Journal of Scientific Exploration, Vol. 26, No. 1, pp. 9–42, 2012 0892-3310/12

RESEARCH ARTICLE

A Review of Sir William Crookes' Papers on Psychic Force with Some Additional Remarks on Psychic Phenomena

Masayoshi Ishida

1-23-24 Toyoshiro, Tokai-mura, Ibaraki 319-1107, Japan
mass_isd162@ybb.ne.jp

I dedicate this paper to Sir William Crookes, Mr. Daniel D. Home, and Professor Robert Hare.

Submitted 10/1/2009, Accepted 11/29/2011

Abstract—A review was conducted of Crookes' lever experiments with the medium Daniel D. Home. The levers were 36″-long boards with a fulcrum at 1.5″ and 4.5″ from the left end in the first and second experiments, respectively, with a spring-balance suspension at the right end. In the first experiment, Crookes did not provide sufficient evidence to conclude that a psychic force exists. In the second experiment, direct contact between Home's hand and the lever was prevented by a water-vessel that had been set exactly over the fulcrum. If the vessel's center of gravity is assumed to have been accidentally off-center by even 5 mm to the right of the fulcrum, a force greater than 114 lbf (51.7 kgf) would have been required to be exerted on the water-vessel when Home's fingertips were dipped in the water to produce the observed increase in spring force (0.714 lbf: 324 gf); the recorded history of the spring force showed a pattern lacking the characteristics of oscillations. These are physically improbable. The analyses show that neither water sloshing nor external tremors can explain the experimental results. Furthermore, some well-known paranormal phenomena are reviewed with a discussion of possible impacts on some fundamental theories of current science.

Keywords: Psychical research—William Crookes—D. D. Home—lever experiments—psychokinesis—psychic force—spring balance—oscillation behavior—systematic errors—levitation—materialization—psychical knowledge

Introduction and Objectives

Journalist and historian Brian Inglis' extensive review of the history of psychical research was published in 1984. The author closed his book writing,

> If I have done nothing else, I hope I have done something to rehabilitate them [men of caliber in psychical research], at least in the eyes of their successors. (Inglis 1984:341)

So let us see the recent activities of their successors. Parapsychologist Dean Radin writes at the beginning of his book *The Conscious Universe*:

> The evidence is based on analysis of more than a thousand experiments investigating various forms of telepathy, clairvoyance, precognition, psychic healing, and psychokinesis. The evidence for these basic phenomena is so well established that most psi researchers today no longer conduct "proof-oriented" experiments. Instead, they focus largely on "process-oriented" questions like, "What influences psi performances?" And "How does it work?" (Radin 1997:6)

About 10 years before Radin's book was published, philosopher of science Stephen Braude became one, if not the first, academic to emphasize the importance of large-scale psychokinesis (PK) phenomena (also called macro-PK) recorded primarily before J. B. Rhine's initiation of laboratory-controlled parapsychology experiments in the 1930s. In his book *The Limits of Influence*, Braude (1986/1997) reviews large-scale PK phenomena that occurred during séances through the mediums D. D. Home, E. Palladino, and others. He argues against refutations offered by many skeptics. Let me call this a "macro-PK campaign." I do agree with Braude on the limits of influence of the laboratory-controlled small-scale PK (also called micro-PK) on mainstream science as well as on parapsychology. This is obvious when one considers the impact of macro-PK phenomena such as "levitation" and "materialization" on science. Indeed, no theory of psi has been put forward that can explain these. These two phenomena are obviously caused by conscious or unconscious human beings and are hence closely related to human consciousness—one of the most enigmatic subjects in current scientific research.

And if as Radin explains the existence of psi phenomena has already been well-established on the basis of more than a thousand experiments, why, then, any need for a review of Crookes' psi experiment with Home? I present the four-fold objectives of my work as follows:

(1) According to the book *Parapsychology in the Twenty-First Century* (Thalbourne & Storm 2005), mainstream parapsychologists still neglect large-scale PK. Hence, a scientific quantitative review of Crookes' lever experiments with Home would assist in the macro-PK campaign.

(2) Referring to Trevor Hall's accusation (1984/1962) of Crookes and the medium Florence Cook, psychologist Irwin writes in his textbook, *An Introduction to Parapsychology* (1989):

> Although there is no direct indication of any similar collusion between Crookes and Home this evidence [Hall's accusation], if confirmed, necessarily would undermine the integrity of Crookes and thereby raise doubts about the validity of all his psychical research including that involving Home. (Irwin 1989:24)

Hence, to an academic psychologist and parapsychologist, Braude's defense (1986) of Home's psi performance appears inadequate against Hall's accusations. My review is intended to examine the lever experiments and the credibility of Crookes and Home.

(3) Home's psi performance displays phenomena ranging from PK to levitation to materialization of a hand. From my point of view, materialization phenomenon in authentic psychical research would have a great impact on current fundamental scientific theories, such as the Big Bang theory explaining the origin of our material world and the Darwinian theory of evolution explaining the origin of the human species. Hence, I personally feel that verification of the credibility of Home's psi performance is important. Moreover, Braude (2007) recently provided supporting (if not yet conclusive) data of paranormal materialization, in which a lady spontaneously produced a metal foil on her body; the foil *did not* dematerialize.

(4) However, the macro-PK campaign has had a limited influence on mainstream science. Why is this so? In my view, it is because the previous criticism still holds: "Unexplained cases are simply unexplained. They can never constitute evidence for any hypothesis" (e.g., see Gardner 1989:191). Hence, my final objective is to speculate about the possible impact of large-scale PK on mainstream scientific research.

The lever experiments were conducted in 1871 at Crookes' private laboratory (Crookes 1874) by William Crookes (1832–1919), Fellow of the Royal Society of London, with the medium Daniel D. Home (1833–1886). Crookes conducted two types of lever experiments. In the first one, Home directly touched one end of a 36″-long horizontal lever of mahogany board, which had a 1.5″-long flat foot (screwed to one end) supported on a table, while the other similar end was suspended from a spring balance. In the second experiment, Home dipped his fingertips into water in a glass vessel, the gravity center of which was set exactly over a knife-edge fulcrum screwed to a 36″-long mahogany board 4.5″ from one end, while the other end was suspended from a spring balance. In both experiments, it was ensured that Home did not do anything except that which was specified. Crookes reported that they observed and recorded scientifically unexplainable increases in the spring force in both experiments. These experiments were not new to Crookes, who stated:

> The references I now give afford an answer to the statement that these results must be verified by others. They have been verified over and over again. Indeed, my own experiments may be regarded merely as verifications of results already obtained and published by eminent scientific men in this and other countries. (Crookes 1874:27)

Crookes submitted his manuscripts on the experimental studies to the Royal Society of London in June 1871 and received technical comments on them from a reviewer. Although Crookes replied to the comments, his manuscripts were eventually rejected by the Committee of Papers of the Royal Society in January 1872. Crookes published his experimental papers in *The Quarterly Journal of Science*, his own scientific journal, in 1871. His experimental results were also published in 1874 in the form of a book reprinted from the Journal.

Many studies by skeptics on the psychical research of Sir William Crookes have been published in books, the most recent being those of Peter Lamont (2005) and Gordon Stein (1993), Ruth Brandon (1983), and Trevor Hall (1984/1962). Among them only Stein made somewhat technical comments on the lever experiments. Studies that present arguments for the defense of Crookes and Home have also been published (e.g., see Braude 1986/1997, E. Jenkins 1982). The former studies view Crookes' work with skepticism. However, to accept the criticisms of Crookes' lever experiments based on cursory reviews by scientists (i.e. reviewers of Crookes' manuscripts) or denouncements by skeptics without any scientifically quantitative basis is unsound and unfair. Hence, the primary objective of the present study is to show that the lever experiments were scientifically sound, even if the observed experimental results cannot be explained using Newtonian mechanics, unless some yet-unknown force or mechanism is assumed (see **Analyses of Crookes' Lever Experiments** section). In other words, the present study will reinforce the defenders' arguments for the credibility of the reported experimental facts. Furthermore, some well-known paranormal phenomena reported by Crookes and other researchers are reviewed with a discussion of possible impacts on some fundamental theories of current science (see ***Possible Implications of Large-Scale Psi Phenomena*** section).

Analyses of Crookes' Lever Experiments

Analysis of the First Lever Experiment

It should be noted that the results of the first lever experiment were presented on the basis of (1) the visual observations of the up-and-down movements of the index of the spring balance made by the experimenters and (2) the range of index movement recorded with an automatic register. The up-and-down movements of the index, however, were not recorded as a function of elapsed time since the start of the experiment.

(1) Specifications of the mahogany lever. The mahogany lever used in the first experiment is specified as follows (the x, y, z axes in Figure 1 represent the Cartesian coordinates for the lever):

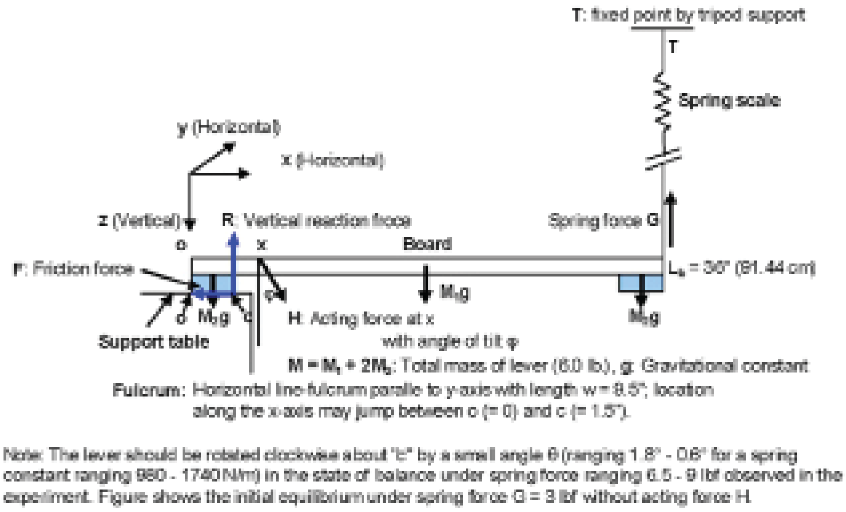

Figure 1. Schematic of the lever system in the first lever experiment.

Board: length L_b = 36″ (91.44 cm), thickness t = 1″ (2.54 cm), width w = 9.5″ (24.13 cm);
Feet: screwed to the board at both ends, length c = 1.5″ (3.81 cm) with the same width and thickness as the board;
The mass of the whole lever: 6 lb (2.722 kg)

On the basis of Crookes' statement: "As will be seen on referring to the cut (Fig. 3) [see Figure 2], the board was arranged perfectly horizontally" (Crookes 1874:15), we assume that at the start of the experiment, the left foot of the board was placed on the table, apparently supported uniformly by the surface of the table. The other end of the board was suspended by a string and a spring balance in series, the whole of which was suspended from a very firm tripod support. The normal weight of the board as so suspended was 3 lb (i.e. G_0 = 3 lbf without Home's presence). If, for now, we ignore force H in Figure 1, an analysis of the static balance of the lever shows: (1) if the fulcrum is at the left end (o) of the left foot, then the total mass of the lever $M = 2G_0/g$ = 6 lb and (2) if the fulcrum is at the right end (c), then $M \approx 1.0455 \times 2G_0/g$ = 6.273 lb, where g is the gravitational constant. Therefore, we assume that the fulcrum was at o (x = 0) at the start of the experiment with the spring force at equilibrium, G_{0o} = 3 lbf. If Crookes set the lever so that the fulcrum was at "c" initially, the spring force at equilibrium was G_{0c} = 2.87 lbf. Hence, the initial setting of the lever by

Crookes was more appropriate than setting it "perfectly horizontally."

