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Illustrations by Benjamin Kessler

Building a Prescient Machine

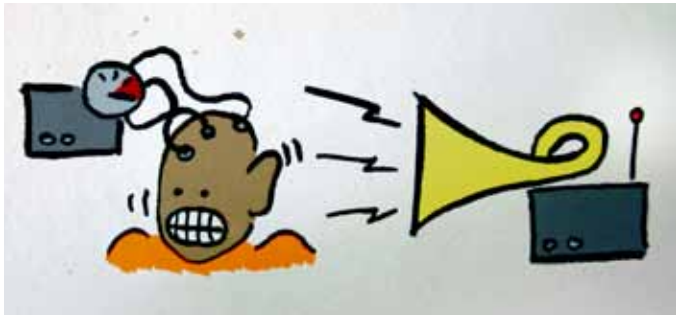
The ideal experiment is one in which humans are not involved. That was my approach when I started researching psi (precognition, telepathy, clairvoyance and psychokinesis), just as for other physics and engineering fields in which I had carried out research. My view of science was based on physicalism, the materialistic concept that everything is composed of matter and energy. For that reason, one of my concerns with psi research has been that every research paper I read involved human (or animal) consciousness. As we all know, consciousness is messy – we can't even agree on a definition of it – and it adds all sorts of undesired variables to controlled experiments. We also know that a well-designed experiment is one that excludes all the variables except for the one being studied. So if, as I assumed, consciousness and everything else is just a manifestation of physical reality, then I should be able figure out a way to study psi without having to use sentient bags of salt water as part of the experiments.

As my ideas about psi were forming, I was attracted to the ideas of Gerald Feinberg, a Columbia University physicist. In the proceedings of a 1974 conference on quantum physics and parapsychology, he described how precognition might have a physical explanation in the form of advanced waves, waves that travel backwards in time and mirror the more usual waves that travel forwards.[1] With advanced waves, precognition is simply memory of things future, he said. The concept was reminiscent of Wheeler-Feynman absorber theory,[2] in which this time symmetry was proposed to understand emission and absorption of electromagnetic waves. The processes involved a combination of the usual retarded waves traveling into the future and advanced waves traveling into the past. Aha!, I thought, a clean physical explanation for these precognition phenomena that psi researchers had explored with murky human subjects.

It turns out that "clean" experiments, those without human subjects, have in fact been carried out to test for the existence of advanced waves. In 1974 a researcher at Haverford College measured a microwave source to see if it received radiation from the future.[3] To an accuracy of one part in 100 million, none was observed. In 1980 a graduate student at the University of California at Irvine published a thesis describing his search for advanced waves to an accuracy of nearly a trillion to one.[4] Again, nothing was observed. Oh, well. Maybe there was a physical ingredient missing in these experiments.

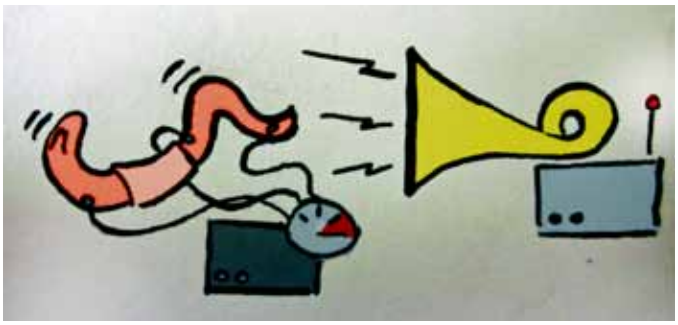
I continued my search to reconcile time-reversed psi processes with physics, applying the second law of thermodynamics to precognition[5] and to the grandfather paradox (blocking an event's cause after the event has already occurred).[6] As my students and I carried out various types of human psi experiments, I kept wondering how one could experimentally study psi in general, and precognition in particular, without involving living systems.

A clue came from an experiment published by James Spottiswoode and Ed May in 2003[7] and replicated several times since. They hooked up subjects with apparatus that logged their skin conductance, a sensitive and fast-responding measure of people's emotional state. The unfortunate subjects were then exposed to randomly timed loud horn blasts. As expected, their skin conductivity shot up after the blast. More subtly, this change started a couple of seconds before the horn blasted, and even before the random source decided when it was going to go off. Because the effect was subtle, over 1000 trials had be to averaged to make the effect stand out well above random fluctuations.



