The Acoustic Properties of Unexplained Rapping Sounds

BARRIE G. COLVIN

Abstract

The wave characteristics of unexplained rapping sounds have been studied and compared with similar-sounding raps produced using normal tapping methods. Differences in low frequency wave properties between the two classes of raps have been noted. There are indications that the acoustic properties of the two classes of sounds are different and that this technique can be used to differentiate between normal and inexplicable rapping sounds witnessed during RSPK activity. A tentative theory of localised stress development followed by a sudden release of tension has been put forward to account for the rapping sounds.

Introduction

Rapping sounds emanating from an unknown source have been widely described in the literature, particularly with respect to investigations of apparent recurrent spontaneous psychokinesis (RSPK) and Spiritualist-type sitter groups (Roll, 1976 and Pearsall, 1972). The phenomenon has been described in cases covering many hundreds of years and vary from slight rapping sounds, scratchings, a "sawing" sound to thunderous banging sounds. RSPK studies, often referred to as poltergeist activity, indicate that as many as 50% of all cases include the production of rapping sounds, often accompanied by other phenomena such as object movements, luminous effects, cold breezes and disturbed bedclothes (Gauld & Cornell, 1979). The quality and frequency of rapping sounds vary enormously from isolated single raps to series of raps occurring on a very regular basis. In a small minority of cases a rapping intelligence has been capable of communicating via a code and answer simple questions put to it by those present. Probably the most well-known case of this type is that of the Fox sisters, dating from 1848. This case had a profound effect upon the wider public and led to the rise in modern Spiritualism (Gauld, 1968). Other similar cases are those of Cideville (Lang, 1904) and Karin (Wijk, 1905). In more recent times, the Andover case of 1974 consisted of messages being clearly rapped out on a wall and on a bed-head, all in the presence of investigators (Colvin, 2008). The rapping sounds in this case varied from light knocks to very heavy bangs, sufficient to cause the walls of the house to vibrate. Of particular importance, the position of the raps could be determined and the localized vibrations felt by the principal investigators. Furthermore, the quality of the messages was good in that there was no ambiguity with regard to specific letters being rapped out using a coded format.

A literature study of so-called rapping poltergeists, together with first-hand and very strong evidence of localised, inexplicable rapping in the Andover case, appears to confirm the notion that sounds of this type seem consistent with the hypothesis that some rapping-like sounds are not caused by obvious, conventional sources. This report looks at the nature of the rapping sounds from an acoustics point of view and is described in two parts, an evaluation of recorded raps from Andover and a more general evaluation, involving a variety of other cases.

On the basis that unexplained raps do exist, and that there may be some differences between their acoustic properties and those of normal rapping sounds, it is worth exploring the history of unexplained rapping effects in some detail. This can then be set as a background against which the results from the current study can be compared.

During his investigation of Kate Fox-Jencken, William Crookes obtained an unusual trace on a smoked glass plate when Kate's hands were placed close to the recording apparatus. Each movement of the recording needle was accompanied by an unusual rapping sound, which Crookes could not explain by normal means (Crookes, 1874). The first audio recordings of unexplained rapping sounds date from 1915 when mechanical engineer, W.J.Crawford, used a phonograph to record rapping sounds at a séance in Northern Ireland (Crawford, 1916). Crawford was interested in establishing whether inexplicable rapping sounds which had been heard by himself and others were in fact truly objective in nature. He concluded that this was indeed the case after having produced three good recordings of such sounds using rather primitive but effective apparatus. Naturally, these recordings proved the objectivity of the sounds but gave no detailed information about their acoustic properties or how the sounds were generated. Some possibly significant information did come to light about forty years later when psychologist Alan Gauld of Nottingham University was informed of the views of Leon Eeman, a specialist in bio-circuits and vibrational healing. Eeman, the author of "Cooperative Healing: The Curative Properties of Human Radiations", apparently discovered that the sound envelope of inexplicable raps rose over time rather than immediately reaching a maximum intensity and then decreasing. Gauld and Cornell also witnessed inexplicable rapping sounds first hand during sittings with L.G. in 1959 (Gauld, 1994). Cornell made recordings of the raps, which were later analysed by Wilkinson and Gauld at Nottingham University (Gauld, 2009). They noted that a sound spectrum analysis of the raps revealed a curious feature in the lower frequency ranges. The amplitude of the sound waves of each rap, instead of beginning at a peak and then dying away, so to speak "worked up" to a peak over a brief period of time. In essence, this confirmed the views of Eeman, discussed above, and forms the basis of the current work aimed at determining whether such views can be verified using more modern techniques applied to a variety of rapping sounds from various poltergeist cases.

An important series of table-rapping experiments was carried out in 1959 to 1961 (Paul, 1963 and Paul, 1963a). The well run tests, which placed emphasis on minimising the possibility of fraud or other natural causes, resulted in the production of clear rapping sounds when in the presence of a non-professional medium. Most of the raps came from the table, around which sat the group of interested sitters. Some raps came from an area up to three metres away from the table. The duration of each rap was between 3 and 6 milliseconds and efforts were made to determine whether correlations could be found between raps and skin temperatures, electrostatic charge, electromagnetic field intensity and ambient particle counts using a Geiger counter. In addition, recordings were made of pulse rate, blood pressure, electromyograms and electroencephalograms. No correlation was found but clear evidence of inexplicable raps, sustained over a period of more than two years was reported.

One of the most important studies of psychokinesis took place in Canada in the 1970s. This enquiry involved the “Philip” project which has not only been described in detail (Owen & Sparrow, 1976) but has also been summarised more recently (Charman, 2008). The series of group sittings around a table involved the production of unexplained raps that were recorded and evaluated over a considerable period of time. Video footage of the events was broadcast on Canadian television. A detailed analysis of the rapping sounds generated at the Paul sittings, as well as those from the Philip group, was undertaken by Whitton (Whitton, 1975 and Whitton, 1976). Both sets of recordings were played back into a storage oscilloscope for visual inspection and were permanently recorded using a Brush strip-chart recorder running at 125 millimetres per second. It is worth noting that the chart recorder was capable of reproducing frequencies up to 200Hz only. However, Whitton has pointed out that the form and duration of the acoustic envelope were identical to those displayed on the storage oscilloscope. The absence of the higher frequencies and harmonics did not alter the overall sound envelope form or the duration.

A similar series of table rapping tests was undertaken in the mid-seventies (Bayless, 1976 and Bayless, 1977). Many of the sounds which were recorded could not be heard at the time of the test but were clearly audible when the tape was played back at a later stage. Bayless carried out most of the tests in conjunction with a medium, Mr Wesley Frank but some notable successes were obtained when Bayless sat alone.

Having established that there may be some differences between normal and unexplained raps, at least from evidence of the kind presented above, I decided to more fully evaluate the acoustic properties not only of the Andover raps, but also raps from cases investigated by other researchers. I was able to obtain recordings from several poltergeist cases, all of which could be subjected to acoustic analysis. The purpose of this work was to examine the notion that unexplained raps have a fundamentally different acoustic waveform to raps produced by normal means. However, in order to appreciate the technical aspects of the investigation, it is necessary to understand at least the fundamentals of acoustic analysis, a short summary of which follows.

General Acoustics

In order to determine whether inexplicable raps are in any way different to normal rapping sounds, it was necessary to fingerprint the rapping sounds using generally-accepted methods of acoustic analysis. In order to understand the procedures involved in the current analysis, some understanding of the nature of acoustics is required. A brief introduction to the subject is given below, including the important and relevant topics of amplitude, waveform and frequency.

Sound can be regarded as the vibration of matter, as perceived by the sense of hearing. Physically, sound is vibrational mechanical energy that propagates through matter as a wave. The waves are characterised by the generic properties of waves, namely frequency, wavelength, period, amplitude, intensity, speed and direction. Sound can be transmitted through gases (including air), plasma, liquids and solids. The matter that supports the sound is called the medium. When passing through air, sound waves are transmitted as longitudinal waves, also called compression waves.

The scientific study of the propogation, absorption and reflection of sound waves is called acoustics. During scientific studies, it is commonplace to experience undesirable waves that obscure the sound signals under investigation. These unwanted sounds are referred to as noise and may be generated by ambient background sounds or various electronic devices. In some cases the level of noise may considerably mask the sound signal being examined.

