Testing Nonlocal Observation as a Source of Intuitive Knowledge

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This study explored the hypothesis that in some cases intuitive knowledge arises from perceptions that are not mediated through the ordinary senses. The possibility of detecting such nonlocal observation was investigated in a pilot test based on the effects of observation on a quantum system. Participants were asked to imagine that they could intuitively perceive a low-intensity laser beam in a distant Michelson interferometer. If such observation were possible, it would theoretically perturb the photons' quantum wave functions and change the pattern of light produced by the interferometer. The optical apparatus was located inside a light-tight, double-steel walled, shielded chamber. Participants sat quietly outside the chamber with eyes closed. The light patterns were recorded by a cooled digital camera once per second, and average illumination levels of these images were compared in counterbalanced mental blocking versus nonblocking conditions. By design, perturbation would produce a lower overall level of illumination, which was predicted to occur during the blocking condition. Based on a series of planned experimental sessions, the outcome was in accordance with the prediction ($z = -2.82$; $P = .002$). This result was primarily due to nine sessions involving experienced meditators (combined $z = -4.28$; $P = 9.4 \times 10^{-6}$); the other nine sessions with nonmeditators were not significant (combined $z = 0.29$; $P = .61$). The same experimental protocol run immediately after 15 of these test sessions, but with no one present, revealed no hardware or protocol artifacts that might have accounted for these results (combined control $z = 1.50$; $P = .93$). Conventional explanations for these results were considered and judged to be implausible. This pilot study suggests the presence of a nonlocal perturbation effect that is consistent with traditional concepts of intuition as a direct means of gaining knowledge about the world, and with the predicted effects of observation on a quantum system.

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INTRODUCTION

"The intuitive mind is a sacred gift and the rational mind is a faithful servant. We have created a society that honors the servant and has forgotten the gift."

–Albert Einstein[1]

Intuition is widely regarded as a key source of inspiration in medical diagnosis,[2-5] technological innovation, business decisions, artistic achievement, and scientific discovery.[6] Based upon an analysis of the lives of numerous scientific icons, Root-Bernstein[7] concluded that "Virtually without exception, the greatest mathematicians and scientists assert that the development of this pictorial, visual, kinesthetic, or generally sensual algorithm [associated with intuition] is the basis for scientific thinking."

But what is intuition? Given its central role in advancing science and civilization, one might expect that this topic has been a keen subject of inquiry, especially within academic psychology, for many decades. Surprisingly, until recently it has been studiously ignored. This may be because the quasi-magical, nonrational nature of intuition presents an embarrassing challenge to science, which prides itself on the power of rational knowing. Intuitive knowledge does not appear to function like the methodical inferences associated with rational thought. It arises "in a flash," or "out of the blue," sometimes with correct answers to thorny scientific and technical problems, elegant solutions to complex mathematical theorems, and complete scores for intricate musical compositions.[8]

Because of the scientific emphasis on rational knowing, and especially of physicalism–the belief that "mental entities, properties, relations and facts are all physical"[9]– other ways of knowing, including intuitive knowing, have been regarded as an inferior epistemology at best and a vestige of superstitious nonsense at worst. For half a century, this belief led academic psychology to utterly deny the importance of subjective experience.[10] Indeed, when behaviorism was in full bloom, many psychologists embraced a perplexing catch-22 in which minds concluded with great confidence that there were no minds at all.

But as the cognitive sciences and neurosciences advanced, the idea of an unconscious mind, once the sole province of psychoanalysis, became scientifically acceptable again. This transformed the original concept of intuition from a mysterious means of gaining unmediated knowledge of the world to the more familiar domain of computer-inspired background information processing. The computer analogy spawned experiments looking for physiological markers of implicit learning, for the brain circuits responsible for the "ah ha" experience,[11,12] and for identification of unconscious cognitive biases.[13] In medical research, suspicions about the accuracy of intuition contributed to the enthusiastic acceptance of evidence-based medicine, which is based on the assumption that a purely rational evaluation of experimental evidence will always be more reliable than educated intuition.[14]

Given these trends, the traditional concept of intuition as a nonrational, nonsensory way of knowing seems well on its way to oblivion. And indeed, experiments testing the possibility that there may be other ways of knowing are rarely reported in psychological, neuroscience, and medical journals. By contrast, in the literature of parapsychology–the discipline that straddles those uncertain realms between physics and psychology– one

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finds numerous relevant experiments. Based on thousands of such reports, there appears to be strong cumulative evidence in favor of unconventional ways of knowing.[15,16] This supports contentions of some nursing researchers that intuitions about patient care–insights that are not based on explicit evidence–can provide significant efficacy in real-world contexts.[2,4] It is noteworthy in this context that the emphasis once placed on evidence-based medicine is now being critically revisited based on studies demonstrating the effectiveness of intuitive decisions in medical contexts,[17,18] and there are renewed calls for reassessing the overly "authoritative aura" that evidence-based medicine has tended to convey.[19]

Further, in the broader arena of human decision making, experiments now show that people are much more efficient at making accurate intuitive decisions than previously thought. After describing one such experiment, Cosmides and Tooby[20] concluded that "It may be time to . . . grant human intuition a little more respect than it has recently been receiving. The evolved mechanisms that undergird our intuitions have been subjected to millions of years of field testing against a very rich and complexly structured environment." These findings, all supporting the idea that there may be many valid ways of knowing, have helped to bring about a rapprochement between meditative disciplines and Western psychology and are fostering a new openness to reevaluating assumptions about the capabilities of the human mind.[21] The motivation of the present study was to explore the traditional concept of intuition by testing whether it was possible to gain knowledge without the use of the ordinary senses. The method was based on the effects of observing and thereby perturbing a quantum system.

THE MEASUREMENT PROBLEM

"[The double-slit experiment] has in it the heart of quantum mechanics. In reality, it contains the only mystery."

–Richard Feynman[22]

The mystery Feynman was referring to is the fact that a quantum object is perturbed (ie, it behaves differently) when it is observed than when it is not observed. This measurement problem violates the common sense assumption that we live in an objective reality that is completely independent of observers. The measurement problem does not imply a solipsistic world where everything is a mental fantasy, nor does it support the new age mantra that one can create one's reality simply by wishing it so. But it does question the orthodox dualistic assumption that subjective and objective are completely separate.

