THE RELATIONSHIP BETWEEN LOCAL GEOMAGNETIC ACTIVITY, MEDITATION AND PSI. PART I: LITERATURE REVIEW AND THEORETICAL MODEL[1]

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INTRODUCTION

A four-year longitudinal research programme investigating the effect of local geomagnetic field fluctuations and meditation on receptive psi has been initiated at a Tibetan monastery in Scotland. This Note is intended to give the theoretical background for this research programme. Research findings from several disparate disciplines have been synthesized into a model that can be used to understand associations of both environmental variables and a person's state of consciousness with an individual's performance in controlled psi tests.

Initially a description of the evidence for both geomagnetic activity (GMA) and meditation relationships with psi is presented. Since GMA exhibits variation by season, and possibly lunar phase, relationships between these cycles and psi are also considered. A theory that connects these variables is then presented, drawing on evidence that GMA may affect the function of the pineal gland within the human brain, and research that suggests that the pineal gland may produce psi-conducive neurochemicals.

GEOMAGNETIC ACTIVITY

The Link between the Sun and Geomagnetic Activity (GMA)

It is necessary to begin by explaining the origin of GMA, so as to give a background to the reasons for investigating local rather than global GMA. There are a large number of global and local variations in GMA. The main component of the Earth's geomagnetic field is generated by electric currents within molten iron slowly moving in the earth's outer core. In addition up to 10% of the overall field is generated by features of the crust and atmosphere, allowing for local anomalies and rapidly changing conditions. The field's intensity varies from approximately 24,000 nanoTesla (nT) to 66,000 nT; a value of approximately 50,000 nT is typical at mid-latitude locations such as the UK.

There is a diurnal variation in the field of approximately 20 nT at mid-latitudes, attributable to thermal and tidal currents in the ionosphere. The largest variations, however, are due to collisions between the Earth's field and fast-moving plasma (electrically charged gas) ejected from the Sun; these variations can reach approximately 250 nT at mid-latitudes. These plasma ejections can be due to spectacular explosions on the sun, known as solar flares, which are most common at the peak of the sun's approximately 11-year activity cycle, or they can be due to coronal holes, lower density areas of the sun's atmosphere, that have 'open'

[1]An earlier version of this paper was presented at the 53rd Parapsychological Association Convention, Paris, 2010.

magnetic field lines. Fluctuations in the geomagnetic field caused by these solar emissions are termed GMA (Campbell, 2003).

A global index of GMA, *ap*, has commonly been used to quantify the degree of disturbance. This index is derived from the difference between the lowest and highest field measurements during a three-hour period from each of 13 observatories around the globe. This index does a poor job, however, of representing the detailed characteristics of the field disturbance. There exist several classes of disturbance known as geomagnetic pulsations (alternatively termed ultra-low frequency (ULF) activity); these fluctuations are classified by frequency (i.e., the number of waves per second), and character: regular sinusoidal or irregular. The size of these pulsations tends to be related to their frequency, ranging at mid-latitudes from 0.01 nT at the high end of the frequency spectrum (5 Hz, period 0.2 s) to 10 nT at the low end (1 mHz, corresponding to an oscillation period of several minutes). Disturbances at different frequencies have different source mechanisms; elucidation of the different processes involved in their generation is an active field of space research (McPherron, 2005).

For an extensive overview of the Earth's magnetic field and GMA, the interested reader is referred to Campbell (2003).

The Link between GMA and Psi

For the past three decades, research in parapsychology has found evidence that psi is related to GMA. This research can be divided into laboratory versus spontaneous studies, and receptive psi (e.g., clairvoyance) versus active psi (e.g., psychokinesis (PK), healing).

The first research into the link between spontaneous receptive psi and GMA was by Schaut and Persinger (1985). Examining cases from Ian Stevenson's collection of cases (Persinger, 1985), the SPR case collection *Phantasms of the Living* (Persinger, 1987), and *Fate* magazine's collection (Schaut & Persinger, 1985; Persinger & Schaut, 1988), they reported that spontaneous telepathic impressions tended to occur on days of low GMA. Persinger (1988) considers that these correlations hold over decades as well as shorter time spans, there being some decades that have noticeably lower GMA than others (e.g., 1870-1879 and 1890-1909). Wilkinson and Gauld (1993) criticised this research for use of inappropriate statistical methods, in particular, failure to account for the skewed distribution of GMA indices. They also analysed spontaneous case collections, including those used by Persinger, and did not find the above correlations.

The first suggestion that the results of laboratory studies of receptive psi may be linked with GMA was made by Adams (1986, 1987), who found that ganzfeld and remote viewing success was greater during periods of low GMA. Makarec and Persinger (1987) analysed a forced-choice card guessing experiment and found a similar relationship. Tart (1988) conducted two psi studies and reported that his results suggested that low GMA on or immediately preceding the day of an experiment was associated with successful psi. Persinger and Krippner (1989), analysing the Maimonides studies, again found that dream psi was stronger during periods of low GMA. Krippner and Persinger (1996) analysed a single dreamer over 20 nights and found that there was significantly higher dream-psi scoring on nights

of low GMA. Haraldsson and Gissurarson (1987) found no relationship between GMA on the day of experiments and psi results, but reported that successful experiments tended to be carried out a day after high GMA. Spottiswoode (1990) analysed 305 remote viewing trials and found that success was greater during periods of low GMA. In a meta-analysis of 51 studies comprising 2,879 free-response trials, Spottiswoode (1997b) reported only a marginally significant relationship between GMA and psi effect size. The link between low GMA and psi did not hold with Honorton's database of 139 ganzfeld sessions (Persinger, 1989), nor for the PEAR database of 334 precognitive remote perception trial (Nelson & Dunne, 1987). Radin (2002) found that animal psi research by Sheldrake showed an effect of GMA, in that the participating dog indicated greater awareness of when his owner was returning home on days of low GMA.[2]

From the foregoing it is clear that, most often, when a relationship between receptive psi and GMA is reported, the correlation is negative; that is to say, psi is more successful when GMA is low. Occasionally, however, the opposite is reported. Radin, McAlpine and Cunningham (1994) found that although "normal" participants showed no evidence of psi, they scored better when GMA was low, but "creative" participants, who did succeed in the ganzfeld sessions, showed stronger psi scoring when GMA was high. In receptive psi experiments during which artificial complex fluctuating magnetic fields were generated near participants, both Persinger, Cook and Tiller (2002) and Booth, Charette and Persinger (2002) exhibited successful psi during high GMA.