Besides other robust experiments on human precognition (or better, presentiment, since a cognitive process is not necessarily involved), experiments had been carried out with animals. In 1967 Robert Morris monitored the amount of swimming activity for three goldfish, and later selected one at random to be scooped out of the water in a net for a short time.[8] With multiple trials he found that only the goldfish that was later scooped out exhibited more swimming. Somehow it was aware of what was going to happen, even before the selection process took place. A decade ago a Masters degree student in Electrical Engineering at the University of Texas, Chester Wildey, carried out 231 trials with chilled earthworms, using an audio speaker to vibrate them.[9] With an impedance bridge to sensitively measure their conductivity (it was an Electrical Engineering degree, after all), he found that the worms showed a noticeable change one second before they were vibrated. The worms seemed to "know" in advance what would happen.

Two years ago Fernando Alvarez in Spain showed that birds reacted to being exposed to a video clip of a snake at least 9 seconds before the video started.[10]



OK, I thought, if a slithery creature at the level of a worm can exhibit precognition, I've got to be able to figure out a way to set up this experiment in an inanimate system, but what can replace the living experimental subject? In living systems there are measureable parameters such as skin conductance that can be used to detect a pre-stimulus response. In a macroscopic physical system, such as a large mechanical system, or a conventional digital electronic system, all the responses are predetermined. There is no room for psi to enter. What we need is a noisy system in which one can't tell from one moment to the next what state the system will be in. There is a long history of association between noise, i.e., random fluctuations, and psi behavior. In some way that has not yet been explained, psi information is carried by noise.

The natural candidate for an inanimate subject is an electronic random number generator (RNG). RNGs use quantum uncertainty, for example from particle decay or thermal fluctuations, to determine whether each bit in a train of output bits will be a 1 or a 0. RNGs have been used as psi receivers in psychokinesis experiments since a physicist named Helmut Schmidt demonstrated the effect 40 years ago. In the psychokinesis experiments, RNGs were monitored to see if human intention could change the output from pure random behavior. Now the idea was jelling. I could monitor the RNG output to see if it deviated from randomness before a stimulus was applied to it.

But how could the stimulus be created? In psi experiments RNGs have also been used to determine when a randomly timed event will occur, such as the horn blast in the Spottiswoode and May experiment. So, I thought, why not have one RNG be the subject, innocently spewing out 1's and 0's, while a second RNG, the controller, decides to do something nefarious to the subject-RNG? The experimenter could then look at the log of the 1's and 0's from the subject-RNG to see whether something unusual happened before the subject-RNG was perturbed.

Someone knowledgeable about RNGs would be needed to set up the apparatus, and I knew just the right person for the job: Adam Curry, who worked for Psyleron, a company that assembled and sold RNG-based products for psi investigations. He was interested in the concept and accepted a small contract to develop the electronics to hook up two Psyleron REGs, and carry out initial testing.

First we had to figure out how to perturb the subject-RNG. Adam tried to affect them externally, but unfortunately the Psyleron REGs were too robust. They hummed along happily no matter what electrical or physical torture he applied. Finally, Adam settled on using the controller-REG to simply shut off the power to the subject-REG at random times. Satisfied that this was torture enough for any electricity-dependent machine, Adam shipped the system to my lab.

Now came the major task of hooking up the system to a computer, developing the software to run it, and tabulating and analyzing the data. Fortunately that semester I was teaching the Edges of Science course at the University of Colorado, in which chiefly undergraduate students carry out psi research projects. A graduate student in my lab carrying out PhD research in a new type of solar cells wanted to learn about this crazy psi stuff he'd been hearing about for years, and signed up for the course. Zixu (James) Zhu agreed to take on the RNG experiment as his course project.