Virtually all of the founders of quantum mechanics, including Bohr, Planck, de Broglie, Heisenberg, Schrödinger, and Einstein, wrote about the perplexing epistemological and ontological challenges presented by the measurement problem.[23-25] Some, like Pauli, Jordan, and Wigner believed that consciousness was not merely important, but was fundamentally responsible in the formation of reality.[26,27] Jordan wrote, "Observations not only disturb what has to be measured, they produce it . . . . We compel [the electron] to assume a definite position . . . . We ourselves produce the results of measurement".[28]

This strong view of the role of consciousness has been echoed by numerous physicists for over a half century, from von Neumann, to Walker, d'Espagnat, Squires, Stapp, and many others.[29-33] A weaker view was expressed by physicist John Bell,[34] who pondered that "The concept of 'measurement' becomes so fuzzy on reflection that it is quite surprising to have it appearing in physical theory *at the most fundamental level* . . . . [D]oes not any *analysis* of measurement require concepts more *fundamental* than measurement? And should not the fundamental theory be about these more fundamental concepts?" Bell did not explicitly nominate consciousness as being that more fundamental concept, but it is a possible candidate.

Although consciousness as a component of physical theory appeals to some physicists, it also introduces an annoying, slippery, and nonmaterial substance into what is otherwise a satisfying material edifice. And it challenges a gut feeling held by many scientists that the physical world was here, more or less in its present form and operating under the same physical laws we know today, long before humans evolved to observe it. Because of such discomforts, many physicists have strongly resisted the idea that consciousness in general, and an experimenter's attention or intention in particular, can play any role in the formation of physical reality.

To help eliminate the need for an observer in quantum mechanics, some have attempted to finesse the measurement problem by simply declaring it a nonproblem.[35] Others deny that there ever was a problem: "Many physicists pay lip service to . . . the notion that quantum mechanics is about observation or results of measurement. But hardly anybody truly believes this anymore–and it is hard for me to believe anyone really ever did."[36] Still others have attempted to clarify the nature of the problem by noting that observation increases our knowledge of a measured system, and "from that position, the so-called measurement problem . . . is not a problem but a consequence of the more fundamental role information plays in quantum physics as compared to classical physics."[37]

After reviewing the relevant literature on the measurement problem, Rosenblum and Kuttner[38] concluded that although most physicists do not believe that observation literally creates reality, something about observation remains deeply important. The only way to avoid the essential role of the observer in quantum experiments is to deny the belief that we have free will. Other physicists agree. Gribbin[39] concluded that "Quantum entities *seem to know when you are watching them*, and adjust their behaviour accordingly . . . . Each single quantum entity seems to know about the whole experimental set-up, including when and where the observer is choosing to monitor it, and about the past and future of the experiment."

Experimental Tests

Because it is central to interpretations of quantum theory, and hence to our understanding of physical reality, discussions about the measurement problem abound in the physics literature. And given its importance, one might expect to find a correspondingly large experimental database in that literature. But it is not so. As with intuition, it is again the literature of parapsychology where most such tests can be found.

Four classes of parapsychological experiments have been most relevant to tests of the measurement problem.[40] They involve (1) experiments testing the effects of intention on the statistical behavior of random events linked to quantum sources,[41-44] (2) studies involving macroscopic random systems such as tossed dice and human physiology as targets of intentional influence,[45,46] (3) experiments involving sequential observation to see whether a second observer could consciously or unconsciously detect if a quantum event had been observed by a first observer,[47-52] and (4) experiments investigating conscious influence of both living and nonliving systems, including effects on photons in optical interferometers as reported here.[53-55]

Together, these studies comprise nearly 900 experiments, conducted by dozens of investigators over six decades.[15,16] Collectively, they provide independently replicable evidence that observers can affect the behavior of physical systems. The absolute magnitudes of the observed effects tend to be small and variable, but from a statistical perspective their existence is well established. Of these experiments, the one that most closely followed Feynman's reference to the "only mystery" in quantum mechanics was a study reported by Ibison and Jeffers.[55]

Jeffers asked a team of participants at York University to "observe, by extra-sensory means . . . monochromatic light passing through a double slit, prior to its registration as an interference pattern by an optical detector."[56] Ibison later asked a team at Princeton University, using the same apparatus, to mentally intend that a bar graph indicating the contrast between optical interference patterns recorded with and without observation "to remain as low as possible."[57] In both cases, the mental effort periods were 30 seconds in length, alternated with no-effort control periods. The team at Princeton reported marginally significant experimental evidence in favor of an observational effect, and the team at York reported a nonsignificant result.

In interpreting this ambivalent outcome, it is useful to know that the Princeton University test employed a small team of dedicated participants who were experienced in conducting these types of mind-matter interaction experiments, whereas the York University test employed unselected participants recruited without regard to their interest or skill. In addition, the York participants were asked to imagine that they could "see" photons leaving the slits in a double-slit apparatus (this was relevant to the test because gaining information about which path a photon takes in a double-slit apparatus would cause the interference pattern to collapse). That task is more difficult than it may seem, for it required unskilled participants to visualize photons in the vicinity of a double slit, which is only a few microns across. If, as it seems more likely, participants imagined focusing on the beam of photons itself, then their observation would, in effect, be equivalent to placing a filter in the path of the entire beam. That would reduce its intensity but it would not change the shape of the resulting interference pattern, and thus Jeffers' specific outcome measure would not be affected no matter how successful the participants were in following his instructions. In the case of Ibison's instructions, despite the marginally significant results he reported, a goal-oriented task seems so detached from the critical issue of gaining *which path* information about the photons that the task may not have been optimal to detect an observer effect. And in both cases, apparently no attempt was taken to optimize the likelihood that participants could maintain a stable mental focus for 30 seconds at a time.

To overcome problems of task difficulty, relevance, and unskilled participants, the present study used an optical interferometer, which is equivalent to a double-slit design, but it provided a macroscopic target area in which to focus one's attention, and it included some participants who were highly experienced at maintaining focused mental states for long periods of time.