The spring balance used in the first experiment would have been the same as or similar to that used in the second experiment. We can see a drawing of the spring balance used in the second experiment in Crookes' paper (Crookes 1874:34), which shows that the scale was rated for a maximum weight of 25 lb (11.34 kg) and had a minimum scale division of 1 lb. Hence, the weight measured by visually reading the scale index had an uncertainty in the reading of ±0.5 lb. On the basis of the total mass of the lever being 6.0 lb and the calculated total volume of the lever being 6,071 cm^3, the average density of the mahogany is calculated to be 0.448 g/cm^3.[1] This value is required in evaluating the mass of the mahogany lever used in the second experiment.

(2) Reported observations in the first experiment. The experiment began with the participation of Home, and Crookes described the experimental observations as follows (see Figure 2).

> Home placed the tips of his fingers lightly on the extreme end of the mahogany board which was resting on the support, while Dr. A. B. and myself sat, one on each side of it, watching for any effect which might be produced. Almost immediately the pointer of the balance was seen to descend. After a few seconds it rose again. This movement was repeated several times, as if by successive waves of the Psychic Force. The end of the board was observed to oscillate slowly up and down during the experiment.
>
> Home now of his own accord took a small handbell and a little card matchbox, which happened to be near, and placed one under each hand, to satisfy us, as he said, that he was not producing the downward pressure (see Fig. 3 [in Figure 2]). The very slow oscillation of the spring balance became more marked, and Dr. A. B., watching the index, said that he saw it descend to 6½ lbs. The normal weight of the board as so suspended being 3 lbs., the additional downward pull was therefore 3½ lbs. On looking immediately afterward at the automatic register, we saw that the index had at one time descended as low as 9 lbs., showing a maximum pull of 6 lbs. upon a board whose normal weight was 3 lbs. [. . .] I need scarcely add that his feet as well as his hands were closely guarded by all in the room. (Crookes 1874:14–15)

(3) Static balance of the lever in the first experiment. Crookes stated that in the experiment, they ensured that

> Mr. Home's fingers were not at any time advanced more than 1½ inches from the extreme end, as shown by a pencil-mark, which, with Dr. A. B.'s acquiescence, I made at the time. (Crookes 1874:15)

Either the right or left end edge of the 1.5″-long foot became the fulcrum of the lever.

After the submission of his manuscript in June 1871 to the Royal Society, Crookes received technical comments on the experiment. As acknowledged by

Crookes when quoting his paper and the comments made in a letter by Professor G. G. Stokes of the Royal Society, there were a couple of points to be clarified. These points were expressed as follows by Stokes, using a schematic figure of the relevant part of the lever.

> The breadth of the foot of the board was, I think, 1.5 or 2 inches, and the bell placed on it was, perhaps, 2 or 3 inches broad. (I can't carry the exact figures in my head.) Join the left edge of the top of the bell, *a*, with the right hand edge, *b*, of the base of the bell, and let *e f* be the joining line. Then we may suppose the fingers to have pressed in any direction short of the limiting line *e f*. Also as the board was rigid, the fulcrum for aught we know may have been at *c*. From *c* let fall a perpendicular *c m* on the line *e f*. Then the pressure of the finger may have acted at the distance, *c m*, from the fulcrum. Also, as the base lay flat on the table and both were rigid, for aught we know, an infinitesimal, and therefore imperceptible, tilt communicated to the table at the time of trying the experiment may have shifted the fulcrum from the edge *d* to the edge *c*, so that the weight of the hand may have acted by an arm longer than before by *c d*, which would have contributed to the result. (Crookes 1874:29)

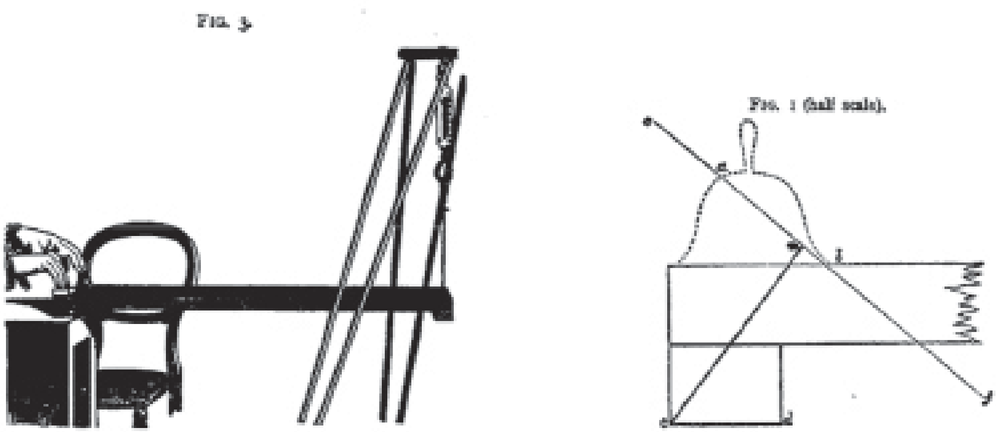

Figure 2. Setup of the first lever experiment and the sketch that accompanied Stokes' comment (Crookes 1874:15,29).

Crookes replied to Stokes' comment by calculating a moment balance of forces using the geometrical configuration shown in Figure 2 (the sketch on the right), writing "even if all your suppositions are granted" (Crookes 1874:30), which may imply that the geometry in Stokes' sketch above does not necessarily agree with the actual geometry in the experiment. That is, since

Crookes ensured that Home's fingers never advanced more than 1½ inches from the extreme end, as shown by a pencil mark, the right end of the handbell base was probably on the left side of the pencil mark, contrary to Stokes' sketch. However, in the following analysis, we use the relative geometrical size of the base of the handbell (estimated to be about 2″ in diameter) shown above. (The notations in the above reported figure are not used in the following, even though the same notation *c* appears).

Let us consider the static balance of the lever in Figure 1, assuming that an external force vector H is applied to the lever at a distance *x* from the left end with an angle of tilt φ from the vertically downward direction of the lever. Force vector H should be considered the sum total of the forces that Home exerted on the lever through his fingers. Because the spring force was observed to increase by 3.5 to 6 lbf, the right end of the lever should have fallen from the horizontal position. Hence, the fulcrum is located at c = 1.5″. The lever should rotate clockwise about the fulcrum by an angle θ, which depends on the spring constant, k_{sp}. Since the k_{sp} for Crookes' scale is estimated to be in the range of 980–1740 N/m,[2] the corresponding angle, θ, is estimated to be in the range of 0.6–1.8° (with the additional extension of the spring from equilibrium being in the range of 9–27 mm). φ′ ≡ (φ − θ) is used in the following equations as the angle of tilt of acting force H from the z-axis in Figure 1. The static balance condition of the lever gives the following results.

$$H = \{(L_b - c) \times G - (1/2)(L_b - 2c) \times M \times g\}/f(\varphi'), \tag{1a}$$
$$f(\varphi') \equiv (x - c) \times \cos(\varphi') + 2t \times \sin(\varphi'), \tag{1b}$$
$$R = M \times g + H \times \cos(\varphi') - G, \tag{2a}$$
$$F \equiv \mu \times R = H \times \sin(\varphi'), \tag{2b}$$

where g and μ are the gravitational constant and coefficient of static friction, respectively; t is the thickness of the board; and M is the total mass of the lever. For the definitions of forces R, G, H, and F = μ × R, see Figure 1.

Equations 2a and 2b result in the following relationship between static friction coefficient μ and angle φ′:

$$\tan(\varphi') = \mu/\{1 - (M \times g - G)/R\}.$$

Because M × g − G ranges from −3 to −0.5 lbf and the reaction, R, is very large (>80 lbf) compared with |M × g − G| as long as force H is exerted close to the fulcrum, μ can be approximately expressed as follows:

$$\mu \approx \tan(\varphi'). \tag{2c}$$

Thus, the maximum angle of friction, $\delta = \tan^{-1}(\mu)$ (estimated as being less than 30°), is approximately equal to the angle of tilt, φ′, when the left foot starts to slide on the support table. From Equation 1a, the required H to give G = 6.5 lbf decreases as φ′ increases. This is shown in Figure 3. The results are summarized as follows:

(1) If H is acting within the range x = [0, c] (i.e. within the left side of the pencil mark) with an angle of tilt φ′ = 0° (i.e. strictly vertical), then no positive H (i.e. downward force) can give any increase in the spring force, G, from its equilibrium value, G_{0c} (2.87 lbf), when the fulcrum is at c (not at o).

(2) H acting at x = c with an angle of tilt φ′ = 30° is as low as 125 lbf (56.7 kgf).

(3) If H is assumed to be applied at x = 2″, 0.5″ to the right of the fulcrum as specified in the sketch (Figure 2) accompanying the comment from Stokes, the required H is about 250 lbf (113 kgf) for φ′= 0; it is about 87 lbf (39 kgf) for φ′ = 30°.[3]

(Note: The φ′ values at singularity in Figure 3 are the root of φ′ in f(φ′) = 0 for a given x within the range [0, c]. The negative solutions for H (i.e. the force pulls the lever upward) are spurious ones that give G = 6.5 lbf if the lever is fixed on the table with a freedom of rotation about the fulcrum at c.)

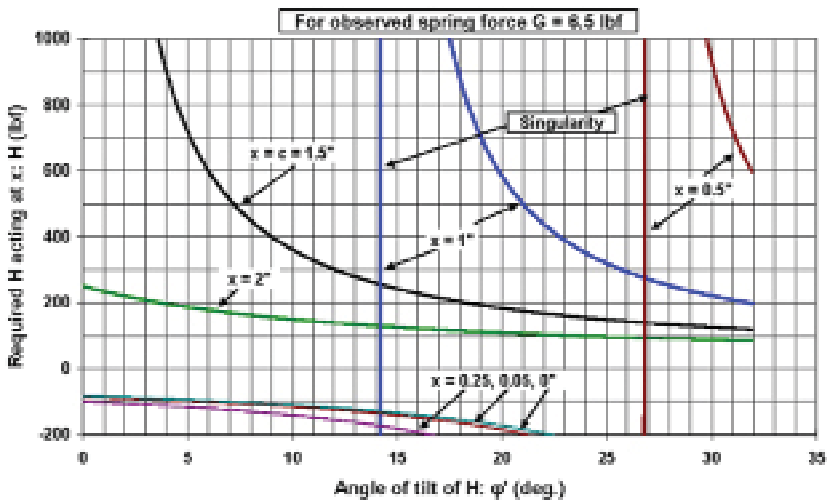

Figure 3. Solution of H for G = 6.5 lbf as a function of φ′ for x within [0, c = 1.5″] and at 2″.

