Possible Application of Silicon Photomultiplier Technology to Detect the Presence of Spirit and Intention: Three Proof-of-Concept Experiments

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Context: Research investigating the survival of consciousness hypothesis has been hampered by the lack of an independent measure of the purported presence of spirit (POS). Although numerous anecdotes involving electronic devices (including tape recorders, answering machines, and computers) claim that POS can be detected with sensitive electromagnetic sensors, little systematic laboratory research has investigated this possibility.

Objective: The purpose of this exploratory laboratory research was to test the feasibility of using a state-of-the-art silicon photomultiplier system to detect low photon levels potentially associated with POS. A PCDMini photon counting device manufactured by sensL provided a sensitive measure of sums of photons over time.

Design: Three proof-of-concept experiments were conducted. Each included multiple five-minute trials of "invited spirit" conditions as well as baseline controls. One experiment included a set of 10 noninvited control trials as well as controls for experimenter intention per se.

Setting: Data were collected as part of a university laboratory devoted to researching advances in consciousness and health.

Participants: The participants were purported spirits presumably motivated to participate in the research.

Intervention: The primary intervention was the experimenter's intention for purported spirits to enter the light-tight chamber on specified trials.

Main Outcome Measures: In a light-tight chamber, the PCDMini device software counted and displayed individual sums of typically 13 to 25 photon detections per approximately 90-milliseconds time periods (in complete darkness, most time periods contained zero photons detected); the number of photon sums could be counted precisely in five-minute periods.

Results: The average number of photon sums was found to be significantly higher in purported POS trials compared with noninvited trials. Matched control trials as well as explicit experimenter intention trials showed no effects.

Conclusion: Silicon photomultiplier devices may be sufficiently sensitive to investigate the POS and experimenter intention (psychokinesis) hypotheses.

Key words: survival of consciousness, detection of spirit, photomultiplier sensors, photons, experimenter intention, spirit intention, psychokinesis

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INTRODUCTION

The survival of consciousness hypothesis has been receiving increased research as well as media attention. A brief review of historical and current research on mediumship was provided by Beischel and Schwartz in this journal in 2007.[1] Contemporary research has employed triple blind studies, and some ongoing research is using quintuple-blind protocols.[2]

As sophisticated as contemporary research with mediums is, the interpretation of the findings is limited. The primary reason is that the presence of spirit (POS) must be inferred from accurately scored information provided by research mediums. The primary theoretical question concerns the source of the information.[3-6] After ruling out fraud and other tricks (sometimes called cold reading), rater bias, and possible experimenter informational leakage or bias by using triple-blind (or more) designs, the remaining possible explanations fall into three broad categories: (1) basic psi (for example, telepathic reading by the medium of the sitter's mind), (2) super-psi (for example, hypothesized retrieval of "dead" [ie, nondynamic] information from the "vacuum" of space [sometimes described as a quantum hologram] or "akashic" field), and (3) survival of consciousness (ie, direct communication with the continuing consciousness/spirit of a deceased person). In this brief report, the term *spirit* is used to refer to the hypothesized continued existence of the consciousness and information (and associated energy) after physical death (also termed an entity); the term *presence* is used to refer the potential hypothesized localization of the consciousness, information, and energy/spirit of the deceased person.

An alternative to using research mediums is to potentially detect the hypothesized energy and information presumed to be associated with spirit. When quantum physics is integrated with feedback and systems theory, the result is the predicted existence of "info-energy" dynamical feedback systems in the "vacuum" of space that can continue to grow and evolve.[7]

The thesis that spirit is luminous and can sometimes be seen by clairvoyants has been put forth throughout recorded history.[8] Moreover, so-called "ghost hunters" typically employ low-light cameras to attempt to detect the localized POS. However, partly for financial as well as political reasons, uni-

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versity investigators have not been supported to apply state-of-the-art superlow-light photon counting devices for potentially detecting POS.