Hubbard and May (1987) have criticised research into the psi-GMA link for relying on global GMA measurements, and have urged that local measurements are made. In line with this advice, Dalton and Stevens (1996) measured local field variations at Edinburgh and in an analysis of 97 ganzfeld sessions reported that psi was associated with high GMA (r_s = 0.29) when using local measurements, but low GMA (r_s = -0.21) when using the global *ap* index. However, using 1-minute measurements of the geomagnetic field from the same observatory (Eskdalemuir), Ryan (2004b) found that psi was associated with low GMA using *both* local and global measurements (r_s = -0.20 and -0.19 respectively).

Ryan (2008) collated results from 343 ganzfeld and remote viewing sessions conducted within the UK and checked for correlations with local GMA, using Fourier transforms to condense 1-second field readings from local magnetometers into activity measurements within various frequency bands. He found that low frequency geomagnetic pulsations were in general associated with poor psi performance, whereas higher frequency pulsations were associated with enhanced psi performance. He suggested that these results may explain the inconsistent relationship between psi and GMA. The low frequency band ("band 3": 0.025 – 0.1 Hz) correlates well with the global GMA *ap* index and therefore this class of activity may explain the associations of psi with low GMA that are most commonly reported. The high frequency band ("band 1": 0.2 – 0.5 Hz) is generally uncorrelated, but occasionally positively correlated with the global GMA *ap* index,

[2]Ryan (2004a) re-analysed this study and found a smaller but still significant effect (p = .024, as opposed to p = .002 in Radin's paper).

so this could account for the occasional contrary finding of an association of receptive psi with high GMA.

Findings of a positive correlation of GMA with psi, whilst unusual with receptive psi, seem to be the norm with spontaneous cases of bereavement hallucinations, hauntings and active psi laboratory research. In particular, research into spontaneous cases has found strong evidence that sudden increases in GMA are associated with poltergeist (Gearhart & Persinger, 1986), and haunting episodes (Braithwaite, 2005; Nichols & Roll, 1999; Roll & Nichols, 2000; Roll & Persinger, 2001). Persinger (1993b) also found that bereavement hallucinations occurred more frequently during days of high GMA. Persinger and Cameron (1986) suggested that local fluctuations in the geomagnetic field may be involved, as their poltergeist cases all occurred close to a geological fault line. Krippner, et al. (1996) reported a significant relationship between both local GMA and the daily Southern Hemisphere GMA index for the Southern Hemisphere, and apparent anomalous events that occurred in the presence of a Brazilian "sensitive". GMA was heightened on those days when there were maximum anomalous events.

This same relationship also holds with laboratory research into active psi. Braud and Dennis (1989) examined four sets of their biological psychokinesis data: spontaneous electrodermal activity, mental influence on electrodermal activity, rate of haemolysis of blood cells in vitro and mental influence on haemolysis rate. They found significant correlations for most of the measures, such that greater effects were shown on days of increased GMA.

It may be that low GMA is related to receptive psi and high GMA to active psi, but it is not clear why bereavement hallucinations and haunting phenomena fall into the latter category. One possibility is that haunting phenomena may be closely related to poltergeist phenomena, which are normally considered to be a form of recurrent spontaneous psychokinesis. Both involve movement of objects, variations in air temperature, etc., including occasional reports of apparitions, which is the main feature of bereavement hallucinations. There is some discussion in parapsychology whether receptive and active psi is a unitary phenomenon or two different phenomena (e.g. Roe, Davey & Stevans, 2006).

Perhaps, by investigating more closely the effect of the different bands found in local GMA, the anomalies concerning the psi-GMA relationship sometime being positive and sometimes negative, can be clarified. Ryan's hypotheses (2008) about the different effects being related to the different bands of GMA can only be explored by looking at local GMA, thus reinforcing Hubbard and May's (1987) concern over the use of global measurements.

The Link between Season and Psi

GMA is subject to pronounced seasonal variations, with the most intense disturbances tending to occur in the equinox months of March/April and September/October. Geomagnetic pulsations also vary by season, but these patterns are more complex and depend on pulsation frequency, latitude, time of day, and solar cycle phase (Jacobs, 1970). If psi is affected by GMA, one might expect to see a seasonal variation in the results of psi experiments. In an examination of 3,325

free response receptive psi trials, Sturrock and Spottiswoode (2007) found exactly this, the main effect being a drop in psi effect size from late May to early July.

Earlier, in his previous meta-analysis, Spottiswoode (1997a) had reported a relationship between receptive psi and local sidereal time (LST). LST is time measured relative to the stars: thus at the September equinox, local clock time and LST coincide, then LST recesses by approximately 4 minutes each day, until again coinciding with local time on the equinox of the September of the following year. At any given time of year, local daytime (when most psi experiments are conducted) will fall within a particular LST range, so if psi effect size varies by season, this will be reflected in a non-uniform distribution of psi effect size by LST. Thus, a seasonal factor acting on psi must necessarily explain some, if not all, of the features of psi effect size by LST. Dalkvist and Westerlund (2000) were the first to suggest that Spottiswoode's findings could be explained if performance was affected by a factor that varied by an interaction of time of day and time of year; i.e. a seasonal effect. In this respect, Spottiswoode's LST findings can be regarded as primarily due to seasonal effects.

The Link between the Moon and Psi

An effect of the moon on GMA has been suggested by various researchers. If this is the case, then apparent lunar phase effects on psi may in fact be attributable to GMA. As in the previous discussion regarding the effect of GMA on psi, once again we see that both active and receptive psi are affected.

With regard to receptive psi, in a series of telepathy tests, Puharich (1973), found increased psi scores at full and dark moon periods, and when Krippner, Becker, Cavallo and Washburn (1972) analysed 80 dream sessions, they also noticed enhanced psi during the full moon period. Radin and Rebman (1994, 1998) found a lunar correlation in their data of casino jackpot and lottery wins. Over a four year period there were 6 jackpot wins — all of them were during the full moon period. Other games also showed enhanced casino payout during the full-moon period, with peak payout within one day of the full moon. There is no way of telling whether these were due to receptive or active psi! Researching active psi, Etzold (2005) evaluated 200,000 retro-PK trials covering 8 years and found significant relationships between both solar activity and lunar phase. In some periods retro-PK results were above chance around the full moon period but during other periods the apparent effect was reversed. Sturrock and Spottiswoode's (2007) analysis also suggested that there may be a relationship between psi performance and lunar phase; they found a peak of psi effect size at about *twice* the lunar synodic frequency.

With regard to research linking lunar phase with GMA, there is evidence that the moon affects the intensity of the geomagnetic field via atmospheric tidal effects (Stening, Carmody & Du, 2002), but no influence on the global index of GMA *ap* has been detected (Rassbach, Dessler & Cameron, 1966; Střeštík, 1998). However, it is possible that lunar effects may be more prominent in other components, such as pulsation classes, of GMA (Fraser-Smith, 1969). Schneider (1967) hypothesised that the moon may interact with the magnetotail (the narrow, elongated area of the Earth's magnetic field that extends away from the sun) during the full-moon period, thereby modulating GMA. Etzold, (2005) suggested that this could be the

mechanism behind the lunar influence on psi. The plausibility of this account seems questionable because the moon has no global magnetic field and thus one would imagine that the interaction between the moon and plasma streams is negligible (Střeštík, 1998). However recent observations from NASA's Lunar Prospector spacecraft suggest that the moon may affect processes in the magnetotail at larger distances upstream than previously considered (Halekas, Poppe, Delory, Farrell & Horányi, 2012), so the question remains open.