Scientific common sense says that if the lever is being tilted downward about the fulcrum at c with a small angle, θ, from the horizontal plane (with a spring force $G > G_{0c}$), then downward force H exerted by Home always reduces G to its equilibrium value, G_{0c}, contrary to the observed change in the spring force. This appears to be quite a strange behavior of the lever caused by Home. It should be noted that these values of H are calculated on the basis of a static balance, assuming that the lever is not in motion. Actually, Crookes reported oscillations of the spring force from the initial equilibrium value.[4] Hence, the reported values of 3.5 and 6 lbf might have included overshoot reactions of the oscillating lever if the oscillation was of a physical nature. (In the second lever experiment, oscillations of a physical nature appear absent [see Figure 6 in the section ***Analysis of the Second Lever Experiment***].) However, the oscillations did occur because there were changes in the spring force caused by Home apparently touching the left foot of the lever.

The analysis in this section has shown that the experimentally observed increase in the spring force would have required a fairly large force H with a non-zero tilt angle φ′ (H > 125 lbf for dG = 3.5 lbf with φ′ <~30°) on the left foot of the lever. Although Crookes did not experimentally measure the force, H (its strength and direction), exerted by Home, it would have been small. The analysis above presents the possibility of explaining the experimental results based on Newtonian mechanics.

Analysis of the Second Lever Experiment

A lever experiment, in fact a series of experiments, was conducted apparently after it became clear that the scientific community was apathetic about the results of the first experiment. As shown in ***Analysis of the First Lever Experiment***, it is not possible to rule out the possibility of causing an increase in the spring force by pressing the left end foot of the lever in the first experiment, even though the force required to realize the observed increase in the spring force is not small. Hence, Crookes tried to eliminate the direct mechanical contact between the lever and Home's fingers by inserting a water vessel between the two in the second lever experiment. The experimental apparatus used in the second lever experiment is shown in Figure 4. A hemispherical copper vessel (N) was immersed in a glass water vessel (I). This copper vessel contained several holes that allowed water to flow between the two vessels, and was supported by a strong iron stand (L, 2″ from the board) on the floor. The vessels were placed 2″ apart.

This setup was a modification of that used by Robert Hare, M.D. (1781−1858), at the University of Pennsylvania in an experiment published in his book (Hare 1855). The double-vessel experimental apparatuses are compared as follows.

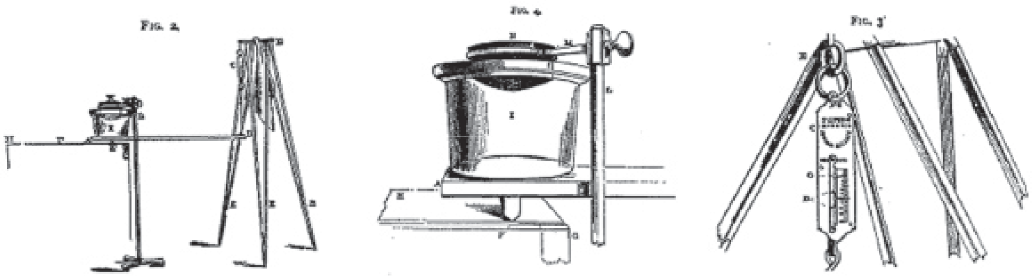

Figure 4. Apparatus of the second lever experiment (Crookes 1874:34–35).

(1) Hare's lever: a total length of 4′, fulcrum located 1′ from the left end, the right end suspended by a spring balance. The center of mass (COM) of the glass water vessel (diameter 9″ and height 5″) was off-center to the right of the fulcrum by 6″.

(2) Crookes' lever: a total length of 3′ (36″), fulcrum located 4.5″ from the left end, the right end suspended by a spring balance. The COM of the glass water vessel (diameter 9″ and height 7.5″) was set exactly over the fulcrum.

The second series of lever experiments with Home comprised four experiments in all: *Experiments* I through IV (*italics* are Crookes' [Crookes 1874:36–38]). Only *Experiment* I can be discussed from an analytical point of view because the other three experiments, in which Home did not mechanically touch the lever directly, not even via the water vessel, are very difficult to simulate on the basis of a physical model. In addition, critical discussions were provided only for *Experiment* I by Stokes. Crookes did not provide enough information on *Experiment* I for us to analytically simulate the experiment. However, we can estimate the necessary data from the figures of the experimental apparatus in his paper, which, Crookes suggested, were made on the basis of photographs (Crookes 1874:79). It should be noted that in *Experiment* I, the observed increases in spring force were fairly small—on the order of 5,000 grain-force (0.714 lbf = 324 gf)—compared with the 3.5–6 lbf observed in the first lever experiment and the 3 lbf and 7 lbf reported by Hare (Hare 1855:164–165). However, in the second series of lever experiments, Crookes recorded the time history of the change in the spring force in an excellent manner by recording the change in the location of the index of the spring balance on a smoked plate glass, which was moved horizontally by a clockwork system.

(1) Static balance of the lever system. Figure 5 is a schematic diagram of the apparatus used in *Experiment* I. The material density of the mahogany board is assumed to be the same as that used in the first lever experiment. The length of the board, L_b, was 36″ and it had a wedge-shaped fulcrum screwed to it. The exact location of the fulcrum along the board was not described by Crookes (1874). In the following, the horizontal locations are defined as the distances from the left end of the lever in Figure 5. The location of the fulcrum is estimated to be at a = 4.5″ on the basis of Figure 4. The horizontal location of the COM of the water vessel is treated here as parameter b, although b will be very close to the fulcrum as described by Crookes (b = a in Figure 5).

It is assumed that the outer diameter of the bottom of the glass vessel was 9″ (Crookes wrote only that the vessel diameter was 9″), and the geometry of the vessel is estimated from Figure 4. It is also assumed that the thickness of the glass vessel was 3 mm, except at the top rim of the vessel. The water height from the inner bottom of the vessel to the water surface in the hemispherical copper vessel was noted in the paper as 5.5″ (in the glass vessel) plus 1.5″ (in the copper vessel); thus a total of 7″.

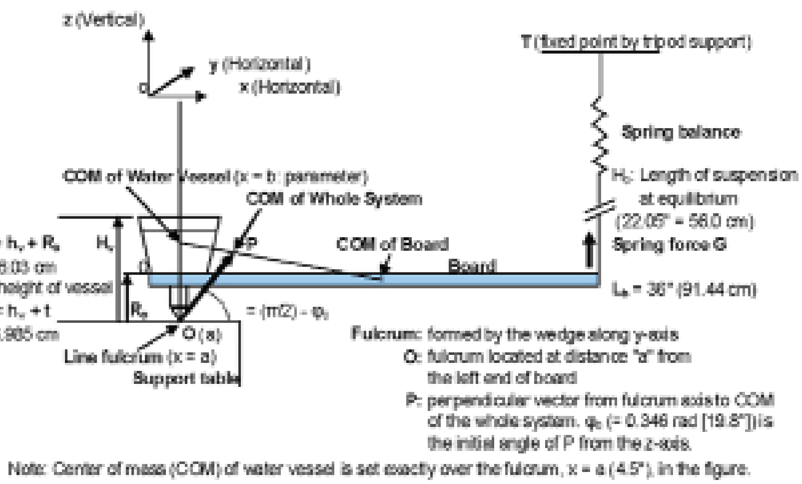

Figure 5. Schematic of the lever system in the second lever experiment.

The geometry of the mahogany board was the same as that specified in the first experiment. The geometry of the fulcrum wedge (assumed to be made of the same mahogany as the board) is estimated on the basis of Figure 4. The average density of the mahogany estimated in the section ***Analysis of the First Lever Experiment***, 0.448 g/cm^3, is assumed. Using these assumptions, the masses of the glass vessel (assumed to be a truncated cone), water, lever board, and fulcrum wedge are estimated as follows[5]:

Total glass volume = 977.7 cm^3
Water volume = 7688 cm^3
Total glass mass = 2.177 kg (assuming glass density = 2.227 g/cm^3)
Water mass = 7.688 kg
Total mass (water plus glass) of the water vessel W = 9.865 kg (21.748 lb)
Total mass of the mahogany lever $M = M_1 + M_2 + M_3$ = 2.617 kg (5.7694 lb)
(M_1: mass of board on the left side of the fulcrum = 0.314 kg,
M_2: mass on the right side of the fulcrum = 2.198 kg,
M_3: mass of the wedge fulcrum = 0.105 kg)

Using these data and assuming that the lever system was set in the static horizontal arrangement with no horizontal force acting, the static mechanical balance of the system in Figure 5 (without Home's presence) gives the spring force G and reaction R to the wedge as follows:

$$G = \{(b - a) \times W - (a/2) \times M_1 + (L_b - a)/2 \times M_2\} \times g / (L_b - a), \quad (3)$$

$$R = (W + M) \times g - G, \quad (4)$$

where

g: gravitational constant,
G: spring force suspending the right end of the board,
R: vertical reaction from the support table to the wedge, *a* and L_b: 4.5″ and 36″, respectively,
b: x-axis location of the COM of the water vessel as a parameter.

The distance b – a is the off-center distance of the COM of the water vessel from the fulcrum. From Equation 3, if the COM is exactly over the fulcrum (b = a), then the spring force G_0 (before the participation of Home) does not depend on W and G_0 = 2.3736 lbf, and the reaction force R = 25.1435 lbf. These two forces together balance the total weight (27.517 lbf) of the water vessel and the mahogany lever as determined by Equation 4.

Crookes reported that he put the vessel exactly over the fulcrum (Crookes 1874:36). How did he set it exactly so? We usually achieve this using Equation 3 as follows. (1) First, set the lever almost perfectly horizontal without the water vessel on it, (2) record the location (G_0) of the index of the spring balance on a smoked glass plate using Crookes' automatic register, (3) place the water vessel (W) such that its COM is almost exactly over the fulcrum, and (4) adjust the horizontal position of the water vessel to exactly reproduce the same location (G_0) of the index of the spring balance as recorded without the water vessel.

Equation 3 then guarantees b = a; that is, the vessel is set exactly over the fulcrum. This is probably what Crookes did. Despite his statement, we assume that the vessel was accidentally set off-center to the right of the fulcrum by 2.63 mm; that is, b – a = 2.63 mm. Under this off-center condition, the spring force at balance changes from G_0 by ΔG = +0.0714 lbf (500 grain-force = 32.4 gf = 0.318 N), which is 1/10 of the experimentally recorded 5,000 grain-force. The initial condition of *Experiment* I was described as follows (see Figure 4).

> The apparatus having been properly adjusted before Home entered the room, he was brought in, and asked to place his fingers in the water in the copper vessel, N. He stood up and dipped the tips of the fingers of his right hand in the water, his other hand and his feet being held. When he said he felt a power, force, or influence, proceeding from his hand, I set the clock going, ... (Crookes 1874:36)

Hence, the change in the spring force, dG(t), recorded by the index of the spring balance at time t since the start of the experiment can be defined by the following equation.

$$dG(t) = G(t) - G_{0H}, \qquad (5)$$

where

G(t): actual spring force at time t,

G_{0H}: G(t) at the start of the recording with Home's fingertips dipped in the water (t = 0 s when Crookes set the clock going); G_{0H} may differ from G_0, which is the spring force at equilibrium before Home was brought into the room.