Schwartz and colleagues[9,10] have been exploring the application of superlow-light charged coupled device cameras to image biophoton light emitted by all living systems. Although the resulting images are extraordinary in terms of image detail and sensitivity, half-hour to one-hour exposure times are not uncommon, making dynamical measurement impossible. Although photomultiplier tubes can not provide images, they can monitor moment-to-moment changes in photonic activity.

With the advent of state-of-the-art silicon photomultiplier sensors, it has become technically and economically feasible to explore the possibility of using them to detect the hypothesized POS. This brief report describes three proof-of-concept experiments, which together point to the feasibility and promise of employing this technology to assess POS as well as possible experimenter intention (psychokinetic) effects.

METHODS

Silicon Photomultiplier System and Light-Tight Chamber

A miniature photon counting device, model PCDMini (sensL Ireland, Blackrock, Cork, Ireland) was used in conjunction with sensL's Integrated Environment software interfaced with LabVIEW drivers. The PCDMini has low timing jitter, low after pulsing, transitor-transistor logic output, it is not damaged by ambient light, its detector is insensitive to magnetic fields, it has controlled thermoelectric cooling to −20°C creating extremely low dark count, and it contains an integrated counting resolution of 200 microseconds. The diameter of the sensor was 100 micrometers.

For experiment I, a double "box within a box" light-tight environment was created; for experiments II and III, it was increased to a triple "box within a box within a box." The PCDMini system (approximately 4 cm × 4 cm × 4cm) was attached with Velcro to a plastic base approximately 18 cm × 21 cm × 4 cm. The actual sensor lens (approximately 1 cm in diameter) peered into an empty white papered covered box approximately 10 cm × 10-cm wide and 5-cm high. The white color reflected light within the box (black would have absorbed the light).

This integrated unit was placed within a larger tightly covered black plastic box approximately 27 cm × 44 cm × 29 cm. It was then placed inside a third, large, tightly covered black plastic box approximately 43 cm × 67 cm × 30 cm. Cables were passed through sealed holes at the bottom of the plastic boxes.

Sums of numbers of photons (counted over approximately 90-millisecond time periods (ie, approximately 12 time periods per second) were displayed and stored by using sensL Integrated Environment software. Photon sums per 90-millisecond time period could range from 0 (no photons detected within a given period) to 10,800,000 (the maximum number within a given period displayed by the software). Operational details of the software are available from sensL on request.

With the covers of the boxes removed, the PCDMini saturated at an average of a total of 3,600 photon sums collected over a five-minute trial (12 × 60 × 5); each individual sum contained 10,800,000 photons. In other words, every 90-millisecond time period within a five-minute period produced a 10,800,000 photon sum. In contrast, with the two covers in place in experiment I, the background (control) light was dramatically reduced to an average of only five photon sums greater than 0 (ie, five time periods out of a possible 3,600) collected over five minutes; each sum contained approximately 13 to 25 photons. Furthermore, in experiments II and III, with three covers in place, the background light was reduced to less than an average of a total of only three photon sums greater than 0 collected over five minutes; again, each sum contained approximately 13 to 25 photon counts. According to sensL, background (dark) counts can vary somewhat across PCDMini systems; the present PCDMini happened to have a particularly low dark count.

Variations in room lighting, presence of more than one person in the room, air temperatures outside and inside the boxes (recorded continuously with Vernier LabPro interface, temperature sensors, and software, Vernier Software & Technology, Beaverton, OR), and time of day, had no observable effects on baseline photon counts recorded with the covers in place. It was not possible in this experiment to determine the source of the baseline (dark) counts. They might be due to emitted photons within the innermost box (including by hypothesized spirit and/or experimenter), electronic noise, cosmic rays, or other external sources.

Experimental Methods

The specifics of each experiment are provided in the context of their respective results sections. In general, combinations of five-minute "spirit intention" (SI) trials (ie, spirit or spirits invited to affect the PCDMini) were intermixed with control trials (baselines). Depending upon the experiment, different spirits were "invited" to participate.