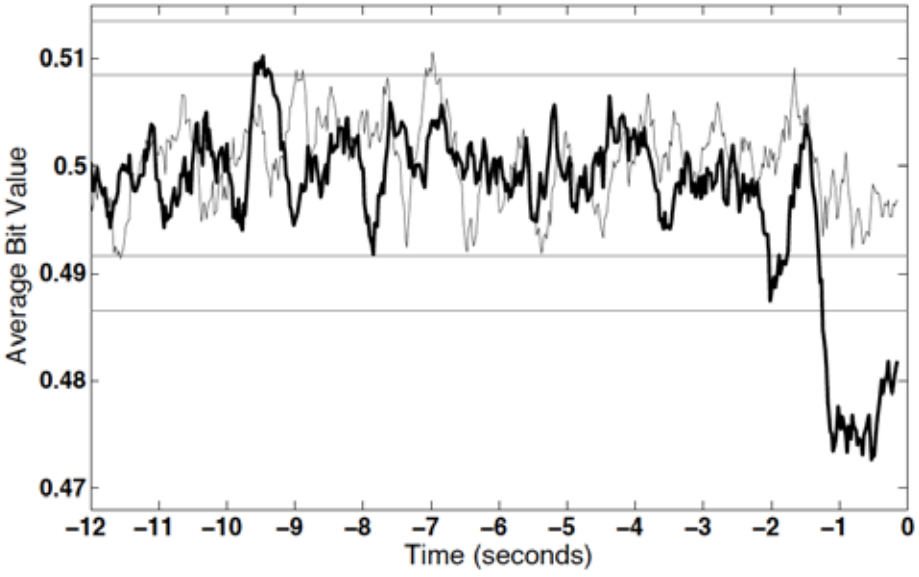
James spent many days programming and debugging the system so that we would be able to tell from the data if the subject-RNG reacted in a non-random way in the seconds before the shut offs by the controller-RNG. He set time to zero at the shut-off time for each trial and then combined a set of trials together.

Finally, we were going to see if we could observe psi without intervention from pesky biological beings!

As James started to run trials we became increasingly enthusiastic. My thoughts often drifted to the experiment, thinking that we might really have found inanimate psi. I often stopped by James' office to check on what was happening. Although my intention was to establish an experiment that was independent of intention, to cover all bases James set his intention in the initial experiments. He first set his intention to see a rise in the subject-RNG output before shut-off compared to control trials in which the wire to shut off the subject-RNG was disconnected so that it never shut off. He had the computer run a few hundred trials. The data appeared to show a rise before shut-off compared to the control, but it was not clear if it was statistically significant. He then set his intention to see a fall before shut-off, and then had the computer run a few hundred trials. The data appeared to show a fall. He set his intention be neutral and the results were ambiguous. To see if there was an effect that was independent of intention, I suggested that James combine the results of these three sets of trials into one set of data with 1,000 trials.

The combined data showed a drop in the subject-RNG output one second before shut off. The drop corresponded to a statistical z-score of –6, with odds against chance of 1 million to one. This was a huge effect! We were floored.

During the next few days James ran three batches of roughly 575 trials each, along with the same number of control runs (with the subject-RNG shut-off wire disconnected). *No particular intention was applied during these runs.* Each of the three batches showed the same behavior as the initial set of 1000 trials. Combining the three batches into one set of data



Can one RNG anticipate when its plug is going to be pulled? This figure shows the average bit value produced by the subject-RNG as a function of time before randomly timed shutoff. The test (thick line) and control (thin line) runs consisted of 1730 trails each. The random fluctuations until about 1 second before shutoff are within a statistically expected range, but the sharp drop in the subject-RNG output 1 second before shutoff deviates from expectation with odds against chance of over 1 trillion to one. The horizontal lines just below 0.51 and just above 0.49 correspond to 99% confidence intervals, and the horizontal line below 0.49 corresponds to the 99.9999% confidence interval.

with 1730 trials resulted in a dramatic dip in the subject-RNG output 1 second before shut off, with odds against chance greater than 1 trillion to one (a statistical z-score of 6.5). Details of the experiments were published last year.[11] In the many years of psychokinesis data compiled by the Princeton Engineering Anomalies Research (PEAR) program, the average deviation from randomness was about 1 bit in 10,000.[12] The deviation in our experiments corresponded to one extra 0 bit in 40 during the last second. This effect size is far greater than any other psychokinesis results I am aware of.