METHODS

Equipment

A five-milliwatt He-Ne laser sent a one-millimeter-diameter beam of 633-nm photons through a set of neutral density filters (Figure 1) into a Michelson interferometer. The laser was a JDS Uniphase Model OS-8514, TEM00 (JDS Uniphase, Miltipas, CA), randomly polarized at 632.8 nm, with a regulated power supply. The neutral density filters were two natural density filters with 1% transmission and one with 5% transmission; the interferometer was a PASCO Model OS-9255A (PASCO, Roseville, CA). The reduced intensity beam passed through a diverging lens and a beam splitter, then half the beam went to one mirror and the other half to a second mirror. The two beams reflected off the mirrors back to the beam splitter where they were combined to form an interference pattern. That pattern passed through a 633-nm narrow-band notch filter and into a thermoelectrically cooled, back-thinned charged-coupled device (CCD) camera. The notch filter was a Semrock MaxLine Model LL01-633-12.5 (Semrock, Rochester, NY); the camera was a back-thinned CCD chip, Hamamatsu Model S7031-0907 (Hamamatsu, Hamamatsu City, Japan), 512 $\times$ 122 pixels, maintained at -10°C via a Peltier thermoelectric cooler. The camera was controlled by a computer with Windows XP running LabView 7.1 (National Instruments, Austin, TX), and it was configured to use a shutter interval of 500 milliseconds (ms) and to record images at a rate of one per second. In practice, it took about 500 ms to process and store each image to the hard disk, thus each nominal one-second frame of data, captured in the form of a 512 $\times$ 122 matrix of pixels, took about 1.5 seconds to process and store.

To reduce artifacts due to ambient vibrations, the interferometer, laser, and camera were secured to a 18-kg block of wood, which in turn rested on a 7.6-cm-thick sheet of foam rubber. The optical apparatus rested on the floor of a 900-kg, double-steel walled, electromagnetically and acoustically shielded room, which in turn rested on a vibration isolation mat on the ground-level, concrete floor of the research laboratory at the Institute of Noetic Sciences (the shielded room was made by Lingren/ETS, Cedar Park, Tex, Series 81, 8 $\times$ 8 $\times$ 7.5 feet). The camera interface and computer used to control the camera were also located inside the shielded room. During experimental sessions, the computer monitor and all sources of light other than the laser were turned off or covered with black tape, and the chamber door was closed. Prior to data collection, the laser, camera, and computer were allowed to warm up for a minimum of one hour.

During a test session, the participant sat quietly on a chair or on the floor about two meters away from the outside wall of the shielded chamber. The experimenter sat about 2.5 meters away from the chamber in front of a computer used to remotely access the CCD camera.

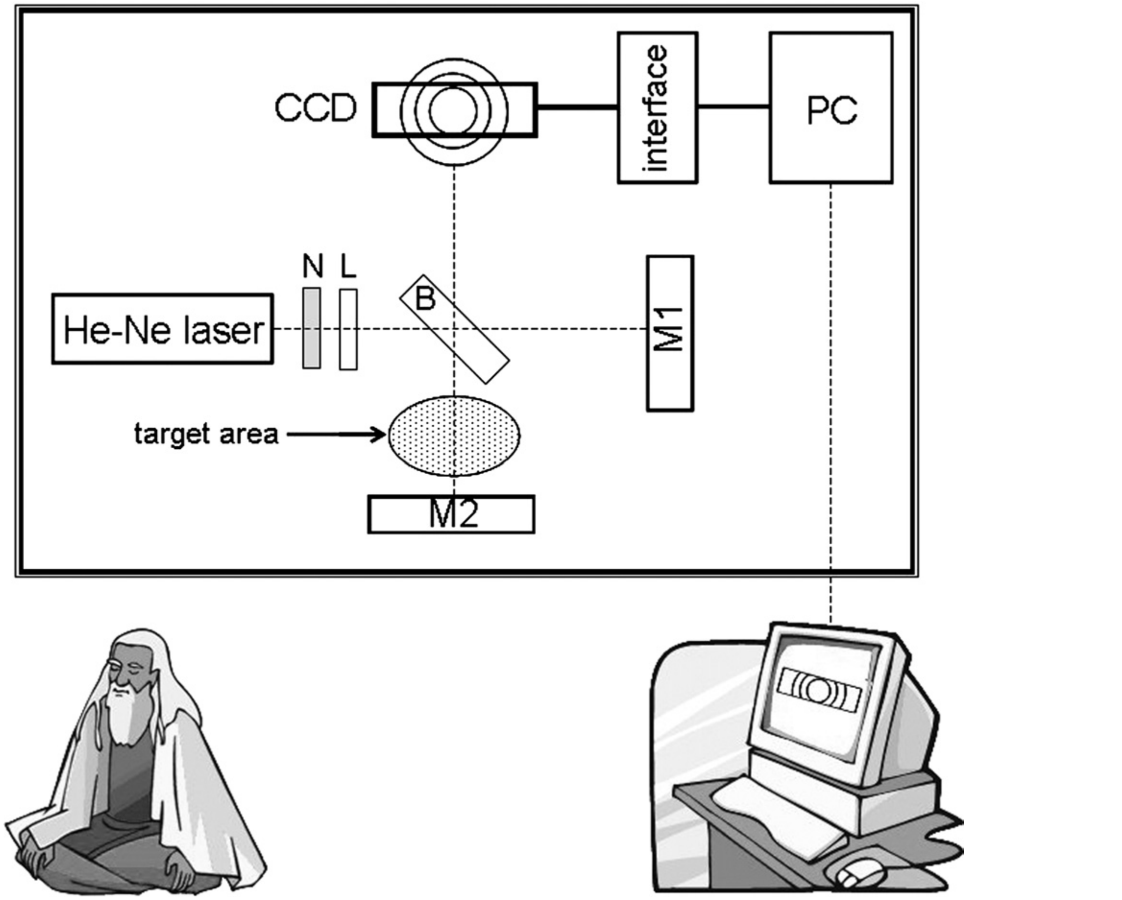

Figure 1. A five-milliwatt He-Ne laser beam passed through three neutral density filters (N) into a Michelson interferometer, where it encountered a diverging lens (L), beam splitter (B), and two mirrors (M1 and M2). The resulting interference pattern passed through a high-performance, narrow-band, notch filter and then into a back-thinned, cooled CCD camera controlled by a computer. The optical apparatus was housed in a double-steel walled, electromagnetically shielded, vibration-isolated, and acoustically dampened room. During experimental sessions, the chamber was sealed to be light tight, and the camera computer was remotely controlled by a second computer outside the chamber via a fiber-optic Ethernet connection. The participant sat quietly outside the shielded room, about two meters from the outer wall; the experimenter sat at the remote computer about 2.5 meters from the shielded room.