Distinguishing a lunar from a solar effect can be problematic because the interval between two successive lunar phases (the synodic period) of 29.5 days is close to the rate of solar rotation, which is approximately 27 days. As the sun is a gaseous body, its rotation varies by latitude and is fastest at the equator. In addition, features such as sunspots can shift in position from one rotation to the next. This can make it challenging to differentiate between solar and lunar effects, particularly when short periods are studied.

THEORETICAL MODEL

The Link between Geomagnetic Activity and the Pineal Gland

Persinger (1989), Roney-Dougal (1988, 1990) and Roney-Dougal and Vogl (1993) have all suggested that the GMA relationship with psi might be connected with the pineal gland.

In general, there is considerable empirical evidence that magnetic fields, both artificial and natural, can affect one's state of consciousness in many ways. Randall and Randall (1991) found a relationship between natural magnetic disturbances caused by the solar wind and hallucinatory experiences. Fuller, Dobson, Wieser and Moser (1995) evoked epileptic type activity using magnetic fields, and Dobson, St. Pierre, Wieser and Fuller (2000) applied magnetic fields to epileptic patients which changed their brain wave patterns. Biogenic magnetite has been found in the brain, which might provide a basis both for its sensitivity to magnetic fields and a possible magnetic sense of direction (Dobson & Grassi, 1996; Kirschvink, Koboyashi-Kirschvink & Woodford, 1992). Another potential effect of GMA on brain activity is the control of chemical reactions within the brain through the coupling of weak low-frequency magnetic fields at sub-atomic levels (Ritz, Thalau, Phillips, Wiltschko & Wiltschko, 2004).

More specifically, Persinger's studies have associated the temporal lobes with the interaction between magnetic fields and psi. He has shown that anomalous perceptions and impressions can be artificially induced by applying temporally complex, weak-intensity (comparable to GMA) magnetic fields to the brain. Persinger (1999) found increased alpha activity over the left temporal lobe following exposure to weak artificial transcerebral magnetic fields in a dark room, and differential entrainment of EEG activity (Persinger, Richards & Koren, 1997). These impressions increase if the individual has an increased susceptibility to temporal lobe epilepsy**.** Persinger's theory is that the magnetic fields induce partial micro-seizures in the temporal lobe regions and the hippocampus/amygdala area (Persinger & Koren, 2001). This follows on from research by Roll (1977) who noticed the

excess of poltergeist-focus children who suffered from epilepsy or some other neurological problem. Neppe (1983) in his research into spontaneous cases noted a link between psi experience and temporal lobe sensitivity, and Persinger (1993a) reported that practitioners of Transcendental Meditation displayed increased partial epileptic-type signs, which are related to the temporal lobes.

The pineal gland is associated with the temporal lobes and limbic system. Persinger (1989, 1993b) suggested a role for melatonin, which is made by the pineal gland, in his temporal lobe/limbic system hypothesis (Persinger, 1983, 1984, 1989; Persinger & Roll, 1985). There is also some tentative support for the melatonin-psi hypothesis from dream ESP research that shows increased precognition test scores at 3:00 a.m., when melatonin is being produced, compared to 8:00 a.m. when there is, in general, lower melatonin production (Luke, Zychowicz, Richterova, Tjurina & Polonnikova, 2010), although this effect was not replicated in a later study (Luke & Zychowicz, 2011).

Reiter and Richardson (1992) reviewed the evidence that magnetic fields depress melatonin production by the pineal gland and found that this occurs primarily at night. In more recent research, conducted in the arctic region, Weydahl, Sothern, Cornelissen and Wetterberg (2000) found that high GMA reduced melatonin production and increased serotonin levels. Welker, Semm, Willig, Commentz and Wiltshchko (1983) suggest that it is the change in the intensity of the field which affects pineal functioning, rather than the overall level. Furthermore there is a window of magnetic field frequency, typically below 30Hz, which appears to be related to both pineal neural activity (Bell, Marino & Chesen, 1992) and psi-type experiences induced by artificial magnetic fields (Persinger & Koren, 2001).

Thus, the suggestion is that, as artificial and natural magnetic fields can induce psi-type experiences, and as spontaneous psi occurs in people with epilepsy and other temporal lobe sensitivity, that possibly the pineal gland is a mediator for a psi-conducive state of consciousness being induced by changes in the magnetic field. This suggestion is supported by the formation in the pineal gland of psi-conducive neurochemicals which are identical to those found in the psychedelic brew, ayahuasca, used by shamans in the Amazonian region.

The Link between the Pineal Gland, Psychedelic Tryptamines and Psi

Both Strassman (2001) and Roney-Dougal (2010) suggest that some psychic, dreaming, psychotic and mystical states may occur through the production of DMT and pinoline in the pineal gland. (For a detailed discussion see Luke [2011], and Luke & Friedman [2010]). Severi (2003), Harvey-Wilson, (2001), McKenna, (1991) and Ring, (1989, 1992) have all noted the similarity between traditional psychedelic-induced shamanic initiations that include DMT-like substances, NDEs, alien abduction experiences, and heightened psychic sensitivity.

Harmala alkaloids (chemically similar to pinoline) and DMT are both found in the Amazonian shamanic brew, Ayahuasca. Ayahuasca was traditionally used by shamans to induce out-of-body and psychic experiences, and for the shamanic healing ritual. The anthropological and ethnobotanical literature is replete with examples of ostensibly paranormal phenomena occurring with the traditional use of psychoactive plants, particularly Ayahuasca (Luke, 2010; Luke & Kittenis, 2005).

Commonly these plants are taken in a ritual context for the express purpose of accessing altered states conducive to clairvoyance, precognition, telepathy, out-of-body travel, psychic diagnosis, psychic healing, and spirit communication (Roney-Dougal, 1986, 1989).

The common neurotransmitter serotonin is known to be most active in the pineal gland where it follows a circadian rhythm and is converted at night into melatonin and pinoline, which Callaway (1988) suggests may regulate the dream cycle. MAO inhibiters, such as pinoline, possibly convert serotonin, with the aid of pineal enzymes, into the potent hallucinogens 5-MeO-DMT, DMT, and bufotenine. In vivo biosynthesis of DMT might also occur through the conversion of the common, nutritionally-essential, amino acid tryptophan (Callaway, 2006; Jacob & Presti, 2005; Shulgin & Shulgin, 1997). So it is possible that the pineal gland is involved in making neurochemicals which create a psi-conducive state of consciousness particularly at night, but also when there are changes in GMA.

