THE PRATT–WOODRUFF EXPERIMENT AND VIABLE EXPLANATORY HYPOTHESES

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ABSTRACT: The Pratt–Woodruff experiment is simulated on a computer and a wide variety of models of card misplacement proposed by critics of the experiment are tested. The results neither confirm nor deny the criticisms. A number of explanatory hypotheses are analyzed, with the conclusion that all are equally viable.—Ed.

C.E.M. Hansel's (1961, 1966) criticism of the Pratt–Woodruff (1939) experiment has been exhumed in a recent heated exchange in the June 1974 number of the *Journal of Parapsychology* (Medhurst & Scott, 1974; Pratt, 1974; Scott, 1974).

Hansel's hypothesis predicts a higher percent of hits on the cards which were "end" cards (E-cards) on the previous run than on the middle (M-cards).[1] This effect is striking in the P.M. data, and Medhurst and Scott (1974) have demonstrated that it is also statistically significant ($p = .012$) in the data of the other four high-scoring subjects.

Pratt (1974) counters as follows:

> I suggest another type of analysis that should help to discriminate between ESP and card misplacement. This is a run-by-run correlation of the percentage of hits found in the E- and M-piles. On the ESP hypothesis we would predict a positive correlation, on the ground that the conditions that favored success in the E-piles in a given run would also be effective toward producing positive scoring in the M-piles. On

[1] In this part of the Pratt–Woodruff experiment, the screened touch matching procedure was used with a screen between the subject and experimenter. On the subject's side of the screen, five stimulus cards were hung on pegs, and five blank cards were placed flat on the table in corresponding positions where they could be seen by the experimenter through an aperture at the bottom of the screen. For each trial, the subject pointed to one of the blank cards, thus indicating his choice of the key card directly above. The experimenter then placed the top card of an ESP deck in the indicated position on his side of the screen underneath a slanting shield and out of range of the subject's vision—Ed's note.

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the card-misplacement hypothesis, on the other hand, little or no correlation would exist, since the Medhurst and Scott hypothesis is that Woodruff simply shifted cards to the E-piles to create spurious hits.

Scott (1974) subsequently found $r = 0.2277$ (154 pairs) for the Pratt correlation in the P.M. data, which is significantly ($p = .002$) different from zero. However, since the percent E- or M-hits to which Pratt refers is equal to the total number of E- or M-hits divided by the total number of E- or M-trials, respectively, whenever an E-hit occurs this decreases the number of M-misses and M-trials simultaneously by one, thus increasing slightly the percent M-hits. This effect is by no means as negligible as Pratt believes. In fact, the largest possible value of the correlation between percent E-hits and percent M-hits calculated in the above manner is to be expected under completely random conditions. This analysis is easily confirmed by a Monte Carlo experiment.

The Monte Carlo Experiment

We can program a computer to "play" the Pratt–Woodruff "game" as follows: A random number between one and five is generated and placed at random in one of five cells which represent the five "key" cards. A count is kept until five numbers of each denomination have been generated, thus simulating the entire card deck. The key cells, which are labeled from one to five, can be shuffled at random between runs and any number of cards can be placed deterministically to match a key cell which was at the end position on a previous run, thus simulating Hansel's hypothesis. This program may be obtained from the author upon request and a copy is also filed with the editors of the *Journal of Parapsychology.*

Since Scott's r value is based on 154 pairs, the program calculates r for 154 runs of 25 trials each. This calculation is repeated a large number of times. The specific number of iterations for each model is given in the tables.

Table 1 shows the effect of misplacing n E-cards per run for $n = 0 \ldots 5$. For 1,000 iterations of a completely random partitioning of the deck, $\mu_r = 0.136 \pm 0.076$. The distribution is not significantly different from normal ($\chi^2 = 11.0, df = 7$).

The observed value of $r = 0.2277$ is well within the 95% acceptance interval for a pure chance process ($n = 0$) as well as for $n = 1$ which reproduces the P. M. scoring rate. In fact, the observed value of r is within the 95% acceptance interval for every value of n listed in Table 1. The higher n values were calculated to show that r

actually decreases with increasing n and is at its maximum for $n = 0$.

Scott (1974) states:

> P.M. was scoring at an average deviation of 1 per run. This might have been achieved in theory by making n misplacements every nth run, for any value of n. The higher the n, the higher the correlation to be expected; but we do not know n and I see no hope of estimating it to a useful degree of precision.

