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An investigation into alleged 'hauntings'

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In cases of alleged hauntings, a large number of seemingly trustworthy witnesses consistently report experiencing unusual phenomena (e.g. apparitions, sudden changes in temperature, a strong sense of presence) in certain locations. The two studies reported here explored the psychological mechanisms that underlie this apparent evidence of 'ghostly' activity. The experiments took place at two locations that have a considerable reputation for being haunted—Hampton Court Palace (Surrey, England) and the South Bridge Vaults (Edinburgh, Scotland). Both studies involved participants walking around these locations and reporting where they experienced unusual phenomena. Results revealed significantly more reports of unusual experiences in areas that had a reputation for being haunted. This effect was not related to participants' prior knowledge about the reputation of these areas. However, the location of participants' experiences correlated significantly with various environmental factors, including, for example, the variance of local magnetic fields and lighting levels. These findings strongly suggest that alleged hauntings may not necessarily represent evidence for 'ghostly' activity, but could be, at least in part, the result of people responding to 'normal' factors in their surroundings.

Recent polls reveal that approximately 38% of Americans believe that ghosts exist (Gallup, 2001), and 13% report having experienced one (MORI, 1998). Such experiences involve a diverse range of phenomena, including apparitions, unusual odours, sudden changes in temperature and a strong sense of presence (Lange, Houran, Harte, & Havens, 1996). In a relatively small number of cases, witnesses consistently report these experiences in certain locations, often giving rise to the belief that these places are 'haunted'. The best of these cases appear evidentially impressive, sometimes lasting several years and involving a large number of seemingly trustworthy witnesses reporting unusual phenomena in the same 'haunted' areas (for further information see Gauld & Cornell, 1979; Houran & Lange, 2001; Irwin, 1999; McCue, 2002). Many of these alleged

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hauntings have been described in several best-selling books on the paranormal, and reported on both television and radio (see e.g. Auerbach, 1986).

These high-profile claims have been the subject of very little well-controlled, systematic, research. This is unfortunate, in part, because media reportage of many of these cases exerts a major influence over the public's belief in the paranormal (National Science Board, 2000). In addition, such work clearly has the potential to contribute to our theoretical understanding of how certain psychological and psychophysiological phenomena (including e.g. hallucination, suggestion and response to subtle environmental stimuli) operate in unusual, but naturalistic, settings (see e.g. Houran & Lange, 1996: Houran & Williams, 1998; Lange & Houran, 1997). The work also could contribute to applied research into several important, and often controversial, areas, including e.g. contagious psychogenic illness, sick building syndrome and other forms of alleged 'environmental illness' (Lundberg, 1998). The present article addresses these issues by outlining the first investigations into two internationally known cases of alleged hauntings.

Experiment 1 took place at Hampton Court Palace. This royal palace was home to many British monarchs for over 500 years, and it is now a popular historical attraction. The palace is also frequently referred to as 'one of the most haunted places in England' (see e.g. Guiley, 1994; Law, 1918: Underwood, 1971), and allegedly contains the ghost of Catherine Howard, the fifth wife of Henry VIII. Fifteen months after her marriage to the King in 1540, Catherine Howard was found guilty of adultery and sentenced to death (Thurley, 1996). Legend suggests that upon hearing the news, Catherine Howard ran to the King to plead for her life, but was dragged back along a section of the Palace now known as 'the Haunted Gallery' (Guiley, 1994; Underwood, 1971). By the turn of the century, the Gallery had become associated with various unusual experiences, including sightings of a 'woman in white' and reports of inexplicable screams (Law, 1918). Since then, visitors to the Gallery have reported other 'ghostly' phenomena, including a strong sense of presence, a feeling of dizziness and sudden changes in temperature (Franklin, 1998). The Haunted Gallery is not the only part of Hampton Court Palace associated with such phenomena, with visitors and staff reporting similar experiences in other areas of the building, including an area known as the Georgian Rooms (Franklin, 1998). Information about the reputation of the Haunted Gallery is widely available to the public, but specific information about the location of experiences in areas such as the Georgian Rooms is not widely available.

Experiment 2 was carried out in part of the South Bridge Vaults in Edinburgh, Scotland. Edinburgh's South Bridge was constructed in the late eighteenth century to ease transportation problems in the city. The Bridge consisted of 19 huge stone arches supporting a wide road lined with several three storey buildings. A series of 'vaults' (i.e. small chambers, rooms and corridors) were built into the Bridge's arches to house workshops, storage areas and accommodation for the poor (Henderson, 1999). However, ineffective waterproofing and overcrowding meant that by the mid-nineteenth century the vaults had degenerated into a disease-ridden slum. The area was abandoned during the late nineteenth century, but rediscovered and opened for public tours in 1996. During some of these tours, both members of the public and guides have experienced many unusual phenomena, including, for example, a strong sense of presence, several apparitions and 'ghostly' footsteps (Wilson, Brogan, & Hollinrake, 1999). As a result, the vaults have acquired an international reputation for being one of the most haunted parts of Scotland's capital city. The public has relatively easy access to

general information about haunt experiences in the vaults, but specific information about the location of particular experiences is not widely available.

EXPERIMENT 1

The first part of Expt 1 examined whether participants would report a disproportionately large number of unusual experiences in apparently 'haunted' areas of the Haunted Gallery and the Georgian Rooms at Hampton Court Palace. Prior to the study, Ian Franklin (IF), a warder at the palace, catalogued many of the reports of unusual phenomena associated with the building. IF reviewed this material and identified areas where people had consistently reported unusual phenomena in both the Haunted Gallery and the Georgian Rooms. The areas identified were classified as 'haunted' whilst the remaining areas were classified as 'controls'. The investigators were blind to these classifications until all data collection had been completed.

Groups of participants walked around either the Haunted Gallery or the Georgian Rooms, and reported if they experienced any unusual phenomena. Participants reporting such phenomena marked the locations of their experiences on a floorplan. It was predicted that the percentage of experiences reported in the 'haunted' areas in both locations would be significantly above chance.