To summarise: the pineal gland produces neurochemicals which are identical with those found in a shamanic brew used specifically to induce spiritual, out-of-body and psychic experiences. In general, these are produced at night and are thought to be the stimulus for the dream state of consciousness. Reports of spontaneous precognitive experiences show that the majority occur at night and during dreams (Rhine, 1981). Also, traditionally, mediums used to work in the dark and at night, so it could well be that this is a psi conducive period linked with the pineal gland's production of pinoline and DMT. The pineal gland is influenced both by the night-day cycle and by changes in GMA. Thus, geomagnetic fluctuations, originating from solar emissions and modulated by seasonal and lunar phase periods, may well be directly stimulating the pineal gland causing secretions of psi-conducive neurochemicals.

Further, it is interesting to note that yogic traditions consider the pineal gland to be the physical aspect of ajna chakra, the third eye, which they consider to be the medium for psychic experiences.

The Link between Meditation and Psi

In the 1970s, Braud (1975) introduced the concept of the psi-conducive state. This is a model which has driven much parapsychological research since then into altered states of consciousness as conducive to the experience of psi phenomena. The model states that psi functioning is enhanced when there is cortical arousal sufficient to maintain conscious awareness, muscular relaxation, reduction of sensory input, and focus on internal attention. In other words, when the receiver is in a state of sensory relaxation and is minimally influenced by ordinary perception. For more recent reviews of this concept see Braud (2002), Roe (2009) and Holt, Simmonds–Moore, Luke and French (2012).

Around the same time Honorton (1977) was developing his model of internal attention states from his readings of the classic yoga text known as Patanjali's sutras. These sutras (Satyananda, 2000) state that when one attains samadhi the "siddhis" (psychic powers) manifest. In meditation there is internal and external noise reduction, and various psycho-physiological correlates, such as EEG alpha rhythm and increased skin resistance, all of which have been found to be associated

with greater psi scoring (Honorton, 1977). Both Yogic and Buddhist teachings state that as one advances in meditation so psi phenomena start to occur. A more detailed review of this relationship is available in Roney-Dougal (2010), and a fuller discussion of Patanjali's yoga sutras in relation to psi research has been given by Braud (2006).

Research into the effect of meditation suggests that it may indeed be a psi-conducive state and increase receptive psi. This research started in the 1970s and in general found that post-meditation scores were better than pre-meditation, e.g., Schmeidler (1970); Dukhan and Rao (1973); Roll and Zill (1981). At the same time a change in methodology occurred with the introduction of free-response techniques. In these procedures the participant verbally described and/or drew their experience of the psi target prior to viewing the target. In other words, they attempted to become consciously aware of the target, in contrast to research which measures the physiological response of the participant to the target, or forced-choice techniques where the person guesses the target from a fixed number of known potential targets, e.g., card symbols. A meta-analysis of all the research by 1976 showed that overall there were 9 significant meditation psi experiments out of a total of 16, giving an overall $p = 6x10^{-12}$ (Honorton, 1977). Schmeidler (1994), who summarised the research from 1978-1992, found that four out of the six studies reported during this period gave significant results.

More recent research into the effect of meditation on receptive psi includes a ganzfeld study by Symmons and Morris (1997), which found no difference between meditators and non-meditators on accuracy of choosing the target. And in a study looking at subconscious physiological responses to a forthcoming target, known as the presentiment experiment, Radin, Vieten, Michel and Selorme (2011) found that advanced meditators with around 20 years of practice showed significant EEG responses before the stimulus was presented. The controls gave no significant prestimulus response. Most of the recent research has looked at the effect of meditation on active psi, which is not directly relevant to this review.

However, the term meditation in all the studies mentioned so far has been used in a very loose way, since many different forms of meditation were practised including: mandala gazing, which is focusing attention on a specific type of picture; pranayama, which comprises a variety of breath techniques; kundalini yoga, which is primarily concentration on energy points called chakras and the energy channels between them; mantra yoga, which is sometimes known as transcendental meditation (TM) and is where certain words are repeated either mentally or out loud; and awareness techniques such as Zen meditation. Clearly, different techniques may result in different states of consciousness, and meditation research has been criticized for assuming that all meditation techniques are the same (Roe, 2009; Schmidt, 2012). A series of studies in India, working initially at an ashram with Yogis (Roney-Dougal & Solfvin, 2006) and then with Tibetan Buddhist monks (Roney-Dougal, Solfvin & Fox, 2008; Roney-Dougal & Solfvin, 2011), strongly suggested that meditation is related to conscious psi awareness, in that meditators with more than 20 years of practice showed more consistent psi-hitting on a receptive psi task compared with beginners; the correlation for the combined Tibetan studies was $r = 0.74$, $p = 0.0005$, confirming that found in the yogic studies

(r = 0.57, p = 0.02). This finding is in line with Yogic and Tibetan teachings, which state that the psi shown by an advanced practitioner is more reliable than the spontaneous psi exhibited naturally by psychics. These studies also looked at the type of meditation used in the psi sessions. In the ashram a kundalini technique called ajapajapa was specifically used, as yogis consider that it stimulates the ajna chakra, the third eye and psychic centre. The final study with the Tibetans compared mantra meditation with visualisation. Whilst no difference was found in the actual sessions, years of practice with visualisation did show the strongest correlation with psi score (rho = 0.49), though this was not significant.

On balance one can conclude that meditators are potentially a psi-conducive population, and so it was decided to run the longitudinal study into the effect of GMA on psi with people who had practiced Tibetan Buddhist meditation for a minimum of 10 years. Research suggests elevation of pineal function during meditation (Neweberg & Iversen, 2003), but the potential connection between meditation, the pineal gland and GMA will not be directly addressed in this study.

Summary of the Theoretical Perspective

We have seen that thirty years of research strongly suggests a link in various different ways between GMA and psi experiences. However there are many anomalies in the findings and the cause of the relationship is still only partially explored. One possibility is that changes in the GMA may affect the pineal gland to make endogenous neurochemicals which are similar to those used in shamanic rituals. There is strong evidence that the pineal's activity is affected by GMA. Anthropological and neurochemical evidence points to the role of pinoline made in the pineal gland creating an endogenous Ayahuasca-type hallucinogen. Amazonian shamans use Ayahuasca for psychic purposes, which suggests that the pineal neurochemicals may be psi-conducive. Yogis consider that meditation can affect one's psi ability, and there are meditation techniques which specifically target ajna chakra, whose physical location is considered to be the pineal gland. Therefore, it is possible that one potential explanation for the psi-conducive nature of meditation may related to activation of the pineal gland during the practice. These relationships are shown in Figure 1.