Table 1

Effect of Misplacing n E-cards per Run

n	E-Piles			M-Piles			Correlations		
	Average Number Hits/25 E-trials	μ_{CR}	σ_{CR}	Average Number Hits/25	μ_{CR}	σ_{CR}	μ_r	σ_r	$\mu_r+2\sigma_r$
0	5.00	0.00	0.91	5.00	0.03	0.95	0.136	0.076	0.288
1	6.61	6.50	0.85	5.20	0.96	0.97	0.132	0.076	0.284
2	8.04	12.61	0.90	5.48	2.21	0.99	0.123	0.080	0.283
3	9.31	18.39	0.82	5.66	2.97	1.00	0.113	0.077	0.267
4	10.48	23.94	0.77	5.96	4.23	0.97	0.098	0.080	0.258
5	11.52	29.18	0.69	6.25	5.37	1.03	0.095	0.076	0.246

Note. Values for $n < 2$ are based on 1,000 iterations of 154 runs of 25 trials each; all other values are based on 100 iterations.

But we do not need to know the value of n. It can only take on the values, 1 through 10, and it is a simple matter to test all of them. The results are shown in Table 2. As Scott predicts, μ_r increases with increasing n, but the observed value of r remains within the 95% acceptance interval for all possible values of n.

Scott (1974) continues:

> Further, the misplacement could have been in favor of E-hits only, or against E-misses in addition; we do not know which, but the choice of model affects the correlation to be expected.

Obviously, the avoidance of E-misses must be defined as follows: Whenever an M-card appears in the target deck, regardless of the call of the subject, the experimenter places it at random on one of the M-piles. If we were to introduce specific and deterministic M-card misplacement, the scoring rate on the M-piles would immediately rise above chance level which is inconsistent with the data (see Table 3 of Medhurst & Scott, 1974). This point is apparently not appreciated. For example Medhurst and Scott (1974) state:

> We did not find the position of the cards placed first or last any easier to identify than the remainder. However, a factor which certainly

favors the first and last cards is the difficulty of *memorizing* the card order of the previous run. Only one or two cards can be easily recalled and it seems natural to concentrate on remembering one or both of the end cards.

Table 2
EFFECT OF MISPLACING n E-CARDS PER RUN EVERY nTH RUN

	E-Piles			M-Piles			Correlations		
n	Average Number Hits/25 E-trials	μ_{CR}	σ_{CR}	Average Number Hits/25 M-trials	μ_{CR}	σ_{CR}	μ_r	σ_r	$\mu_r+2\sigma_r$
1	6.61	6.50	0.85	5.20	0.96	0.97	0.132	0.076	0.284
2	6.61	6.49	0.94	5.19	0.88	0.94	0.144	0.075	0.294
3	6.63	6.56	0.87	5.21	0.98	0.97	0.178	0.076	0.330
4	6.59	6.40	0.83	5.22	1.04	0.99	0.192	0.073	0.338
5	6.56	6.30	0.84	5.20	0.92	0.77	0.207	0.083	0.374
6	6.54	6.21	0.86	5.20	0.92	1.00	0.228	0.080	0.388
7	6.59	6.43	0.96	5.21	0.99	0.97	0.257	0.082	0.420
8	6.61	6.51	0.74	5.19	0.91	0.99	0.287	0.086	0.458
9	6.58	6.37	0.81	5.18	0.87	1.05	0.325	0.083	0.491
10	6.58	6.37	0.84	5.21	1.01	1.00	0.329	0.077	0.482

Note. Values for $n > 1$ are based on 100 iterations of 154 runs of 25 trials each; values for $n = 1$ are based on 1,000 iterations.

At this point it should have been stressed that the most solid evidence against deterministic M-card misplacement is that none of the subjects scored significantly above chance level on the M-piles (subject C. C. scored at $p = .045$, which is quite marginal).

Table 3 shows the effect of avoidance of E-misses defined as above. When no deterministic E-hits are present, the P.M. scoring rate cannot be achieved without well over five avoidances per run. When one deterministic E-hit is present, the M-pile scoring rate rises above chance level for $a \geqslant 3$ where a is the number of E-miss avoidances. The observed value of r is well within the 95% confidence interval for $a < 3$. In fact, the observed value of $r = 0.2277$ is well within the 95% confidence interval for all 25 models listed in Tables 1, 2, and 3.

We conclude that Pratt's proposed statistic is insensitive and inappropriate as a test for ESP because the observed value is consistent with such a wide variety of alternative models which do not necessarily involve ESP.