Some researchers have argued that the witnesses involved in alleged hauntings may have had prior knowledge about which parts of a building were 'haunted', and that this may be responsible for them reporting a disproportionately large number of unusual experiences in these areas. There are several ways in which this may happen. For example, witnesses' prior knowledge about a 'haunted' area may cause them to assign special significance to any unusual phenomenon experienced in that area, therefore increasing the likelihood of them telling others about their experience. Alternatively, such information may have increased witnesses' anxiety levels when entering these areas, and this, in turn, may have resulted in the witnesses experiencing mild psychosomatic and hallucinatory phenomena. A second part of Expt 1 evaluated whether any disproportionate reporting of unusual experiences in 'haunted' areas would be due to participants' prior knowledge about previous reports of 'ghostly' activity. Prior to visiting either the Haunted Gallery or the Georgian Rooms, participants rated the degree to which they knew where in these locations people had experienced 'ghostly' phenomena in the past. The 'prior knowledge' hypothesis predicted that participants indicating a high level of prior knowledge would report a greater percentage of experiences in the 'haunted' areas than those indicating a low level of prior knowledge. Of course, participants can only report on their prior *conscious* knowledge. It is theoretically possible that participants may be influenced by their unconscious knowledge of haunted locations (e.g. knowledge acquired earlier but now forgotten). However, due to the difficulty of assessing unconscious knowledge, and for ease of expression, we will use the phrase 'prior knowledge' throughout this article to refer to prior conscious knowledge.

Others have challenged the 'prior knowledge' hypothesis, noting that witnesses often claim to have been unaware of the reputation of a 'haunted' building prior to their experiences (see e.g. MacKenzie, 1982). This position has recently received empirical support from several studies conducted by Maher and her colleagues (for a review of these experiments, see Maher, 1999), using a quantitative technique pioneered by

Schmeidler (1966). In these experiments, mediums (individuals claiming to be sensitive to the presence of ghosts) were asked to walk through a 'haunted' building and mark floorplans to indicate where they felt a ghostly presence. These locations were then compared to the 'haunted' areas of the building (i.e. places in which witnesses had consistently reported ghostly phenomena). These experiments were not conducted in well-known 'haunted' buildings and none of the participants had any prior knowledge about the locations in which witnesses had reported 'ghostly' phenomena. Nevertheless, results from several studies demonstrate a significant relationship between the locations identified by the mediums and the 'haunted' areas. These findings suggest that many alleged hauntings may be the result of some people responding to some form of 'environmental cue' present in apparently 'haunted' areas (Lange *et al.*, 1996). Writers and researchers have suggested a huge range of factors to which people may be responding (for a review, see Houran, 1997). Some have suggested that these locations are actually haunted, and that people are responding to the presence of a discarnate spirit (e.g. Roberts, 1990). In contrast, others have suggested more mundane possibilities, including, for example, that these areas are simply rather cold and draughty (e.g. Nickell, 2001; Underwood, 1986). Others have speculated about the potential role played by rather more controversial physical factors, including, for example, low frequency sound waves (Tandy, 2000; Tandy & Lawrence, 1998), radioactivity (Radin & Roll, 1994) and local magnetic fields (Roll & Persinger, 2001).

A third part of Expt 1 thus examined the potential relationships among the 'haunted' areas, participants' reports of unusual experiences and magnetic fields. Measuring of the local magnetic field activity (i.e. all fluctuations between the range 0 to 3 kHz, whether of natural or artificial origins) was carried out because a relatively large amount of research has suggested a strong relationship between alleged hauntings and magnetic fields within this range. This work dates back to the mid 1980s, when Persinger (1985) speculated that changes in geomagnetic fields (created e.g. by tectonic stresses in the earth's crust) could stimulate the brain's temporal lobes and produce many of the subjective experiences associated with hauntings. Others have extended these ideas to account for physical manifestations including, for example, cold spots, electrical effects, popping sounds, etc. (see e.g. Houran & Lange, 1998). In a preliminary test of this theory, Gearhart and Persinger (1986) examined large case collections of alleged hauntings, and reported finding significant relationships between the time of onset of unusual phenomena and sudden increases in global geomagnetic activity (for a critique of this and related work, see Rutowski (1984) and Wilkinson & Gauld (1993)). More recent support has come from several on-site investigations of alleged hauntings that have reported unusual local magnetic activity (for an overview, see Roll & Persinger, 2001). Some of this work has noted that the effect seems to be associated with high levels of magnetic activity (Halgreen, Walter, Cherlow, & Cranall, 1978: Konig, Fraser, & Powell, 1981), whilst other researchers have related the effect more to variance in magnetic fields (see e.g. Persinger, 1985).

In Expt 1, the mean strength and variance of the magnetic field was measured in the Haunted Gallery and the Georgian Rooms. It was predicted that there would be significant differences between the mean field strength and variance in the 'haunted' and 'control' areas. It was also predicted that there would be a significant correlation between the number of unusual experiences reported by participants in each area, and the mean strength and variance of the magnetic field in those areas.

Method

Classifying 'haunted' and 'control' areas

IF had catalogued a large number of reports of unusual phenomena experienced by staff and visitors at Hampton Court Palace (Franklin, 1998). These reports dated from the end of the last century to the present day, and consisted of material from newspapers, magazines, books and IF's interviews with witnesses. Prior to the experiment, RW asked IF to identify where in the Haunted Gallery and the Georgian Rooms people had consistently reported unusual experiences. The palace supplied floorplans of both the Haunted Gallery and the Georgian Rooms. RW divided each of these floorplans into 24 equally sized areas and asked IF to mark the areas in which people had consistently reported unusual experiences. Areas marked by IF were classified as 'haunted' whilst unmarked areas were classified as 'controls'. IF marked seven areas in the Haunted Gallery and six areas in the Georgian Rooms. These floorplans were not seen by the investigators until all data collection had been completed. To avoid bias, RW, the assistant experimenters, who guided participants to the locations, and PS, who mapped the magnetic fields, were blind to the identity of these areas.