Procedure

The experimenter asked each participant either to imagine that he or she could intuitively sense the presence of the photons in a specific area of the interferometer (noted in Figure 1) or to withdraw that intuitive perception and allow the photons to pass through that same area unimpeded. The participant did this with eyes closed, sitting quietly outside the shielded room. The experimenter, stationed within six feet of the participant, used the computer to remotely control the camera, setting it to automatically run for 20 camera frames per run. He also verbally announced each run's condition (block or pass) to the participant, following a preset sequence of counterbalanced conditions.

Each blocking or passing run consisted of 20 frames, each frame composed of a 500-ms exposure taken at one 1-second intervals, plus 500 ms to record the image, for a total of 30 seconds per run. The experimenter followed one of two preplanned counterbalanced sequences of blocking/passing runs per experimental session, as described in Table 1. Counterbalanced sequences were used to counteract possible drifts in the interferometer's fringes due to ambient environmental fluctuations. Most test sessions consisted of 16 runs, or a total of about eight minutes per session.

Runs lasting only 30 seconds may not sound overly demanding, but accomplishing this mental task with high stability and intense focus is more difficult than it seems. Without extensive practice in holding one's mind tightly focused on a single task, thoughts tend to wander every few seconds. Indeed, within 30 seconds untrained minds can branch into so many fantasies that the original task itself is completely forgotten. Thus, to help optimize adherence to the task at hand, some participants recruited for this study were required to have experience in one or more mental focusing techniques. Special emphasis was placed on recruiting highly experienced meditators who were actively engaged in a daily practice.

Table 1. Participants, Counterbalanced Sequences, and Meditator Type Used in 18 Experimental Sessions

Session*	Sequence	Type
1†	BA BA BA AB AB	Meditator
2	ABBA BAAB BAAB ABBA	Nonmeditator
3	ABBA BAAB BAAB ABBA	Nonmeditator
4†	ABBA BAAB BAAB AB	Nonmeditator
5‡	ABBA BAAB BAAB ABBA	Meditator
6§	ABBA BAAB BAAB AB	Meditator
7	ABBA BAAB BAAB ABBA	Nonmeditator
8‡	ABBA BAAB BAAB ABBA	Meditator
9‡	BAAB ABBA ABBA BAAB	Meditator
10	BAAB ABBA ABBA BAAB	Meditator
11	BAAB ABBA ABBA BAAB	Meditator
12	BAAB ABBA ABBA BAAB	Nonmeditator
13	BAAB ABBA ABBA BAAB	Meditator
14	BAAB ABBA ABBA BAAB	Nonmeditator
15	BAAB ABBA ABBA BAAB	Nonmeditator
16	ABBA BAAB BAAB ABBA	Meditator
17	ABBA BAAB BAAB ABBA	Nonmeditator
18	BAAB ABBA ABBA BAAB	Nonmeditator

A, blocking condition; B, passing condition.

*In control sessions following the experimental sessions, the same counterbalanced sequence was used. Session 1 used a simple alternating counterbalancing scheme; this was changed to an ABBA-BAAB style counterbalancing in all subsequent sessions because the latter is more effective in reducing potential biasing effects of signal drift.

†In sessions 1 and 4, the last two planned runs were inadvertently dropped.

‡Note that in sessions 5, 8, and 17, two or three people participated simultaneously.

§Something unusual may have happened in session 6. During that session, for unknown reasons the last blocking run failed to record properly. This glitch was discovered a few hours later when the data were being analyzed. But as soon as that session had ended, the participant, an experienced meditator, reported that he felt his efforts in the last blocking run had been particularly effective. The experimenter was surprised to hear this because he had felt peculiarly dissociated at the end of that session. On mentioning this coincidence, two videographers who happened to be filming that session each reported that they too had independently experienced unusual sensations during the same period. Whether these experiential and hardware synchronicities were related is unknown.

Analysis

Figure 2 (top) shows an interference pattern as captured in a single frame by the CCD camera when both arms of the interferometer were open (ie, the split beams were allowed to pass unobstructed through the interferometer). The surface of the plot indicates image intensity recorded at each pixel during fifty 500-ms exposures. Figure 2 (bottom) shows what happens when the laser beam passing through the target area in one of the interferometer arms (indicated in Figure 1) was physically blocked with a piece of black cardboard. Note that these images show only a small portion of the overall interference pattern because the CCD aperture was rather small (12.3×2.9 mm).

From these images, we see that physically blocking the beam in one arm of the interferometer caused two conspicuous changes: the wavy interference pattern transformed into a smooth pattern and the overall level of illumination intensity declined. The former occurred because interference was prevented, which occurs when blocking one slit in a two-slit apparatus, and the latter occurred because approximately half of the available photons were physically prevented from reaching the camera.

If one calculates the average illumination levels in Figure 2 collapsed across the respective x-axes, the result is two curves providing average cross sections (and one standard error bars) along the y-axis. These two curves are shown in Figure 3 and the difference between those two curves in Figure 4.

As indicated in Figure 2, the two-dimensional intensity surface produced by the interference pattern can be quite complex. In practice, this pattern tended to differ from one test session to the next, primarily due to miniscule differences in ambient temperature (mirror movements on the order of a quarter wavelength of light are detectable in a Michelson interferometer). Thus, for the sake of analytical clarity, we based the formal analysis not on a change in the precise shape of the interference pattern but rather on an expected *decrease* in average illumination level over the entire CCD image during the blocking as compared with the passing conditions (Figure 4).

To test this hypothesis, the average illumination intensity across all pixels per CCD frame was calculated for each image (e.g. a total of $8 \times 20 = 160$ frames per condition), and then a Wilcoxon rank sum statistic was used to compare the two sets of averages across the blocking and passing conditions. The result of the Wilcoxon test was expressed in terms of a single, standard normal z score, which was predicted to be negative, reflecting a lower illumination intensity observed during the blocking condition. Because the hypothesis was directional, one-tailed P values were employed.

To test the hardware, software, design protocol, and analytical procedures for possible artifacts, after the first five experimental sessions were completed, all subsequent sessions included a control run, in which the same test was allowed to proceed automatically without anyone being present in the laboratory or paying attention to the interferometer. Data from these control sessions were analyzed in the same way as in the experimental sessions. All analyses were performed in custom Matlab 7.0 programs (Mathworks, Natick, MA).