In experiment I, the author as experimenter, claiming no skills as a medium or psychic, attempted to directly affect the photo counts with his own intention trials. Also, sets of "no-intention" control trials were interspersed with conventional baseline trials. Experiment II had an unequal number of trials.

The hypothesized spirit participants had all been involved to various degrees in previous mediumship research in the author's research. Four research mediums independently claimed that these hypothesized spirits (1) were committed to the research, and (2) would listen for mental requests from the experimenter to be present and follow the procedures as requested. In experiments I and II, the hypothesized spirits were invited mentally (ie, in the author/experimenter's mind). In experiment III, the hypothesized spirits were mentally instructed to watch a large computer monitor; printed instructions on the screen indicated SI and control/baseline trials.

There was no attempt in this set of proof-of-concept experiments to include a blinded protocol with research mediums to verify independently whether specific spirits presumably "showed up" or not in specific trials. We reasoned that if positive effects were obtained in the initial experiments, the findings would stimulate and justify the conduct of future more extensive and systematic research.

Since virtually nothing is currently known about hypothesized spirits' potential abilities to affect photon sensing devices, the author hypothesized that practice with the system might

increase the probability of obtaining experimental results. Prior to the beginning of experiment I, and continuing through experiments II and III, the hardware and software were left running during the evenings (and sometimes during the days). Hypothesized spirits were encouraged by the author, through his imagination, to "play with the equipment" and potentially learn how to use it in the physical absence of the experimenter.

Conventional analyses of variance (ANOVAs) and *t* tests were employed; means with standard error bars are displayed.

RESULTS

Experiment I: Comparison of SI, Experimenter Intention, and No Intention

Experiment I consisted of three sets of experimental trials; each set contained SI trials and matching baseline control trials. The first and third sets consisted of five SI and five baseline trials; the second set had 10 SI and 10 baseline trials. Trials were 300 seconds (five minutes) in duration. The hypothesized spirits were Susy and Marcia in set one; Susy, Marcia, and Harry in set two; and Sophia in set three. For set one, SI and baseline trials alternated. For sets two and three, the SI trials were followed by baseline trials (in experiment II, the trials were randomized; in experiment III, the trials were counterbalanced).

To investigate possible experimenter intention effects, experiment I included a set of five alternating experimenter intention (psychokinesis) and baseline trials.

In addition, to examine possible order effects, experiment I included a set of 10 alternating no intention trials (where spirits were expressly instructed not to be present) and baseline trials. Possible order effects were reexamined in experiment III. The results are shown in Figure 1.

A two-way ANOVA with intention (intention vs baseline) as the within-subjects factor, and conditions (SI, experimenter intention, and no intention) as the between-subjects factor, revealed a significant intention by condition interaction ($F[2,32] = 6.408$; $P < .005$).

When the SI condition was examined separately (two bars on the left) in a separate two-way ANOVA with intention as the within-subjects factor and sets (one to three) as the between-subjects factor, a main effect for intention (SI versus baseline) emerged ($F[1,17] = 20.730$; $P < .0005$). The SI versus baseline comparisons for set one (means 9.0 vs 5.8, SEs 0.85 and 0.88), set two (means 6.2 vs 4.1, SEs 0.61 and 0.63), and set three (means 9.0 and 5.8, SEs 0.87 and 0.88), were each significant by *t* test.

There were no significant effects for the experimenter intention (middle two bars) or no intention conditions (left two bars).

Experiment II: Between Subjects Replication with Hypothesized Individual Spirits

Experiment II replicated the within-subjects intention factor (SI versus baseline) in two separate sets of trials; the first set of trials with the hypothesized Sophia, the second set of trials with the hypothesized Harry. There were unequal numbers of trials and orders per set. For Sophia there were 4 SI trials with 10 baseline trials preceding and following the SI trials. For Harry there were eight SI trials with four baseline trials interspersed randomly. Trials were again 300 seconds in duration.

