Thursday afternoon

ANALYSIS OF THE SUBJECT-MACHINE RELATIONSHIP

Approved For Release 2003/04/18 : CIA-RDP96-00787R000200150011-4

TABLE OF CONTENTS

Overview

An apparent phenomenon which defies the theory of probability occurs when Subject 2 plays this experimental game. He significantly exceeds his probability of success, .25, by scoring over .29. The question that this report addresses is: Is there a statistical or logical reason why he did so well? The methodology used to attack this problem and the resulting conclusions are summarized below. This summary can also serve as an outline to this detailed report.

I. Statistical Analysis of the Machine Experimental Data

Pre-experiment data analysis discovered a non-random characteristic through the examination of forward-backward state transitions (i.e., Red-Blue, Blue-Red). However, the coefficient of correlation between the forward and backward states of .58 for the experimental data, .49 for Machine 1 data and .48 for Machine 2 data were considered low enough that this approach was dropped. Pre-experiment state transitions had a coefficient of correlation of .93.

The experimental data randomness analysis consisted of examining the distribution of color totals and the distribution of each color taken over various combinations and permutations of the data. No evidence of non-randomness was discovered.

II. Analysis of the Subjects' Data Responses

The subject's responses were analyzed with the emphasis on the discovery of his strategy or the unveiling of a trend which would give him a statistical advantage. The possibilities investigated produces no solid reason how he was able to be so successful. However, in one case there is a strong indication why he was able to succeed. It appears that he was learning the states of Machine 2. The details of this are in the remainder of the report.

Miscellaneous

The report contains a section entitled "Miscellaneous" for the purpose of displaying detailed data which wasn't directly required by the above more general analysis. Details such as how many successful choices in the color red during the 50th trial were there, or what was the relationship of the number of passes to the number of successes.

The terminology used is as follows: the term "trial" refers to the string of machine states and corresponding choices from the time the subject begins until he makes 25 non-passing choices. A sample is a machine state and/or subject choice (including passes). There are (25 + # passes/trial) samples in each trial.

I. Statistical Analysis of the Machine Experimental Data

SG1I

Forward-backward State Transition Analysis

In a previous memorandum (Memo ORD 2240-75, 12 June 1975 to the question of randomness with the emphasis on state transitions as an indication of non-randomness was addressed. The data used in the investigation consisted of pre-experiment trials. The purpose of this section is to do a similar investigation using the actual data which occurred during S2's experiment.

Table 1 presents all possible transition frequencies. All transitions should have equal probability.

	YELLOW	GREEN	BLUE	RED
YELLOW	204	199	199	216
GREEN	192	218	222	207
BLUE	211	206	228	222
RED	209	206	223	221

Restructuring into a two-by-six table as in Ref 1 produces:

	Y/G	Y/B	Y/R	G/B	G/R	B/R
FORWARD	199	199	216	222	207	222
BACKWARD	192	211	209	206	206	223

The conclusion based on pre-experimental data was that these state-pairs show a very strong relationship between forward and backward transition frequencies (coefficient of correlation =.93). However, computing the coefficient of correlation, p_{S2} actual data = .58, it becomes apparent that the degree of dependence is slightly reduced. Therefore the dependence of forward to backward states can no longer be considered as a strong indicator of non-randomness.

The data used in the above discussion consisted of trials from both machine 1 and machine 2. Since non-randomness, made apparent by the state transitions, clearly existed for pre-experimental data, the investigation of the experimental data continued to include a search for this trend in the individual machines. The transitions (including identity) are as follows:

Machine 1

	YELLOW	GREEN	BLUE	RED
YELLOW	96	79	88	92
GREEN	85	87	86	88
BLUE	85	82	90	87
RED	91	91	83	92

Machine 2

	YELLOW	GREEN	BLUE	RED
YELLOW	108	120	111	124
GREEN	107	131	136	119
BLUE	126	124	138	135
RED	118	115	140	129

Computing the two coefficients of correlation,

$$\rho'_{\substack{\text{machine 1}\\ \text{s2 data}}} = .4934$$

and

$$\rho'_{\substack{\text{machine 2}\\ \text{s2 data}}} = .4838$$

it is obvious that the forward and backward transitions are even less dependent than in the combined case. Thus ended the search for non-randomness through state transition.

As a by-product the following table is produced for general information.

	BOTH MACHINES		MACHINE 1		MACHINE 2	
	MEAN	SD	MEAN	SD	MEAN	SD
FORWARD	210.8	10.7	86.6	4.27	124	9.74
BACKWARD	207.8	9.00	86.2	3.92	121	11.25
TOTAL DATA POINTS	3483		1446		2037	
COEFF OF COV	.5843		.4934		.4838	

3141
2702
3650

Experimental Data Randomness Analysis

The machine data used during the S2 experiment has been combined, summarized and/or permuted in an attempt to establish evidence or randomness or non-randomness. If an obvious indication of non-randomness would have evolved this task would be simplified because it would have become a closed form problem (i.e., the solution would be - the data has non-random characteristics). However, what has resulted is that various forms of the data have been examined with all indicating that the data is random.

biased investigator

Tables, plots and commentary are presented in this section to demonstrate randomness and in some cases just to provide general information concerning the machines data.

The distribution of the colors collectively and for each machine is as follows:

	Yellow	Green	Blue	Red	Total	Mean
Machine 1	365	353	356	372	1446	361.5
Machine 2	475	505	538	519	2037	509.25
TOTAL	840	858	891	891	3483	870.75

Machine 1 was not used in as many trials as machine 2 (44 trials to 56 for machine 2), thus the difference in totals. The standard deviation of binomial distribution with n=3483 and p=1/4 is 25.56 which would imply that each separate number is reasonably close to the mean.

Accepting the distribution of the totals consider the distribution of the colors throughout the experiment. The popluations used for this investigation consisted of the first 25 samples of each trial (100 trials total). This population is acceptable since the distribution of its totals was reasonable and since the performance of S2 was approximately the same (success-29.61%) for this subset.

The following three approaches comprise the strategy used to attack the question of color distribution.

1. Each trial (abbreviated to 25 samples) as analyzed separate interval. Obviously this will indicate any bias within each trial.
2. The data (2500 samples) is divided into intervals of five samples each. This will indicate unusual repetitions either within the interval or interval-by-interval.
3. The data is reformatted into 25 intervals of 100 samples, where the nth interval consists of the nth sample in each trial.

The results of approach 1 is shown in Figures 1.1.a, 1.1.b, 1.1.c, and 1.1.d.

The binomial distribution for this strategy (n=25 p=1/4) is mean 6.25 and the variance 4.69. The plots indicate randomness throughout the 100 trials.

The results of approach 2 are similar to approach 1 and are shown in the four tables in Figure 1.2. The plots indicated randomness but are not shown because of monotomy. The binomial distribution mean is 1.25 and the variance .94.

