

Magnetospheric and Lunar Interactions with Reported Sensory Hallucinations: An Exploratory Study¹

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Abstract. Geomagnetic activity (GMA) and the lunar cycle have previously been postulated to facilitate hallucinatory experiences that are subsequently interpreted as haunting activity. However, findings from previous studies investigating possible connections are limited by relatively small sample sizes, broad temporal resolution, or artificial laboratory settings. To address these limitations, an exploratory analysis was conducted on 26 years of witness statements comprising 723 unique reports of apparent haunting activity, obtained from management at Port Arthur Historic Penal Colony, Tasmania, Australia. We compared frequency of reports with moon phase, the solar cycle, and monthly, daily, and hourly measures of GMA (using the Ap index). Report distribution was significantly correlated both with annual variation in GMA and solar cycle sunspot frequency. Intraday distributions revealed that reports were more likely to occur during times below mean daily GMA. Furthermore, significantly higher frequency of reports occurred during the two-day period around the new and full moon. The findings suggest that sensory hallucinations, experienced as haunt activity occur preferentially during specific periods outside of maximal GMA; during either relatively quiet periods or perhaps during periods with magnetic variations more suited to interaction with biological processes. The observed lunar effect is likely psychogenic in nature due to sensory feedback.

Keywords: Magnetosphere; Moon; Geomagnetic; Ghosts; Haunting

Approximately 20-30% of the population is likely to experience anomalous events commonly termed ghost or haunting activity at some point in their lives (Haraldsson, 2009). These experiences may occur across any sensory modality, ranging from visual, auditory, tactile, olfactory, as well as sensory processes such as feelings of a sensed presence and fear (Alvarado & Zingrone, 1995). One theory for their generation focuses on the possibility of magnetic fields perturbing biological processes, which may lead to hallucinatory activity (Persinger, Tiller, & Koren, 2000). This activity is subsequently intuited as supernatural in origin. One main source of magnetic field perturbation arises from the interaction of the earth's geomagnetic field with the stream of charged particles emanating from the sun in the form of solar wind. The variability in both the speed and the intensity of solar wind speed results in highly dynamic conditions within the earth's magnetosphere that can be measured at ground level.

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Weak magnetic fields applied to left (Tiller & Persinger, 2002) and right (Cook & Persinger, 2001) temporal lobes of the brain have been demonstrated to induce hallucinations in the form of a subjectively felt presence. Outside the laboratory environment, bereavement related hallucinations have been shown to be more frequent during periods of increased geomagnetic activity (GMA) (Persinger, 1988), and in-situ magnetic fields have also been implicated in experiences of paranormal phenomena (Braithwaite & Townsend, 2005; Roll & Nichols, 2000; Wiseman, Watt, Greening, Stevens, & O'Keeffe, 2002).

Randall and Randall (1991) analyzed 49 apparition experiences on a monthly basis over a 15 year period. A significant positive correlation was observed in relation to mean monthly values of the average antipodal (aa) index for the 15-year period. The aa index, derived from 2 antipodal magnetometer stations, provides a measure of geomagnetic disturbance at the earth's surface caused largely by solar wind. The aa index and more contemporary GMA indices (e.g., Kp and Ap) that utilize greater numbers of magnetometer stations, all display a prominent semi-annual variation, showing equinoctial peaks (March & September) and solstitial troughs (June & December). The observation made by Randall and Randall that the frequency of sensory hallucinations followed the same annual variation prompted us to study possible GMA influences on sensory processing in the general population.

The present work extends upon their study by analyzing similar phenomena at a higher temporal resolution and with a greater sample size. An exploratory analysis of 26 years of eyewitness reports of apparent haunting activity (1989-2014) from the Port Arthur penal settlement, Australia is presented. The penal settlement was operational between 1830 and 1877 and housed up to 1, 200 convicts at its peak in 1846. The Port Arthur Historic Site Management Authority (PAHSMA) has catalogued contemporary eyewitness statements of supposed haunting activity since the late 1980s. The qualitative and quantitative nature of the data provides an ideal opportunity to extend on prior studies of geomagnetic influence on sensory hallucinations.

In addition to geomagnetic activity, lunar cycle was also considered in this study for two reasons: 1) the possible influence of the moon on perturbations of the earth's GMA, and 2) to address the popular belief that moon phase plays a role in behavioral and psychiatric conditions.

The possibility of indirect physical effects of moon phase on biological systems cannot be dismissed. The lunar effects on the earth's GMA has been shown by two mechanisms: 1) gravitational forcing of the lower atmosphere; compressing and expanding the ionosphere (Gasperini & Forbes, 2014; Lühr, Siddiqui, & Maus, 2012), and 2) by physical interference with either solar wind or earth's magnetosphere during new and full moon periods (Akimov & Dyatel, 2012; Majmudar & Rao, 1983; Rangarajan, 1980). Evidence of magnetically induced changes in epileptiform activity has been shown (Michon, Koren, & Persinger, 1996; Persinger, Hoang, & Baker-Price, 2009), and a possible association between non-seizure epileptiform-like activity and hallucinatory events has been suggested (Persinger, 1995). Significant variations in clustering of seizures around moon phases (Hadzic, Mladina, Hadzic, & Numanovic, 2010; Polychronopoulos et al., 2006; Ruegg, Hunziker, Marsch, & Schindler, 2008), with non-epileptic seizures being highest around the full moon quarter (Benbadis, Chang, Hunter, & Wang, 2004) lend support to the hypothesis that individuals within the population displaying non-clinical epileptic-like activity in the

temporal lobes (Persinger & Makarec, 1987, 1993) may be more susceptible to the influence of complex magnetic field variations (Persinger, 1995; Persinger et al., 2009; Persinger & Saroka, 2013).