The results are displayed in Figure 2 for Sophia (left two bars) and Harry (right two bars).

A one-way ANOVA across the four means revealed a significant main effect ($F[3,22] = 20.442$; $P < .00001$). *T* tests yielded significant SI versus baseline effects for Sophia and Harry trials combined ($t = 7.961$; $df = 24$; $P < .000001$), as well as SI versus

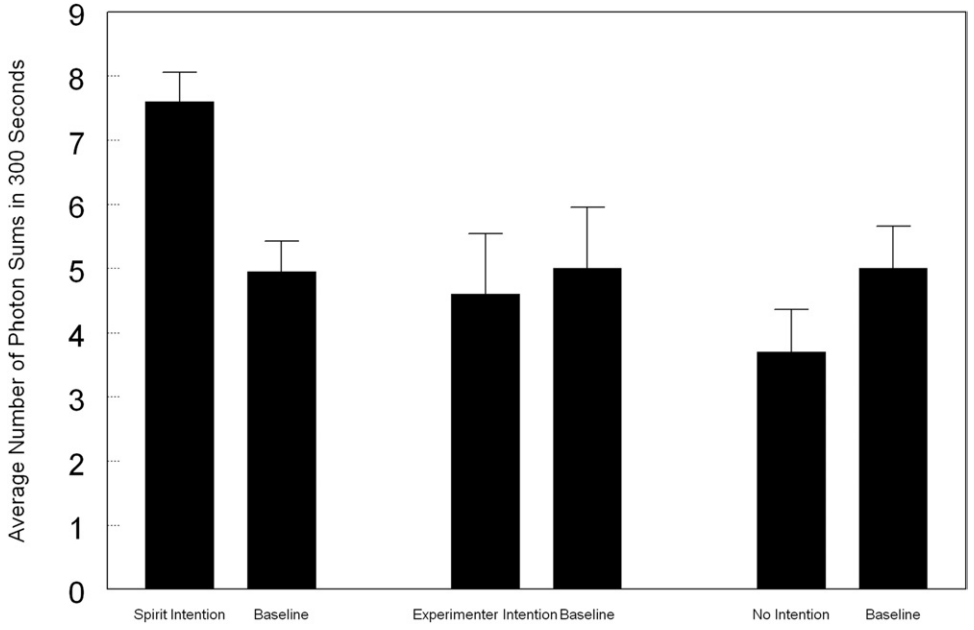

Figure 1. Effects of spirit intention (left bars), experimenter intention (middle bars), and no-intention (right bars), each compared with baselines. Trials were 300 seconds in duration.