The binomial distribution mean and variance for approach 3 is 25 and 18.75 respectively (Figure 1.3). A plot of the data (Figure 1.4) for the "RED" case because of the concern for the higher variance and ranges. The 13th sample seems to have an unusually high frequency of "RED" (44%). However in general this investigation has not produced a significant non-random characteristic.

sample size	100
maximum	12
minimum	3
range	9
mean	6.23
variance	4.239494949
standard deviation	2.059003387
mean deviation	1.6314
median	6
mode	6

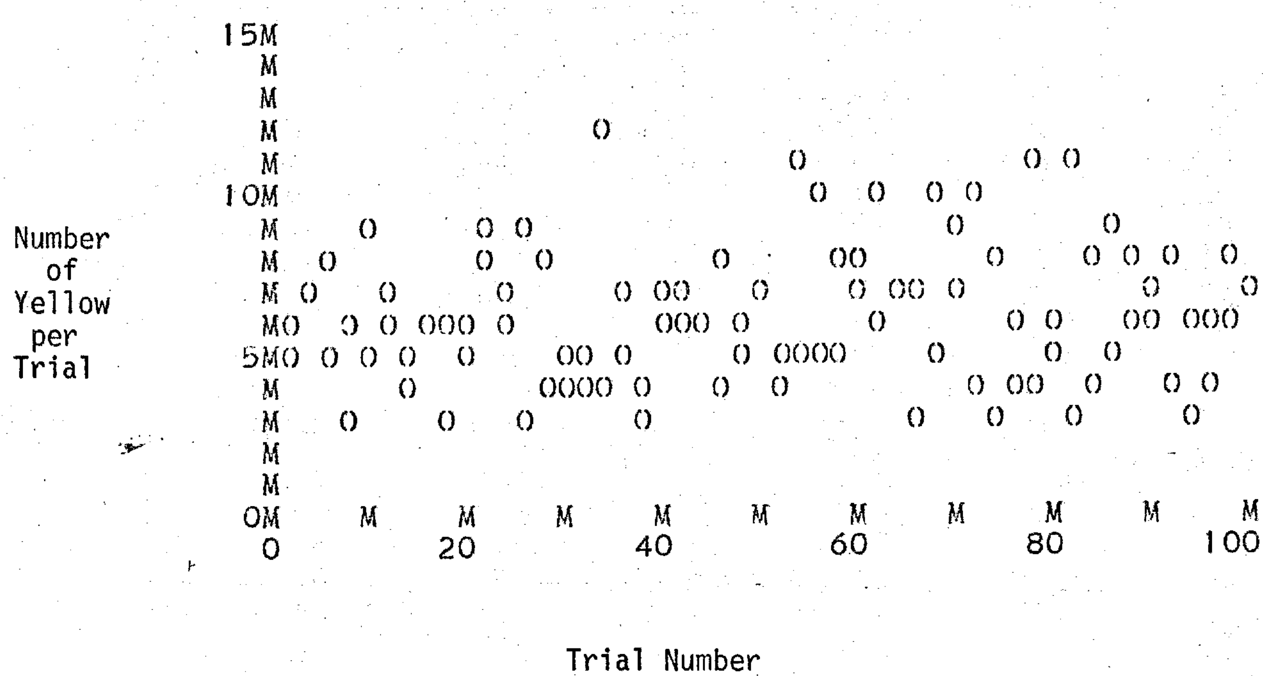


Figure 1.1.a Distribution of Machine Yellows Over Trials

sample size	100
maximum	12
minimum	0
range	12
mean	6.13
variance	5.851616162
standard deviation	2.419011402
mean deviation	1.9404
median	6
mode	5 7

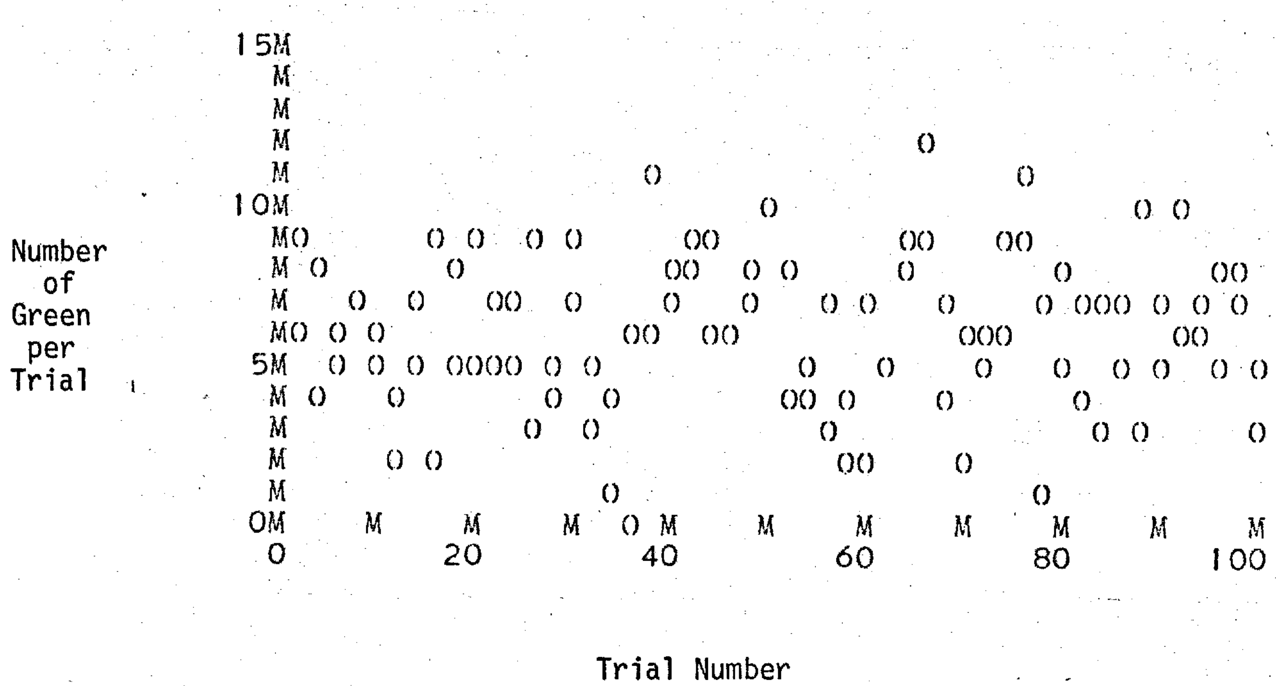


Figure 1.1.b Distribution of Machine Greens Over Trials

sample size	100
maximum	11
minimum	1
range	10
mean	6.21
variance	5.218080808
standard deviation	2.284311889
mean deviation	1.8194
median	6
mode	6