Questionnaires

In Questionnaire 1 participants rated the degree to which they knew where, in the Haunted Gallery or Georgian Rooms, people had experienced unusual phenomena in the past (definitely yes, probably yes, uncertain, probably no, definitely no).[1]

Questionnaire 2 asked participants to quietly walk around the Haunted Gallery or the Georgian Rooms, write a brief description of any unusual phenomena they experienced, indicate whether they believed that their experience(s) were due to a ghost (definitely yes, probably yes, uncertain, probably no, definitely no) and mark where they were standing when they had their experience(s) on a floorplan. The floorplan included in this questionnaire had not been divided into areas.

Procedure

Participants were self-selecting members of the public visiting Hampton Court Palace in late May/early June 2000. They had seen leaflets inviting their participation; thus they knew they were taking part in a scientific investigation. Participants took part in one of three daily sessions held over the course of 6 days. Each session involved a maximum of 40 people. Participants were first randomly split into two groups, according to where they had chosen to sit, with one half of the room forming Group 1 and the other half forming Group 2, in a counterbalanced order. All participants then completed Questionnaire 1, with Group 1 being asked about their prior knowledge concerning the Haunted Gallery, whilst Group 2 were asked about the Georgian Rooms. RW then gave a short talk about scientific research into ghosts. The talk was presented in an atmospheric setting, with lowered lighting. RW briefly described the historical tale of Catherine Howard, as outlined in the introduction, but without mentioning the location in which related haunting-type experiences had reportedly occurred. The talk also

[1] *Questionnaire 1 also contained other items including whether participants believed that ghosts exist, the frequency with which they had experienced 'ghostly' phenomena in the past, etc. The results of these items and related analyses are reported in Wiseman, Watt, Greening, Stevens, and O'Keeffe (2001). In summary, participants reporting prior belief in ghosts reported significantly more unusual phenomena during the experiment than disbelievers, and were significantly more likely to attribute the phenomena to ghosts.*

illustrated some of the apparatus that could be used in haunting investigations, such as heat-sensitive cameras and instruments sensitive to magnetic activity. Finally, RW outlined the purpose and methodology of the experiment.[2] Participants were then escorted by an assistant experimenter to either the Haunted Gallery (Group 1) or the Georgian Rooms (Group 2). Once at the location, the participants were free to walk around the location according to their individual preferences, and completed Questionnaire 2. Although participants were able to drop out of the experiment at any time without penalty, none did. Assistant experimenters were always on hand if needed by participants when they were in the test locations. Participants were also given RW's contact details in case they required further advice or information following the conclusion of the studies.

The first six sessions were pilot sessions, whose purpose was to check the practicability of the planned protocol, and to help identify areas for placement of measurement equipment. Data from the pilot sessions are not included in the analyses reported below.

Mapping the magnetic fields

Local magnetic fields were measured using two Mag-03MS100 3-axis sensors feeding into a laptop computer via a Mag-03DAM Data Acquisition Module (Bartington Instruments, Witney, Oxford). This system had a measuring range of 100 μT with a resolution of 0.1 nT, and recorded both static and dynamic components of the local field between 0 and 3 kHz. The system had a sampling rate of 1 Hz. Each sensor produced three streams of data, corresponding to the x, y and z axes of the local magnetic field, with a sampling rate of once per second. The three data streams were then combined to give the total field strength (using the formula sqrt [x(squared) + y(squared) + z(squared)]), and the mean field strength and variance was calculated from the resulting values.

Because the experimenters remained blind to IF's classification of 'haunted' and 'control' areas, it was necessary to find another way of selecting areas for placement of the instruments. Due to security and safety considerations, it was only possible to place the magnetic sensing equipment in 12 areas (six areas in the Georgian Rooms and six in the Haunted Gallery). These areas were agreed upon by RW and Hampton Court Palace administration on the basis of three criteria. First, to maximize the chances of detecting any anomalies in the magnetic fields, many of the areas chosen were those associated with a large number of reports of unusual experiences, derived from the pilot sessions; others were associated with a low number of reported unusual experiences. Secondly, to help minimize visitor disruption, the areas were not located in especially busy or narrow parts of the Haunted Gallery or the Georgian Rooms. Thirdly, to minimize the amount of time the equipment was in place, the areas were chosen such that they could be mapped in adjacent pairs.[3] All measurements were made by PS, who was blind to the

[2] *As an additional investigation of the effects of suggestion on reported ghostly experiences, during his introductory talk to participants RW made suggestions that one of the two locations was 'active' while the other was 'inactive' (in terms of recent frequency of reported ghostly experiences, but giving no specific suggestions as to where in each location experiences had been reported). To avoid systematic bias, these suggestions were made in a counterbalanced fashion. For sake of brevity, and because suggestion appeared to have little effect on reported experiences, this manipulation will receive no further attention in this article. More detail of the method and results of this manipulation can be found in the article by Wiseman* et al. *(2002).*

[3] *Once IF's classification of 'haunted' and 'control' areas was revealed at the end of the study, it transpired that the 12 areas chosen by RW consisted of six haunted and six control areas as identified by IF. The analyses for magnetic fields therefore refer to this 'sub-group' of six haunted and six control areas and not to the entire group of 13 haunted and 35 control areas.*

number of unusual experiences reported in each of the areas whilst setting-up and operating the magnetic field sensors. Magnetic data was recorded for thirty minutes in each area. Recording took place while tourists were visiting the area, but not during any experimental sessions. Hence the magnetic measurement procedure would not bias participants' reports.

Participants

There were 678 participants who each attended 1 of the 18 sessions. Some of the participants (131) were excluded as they did not complete all of the items on Questionnaire 1 and a further 85 were excluded for not completing all of the items on Questionnaire 2. The number of participants remaining was 462 (163 males, 299 females; mean age: 35.0, age range: 7 to 82, *SD*= 16.3). As the 18 groups of participants were assigned to one of the two locations, there was a total of 36 groups of participants.