Two important properties of sound are the amplitude and the frequency. Broadly speaking, these properties relate to the loudness of the sound and its pitch. The amplitude is often measured in terms of sound pressure level, which is defined as the difference between the actual pressure in the medium at a particular point and time, and the average pressure of the medium at that same point. As the human ear can detect sounds with a very wide range of amplitudes, sound pressure is often measured as a level on a logarithmic decibel scale. The amplitude of any sound, including a very simple sound such as a rap, varies with time. The amplitude/time graph is known as the acoustic waveform and is a pictorial view of how the amplitude or strength of the sound varies with time. Clearly, when an object is struck, such as a hammer hitting a bell, the amplitude immediately rises to a maximum and then decays with time. In the case of a bell the decay period may be many seconds. In the case of a knuckle being used to hit a solid wooden desktop, the amplitude will again reach its maximum very quickly but the decay period will be very short due to the dampening effect of the solid wooden structure.

The pitch of the sound is expressed in terms of frequency, that is the number of wave vibrations occurring in a second. The higher the number of waves occurring within one second (cycles) the higher the pitch of the sound. As an example, on a standard 88 key piano, the lowest note, bottom A has a frequency of only 27.5 vibrations (or cycles) per second. This is denoted by 27.5 Hz. Similarly, the highest note (top C) has a frequency of 4186 Hz (or 4.186 kHz). Middle C has an intermediate frequency of 261.6 Hz. Humans are able to hear sounds within a frequency range from

20 Hz to 20,000 Hz. Some dogs can hear much higher frequencies (up to 60,000 Hz) with bats, whales and dolphins capable of hearing frequencies up to 150,000 Hz.

Whilst this very short introduction to sound explains the basic principles, the subject of acoustics is extremely complex, particularly when considering the methods of sound generation and measurement. Further information on general acoustics can be found in the literature (Everest, 2001). It is probably reasonable to state that rapping sounds are, in principle, some of the simplest sound forms to analyse. However, their detailed forms are influenced by a number of factors, which need to be taken into account. A series of sounds, or even a simple short sound, are normally depicted as variations in amplitude with time. It is also possible to view sounds in terms of frequency variations with time. The wave-pattern of even a very simple sound is influenced by the recording method used, particularly the type of microphone used, the spectral response of the equipment and the level of noise generated by the recording device and the ambient conditions. For this reason, it is imperative that the interpretation of potentially anomalous sounds takes account of possible artefacts arising from recording methods or specific characteristics of the recording equipment.

Modern techniques allow the waveform to be modified, having firstly converted it into a digital format. For example, background noise can be eliminated or certain frequency bands can be either excluded or included in the analysis of a sound. In this way, a waveform can be generated in which, for example, only lower frequencies are included. Furthermore, amplitude, frequency and time can all be presented as a composite graph, examples of which are given later. This technique, known as the Fast Fourier Transform, is particularly useful and has become an integral part of acoustics procedures. It is essentially a mathematical method for transforming a function of time into a function of frequency. It is based on Fourier theory, which states that any waveform consists of an infinite sum of sine and cosine functions allowing both frequency and amplitude to be quickly and easily measured. It is often used for filtering and for frequency analysis procedures.

Source

Ideally rapping sounds recorded at different locations and at different times should be recorded using the same, or similar, instruments and the same experimental procedures. At some point in the future a standardised method of recording unexplained raps may be agreed. The current study, however, involves the analysis of recorded raps from a variety of cases using significantly different types of apparatus. In most cases, it is not known what type of recorder or microphone was used, or indeed anything about the conditions prevailing at the time. Therefore the results of this study must be viewed in the light of this issue.

In order to make a meaningful comparison between normal and unexplained raps, it was necessary to generate normal rapping sounds using a variety of hammers and several types of hard substrates. Striking sounds were produced in various ways and included the following:

1. Knuckle tapped on a brick wall.
2. Knuckle tapped on a plasterboard wall.
3. Teaspoon tapped on a crystal glass.
4. Playing Middle C on a piano.
5. Rubber hammer striking a wooden desk.
6. Rubber hammer striking a hard rubber object.

Clearly these six recordings are typical raps produced by normal methods and are by no means exhaustive or necessarily typical of all normally-produced rapping sounds. They were chosen in order to reflect a fairly diverse range of rapping sounds in terms of amplitude, decay period and frequency.

Normal Rapping Sounds

In order to allow the comparison between unexplained and normal rapping sounds, I have included waveforms and frequency graphs of both types of raps. These visual representations were obtained using Adobe Audition software. Normal raps are clearly produced by tapping a hard object against another hard object. This striking action causes a localized increase in air pressure that is transmitted to the ear-drum, causes a vibration and is heard as a sound. The waveform shown in Fig.1 represents the amplitude-time graph of a rap produced by tapping on a wall using the knuckle of the middle finger. The horizontal axis represents time, in this case covering a period of about half a second, the vertical axis representing the volume of the sound, expressed as amplitude.

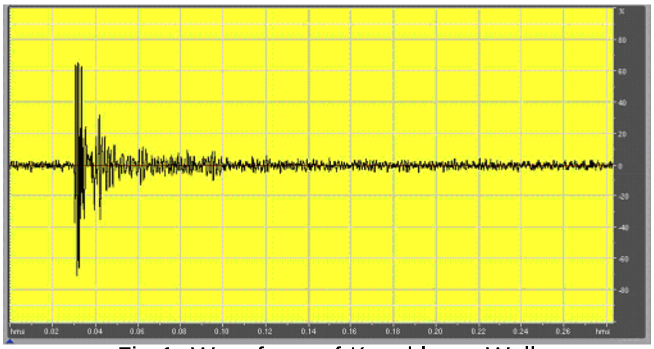

Fig.1 Waveform of Knuckle on Wall

It is evident that the amplitude increases instantaneously the moment that the knuckle makes contact with the wall. The impact causes a localized vibration of molecules within the wall although the vibrations last only a fraction of a second as seen by the rather fast decay of the amplitude, something which is very common in a highly damped situation. At least part of the waveform during the decay period results from sounds recorded after having been reflected from walls or other solid surfaces.
It is also possible to obtain some information with regard to the frequency components of the rapping sound. This is shown below and was also obtained using Adobe Audition software and the Fast Fourier Transform (FFT) method.

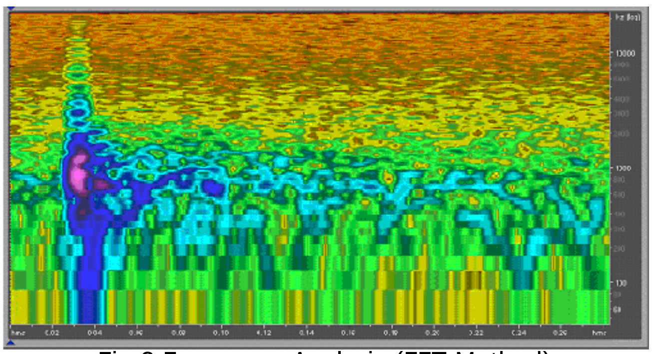

Fig.2 Frequency Analysis (FFT Method)

This form of representation is particularly useful in that amplitude, frequency and time are all combined together. In this case, it can been seen that at the moment the knuckle makes contact with the wall, the most prominent frequency is at around 1kHz (indicated by the pink area) although other frequencies are evident covering much of the spectrum. The important aspect of this graph is the depiction of a very precise moment when the impact is made, very much in keeping with the waveform graph shown previously. Another method of viewing this information is to combine both waveform and frequency information as two separate but overlapping graphs as shown below.

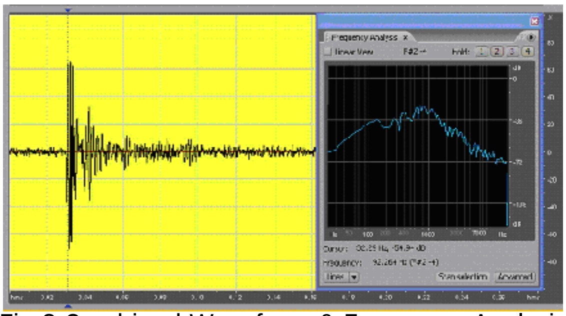
Fig.3 Combined Waveform & Frequency Analysis

The left-hand part of Fig.3 shows the normal waveform as given in Fig.1 and the right-hand side shows the frequency distribution at the cursor point of the waveform graph. In the example above, the cursor has been placed at the initial impact position (0.03 secs) and the frequency analysis shows that the dominant frequency at this point is at 1kHz. The important and useful aspect of this feature is that the cursor can be moved in the waveform time domain and the corresponding frequency distribution compared at different positions within the waveform envelope.