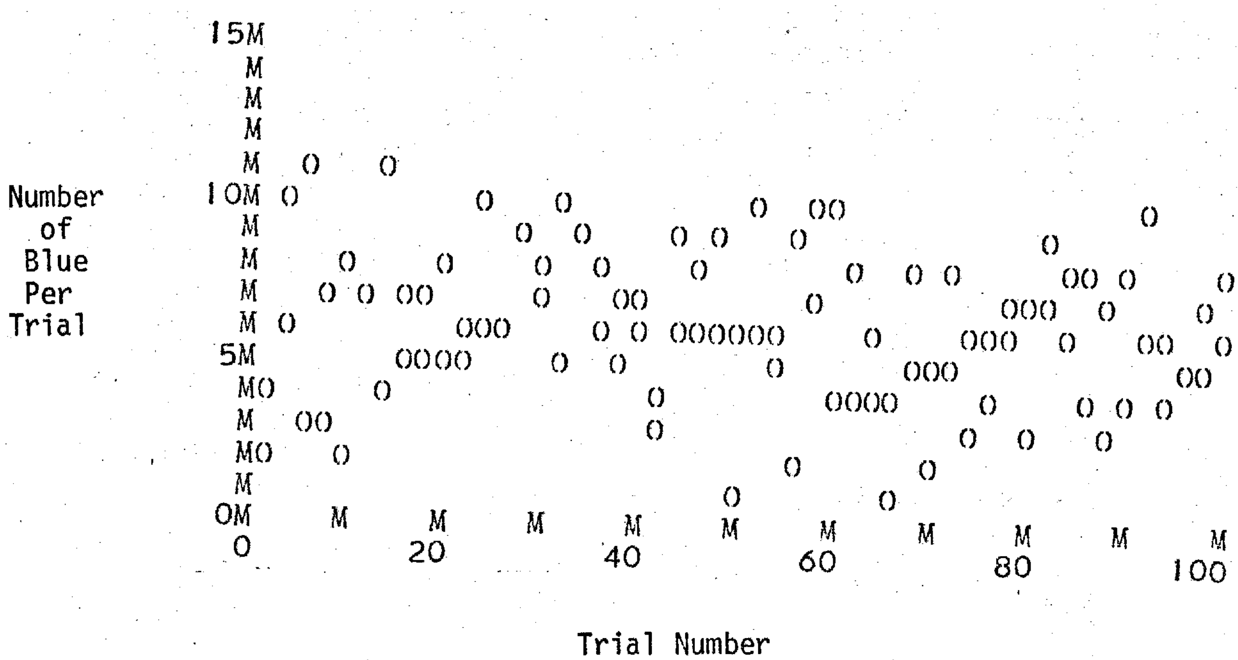


Figure 1.1c Distribution of Blue Over Trials

sample size	100
maximum	12
minimum	1
range	11
mean	6.43
variance	4.631414141
standard deviation	2.152072058
mean deviation	1.7158
median	6
mode	6

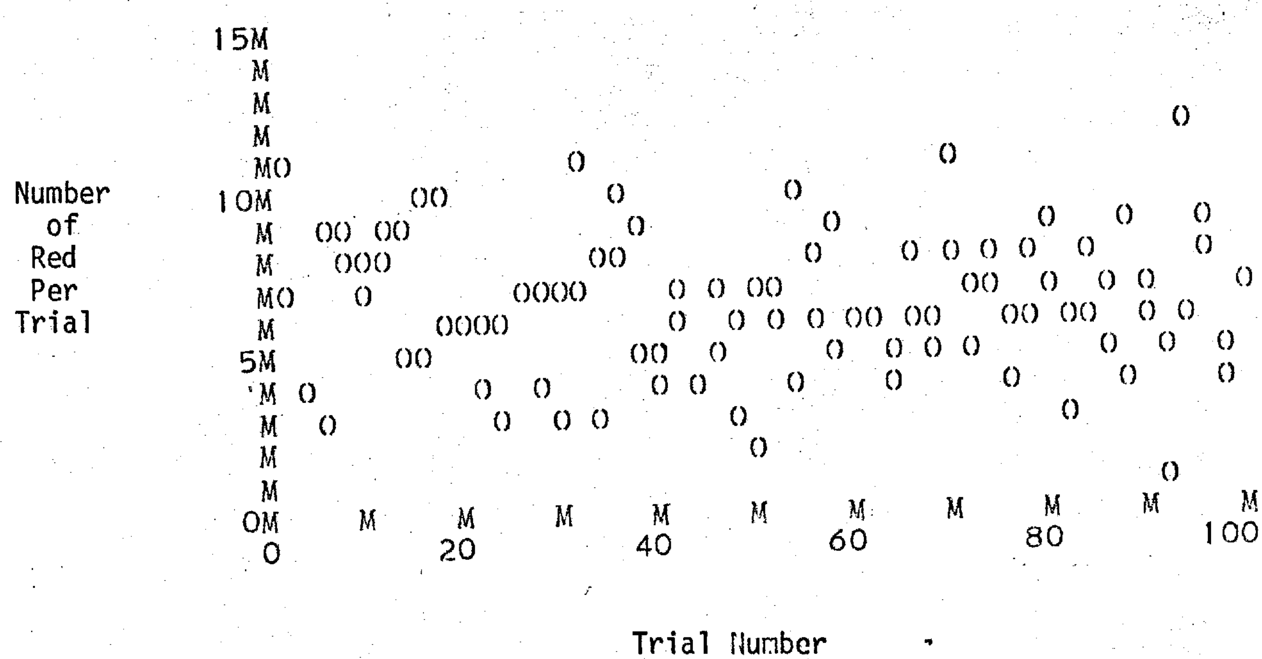


Figure 1.1.d Distribution of Machine Reds Over Trials

Approved For Release 2003/04/18 : CIA-RDP96-00787R000200150011-4

Distribution of [illegible]

sample size	500
maximum	5
minimum	0
range	5
mean	1.246
variance	0.9594028056
standard deviation	0.9794910952
mean deviation	0.784848
median	1
mode	1

Distribution of Green

sample size	500
maximum	5
minimum	0
range	5
mean	1.226
variance	0.9969178357
standard deviation	0.9984577285
mean deviation	0.804512
median	1
mode	1

Distribution of Blue

dstat grp;<3:

sample size	500
maximum	4
minimum	0
range	4
mean	1.242
variance	0.9573507014
standard deviation	0.9784429985
mean deviation	0.792792
median	1
mode	1

Distribution of Red

sample size	500
maximum	5
minimum	0
range	5
mean	1.286
variance	1.026256513
standard deviation	1.013043194
mean deviation	0.823216
median	1
mode	1

Figure 1.2 Distribution of M[illegible] Colors When Samples are Taken Five at a Time

Yellow Distribution

sample size	25
maximum	31
minimum	19
range	12
mean	24.92
variance	10.57666667
standard deviation	3.252178757
mean deviation	2.6304
median	24
mode	24

Green Distribution

sample size	25
maximum	35
minimum	15
range	20
mean	24.52
variance	24.59333333
standard deviation	4.959166597
mean deviation	3.9392
median	25
mode	22 25

Blue Distribution

sample size	25
maximum	34
minimum	19
range	15
mean	24.84
variance	14.47333333
standard deviation	3.804383437
mean deviation	2.9664
median	25
mode	26

Red Distribution

sample size	25
maximum	44
minimum	16
range	28
mean	25.72
variance	26.71
standard deviation	5.168171824
mean deviation	3.3664
median	25
mode	25

Figure 1.3 Distribution of Machine Colors When Samples are Taken 100 at a Time

(One From Each Trial)