The small change in spring force, dG, was recorded using a special device on "a sheet of plate-glass which has been smoked over a flame." To represent him correctly, I quote his explanation of the recording system (in Crookes' Fig. 2 and Fig. 3 that are shown in Figure 4 of this paper):

> The following piece of apparatus is not shown in the figures. To the moving index, o, of the spring balance, a fine steel point is soldered, projecting horizontally outwards. In front of the balance, and firmly fastened to it, is a grooved frame carrying a flat box similar to the dark box of a photographic camera. This box is made to travel by clock-work horizontally in front of the moving index, and it contains a sheet of plate-glass which has been smoked over a flame. The projecting steel point impresses a mark on this smoked surface. If the balance is at rest, and the clock set going, the result is a perfectly straight horizontal line. If the clock is stopped and weights are placed on the end B of the board, the result is a vertical line, whose length depends on the weight applied. If, whilst the clock draws the plate along, the weight of the board (or the tension on the balance) varies, the result is a curved line, from which the tension in grains at any moment during the continuance of the experiments can be calculated. (Crookes 1874:34–35)

As written by Crookes in quoting his paper and comments given in a letter by the reviewer, Stokes, there were a couple of points to be clarified in the experiment. These points were expressed as follows by Stokes (Crookes 1874:29).

> (a) In your second paper the uncertainty as to the broad bearing is removed. But when the hand was dipped into the water the pressure on the base of the glass vessel (after a little time if the connecting hole be narrow) is increased by the weight of water displaced, and that would of course depress the balance.
>
> (b) I don't think much of mere tremors, for it would require very elaborate appliances to prove that they were not due to a passing train or omnibus or to a tremor in the body of one of the company.

Stokes' comment (a) is irrelevant if the initial condition of the experiment is carefully taken into consideration. The recorded force is the "change in spring force" from its initial value after the start of the experiment as defined by Equation 5. The effect of the buoyant force caused by the finger dipping on the static balance of the lever is included in G_{0H}, the initial value of the spring force, in Equation 5. What is not included in G_{0H} is everything that happens, including the effect of any change in the buoyant force, after the start of the experiment. The following reply of Crookes to Stokes' comment (a) above shows that $b - a \approx 0$ for Crookes' lever:

> . . . I have just tried the experiment of immersing my hand to the very utmost in the copper vessel (Home only dipped in the tips of his fingers) and the rise of the level of the water is not sufficient to produce any movement whatever on the index of the balance, the friction of the apparatus being enough to absorb the ounce or two thus added to the weight. (Crookes 1874:30)

The spring force G is given by Equation 3, which shows that if the gravity force on the water vessel mass, W, is increased by an amount $\Delta W \times g$, owing to the dipping of the fingertips for example, the change in G, (i.e. ΔG) can be calculated by (differentiating Equation 3 with respect to W).

$$\Delta G = (b - a)/(L_b - a) \times \Delta W \times g \quad (6a)$$

$$= O_{ff}/800.1 \times \Delta W \times g, \quad (6b)$$

with $O_{ff} \equiv (b - a)$ in millimeters.

It is assumed in Equation 6a or 6b that the addition of ΔW does not change the horizontal location of the COM of the water vessel. If ΔW is the weight of 3 cubic inches (49.16 cm^3) of water displaced by the dipped fingertips (Crookes 1874:76) (that is, ΔW = 49.16 g = 758.7 grains and O_{ff} = +2.63 mm as discussed above), then ΔG is +2.5 grain-force (0.16 gf), which would be below the sensitivity of Crookes' scale. One may argue that an addition of ΔW shifts the COM of the water vessel (W = 9.865 kg). A moment balance calculation shows that an addition of ΔW = 49.16 g within the diameter (~152 mm) of the hemispherical copper vessel never shifts the COM by more than 0.4 mm.

Conversely, to give the experimentally recorded quasistatic increase of ΔG = 5,000 grain-force in the spring force, Equation 6b requires a weight ΔW = 217.3 lb (98.5 kg) to be added to the water vessel under the off-center condition O_{ff} = +2.63 mm; if O_{ff} = +5 mm, then ΔW > 114 lb (51.7 kg). If O_{ff} = 0, then no value of ΔW (that does not change the horizontal location of the COM) results in a change in the spring force.

In Equation 6a, $(b - a)/(L_b - a)$ is the ratio of the arm lengths of the gravity force on the water vessel W × g and the spring force G. This ratio is almost equal to zero for Crookes' lever, while it is 1/6 for Hare's lever, as mentioned at the beginning of the section ***Analysis of the Second Lever Experiment***. Hare (1855) reported that his experimental subjects (mediums) dipped their hands in his hemispherical copper vessel and his spring balance showed an increase in the spring force of 3 lbf for Subject A and 7 lbf for Subject B (Hare 1855:164–165), which means that external forces of 18 lbf (8.16 kgf) and 42 lbf (19.05 kgf), respectively, must have been exerted vertically downward on the water vessel by the subjects. However, according to static hydraulics, Home in Crookes' experiment or Subject A or B in Hare's experiment could only exert a force corresponding to a reaction against the buoyant force they received when they dipped their fingertips or hands in the water, and these buoyant forces could never have exceeded 2.2 lbf (1 kgf) (for example, the total volume of both hands of the present author up to the wrists is about 560 cm^3). Hence, static mechanics concludes that it is impossible to exert such a magnitude of force on the water vessel by simply dipping fingertips or hands in the water.

The recorded experimental data or observations in Crookes' (the second lever experiment) and Hare's experiments mean that the increases in the spring force were very likely caused by the mediums, and to explain the results on the basis of Newtonian mechanics we need to assume the supposed "psychic force" (in Crookes' terms [1874:100–102]) or some other mechanism in the analysis. Similar reported results of increases in the spring force in Crookes' other experiments (*Experiments* II, III, and IV) with Home are consistent with this interpretation. In these other experiments, the water vessel, together with the iron stand, was removed from the system and Home was directed either to place both of his hands on the support table of the apparatus at P (in *Experiment* II) or to stand one foot (in *Experiment* III) or three feet (in *Experiment* IV) away from the lever with his hands and feet being firmly grasped by a bystander (Crookes 1874:37–38).

As discussed above, what is not included in G_{0H} in Equation 5 is any change in the spring force, including that caused by the change in the buoyant force on

Home's fingertips, which were possibly moving in the water, after the start of the experiment. Here, we are addressing dynamic mechanical effects, which were the subject of comment (b) made by Stokes. These dynamic mechanical effects are investigated in the following subsections.

(2) Simulation of dynamic behavior of the lever system.

(a) A model of small oscillations of the lever system. It is assumed that the lever and water vessel form a rigid body system for small oscillations about the fulcrum in Figure 5, although the water in the vessel is definitely not a rigid body (the effect of water sloshing in the vessel is discussed later). The rotation angle, θ, is defined as the angle between the fixed vertical z-axis and the axis that is fixed to the lever at the fulcrum at *a* and coincides with the z-axis at equilibrium. When the whole rigid body is rotated clockwise by angle θ, the vector, *P*, that defines the location of the COM of the whole system of the rigid body and is perpendicular to the fulcrum axis is also rotated by the same angle. The small oscillations of angle θ can be described by the following small oscillation equation of one degree of freedom:

$$\theta'' + 2\sigma\theta' + \omega_n^2\theta = \Sigma_i N_{ext,\,i}(t)/I_{yrt}, \quad (7a)$$
$$\omega_n^2 \equiv [k_{sp} \times A_0^2 - \mu g \times P \times \cos(\varphi_0)]/I_{yrt}, \quad (7b)$$

where

θ: rotation angle (rad);

ω_n: angular frequency of the natural oscillation of the system (rad/s);[6]

σ: damping coefficient of oscillation (1/s);

k_{sp}: spring constant (N/m), assumed to be either 980 or 1740 N/m;

A_0: initial arm length, A(θ = 0), of the spring force from the fulcrum axis (m), $A_0 = L_b - a = 0.8001$ m;

μ: total mass of the system (≡ W + M_1 + M_2 + M_3 in the static balance analysis in ***Analysis of the Second Lever Experiment***, ***(1)***) (kg), 12.482 kg;

g: gravitational constant (9.8 m/s^2);

P: distance from the fulcrum to the COM of the whole system (m), 0.2052 m;

φ_0: initial angle of vector P from the z-axis (rad), 0.346 rad (19.8°);

I_{yrt}: moment of inertia of the COM of the whole system about the fulcrum axis (kg·m^2), 1.023 kg·m^2;

$N_{ext,\,i}(t)$: time (t)-dependent moment (N·m) of the i-th external force (except for gravity and the spring force) about the fulcrum axis, where Σ_i indicates summation over i;

θ′, θ″: angular velocity and acceleration of the rotation angle θ, dθ/dt, and d^{2}θ/dt^2.

The above data for P, φ_o, and I_{yrt} are calculated assuming that the COM of the water vessel was set exactly over the fulcrum. The initial condition should be consistent with that of the experiment; it is assumed that the system was at equilibrium at t = 0 s, that is, $\theta = 0$ and $\theta' = 0$. The linear differential Equation 7a is solved numerically using the Euler–Romberg method.

The moment of the external force, $N_{ext,\,i}$ (t), depends on the arm length of each external force, $F_{ext,\,i}$ (t), from the fulcrum axis. Three external forces are considered in the following analyses:

(a) the force applied vertically downward on the spring suspension with arm length $A(\theta)$,

(b) the force caused by the sloshing of the water which is assumed to exert a horizontal force against the inner surface of the water vessel, assuming the arm length to be the height (H_v in Figure 5) of the water surface above the fulcrum, and

(c) the vertically downward force applied to the lever at an off-center location from the fulcrum—this force is supposed to simulate the effect of a change in the location of the COM of the water due to sloshing in the vessel.

(b) Simulation of oscillation behaviors in the second lever experiment. Two cases are simulated using the computer model: (1) pulling down of the right end of the lever to simulate the spring force history recorded in *Experiment* I and (2) the superimposing of external forces caused by water sloshing and external tremors onto the force in the first case.

***Case 1: Pulling down the right end of the lever to simulate the spring force history recorded in Experiment* I.**

A history of an external downward force $F_{ext}(t) = F_{psy}(t)$, produced from Fig. 5 in Crookes' paper in the form of a timetable, is exerted on the right end of the lever (see Fig. 5 in Figure 9A of this paper). The table data are interpolated with respect to time to obtain $F_{ext}(t)$ at any transient time. In the calculation, k_{sp} = 980 N/m and σ = 1.0/s were assumed. The large σ value is an effective damping coefficient, which takes into account the effect of water sloshing in the vessel (if the water in the vessel is assumed to be a rigid body, $\sigma \approx 0.3$/s).[7] The calculated results are shown in Figure 6 (the ordinate is shown upside down in accordance with the original Fig. 5 in Crookes' paper).