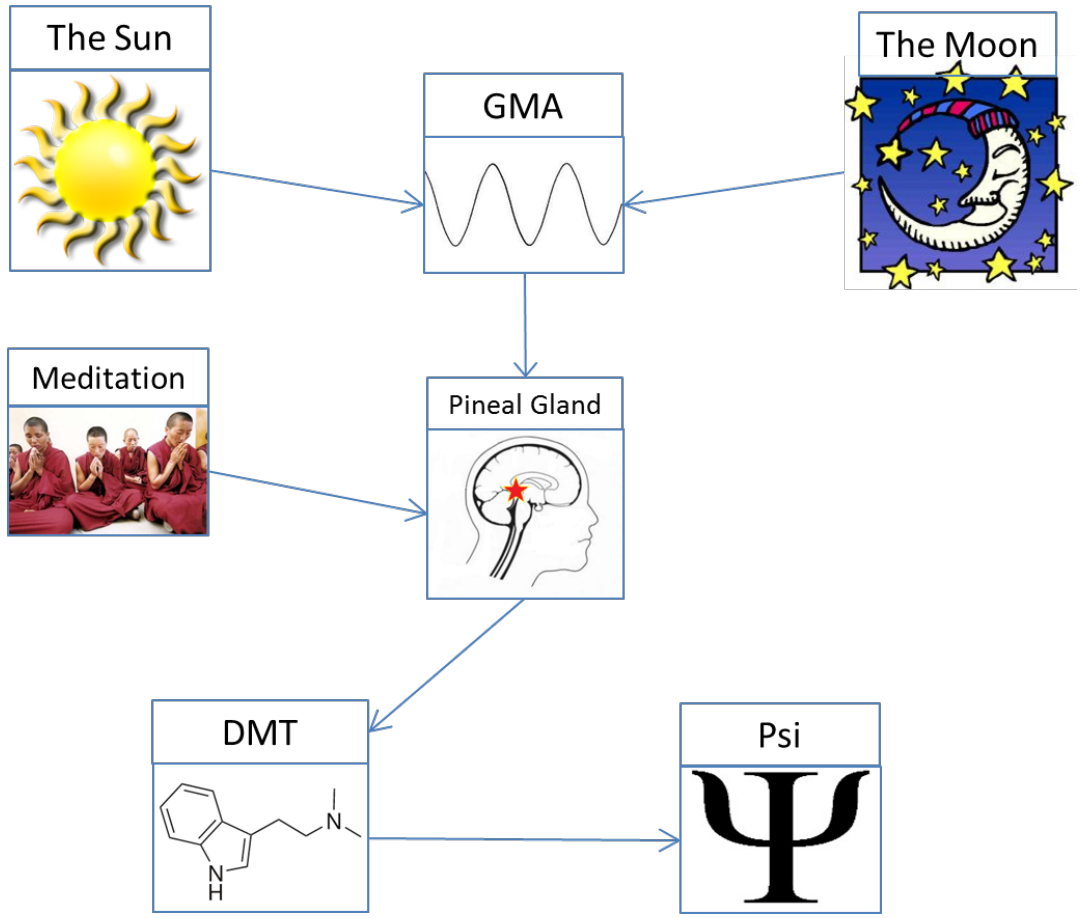

Figure 1. Theoretical model explored in this review

LONGITUDINAL STUDY OF LOCAL GMA AND PSI WITH LONG-TERM MEDITATORS

Based on the model described here and illustrated in Figure 1, a long-term study is now underway to explore the effects of local GMA on psi. One of the key aims of the proposed project is to replicate and extend the work of Ryan (2008), by exploring the features of local GMA that may modulate performance in receptive psi trials. The GMA-psi literature shows an anomaly in that on some occasions increased GMA is related to psi and on others decreased GMA is related to psi. This may be connected with differences between active or receptive psi – or it may be that investigating local GMA where the different bands can be discriminated will resolve the anomaly. By gathering data from the same population over a four year period it will be possible to look at the effect of lunar, seasonal, and sunspot cycles on the GMA-psi correlation. The two main reasons for working with meditators is the evidence that they are a potentially psi-conducive population, and the proximity of Samye Ling Tibetan Centre to Eskdalemuir Observatory, which is in the same valley. The Eskdalemuir Observatory is Britain's first purpose built geological

observatory and gathers extremely high quality measurements of the geomagnetic field at a time resolution of 1-second.

An initial two year study has been completed and will be submitted for publication in due course. The primary hypotheses being tested in this study are that psi scoring will be related to the different frequencies (bands) of GMA (negatively with band 3 and positively with band 1), and that psi scoring will be positively correlated with years of meditation practice. A number of other exploratory hypotheses are also being tested such as lunar and seasonal variations in psi and its relationship to temporal lobe lability, and the psychological effects of meditation.

ACKNOWLEDGEMENTS

We gratefully acknowledge Perrott-Warrick Fund, and Bial Foundation, Bursary no. 189/08, for financial support. And deep gratitude to the Editor and referee whose suggestions have greatly improved the quality of this paper.

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REFERENCES

Adams, M. H. (1986) Variability in remote-viewing performance: Possible relationship to the geomagnetic field. In Weiner, D. H. & Radin, D. I. (Eds.) *Research in Parapsychology 1985,* 25. Metuchen, NJ: Scarecrow Press.

Adams, M. H. (1987) Persistent temporal relationship of ganzfeld results to geomagnetic activity, appropriateness of using standard geomagnetic indices. In Weiner, D. H. & Nelson, R. D. (Eds.) *Research in Parapsychology 1986,* 78. Metuchen, NJ: Scarecrow Press.

Bell, G. B., Marino, A. A. & Chesen, A. L. (1992) Frequency-specific responses in the human brain caused by electromagnetic fields. *Journal of the Neurological Sciences 123*, 26-32.

Booth, J. N., Charette, J. C. & Persinger, M. A. (2002) Rankings of stimuli that evoked memories in significant others after exposure to circumcerebral magnetic fields: correlations with ambient magnetic activity. *Perceptual and Motor Skills 95*, 555-558.

Braithwaite, J. J. (2005) Using digital magnetometry to quantify anomalous magnetic fields associated with spontaneous strange experiences: The magnetic anomaly detection system (MADS). *JP 69*, 151-171.

Braud, W. G. (1975) Psi-conducive States. *Journal of Communication, 25*, 142-52.

Braud, W. G. (2002) Psi-favourable conditions. In Ramohan, V.G. (Ed.) *New Frontiers of Human Science*, 95-118. North Carolina, USA: McFarland.