However, it is also important to consider the psychogenic effect of the moon phases on reported paranormal activity. The *Transylvanian effect* is the term given for the common belief that lunar events cause physiological and psychological disturbance (Mason, 1997). Belief in the Transylvanian effect is quite common among mental health professionals (Vance, 1995). Those with beliefs in the paranormal have also been found to believe that the moon affects behavior (Rotton & Kelly, 1985b). Such beliefs can contribute to cognitive biases that could lead to differences in the frequency of reported paranormal events for certain moon phases. For example, Kelly, Rotton, and Culver (1996) outline how holding certain beliefs can result in cognitive biases such as selective perception and exposure to events that confirm these beliefs, resulting in illusory correlations.

Given that studies of lunar cycle influence on behavioral and psychiatric conditions are largely discordant (Barr, 2000; Danzl, 1987; Parmar et al., 2014; Rotton & Kelly, 1985a), effects of the lunar cycle on sensory hallucinations were not anticipated despite theoretical considerations.

This paper intends to address the hypotheses that: 1) Significant positive relations would be observed between report frequency and monthly and daily measures of geomagnetic activity as measured by the Ap index, 2) a significant positive relation would be observed between report frequency and sunspot activity, and, 3) a non-significant relation would be observed between report frequency and lunar cycle.

Method

Participants

A total of 1032 witness reports were provided by Port Arthur Historic Site Management Authority (PAHSMA) for the years 1989-2014. These were filtered through a two-stage process; first, reports were discarded if they contained no date/time record or if the report did not pertain to an actual experience on the site (135 reports). Second, multiple reports submitted by numerous witnesses to the same incident were collapsed into a single report for the purpose of comparison with geomagnetic and lunar data (174 reports). This resulted in the 723 unique incidents used for analysis in this study, of which 423 were witnessed by women, 259 by men, and 19 by both (22 did not state their gender). Age was provided for just over half of this sample ($n = 375$) and ranged from 2-80 years-of-age. The reports were submitted from day visitors as well as visitors undertaking nighttime ghost tours. The reports spanned all sensory modalities, including visual, auditory, tactile, olfactory, asensory, and combinations thereof. All dates and times were adjusted to universal time for comparison with Ap data provided in the same format.

Data of sunspot numbers were obtained from the Australian Bureau of Meteorology, Space Weather Services (sws.bom.gov.au/Educational/2/3/6). The Ap index data was obtained from the National Geophysical Data Centre, Boulder, Colorado (ftp://ftp.ngdc.noaa.gov/STP/GEOMAGNETIC_DATA/INDICES/KP_AP/). Moon phase data were obtained online from [timeanddate.com \(timeanddate.com/moon/phases/australia/hobart\)](http://timeanddate.com/moon/phases/australia/hobart)

Analysis

Analysis of correlations between datasets was conducted using Kendall's tau on detrended data using a \log_n transformation (to remove linear trends). Analysis was performed using SPSS (IBM SPSS Statistics, 24). Distributions within datasets were analyzed using Chi-Square Goodness-of-fit tests. Statistically significant distributions were further analyzed using standardized residual calculations to determine categories of significance and their direction. Standardized residuals were calculated according to Shapre (2015) using the following formula:

Standardized Residual = $(O-E)/\sqrt{E}$, where O is the observed count and E is the expected count.

A significance threshold level of ± 3 was used, which corresponds approximately to a $z = 2.96$.

Effect size calculations were conducted using G*Power (v 3.1.9.2, University of Dusseldorf), with the magnitude of effect sizes (small, medium or large) derived from Cohen (1988).

Results

Geomagnetic Activity

Sample size for the following statistical tests met criteria to detect a medium effect size at $\alpha \leq .05$, resulting in statistical power $(1 - \beta) = .80$ or greater. This combination of power and effect size allows a high level of confidence in interpreting the practical meaningfulness when rejecting the null hypothesis.

The distribution of the 723 unique reports was compared to the 11-year solar cycle in energy output (Fig. 1), as measured by the annual sunspot number. Fewer reports occurred during more active portions of the solar cycle ($r^t = -.40$, $n = 25$, $p = .005$) with sunspot activity accounting for 45% of the variability in report frequency.