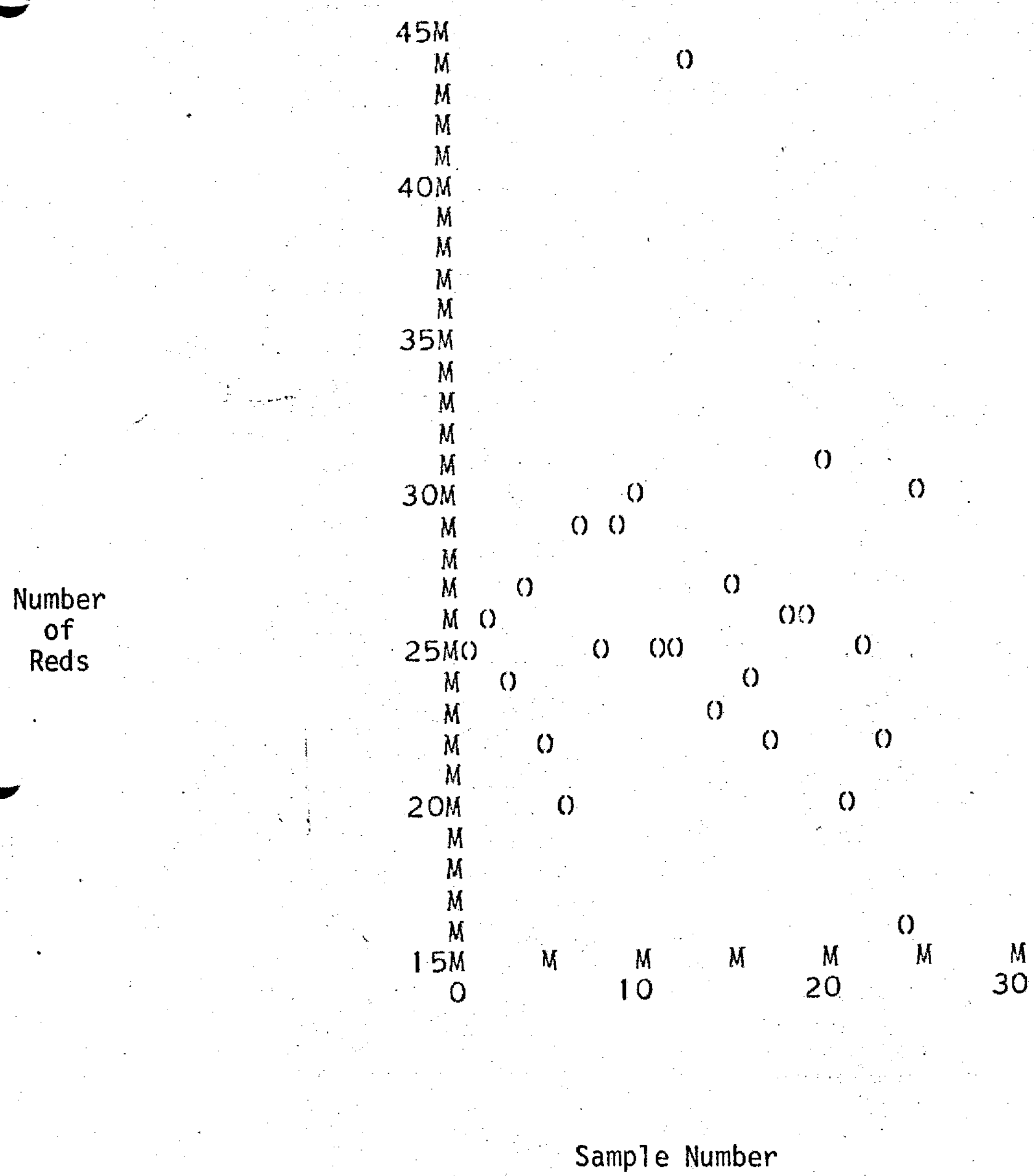


Figure 1.4 Distribution of Machine "Reds" when the Samples are taken 100 at a time (one from each trial)

Approach 1 has been repeated for Machine 1 and Machine 2 separately to check for abnormalities. The binomial distribution mean and variance are as follows:

	Trials	Mean	Variance
Machine 1	44	11	8.25
Machine 2	56	14	10.5

Yellow

	Machine 1	Machine 2
sample size	25	25
maximum	16	19
minimum	7	7
range	9	12
mean	11.4	13.52
variance	7.75	7.51
standard deviation	2.783882181	2.740437921
mean deviation	2.224	2.176
median	12	14
mode	12	15

Green

	Machine 1	Machine 2
sample size	25	25
maximum	17	24
minimum	4	8
range	13	16
mean	10.68	13.84
variance	9.726666667	12.72333333
standard deviation	3.118760438	3.56697818
mean deviation	2.3584	2.7808
median	11	13
mode	11	13

Blue

	Machine 1	Machine 2
sample size	25	25
maximum	15	25
minimum	3	10
range	12	15
mean	10.32	14.12
variance	7.726666667	8.943333333
standard deviation	2.779688232	2.990540642
mean deviation	2.3072	1.984
median	11	14
mode	8 12	15

Red

	Machine 1	Machine 2
sample size	25	25
maximum	19	21
minimum	4	11
range	15	10
mean	11.6	14.52
variance	10.5	10.01
standard deviation	3.240370349	3.163853404
mean deviation	2.4	2.6624
median	12	13
mode	12	11 13

Figure 1. Machine Color Distribution for Machine 1 and Machine 2 on a Trial To Trial Basis (14)

Best Strategy

Based on the above analysis what is the best strategy to pursue? No good strategy is available based on the randomness of the data. The best possible strategy based on the above transition matrices is:

1. If the subject can't distinguish between machine then press blue when blue appears, else pass.
2. If the subject can distinguish them on Machine 1, press yellow when yellow occurs, and on Machine 2 press blue when red occurs.

For all its worth, of the existing data the following success would result - 26%, 26%, and 27%.

Analysis of S2 Data Responses

The attempt here is to discover a reason for S2's success at responding. The investigation was unable to give a definitive reason for his success. Although no strategies were uncovered there was in one case a indication that the subject was learning.

Two major approaches have been taken in this investigation. They are as follows:

These are two questions

1. Strategy of S2 - Was there any trends in the way he guessed? Did he respond based on the previous state of the machine?
2. Hit analysis - Did the subjects' hits (correct choices) increase within a run; did it increase from run to run (i.e., was he learning?)

Strategy of S2

For general information and future reference the first figure (Figure 2.1) presented is the actual choices. One item of curiosity from this is that when he passes, he tends to do it in strings. This characteristic of course wasn't pursued because of its insignificance to this report; however, observations like that are pointed out throughout the report as possible importance to those in the field.

Total Color Choices

The distribution of S2's color choice totals are shown below.

```
0210232010213003020300330
0203121303030330000102332
3003103030312032103222123
0233310020320130300020313
3030030010303031313030103
3303031303030003202103103
0323030303020301032030330
0320303030302103030301303
0303032022303010313021020
3010103103013303013023013
0313023313303102013103231
0210310310310332031030230
3030203103030130130303023
3030323013030203010330303
3030030302303130313031300
3023130302102313010130203
303070307300103077230770731377030773
320301303077307070130303723770373
03023010737037737301730307177707207370
021303077730702302303070723730703
03701037777321033700371307077301031
0777377730777317077377037233103273073030373
373031377773073277307707307707073007077773203
307370307302130313313777073023777377770
03031700120120313027772323103
0131320203120310773071730777772031
30373030377730301307307770330377777773070
31217033030130037777771300012003
0027307703772777773107773777777737777777731321330130 70
3173777777777777771707107777777301377770737031327777777030777737013
3777707777017777777770307373177777303031031031020
37717270777701307173717777377777777777702030317013201
0377777777777377010377777770777077777777773013131303230320
002307130130777777777777713013023201303
077777701010203010230703730270730777777713
3071377703707770377777323107777777777777777703130777777777777777777370370 3771
30207777130370313031302103701377777777777777770
31037321013013102310370107731
31313023130132013023730177703
1303737373013013207777737777777777707313021071
1373103737317302177273177131777777777703733170
13237013077072313103127773713173777373
3137777777777773777033131021371777777170777317271207 13
01237073773177731737201720307072170130
073373113701310701077201377032770070
321317032331303203723032123
137370710303107720311307100323773
10307710237371307307230233203730
2030330231313302212121331
2307770127321200030333130300
```