Braud, W. G. (2006) Patanjali yoga and siddhis: their relevance to parapsychological theory and research. In Rao, K. R., Cornelissen, M. & Dala. J. (Eds.) *Handbook of Indian Psychology*. Delhi: Motilal Banarsidass.

Braud, W. G. & Dennis, S. P. (1989) Geophysical variables and behaviour: LVIII. Autonomic activity, hemolysis, and biological psychokinesis: Possible relationships with geomagnetic field activity. *Perceptual and Motor Skills 68*, 1243-1254.

Callaway, J. C. (1988) A proposed mechanism for the visions of dream sleep. *Medical Hypotheses 26*, 119-24.

Callaway, J. C. (2006) Phytochemistry and neuropharmacology of ayahuasca. In Metzner, R. (ed.) *Sacred vine of the spirits: Ayahuasca*, 94-116. Rochester, VT: Park Street.

Campbell, W. H. (2003) *Introduction to geomagnetic fields (2nd edition)*.Cambridge: Cambridge University Press.

Dalkvist, J. & Westerlund, J. (2000) Local sidereal time, global geomagnetic field and memory. *Proceedings of Presented Papers: The Parapsychological Association 43rd Annual Convention held in conjunction with the Society for Psychical Research*, 58-72.

Dalton, K. & Stevens, P. (1996) Geomagnetism and the Edinburgh automated ganzfeld. *EJP 12*, 23-24.

Dobson, J. & Grassi, P. (1996) Magnetic properties of human hippocampal tissue: Evidence for biogenic magnetite in the human brain. *Brain Research Bulletin 39*, 255-259.

Dobson, J., St.Pierre, T., Wieser, H. G. & Fuller, M. (2000) Changes in paroxysmal brainwave patterns of epileptics by weak-field magnetic stimulation. *Bioelectromagnetics 21*, 94-99.

Dukhan, H. & Rao, K. R. (1973) Meditation and ESP scoring. In Roll, W. G., Morris, R. L. & Morris, J. D. (Eds.) *Research in Parapsychology 1972*, 148-151. Metuchen, NJ: Scarecrow Press.

Etzold, E. (2005) Solar-periodic full moon effect in the Fourmilab retropsychokinesis project experiment data: An exploratory study. *JP 69*, 233-262.

Fraser-Smith, A. C. (1969) A possible full-moon enhancement of hydromagnetic emission activity. *Journal of Geophysical Research 74 (11)*, 2987–2995.

Fuller, M., Dobson, J., Wieser, H. G. & Moser, S. (1995) On the sensitivity of the human brain to magnetic fields: Evocation of epileptiform activity. *Brain Research Bulletin 36*, 155-159.

Gearhart, L. & Persinger, M. A. (1986) Geophysical variables and behavior: XXXIII. Onset of historical poltergeist episodes with sudden increases in geomagnetic activity. *Perceptual & Motor Skills 62*, 463-466.

Halekas, J. S., Poppe, A., Delory, G. T., Farrell, W. M. & Horányi, M. (2012) Solar wind interaction with the dayside lunar surface and crustal magnetic fields: Evidence for precursor effects. *Earth, Planets and Space 64*, 73-82.

Haraldsson, E. & Gissurarson, L. R. (1987) Does geomagnetic activity affect extrasensory perception? *Journal of Personality and Individual Differences 8*, 745-747.

Harvey-Wilson, S. (2001) Shamanism and alien abductions: A comparative study. *Australian Journal of Parapsychology 1 (2)*, 103-116.

Honorton, C. (1977) Psi and internal attention states. In Wolman, B. B. (Ed.) *Handbook of Parapsychology*, 435-472. New York, USA: Van Nostrand Rheinhold.

Hubbard, G. S. & May, E. C. (1987) Aspects of the measurement and application of geomagnetic indices and extremely low frequency electromagnetic radiation for use in parapsychology. In Weiner D. H. and Nelson, R. D. (eds.) *Research in Parapsychology 1986*, 79-82. Metuchen, NJ: Scarecrow Press.

Jacobs, J. A. (1970) *Geomagnetic Micropulsations*. Germany: Springer-Verlag.

Jacob, M. S., & Presti, D. E. (2005) Endogenous psychoactive tryptamines reconsidered: An anxiolytic role for dimethyltryptamine. *Medical Hypotheses 64*, 930-937.

Kirschvink, J. L., Kobayashi-Kirschvink, A. & Woodford, B. J. (1992) Magnetite biomineralization in the human brain. *Proceedings of the National Academy of Sciences 89*, 7683-7687.

Krippner, S., Becker, A., Cavallo, M. & Washburn, B. (1972) Electrophysiological studies of ESP in dreams: Lunar cycle differences in 80 telepathy sessions. *Human Dimensions 1 (1)*, 14-19.

Krippner, S., & Persinger, M. (1996) Evidence for enhanced congruence between dreams and distant target material during periods of decreased geomagnetic activity. *Journal of Scientific Exploration 10*, 487-493.

Krippner, S., Winkler, M., Amiden, A., Crema, R., Kelson, R., Lal Arora, H. & Weil, P. (1996) Physiological and geomagnetic correlates of apparent anomalous phenomena observed in the presence of a Brazilian "sensitive." *Journal of Scientific Exploration 10 (2)*, 281-298.

Luke, D. (2010) Anthropology and parapsychology: Still hostile sisters in science? *Time and Mind: The Journal of Archaeology, Consciousness & Culture 3*, 245-266.

Luke, D. (2011) Discarnate entities and dimethyltryptamine (DMT): Psychopharmacology, phenomenology and ontology. *JSPR 75*, 26-42.

Luke, D. & Friedman, H. (2010) The neurochemistry of psi reports and associated experiences. In Krippner, S. and Friedman H. (eds.) *Mysterious minds: The neurobiology of psychics, mediums and other extraordinary people*, 163-185. Westport, CT: Greenwood / Praeger.

Luke, D. P. & Kittenis, M. (2005) A preliminary survey of paranormal experiences with psychoactive drugs. *JP 69 (2)*, 305-327.

Luke, D., Zychowicz, K., Richterova, O., Tjurina, I. & Polonnikova, J. (2010) An indirect approach to the neurobiology of psi: Precognition and circadian rhythms. *Proceedings of Presented Papers: The 6th Neuroscience & Parapsychology Psi Meeting, 106-108.*

Luke, D. & Zychowicz, K. (2011) Working the graveyard shift at the witching hour: Further exploration of dreams, psi and circadian rhythms. *Proceedings of Presented Papers: The Parapsychological Association 54t Annual Convention,* 15.

Makarec, K. & Persinger, M. A. (1987) Geophysical variables and behavior: XLIII. Negative correlation between accuracy of card-guessing and geomagnetic activity: A case study. *Perceptual and Motor Skills 65*, 105-106.