The annual variation of report numbers with respect to GMA (Figure 2a) shows the similarity in the cyclical trend between the monthly mean Ap index and the monthly report counts. With the exception of the months of January and December, the distribution of reports was found to have a strong positive correlation with GMA (Kendall's tau, $r_t = .69$, $n = 10$, $p = .006$) with the Ap index accounting for 58% of the variability in report frequency. The January and December periods comprise months of peak tourism and are a probable cause of the inflated number of reports in those months. Variations in the number of Port Arthur visitors could not be adjusted for due to insufficient attendance information. A scatterplot of monthly report numbers and monthly GMA (Fig. 2b) shows a distinct separation of the January and December months (squares) from the remainder of the months (circles).

With the exception of the January and December extremes, the positive correlation found in the annual variation (Fig. 2) indicates a greater number of reports during months of higher geomagnetic disturbance. This positive correlation between reports and GMA on an annual level is difficult to reconcile with the contrasting negative correlation over a longer solar cycle period of 11 years. The observation that report counts decrease during solar maxima (Fig.1) yet increase during months of higher average GMA (Fig. 2) suggests that absolute intensity of GMA perturbations are not the primary factor. It may be

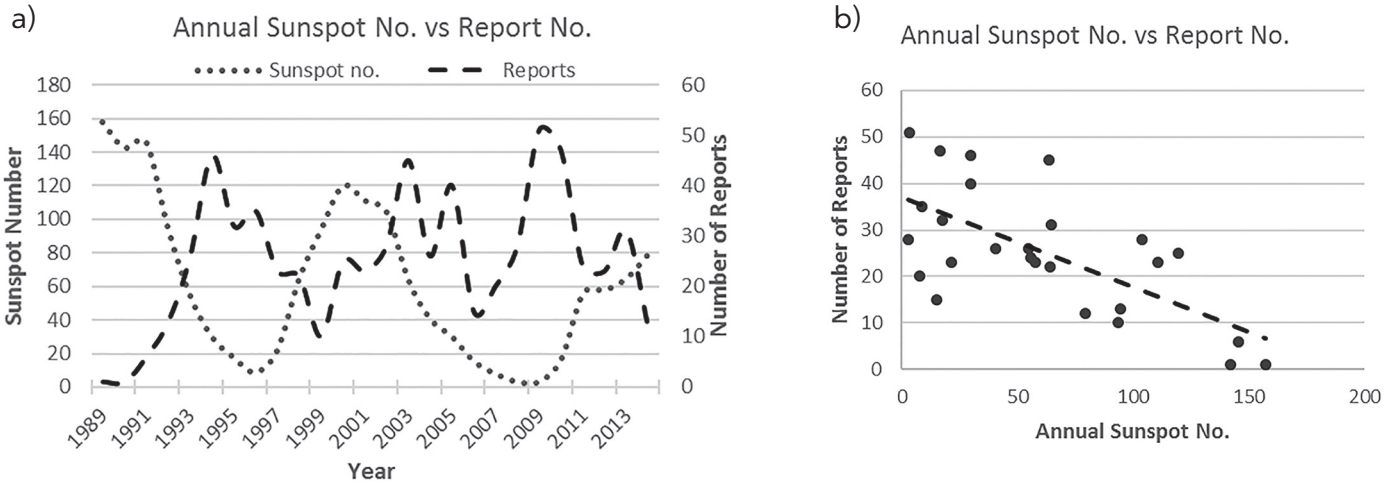


Figure 1: a) Plot of the number of reports per year and the corresponding sunspot count for the years in question. b) Scatterplot of report numbers with sunspot number.

the pattern of activity that is more influential on the phenomenon than the absolute magnitude of the GMA. The features of GMA that influence the witnessing of phenomena may be suppressed or obscured during more active periods of the solar cycle.

The distribution of reports based on average monthly GMA indicates greater than expected report numbers for months of lower GMA. A histogram of report numbers for increasing levels of monthly Ap values is shown (Fig. 3) overlaid with a line graph indicating the distribution of all months over the 26-year period with their corresponding Ap values. The Ap index was truncated to the initial 30 values for sake of clarity. The distribution of the 26-year population of Ap values overlaps well with the distribution