The purpose of this simulation is to show how the spring balance will respond if $F_{psy}(t)$ is applied to the right end of the lever, although $F_{psy}(t)$ itself is the experimentally recorded change in the spring force. An obviously strange feature concluded from Figure 6 is that the experimentally recorded change in the spring force, $F_{psy}(t)$, does not show the oscillation behavior calculated using the theoretical model. The damped oscillations calculated just after t = 2.5 s in Figure 6, which are caused by the fast increase and almost abrupt stop in the change in $F_{psy}(t)$ within a system period $T_p = 2\pi/\omega_n$ = 0.26 s (ω_n = 24.32 rad/s

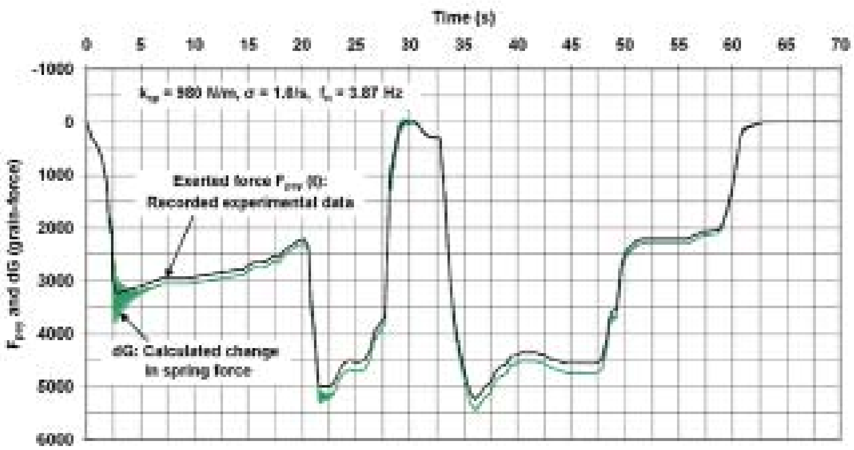

Figure 6. Case 1a: Simulation of the change in spring force in *Experiment* I (with k_{sp} = 980 N/m and damping coefficient σ = 1.0/s; exerted F_{ext} (t) = F_{psy}(t)).

for k_{sp} = 980 N/m), could have been recorded by the movement of the scale index if Home, who was judged to be a total charlatan by Stein (1993:97) and Martin Gardner (1989:xiv), somehow physically pulled down the right end of the lever in such a way as to result in F_{psy}(t), using an almost invisible thread or "some clever mechanical arrangements, or legerdemain" (Crookes 1874:98) to fool the investigators. (We can see similar damped oscillations when we put a weight on a spring balance if the weight is within the maximum weight for the balance.) The damped oscillations are due to the inertia of the lever: The lever cannot abruptly stop at an equilibrium position for the temporally reached maximum force level (about 3,200 grain-force) because of its inertia. An equivalent mass, M_{eff}, of the lever system to a simple harmonic oscillator can be defined as $M_{eff} = k_{sp}/\omega_n^2$; the inertia is roughly that of a 1.66 kg mass for k_{sp} = 980 N/m. The recorded F_{psy}(t) showed a pattern of variations in the spring force, but *the pattern lacks the characteristics of oscillations*, as if the lever system were no longer a harmonic oscillator. A small difference is seen between F_{psy}(t) and the calculated response in Figure 6, and it is as large as 190 grain-force at t = 36 s; this difference can be explained by an increase in the arm length (P × cos[φ_o] × θ in Equations 7a and 7b) of the gravity force caused by a small increase in the rotation angle, θ (≈ 0.0043 rad = 0.25°).

If the spring constant is as great as 1,740 N/m, the damped oscillations just after t = 2.5 s are a little less remarkable than the case with 980 N/m because the system period T_p is shorter or the inertia of the lever M_{eff} is less (ω_n = 32.66 rad/s, T_p = 0.19 s, M_{eff} = 1.63 kg for k_{sp} = 1,740 N/m).

The results of the analytical simulation suggest that the recorded change in the spring force in *Experiment* I was caused not by a natural external disturbance or a force pulling down the lever using a thread but by an unknown force in a very deliberate manner, apparently suppressing the oscillations of the system.[8] This reasoning is further justified by the following results for Case 2.

Case 2: Superimposing external forces caused by water sloshing and external tremors onto the force in Case 1.

In this simulation, external forces caused by water sloshing and external tremors are considered.

(a) Water sloshing. Stokes did not use the term "sloshing"[9] in his comment (b) on the second lever experiment. A possible effect of water sloshing was mentioned by Stein in his book, referring to Robert Hare's book (1855):

> Nevertheless, the possibility remains that some of the water could have been "sloshed" far enough off the fulcrum to have registered on the scale. (Stein 1993:96)

This comment by Stein on the possible effect of water sloshing is intended to claim that even if the water vessel was set exactly over the fulcrum, the horizontal location of the COM of the water vessel might have shifted "far enough off the fulcrum" when water sloshed in the vessel; hence, the effect would have registered on the scale.

The dynamic response of the lever system to the water sloshing is simulated in the following way. When speculating on the effect of water sloshing in the vessel, there is another point to consider. If the water mass sloshes in a direction perpendicular to the fulcrum axis, the impulse caused by water sloshing against the vessel wall gives an impulsive torque about the fulcrum. The arm length of the impulse could be provided by the height of the top of the vessel (H_v = 260.3 mm) from the support table in Figure 5.

How large will the impulse be? A very simple model is provided to give the possible maximum impulse of water sloshing in *Experiment* I (see Figure 7). Crookes reported that the depth of the water in the copper vessel was 1.5″. Suppose that there is a horizontal dividing surface in the glass vessel at a depth of 1.5″ (38.1 mm) from the water surface. The divider completely separates the top part of the water from the lower part. Now, let us forget the copper vessel. Suppose further that the top water is gathered to the left side of the top pool by a vertical divider that is parallel to the fulcrum axis. The total mass of the water in this shifted pool is estimated to be M_{up} = 1.657 kg, and the pool height becomes h_2 = 50.8 mm (corresponding to the estimated top of the vessel). Now, suppose that the vertical divider is removed suddenly, and the water is free to flow from the shifted left pool to the empty right pool. The water rushes to the inner surface of the vessel wall of the right pool and imparts an impulsive force.

This model gives the *x*-component of the sloshing force, $F_{slosh\ 1} = 0.72$ N, whose moment is $N_{slosh\ 1} = H_v \times F_{slosh\ 1} = 0.187$ N·m with a duration of the impulse dt = 0.1 s. $N_{slosh\ 1}$ is assumed to be an alternating square impulse; it is a clockwise torque when water sloshes to the right and counterclockwise torque when water sloshes to the left. The sloshing impulse is assumed to start at $t_0 = 1$ s into the transience and to repeat several times with the same duration, dt = 0.1 s, and alternating plus and minus signs. It is assumed that there are calm periods of the same dt between impulses. Because the sloshing phenomenon eventually disappears, the impulse is multiplied by the function $\exp\{-(t - t_0)/\tau\}$ with an arbitrarily assumed $\tau = 2$ s. The period of sloshing is $T_{slosh} = 3 \times dt = 0.3$ s; $\omega_{slosh} = 2\pi/T_{slosh} = 20.9$ rad/s.

To be consistent with this water sloshing, the effect of the change in the location of the COM (oG_m in Figure 7) of the upper pool water with respect to the fulcrum should be considered, and this latter effect is far greater than the former. The COM, which is initially set exactly over the fulcrum, is shifted from the fulcrum by $oG_m = 33.4$ mm. The maximum torque of the latter effect is calculated as $N_{slosh\ 2} = oG_m \times F_{slosh\ 2} = oG_m \times (M_{up} \times g) = 0.542$ N·m. The arm length, oG, is assumed to change as $oG(t) = oG_m \times \sin[\omega_{slosh}(t - t_0)]$. This formulation is considered specifically for the case of Crookes' lever, in which the water vessel is located exactly over the fulcrum at equilibrium ($O_{ff} = 0$). $N_{slosh\ 2}$ is in phase with $N_{slosh\ 1}$.

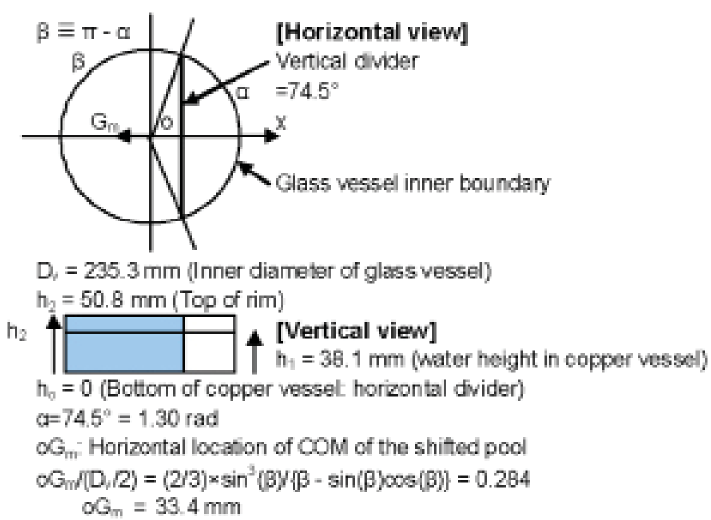

Figure 7. Schematic of the water-sloshing model with a shifted water pool above the bottom of the copper vessel.

Because the buoyant force on the dipped fingertips could never have exceeded 1 kgf, as discussed in ***(1) Static balance of the lever system***, any change in the buoyant force caused by moving fingertips could never have exceeded 1 kgf. Hence, $N_{slosh\ 2}$ (moment of 1.657 kgf) covers the effect of the change in the buoyant force on the lever; that is, we do not need to simulate the effect specifically.

(b) External tremors. An external tremor, F_{ext} (t), is assumed to be exerted vertically on the right end of the lever. Any F_{ext} (t) can be decomposed into a Fourier spectrum, regardless of whether the spectrum is discrete or continuous. The lever system responds to the external tremor on the basis of its own natural oscillation frequency, $f_n = \omega_n/2\pi$ (3.87 Hz). Hence, let us consider only the case in which F_{ext} (t) has the form of $F_{exo} \times \sin(\omega_{ex} t)$, with ω_{ex} as a parameter around the natural angular frequency of the lever system, ω_n. The amplitude, F_{exo}, can be arbitrarily assumed for Case 2. Suppose that an external tremor accidentally caused, not by Home, but by another person or an omnibus or train passing near Crookes' house resulted in an additional maximum extension of the spring as large as 1 mm. In this case, F_{exo} may be assumed to be $F_{exo} = k_{sp} \times 0.001$ N. F_{exo} is 0.98 N for $k_{sp} = 980$ N/m. F_{exo} should be the Fourier spectrum of $F_{ext}(t)$ at $\omega = \omega_{ex}$. The arm length of $F_{ext}(t)$ is A_0 (= $[L_b - a]$ = 0.8001 m in Figure 5). The torque of $F_{ext}(t)$ is $N_{ext}(t) = F_{ext}(t) \times A_0$.

Assuming external tremors of $F_{ext}(t) = 0.98 \times \sin(\omega_{ex} t)$ with two arbitrarily assumed frequencies ($f_{ex} = \omega_{ex}/2\pi$), $f_{ext1} = 10$ Hz and $f_{ext2} = 5$ Hz, the system response is calculated for the superposed forces. The first tremor is arbitrarily assumed to gradually start at t = 10 s and disappear at t = 17 s; the second is assumed to start at 40 s and disappear at t = 50 s.