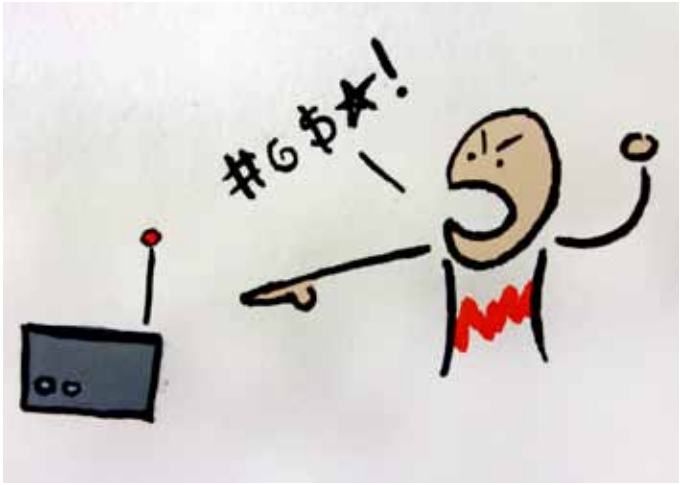
James reexamined the system multiple times to make sure that there was no error in the time stamps that the computer produced for each trial, and no external effects that might produce artifacts such as electromagnetic pick-up between the RNGs or sensitivity to external interference. There were none. The data were real.

Could we use this effect to make predictions? Could we, for example, set up a hundred or so RNGs running in parallel (cheap chip-based RNGs are available) and combine the results in a computer in real time? Then go to a casino with a roulette wheel, and spin the wheel, knowing that if it lands on red you will leave the RNGs on, and if it lands on black you will shut them off. Then one second before the roulette wheel stops, you place your bet on red if the RNGs are showing random behavior, or on black if they are deviating from randomness. When the wheel stops, shut off the RNGs or not, depending upon whether the result is black or red. Then put your winnings into the bank.

James and I decided to explore how the RNG precognition would vary as we changed system parameters. We had been tabulating 40 bits per second. To explore if the bit rate affected the magnitude of the effect, James changed that to 10 bits per second. The dip in the subject-RNG output before shut-off disappeared. We were puzzled. We tried a run with a higher bit rate, 100 bits per second. Again, no dip. After two weeks of no effect we decided to do a sanity check. We ran the system at the original 40 bits per second. The system and the program were identical to the original ones that gave a huge effect. We saw no dip!

What the devil was going on? There was one inescapable answer—and it was exactly the one I didn't want to see. As Sherlock Holmes famously quipped, "when you have eliminated the impossible, whatever remains, however improbable, must be the truth." We were looking at an experimenter effect, where the experimenter inadvertently affects the results. It was our interest and enthusiasm that had produced the original dips in the data. When that waned or became muddled, the effect disappeared. It was a psi effect, but not what I had wanted. I had wanted to create a psi experiment with an inanimate system that avoided effects of human consciousness, but its wily influence still entered through the back door.

Over the next few months a new student developed new software and new shut-off hardware to test the effect. For a short time he saw a dip in the subject-RNG output before shut off, but then the effect disappeared, never to be seen again.



If consciousness and everything else were just a manifestation of physical reality, then we should have been able to build a psi machine independent of us and any other living being. The experiment we carried out was an attempt to do that, and it failed. Reluctantly, kicking and screaming, I was led to conclude that my physicalism/materialism mindset was just not valid.

Bob Jahn, the phycisist who co-directed the PEAR Program at Princeton, had once asked the Dalai Lama whether or not an RNG was conscious. "If we regard them as conscious," the Dalai Lama replied, "they are conscious." As we learned from our experiment, any consciousness that the RNG might exhibit is an extension of our own, and is not independent of it. (But then again, are any of us independently conscious?)

I have suspended my quest to find a machine capable of producing inanimate psi.

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And for the spot art, thank you Benjamin Kessler. RNGs, of course, don't really have antennas.

GARRET MODDEL has been a Professor of Electrical, Computer, and Energy Engineering at the University of Colorado since 1985. Along with quantum engineering of new thin-film energy conversion technologies, his research group investigates psi phenomena. He has invented a range of new energy technologies, with 30 patents, and founded several high-tech start-up companies. He recently served as president of the Society for Scientific Exploration. Dr. Moddel earned a BSEE degree from Stanford and MS and PhD degrees in Applied Physics from Harvard.