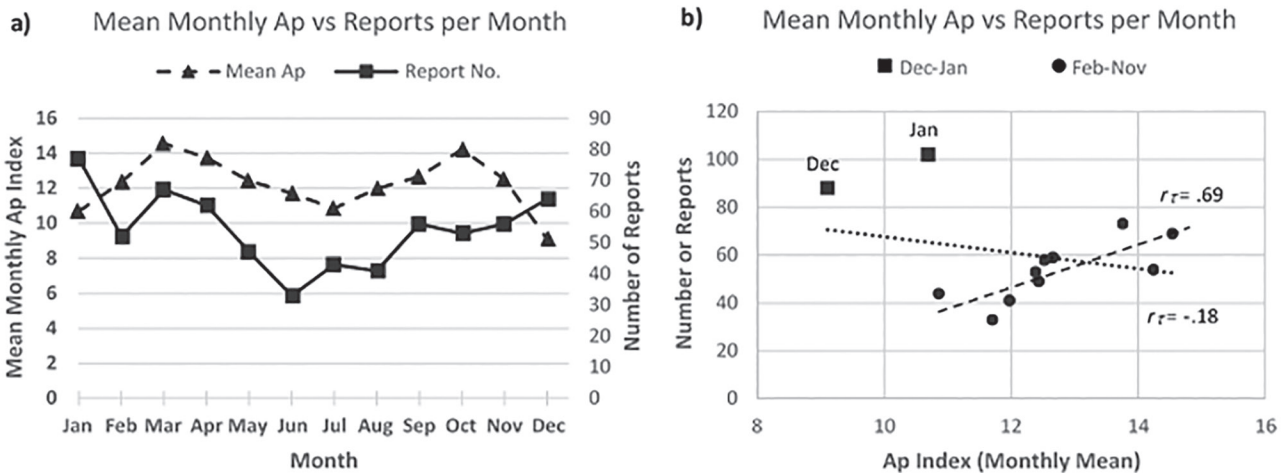


Figure 2: Distribution of reports by month compared to Ap index of geomagnetic disturbance. a) A plot which shows the cyclical trend of the mean monthly Ap index and a similar trend in the report frequency (with the exception of Jan and Dec months). b) A scatterplot that shows the Jan and Dec data points (squares) and their relative displacement from the remainder of the data points. $R = .69$ The correlation of months Feb – Nov with Jan and Dec excluded was $r = .69$; $r = -.18$ is the correlation when Jan and Dec months are included.

of reports for higher values, but significant discrepancies arise at Ap levels below 10 ($\chi^2(31) = 121.02, p < .001$). The effect size value ($w = .42$) suggests a moderate to high practical significance. Post hoc standardized residual analysis indicated that data points with significant variation from expected levels were Ap levels of 4, 5, 6 and 10 (marked by asterisk "*" in Fig. 3).

Report distribution across daily Ap values for the 26-year data population (Fig. 4) shows a uniform, non-significant spread across all levels of activity. A line-graph overlay shows the distribution of daily Ap values for the 26-year period. The two distributions were not significantly different, $\chi^2(31) = 43.33, p = .055$, indicating report distribution was spread equally across all levels of daily Ap.

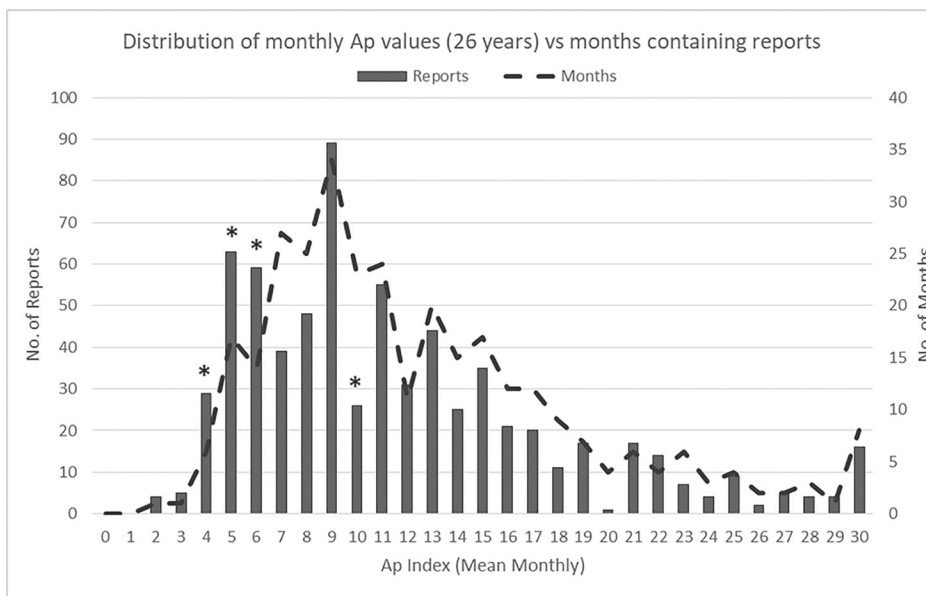


Figure 3: Histogram of reports distributed by monthly Ap level. The overlay line-graph shows the 26-year population of months and their distribution, which acts as a measure of expected distribution. Asterisks (*) indicate a significant deviation from that expected (measured using standardized residuals greater than ± 3).

The apparent preference for months of lower GMA suggests that increased report frequency is more likely during periods with a greater proportion of quiet time (lower GMA). This is supported by intra-day comparison of the eight 3-hourly ap values that comprise the daily Ap value. The ap values at the time of the reports (Fig. 5) were found to be unevenly distributed relative to the mean Ap, with significantly more reports occurring at quieter portions of the day, $\chi^2(2) = 57, p < .001$. The effect size value ($w = .32$) suggests a medium practical significance. Standard residuals (greater than ± 3) indicate direction of significance with substantially more reports occurring at ap levels below their corresponding daily average. This effect was not due to natural variations in distribution as the total sub-population of ap values for the 552 days in question were evenly distributed above and below the mean, $t(551), p = .67$.