Table 3

EFFECT OF n DETERMINISTIC E-HITS PER RUN IN CONJUNCTION WITH AVOIDANCE OF a E-MISSES

n	a	E-Piles: Average Number Hits/25 E-trials	E-Piles: μ_{CR}	E-Piles: σ_{CR}	M-Piles: Average Number Hits/25 M-trials	M-Piles: μ_{CR}	M-Piles: σ_{CR}	Correlations: μ_r	Correlations: σ_r	Correlations: $\mu_r+2\sigma_r$
0	1	5.19	0.72	0.91	5.07	0.33	0.84	0.118	0.084	0.287
	2	5.41	1.55	1.08	5.16	0.78	1.01	0.121	0.076	0.272
	3	5.69	2.53	1.04	5.23	1.13	0.92	0.121	0.075	0.271
	4	5.95	3.41	0.94	5.32	1.63	0.99	0.102	0.080	0.263
	5	6.19	4.17	0.90	5.37	1.91	1.00	0.104	0.075	0.255
1	1	6.84	7.33	0.86	5.29	1.37	0.93	0.128	0.067	0.262
	2	7.15	8.35	0.89	5.37	1.80	0.98	0.116	0.073	0.262
	3	7.46	9.39	0.81	5.48	2.33	0.93	0.106	0.084	0.274
	4	7.77	10.31	0.89	5.54	2.69	0.90	0.103	0.080	0.263
	5	8.12	11.36	0.92	5.61	3.05	0.94	0.087	0.073	0.234

Note. All values are based on 100 iterations of 154 runs of 25 trials each.

DISCUSSION

The hypotheses under consideration are: (a) ESP on the part of the subject; (b) cheating or conscious E-card misplacement by Woodruff after consciously memorizing the end cards from the previous run and looking at the deck during the run; (c) unconscious E-card misplacement by Woodruff on the basis of information obtained from small sensory cues.

The third hypothesis has been perhaps too readily discarded by both Pratt and Scott under the argument that the observed decline effect would not be expected. This reasoning assumes that unconscious mental processes should exhibit the same type, degree, and rate of learning as conscious mental processes. What evidence is there for such an assumption?

Our ignorance of unconscious processes is so vast at the present time that if speculation is to be entertained, it should at least be varied. Let us assume that after the very first run Woodruff subconsciously noted the key E-card positions and during the first scoring cataloged several minimal card identification cues on the card backs. It is well established that subjects in ESP experiments can absorb extremely minimal cues from the test situation. It is also well known that specific experimenters tend to obtain highly specific types of results. As J. B. Rhine put it, the experimenter "leaves his mark" on the results. If the process of information gathering and processing were entirely subconscious, why should it not be subject to the same fatigue, boredom, and decline as ESP itself, which is presumably totally subconscious?

Furthermore, a decline in scoring of +92 to −121 from the upper left quarter to the lower right quarter of a scoring sheet (the so-called QD) was observed in the experiment of Oram (1954) where subjects simply matched digits from a standard random number table. According to Nicol (1955) this is "the most significant (p = .0002) single QD in the annals of psychical research." Oram (1955) can only comment that ". . . the declines obtained are very strange. . . ."

It hardly seems justified to discard hypotheses on the basis of a phenomenon whose workings we clearly do not yet understand at all. Therefore I see no grounds for discarding any of the three hypotheses listed above. In fact, we could add (d) information gathering on the part of the experimenter by ESP followed by unconscious E-card misplacement. Any combination of hypotheses (a), (c) and (d) is also plausible. Hypotheses (b) and (c) offer an obvious explanation of the higher E-scoring. Under (a) and (d) the explanation is more involved but nevertheless possible.

The GESP hypothesis essentially assumes information transfer from the environment (which may include the mind of a telepathic transmitter) to the subject by some means other than the well-known and well-characterized sensory processes. Let us hypothesize that this information bypasses the control of consciousness and enters the memory banks where its retrieval obeys the same laws and patterns as any other form of sensory information retrieval.

Hansel's reasoning that the memory mechanisms would focus on the end cards is also applicable to the ESP hypothesis. The subject usually attempted to replace the key cards in a different order each time. This requires short-term memory storage of the order from the previous run. The end cards having stronger memory traces than the middle ones received a greater number of hits. This same general memory retrieval mechanism would be expected in all high-scoring subjects, which is precisely what is observed. If the experimenter is unconsciously misplacing E-cards, even if his information comes from ESP, the sensory observation of the end cards after each run could serve as the memory trace. A general relationship between psi and memory is suggested by a number of old and new studies (Roll, 1966; Feather, 1967; Kanthamani & Rao, 1974; Honorton & Harper, 1974).

It should be noted that the E-card effect is distinct from but related to the well-known phenomenon of terminal salience (Rhine, 1941; Pratt, 1961). Terminal salience has been offered as independent evidence of the nonfortuitous character of the psi phenomenon. It is explainable under the hypothesis that general cognitive functions, operative in the psi phenomenon, discriminate between end and middle positions within a given run in much the same manner as the memory facility does in remembering the end positions of the key cards from the previous run in the Pratt–Woodruff experiment.

Therefore all hypotheses listed above offer complete explanations of the data. Unfortunately, the test suggested by Pratt does not allow us to rule out any of them. Nothing published to date "moves the balance at least some distance" (Medhurst & Scott, 1974) toward any hypothesis. Regardless of one's personal preference, they are all equally viable scientific hypotheses.

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