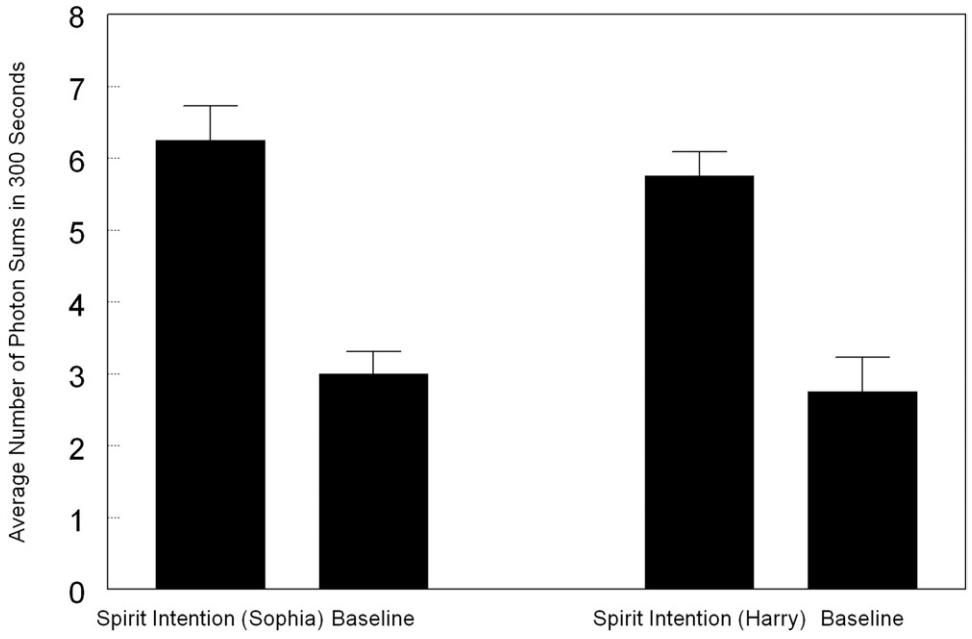

Figure 2. Effects of spirit intention for Sophia (left bars) and Harry (right bars), each compared with baselines. Trials were 300 seconds in duration.

baseline effects separately for Sophia trials ($t = 8.731$; $df = 12$; $P < .000002$) and Harry trials ($t = 3.840$; $df = 10$; $P < .003$).

Experiment III: Possible Yes and No Responses with an Individual SI

To explore the feasibility of potentially developing the technology as a binary SI response detector, an exploratory experiment was conducted comparing baseline (B), yes (Y) and no (N) response trials with hypothesized Harry. At the onset of each SI trial, instructions were displayed on a large computer monitor for the hypothesized spirit to attempt to make yes or no responses. The specifics regarding what would be defined as a yes and no photon sum pattern was to be determined by the hypothesized SI; the experimenter was blind to what the possible difference, if any, might be. Trials were 300 seconds in duration. The order of trials was BYN BNY BYN BNY. Whereas the B trials always preceded the Y and N trials, the order of the Y and N trials were counterbalanced.

A two-way ANOVA with conditions (BYN) and order (two) as within-subjects factors revealed a main effect for BYN ($F[2,4] = 8.583$; $P < .003$). The two-way interaction with order was not significant. The BYN means for the two orders (BYN and BNY) were similar (BYN order, means: B = 4.5, Y = 7.5 and N = 4.5; BNY order, means B = 4.0, N = 6.5, Y = 5.0; SEs, B = 0.79, Y = 0.50, N = 0.35, and B = 0.79, N = 0.50, Y = 0.35). Separate *t* tests revealed that Y was significantly different from both B and N.

Close examination of the raw data revealed that for the Y trials (but not the X trials or the baseline trials), increases in numbers of photon sums appeared within the first 150; the number of photon sums were 5, 4, 6, and 6, respectively.

To examine this more closely, the data were recoded in terms of 150-second periods. Figure 3 displays the results for Harry.

A two-way ANOVA with conditions (BYN) and time (two; ie, 0-150 seconds, 151-300 seconds) as within-subject factors revealed a significant BYN by time interaction ($F[5,15] = 4.402$; $P < .01$). It can be seen that the Y effect showed up within the first 150 seconds and dropped slightly below baseline values during the second 150 seconds.

To explore this timing effect further, the actual time it took for the first photon sum to appear for each trial was calculated. The mean times to first photon sums for the baseline, yes, and no trials were 57.5, 23.8, and 87.5 seconds, respectively (SEs 16.8, 4.5, and 12.5). The means indicates that for the yes trials, the appearance of the first photon occurred more quickly compared with the baseline trials, whereas for the no trials the appearance of the first photon sum occurred more slowly compared with baseline trials.

A two-way ANOVA with conditions (BYN) and order (two) as within-subjects factors revealed a main effect for conditions ($F[4,2] = 8.528$; $P < .036$). The condition by order interaction was also significant ($F [2,4] = 8.074$; $P < .039$); the time it took for the first photon sum to appear was greater for N trials for the BNY order compared with the BYN order. In other words, when the N trials came first, there was a further delay in generating the first photon sum; this might suggest that the apparent increase in photon sums observed in Figure 3 for the N trials for seconds during seconds 151-300 might reflect an intentional SI no effect.