The torques of these four external disturbances, $N_{ext,\ i}$ (t) in Equation 7a, as specified in ***(a)*** and ***(b)*** above are shown together with the torque of the force $0.964 \times F_{psy}(t)$ (with an adjusting factor of 0.964) in Figure 8A (the ordinate is shown upside down).

The calculated system response is shown in Figure 8B. The lever system has a natural frequency, f_n (= $\omega_n/2\pi$) = 3.87 Hz. The assumed fundamental frequency of water sloshing is $f_{slosh} = 3.33$ Hz; the frequency ratios f_{slosh}/f_n, f_{ext1}/f_n, and f_{ext2}/f_n are 0.86, 2.58, and 1.29, respectively. The first and third frequency ratios are relatively close to the resonance value (1.0), and hence these two disturbances are amplified in the system response, as seen in Figure 8B. One may argue that if the water sloshes in the vessel and the lever system responds to the impulse, then the natural angular frequency, ω_n, in the basic Equation 7b will no longer be constant but dependent on time t. This situation will be the case of "parametrically excited oscillation." However, even if such an effect is taken into account, the system behaves in an oscillating manner very different from the recorded history of the change in the spring force, $F_{psy}(t)$, in *Experiment* I.

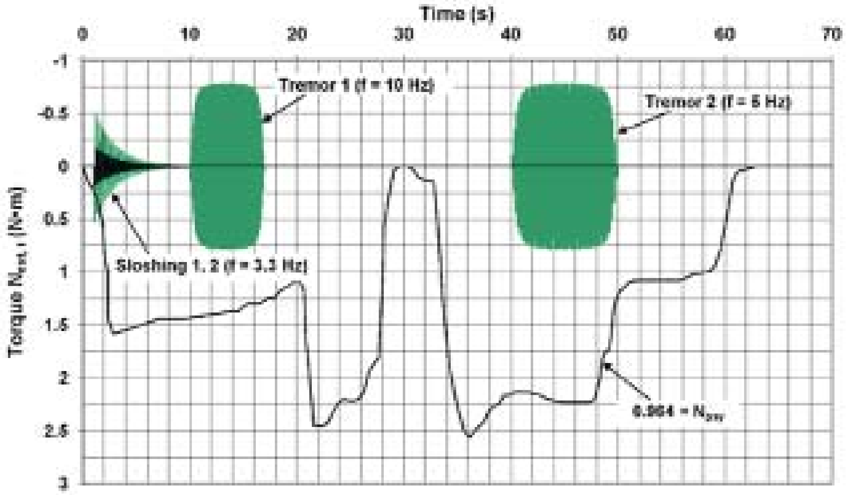

Figure 8A. Torques of external forces supposed in Case 2.

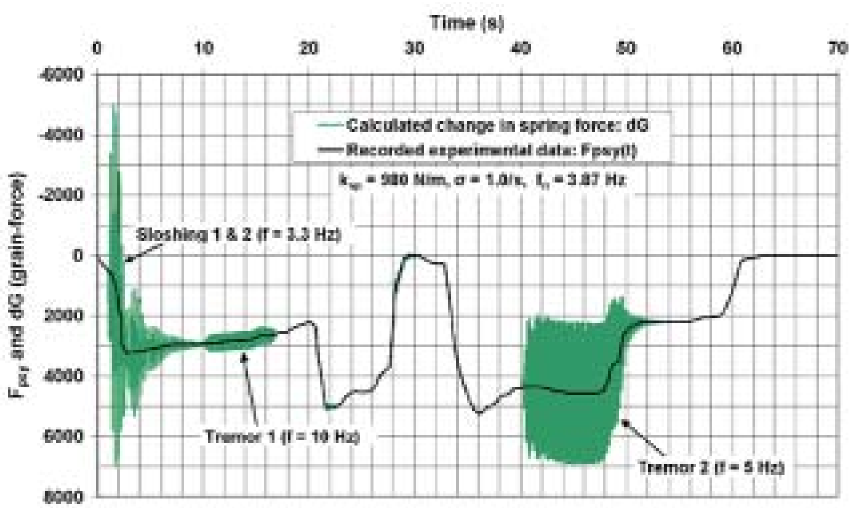

Figure 8B. Case 2: System response to the superimposed external forces/ torques in Figure 8A (with k_{sp} = 980 N/m and σ = 1.0/s).

Hence, Figure 8B provides our response to the comment of Stokes on the probable effect of external tremors and the comment of Stein on the probable effect of water sloshing in the vessel. If there had been such disturbances as speculated in Crookes' *Experiment* I, the effects would have appeared as calculated in Figure 8B. However, the recorded system response seems to have shown no effect from such disturbances.

If there is no force $F_{psy}(t)$, or, equivalently, if Home was not present at the scene of *Experiment* I, and only the speculated external disturbances exist, then the system response shows oscillations about the equilibrium, i.e. the baseline (dG = 0), caused by the sloshing and external tremors. Even if the maximum extension of the spring due to the external tremors becomes larger than the assumed 1 mm, the system response is basically the same, i.e. oscillations about the baseline.

Finally, all these theoretical analyses of the second lever experiment presuppose some uncertainties in the geometry and mass of the water vessel. These uncertainties affect the inertial moment of the water vessel. For example, the actual thickness of the glass vessel may have been 5 mm instead of the assumed 3 mm. This thicker glass vessel results in an approximately 4.6% increase in the total mass (W) of the water vessel containing water and a 4% increase in the total mass (μ) of the lever system. These increases result in a 6% increase in the total moment of inertia (I_{yrt}) and a 1.4% decrease in the natural angular frequency, ω_n. The biggest uncertainty in the analysis is probably in the spring constant k_{sp} (due to a lack of information in Crookes' paper [1874]). The natural angular frequency is increased by 34% (from 24.3 to 32.7 rad/s) if k_{sp} changes from 980 to 1740 N/m; hence, the parametric cases of k_{sp} have been mentioned in the above analyses. These analytical results correspond to what Crookes stated in his reply to Stokes' comment (b):

> You say "you don't think much of mere tremors," as if in the other experiments described in my second paper the movements of the apparatus were only of this kind. This is not the case; the quivering of the apparatus always took place before the index moved, and the upward and downward motion of the board and index was of a very slow and deliberate character, occupying several seconds for each rise and fall; a tremor produced by passing vehicles is a very different thing from a steady vertical pull of from 4 to 8 lbs., lasting for several seconds. (Crookes 1874:30)

Had Crookes shown the natural oscillation behavior, that is "the quivering," of the apparatus in a figure recorded with his system, his argument would have been more persuasive. The theoretical results presented above can be expected from the start without performing any calculation, if not on a quantitative basis. The reviewers of Crookes' papers could have at least given some constructive advice on ways to clarify any scientific ambiguities in his experiments for the acceptance of his papers. The conclusion of ***Analysis of the Second Lever***

Experiment section is that the speculations of Stokes and Stein cannot explain the recorded history of the change in the spring force in *Experiment* I. Although we cannot explain the exact procedure, we are compelled to conclude that Home exerted force $F_{psy}(t)$ on the lever system when he said "he felt a power, force, or influence" as he dipped his fingertips in water. *In my view*, Crookes' four experiments, *Experiments* I to IV, in the second series of experiments and the previously mentioned Hare's cases together probably demonstrate the existence of macro-PK. However, I expect many criticisms against this view of mine; hence, let me continue the discussions in the ***Discussion*** section and ***Possible Explanation of Crookes' Experiments?*** section.

Many researchers have defended Home's psychic abilities against various skeptical arguments to refute his cases. I hope this study enhances Home's credibility and stimulates mainstream scientists' interest in paranormal phenomena in general.

Discussion

(1) Control of experiments. The experimentalist Crookes wrote:

> In the meanwhile I trust that others will be induced to pursue the investigation in its scientific form. It should, however, be understood that, equally with all other scientific experiments, these researches must be conducted in strict compliance with the conditions under which the force is developed. (Crookes 1874:42)

From the above extract as well as from other quotations of Crookes in which he described how he prevented, with his collaborators, Home from performing any tricks in his experiments, I have no grounds to say that Crookes did not have sufficient control over his experiments with Home. Apparently, the fact that Crookes' (1874) descriptions are insufficient to recreate his experimental setup may invite criticism from the scientific community. Further, when one sees the recorded results (Figs. 5, 6, 7, and 8 in Crookes' paper [1874:37–38]; the first two figures are reproduced in Figure 9A and 9B in this paper), the figures reveal that the recording device was primitive. Nevertheless, the device was sensitive enough to record 5,000 grain-force and some abrupt changes in the spring force. One may evaluate Crookes' experimental setup as rough or primitive, and hence, one may say that the 5,000 grain-force (324 gf = 3.18 N) recorded by Crookes' device results in only a few millimeters of extension in his spring balance, which can be easily realized in conceivable ways such as external disturbances to the experimental setup. Three examples of such conceivable disturbances were *explicitly expressed* by Stokes and Stein, as discussed in Cases 1 and 2 in the section ***Simulation of Dynamic Behavior of the Lever System***, in which I rebut their arguments. It should be noted again that

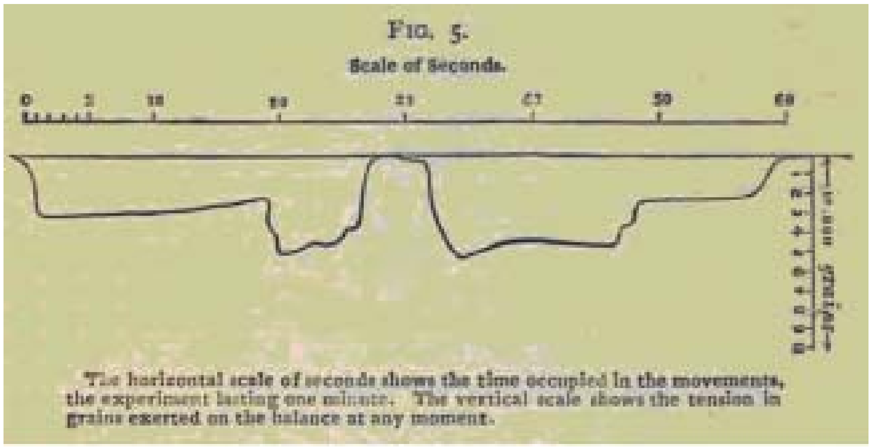

Figure 9A. Reproduction of Crookes' Fig. 5: Result of *Experiment* I (Crookes 1874:37).

