[Note: The experiment described here has been implemented as the "Card Draw Test" at www.gotpsi.org, and has been operational since February 2004. A 10-stage Markov chain is employed, but the experiment is otherwise the same as described below.]

Can Causal Influence Propagate Backwards in Time? - a Simple Experiment in Markov Chains and Causality

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Abstract: We describe here a simple experiment in psychic phenomena (Psi) where the usual target generator is replaced by a cascade of randomly controlled stages of a Markov Chain. If the experiment is successful, examination of the intermediate stages of the chain will indicate whether, and how, backward causation plays a role in some forms of Psi functioning.

The basic PK experiment

Figure 1 shows a simple canonical *psychokinesis* (PK) experiment where the Subject tries to influence the output of a random number generator (RNG). The Result bitstream R is nominally unbiased, 50% 0s and 50% 1s. The Subject only observes the bitstream (via the dashed line) and cannot directly influence it by any known physical means. There is ample evidence in the literature that subjects can sometimes produce by conscious choice an excess of 1s or 0s, as desired, in this type of experiment (Jahn et al, 1997).

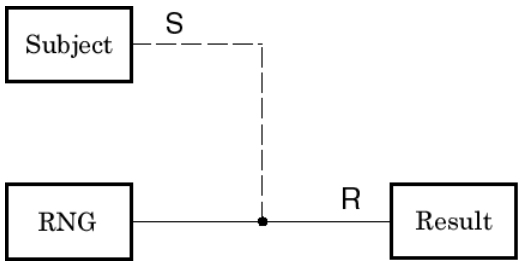

Figure 1. A simple PK experiment.

The effects observed in these experiments are typically small, but persistent, and can be statistically quite significant across a large number of trials and subjects. The protocol usually includes a randomly-determined direction for each trial or group of trials of "more 1s", "more 0s", or neither (as a control), so as to avoid accumulation of any inherent biases which might exist in the experimental situation.

The Markov Chain PK experiment

In the Markov Chain version of the experiment[1], proposed here, the random number generator is replaced by a *series* of random generators each controlling a transformation or mixing function, as shown in Figure 2. (Three stages of transformation are shown, but any number can be used.) Note that *all of the RNGs participate in the generation of each bit of stream R*. Random bits produced by the first generator (T0) may be further scrambled by each of the transformations depending on the outputs of subsequent generators. As before, the Subject observes R and attempts to influence it mentally.

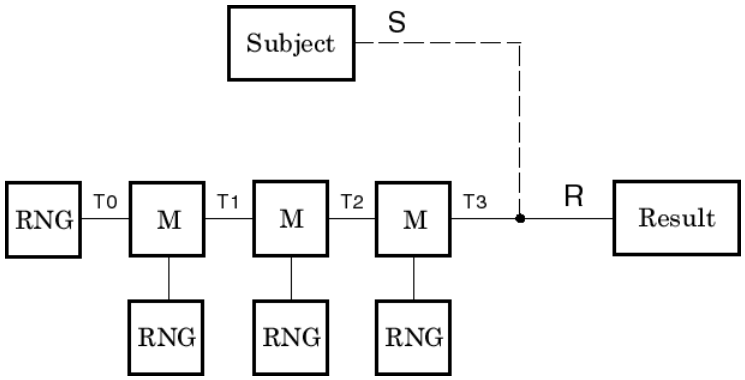

Figure 2. The Markov Chain PK experiment.

Each transformation or mixing box M has the following form, represented as a Link Table (case or transition table), with x and y indicating the left and right terminals respectively. The value of n represents the probability or weight of the given case.

x	y	n
0	0	.75
0	1	.25
1	0	.25
1	1	.75

Figure 3. Transformation M.

It can be seen that 75% of the values remain the same (0 =>0, 1=>1) when passing thru the M box, while 25% are inverted (0 =>1, 1=>0). The associated RNG determines whether this inversion takes place, with probability 1/4 as shown in the table.

[1] An small-scale version of this experiment was conducted at Interval Research in 2000, with quite interesting results. See Dean Radin's illuminating description (Radin 2000).

Analysis

Suppose the experiment has been run, and the results include a significant excess of 1s when desired at T3, for example. Then an interesting question is: *How was this excess contributed by the participating generators?* We can answer this question -- and learn something important about the nature of causality and randomness -- just by observing the distribution of 1s and 0s at each stage of the chain.