Many examples of normally-produced rapping sounds have been analyzed by this method, ranging from the tapping of a wine glass with a metal spoon, to the playing of middle-C on a piano (hammer striking a metal string). See Figs. 4 and 5.

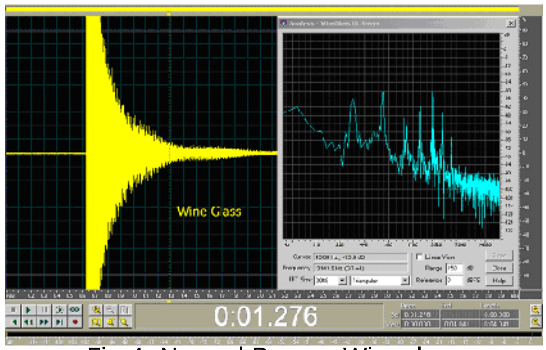

Fig.4. Normal Rap on Wineglass

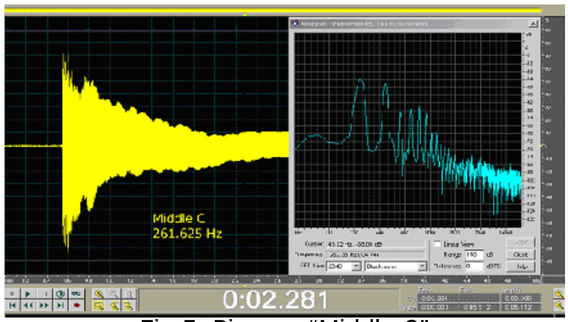

Fig.5. Piano – “Middle C”

There were obvious subjective and analytical differences between the various sounds, particularly with regard to the frequency distribution and the decay period of the sound. In the case of a metal hammer being used to strike a brass bell, the waveform decayed over a period of more than twenty seconds, quite dissimilar to knocks produced on brick walls. This is to be expected and clearly represents differences in type and form of the objects under consideration. However, the single common feature of all normal raps was that all waveforms followed a similar pattern in that the amplitude rose very sharply at the moment of impact. This was the case even when attempts were specifically made to produce a more gradual rise in amplitude. Following discussions with two acoustic engineers at the BBC R&D centre, Oliver Rook and Andrew Mason made some suggestions as to how it might be possible to produce a rapping sound by normal means in which the amplitude would increase in strength in a relatively slow manner. These included the use of a softer striking implement such as a rubber hammer. This was done using various striking surfaces ranging from a soft wood (balsa) to a rubber mat. However, as shown in Fig. 6, the waveform maintained the shape expected of a normally-produced rapping sound.

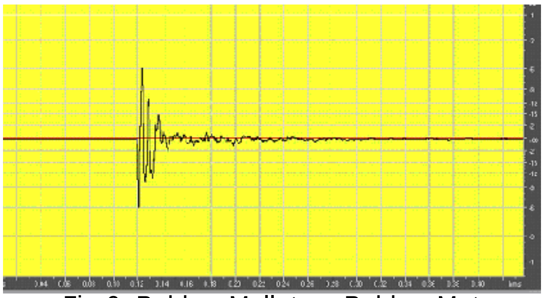

Fig.6. Rubber Mallet on Rubber Mat

The only substantial difference between this sound and other normal sounds is the relatively short decay period, something that would be expected for a soft, damped material such as rubber. Many other examples of standard rapping sounds have been evaluated in a similar manner. On each occasion the waveform has conformed to the normal shape – a rapid rise to maximum amplitude followed by a relatively slow decay. The decay period has always been in keeping with the expected result based upon the known damping characteristics of the diverse range of materials under investigation.

Evaluation of Recordings from the Andover Case

Having recorded rapping sounds at the Andover case in 1974, in circumstances which precluded the use of fraud or other normal methods, I felt that it would be useful to determine whether any fundamental acoustic differences existed between normally produced and currently unexplained rapping sounds. I contacted Bruel & Kjaer (B&K), specialists in instrumentation for sound analysis. Their Applications Engineer, John Shelton, was prepared to evaluate a number of simple rapping sounds and to report back with his findings. I made it clear to him that at this initial stage I did not want to tell him what the rapping sounds were of but that further details could be shared at a later date.

Procedure

In May 1985 I sent B&K a cassette tape with 10 rapping sounds, 7 of which were produced by normal means, such as knocking on a table with a pencil, tapping on a wall using the knuckle of my middle finger etc. Attempts were made to produce sounds that subjectively were similar to the unexplained variety. Three rapping sounds were taken from apparent poltergeist cases, two from the Andover case and one from the Sauchie case of 1960. I asked B&K to simply analyze the sounds and send me their findings, including their thoughts on similarities and differences between them. Having contacted me to confirm that the analysis had been carried out, I was then sent a copy of the analysis for my records. I then visited John Shelton at B&K’s office in Hounslow to discuss the findings in more detail and introduced to him the concept of inexplicable rapping sounds. This included the assertion of Joel Whitton that paranormal raps have a different waveform to normal raps. Whitton had evaluated the wave properties of unexplained raps obtained at group sittings and concluded that "the maximum amplitude of the sound vibrations occurs nearer the end of the rap sound-burst" compared with control raps. At this stage, I gave Shelton a copy of Whitton's article entitled "Paramorphic Table Rappings: Acoustic Analysis", (Whitton, 1976). The report detailed Whitton's findings in relation to recordings made at the Philip group and at the Paul group. Shelton agreed to evaluate and report on the ten sounds in the light of Whitton's published report.

B&K's Results and Interpretation

I received Shelton's 25-page report in March 1986. The following summary reflects the main points from the report including subjective remarks, the method of analysis and the various conclusions.

The cassette tape supplied to Shelton was played using a Yamaha K-420 recorder and fed to a B&K Type 2033 high-resolution signal analyser. He also used a B&K Type 7400 digital cassette recorder and a Type 2313 graphics recorder with BZ7002 applications package. It was felt that most of the recordings contained considerable background noise such as mains hum although Shelton did not consider this to be a problem in the majority of analyses. There was apparently a slight speed mismatch between the cassette recorders used for recording and playback that resulted in all recorded frequencies being approximately 1% high. Shelton then made some subjective comments on the ten sounds including terms such as "well damped with no obvious resonances", "quiet sound, expect low frequency resonance".

Following a detailed analysis of the sounds, representative samples of each were plotted in the time domain, the majority over an 80ms period but some over 800ms. In addition, a Fast Fourier Transform was performed on each 1k sample data block to yield the frequency content of the signal.

Shelton noted that in general the sounds were quite different. However, he also remarked that sounds 4, 7 and 9 were all very similar, being relatively quiet and showing a similar low frequency resonance. These three recordings were taken from Sauchie (sound 4) and Andover (sounds 7 and 9).

Shelton clearly had significant reservations about the conclusions reached by Whitton. He felt that Whitton made several fundamental mistakes in concluding that the signals recorded from the Philip group were identical to those of the Paul group. As Shelton points out, the sounds from the Philip group were recorded from a suspended metal plate, whilst those from the Paul group were taken near a wooden table. Even accepting that the initial stimulus, howsoever caused, is identical in both cases, the resulting sound would be likely to be different, as the transmission paths through the structures and the acoustic radiation properties would be very different.

It has to be remembered that Whitton's results are taken from chart recorders which have a limited capability of recording sounds up to 200Hz in frequency only. Since the current set of results show transients above that frequency, Whitton is essentially applying a low-pass filter at 200Hz. This procedure itself will lend a certain similarity to any impulsive signal, causing an apparent resonance to appear in the time signal at the cut-off frequency. To further high-pass filter the signal before making any comparison, as Whitton does, is simply to make any similarity even less surprising and any comparison very tenuous. Shelton points out that there may well be a distinctive "W" waveform that characterises a paranormal rapping sound, but the way in which the evidence is achieved is open to a lot of question. He concludes that a better approach would be to ensure that the most accurate means of recording and analysing the results be undertaken so that further comparisons are meaningful. The domain in which the comparisons are done is also felt to be important. He felt that if comparisons are done in the time domain, as in Whitton's paper, then the phase response of the recording medium becomes important if the waveform is not to be distorted. If, however, the frequency domain is utilised, then comparisons are not only more meaningful but considerably easier. This should be borne in mind for future work in this area.