Lunar Cycle

When report numbers were plotted by the (approx. 29.5 days) lunar cycle, a distinct increase in reports was evident around the new moon and full moon phases (Fig. 6). Chi-squared goodness-of-fit

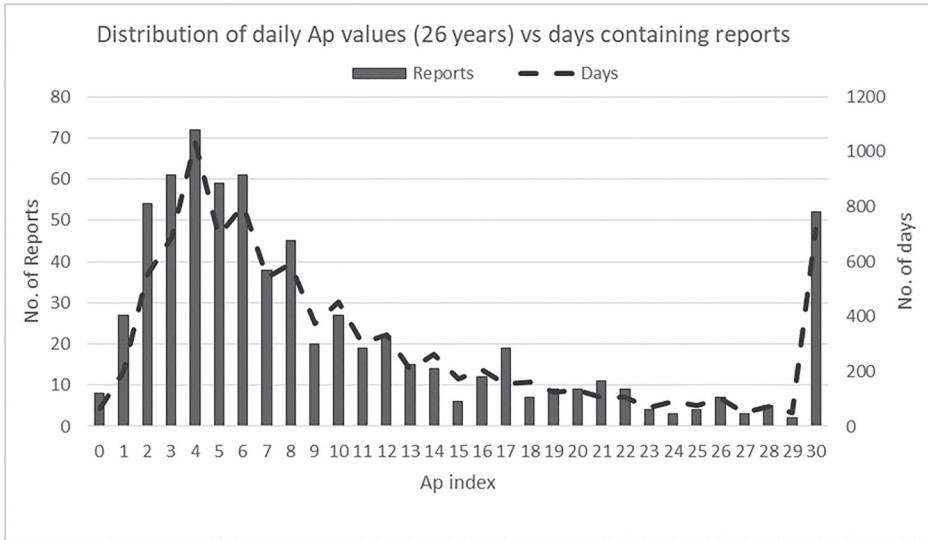


Figure 4: Histogram of reports distributed by daily Ap level. Overlay line-graph shows the 25-year population of days by Ap level, which acts as a measure of expected distribution.

analysis showed a significant deviation from the expected counts of 24.1 reports per day (Fig. 6, dotted line), $\chi^2(29) = 266.9, p < .001$. Furthermore, the effect size ($w = .61$) indicates a large practical significance. Analysis of standardized residuals confirmed days pertaining to the new moon (days 1 & half day 29.5) and the full moon (day 15 and 16) were significantly more frequent. More precisely, greater report frequency is evident in the two days centered on the new moon but offset for the full moon to favor the waning period.

Figure 5: Magnitude of the 3-hourly ap value corresponding to the time of the experience relative to the mean daily Ap. Standard residuals greater than ± 3 were used to determine significance and direction of values.

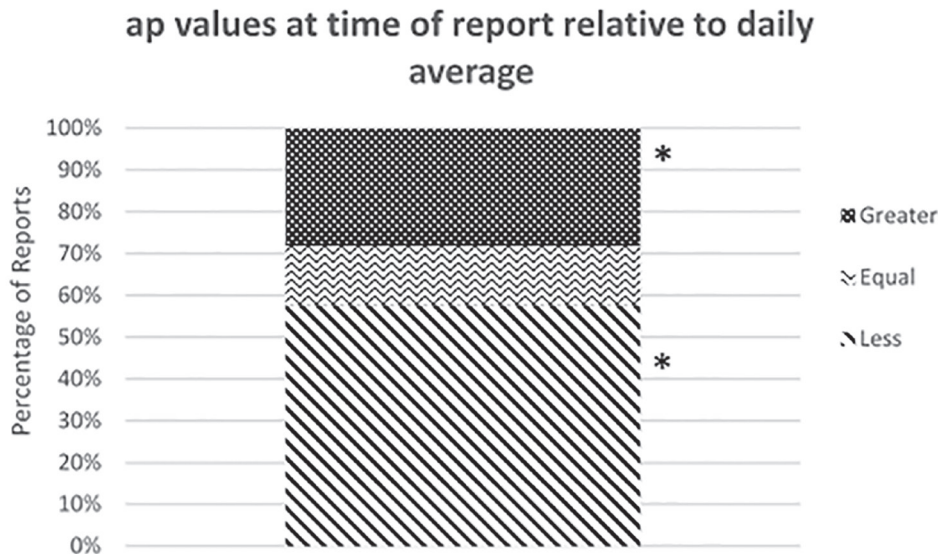
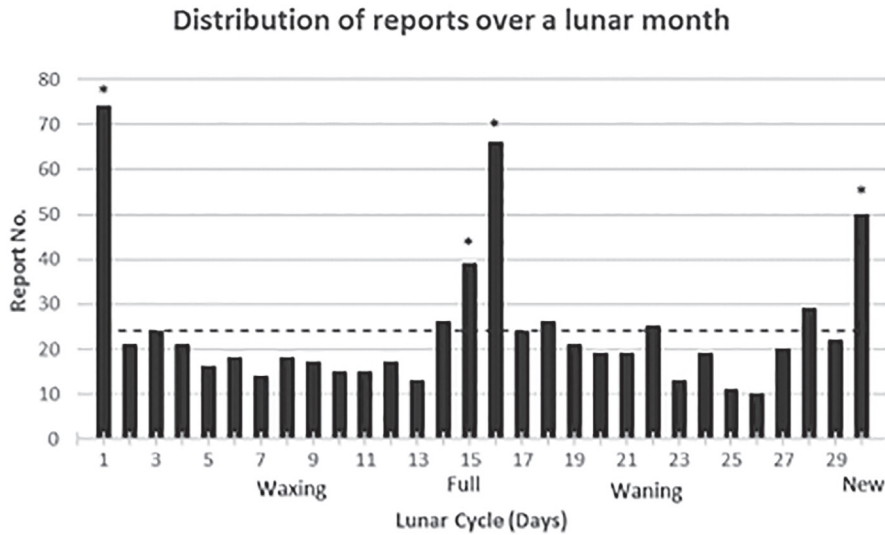


