focused magnetic pulse (or series of repetitive pulses, rTMS), that is easily capable of penetrating the skull and induces a large current within neural systems in the outer cortical surface of the brain. Depending on the location chosen, this current can disrupt processing in certain systems, creating a kind of temporary 'virtual lesion', or can facilitate processing within a particular network. The amplitudes used are very high and are usually in or around the 1 Tesla range (more than 20,000 times the strength of the earth's field). The effects are immediate, with a 1 ms (millisecond) temporal resolution and a 1 cm spatial resolution. In other words, the effects occur as the pulse is being applied. Due to the high amplitudes typically used in TMS, the temporal lobes are generally not stimulated as this may induce epileptic fits in participants. Although TMS is used in a different way and at different amplitudes by clinicians and cognitive scientists, the manner in which TMS actually stimulates neural cortex is the same. That is to say, the biophysics are the same: TMS works by inducing a large and immediate disruptive current in the brain. This will have consequences for the processing of information and can influence visual perception / awareness.

In contrast, TCS uses very weak complex magnetic fields that can be used to stimulate all regions of the cortex. Persinger and colleagues (Persinger, 1999, 1988; Persinger & Koren, 2001; Persinger, & Richards, 1994; Persinger *et al.*, 1997) have suggested that these magnetic fields can cause complex epileptic-like partial micro-seizures in temporal-lobe regions of neuronal hypersensitive participants. The result is hallucination. The EMFs used in TCS are very weak, generally in the region of 100 - 5000nT, and of low-frequency (typically <30Hz). These low-frequency fields are often pulsed, say for 1 second every 3 seconds. It has been argued that such field complexity, rather than actual excessive field magnitude, is the crucial factor for inducing many of these types of experience (Persinger & Koren, 2001; Persinger & Richards, 1994; Persinger *et al.*, 1997). Indeed, a number of specific and exotic pulse patterns have been generated that vary across a number of dimensions including: (i) the onset ramp times of pulses (the time taken for the pulse to rise to maximum), (ii) their overall amplitudes, (iii) offset ramp times (the time taken for the pulse to drop back to zero), (iv) how this can vary across the pulses in a series of repetitive spikes, and (v) how closely packed a series of pulses are over a particularly time period (see Persinger & Koren, 2001). Importantly, unlike TMS, this method of stimulation is not instantaneous, with participants generally undergoing 15 – 20mins of exposure before the effects on experience are reported.

Furthermore, the spatial resolution of TCS is not as specific as these fields are applied in a much more general way to whole regions (eg. lobes) of the brain at a time. Also it is typical with TCS to reduce sensory input (blindfolds / earmuffs etc) during experimental stimulation.

It is clear from the description above that the methods of stimulation are quite distinct and produce distinct effects. TCS does not seem to induce a direct current in the brain in the manner that the high amplitude TMS is known to do. This implies another mechanism for interacting with the brain. There are other important differences worth noting. In TCS, the sham baseline condition (where no magnetic field is applied, unknown to the participant) often produces a sizable minority of experiences (sometimes in the region of 10% - 15%). These must be due to a combination of expectation and the process of sensory reduction itself producing its own effects. Furthermore, the crucial long (15 – 20 min) exposure time strongly implies a more indirect mechanism. Indeed, when one looks at the figures themselves, it becomes obvious that these stimulation techniques are interacting with neural tissue in diverse ways. For instance, it is clear that the amplitudes used in TCS are nowhere near high enough to induce a direct current in the cortex in any way similar to that of TMS. Indeed, the degree to which such low fields can penetrate the scalp, the skull, cross the air gap, and actually reach the cortex has been questioned by some critics. What is clear is that at the very least, the biophysics of TCS seem distinct from other more traditional methods of stimulation. The stimulatory effects of TCS, though well documented, certainly appear to be more subtle, and indirect.

In terms of an individual neuron, the strength (amplitude) at which it fires is relatively constant under normal conditions. It is an absolute, pre-determined, all-or-none affair. However, the likelihood of that neuron firing or not and the rate of that firing (its frequency) can be altered in some circumstances. At a descriptive level, it would seem that TCS signals closely 'mimic' neuronal activity patterns and hence become integrated into the ongoing perceptual processing represented by a particular neuronal state at that time. What is less clear is how this 'mimicking' and integration process actually comes about. One possibility is that TCS may work initially by variant effects on the hyperpolarisation (decreasing the likelihood of the cell firing) of individual systems of neurons, influencing the likelihood of whether or not they fire. This may start a kind of localised cascade effect through discrete neural sub-systems, disrupting the natural temporal firing rate of these systems. One can imagine that by placing an inhibitory neural circuit in an increased state of hyperpolarisation (ie. less likely to fire) one could potentially generate a state of excitation in some circuits. Other things that may be crucial involve effects on certain, specific psychopharmacological agents involved in mediating membrane potentials and synaptic transmission, including the passage of ions within and between neurons. Indeed, in my opinion, the ionic environment within and between neurons may well prove crucial for the initiation and propagation of partial seizure that may then be taken up by other synapse-mediated mechanisms (this has been currently overlooked by many researchers).