Digital Evaluation of Recorded Rapping Sounds.

For this study, recordings of inexplicable rapping effects were obtained from several sources involving RSPK cases in several countries, covering the forty-year period from 1960 to 2000. The objective was to use modern techniques of analysis, based on the idea of converting the recorded sounds to digital format followed by analytical techniques aimed at deriving maximum information about the waveforms and frequency distributions. The recordings by their very nature can only be evaluated in their original form and are therefore subject to a degree of variability in terms of location, recording equipment, recording technique etc. In some cases, only a copy of the original recording was accessible, in other cases the original was available. In one case, Enfield, the format was that of a 9 inch reel-to-reel magnetic tape running at a very slow speed. For this reason the experimental conditions could not be regarded as consistent throughout, a point which needs to be borne in mind when interpreting the results of this study. Furthermore, some cases consisted of only one or two raps in total. Others, particularly the Andover case, contained many more examples of rapping sounds, allowing some comparison to be made of acoustic properties within a specific case study. In cases where numerous inexplicable raps have been recorded, a typical waveform has been included in this study.

Each of the recordings was played back on appropriate equipment and the output fed into the "Line In" socket of a Lenovo computer, operating under Windows XP software. The recordings were digitised by saving them as wav files, using Adobe Audition as the recording and analysing software. This software is a powerful tool used extensively in the music industry and capable of accurately monitoring the details of acoustic subjects. It is also capable of modifying and enhancing the waveforms, allowing one to reduce hiss and noise as well as evaluating the frequency characteristics. It can, for example, generate amplitude/time waveforms for all frequencies within a specified frequency band. If one is interested in the lower frequencies only, the higher frequency bands can be removed allowing a comparison of low frequency waveforms only. The versatility of this software allows a detailed analysis of sounds to be easily made.

Case Studies, Rapping Sounds.

Sauchie (1960)

The Sauchie case involved typical poltergeist activity in the vicinity of an eleven year old girl, Virginia Campbell. The case was investigated at the time by a local priest, Rev. T. W. Lund and two physicians, Dr. W. H. Nisbet and Dr. William Logan. Other witnesses to some of the events were Sheila Logan (Dr. Logan's wife) and Virginia's teacher, Miss Margaret Stewart. The details of the case (Owen, 1964) show that the main phenomena witnessed by the above can be summarised as both soft and loud knockings and the movement of various objects including a large linen chest, a pillow and a school desk. The most common feature of the case was the occurrence of loud knocking sounds, which could not be accounted for by normal means. Dr. Logan set up a tape recorder in the bedroom next to Virginia's room. This was connected to a microphone, which was placed in Virginia's bedroom. In his testimony, Dr. Logan explained that "Sounds ranging from hardly perceptible tappings to violent knocks, agitated and demanding, were heard and recorded on the tape".

Following some correspondence with both Rev. Lund and Dr. Nisbet, I was able to trace the recordings made by them. Some of the recorded knocks were featured in a BBC radio programme and I was able to trace the tape to the BBC archives at Broadcasting House, London. They provided me with a cassette tape of the sounds in 1985. Further witness statements were obtained many years later, information which supported the details given by Owen but which also included further information on the case (Allen, 2000).

Thun (1967)

This case centred around a woman who had been recently discharged from a sanatorium in which she had been treated for addiction and depression. She lived in a small flat in Thun, a small town close to Bern in Switzerland. Typical poltergeist activity was reported including the regular movement of objects. One notable example included the inexplicable movement of a tape-recorder, which was witnessed by its owner, a journalist. The principal phenomenon was that of unexplained raps, often beating out the tune of a well-known song. The case was dramatic enough to force the local authorities to evacuate the flat and house the other occupants, including her daughter and mother, in other parts of the town. The rapping sounds were taken from a CD entitled "Okkulte Stimmen" edited by Andreas Fischer and Thomas Knoefel in cooperation with Melvyn Willin.

Schleswig (1968)

This Swiss case mainly involved rapping phenomena, centred around a 13 year old boy. The boy had lived with elderly foster parents since the age of five. There were also some examples of inexplicable object movements including a cushion that rose vertically, and then moved slowly through the air towards the kitchen door. There were several witnesses to the events who recorded that on occasions the knocking sounds were so intense that the couch and the floor vibrated as though a pneumatic drill was being used in the vicinity. The Schleswig track was recorded as 16-bit stereo at 44100Hz with an uncompressed file size of 21.4 MB. In total it lasted for just over two minutes and was again taken from the “Okkulte Stimmen” CD referred to above.

Pursruck (1971)

This case, researched by Hans Bender, involved the production of significant rapping sounds in the vicinity of two sisters, aged 11 and 13. The phenomena usually occurred when they were lying in bed together. The effects were observed at close quarters and Bender was convinced that the rappings were paranormal in origin. Many recordings were made of the phenomena themselves as well as the verbal exchanges which took place between the sisters. This file was available as 16-bit stereo and 44100Hz. It lasted for about 38 seconds and had an uncompressed size of 6.4MB.

Ipiranga (1973)

This case has been described in some detail (Playfair, 1975) and was the subject of an investigation by the Brazilian Institute for Psychobiophysical Research (IBPP). It was known as PK-15 because it was the fifteenth case investigated by the group, which exhibited psychokinesis. The events occurred in a modest house in the centre of Sao Paulo. In common with other cases, the outbreak occurred within a quite normal family environment and eventually caused a degree of desperation to the family who moved house several times in an attempt to rid themselves of the poltergeist force. In addition to rapping sounds, this case involved other typical poltergeist effects such as furniture being thrown around as well as clothing and bedding catching fire. Playfair experienced very loud banging sounds just as he was falling asleep. Managing to switch on his tape-recorder in time, he obtained good quality recordings of events including eleven deafening bangs as though someone was thumping the wooden floor with a broom handle. Seven investigators from IBPP visited the house on various occasions and all agreed that the strange events had an intelligence behind them. Of particular significance, Playfair also produced normal rapping sounds at the time of the investigation, an example of which is described later.

La Machine (1973)

Based on recordings made by a Dr Alfred Krantz, rapping sounds which answered questions posed by investigators were experienced by numerous people, including neighbours, journalists and police. No formal report exists of this case. However, the events occurred in a small house in the old mining town of La Machine, France. The events surrounded an 11-year old boy who often directed questions to the rapping entity. However, various police agents also performed this task and received meaningful messages in the form of a rapping code. It is recorded that the raps ranged from very slight to extremely loud. On at least one occasion the walls were felt to vibrate and the chandelier would swing from the ceiling.

Dr Krantz reported that "...I went to the house accompanied by a gendarme. I was a witness during one of the normal questioning sessions and I then made the present recording. The investigations carried out on site allowed me to state that there was no tampering or undue manipulations in producing sounds in the wall. There was nothing abnormal to report in the loft or the cellar. The young Dominique, lying in his bed, was not making any movement – just asking questions and inviting the ghost to state the time, whistle and count with him etc. I myself have personally had a conversation with the ghost. I asked it to answer certain questions and have obtained various accurate answers". (Translated from the French original).

Andover (1974)

I investigated this case (Colvin, 2008) and recorded rapping sounds in the bedroom of a young girl, Theresa Andrews. Unusually, the rapping sounds spelt out messages in reply to questions posed by the family and by myself. The rapping sounds were often produced on a bedroom wall but on occasions, and at our request, were also produced on items of furniture such as a bed or headboard. All rapping sounds, including very loud thumping sounds on an exterior wall, took place in conditions of bright light. Together with a colleague, Dr Reinhart Schiffauer, we were able to precisely determine the location of the rapping sounds and audio recordings were made of them.

Enfield (1977)

This case has been reported in detail (Playfair, 1980) and has been the subject of a number of television documentaries. It took place in a north London council house which was rented by a single mother, Peggy Hodgson, and her four children. Rapping sounds were heard on a bedroom wall and it was reported that toys were thrown around by an unseen force. In addition, a police officer witnessed a chair being moved, again by an unknown force. The case was investigated on behalf of the SPR by Maurice Grosse and Guy Lyon Playfair, both of whom were convinced of the paranormal interpretation of events following their 13 month investigation. I obtained access to the original recordings, made on a reel-to-reel recorder by Maurice Grosse.

