ORD 2240-75

12 June 1975

MEMORANDUM FOR: OTS/CB

SG1I

ATTENTION: [redacted]

SUBJECT: Evidence for Non-Randomness of "Four-State Electronic Random Stimulus Generator"

REFERENCE: OTS/CB Memorandum #75-60

As requested in the last paragraph of the referenced memorandum, we have investigated the data provided to establish evidence for randomness. The basis for suggesting non-randomness is as follows:

Table 1 of the Reference provides data concerning frequencies of:

A. Initial States

B. State Transitions

Since the experiment consisted of requiring the subjects to indicate the next-to-be presented state, it would seem most important to establish that all possible transitions occur with equal probability. To test for possible non-equality of transitions, we extracted the observed frequencies of non-identity transitions to form the following table:

	Yellow	Green	Blue	Red
Y	-	764	765	790
G	777	-	773	863
B	776	796	-	773
R	787	852	803	-

This table can be restructured as a two-by-six table as follows:

	Y/G	Y/B	Y/R	G/B	G/R	B/R
Forward	764	765	790	773	863	773
Backward	777	776	787	796	852	803

The table thus restructured brings together all possible non-identity transitions viewed as state-pairs. For instance, Col. 1 shows that there were 764 transitions from the yellow state to the green state and there were 777 transitions from the green state to the yellow state. Under the hypothesis that all state transitions are equally probable and equally affected by chance the observed frequency with which forward transitions occur should be unrelated to that with which backward transitions occur in the same pair. This condition is not met. There is a very strong relationship between the observed forward and backward transition frequencies. The coefficient of correlation between frequencies for these two directions, computed across all six possible non-identity transitions is .93, ($p < .01$) (see attached graph). This finding shows that there were, in fact, systematic pair-wise biases associated with the electronic processes by which the transitions were selected.

The finding that the forward and backward transitions are closely associated with respect to joint probability of occurrence suggests that they can be considered as having been drawn from the same population. To test this, we computed the forward and backward mean and the Standard Deviation (SD) of the observed frequencies. They are:

	Mean	SD
Forward	788	37.9
Backward	798	28.25

The standard error of the difference between these two means is 15.59 while the difference between them is only ten; clearly

these data may be merged. Merging them provides the following table:

	Y/G	Y/B	Y/R	G/B	G/R	B/R	Total
Observed Frequency	1541	1541	1577	1569	1715	1576	9519
Expected Frequency Under Null Hypothesis	1586.5	1586.5	1586.5	1586.5	1586.5	1586.5	9519
Chi Square	1.305	1.305	.057	.193	10.408	.069	

Total Chi Square = 13.337 df=5 p=.02

In the above table it can be seen that the large excess of observed transitions involving the red-green pair is significant at the .02 level. Inspection of the observed frequencies reveals that there are almost ten percent more transitions involving the red-green pair than the average of the other five possible non-identity transitions.

These results suggest that adopting (for whatever conscious or unconscious reason) a strategy of "When green, press red, when red, press green and, otherwise use the 'pass' button as much as possible" will increase one's hit score. Using an instrument with the above-described characteristics and strategies such as this is certain to produce "statistically significant" results, given enough trials and the assumption of random transition probabilities. Other biases also exist which could form the bases of other enhancing strategies but the above discussion would seem adequate to establish the existence of non-randomness which we have suggested.

The report available to us contains data only upon one test of one instrument. It must, therefore, be assumed that the other instruments demonstrated non-random characteristics of a similar nature. Further, the report does not reveal which subject used

which instrument so we are unable to ascertain whether or not subject number 2's results could be due to the effects discussed above, but the magnitude of the effect is adequate to explain the results if one assumes the adoption of a selection strategy which "capitalizes" upon the non-random characteristics which are demonstrably present.

SG1I

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Attachment

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