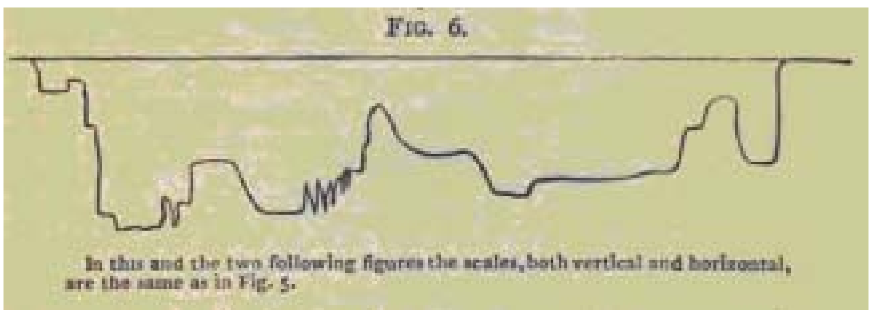

Figure 9B. Reproduction of Crookes' Fig. 6: Result of *Experiment* II (Crookes 1874:37).

the recorded $F_{psy}(t)$ showed a pattern of variations in the spring force, but *the pattern lacks the characteristics of oscillations*; any conceivable way to explain Crookes' results must realize *this feature*.

However, it is more than 140 years since the experiments of Hare and Crookes, and hence contemporary replication of the experiments is desirable to further confirm the validity of their experimental results. Some replication experiments, if not of *reproducible* nature, could be possible in the future; hence, the analyses in this paper have a meaning and are not futile.

(2) Non-reproducibility of Crookes' experiments. Obviously, Crookes could not *reproduce the same results* even in his own experiments, as he stated:

> In the case of Home, the development of this force [psychic force] varies enormously, not only from week to week, but from hour to hour; on some occasions the force is inappreciable by my tests for an hour or more, and then suddenly reappears in great strength. (Crookes 1874:40)

Crookes did not discard his results despite the non-reproducibility of the results, and obviously this earned him the contempt of the scientific community, as detailed in Crookes (1874:45–80). One cannot propose or standardize any cause-and-effect law on the basis of such phenomena. It has been considered that *scientifically significant physical phenomenon* is that which can be regularly reproduced by anyone who conducts the appropriate experiment in the way prescribed. This reinforces the previously mentioned critical statement: "Unexplained cases are simply unexplained. They can never constitute evidence for any hypothesis." However, this criticism is in conflict with the spirit of scientific research. If we continue to ignore the unexplained cases, we will never learn what is within them. Obviously, to search for the reason why the supposed mind–matter interaction such as that in Crookes' experiments is irregular and probably impossible to reproduce is one major theme for psi-theoreticians.

Additional Remarks on Psychic Phenomena

Possible Explanation of Crookes' Experiments?

Assuming that macro-PK really exists, as recorded in Crookes' second series of lever experiments, and that it is a result of the interaction between the human mind (or the brain) and inanimate matter, the next question is how the interaction could occur. Radin (1997) writes in Chapter 16: Theory: "This is not to say that there are no theories of psi, for actually there are many. They range from . . . (pp. 277–278)." However, I would like to introduce an idea to explain psi-phenomena in general, on the basis of some relevant discussions made so far in parapsychology studies.

Irwin introduced several specific theories and pre-theoretical ideas to explain psi phenomena (in the category of extrasensory perception [ESP] and micro-PK) in his introductory textbook on parapsychology (1989:Chapter 8). Among them, the idea of "pseudosensory models" (of ESP), which is obviously related to the idea of the "sixth sense," attracted my attention. Moreover, Radin writes about "What psi implies for various fields of scientific research" in his book *The Conscious Universe* (1997:Chapter 17). He asks questions about possible implications for biological research. Among them, "Are there secret senses we have overlooked?" (Radin 1997:292) attracted my attention. Moreover, there is Charles Richet's "cryptesthesia" (for explaining ESP), meaning "*the human mind* [as a function of the brain] *has means of cognition other than our five poor senses*" (Richet 1923:600).These ideas suppose that the human brain has some yet-to-be found sensory functions other than the five senses.

My interest is about psychical knowledge that broadly explains psi phenomena (from ESP to macro-PK) on the basis of "inner senses" used in everyday life by our subconscious self, i.e. the inner self or inner ego. Some of the scientific basis of the significance of this psychical knowledge was described in Ishida (2010:Section 4.3). This psychical knowledge explains that we use our five outer (physical) senses as extensions of the inner senses; our physical senses allow us to perceive the physical world because they, as extensions of the inner senses, are finely attuned to the physical world. I refer to at least nine "inner senses," described primarily in Roberts (1997a, 1997b). Roberts summarized the nine inner senses in her book *The Seth Material* (2001/1970:Chapter 19), but in modest words, i.e. ignoring the more flagrant terms such as levitation, teleportation, and space travel. According to this psychical knowledge, the biological instinct is closely related to the sixth inner sense, which Roberts called "Innate Knowledge of Basic Reality." Regarding ESP, this psychical knowledge says:

> And while awareness of clairvoyance is fairly rare, it does exist; and though watered down in most instances, is a natural method of warning individuals of happening with which their own outer senses would not be familiar. It is a natural method of protecting the individual by giving him an inner knowledge of events. Without constant clairvoyance on the part of every man and woman, existence on your plane would involve such inner, psychological insecurity that it would be completely unbearable.
>
> [. . .] As telepathy operates constantly at a subconscious level, as a basis for all language and communication, so clairvoyance operates continually so that the physical organism can prepare itself to face its challenges. (Roberts 1997b:16–17, *ES2*/Session 44 on April 15, 1964)[10]

Hence, it is my expectation that parapsychologists gain greater insight into psi phenomena by unearthing cryptesthesia or secret senses that we may be unaware of. In my opinion, paranormal phenomena will never be understood as long as researchers confine themselves to a closed understanding of the physical dimensions. The above-mentioned inner self belongs to the nonphysical dimension. In my previous work (Ishida 2010), I stressed that physical dimensions are not a closed system, but are connected to nonphysical dimensions via a bridge of "consciousness," and it is via this bridge that the cherished law of conservation of energy is probably violated in the several well-known modes of psychological transition events, which are a blind spot for physicists. According to the above-mentioned psychical knowledge, human ego has its root in the unconscious self, which belongs to nonphysical dimensions. To understand the paranormal phenomena in psychical research, we need a detailed knowledge of the abilities of the unconscious self, which have been extensively reviewed in Ellenberger's (1970) book *The Discovery of the Unconscious*. If I understand him correctly, this is one of the points that Jule Eisenbud emphasized in his book *Parapsychology and the Unconscious* (1983).

Possible Implications of Large-Scale Psi Phenomena

Levitation and materialization phenomena in psychical research, if verified as authentic, could have a great influence on mainstream science. Even the levitation phenomenon of macro-PK, which appears very close to reality because there are contemporary people (of the Transcendental Meditation organization) who are apparently practicing levitation in their own circle, could have a great impact on physics, if the mechanism of interaction between the mind and matter is explained. I would like to focus on the materialization phenomenon in this section to discuss its possible implications for mainstream science.

The temporal materialization and dematerialization of a human hand or an apparently living human form in psychical research is well-known since the initiation of psychical research in 1882. The materialization of Katie King in Crookes' séances (Crookes 1874:108–112) with the medium Florence Cook (conducted a few years after the lever experiments with Home) became notorious because of the alleged exposure of Miss Florence Cook as a fraud in her other séances (e.g., see Hall 1984, Stein 1993:43–48). However, materialization events are not specific only to Crookes' cases. Many similar events have been reported up until the early 20th century (e.g., see Carrington 1939, Beloff 1993), and to my knowledge events have been reported as recently as 1964 and 1968 (see Roberts 1997a:52–58, 1999:218–221, 2000:295–296). Many psychical researchers are strongly convinced of their experiences of materialization events; for example, Hereward Carrington (1880–1958) quoted Theodore Flournoy (1854–1920) as follows:[11]

> If such a phenomenon is authentic, it would be interesting to note the revolution which must necessarily follow in our biological ideas. Nature has taken upon our globe some hundred million years to transmute chemical substances into humanity; yet now it requires but twenty years to complete an adult; and *voilà!* by means of a young girl asleep behind a curtain it is possible, by reason of a species of partheno-genesis of a nature yet unguessed, to produce in two minutes a veritable Arab, of fine stature, with a beard down to his chin, walking, speaking, breathing as ourselves . . .

After quoting Flournoy, Carrington continued:

> It is hardly to be wondered at that biologists reject the very idea *a priori!* Nevertheless, there is much evidence in its favour, and I personally am quite convinced of the actuality of materialization. In saying this, however, it must not be understood that I accept the majority of phenomena which have been adduced in its favour; far from it. With few exceptions, every materializing medium whom I have ever seen has turned out, upon investigation, to be an arrant fraud. Nevertheless, such phenomena exist, and I believe that, in the presence of Eusapia Palladino, I have seen materializations of an unquestionably genuine character. I have seen, touched, and felt hands and portions of a living body which have occasionally melted within my grasp. It is my belief that similar manifestations have been seen by others, in the presence of such mediums as Home, Eva C., Willy and Rudi Schneider, etc. Genuine phenomena of the sort may be *rare*, but they are, in my estimation, undoubted. (Carrington 1939:77–78)

As reported by Crookes in his séances with Home (Crookes 1874:92–93), materialization phenomenon reported by psychical research had been known to scientists for at least 60 years before the discovery (in 1932) of the production of electron–positron pairs which manifest in cosmic ray showers in a cloud chamber for less than 1 ms before positron annihilation. The phenomenon of "materialization and dematerialization" in psychical research has nothing to do with the "production and annihilation" of matter and antimatter in physics. Besides, in Braude's more recent book, *The Gold Leaf Lady* (2007), he writes in Chapter 1 about the results of his field research conducted from 1988 to 1990 on a lady in Florida (with the help of psychiatrist and parapsychologist Berthold Schwarz, who informed Braude of the lady's peculiar abilities). The lady apparently spontaneously produces a metal foil on her body. The metal foil has a composition similar to a Dutch metal (an alloy of primary composition 84% Cu + 16% Zn, with a light golden color and excellent ductility). The important point is, if the materialization of the foil is authentic, that the materialized metal is a *real metal* alloy that *does not* dematerialize (hence, it can be subjected to chemical analysis). Although Braude appears confident of the authenticity of this phenomenon on the basis of his own observations, he appears very careful in drawing any scientific conclusions before much more study on this case is done. How these metal foils were produced by the lady, much like the materialization–dematerialization phenomenon, remains to be explained.

And, to quote the previous criticism: "Unexplained cases are simply unexplained. They can never constitute evidence for any hypothesis." However, the act of ignoring physical facts surrounding paranormal phenomena may be similar to the act of ignoring *systematic errors* in scientific experiments, and, from my point of view, the systematic neglect has been conducted intentionally (e.g., see Inglis 1984:Chapter 10) without realizing, or with realizing the threat of, their possible impacts on successful science. The possible impact of the findings of paranormal phenomena on current science is briefly speculated upon in this section to respond to this criticism. With reference to the "one experience," mentioned in Carrington's quote above, *if and only if this experience is authentic*, would it cast serious doubts on (if not undermine) both (1) the *Big Bang* theory explaining the origin of our material world and (2) the *Darwinian theory of evolution* explaining the origin of the human species. I have the following explanations:

(1) According to the Big Bang theory, our material world is supposed to have originated entirely from pair-production of particles and antiparticles. Somehow, most of the antiparticles mysteriously disappeared from our observations, leaving behind largely ordinary particles from the pair-productions (through some yet-to-be-discovered strong CP violation mechanism or other mechanisms). This theory completely ignores the undeniable materialization phenomenon as recorded in psychical research.