Santa Rosa (1988)

Very little is known about this case other than what appeared on a Brazilian television programme. The case took place in the Brazilian state of Rio Grande do Sul and was investigated by a team from TV Globo and a Jesuit priest, Father Edvino Friedrichs. It involved a young girl who was at the centre of knocking sounds, which occurred on the walls of her bedroom. A copy of the television recording was supplied to me by Guy Lyon Playfair who undertook a number of investigations in Brazil.

Euston Square (2000)

This case was investigated by Maurice Grosse (MG) and Mary Rose Barrington (MRB), using both video and audio recording methods to help in the examination of events at an apartment in London (Grosse & Barrington, 2001). The events surrounded a 7-year old boy by the name of Edwin. I obtained video recordings of events from MG and a separate audio recording from MRB who had used her own audio recorder on some occasions. The case was unusual in two ways. Firstly, unexplained rapping effects were recorded by two different investigators on different types of apparatus, both of which I was loaned for the purpose of this work. Secondly, in addition to inexplicable rapping sounds, Edwin clearly made some knocking sounds on the side of his bed by normal means. This gave me the opportunity of comparing the acoustic properties of the two types of sound.

Evaluation of Rapping Sounds

The same digital evaluation techniques as described above (using Adobe Audition software) were used to analyze the various rapping sounds described previously. Taken in chronological order, the various waveforms are described below.

Sauchie (1960)

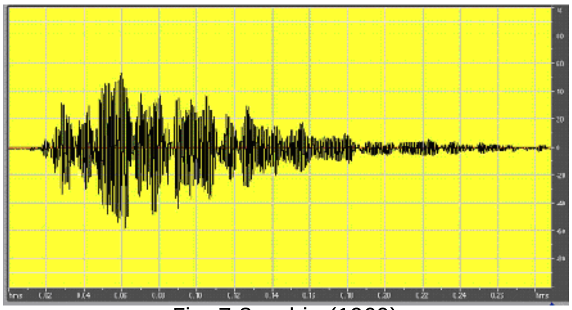

Fig. 7 Sauchie (1960)

This rapping sound, which contained relatively high levels of noise, does show a rather slow increase to maximum amplitude followed by an even slower decrease. The overall pattern of the waveform is quite unlike those produced by normal means and could be described as “working up to a maximum” in support of the theory being tested.

Thun (1967)

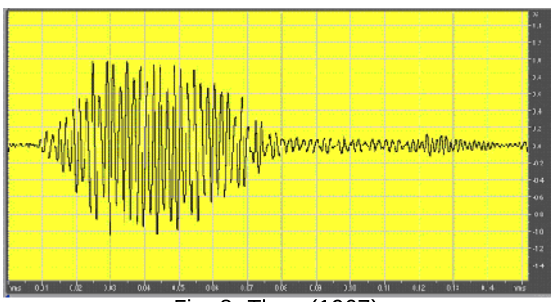

Fig. 8 Thun (1967)

Similarly, the raps experienced during the Thun case show a gradual increase in amplitude giving rise to a rather ovoid-shaped waveform resulting from a similar gradual decrease in amplitude.

Schleswig (1968)

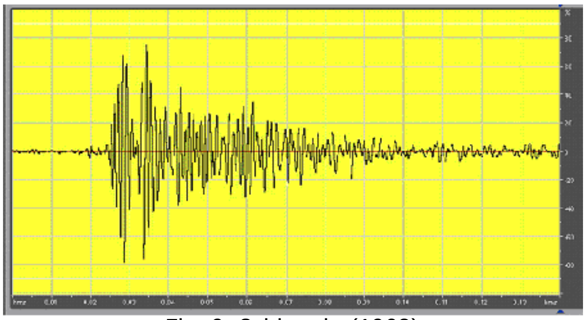

Fig. 9 Schleswig (1968)

Rather similar in form to the Sauchie case, Schleswig shows the gradual, although faster, increase in amplitude. There are at least six relatively small but progressively increasing vibrations prior to the point of maximum amplitude.

Pursruck (1971)

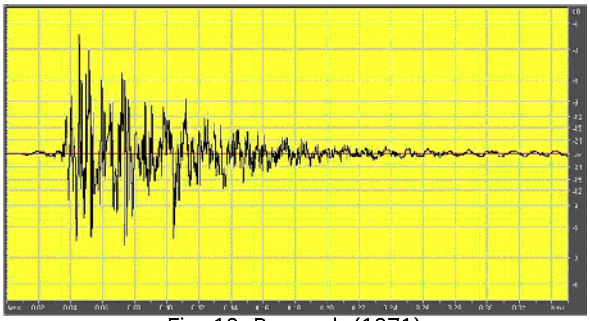

Fig. 10 Pursruck (1971)

Whilst this example shows the same type of steady increase to maximum amplitude, there are only four vibrations prior to this point. The overall pattern is nevertheless typical of unexplained rapping sounds in general.

Ipiranga (1973)

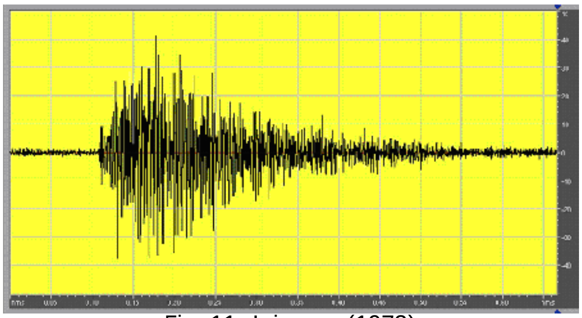

Fig. 11 Ipiranga (1973)

High levels of noise are clearly seen on this trace but the overall pattern is in keeping with the theoretical considerations of slow rise to maximum amplitude. During the investigation, Mr Guy Playfair produced several normal raps in the vicinity of the unexplained rapping sounds by hitting the floor with a broom-handle. A trace of this rapping sound is shown below:

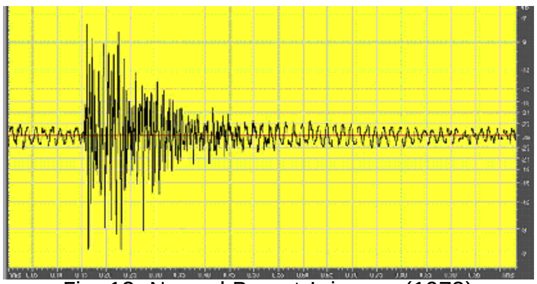

Fig. 12 Normal Rap at Ipiranga (1973)

Again, although there is clear evidence of noise, probably due to the recording equipment, the instantaneous amplitude increase is typical of a normal rapping sound.

La Machine

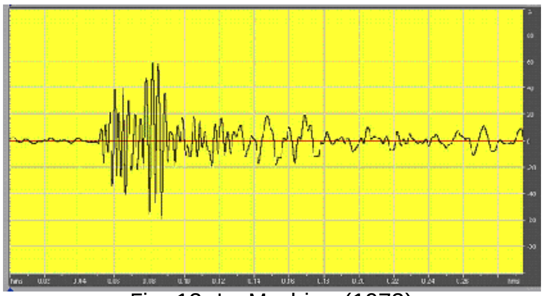

Fig. 13 La Machine (1973)

Within the waveform of a single rap, the double set of high-amplitude sections are separated by a brief period of lower amplitude. This has not been seen before apart from some similarities at Schleswig. However, the initial part of the waveform retains the usual shape associated with unexplained rapping sounds.

Andover

Figure 14 shows the waveform of a rap taken from the Andover case recorded by me in 1974. As previously explained, I made this recording under conditions that, to my mind, excluded all normal means of production.