Comparison of Hypothesized Harry and Susy Performance

In this journal, Radin[11] reported that meditators were successful in influencing photon measurements in an interferometer; nonmeditators were unsuccessful. Moreover, one meditator showed exceptional performance. If living persons vary in their ability to affect an interferometer, the question arises whether spirits might vary in their ability to affect a silicon photomultiplier.

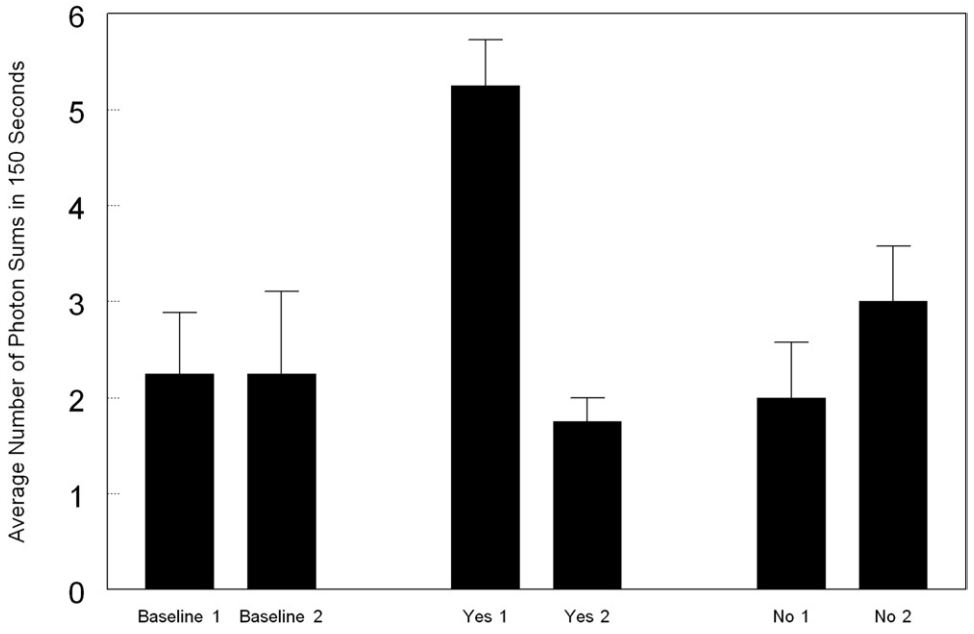

Figure 3. Effects of spirit intention (for Harry) for baselines (left bars), yes trials (middle bars), and no trials (right bars), for Harry. Trials were broken into 0-150 seconds and 151-300 seconds per pair of bars.

It was possible to examine potential individual differences in SI performance with the PCDMini. Although experiments II and III were run sequentially, hypothesized Harry's performance was compared with another hypothesized spirit (Susy) whose data was collected sequentially as well. In experiment II, both Harry and Susy had four trials. In experiment III, Harry had four trials; Susy had two. Despite these clearly small numbers, the combined observations were potentially illuminating about possible individual differences in SI performance between spirits and pointed to future systematic research; hence they were included in this brief report.

In experiment II, as described above, whereas Harry had an average of 5.8 photon sums for SI trials compared with 2.8 for baselines, Susy had smaller difference (average of 3.8 for SI trials compared with 3.0 for baselines). A two-way ANOVA with intention (SI versus baseline) and hypothesized spirits (Harry vs Susy) revealed a significant conditions-by-spirits interaction ($F[1,22] = 6.98$; $P < .01$).

In experiment III, as reported above, whereas Harry had an average of 5.0, 7.5, and 5.0 for BYN trials in the BYN order (which was replicated 4.0, 6.5, and 5.0 for the second order), Susy only had an average for BYN trials in the BYN order of 4.0, 2.0, and 3.5 (ie, she showed no apparent yes trial effect). A two-way ANOVA with conditions (BYN) and hypothesized spirits (Harry vs Susy) revealed a significant conditions-by-spirit interaction ($F[4,6] = 5.385$; $P < .03$).