Figure 6: Distribution of reports by day of the lunar cycle (~29.5 days). Evident are the four days of elevated report numbers (marked by an asterisk), clustering around the phases of the new and full moon. The dashed line indicates the expected report count (24.1). Asterisk (*) indicates a significant deviation from that expected (measured using standardized residuals $> \pm 3$).



Discussion

The geomagnetic field data of the present study showed two general patterns. First, as predicted, a significant positive association was evident between annual variations in GMA and hallucinatory experiences in the form of witness reports, whereby more reports occurred during months of greater GMA. Conversely, a significant negative association was observed both at longer and at shorter temporal scales (i.e., solar cycle and daily variations respectively), with higher levels of GMA corresponding to lower report numbers.

Contrary to hypotheses on the span of a solar cycle (11 years), report frequency diminished during periods of high solar activity, when GMA disturbances are more frequent. On a monthly scale, reports were distributed over a broad range of GMA spanning low and high Ap levels, but there exists a preference for months of lower Ap values. It is likely that this preference for lower mean monthly Ap values is obscured when data are viewed at a seasonal level, as in the study by Randall and Randall. Finally, at a daily level, reports are equally likely to occur on any day regardless of the level of activity but occur largely during the quieter portion of the day, below the daily average.

Although our initial hypothesis was supported in that annually incidences occur more frequently during higher periods of geomagnetic disturbance, the current finding suggests that it is not the absolute level of disturbance but rather the quieter times around the disturbed period that are more conducive to generation of the phenomenon. High absolute levels of GMA have been correlated to physiological and behavioral factors, such as melatonin levels, temporal lobe epileptiform-type activity and hospital admissions (Burch, Reif, & Yost, 2008; Kay, 1994; Persinger, 1988). However, the effect of magnetic stim-

ulation focusing not on intensity, but rather on its biological “meaningfulness” has also been observed (Persinger, 2006; Persinger et al., 2009; Persinger, Koren, & O’Connor, 2001; Tiller & Persinger, 2002). The term biological “meaningful” is somewhat loosely defined, but implies particular combinations of frequency, intensity, waveform, and possibly spectral complexity that makes them physiologically significant (Sienkiewicz, Jones, & Bottomley, 2005).

In support of this idea are studies of ion-cyclotron type resonance (ICR) as a potential coupling mechanism of weak magnetic fields and biological tissue. Ion-cyclotron type resonance requires specific frequencies and intensities of magnetic fields to produce a “window effect”; an ideal energy transfer with the magnetic or electric fields of oscillating ions (Liboff, 2010). Zhadin and colleagues (1998), found that conductivity of polar amino acids in solution changed sharply under exposure to AC magnetic fields when those fields were tuned to the specific charge-to-mass ratio of the amino acid (i.e., ICR conditions). Furthermore, this effect was observed with magnetic field intensities of the order of 50 nT. At only 40 nT, dissolution of peptide bonds in proteins were observed when exposed to magnetic fields tuned to the ICR conditions of the amino acid (Novikov & Fesenko, 2001). This ion cyclotron resonance could exert an effect on small ions such as the ubiquitous Ca^{2+} ion. The flow-on effect could impact modulation of homeostasis, neuronal conductivity or a multitude of other physiological processes (Liboff, 1997; Pazur & Rassadina, 2009).

The ICR mechanism is one that seems to agree well with the requirements for specificity and intensity of stimulus parameters. However, other proposed mechanisms should also be considered. The discovery of magnetically sensitive magnetite crystals in the human brain constitutes possibly the most direct mechanism of magnetic field interactions with biological tissue (Kirschvink, Kobayashi-Kirschvink, Diaz-Ricci, & Kirschvink, 1992; Kirschvink, Kobayashi-Kirschvink, & Woodford, 1992). Found throughout the brain, the potential effects of these crystals on physiological and cognitive processes are of much interest. Another potential mechanism comprises calcite microcrystals, which reside within the pineal gland. The crystals have been proposed as a possible transduction mechanism for electromagnetic fields (Baconnier et al., 2002). It could be speculated that the presence of these microcrystals in the pineal gland may be related to a number of melatonin related processes influenced by magnetic field stimulation (Burch, Reif, & Yost, 1999; Persinger, 2006).