Figure 2.1 Subject 2 Color Choices for First Fifty Trials (0-yellow, 1-green, 2-blue, 3-red, 7-pass)

3230313012021370771232172303O
0311373077173102037777777770377373017333070
20703123070231703030330133703
30170102031730730300330313713
0100777737370730377717377727337773107707771307773737773
207073707317773700770373700027317777070777770737777773777 3
0173033032037033032701370301 3
3037170332073030737730130237372O3
0373737303373032173233377173733707371
23707377313033333703773773707173777377373270
1310730373773010333337073731 3707700
33373707730730373333130373370707770733
033037737703337337777077777327777301027337333
03030372000037737337770773773303O332
330321332703232331301213 30
10701101301101313030230123
30070330072373003037177713777703 3002
03133737370300032000300010 03
302332131000001371303703037770
77201771007703072370313731013777377177777303
33717101771137130021733373303073 3
307173737170771301173037073013733 70071
03303203020071027107377121270703
0323132732037302377033111 0077700
33173707371071317331331730117207073
27131310732703327773117713032 3303
3000373300033003710303071330
3012700133330130777370773733033777707 70
03037030370737323113707107320017 73
3773307007200077030037313000300 2
13200200030030377030073172337 0
3070720702077330703303030377737773737707 3
07077730703700377777077317073303073070777707373 73
0070773737700307373077777707377777737773770300077773333
1301037132010717301002720073723
31013103170013000017300730 20
03777200707731007707073730072007307007 00
30300007100000232113002002
3031301301320130231033003
2301203130120310311303120
3013023103173713073032300131
301301301320130210130230 3
130231032303713273031030130
301031031077323031307302133 1
310313031737701373001330033777713
3130103031033030737707003771700 3
02313033201370013723020133 0
021737310310130370007302777731037 3
137073107103702373132710331073703
33130030170730107070037107370071 3

Figure 2.1 (Continued) S2 Color Choices for Last 50 Trials

	Yellow	Green	Blue	Red
Total Times Chosen	881	411	237	971
% of Total	35%	16.5%	9.5%	39%

The first inclination is to try and determine how his strategy of choosing so many yellows and reds benefitted him. Examine the following table:

	Yellow	Green	Blue	Red
Total Number of Hits	255	127	~~50~~ 60	292
% of Total Hits	35%	17%	8%	40%
% of Success in Color (Hits - Correct Choices)	29%	31%	25%	30%

As can be seen his results with blue are significantly lower than the others. However, assuming the probability of success to be .25 and using the binomial distribution the expected value =69 and the standard deviation = 7. The inference from this is that the 60 Blue hits are not a statistical abnormality. However, it is curious that he did so much worse on his lowest preference.

State Transition Color Choice

This investigation consists of examining the states of the machine verses the choice on the next sample of the subject (i.e., if the machine shows "red" does the subject consistently choose one color on the next turn). Consider the following table:

		Machine					
	MACH \ SUBS	Yellow	Green	Blue	Red	Pass	% Pass
SUBJECT	Yellow	106	119	69	314	210	26%
	Green	177	25	69	316	252	30%
	Blue	241	99	27	198	302	35%
	Red	322	157	65	97	218	25%

r = .30

The subject obviously avoids repeats (i.e., he assumes the machine won't repeat a color) which, based on the machine data analysis, isn't a strategy which would give him a statistical advantage. Previous analysis showed that identity transitions are approximately equally probable as nonidentity. Notice also that he passes 35% of the time after seeing a blue.

The same state transitions are shown below separated by machine.

		Yellow	Green	Blue	Red	Pass
MACHINE 1	Yellow	48	49	25	150	83
	Green	62	13	35	153	83
	Blue	105	36	10	78	115
	Red	133	72	30	58	64
MACHINE 2	Yellow	58	70	44	164	127
	Green	115	12	34	163	169
	Blue	136	63	17	120	187
	Red	189	85	35	39	154

$\chi^2 = .94$

The negative state transition (i.e., relationship of the subject color choice to the machine state on the <u>next</u> sample) is considered too bizarre of a concept to be presented in this section. Results of that investigation is found in the section entitled "miscellaneous"

Hit Analysis

This section is significantly more important than the randomization analysis of the machine data. The reason is that if he is not learning from the machine or he is not taking advantage of biases then the discovery of such non-randomness is of little value to the overall analysis.

Learning from Trial to Trial

The question of whether the subject learned from trial to trial can best be answered by examining the following three plots. The first is the number of hits vs. the trial number, the second is a frequency distribution of the number of trials vs. number of hits, the third is the accumulated probability vs. the trial number.