Taken together, these findings suggest that hypothesized Harry was more successful at doing both SI tasks (ie, experiments II and III) than hypothesized Susy. In other words, it is possible that individual differences in affecting photonic measurement systems may exist between living consciousnesses whether they are in the physical or the spiritual.

DISCUSSION

The combined results of these exploratory proof-of-concept experiments point to the possibility that human intention, either involving (1) spirit (ie, deceased) intention, (2) experimenter (physically alive) intention (psychokinesis), or (3) a combination of the two, can be associated with increases in photon emission detected by a highly sensitive silicon photomultiplier system and measured under light-tight conditions.

The experiments reported herein can not discern the source of the apparent intention effects—hypothesized spirit and/or experimenter psychokinesis. To disentangle the potential relative contributions of spirit and/or experimenter intentions, future research can employ (1) blinded experimenters (who do not know the identities of the hypothesized spirits, and also do not receive photon sum feedback, (2) skeptical experimenters, and also (3) computer-automated procedures where the entire experiment (including the order of trials) can be executed when the experimenter is not present. The reason for reporting the present set of findings is to stimulate future research as well as increase the potential for funding.

It is notable that the current findings are not consistent with the hypothesis that the observed effects can be explained solely in terms of direct experimenter intention. First, in experiment I, the experimenter was unsuccessful in producing psychokinetic photonic effects himself (at least consciously). And second, similar to reports in mediumship[3] claiming that certain spirits are more effective in bringing forth information (potentially due to the personality, motivation, and skills of the spirits), the findings contrasting Harry with Susy (replicated across experiments II and III) suggest the possibility that SI effects on silicon photomultipliers may vary across spirits as a function of spirit "personality," motivation, and skill. As mentioned previously, these

potential individual differences in SI effects are consistent with Radin's observations concerning individual differences in living experimenter and/or subject intention effects on a photonic measurement system.[11]

Third, although beyond the scope of this brief report, numerous anomalous effects–especially involving large magnitude photon sums–were observed almost exclusively with Harry and not with Susy, Marcia, or Sophia. Whereas under these light-tight operating conditions, the large majority of the photon sums (98%) that were recorded were below 30 photon counts, occasional photon sums ranging from 40 to 170 units were observed, and they occurred almost exclusively (95%) during Harry recording periods. Moreover, they sometimes occurred in response to instructions to Harry to produce one or more large photon sums in a five-minute period; this observation suggests a significant opportunity for future research.

Thus far, the experimenter has been unsuccessful in producing such large magnitude photon sums himself, let alone producing the pattern of photon sum findings reported herein. However, future research may reveal that if experienced meditators (or other exceptional subjects) served as experimenters, they might be able to intentionally and reliably influence the silicon multiplier detection system. Although some of the present findings are supportive of the SI interpretation, it is possible that unknown psychological factors in the experimenter could have unknowingly led him to (1) fail to be able to produce the effects by himself (experiment I) and (2) caused the larger magnitude Harry findings (as well as anomalous hypothesized Harry-related effects) to occur.

Failure to recognize the importance of potential individual differences in both experimenter and SI effects could result in future research on SI producing inconsistent if not null results. Also, future research can examine the role that practice with the technology potentially increases hypothesized spirits and/or experimenters abilities to affect the devices in a reliable manner.

In closing, although the present findings are consistent with the hypothesis that human intention–be it of spirit and/or experimenter–can produce subtle increases in photons, it is conceivable that the observed intention effects were somehow (1) modulating the sensor itself, (2) the environment directly adjacent to the sensor, and/or (3) the electronics receiving and processing the signals from the sensor. Future research can explore the wide range of questions that arise with the potential applications of this new technology to consciousness research.

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