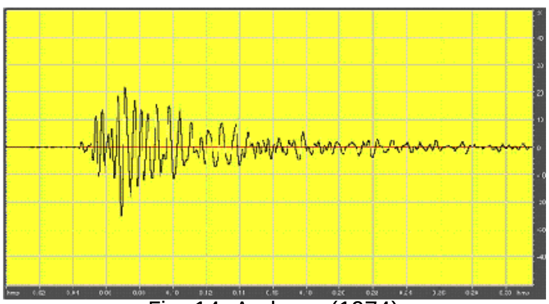

Fig. 14 Andover (1974)

The waveform is that of a typical rap with the low frequency sounds only. All frequencies above 1kHz have been removed in order to depict the acoustic envelope of low frequency vibrations only. However, the overall shape of the graph is very similar to that of the same sound including the full range of frequencies. At the moment of impact there is no immediate increase in amplitude but a more gradual increase to a maximum, followed by a relatively gradual decrease in intensity. An evaluation of the frequency characteristics of unexplained rapping sounds at Andover indicated that the frequency distribution of the sound was also somewhat different to the normally-produced type. A comparison of Figs. 15 and 16 shows two typical differences between the two types of raps, each being produced at the time of the Andover investigation.

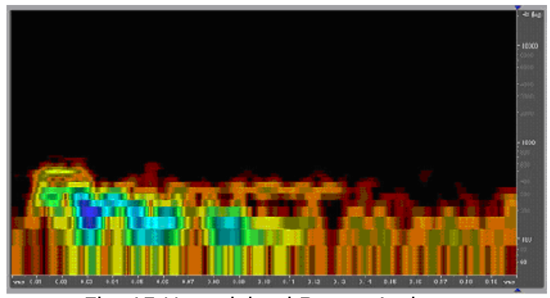

Fig. 15 Unexplained Rap at Andover.

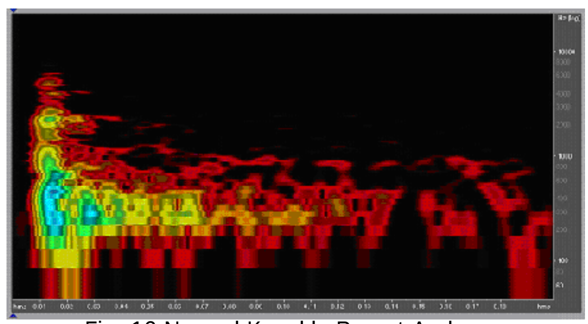

Fig. 16 Normal Knuckle Rap at Andover.

Firstly, Fig. 15 shows that there is clearly some acoustic activity well before the occurrence of the maximum amplitude, designated by the bright blue area at 0.03 secs. This is in keeping with the waveform graph shown in Fig. 14 and represents the relatively slow build-up to maximum intensity. It can be seen that the frequency at maximum amplitude is about 150 Hz.
Secondly, all of the acoustic activity in the unexplained rap occurred below 1kHz. This is a typical observation for

unexplained raps. By contrast, Fig. 16 shows significant activity for normal raps up to frequencies of about 10kHz. It is also clear that the maximum amplitude (blue area) occurs much sooner in the development of the rapping sound. Note that the well-defined acoustic contours to the left of the blue area are much thinner in Fig. 16.

Enfield

Recorded by Maurice Grosse using a reel-to-reel tape recorder running at a rather slow speed of 15/16 inch per second, the digitized signal of the rapping sound was saved as a wav file, suitable for analysis using Adobe Audition software. Again, the initial relatively slow increase in amplitude is noted.

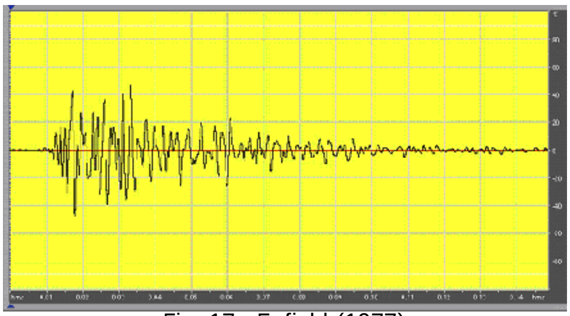

Fig. 17 Enfield (1977)

On the evening of 23rd October 1977, one of the investigators rapped by normal means on the bedroom floor. The acoustic envelope of the sound is shown below:

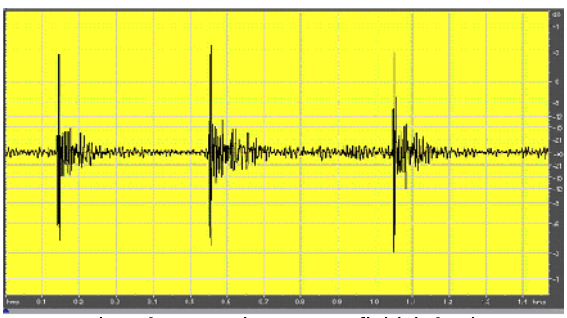

Fig. 18 Normal Rap at Enfield (1977)

The three consecutive raps show the typical form expected of a normally-produced rap, with an instantaneous amplitude increase followed by a relatively rapid decrease.

Santa Rosa

This case was televised and the rapping sounds were taken from the audio track of the programme. Again, the same type of waveform is seen, as shown in Fig. 19.

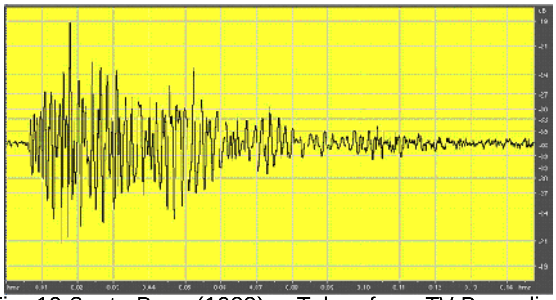

Fig. 19 Santa Rosa (1988) - Taken from TV Recording

Euston Square

This case, which was investigated by Maurice Grosse (MG) and Mary Rose Barrington (MRB), was particularly interesting in that several types of recordings were made. Unexplained raps were witnessed by both investigators and recorded independently using different types of equipment. MG used a video recorder, from which the audio track was isolated for analytical purposes, and MRB used a small dictaphone.

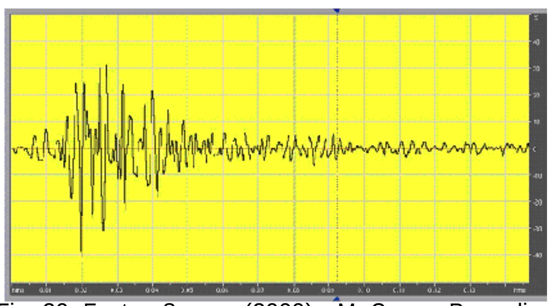

Fig. 20 Euston Square (2000) : M. Grosse Recording

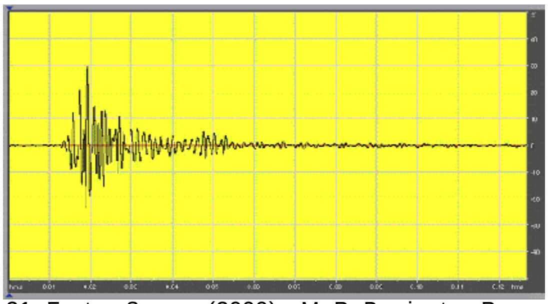

Fig. 21 Euston Square (2000) : M. R. Barrington Recording

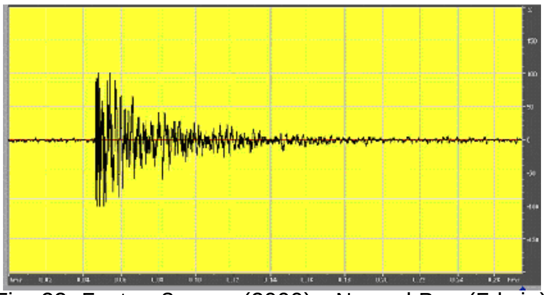

Fig. 22 Euston Square (2000) : Normal Rap (Edwin)

It can be seen that the unexplained raps recorded by both Grosse and Barrington exhibit the same slow rate of amplitude development as seen with other cases. As shown in Fig. 22, this is not the case with the recording made of Edwin producing a normal rapping sound on the side of his bed.

This effect is even more pronounced when one compares Figs. 23 and 24, showing the FFT versions, again taken from the Euston Square case.