McKenna, T. (1991) *The archaic revival: Speculations on psychedelic mushrooms, the Amazon, virtual reality, UFOs, evolution, shamanism, the rebirth of the Goddess, and the end of history.* San Francisco: Harper.

McPherron, R. (2005) Magnetic Pulsations: Their Sources and Relation to Solar Wind and Geomagnetic Activity. *Surveys in Geophysics 26 (5)*, 545-592.

Nelson, R. D. & Dunne, B. (1987) Attempted correlation of engineering anomalies with global geomagnetic activity. In Weiner, D.H. and Nelson, R. D. (eds.) *Research in Parapsychology 1986,* 82-85. Metuchen, NJ: Scarecrow Press.

Neppe, V. M. (1983) Temporal lobe symptomatology in subjective paranormal experiments. *JASPR 77*, 1-29.

Nichols, A. & Roll, W. G. (1999) Discovery of electromagnetic anomalies in two reputedly haunted castles in Scandinavia. *Proceedings of Presented Papers: The Parapsychological Association 42nd Annual Convention*, 219-236.

Persinger, M. A. (1983) Religious and mystical experiences as artifacts of temporal lobe function: A general hypothesis. *Perceptual and Motor Skills 57*, 1255-1262.

Persinger, M. A. (1984) Propensity to report paranormal experiences is correlated with temporal lobe signs. *Perceptual and Motor Skills 59*, 583-586.

Persinger, M. A. (1985) Geophysical variables and behavior. XXX. Intense paranormal experiences occur during days of quiet global geomagnetic activity. *Perceptual and Motor Skills 61*, 320-322.

Persinger, M. A. (1987) Spontaneous telepathic experiences from *Phantasms of the Living* and low global geomagnetic activity. *JASPR 81*, 23-36.

Persinger, M. A. (1988) Increased geomagnetic activity and the occurrence of bereavement hallucinations: Evidence for a melatonin mediated microseizuring in the temporal lobe? *Neuroscience Letters 88,* 271-274.

Persinger, M. A. (1989) Psi phenomena and temporal lobe activity: The geomagnetic factor. In Henkel, L.A. and Berger, R.E. (eds.) *Research in Parapsychology 1988,* 121-156. Metuchen, NJ: Scarecrow Press.

Persinger, M. A. (1993a) Transcendental meditation and general meditation are associated with enhanced complex partial epileptic-like signs: Evidence for "cognitive" kindling? *Perceptual and Motor Skills 76*, 80-82.

Persinger, M. A. (1993b) Average diurnal changes in melatonin levels are associated with hourly incidence of bereavement apparitions: Support for the hypothesis of temporal (limbic) lobe microseizuring. *Perceptual and Motor Skills 76*, 444-446.

Persinger, M. A. (1999) Increased emergence of alpha activity over the left but not the right temporal lobe within a dark acoustic chamber: Differential response to the left but not to the right hemisphere to transcerebral magnetic fields. *International Journal of Psychophysiology 34*, 163-169.

Persinger, M. A. & Cameron, R. A. (1986) Are earth faults at fault in some poltergeist-like episodes? *JASPR 80*, 49-74.

Persinger, M. A., Cook, C. M. & Tiller, S. G. (2002) Enhancement of images of possible memories of others during exposure to circumcerebral magnetic fields: Correlations with ambient geomagnetic activity. *Perceptual and Motor Skills 95*, 531-543.

Persinger, M. A. & Koren, S. A. (2001) Predicting the characteristics of haunt phenomena from geomagnetic factors and brain sensitivity: evidence from field and experimental studies. In Houran, J. and Lange, R. (eds.) *Hauntings and Poltergeists: Multidisciplinary Perspectives*, 179-194. Jefferson, North Carolina: McFarland.

Persinger, M. A. & Krippner, S. (1989) Dream ESP experiments and geomagnetic activity. *JASPR 83*, 101-116.

Persinger, M. A., Richards, P. M. & Koren, S. A. (1997) Differential entrainment of electroencephalographic activity by weak complex electromagnetic fields. *Perceptual and Motor Skills 84*, 527-536.

Persinger, M. A. & Roll, W. G. (Eds.) (1985) *The temporal lobe factor in psi phenomena*. Metuchen, NJ: Scarecrow Press.

Persinger, M. A. & Schaut, G. B. (1988) Geomagnetic factors in subjective telepathic, precognitive, and postmortem experiences. *JASPR 82*, 217 - 236.

Puharich, A. (1973) *Beyond telepathy*. Garden City, NY: Anchor Books.

Radin, D. I. (2002) A dog that seems to know when his owner is coming home: Effect of environmental variables. *Journal of Scientific Exploration 16*, 579-592.

Radin, D. I., McAlpine, S. & Cunningham, S. (1994) Geomagnetism and psi in the ganzfeld. *JSPR 59*, 352-363.

Radin, D. I. & Rebman, J. M. (1994) Lunar correlates of normal, abnormal, and anomalous human behavior. *Subtle Energies and Energy Medicine 5*, 209.

Radin, D. I. & Rebman, J. M. (1998) Seeking psi in the casino. *JSPR 62*, 193-219.

Radin, D. I. Vieten, C., Michel, L. & Delorme, A. (2011) Electrocortical activity prior to unpredictable stimuli in meditators and nonmeditators. *Explore 7 (5)*, 286 – 299.

Randall, W. & Randall, S. (1991) The solar wind and hallucinations – a possible relation due to magnetic disturbances. *Bioelectromagnetics 12*, 67.

Rassbach, M. E., Dessler, A. J. & Cameron, A. G. W. (1966) The lunar period, the solar period, and Kp. *Journal of Geophysical Research 71 (17)*, 4141–4146.

Reiter, R. J. & Richardson, B. A. (1992) Magnetic field effects on pineal indoleamine metabolism and possible biological consequences. *Journal of the Federation of American Societies for Experimental Biology 6 (6)*, 2283-7.

Rhine, L. E. (1981) *The Invisible Picture.* Jefferson, USA: McFarland.

Ring, K. (1989) Near-death and UFO encounters as shamanic initiations: Some conceptual and evolutionary implications. *ReVision, 11 (3)*, 14-22.

Ring, K. (1992) *The Omega Project: Near-death experiences, UFO encounters and mind at large*. New York: William Morrow & Co.

Ritz, T., Thalau, P., Phillips, J. B., Wiltschko, R. & Wiltschko, W. (2004) Resonance effects indicate a radical-pair mechanism for avian magnetic compass. *Nature 429*, 177-180.

Roe, C. A. (2009) The role of altered states of consciousness in extrasensory experiences. In Smith, M. (ed.) *Anomalous experiences: Essays from parapsychological and psychological perspectives*, 25 – 49. Jefferson, NC: McFarland.