Results

Participants reported a total of 431 unusual experiences: 189 (43.8%) of these experiences were reported in the Haunted Gallery and 242 (56.2%) in the Georgian Rooms; 215 (46.5%) participants reported at least one experience, and the mean number of experiences for participants reporting one or more experiences was 2.0 (*SD*= 1.45). Approximately two thirds of these experiences involved an unusual change in temperature. The remaining one third involved a mixture of phenomena including, for example, a feeling of dizziness, headaches, sickness, shortness of breath, some form of 'force', a foul odour, a sense of presence and intense emotional feelings. When asked whether their experiences were due to a ghost, 8 (3.72%) participants indicated 'Definitely yes', 22 (10.23%) 'Probably yes', 80 (37.21%) 'Uncertain', 87 (40.46%) 'Probably no' and 18 (8.37%) 'Definitely no'. It is difficult to assess the extent to which these experiences may have been elicited or dampened by the context of the pre-experiment talk. However, it is worth noting that both locations were well lit and relatively noisy and busy with tourists and were therefore less atmospheric than the context in which the talk was given. Given these circumstances, it was perhaps surprising that so many participants reported having experiences.

Participant grouping

Each of the 36 groups completed Questionnaire 2 whilst walking around either the Haunted Gallery or the Georgian Rooms. Individual responses to the questionnaire cannot therefore be considered statistically independent as they may have influenced, and been influenced by, other members of the group. For example, friends and family members were likely to have sat beside one another and therefore to have been assigned to the same group, so they may have interacted more with one another than strangers might. As a result, participants' responses to the questionnaire were combined within each of the 36 groups so the group is the unit of analysis (see Rosenthal & Rosnow, 1991).

Percentage of experiences reported in 'haunted' areas

The floorplans that had been divided into 24 areas were photocopied onto acetate and used to classify the location of each of the experiences reported by participants. This

classification was carried out by EG and CO, whilst blind to both the location of the 'haunted' and 'control' areas and the results of the magnetic field measurements. Given that there were seven 'haunted' areas in the Haunted Gallery and six in the Georgian Rooms, single mean *t* tests were used to compare the actual percentage of experiences reported in these areas with the chance baselines of 29.16% and 25% respectively. Both analyses found the percentage of experiences to be significantly greater than chance (see Table 1).

Table 1. The *df*, population means, *t* values (single group) and *p* values (two-tailed) comparing the percentage of experiences reported in the 'haunted' areas of the Haunted Gallery and the Georgian Rooms against chance

	% in haunted areas	Degree of freedom	Population mean	*t* test (single group)	*p* (two-tailed)
Haunted Gallery	38.83	16	29.16	2.954	.009
Georgian Rooms	46.24	17	25	3.494	.003

Prior knowledge

Each group's 'prior knowledge score' consisted of the mean of participants' responses to the question concerning the extent to which they knew where other people had reported unusual experiences in either the Haunted Gallery or the Georgian Rooms (coded on a 5-point scale from 1 (definitely yes) to 5 (definitely no)). Each group was then classified as having either 'High' or 'Low' levels of prior knowledge on the basis of a median split. This resulted in 18 groups being classified as 'High' (mean score = 3.89, *SD* = .33) and 18 groups as 'Low' (mean score = 4.51, *SD* = .18). There was a nonsignificant difference between the percentage of experiences reported in the 'haunted' areas by the 'High' and 'Low' levels of prior knowledge groups in either the Haunted Gallery ($t(15) = 1.66$, unpaired, $p = .12$, two-tailed) or the Georgian Rooms ($t(16) = -.14$, unpaired $p = .89$, two-tailed).

Magnetic fields

There was a nonsignificant difference in the mean magnetic field strength between the 'haunted' and 'control' areas (unpaired $t(10) = 1.55$, $p = .15$, two-tailed). However, there was a significant difference in the variance of the field between the two types of areas (unpaired $t(10) = 2.34$, $p = .04$, two-tailed), with the 'haunted' areas ($M = 12.71$, $SD = 12.10$) displaying a higher variance than 'control' areas ($M = 2.16$, $SD = 1.03$).

Spearman rank correlation coefficients were calculated between the number of experiences reported by each group within each of the 12 areas for which magnetic data was obtained, and mean strength and variance of the magnetic field in those areas.[4] One sample *t* tests were then used to examine whether the sample mean of these correlations differed significantly from zero. These analyses revealed a nonsignificant

[4] *There were three groups for which no experiences were reported in the 12 areas. As it was not possible to calculate a correlation in these cases, these three groups were not included in the analyses.*

relationship between the number of experiences reported and the mean field strength (1 sample $t(32) = .82$, $p = .42$, two-tailed). A significant relationship was found between the variance of the field and number of unusual experiences reported (1 sample $t(32) = 2.15$, $p = .04$, two-tailed).

Discussion

The experiment first examined whether participants would report a disproportionately large number of unusual experiences in the 'haunted' areas. These 'haunted' areas had been classified on the basis of prior reports. By chance, it was expected that approximately 29% of participants' unusual experiences would be reported in the 'haunted' areas of the Haunted Gallery, and 25% in the Georgian Rooms. However, groups of participants visiting both rooms reported significantly more unusual experiences in the 'haunted' areas within both locations. These findings strongly support the notion that people's unusual experiences are not evenly distributed across the locations, but instead concentrate in 'haunted' areas. In addition, the findings suggest that the areas in which people report their experiences are consistent across time. In short, these empirical findings validate several characteristics of spontaneous haunt experiences suggested by anecdotal reports.

Prior to entering either the Haunted Gallery or the Georgian Rooms, participants were asked to rate the degree to which they knew where people had reported unusual experiences in these locations in the past. The results showed that participants' level of prior knowledge was not significantly related to the percentage of experiences reported in the 'haunted' areas. These findings do not support the notion that the disproportionately large number of unusual experiences reported in 'haunted' areas is due to participants' prior conscious knowledge about the location.