RESULTS

Twenty experimental sessions were preplanned. The first two sessions had sporadic problems in capturing the image frames, reducing the usable experimental dataset to 18 sessions. These problems were traced to an incorrect data acquisition board originally supplied with the camera. After exchanging the board for the correct model, all camera images were successfully collected without incident. Immediately following the last 15 of those sessions, control sessions were also run. See Table 1 for further details about each session.

We were fortunate to recruit four highly experienced meditators to participate in this test, each was an acknowledged master of a contemplative tradition, with many decades of continuous meditative practice. A fifth individual with two years of active

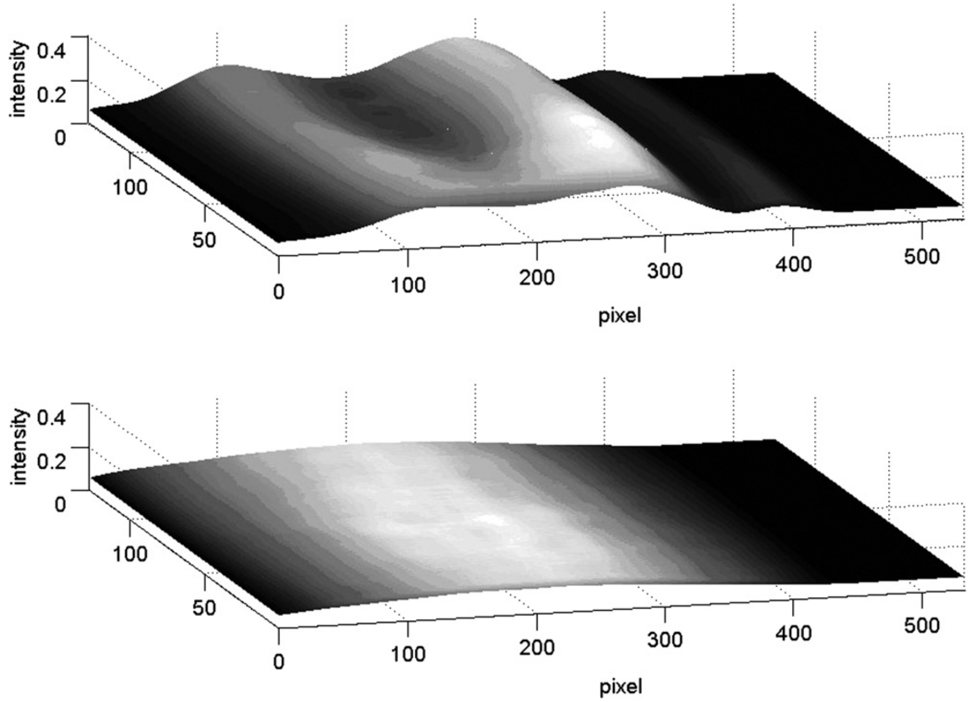

Figure 2. Average intensities recorded by the CCD camera in 50 repeated exposures, each exposure consisting of 500 milliseconds. The top image shows the illumination intensity (z-axis) observed when both arms of the interferometer were physically open; the bottom image shows the intensity pattern when the target arm was physically blocked. The x- and y-axes show the pixels of the CCD (122 $\times$ 512, respectively).

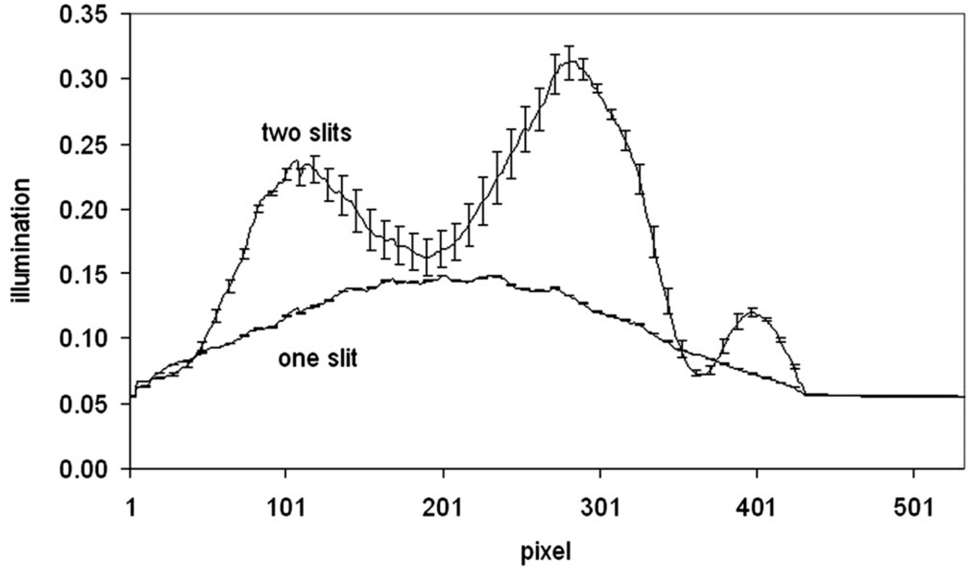

Figure 3. Average illumination intensity (in terms of voltage levels returned by the CCD) in the physically blocked (one slit blocked) and passed (both slits open) conditions, based on 50 frames in each condition. One standard deviation error bars are shown for both curves. For the one-slit condition, the error bars are quite small, indicating the stability of the laser and camera. The larger error bars in the two-slit condition reflect the exquisite sensitivity of the interferometer to environmental fluctuations. Pixels 420 to 512 were blocked by the edge of the notch filter.