The usual assumption in this case might be that only T3 will be seen to be anomalous, while T0-2 remain uniformly distributed. If so, very unusual behavior would be required of the third RNG. Also, if this were the case, how did this one generator become affected and the others did not? According to conventional theory, the four RNGs are in principle independent, so what happens at T3 should have no effect on T0-2.

Another hypothesis would be that the RNG at the head of the chain (T0) is the only one affected, and is sufficiently disturbed to produce the observed result at T3 even while subject to the information-losing transformations. Yet another hypothesis would posit that a constant bias is somehow induced in all four generators. *Each of these hypotheses has it own signature in the intermediate chain values.*

If our hypothesis about symmetrical causation (Shoup 2000, Etter 2001b) is supported, there will be an effect felt backward through the Markov chain. Figure 4 shows this effect computed for various levels of bias that might be seen at the output R. At each stage, a proportional effect is computed, following this theory, whereby the associated RNG is perturbed as little as possible while still meeting the requirements of the results which were observed at the output T3 = R.

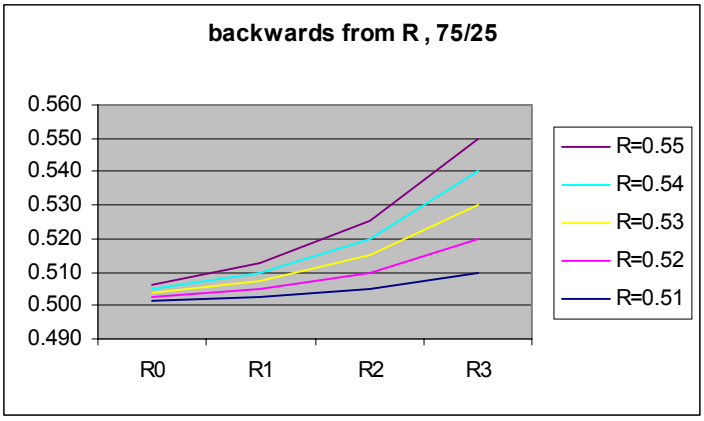

Figure 4. Hypothetical backwards Markov chain probabilities.

For example, if the output Results stream (T2) shows a bias of 52% 1s, then the stream at T2 ought to show a bias of about 51% and T1 similarly about 50.5%. According to this

hypothesis, a simple calculation can be made at each stage to predict the amount of backward influence due to the subject's supposed effect on the output stream R.

The distribution of causal influence in this aggregate situation can be seen simply by examining the experimental data from the intermediate stages of the Markov chain. For examples from the preliminary experiment, see (Radin 2000).

Implementation and protocol

It is proposed that this experiment be implemented using true random number generators, and a potentially large number of subjects, in the context of the Boundary Institute's suite of "On-Line Psi Tests" (http://www.gotpsi.org/). These on-line tests have been in continual operation since September 2000, and over 13 million experimental trials have been contributed thus far (August 2002) by over 85,000 users all over the globe. We can expect several thousand trials per day on the new proposed experiment once it is fully operational, and thus significant statistical power should be readily available.

A new Psi test invoking psychokinesis will be created for this experiment, with an appealing interface similar to the existing on-line games. As with prior Psi tests, users will have the opportunity to compete, and to see their scores listed on the daily "Hall of Fame". As usual, all data will be carefully timestamped and recorded, with various consistency checks and monitors ongoing.

What's the new idea?

The concept of a Markov process is a mathematical formalization of our intuition that no information from the past can reach the future without passing through the present. To put that intuition in another way, the *state* of the present is the *sole connection* between past events and future events. We of course take this for granted in everyday practical life, and it would not be an exaggeration to call the Markov property the defining assumption of classical science and technology.

Thus a better understanding of causality and influence as a Markov process would be a significant contribution to progress towards a complete physical theory, including both forward and backward effects and Psi as well.

If the experiment is successful in demonstrating Psi effects, we will have a definitive test of the hypothesis of backwards influence, and a definitive challenge to the assumption of immutable randomness in these RNGs. The results should have significant implications for physics, for science as a whole, and for society at large.

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[*] Available on the Boundary Institute web site http://www.boundary.org/.
[**] Available at http://www.fourmilab.ch/rpkp.