Thirdly, the experiment examined the possibility that there were significant differences between the strength and variance of the magnetic fields between the 'haunted', and 'control', areas. Results suggested no significant differences in the mean strength of the magnetic field between the two types of areas. However, the variance of the local magnetic field was significantly greater in 'haunted' than 'control' areas, and there was a significant relationship between the magnetic variance and the mean number of unusual experiences reported by groups of participants. These results seem consistent with previous research suggesting a relationship between local magnetic field activity and haunt reports.

Experiment 2 (see below) built upon both the methodology and results of Expt 1. First, in Expt 1, areas within the Haunted Gallery and the Georgian Rooms were classified as either 'haunted' or 'control'. Experiment 2 provided a more fine-grained classification of areas by using a venue in which it was possible to rank order each of the areas from 'most' to 'least' 'haunted'. Secondly, in Expt 1, the nature of the venue resulted in participants having to walk around each of the locations in groups, and thus their data had to be analysed and interpreted at a group level. Unfortunately, this resulted in the study having low statistical power, and it is possible that the locations, having tourists as well as up to 20 participants walking around, were relatively noisy and therefore not conducive to haunt experiences. These issues were overcome in Experiment 2 by using a venue in which participants could visit areas on their own, and thus produce data that could be analysed and interpreted independently. Finally, Expt 2 measured a far greater number of environmental variables.

EXPERIMENT 2

The experiment took place in 10 of the South Bridge Vaults in Edinburgh. For the past few years, the company conducting guided tours through the underground vaults has maintained a collection of any unusual experiences reported by both guides and visitors. Prior to the experiment, RW asked Fran Hollinrake (FH), a senior tour guide, to review this database and rank order the vaults between 1 ('least haunted', i.e. smallest number of unusual experiences) and 10 ('most haunted', i.e. largest number of unusual experiences). This was referred to as the 'Haunted Order' of the vaults.

During the experiment, participants were asked to spend approximately 10 min in one of the vaults on their own, write down any unusual phenomena they experienced and rate the degree to which they believed that these experiences were due to a ghost. On the basis of the results obtained in Expt 1, it was predicted that there would be a significant correlation between the 'Haunted Order' and mean number of experiences reported in each vault. That is, it was predicted that the location of past haunt reports would be predictive of the location of haunt reports in the current study.

The experiment also investigated the potential relationship between participants' prior knowledge about the vaults and their reports of unusual phenomena. Prior to visiting the vaults, participants noted whether they knew where people had reported unusual experiences in the vaults in the past. Based on the results of Expt 1, it was predicted that the correlations between the 'Haunted Order', and the mean number of experiences reported in each vault, would be significant among participants who indicated no prior knowledge of the vaults.

The experiment also examined a wider range of environmental variables than Expt 1, including, the mean strength and variance of the local magnetic field, air temperature, air movement, the vaults' interior lighting levels, the lighting level directly outside the entrances to the vaults, the floorspaces of the vaults and their height. It was predicted that there would be significant correlations between these variables and both the 'Haunted Order', and the mean number of reported experiences in each vault.

Method

Questionnaires

Questionnaire 1 asked participants whether they had heard (e.g. from friends, the media, publications about the vaults) where in the vaults people have reported experiencing unusual phenomena (possible responses: yes, uncertain, no).[5]

Questionnaire 2 instructed participants to spend a few minutes in a vault and then report any phenomena that they experienced. They were asked to report all of their unusual experiences, no matter how faint, and to include all types of experiences (including e.g. unusual changes in temperature, smells, tastes, a sense of presence, etc.). The questionnaire contained four boxes, and participants were asked to briefly describe each of their experiences in one of the boxes. They were also asked to rate whether they thought that each of their experiences was due to a ghost (definitely yes, probably yes,

[5] *Other items on the questionnaire asked participants whether they believed in the existence of ghosts, whether they believed that they had previously experienced a ghost, etc. The findings will be reported in a separate article.*

uncertain, probably no, definitely no). If participants did not experience anything unusual then they were instructed to simply return the blank questionnaire.

Procedure

The experiment was carried out in April 2001. Participants were self-selecting members of the public who had seen the experiment listed in the programme of the Edinburgh International Science Festival. Participants took part in one of six daily sessions held over the course of 4 days. Each session involved a maximum of 10 people. The first part took place in a private function room close to the vaults. At the start of the experiment, RW handed out numbered clipboards randomly, which assigned a participant number to each person. RW briefly outlined the purpose and procedure of the study, and demonstrated the kinds of apparatus that could be used in scientific research into ghosts. RW then asked participants to complete Questionnaire 1. Participants were then taken as a group down to the vaults by FH, and then taken individually to a vault according to their randomly assigned participant number (i.e. participant number 1 went to vault 1). Note that RW was blind to the haunted order so he could not introduce bias by, say, assigning apparently suggestible participants to particular vaults. FH was not blind to the haunted order, but due to uneven flooring and low ceilings in parts of the vaults her presence was needed for safety insurance reasons, and she had very limited interactions with participants. Participants spent approximately 10 min in the vault and completed Questionnaire 2. During this time FH retired to a separate area of the vaults so she did not inadvertently influence participants' reports. Two assistant experimenters, who were blind to the haunted order, monitored participants while they completed their questionnaire and were available in case anyone had a query or a problem. Participants then returned their questionnaires to the assistant experimenters. Participants were able to drop out of the experiment at any time without penalty. Two did so. Participants were also given RW's contact details in case they required further advice or information following the conclusion of the studies.

Apparatus

Magnetic fields, air temperature and air movement

Local magnetic fields were measured using the same equipment as employed in Expt 1, but with an increased sampling rate of 4 Hz. Air temperature and air movement were measured with a Testo 445 multi-purpose datalogger connected to a Testo Hot Bulb probe (temperature range: – 20 to + 70C, movement: 0 to 10 m/s: accuracy, sampling at a rate of 0.5 Hz). Both the magnetic sensors and air temperature/movement probe were placed into one vault prior to each group's arrival. The participant in the vault was asked to remain a few feet from the equipment to prevent potential artifacts. The equipment logged data for 10 min. All measurements were made by PS, who was blind to the number of unusual experiences reported in each of the areas whilst setting up and operating the equipment. The magnetic sensor was sited at head height on a level part of the floor, at least 1 m away from the participant and on the opposite side of the room to any lighting circuits. When the participant arrived, PS started the recording and then left the vault.