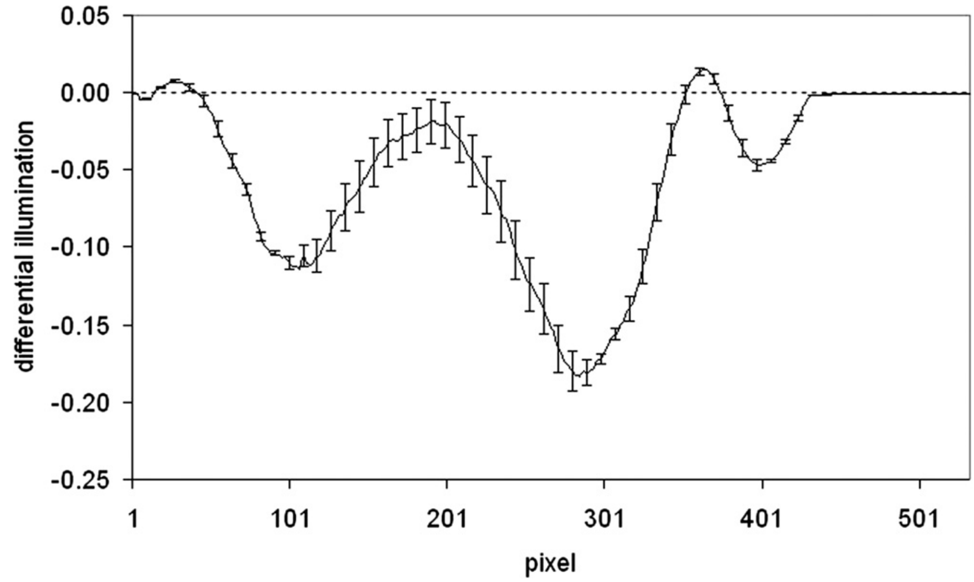

Figure 4. Difference in illumination levels (physically blocked vs passed conditions). Error bars are one standard error of the difference.

meditation practice also participated; together these five participants contributed nine sessions. Five other individuals with less than two years of meditation practice, or with a lapsed practice, contributed nine additional sessions. For expository reasons, the latter group will be referred to as nonmeditators.

Figure 5 summarizes the results of the Wilcoxon tests per session; Figure 6 shows the same information in the form of a cumulative Stouffer z score. The combined terminal z score for all experimental sessions was significantly negative as predicted, $z = -2.82$ ($P = .002$). The same terminal z score for all control sessions was $z = 1.50$ ($P = .93$), indicating that the experimental results were not caused by procedural or analytical artifacts.

Figure 7 shows the cumulative z score for the nine sessions with experienced meditators and nine sessions with nonmeditators. The terminal results here were strikingly different, with the experienced meditators resulting in a combined $z = -4.28$ (p =

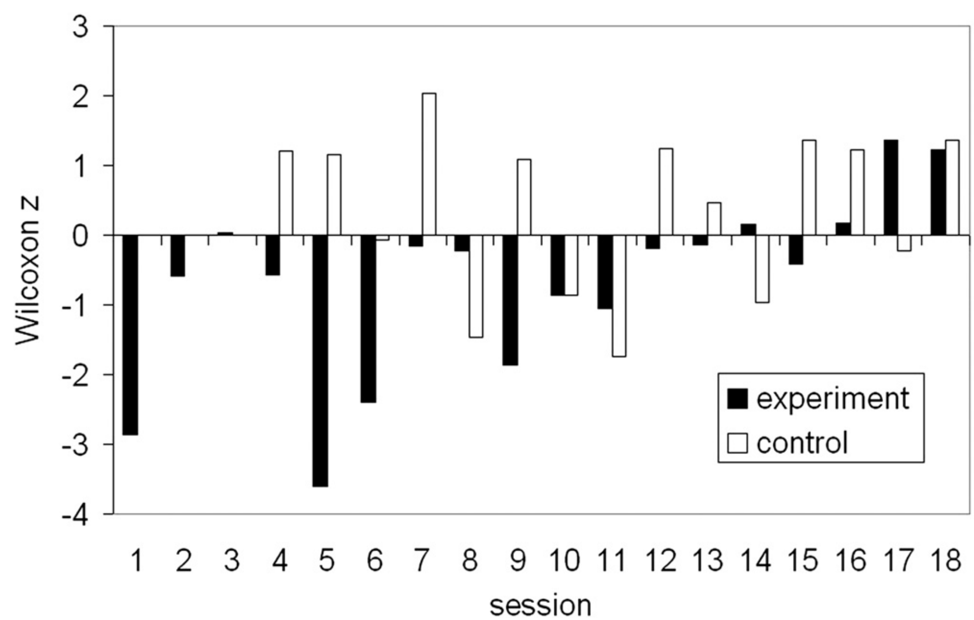

Figure 5. Results of Wilcoxon rank sum test, expressed as a z score, for all experimental and control sessions. Experienced meditators participated in sessions 1, 5, 6, 8 to 11, 13, and 16. Among those sessions, 8 of 9 resulted in the predicted negative z scores. Among nonmeditators, 5 of 9 sessions resulted in negative z scores.

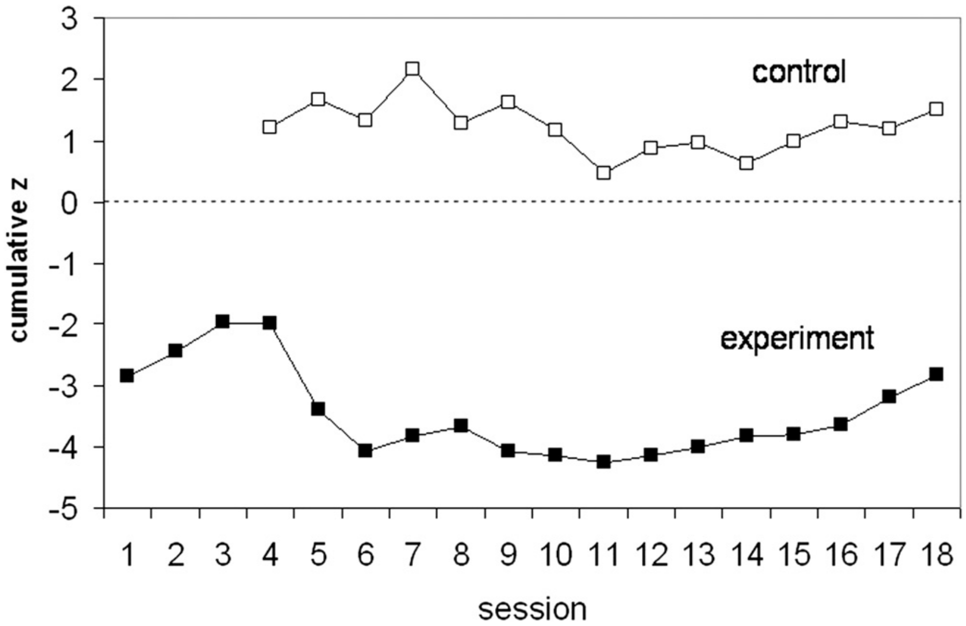

Figure 6. Cumulative Wilcoxon z scores in experimental and control runs. The terminal experimental z score was $z = -2.82$ ($P = .002$, one-tail) and the terminal control z score was $z = 1.50$ ($P = .93$).