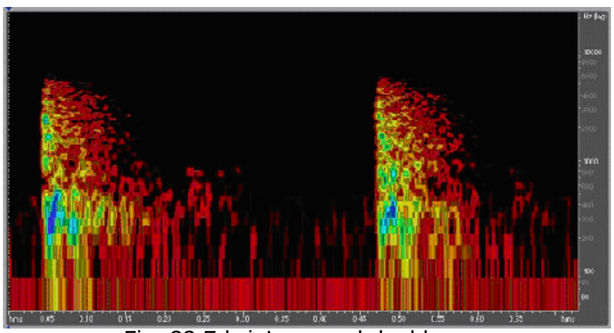

Fig. 23 Edwin's normal double rap.

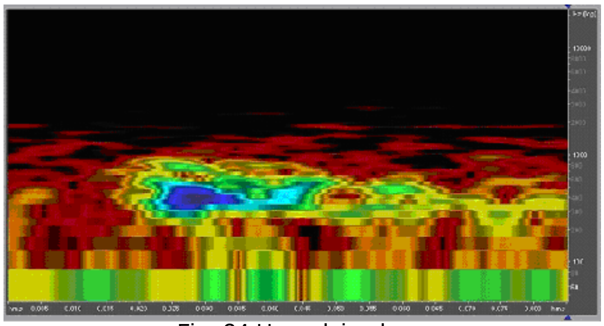

Fig. 24 Unexplained rap

The normal, double rap, made by Edwin tapping the side of his bed, shows the expected, immediate rise in amplitude (Fig. 23). The blue area denotes the area of maximum intensity, corresponding to a frequency of about 400 Hz in both cases. These raps show the characteristic sharp edge, which develops at the onset of the rap. By contrast, the unexplained rap (Fig. 24) lacks both the abrupt amplitude escalation and any significant activity at frequencies above 1kHz.

Discussion of Results

Normal rapping sounds have been recorded and analysed using the acoustics software, Adobe Audition. Sounds have been produced by striking various hard objects on relatively hard surfaces. In all cases, a normal acoustic waveform has been obtained. Even when attempts have been made to produce normal waveforms with similar characteristics to unexplained rapping effects, it has not yet been possible to do so. The characteristics of the waveform follow the expected shape, namely a very rapid rise in amplitude followed by a relatively gradual decrease to zero. The frequency distribution of the waveform was also as expected and was dependent on the type of objects being used to create the rapping sound. A hammer struck against a solid oak desk showed a frequency band that was mainly in the 50 Hz to 300 Hz region with a very short decay period. In the case of a teaspoon hitting a crystal wine glass, the frequency range was 300 Hz to 3000 Hz and the decay period was much longer (3 seconds). Despite these large and expected differences, the abrupt rise to maximum amplitude was similar across all samples and again as expected.

In the case of waveforms from the ten samples of unexplained rapping effects, the frequencies varied widely and were in keeping with the subjective assessment of sound pitch prior to analysis. However, and somewhat unexpectedly, the results showed a rather slow initial rise to maximum amplitude in all cases. There appears to be no relationship between the frequency of the raps and their speed to maximum amplitude. There are clear differences in the shape of the waveform across the range of inexplicable rapping sounds subjected to acoustic analysis.

It is clearly important to determine whether the results obtained for the ten currently inexplicable rapping sounds could possibly be explained by normal means. It is also important to explore all potential normal explanations before advocating the possibility of a force outside the conventional, known laws of physics. As already stated, sound production and sound analysis is a rather complex science. As with ostensibly paranormal photography, which has often been shown to involve quite normal explanations, unusual effects within acoustics can often be ascribed to unusual, but scientifically normal, acoustic effects.

One of the possible normal explanations put forward to explain the results is that certain types of microphones might give rise to anomalous results due to their inherent qualities and mode of operation. A microphone is simply a sensor that converts sound into an electrical signal. The most common types consist of a thin membrane that vibrates in response to sound pressure. This movement is subsequently translated into an electrical signal using one of several techniques. Most examples use electromagnetic induction, capacitance change, piezoelectric generation or light modulation to convert the mechanical vibration of the membrane to an electrical signal. The question that arises in relation to a short impulse such as a rap is whether or not there could be a delay in the response between the production of the sound and the vibration of the membrane. Could the inertia of the membrane, particularly with microphones dating back to the 1970s, lead to a relatively slow increase to maximum amplitude when subjected to a short burst of acoustic energy?

In order to test this theory, I produced normal rapping sounds using a variety of implements and recorded the wave properties using several types of microphones. These ranged from an old Philips reel-to-reel (Model EL3549A) tape recorder manufactured in 1959, together with a medium impedance (583 ohms) dynamic microphone (EL3782), to several types of more modern machines including cassette tape decks and dictaphones.

In addition, a Logitech USB direct-feed microphone was used, albeit one with automatic noise-cancelling technology.

In all cases, conventional raps exhibited the normal type of waveform. The signal amplitude rose to its maximum value within a very short time and decreased to zero relatively slowly.

There appear to be reasonable grounds for concluding that unexplained rapping effects produced at various apparent poltergeist cases in a variety of countries exhibit an unusual acoustic waveform pattern, characterised by a relatively slow rise to maximum amplitude, followed by an equally slow decline in amplitude. Furthermore, the frequency range of the raps is usually limited to less than about 1kHz. These characteristics have been noted in all cases, no matter what type of recording apparatus was used during the original investigation. It is regarded as significant that all poltergeist cases which are thought to be genuine, and for which recorded rapping sounds were obtained by the investigators, have shown the same type of unusual acoustic waveform. Similarly, the waveforms of all normal rapping sounds that were recorded at the time of the investigation (Ipiranga, Enfield and Euston Square) showed a normal waveform pattern and very much in keeping with the pattern obtained more recently by normal means under controlled conditions.

The fact that audio recordings from a number of ostensibly genuine poltergeist cases, covering a long period of time and occurring in various parts of the world all show a similar unusual audio waveform is regarded as significant. This is particularly relevant in view of the fact that these similar recordings were made with completely different types of recording apparatus. This observation needs to be subjected to further experimental analysis during the investigation of future cases and emphasis should be placed on improving the methodology in view of these observations. In particular, background noise levels should be reduced as far as possible, high performance microphones and solid-state digital recorders should be used. In addition, it would be useful to measure the acoustic properties of raps using as broad a frequency range as possible, particularly in the low frequency (infra-sound) region.

The central question arising from these observations concerns the modus operandi of the rapping phenomena. In particular, one might wonder how the raps are produced in the first place, how do the laws of physics explain these events and how do we gain further information about them? Are there any clues arising from the unusual waveforms that might tell us more about their nature?

Perhaps the most significant finding in this study is that the generally recognised description of the rap-like sounds often reported at poltergeist investigations are not actually raps at all. A rap is normally associated with sound produced when one solid object strikes another. Under these circumstances, the amplitude of the sound is immediately at its maximum, corresponding to maximum energy transfer and therefore maximum vibration at the moment of impact. The unexplained rapping effects described in this study are clearly different to this and appear to involve the relatively slow build-up of a stress within a material, culminating in an audible sound when the level of stress reaches a specific magnitude. The reasons and precise physics of this mechanism are unknown and shall require a substantial amount of experimental work to determine the underlying principles involved in their production. It should be emphasised that the theory of localised stress build-up and release referred to above is quite unlike the effects described previously by others (Persinger & Cameron, 1986; Persinger & Koren, 2001). Those authors suggest that some poltergeist effects may arise from geological stresses or changes in geomagnetism which lead to immense changes within the earth's internal structure. Whilst these types of changes may be relevant to some cases of poltergeist activity, this mechanism cannot account for the very specific and focussed effects described above and described very widely within the literature. I believe that the stress build-up and release leading to unexplained rapping sounds has a very different origin and derives from a very localised source. However, at this point it is not possible to derive further information about the energy source. This will only be accomplished as a result of more detailed work with modern equipment in the future investigation of poltergeist cases or by studying rapping effects in sitter groups.

I mentioned earlier that it has not been possible to normally produce a waveform having the same format as those derived from various poltergeist cases. However, in view of the fact that the waveforms seem to indicate a mechanism of increasing internal stress (followed by an audible relief of that stress), it seemed to me that the waveform should in principle be similar to that found in some naturally-occurring events. Loud bangs are often heard during an earthquake, whereby a geological stress is built up over a short period of time and then a release of the stress coincides with an audible explosion and the possible movement of strata. Could the unexplained rapping effects and the earthquake mechanism be similar, albeit on widely different scales? Based on the fact that they might be similar in nature, I looked into the waveform patterns associated with these geological events. Two examples are shown below. Fig. 25 shows the waveform of a seismograph recorded during an earthquake on Ascension Island in 2007.