Light readings and physical dimensions

The light levels within, and directly outside, each vault were measured using a Vital Technologies Corporation Tricorder. At the end of the experiment, RW recorded the light levels and physical dimensions of each vault. Light levels were recorded from the centre of each vault, and involved pointing the light meter towards each of the walls of the vault and taking an average of the readings obtained. The light level directly outside the vault was obtained by placing the light meter in the centre of the vault and pointing it towards the doorway of the vault.

Participants

The participants (N = 218) each attended one of the 24 sessions in groups of up to 10 (91 males, 127 females); mean age: 35.3 (SD= 13.20, age range: 11 to 77).

Results

Participants reported a total of 172 unusual experiences: 95 (43.58%) participants reported at least one experience, and the mean number of experiences for participants reporting one or more experiences was 1.81 (SD= .94). Again, the majority of these experiences involved an unusual change in temperature, but also included descriptions of apparitions, a strong sense of being watched, burning sensations, strange sounds, odd odours, etc. When asked to rate whether experiences were due to a ghost, 1 (.67%) experience was rated 'Definitely yes', 4 (2.67%) 'Probably yes', 58 (38.67%) 'Uncertain', 65 (43.33%) 'Probably no' and 22 (14.67%) 'Definitely no'.

Hypotheses

The correlation between the 'Haunted Order' and the mean number of unusual experiences reported in each vault, was significant (N= 10, rho = .76, p = .02, two-tailed).

Prior knowledge

Participants indicating 'yes' or 'uncertain' to the question regarding prior knowledge about where in the vaults people had experienced unusual phenomena in the past were then excluded from the data (N= 31). The correlation between the 'Haunted Order' and the mean number of unusual experiences reported by the remaining participants was highly significant (N= 10, rho = .87, p = .009, two-tailed).

Environmental variables

Table 2 contains the correlations between each of the environmental variables, and both the 'Haunted Order' and the mean number of experiences reported by participants. Overall, the magnetic field readings varied from 47,018–51,588 nT, SD from 4–32 nT. All of these measurements are within the natural fluctuation ranges and are not inherently anomalous. This is to be expected given that the vaults had no mains wiring other than a single, minimal lighting circuit.

Table 2. Spearman rank correlation coefficients (corrected for ties), and two-tailed *p* values (in parentheses), between each of the environmental variables, and both the 'Haunted Order' and mean number of unusual experiences reported by participants with no prior knowledge of the vaults. Statistically significant values are highlighted in bold

	Correlation with 'Haunted Order' ($N = 10$)	Correlation with mean number of unusual experiences ($N = 10$)
Magnetic mean	– .2	– .33
	(.55)	(.32)
Magnetic variance	.53	.39
	(.11)	(.24)
Air temperature	– .22	– .10
	(.50)	(.76)
Air velocity	.16	.43
	(.63)	(.19)
Interior light levels	– .50	– .26
	(.13)	(.43)
Exterior light levels	**.74**	**.84**
	(.03)	**(.01)**
Floorspace	**.73**	.58
	(.03)	(.08)
Height	**.65**	**.64**
	(.05)	**(.05)**

GENERAL DISCUSSION

The results of Expts 1 and 2 are highly consistent, with around 45% of participants in each experiment reporting at least one unusual experience. Some of these experiences were powerful for participants and were interpreted as being due to a ghost. Regardless of their interpretation by participants, all of these experiences are important and relevant to the question of the phenomenology of haunt experiences, as they give an indication of the incidence and nature of unusual experiences under controlled conditions in a potentially haunted location. In addition, it has been argued that the interpretation of such unusual experiences may be mediated by contextual variables (Lange *et al.*, 1996), such that the same experience may in one context be interpreted as ghostly, and in another context be interpreted as having a non-paranormal origin. Experiment 1 took place in a relatively well lit and busy location in which participants mingled as a group. In contrast, the setting for Experiment 2 was quiet, dank and dimly lit, and participants were alone while they rated their vault. While some aspects of the Hampton Court Palace setting may not have been conducive to ghostly experiences compared to the South Bridge Vaults, perhaps surprisingly a similar proportion of experiences was reported in each location. However, haunt experiences can and do occur in group settings and some authors have even suggested that group contagion effects may increase reports of haunt experiences (Lange & Houran, 1998, 1999). It is therefore possible that group contagion effects may have counteracted to some extent the less conducive aspects of the location in the Hampton Court Palace study.

The unusual experiences reported by participants in our two studies are comparable to many of the experiences that have been reported in the past in the two locations.

These past reports have contributed to the 'haunted' reputation of Hampton Court Palace and the South Bridge Vaults. Therefore, our findings can facilitate an understanding of these alleged hauntings. Our studies are perhaps less pertinent to highly documented cases in which a series of witnesses have reported seeing the same apparition over a long period of time (e.g. Gauld & Cornell, 1979; MacKenzie, 1982). However it has been noted (e.g. Beloff, 2001) that such cases are relatively rare. Also, the setting of our studies, in locations with haunted reputations, might not be directly comparable to those cases where unexpected experiences occur, for example when the experient had no prior conscious knowledge that the site might be haunted.

In Expt 1, participants reported a disproportionately large number of unusual experiences in 'haunted' areas. In Expt 2, there was a significant correlation between the 'Haunted Order' and the mean number of experiences reported in each vault. Together, these findings provide strong support for the notion that witnesses' reports of unusual experiences are not evenly distributed throughout the locations, but are instead concentrated in certain areas. In addition, they suggest that the locations in which their experiences are reported are highly consistent over time, as these are the areas in which most experiences have been reported in the past.