9.4×10^{-6}) and the nonmeditators resulting in $z = 0.29$ ($P = .61$). This supports the expectation that the postulated intuitive observation effect would require an ability to sustain a highly stable, focused concentration.

Post Hoc Analysis

It is instructive to examine the results of an experimental session contributed by one of the experienced meditators (session six). The bold curve in Figure 8 shows the difference

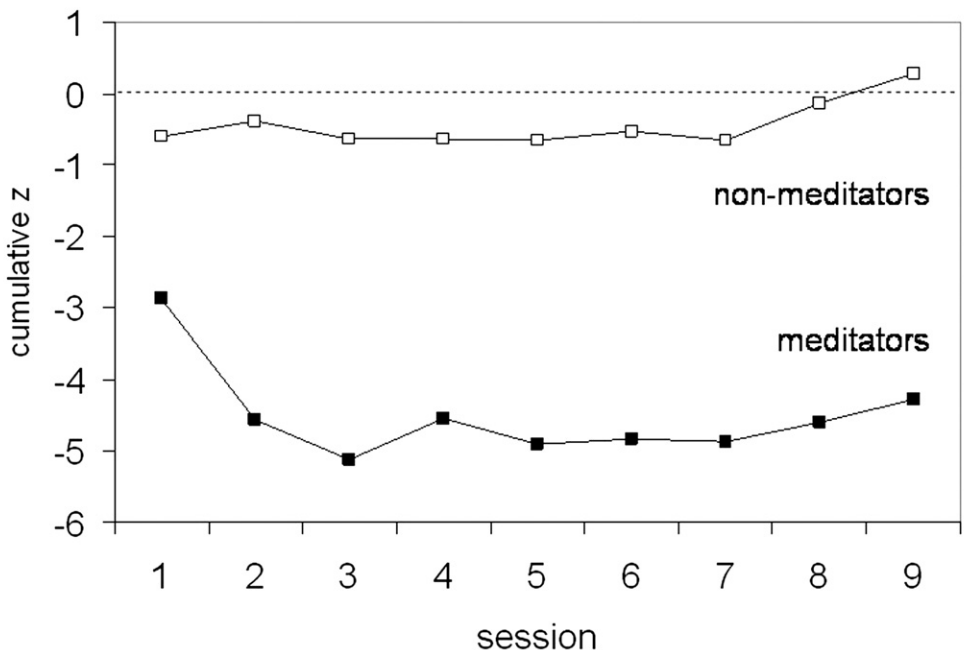

Figure 7. Cumulative results for experienced meditators and nonmeditators. Meditators terminal z score was $z = -4.28$ ($p = 9.4 \times 10^{-6}$) and nonmeditators terminal z score was $z = 0.29$ ($P = .61$). Control sessions run immediately after the experienced meditators' sessions resulted in a terminal z score of $z = 0.46$ ($P = .68$).

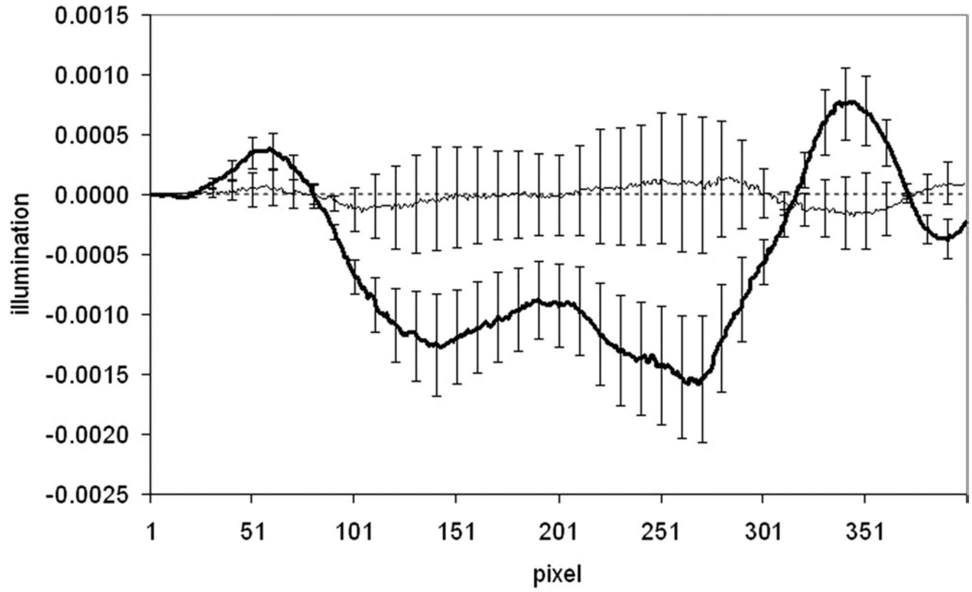

Figure 8. Session six difference in average illumination levels (expressed in terms of differences in average voltage values recorded by the CCD pixels) for experimental (bold line) and control (thin line) conditions, with error bars representing one standard error. Note that error bars in both cases are about the same, suggesting that the lower illumination level recorded during the experimental run was not due to artifacts.

between the blocking versus passing conditions for the experimental session, and the thin curve shows the same analysis applied to the control session run immediately afterward. From these curves, it can be seen that the absolute magnitude of the illumination changes was tiny, but the error bars show that the blocking versus passing differences observed in the experimental condition were statistically nontrivial, and in the control session the same differences were essentially flat. In addition, the error bars in these two sessions were about the same, indicating that the outcome of the experimental session was not due to vibrations or drift artifacts.

DISCUSSION

This experiment indicated that a nonlocally observed quantum system behaved differently than an unobserved system. It also supported the traditional idea of intuition as a means of gaining direct knowledge of the world, unmediated by the ordinary senses. Because the latter result would be considered anomalous by orthodox epistemologies, it is prudent to consider alternative conventional explanations for the observed effects. There are three leading contenders: drifts in illumination levels that caused artifacts mimicking an apparent observer effect, violation of statistical assumptions, and selective data reporting.