The findings within this study tend to support a biologically meaningful theory for reports of apparent haunting activity. Indeed, certain aspects of haunt type phenomena, such as a sensed-presence and feelings of fear have been induced experimentally (Cook & Persinger, 2001; Tiller & Persinger, 2002; (Cook & Persinger, 2001; Tiller & Persinger, 2002; although see Granqvist et. al., 2005, for a critique of these findings) and were offered as a valid explanation for sites reputed to be haunted (Persinger et al., 2001; Wiseman, Watt, Stevens, Greening, & O’Keeffe, 2003). Selective generation of positive or negative emotions related to a sensed presence have been induced by the appropriate pattern of magnetic stimulation (Persinger et al., 2000). The possibility should be considered that natural, low frequency fields generated within the earth-ionospheric cavity, but disrupted by more intense GMA, may influence the rate of incidence (Persinger, 1985). The exact nature of the stimulus pattern (or its complexity) pertaining to the phenomenon is uncertain at this stage. One avenue of inquiry, as a starting point, is the wide range of ultra-low frequency (ULF) magnetic pulsations that are known to be generated in the magneto-

sphere due to a variety of physical processes and instabilities. These pulsations have periods of 1 - 1000 sec (or longer) and are continuous or irregular in nature (Allan & Poulter, 1992; Saito, 1969). It is possible that pulsation activity within these ranges may be influential to the generation of the phenomenon.

A surprising finding within this study involves the relation between lunar cycle and frequency of reports. In contrast to our hypotheses, disproportionately more reports coincided with both the full and the new moon phases. Given the lack of empirical support surrounding the influence of the moon on human physiology (Ownes & McGowen, 2006), it is likely that this finding is a result of psychogenic factors. For example, experiencers may misinterpret vague sensory inputs as supernatural in origin due to cognitive bias. Those holding beliefs in the paranormal have been found to believe that the moon influences behavior (Rotton & Kelly, 1985b). Therefore, belief in the influence of lunar phases upon incidence of paranormal events may result in selective perception (e.g., hypervigilance to suspected paranormal events due to the presence of a full moon), selective recall and selective exposure (e.g., attending the ghost tour during a full moon due to the belief that a paranormal event will be witnessed), giving rise to increased reports during the full moon (Kelly, Rotton, & Culver, 1996). With respect to the new moon, although generally not associated with supernatural incidence (Bevington, 2015), the effect may be due to the absence of illumination during this portion of the lunar cycle. The lack of illumination during a new moon compared to other moon phases would only further increase the likelihood of misinterpretation of already vague stimuli.

Despite the likely role of psychogenic factors resulting in cognitive bias, it is interesting to note that the moon does exert an influence on the general level of GMA, through both gravitational effects on the lower atmosphere and ionosphere and by physical interference with the sun-earth magnetic connection (Akimov & Dyatel, 2012; Majmudar & Rao, 1983; Rangarajan, 1980). However, due to absence of suitable controls within this study, any possible lunar influences via environmental mechanisms cannot be clearly separated from the psychological factors.

The observations made in this study and prior studies have shown a relation between sensory hallucinations and geomagnetic activity, but only on a broad planetary level, as indicated by the planetary indices of GMA. Future investigation of the notion that certain geomagnetic spectral components play a role in hallucinatory experiences would benefit from the use of magnetic field data of higher spatio-temporal resolution to elucidate the dynamic changes specific to the geographic location in question.

The wealth and breadth of data accumulated here over a 26-year period provides valuable insights, but also exhibits some limitations inherent in the nature of its acquisition. The unplanned format of the reports results in an absence of suitable control groups to make statistical comparisons at behavioral levels. Because of these limitations, a reproduction of these findings is needed using suitable controls to eliminate the impact of potential confounds on the findings. As the phenomena reported here are largely biological in nature, future efforts would benefit in analyzing environmental factors in conjunction with experiencer traits such as socio-cultural characteristics, neurophysiological factors, or personality traits.

With respect to GMA, the distribution of sensory hallucination reports show a preference for quieter portions of the day, but, curiously, for those days that reside in seasons of higher geomagnetic distur-

bance. These findings suggest that time periods situated within more complex variability may be more conducive to sensory hallucinations than absolute intensity. A significant interaction between lunar cycle and report frequency was also observed, but environmental and psychological mechanisms of action could not be discriminated. The geomagnetic findings suggest a mechanism emphasizing spatio-temporal variation over intensity for increasing the likelihood of sensory hallucination experiences within the general population. The significant environmental interactions with sensory processing found in this study offer a predictor of anomalous occurrence likelihood in the real world.

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Interactions Magnétosphériques et Lunaires avec les Hallucinations Sensorielles Rapportées: Une Étude Exploratoire