Persinger (1988; Persinger & Koren, 2001; Persinger & Richards, 1994; Persinger, Richards, & Koren, 1997) often goes into great detail concerning how such effects could come about. However, it is important to point out that none of those mechanisms is directly supported by the stimulation data so far available. Indeed, the claim that TCS stimulates deep inside the temporal lobes and into para-hippocampal regions is also not directly supported by the behavioural data. Recruiting EEG data is not as convincing as might first appear either, as these devices record electrical activity on the surface of the cortex only. In other words, EEG activity is a consequence that does not inform the researcher in any way as to the causal mechanisms underlying such activity. It seems that the assumption of the involvement of particular deeply embedded structures is based on the content of the hallucination mapping onto the principal known function of particular structures (eg. hippocampus = memory / imagery, amygdala = emotional responses). There is, of course, nothing wrong with doing this – but it does not directly demonstrate that these EMFs are crucially and exclusively interacting with those structures. Note that it is not being suggested that such EMFs are not having an effect, more that the actual mechanism of interaction is less well known and less supported than the existence of the actual effect itself. Basically, the biophysics of TCS are still largely unclear and future research would do well to reappraise the possible mechanisms for magnetic stimulation using these fields.

So what does all this mean for researchers in the field trying to quantify magnetic fields potentially associated with strange haunt-type experiences and events? Well, simply detecting the odd transient pulse in the background field is likely to be of little use in terms of brain stimulation (which means certain popular devices are also worthless: see Braithwaite, 2003). It is also highly unlikely that individuals will ever be exposed to fields in the Tesla region from the natural setting; this effectively rules out a biophysical mechanism of direct and instantaneous current inducement in neurons (analogous to TMS). If we assume that the fields used in the laboratory are closely approximate to the important fields available in haunted locations, then it would seem that such fields would need to be present for some time and the individual must be exposed to them for some time (at least for the amplitudes used in the laboratory). This seems to be a perfectly reasonable position to take, in the first instance.

It might also seem reasonable at first to further assume that the larger any ‘pulse’, transient or more stable shift might be, then the greater the chance of stimulation. Although possible, this is not as logical a development as it might first appear. It is important to remember that TCS studies use very low-amplitude fields and get dramatic effects. From this we know that high amplitudes are not necessary at all, at least under those circumstances. What seems more crucial here is the complexity of the fields used; that is how they vary in amplitude over time, phase, frequency, pulse duration, pulse patterns, etc. Of course, the individual would still need to be exposed to these fields for some time (that is to say, it would not be an instantaneous effect), but the crucial factor here seems to be complexity. This increased duration highlights a potential chronic exposure effect in some cases.

Developing these ideas further, we might want to assume that the stronger the magnetic anomaly (be it constant or transient), then the more likely it is to induce physiological changes over a shorter period of time. Persinger (1999) has estimated that in some circumstances such fields in the natural setting would need to be 10 to 50 times stronger than those used in the laboratory, even for hypersensitive individuals. As a crude and general rule this basically equates to fields in the region of 10000 - 50000nT and above as being potentially important (this is on top of any background source).

This may at first seem at odds with the claim that complexity, and not strength, is the important issue. However, the figures given above are a theoretical estimate of the amplitude contained within a field that is still varying in a complex way. So, although the figure pertains only to amplitude, that should not be taken to mean that the field should only be described in terms of its amplitude. We still need to assume a complex magnetic environment as a context for these values: a field of 50000nT may be distributed across numerous frequencies. A simple sine wave (ie. from mains power supplies) of these magnitudes seems to have no implications for experience – so researchers need to avoid being misled into thinking that 'hotspots' are indicated by high amplitudes alone. Furthermore, medical imaging techniques can use massive simple fields (DC fields in the 2-3 Tesla range) which have no consequence for experience whatsoever. I recently took measurements at a railway station and found AC fields of around 75000nT. I am not aware of multiple strange experiences there (despite the large numbers of people passing through and workers exposed to this level on a daily basis). However, what unites these examples is the fact that the sources produce relatively simple magnetic fields of a prime fundamental constant frequency that contain most of the measured energy. These fields look nothing like TCS fields and, based on present findings, they have few, if any, implications for cognition and strange experience.

Finally, it may be the case that, as TMS and TCS clearly stimulate the brain via distinct biophysical mechanisms, there may be many quite distinct ways for TCS type fields to engage with neural processes. So it may be that there is not one method of interaction at work here. This certainly remains a possibility. Perhaps higher-amplitude fields (though still not too high) need to be more 'complex' as the complexity matches brain signals and as such is more likely to be integrated into the current neural state. So here increased complexity compensates for the excessive amplitude, which the brain would normally not accept into its ongoing processing. The higher amplitude may accelerate the rate and propagation of the stimulation through neural architecture. Conversely, low-amplitude fields, though obviously still needing to be very complex, could perhaps be less complex (relatively) and not need to be very strong in order to become assimilated into the neural process. This may happen in a more diffuse, reserved and time-consuming manner. However, the key in both instances is the complexity of the fields involved. These possibilities remain little more than speculations at present. The main point here is that the biophysics of TCS fields are not well known, we would do well to look at these before contemplating too much about the varieties of engagement principles between magnetic fields and the brain.

NB: See pages 3-6 in this issue for a concise description of the magnetic field characteristics that paranormal researchers should be looking for in the field. Ed.

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