In the first case, controls against signal drift were accomplished through six design features: (1) the test environment was allowed to reach thermal equilibrium by warming up all the equipment for at least an hour prior to each session, (2) the optical apparatus was enclosed inside a shielded room during each session, (3) that room was optically sealed during all sessions, and (4) participants directed their attention toward the apparatus from outside the chamber. If (5) the electrical equipment in the chamber had caused a rise in ambient temperature over the course of a session, effects of such drift would have balanced out by the use of short-period counterbalanced conditions, which eliminates biasing effects that can occur with systematic (linear) drifts. Systematic artifacts due to (6) vibration were unlikely not only because any such artifacts would have had to fortuitously conform to the counterbalancing pattern, but also because both the apparatus and the shielded room were independently shielded against vibrations, and because participants and experimenter were required to sit quietly during each session.

However, it should be noted that for *nonlinear* drifts in temperature, the use of counterbalanced sequences would not have been sufficient to completely rule out artifacts. To study possible biases introduced by such drifts, the control sessions were conducted immediately after the experimental sessions. Those sessions resulted in a nonsignificant overall outcome, reducing the plausibility of an explanation based on temperature drift. However, because temperature was not independently recorded during these sessions, this explanation cannot be firmly excluded.

A second conventional explanation is that statistical artifacts might have arisen due to non-normal distributions of the average illumination measures recorded by the CCD. Violation of parametric statistical assumptions was avoided through the use of the nonparametric Wilcoxon rank sum statistic.

A third potential explanation is that the reported data represent a selected subset of a larger collection of data. This is not the case. A series of 20 experimental sessions was preplanned, and excepting the initial two sessions that experienced data acquisition problems, all other data in all experimental sessions are reported. The series of 15 control sessions was not planned in advance, but was added to the testing protocol after the first five sessions to provide a secondary way of assessing possible artifacts in the data collection, counterbalancing, and analytical processes.

One may also wonder whether the experimenter's manual control of the beginning of each run might have introduced a bias. This manual procedure was necessary because participants sat quietly with eyes closed during the session, so the experimenter had to provide an audible prompt at the beginning of each successive run by announcing its pass or block condition. The question is, through this manual procedure, could the experimenter have biased the resulting images to favor the hypothesis? Although the camera software displayed each frame image as it was taken by the camera, and the experimenter could see those images, changes from one exposure to the next were imperceptible as indicated by the tiny changes in illumination magnitude shown in Figure 8. At the end of each session, the experimenter could not tell if the session was successful; only after applying the statistical analyses was it possible to measure differences between the two conditions. In any case, the experimenter merely announced the condition of each run and started the data collection program; the next 20 frames were then collected automatically. Unless the experimenter was able to outguess what the camera was about to observe 30 seconds in the future (which cannot be dismissed as a possibility[58]) then manual operation of the test could not have biased the outcome.

Decline Effects

From Figure 5, we see that experimental effects declined over the course of the experiment. Similar declines have been frequently noted in previous experiments involving nonlocal perception and intention.[59] Researchers have proposed that these declines may be due to inherent limiting factors in complex, recursive systems, social factors, environmental influences, or psychological factors. In the present case, after conducting 13 sessions (not counting the first two sessions with hardware problems), the experimenter became concerned that 12 of those 13 sessions had gone in the predicted direction.

For ease of exposition, I will now switch to first person pronouns. Although I had employed numerous design features to avoid artifacts, and only four of the 10 control sessions conducted to that point had gone in the predicted direction, I still found it difficult to believe that the experimental effect was as easily repeatable as the results were suggesting. I knew that if I had trouble believing it, I could hardly expect anyone else to accept these results. So I found that my intentions for the experiment changed—I no longer hoped to observe results solely in the predicted direction, but rather I found myself hoping that some of the remaining sessions would go *against* the prediction, to validate that the methodology was not biased.

If one is prepared to take the hypothesis of mind-matter interactions seriously, then the experimenter's intentions and expectations cannot be completely excluded from the object of study. When my goals changed, the constellation of relationships that composed the experiment also changed. I suspected at the time that this shift would create an intentional double bind—to simultaneously confirm and disconfirm the prediction—that would very likely cause the results to disappear, but I also found that I could not easily banish my new intentions once they arose because they were not frivolous concerns. I mention this internal conflict, which is often glossed over or ignored in conventional scientific reports, to help illustrate the complexities one faces when conducting experiments involving intention. Extracting an investigator's intentions from an experiment seeking to measure intentional effects may not be possible, even in principle. This highlights the special epistemological challenges faced by studying systems that are sensitive to observer effects, including experiments in the life sciences and especially in healthcare.

CONCLUSION

This article inquires about the source of intuitive knowledge. Based on the present pilot study, one source of intuitive knowledge appears to involve a means of gaining information that is not mediated by the ordinary senses. If this conclusion is correct, it raises the radical possibility that the existence of such nonlocal mental capabilities—a form of *first sight* that precedes sensory awareness, as philosopher John Locke[60] (1690) put it—may help shape the nature of physical reality itself through quantum observer effects. Further speculations about such basic ontological issues are enticing to pursue but they are also premature pending replications of this effect.

A number of refinements should be considered for replication attempts: (1) Emphasis should be placed on recruiting highly experienced meditators. The present results were attributable solely to those participants. It is relevant that a review of 16 experiments reported in the 1970s,[61] all investigating various nonlocal phenomena associated with meditation, estimated that their combined results were significant at $P = 6 \times 10^{-12}$. Few systematic replications of similar studies involving meditators have been reported since then, but it appears to be a special population worth pursuing. (2) It would be interesting to test the effects of *dose,* meaning the timing of the mental blocking periods, and also the distance between the meditators and the optical apparatus. (3) Temperature and vibration should be independently measured to see how image illumination levels are affected by such environmental factors. (4) The optical apparatus could be further isolated from ambient fluctuations by housing it within a temperature- and humidity-controlled chamber. (5) A prespecified interference pattern shape could be devised to standardize the camera images across separate runs and sessions. This would allow development of an analytical test based on predicted changes in specific interference fringes, which would be the ideal measure in this type of experiment. And finally, (6) it would be valuable to use computer voice prompting to automatically inform the participant at the beginning and end of each blocking and passing run. This would eliminate the need for the experimenter to manually announce the test conditions or even to be present during the data collection periods.

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