(2) According to the Darwinian theory of evolution, biologically speaking, the human form can be produced only as an infant from a human female after approximately 9 months from impregnation whether or not the method is natural or artificial methods. This theory too ignores the undeniable fact quoted from Flournoy's writing above (i.e. "the revolution which must necessarily follow in our biological ideas").

(3) Using (1) and (2), we can conclude that these two fundamental theories, i.e. the Big Bang theory and the Darwinian theory of evolution, are *dogmatic and biased* because they conveniently neglect the undeniable facts ascertained in psychical research. The loopholes in the above-mentioned fundamental theories can be justified specifically because (a) modern physics, despite its rapid progress, is still grappling with unanswered questions (ten mysteries), including the above-mentioned asymmetry between matter and antimatter (see Kane 2004) and (b) the origin of life on Earth (long after the birth of our apparently life-friendly universe) still needs to be satisfactorily explained (see Dyson 1999, Davies, 1999, 2007) prior to the point that Darwinian evolution of life began all the way up to the human species equipped with ego-directed consciousness.

Such loopholes in the fundamental theories explaining the origin of the universe, life on Earth, developments of human species, and human consciousness may jeopardize further advancements in the field. I would like to close this paper quoting the above-mentioned psychical knowledge:

> Consciousness and matter and energy are one, but consciousness initiates the transformation of energy into matter. (Roberts 1997c:120–121, *Dreams,* Volume 1/Session 882 on September 26, 1979)[12]

Notes

[1] According to a science handbook, the density of mahogany ranges from 0.45 to 1.06 g/cm^3, depending on the moisture content (National Astronomy Laboratory Japan 2003). Mahogany with 11% moisture content has a density of 0.5 g/cm^3.

[2] This is based on a bold assumption. Assuming geometrical proportionality between Figs. 2 and 3 on p. 34 of Crookes (1874), the spring is estimated to expand 64 mm for the maximum weight of 25 lb. If this estimate is roughly correct, then k_{sp} is estimated to be 1740 N/m. The spring constant 980 N/m is for the spring balance (maximum weight 10 kg = 22.0 lb with maximum extension 10 cm) used in the mock-up experiments which were conducted by this author.

[3] The angle of tilt of line $e - f$ from the vertical line in the quoted sketch is estimated to be $\varphi \approx 52.5°$ and the required H is 66.2 lbf (30.0 kgf) for the angle; however, the angle probably exceeds the maximum angle of friction of the system.

[4] The equation constants (in Equation 7b in the section ***Simulation of Dynamic Behavior of the Lever System***) of natural oscillation of the first lever experiment are: A_0 = 0.8763 m, μ (kg) = 2.7216, P (m) = 0.4208, φ_0 = 84.805° = 1.48 rad, and I_{yrt} (kg·m^2) = 0.6321. Estimated range of the spring constant k_{sp} of Crookes' scale is from 980 to 1740 N/m; corresponding range of natural oscillation frequency is from 5.5 to 7.3 Hz.

[5] One may wonder about the meaning of the detailed numbers estimated below when the uncertainty is definitely large; however, these are shown to record what data are used in the following analyses. The effect of uncertainty on the calculations will be discussed when necessary.

[6] A higher order approximation for ω_n^2 depends on the equilibrium length of the suspension (string plus spring balance in Figure 5), H_0 (22.05″ = 56.0 cm) and its natural length without load, J_0 (21.62' = 54.93 cm for k_{sp} = 980 N/m) as follows:

$$\omega_n^2 = [k_{sp} \times A_0^2 \{1 + (1 - (J_0/H_0)) \times (H_0 \times R_0 + R_0^2)/ A_0^2\}$$
$$- \mu g \times P \times \cos(\varphi_0)]/I_{yrt}$$
$$\approx [k_{sp} \times A_0^2 - \mu g \times P \times \cos(\varphi_0)]/I_{yrt}.$$

The neglected term in the right side of the ω_n^2 expression above contributes (to ω_n) by less than 0.1% in Crookes' lever.

[7] The effective damping coefficient (σ = 1.0/s) was determined based on the results of a mock-up experiment conducted by this author for this study. The geometry of the board in the mock-up was approximately adjusted to that of Crookes' board. The total weight of the board was 2.9 kg (cf. 2.62 kg for Crookes' board). The plastic bucket geometry was an average outer diameter of 250 mm, thickness of 2 mm, height of 220 mm, and weight of 9.6 kg when filled with water; these values in Crookes' experiment are estimated to be 235.3, 3, 190.5 mm, and 9.86 kg, respectively. If $\sigma < 1.0$, then the calculated damping oscillations in Figure 6 are prolonged.

[8] We can probably produce an F(t) history like $F_{psy}(t)$ without damped oscillations, for example, by holding the right end of the lever and carefully moving it up and down using hands, within 3 to 2 mm, for a k_{sp} varying from 980 to 1740 N/m, respectively. However, the lever is no longer a harmonic oscillator under such a condition.

[9] Mechanical interaction between a tank wall and sloshing liquid within the tank is a modern engineering problem, like that posed by a large oil tank in the event of an earthquake.

[10] From the book *The Early Sessions: Book 2 of The Seth Material*, © 1997, Jane Roberts. Reprinted by permission of New Awareness Network, Inc. P. O. Box 192, Manhasset, NY 11030. All rights reserved.

[11] This quotation of Flournoy by Carrington was made from the former's writing (Flournoy 1911:220−222) based on the paper by Professor of physiology Charles Richet (1850−1935) published in *The Annals of Psychical Science* (October and November, 1905).

[12] From the book *Dreams, "Evolution," and Value Fulfillment, A Seth Book,* Volume One © 1997, Jane Roberts. Reprinted by permission of Amber-Allen Publishing, Inc. P. O. Box 6657, San Rafael, CA 94903. All rights reserved.

Acknowledgments

This study is, in a sense, a trial of the completion of the 140-year-old unfinished papers of Sir William Crookes. I would like to thank the reviewers and the editors of the *Journal of Scientific Exploration* for their constructive advice on ways to clarify any scientific ambiguities for acceptance of this paper during several rounds of their patient review process.

References

Beloff, J. (1993). *Parapsychology: A Concise History* (Chapter 4). New York: St. Martin's Press.

Brandon, R. (1983). *The Spiritualists: The Passion for the Occult in the Nineteenth and Twentieth Centuries*. London: Weidenfeld and Nicolson.

Braude, S. E. (1986). *The Limits of Influence: Psychokinesis and the Philosophy of Science*. New York/London: Routledge & Kegan Paul. [Second edition, 1997, Lanham, MD: University Press of America]

Braude, S. E. (2007). *The Gold Leaf Lady and Other Parapsychological Investigations*. Chicago University Press.

Carrington, H. (1939). *Laboratory Investigations into Psychic Phenomena*. Philadelphia: The David McKay Co.

Crookes, W., Sir (1874). *Researches in the Phenomena of Spiritualism.* London: J. Burns. [Previously published in 1871 in *The Quarterly Journal of Science* now available from Pomeroy, WA: Health Research]

Davies, P. C. W. (1999). *The Fifth Miracle: The Search for the Origin and Meaning of Life*. New York: Simon & Schuster Paperbacks.

Davies, P. C. W. (2007). *Cosmic Jackpot: Why Our Universe Is Just Right for Life*. New York: Houghton Mifflin.

Dyson, F. J. (1999). *Origins of Life* (second edition). Cambridge University Press.

Eisenbud, J. (1983). *Parapsychology and the Unconscious.* Berkeley: North Atlantic Books.

Ellenberger, H. F. (1970). *The Discovery of the Unconscious: The History and Evolution of Dynamic Psychiatry.* New York: Basic Books.

Flournoy, T. (1911). *Spiritism and Psychology* (translated by H. Carrington). New York/London: Harper & Brothers.

Gardner, M. (1989). *Science: Good, Bad and Bogus* (paperback edition). [Initially published in 1981, Buffalo, NY: Prometheus Books]

Hall, T. H. (1984). *The Medium and the Scientist: The Story of Florence Cook and William Crookes*.

Buffalo, NY: Prometheus Books. [Originally published in 1962 as *The Spiritualists*, London: Duckworth]

Hare, R. (1855). *Experimental Investigation of the Spirit Manifestations, Demonstrating the Existence of Spirits and Their Communion with Mortals* (Plate III & pp. 164–165). New York: Partridge & Brittan.

Inglis, B. (1984). *Science and Parascience: A History of the Paranormal, 1914–1939*. London: Hodder and Stoughton.

Irwin, H. J. (1989). *An Introduction to Parapsychology*. Jefferson, NC: McFarland.

Ishida, M. (2010). Rebuttal to claimed refutations of Duncan MacDougall's experiment on human weight change at the moment of death. *Journal of Scientific Exploration*, *24*, 5–39.

Jenkins, E. (1982). *The Shadow and the Light: A Defence of Daniel Dunglas Home, the Medium*. London: Hamish Hamilton.

Kane, G. (2004). The dawn of physics beyond the standard model. *Scientific American Exclusive Online*, *12,* 53–60.

Lamont, P. (2005). *The First Psychic: The Peculiar Mystery of a Notorious Victorian Wizard*. London: Abacus.

National Astronomical Observatory Japan (2003). *Rika Nenpyo 2003* [in Japanese]. Tokyo: Maruzen. p. 370.

Radin, D. I. (1997). *The Conscious Universe: The Scientific Truth of Psychic Phenomena*. San Francisco: HarperEdge.

Richet, C. (1923). *Thirty Years of Psychical Research: Being a Treatise on Metapsychics* (translated by S. DeBrath). London: W. Collins Sons.

Roberts, J. (1997a). *The Early Sessions: Book 1 of The Seth Material* (Inner senses in Sessions 20, 24, 35–41 in 1964). Manhasset, NY: New Awareness Network.

Roberts, J. (1997b). *The Early Sessions: Book 2 of The Seth Material* (Inner senses in Session 50, on May 4, 1964). Manhasset, NY: New Awareness Network.

Roberts, J. (1997c). *Dreams, "Evolution," and Value Fulfillment*, *Volume One* (new edition). San Rafael, CA: Amber-Allen Publishing. [Originally published in 1988 and 1986, Upper Saddle River, NJ: Prentice-Hall]

Roberts, J. (1999). *The Early Sessions: Book 6 of The Seth Material* (pp. 218–221, Session 266 on June 9, 1966). Manhasset, NY: New Awareness Network.

Roberts, J. (2000). *The Early Sessions: Book 8 of The Seth Material* (pp. 295–296, Session 412 on May 27, 1968). Manhasset, NY: New Awareness Network.

Roberts, J. (2001). *The Seth Material*. Manhasset, NY: New Awareness Network. [Originally published in 1970, Upper Saddle River, NJ: Prentice-Hall]

Stein, G. (1993). *The Sorcerer of Kings: The Case of Daniel Dunglas Home and William Crookes*. Buffalo, NY: Prometheus Books.

Thalbourne, M. A., & Storm, L. (Eds.) (2005). *Parapsychology in the Twenty-First Century: Essays on the Future of Psychical Research*. Jefferson, NC: McFarland.