Résumé. Il a précédemment été affirmé que l'activité géomagnétique (GMA) et le cycle lunaire pouvaient faciliter les expériences hallucinatoires qui sont subséquemment interprétées comme relatives à des activités de hantise. Toutefois, les résultats des précédentes études investiguant ces possibles connexions ont pour limites de n'avoir que des échantillons de petite taille, de larges résolutions temporelles, ou des conditions de laboratoire artificielles. Afin de parer ces limitations, une étude exploratoire a été conduite sur 26 years d'affirmations faites par des témoins, pour un total de 723 rapports distincts, d'activité apparente de hantise, obtenus par l'équipe du Port Arthur Historic Penal Colony, en Tasmanie, Australie. Nous avons comparé la fréquence des rapports avec les phases de la lune, le cycle solaire, et des mesures mensuelles, quotidiennes ou heure par heure de la GMA (en utilisant l'index Ap). La distribution des rapports était significativement corrélée à la fois avec la variation annuelle de la GMA et la fréquence des taches solaires dans le cycle solaire. Les distributions dans une même journée révélaient que les rapports étaient plus susceptibles d'être faits durant les périodes où la GMA était inférieure à sa moyenne quotidienne. De plus, des fréquences significativement plus élevées de rapports se sont produits durant la période de deux jours autour de la nouvelle et pleine lune. Ces résultats suggèrent que les hallucinations sensorielles, vécues sous la forme d'activité de hantise, se produisent de façon préférentielle durant des périodes spécifiques en dehors de la GMA maximale ; durant des périodes soit relativement calmes ou peut-être durant des périodes où les variations magnétiques sont les plus susceptibles d'interagir avec les processus biologiques. L'effet lunaire observé est probablement d'ordre psychogénique et dû à un feedback sensoriel.

Magnetosphärische und lunare Wechselwirkungen mit berichteten sensorischen Halluzinationen: Eine explorative Studie

Zusammenfassung. Bereits früher wurde vermutet, dass die geomagnetische Aktivität (GMA) und der Mondzyklus im Zusammenhang mit halluzinatorischen Erfahrungen stehen, die anschließend als Geisteserscheinungen interpretiert wurden. Die Aussagekraft früherer Studien, in denen solche Zusammen-

hänge untersucht wurden, ist jedoch aufgrund relativ kleiner Stichprobengrößen, einer breiten zeitlichen Auflösung oder einer künstlichen Laborsituation begrenzt. Um diese Einschränkungen zu begegnen, wurde eine explorative Analyse von 26 Jahren umfassenden Zeugenaussagen durchgeführt, die 723 besondere Berichte über scheinbar geisterhafte Aktivitäten umfassen, die von der Verwaltung der Port Arthur Historic Penal Colony, Tasmanien, Australien, zur Verfügung gestellt wurden. Wir verglichen die Häufigkeit der Berichte mit der Mondphase, dem Sonnenfleckenzyklus und den monatlichen, täglichen und stündlichen Messungen der GMA (unter Verwendung des Ap-Index). Die Berichtsverteilung war sowohl mit den jährlichen Schwankungen der GMA als auch mit der Häufigkeit der Sonnenflecken im Sonnenfleckenzyklus signifikant korreliert. Verteilungen im Tagesverlauf ergaben, dass die Wahrscheinlichkeit dafür, dass Berichte in Zeiten unterhalb der durchschnittlichen täglichen GMA auftreten, höher war. Darüber hinaus wurden während zweier Tage um den Neu- und Vollmond herum deutlich mehr Berichte registriert. Die Ergebnisse deuten darauf hin, dass sensorische Halluzinationen, die als spukhafte Vorfälle erlebt werden, vorzugsweise in bestimmten Perioden außerhalb der maximalen GMA auftreten; entweder in relativ ruhigen Perioden oder vielleicht in Perioden mit Magnetfeldänderungen, die mit biologischen Prozessen eher wechselwirken. Der beobachtete Mondeinfluss dürfte eher psychogener Natur sein, da er mit sensorischem Feedback zusammenhängt.

Interacciones Magnetosféricas y Lunares con Informes de Alucinaciones Sensoriales: Un Estudio Exploratorio

Resumen. La actividad geomagnética (GMA) y el ciclo lunar se han postulado previamente como adyuvantes de experiencias alucinatorias que posteriormente se interpretan como actividades fantasmales. Sin embargo, los resultados de estudios previos que investigaron posibles conexiones estuvieron limitados por tamaños de muestra relativamente pequeños, resolución temporal amplia, o entornos artificiales de laboratorio. Para subsanar estas limitaciones, realizamos un análisis exploratorio de 26 años de declaraciones de testigos que incluyeron 723 informes individuales de actividad fantasmal aparente, obtenidos por la administración de la Colonia Penal Histórica de Port Arthur, Tasmania, Australia. Comparamos la frecuencia de los informes con la fase lunar, el ciclo solar y las mediciones mensuales, diarias, y por hora de GMA (utilizando el índice Ap). La distribución de los informes correlacionó significativamente tanto con la variación anual en GMA como con la frecuencia de las manchas solares del ciclo solar. Las distribuciones durante el día revelaron que los informes tenían más probabilidades de ocurrir durante tiempos por debajo de la media diaria de GMA. Además, se produjo una frecuencia significativamente mayor de informes durante el período de dos días alrededor de la luna nueva y la luna llena. Los resultados sugieren que las alucinaciones sensoriales, experimentadas como actividad fantasmal, ocurren preferentemente durante períodos específicos fuera de la GMA máxima; durante períodos relativamente tranquilos, o quizás durante períodos con variaciones magnéticas más adecuadas para la interacción con procesos biológicos. El efecto lunar observado es probablemente de naturaleza psicógena debido a la retroalimentación sensorial.