Roe, C. A., Davey R. & Stevens, P. (2006) Experimenter effects in laboratory tests of ESP and PK using a common protocol, *Journal of Scientific Exploration 20 (2),* 239-253.

Roll, W. G. (1977) Poltergeists. In Wolman, B. B. (ed.) *Handbook of Parapsychology*, 382-413. New York, USA: Van Nostrand Rheinhold.

Roll, W. G. & Nichols, A. (2000) Psychological and electromagnetic aspects of haunts. *Proceedings of Presented Papers: The Parapsychological Association 43rd Annual Convention*, 364-378.

Roll, W. G. & Persinger, M. A. (2001) Investigations of poltergeists and haunts: a review and interpretation. In Houran, J. & Lange, R. (Eds.) *Hauntings and Poltergeists: Multidisciplinary Perspectives*, 123-163. Jefferson, NC: McFarland.

Roll, W. G. & Zill, R. (1981) Psi scoring on individual and group targets before and after meditation. In Roll, W.G. & Beloff, J. (Eds.) *Research in Parapsychology 1980*, 73-75. Metuchen, NJ: Scarecrow Press,

Roney-Dougal, S. M. (1986) Some speculations on a possible psychic effect of harmaline. In Weiner, D. H. and Radin, D.I. (Eds) *Research in Parapsychology 1985*, 120-123. Metuchen, NJ: Scarecrow Press.

Roney-Dougal, S. M. (1988) The pineal gland's possible role as a psi-conducive neuromodulator. *Proceedings of an International Conference on Paranormal Research,* Fort Collins, CO: Colorado State Univ.

Roney-Dougal, S. M. (1989) Recent findings relating to the possible role of the pineal gland in affecting psychic ability. *JSPR 56*, 313-28.

Roney-Dougal, S. M. (1990) Geomagnetism and the pineal gland: Some speculations. In Henkel, L. A. & Palmer, J. (eds.) *Research in Parapsychology 1989*, 57-61. Metuchen, NJ: Scarecrow Press.

Roney-Dougal, S. M. (2010) *Where Science and Magic Meet (3rd edition).* Glastonbury, Britain: Green Magic Publications.

Roney-Dougal, S. M. and Solfvin, J. (2006) Yogic attainment in relation to awareness of precognitive targets. *JP 70*, 91-120.

Roney-Dougal, S. M. & Solfvin, J. (2011) Exploring the relationship between Tibetan meditation attainment and precognition. *Journal of Scientific Exploration 24*, 29-46.

Roney-Dougal, S. M., Solfvin, J. & Fox, J. (2008) An exploration of degree of meditation attainment in relation to psychic awareness with Tibetan Buddhists. *Journal of Scientific Exploration 22*, 161-178.

Roney-Dougal, S. M. & Vögl, G. (1993) Some speculations on the effect of geomagnetism on the pineal gland. *JSPR 59*, 1-15.

Ryan, A. (2004a) [A dog that seems to know when his owner is coming home: Effect of environmental variables: A reassessment] Unpublished analysis.

Ryan, A. (2004b) Exploring the association between ESP and geomagnetic activity using 5-second local geomagnetic field measurements. Paper presented at *The 28th International Conference of the Society for Psychical Research, Winchester, UK.*

Ryan, A. (2008) New insights into the links between ESP and geomagnetic activity. *Journal of Scientific Exploration 22,* 333-358.

Satyananda Saraswati, Sw. (2000) *Four Chapters on Freedom*. Munger, India: Yoga Publications Trust.

Severi, B. (2003) Sciamani e psichedelia. [Shamans and psychedelics]. *Quaderni de Parapsychologia 34* (1), 36.

Schaut, G.B. & Persinger, M.A. (1985) Subjective telepathic experiences, geomagnetic activity and the ELF hypothesis. Part 1. Data analyses. *Psi Research 4 (1),* 4 -20.

Schmeidler, G. (1970) High ESP scores after a swami's brief instruction in meditation and breathing. *JASPR 64*, 100-103.

Schmeidler, G. (1994) ESP experiments 1978-1992. In Krippner, S. (ed.), *Advances in Parapsychological Research, Vol. 7,* 104-197. Jefferson, NC: McFarland.

Schmidt, S. (2012) What meditation can do: Mental health or exceptional experiences. In Simmonds-Moore, C. (ed.) *Exceptional experiences and health. Essays on Mind, Body and Human Potential,* 113 – 130. Jefferson, NC: McFarland

Schneider, O. (1967) Interaction of the moon with the Earth's magnetosphere. *Space Science Reviews 6 (5),* 655-704.

Shulgin, A. T. & Shulgin, A. (1997) *TIHKAL: The continuation*. Berkeley, CA: Transform Press.

Spottiswoode, S. J. P. (1990) Geomagnetic activity and anomalous cognition: A preliminary report of new evidence. *Subtle Energies 1*, 65-77.

Spottiswoode, S. J. P. (1997a) Apparent association between effect size in free response anomalous cognition experiments and local sidereal time. *Journal of Scientific Exploration 11*, 109-122.

Spottiswoode, S. J. P. (1997b) Geomagnetic fluctuations and free-response anomalous cognition: a new understanding. *JP 61*, 3-12.

Stening, R. J., Carmody, C. & Du, J. (2002) Simulating the lunar geomagnetic variations. *Journal of Geophysical Research 107 (A7),* SIA 12-1 – SIA 12-11.

Strassman, R. (2001) *DMT: The spirit molecule.* South Paris, ME: Park St. Press.

Střeštík, J. (1998) Spectrum of geomagnetic activity in the period range 5–60 days: possible lunar influences. *Annales Geophysicae 16 (7),* 804-811.

Sturrock, P. A. & Spottiswoode, S. J. P. (2007) Time-series spectrum analysis of performance in free response anomalous cognition experiments. *Journal of Scientific Exploration 21*, 47-66.

Symmons, C. & Morris, R. L. (1997) Drumming at seven Hz and automated ganzfeld performance. *Proceedings of Presented Papers: The Parapsychological Association 40th Annual Convention,* 441–453.

Tart, C. T. (1988) Geomagnetic effects on GESP: Two studies. *JASPR 82*, 193 - 216.

Welker, H. A., Semm, P., Willig, R. P., Commentz, J. C., & Wiltshchko, W. (1983) Effects of an artificial magnetic field on serotonin N-acetyltransferase activity and melatonin content of the rat pineal gland. *Experimental Brain Research 50*, 426-432.

Weydahl, A., Sothern, R. B., Cornelissen, G. & Wetterberg, L. (2001) Geomagnetic activity influences the melatonin secretion at latitude 70 degrees N. *Biomedicine and Pharmacotherapy 55*, 57s-62s.

Wilkinson, H. P. & Gauld, A. (1993) Geomagnetism and anomalous experience, 1868 - 1980. *Proc SPR 57,* 275-310.