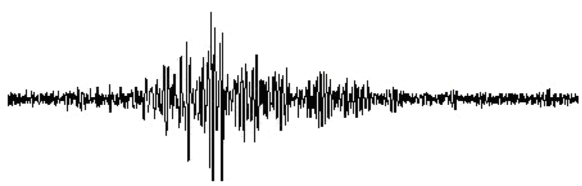

Fig. 25 Seismogram from Ascension Island (2007)

A similar waveform is shown in Fig. 26, recorded by the British Geological Survey in March 2009. It was described at the time as being "like an explosion".

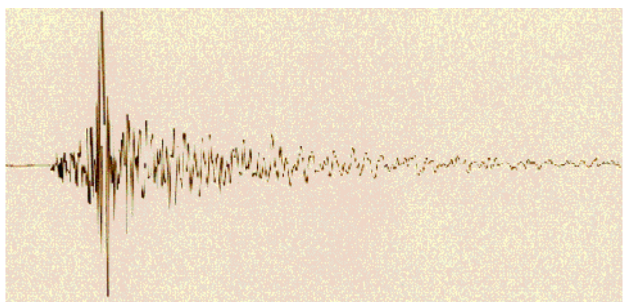

Fig. 26 Seismogram from Folkestone (2009)

The similarity between these waveforms and those of the various unexplained raps is clear. The relatively gradual increase in intensity/amplitude is very similar to the rapping sounds examined in this study and is to date the only known waveform of this type that has been generated by normal means. It is therefore worth considering whether inexplicable raps could result from a release of internal pressures or stresses within a material such as a wooden table or a wall.

It is worth pointing out that some evidence of this kind comes from two separate experimental sittings that took place some years ago and have been described in the literature. During the Philip Group sittings (Owen & Sparrow, 1976), in which rapping sounds were recorded, it was noted that “the initial raps in a sitting are not usually heard but felt, as a kind of vibration within the table top. As the sittings continue the raps become loud enough to hear. Perhaps each individual rap builds up from a small vibration into a loud noise. Possibly each rap starts with the movement or vibration of molecules within the table top until the disturbance is strong enough to produce noise”.

Similar ideas have been expressed as a result of experiments carried out by the SORRAT group in 1961 (Richards, 1982). It was recorded that: “We all agreed that the vibrations seemed to come from within the wood itself. As Dr. Neihardt said ‘It is almost a molecular or sub-molecular vibration, as though the components of the wood fibers are straining against one another’.” Elsewhere in the same publication it was noted that “Whatever caused the raps, it did not seem to be a solid object striking the surface of the floor or other resonating areas. The sounds seemed to come from within the wood itself”. These speculations do seem to support the notion that the rapping sounds are fundamentally different to sounds generated by percussive means. They appear to develop from within the molecular structure of the substrate, go through a vibrational phase and then emit an audible sound as the resultant stress is released. This mechanism is somewhat similar to that pertaining to earthquakes, albeit on a much smaller scale. I am not suggesting that the occurrence of earthquakes, or indeed any other similar theory of fault-lines or geomagnetism, are responsible for the observed effects. In fact, this type of conjecture clearly fails to explain the facts surrounding cases of the type described in this study.

Regarding the evidence presented in this enquiry, together with the conjectures regarding the possible mechanism of rap production, it has to be borne in mind that the overall objective of the work is to present the facts as they appear with a view to developing a methodology for future investigations of rapping phenomena. There is no obvious reason as to why the raps occur or indeed how they occur. However, I do believe that the evidence for raps that are produced by currently unknown means is strong. Furthermore, the evidence supporting the notion that the raps can be used as a means of communication is also strong.

The principal reason for describing the effects in such detail, and putting forward a tentative theory of a localised explosive/stress-relieving system, is in order to ensure that future investigators take account of this possible mechanism when carrying out their own scientific analysis of similar cases. In addition to recording rapping sounds using conventional acoustic measures (including the use of infrasonics and ultrasonics), it would be useful to introduce vibrational analysis using both conventional techniques and other methods. These would include laser interferometry, a technique that is capable of analysing the patterns of vibrating surfaces.

Acknowledgments

I would like to thank all those who helped in the provision of sounds from various poltergeist cases. Special thanks go to Guy Lyon Playfair who made available tapes from the cases of La Machine, Santa Rosa and Euston Square. Also to Rev.T.W. Lund and Margaret Cox (BBC Archives) for the Sauchie tape, to Suzuko Hashizume for the Ipiranga tape, Maurice Grosse and Melvyn Willin for Enfield. Thanks also go to Andreas Fischer and Melvyn Willin for access to the Schleswig, Thun and Pursruck recordings and to Laurence Morlaas for transcribing the tape recording of the La Machine case.

References

Allen, B (2000) The Legacy of the Sauchie Poltergeist at www.p-e-g.co.uk/Web/Articles/ARTICLESFramesPage.htm

Bayless, R (1976) Tape-Recording of Paranormally Generated Acoustical Raps. New Horizons, 2 (2), 12-17.

Bayless, R (1977) Tape-Recoded, low amplitude psychokinesis. New Horizons, 2 (3), 22-26.

Charman, R.A. (2008) Conjuring Up Philip. The Paranormal Review, 48, 16-22.

Colvin, B.G. (2008) The Andover Case: A Responsive Rapping Poltergeist, JSPR 72 1-20.

Crawford, W.J. (1916) The Reality of Psychic Phenomena. London. John M. Watkins.

Crookes, W. (1874) Researches in the Phenomena of Spiritualism. London. J. Burns.

Everest, F.A. (2001) Master Handbook of Acoustics. McGraw-Hill.

Gauld, A. (1968) The Founders of Psychical Research. London. Routledge & Kegan Paul.

Gauld, A. (1994) Experiences in Physical Circles, The Psi Researcher 14, 3-7.

Gauld, A. (2009) Private Correspondence.

Gauld, A and Cornell, A.D. (1979) Poltergeists. London. Routledge & Kegan Paul.

Grosse, M and Barrington, M.R. (2001) Report on Psychokinetic Activity Surrounding a Seven-Year-Old Boy. JSPR 65, 207-217.

Lang, A. (1904) The Poltergeist of Cideville. ProcSPR 18, 454-463.

Owen, A.R.G. (1964) Can We Explain The Poltergeist? New York. Garrett Publications.

Owen, I.M. and Sparrow, M. (1976) Conjuring Up Philip. New York. Harper and Row.

Paul, M.A., Fantl, K., Gardner, L.B and Puharich, H.K. 1963) A Study of Telergic Phenomena. Parapsychology, 5, 129-140.

Paul, M.A., Fantl, K., Gardner, L.B and Puharich, H.K. (1963) A Study of Telergic Phenomena. Parapsychology, 5, 179-195.

Pearsall, R. (1972) The Table Rappers. London. Michael Joseph Ltd.

Persinger, M.A. & Cameron, R.A. (1986) Are Earth Faults at Fault In Some Poltergeist-Like Episodes? J[A]SPR, 80, 49-73.

Persinger, M.A. & Koren, S.A. (2001) Predicting the Characteristics of Haunt Phenomena from Geomagnetic Factors and Brain Sensitivity. In Houran. J & Lange. R. (eds.) Hauntings and Poltergeists: Multidisciplinary Perspectives (pp. 179-194). Jefferson, NC : McFarland.

Playfair, G.L. (1975) The Flying Cow. London. Souvenir Press.

Playfair, G.L. (1980) This House Is Haunted. London. Souvenir Press.

Richards, J.T. (1982) SORRAT: A History of the Neihardt Psychokinesis Experiments, 1961-1981. London. Scarecrow Press.

Roll, W.G. (1976) The Poltergeist. London. Wyndham Publications Ltd.

Whitton, J.L (1976) Paramorphic Table Rappings: Acoustic Analysis. New Horizons, 2 (2) 7-11.

Whitton, J.L (1975) Qualitative Time-Domain Analysis of Acoustic Envelopes of Psychokinetic Table Rappings. New Horizons, 2 (1), 21-24.

Wijk, H. (1905) Karin: an experimental study of spontaneous rappings. The Annals of Psychical Science, 143-180.