Both experiments also assessed the notion that this clustering of reports could have been due to participants having prior knowledge about where people have reported unusual experiences in the past. This idea has been proposed to account for many cases of alleged hauntings. However, the results from both experiments provided no support for this hypothesis. In Expt 1 there were no significant differences between the proportion of unusual experiences reported in the 'haunted' areas by groups of participants with 'high' and 'low' levels of prior knowledge. In the second experiment the correlation, between the 'Haunted Order' and the mean number of experiences reported in each vault, was significant among participants with no prior knowledge. Although we cannot rule out the possible effects of priming, expectation, and belief in the paranormal to account for people's reported experiences, these results strongly suggest that conscious 'prior knowledge' does not account for the clustering of experiences in certain locations within the two test sites. The finding that locations where experiences are reported is consistent over time, irrespective of prior knowledge, conceptually replicates previous fieldwork (e.g. Maher & Schmeidler, 1975; Schmeidler, 1966).

Thirdly, both experiments also examined whether the alleged haunting may be due, at least in part, to participants responding to environmental cues. In Expt 1, the variance of the local magnetic field in the 'haunted' areas was significantly greater than of the 'control' areas. In addition, the number of unusual experiences reported by participants was correlated with magnetic variance. This was not replicated in Expt 2, which found a nonsignificant positive correlation between magnetic variance and the haunted order. These results provide some support for the controversial theory that the presence of certain types of local magnetic fields may impact upon a range of psychological, psychophysiological and health-related variables (Korinevskaya, Kholodov, & Korinevskii, 1993; Voustianiouk & Kaufmann, 2000). A controlled laboratory study by Stevens (2001), for instance, showed psychological and physiological reactions to a changing magnetic field of comparable magnitude to those measured in our two experimental venues. Even subtle psychological and physiological changes occurring in a context that might suggest paranormal events (e.g. occurring to a person who believes in ghosts, occurring in a location with a haunted reputation) may lead to that person making a 'paranormal' attribution to what they might otherwise interpret as an

ambiguous stimulus. And it has been shown that experimentally applied weak magnetic fields can lead to more powerful and compelling experiences, such as a sensed presence, that are directly comparable to the kinds of experiences that are spontaneously reported (e.g. Persinger, 2001). Such findings suggest that magnetic fields, along with a range of other variables, together may account for some haunting experiences.

Results from Expt 2 also suggested that visual features of the environment may play a key role in causing people to report unusual experiences. The position of vaults in the 'Haunted Order' was positively correlated with the light level directly outside the vault, floorspace and height. In addition, the mean number of unusual experiences reported in the vaults was positively correlated with exterior light levels and height. These findings could be interpreted in several ways. For example, it is possible that these visual features might match the stereotype of a typically 'haunted' place held by participants, and thus induce mild psychosomatic and hallucinatory experiences. Alternatively, these features might directly cause unusual physical and psychological experiences. For example, participants walking from a relatively well-lit corridor into a much darker vault may cause them to experience the types of unusual phenomena associated with mild sensory deprivation (see e.g. Munro & Persinger, 1992; Tiller & Persinger, 1994). Likewise, especially large or high vaults may have caused participants to feel especially vulnerable and uneasy. Finally, these variables may covary with another factor (e.g. the production of unusual shadows) which are responsible for the reporting of unusual experiences. Future work should attempt to tease apart these competing interpretations of the phenomena by recording the number of unusual experiences reported by participants whilst systematically manipulating these factors (e.g. lighting levels and the variance of the local magnetic field). Multivariate modelling could be employed in future to understand the relative importance for haunt experiences of the variety of environmental and psychological factors that have been highlighted by investigations such as ours. As argued by Houran and Lange (1996), no single physical mechanism is likely to account for all cases of haunts.

In short, both of these experiments have yielded considerable insight into these two alleged 'hauntings'. Both experiments have demonstrated that the reputation of these locations is not based upon questionable eyewitness testimony, nor can the distribution of the experiences within the sites be explained by witnesses' prior knowledge. Instead, the data strongly support the notion that people consistently report unusual experiences in 'haunted' areas because of environmental factors, which may differ across locations. Further, our experiments have started to identify some of these factors, including the variance of local magnetic fields, size of location and lighting levels — stimuli of which witnesses may not be consciously aware. Taken together, these findings strongly suggest that these alleged hauntings do not represent evidence for 'ghostly' activity, but are instead the result of people responding — perhaps unwittingly — to 'normal' factors in their surroundings.

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References

Auerbach, L. (1986). *ESP, hauntings and poltergeists.* New York: Warner Books.

Beloff, J. (2001). Foreword. In J. Houran & R. Lange (Eds), *Hauntings and poltergeists: Multidisciplinary perspectives.* Jefferson, NC: McFarland.

Franklin, I. (1998). *Hampton Court ghosts.* Unpublished manuscript.

Gallup (2001). *Americans' belief in psychic and paranormal phenomena is up over last decade* (http://www.gallup.com/poll/releases/pr010608.asp).

Gauld, A., & Cornell, A. D. (1979). *Poltergeists.* Boston, MA: Routledge & Kegan Paul.

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

Guiley, R. E. (1994). *The Guinness encyclopedia of ghosts and spirits.* London: Guinness Publishing.

Halgreen, E., Walter, R. D., Cherlow, D. D., & Cranall, P. H. (1978). Mental phenomena evoked by electrical stimulation of the human hippocampal formation and amygdala. *Brain*, *101*, 83–117.

Henderson, J. (1999). *The town below the ground.* London: Mainstream.

Houran, J. (1997). Ambiguous origins and indications of 'poltergeists'. *Perceptual and Motor Skills*, *84*, 339–344.

Houran, J., & Lange, R. (1996). Hauntings and poltergeist-like episodes as a confluence of conventional phenomena: A general hypothesis. *Perceptual and Motor Skills*, *83*, 1307–1316.