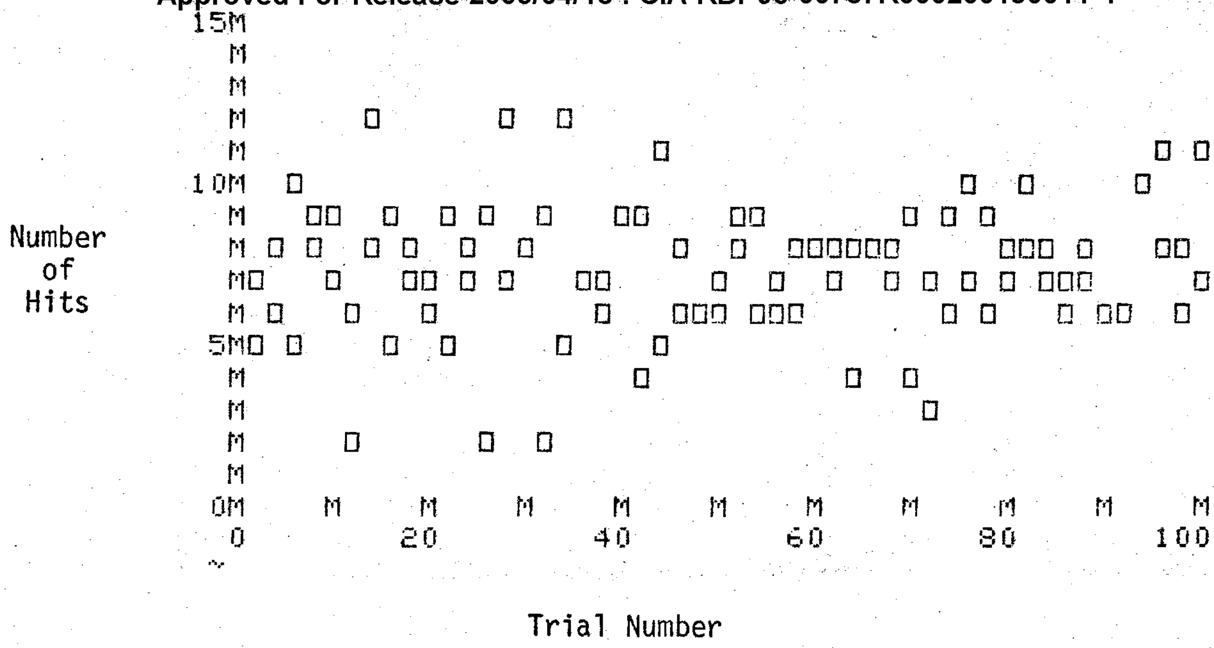


Figure 2.2 Plot of number of hits/trial

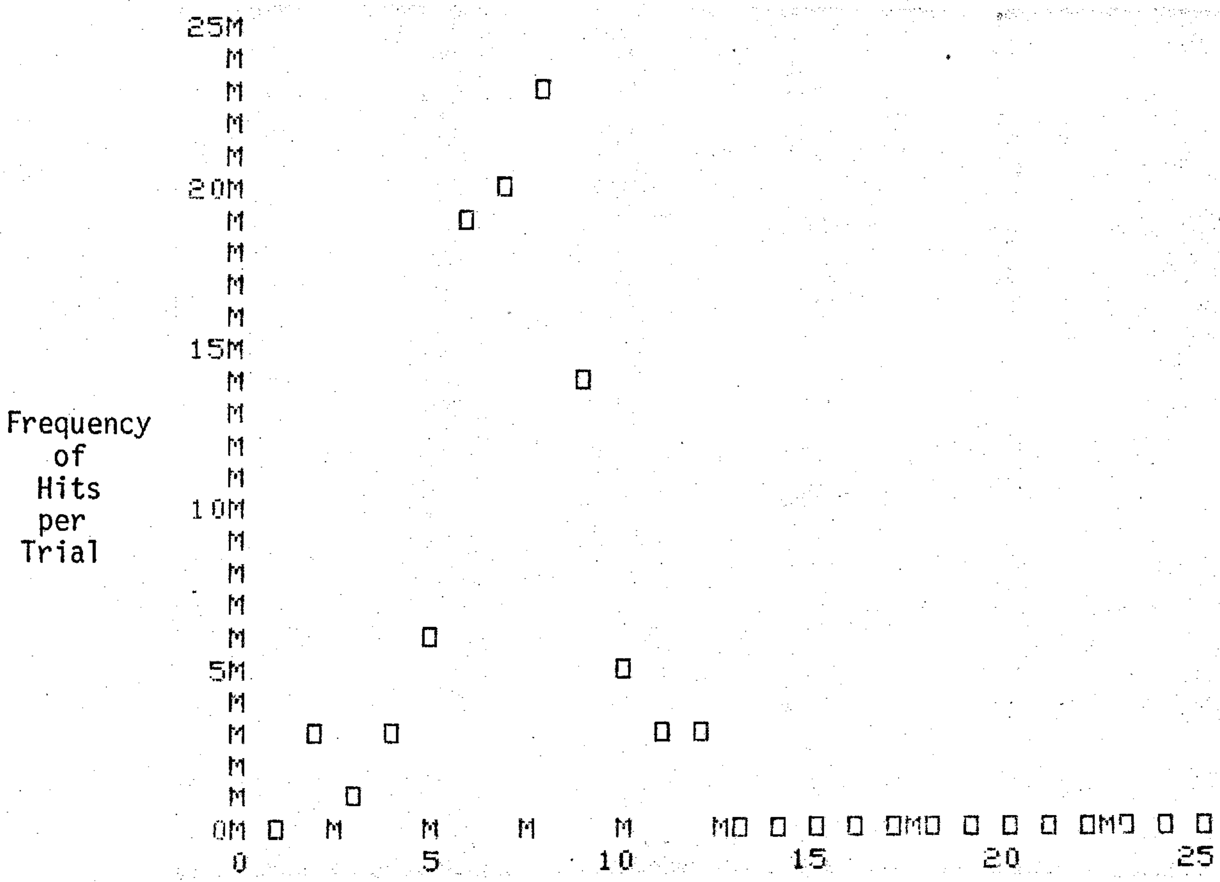


Figure 2.3 Frequency plot of Number of Hits

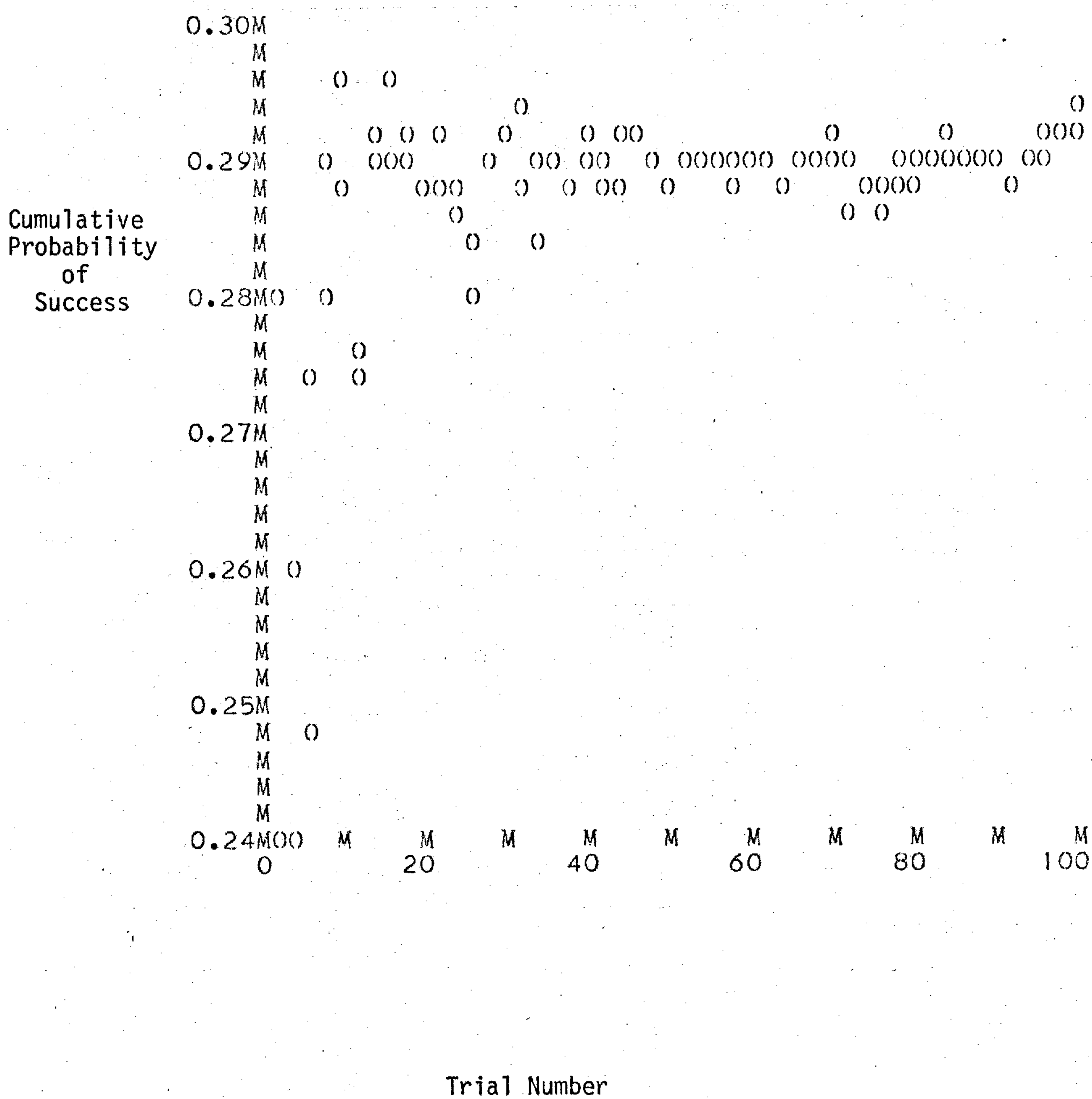


Figure 2.4 Cumulative Success Ratio of Subject (both machines used)