Houran, J., & Lange, R. (1998). Rationale and application of a multi-energy sensor array in the investigation of haunting and poltergeist cases. *Journal of the Society for Psychical Research, 62*, 324–336.

Houran, J., & Lange, R. (Eds.) (2001). *Hauntings and poltergeists: Multidisciplinary perspectives.* Jefferson, NC: McFarland.

Houran, J., & Williams, C. (1998). Relation of tolerance of ambiguity to global and specific paranormal experience. *Psychological Reports*, *83*, 807–818.

Irwin, H. J. (1999). *An introduction to parapsychology* (3rd ed.). Jefferson, NC: McFarland.

Konig, H., Fraser, J. T., & Powell, R. (1981). *Biological effects of environmental electromagnetism.* Berlin: Springer-Verlag.

Korinevskaya, I. V., Kholodov, Y. A., & Korinevskii, A. V. (1993). Effect of bilateral peripheral application of an alternating magnetic field on the EEG in humans. *Human Physiology*, *19*, 213–217.

Lange, R., & Houran, J. (1997). Context-induced paranormal experiences: Support for Houran and Lange's model of haunting phenomena. *Perceptual and Motor Skills*, *84*, 1455–1458.

Lange, R., & Houran, J. (1998). Delusions of the paranormal: A haunting question of perception. *Journal of Nervous and Mental Disease, 186*, 637–645.

Lange, R., & Houran, J. (1999). The role of fear in delusions of the paranormal. *Journal of Nervous and Mental Disease, 187*, 159–166.

Lange, R., Houran, J., Harte, T. M., & Havens, R. A. (1996). Contextual mediation of perceptions in hauntings and poltergeist-like experiences. *Perceptual and Motor Skills*, *82*, 755–762.

Law, E. (1918). *The Haunted Gallery of Hampton Court.* London: Rees.

Lundberg, A. (1998). *The environment and mental health: A guide for clinicians.* Mahwah, NJ: Erlbaum.

MacKenzie, A. (1982). *Hauntings and apparitions.* London: Paladin Grafton.

Maher, M. C. (1999). Riding the waves in search of the particles: A modern study of ghosts and apparitions. *Journal of Parapsychology*, *63*, 47–80.

Maher, M. C., & Schmeidler, G. R. (1975). Quantitative investigation of a recurrent apparition. *Journal of the American Society for Psychical Research, 69*, 341–351.

McCue, P. A. (2002). Theories of haunting: A critical overview. *Journal of the Society for Psychical Research, 66*, 1–21.

MORI (1998). Poll on the Paranormal. Commissioned by the *Sun* newspaper, February, 1998.

Munro, C., & Persinger, M. A. (1992). Relative right temporal–lobe theta activity correlates with Vingiano's hemispheric quotient and the 'sensed presence'. *Perceptual and Motor Skills*, *75*, 899–903.

National Science Board (2000). *Science and engineering indicators.* Arlington, VA: National Science Federation.

Nickell, J. (2001). Phantoms, frauds, or fantasies? In J. Houran & R. Lange (Eds), *Hauntings and poltergeists: Multidisciplinary perspectives* (pp. 214–223). Jefferson, NC: McFarland.

Persinger, M. A. (1985). Geophysical variables and behaviour: XXII. The Tectonogenic Strain Continuum of Unusual Events. *Perceptual and Motor Skills*, *60*, 59–65.

Persinger, M. A. (2001). The neuropsychiatry of paranormal experiences. *Journal of Neuropsychiatry and Clinical Neuroscience, 13*, 515–524.

Radin, D., & Roll, W. G. (1994). A radioactive ghost in a music hall. *Proceedings of the 37th Annual Conference of the Parapsychological Association*, 337–346.

Roberts, J. A. (1990). *Holy ghostbuster.* Dorset: Element.

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

Rosenthal, R., & Rosnow, R. L. (1991). *Essentials of behavioral research: Methods and data analysis* (2nd ed.). New York: McGraw-Hill.

Rutkowski, C. A. (1984). Geophysical variables and human behaviour: XVI. Some criticisms. *Perceptual and Motor Skills*, *58*, 840–842.

Schmeidler, G. R. (1966). Quantitative investigation of a 'haunted house'. *Journal of the American Society for Psychical Research, 60*, 137–149.

Stevens, P. (2001). Effects of 5s exposures to a 50 μT, 20 Hz magnetic field on skin conductance and ratings of affect and arousal. *Bioelectromagnetics, 22*, 219–223.

Tandy, V. (2000) Something in the cellar. *Journal of the Society for Psychical Research*, *64*, 129–140.

Tandy, V., & Lawrence, T. R. (1998). The ghost in the machine. *Journal of the Society for Psychical Research*, *62*, 360–364.

Thurley, S. (1996). *Hampton Court Palace.* London: Historic Royal Palaces Agency.

Tiller, S. G., & Persinger, M. A. (1994). Elevated incidence of a sensed presence and sexual arousal during partial sensory deprivation and sensitivity to hypnosis: Implications for hemisphericity and gender differences. *Perceptual and Motor Skills*, *79*, 1527–1531.

Underwood, P. (1971). *The A–Z of British ghosts*. London: Chancellor Press.

Underwood, P. (1986). *The ghost hunter's guide.* Dorset: Blandford Press.

Voustianiouk, A., & Kaufmann, H. (2000). Magnetic fields and the central nervous system. *Clinical Neurophysiology, 111*, 1934–1935.

Wilson, A. J., Brogan, D., & Hollinrake, F. (1999). *Hidden and haunted: Underground Edinburgh.* Edinburgh: Mercat Tours.

Wilkinson, H. P., & Gauld, A. (1993). Geomagnetism and anomalous experiences, 1868–1980. *Proceedings of the Society for Psychical Research*, *57*, 275–310.

Wiseman, R., Watt, C., Greening, E., Stevens, P., & O'Keeffe, C. (2002). An investigation into the alleged haunting of Hampton Court Palace. Psychological variables and magnetic fields. *Journal of Parapsychology, 66*, 387–408.

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