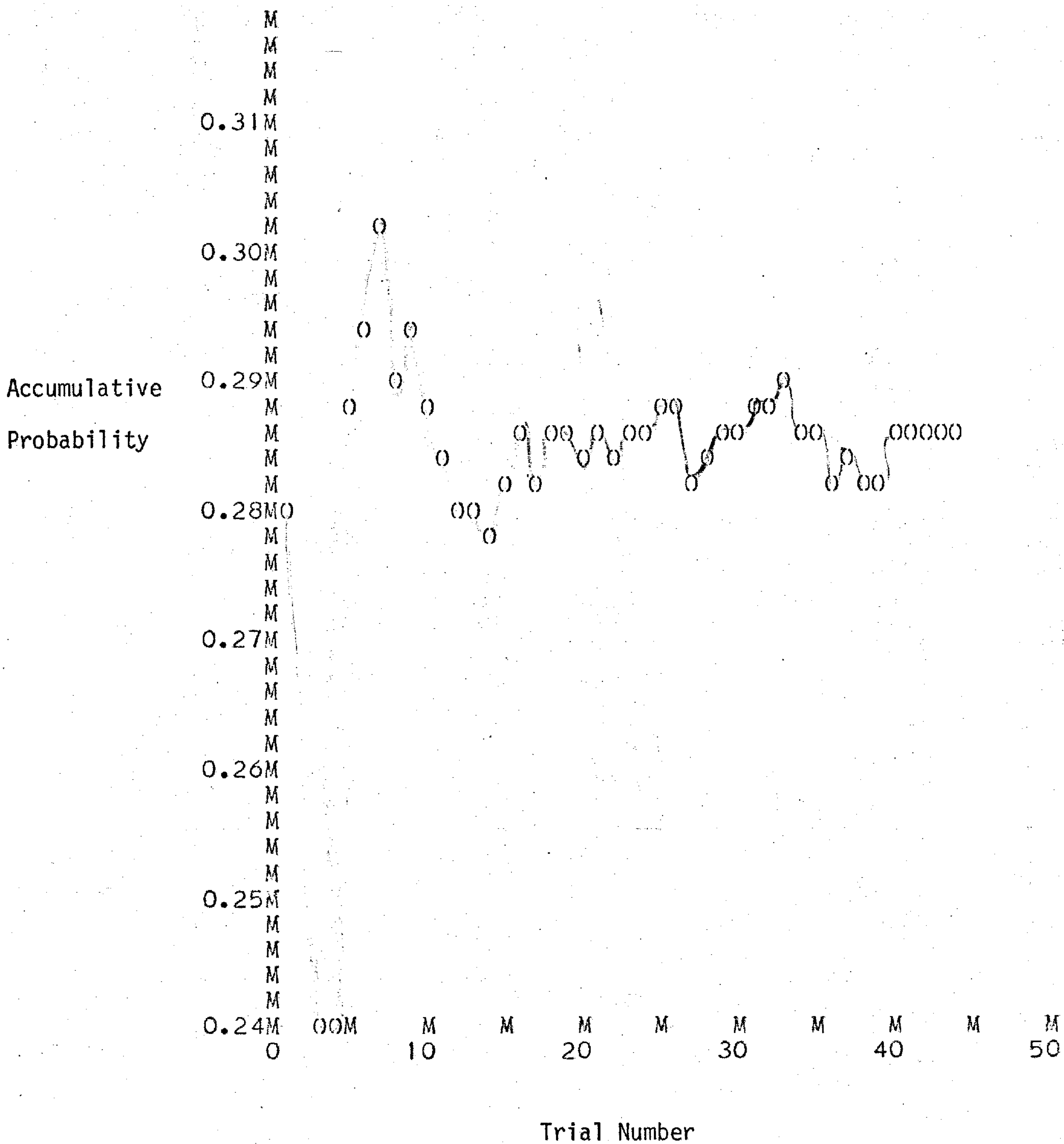
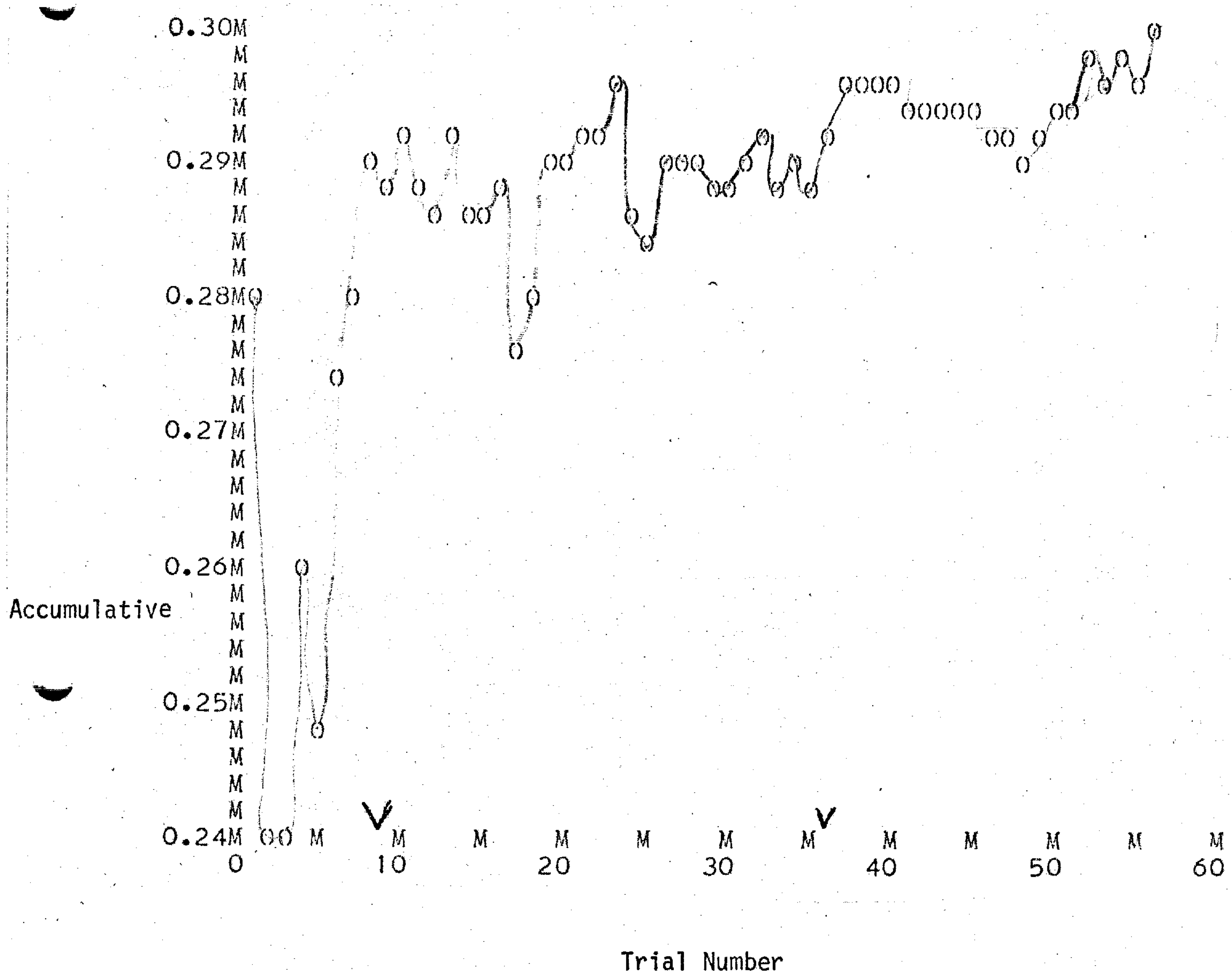


Figure 2.5 Accumulative Probability of Success on Machine 1



Note: V - Points at which he switches machines

Figure 2.6 Accumulative Probability of Success on Machine 2

The first plot (Figure 2.2) demonstrates the randomness of the number of hits while the second plot (Figure 2.3) demonstrates the frequency distribution takes on a "normal" appearance. The accumulative probability plots, at first glance, indicates that the subject was in a learning mode for the first five trials. A closer examination of the data indicates that this can occur naturally as part of the statistical distribution.

The first three number of hits points are 7, 5, and 6 considering the first 75 points as the population with probability of success = .2936 (the final probability) then the expected value is 22 (using binomial distribution) and the variance is 15.55 (S.D=3.9). As a normal deviation from the mean (i.e., using normal distribution approximation $P(x<18)=.13$.

Although the observed learning can be rationalized as a natural statistical deviation it warranted further investigation. The plots of the accumulative probability of success for machine 1 and machine 2 are presented in Figure 2.5 and Figure 2.6. The plot for machine 1 (Figure 2.5) is a typical sinesodial decreasing amplitude convergent curve. The plot for machine 2 however, is very suspicious in terms of learning. The major peaks of the curve (at approximately trial 10, 23, 40 and 56) are increasing which implies his probability of success is continuing to increase instead of converging on one point. Another interesting points ~~is that~~ the points at which he switches onto machine 2 are 1, 9, and 36.

Also of concern is the sharp upward turn during the last 8 samples. The hits totals for this period, starting at sample 49 is 10, 10, 8 11, 6, 8, 7, and 11 for a total of 71 hits out of a possible 200 for a probability of success of .36. Once again using the binomial distribution and using the probability of success of .29 (the cumulative probability up to the 49th point) the expected mean is 58 and the standard deviation 6.42. Using the

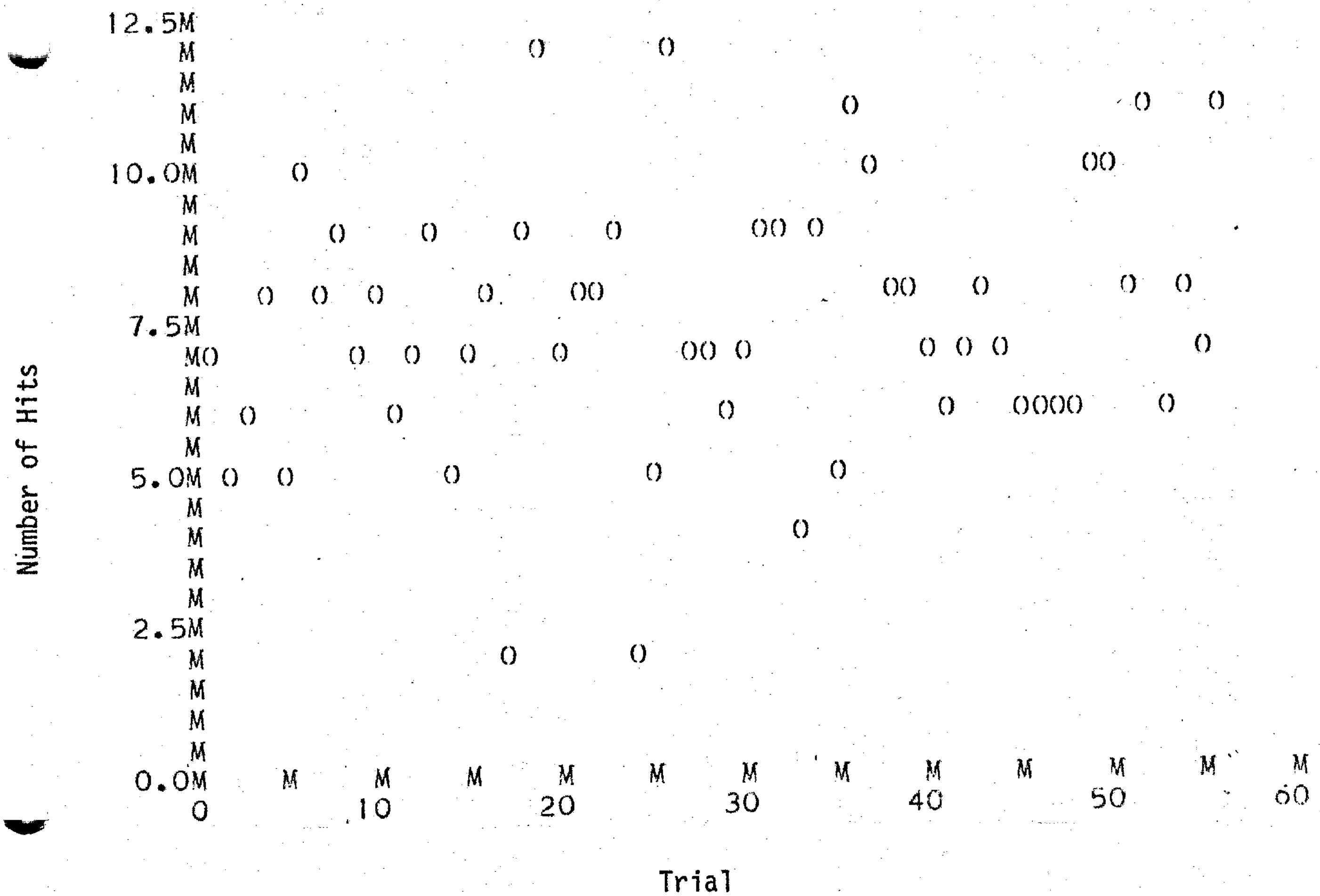


Figure 2.7 Plot of Number of Hits on Machine 1

normal approximation the probability P(X 71)=.02 of such an occurrence is quite low.

Although there are only 56 data points in this population and the apparent abnormalities are statistically possible (with low probability) this investigation concludes that the subject's learning for this case must be flagged as a real possibility. Figure 2.7 (Number of hits on Machine 1) has been added to provide clarity. It appears that the subject just didn't have "low hit" days toward the end.

Learning within a Trial

The question of learning within a trial or run has been investigated, ? from both machines? by summing the number of hits of the Ith sample for the run. The results are somewhat distorted because of the inequitable distribution of passes. The lower numbered samples have significantly more hits because of this. A plot of the number of hits per sample vs. sample number is shown in Figure ~~2.7~~ 2.5?

Notice that the first sample has a value of 34 hits. This means that everytime he ists down for a new 25 sample trial he hits 34% of the time on his first try. With this in mind along with the rest of the data points, it is obvious that the subject doesn't learn throughout the trial.

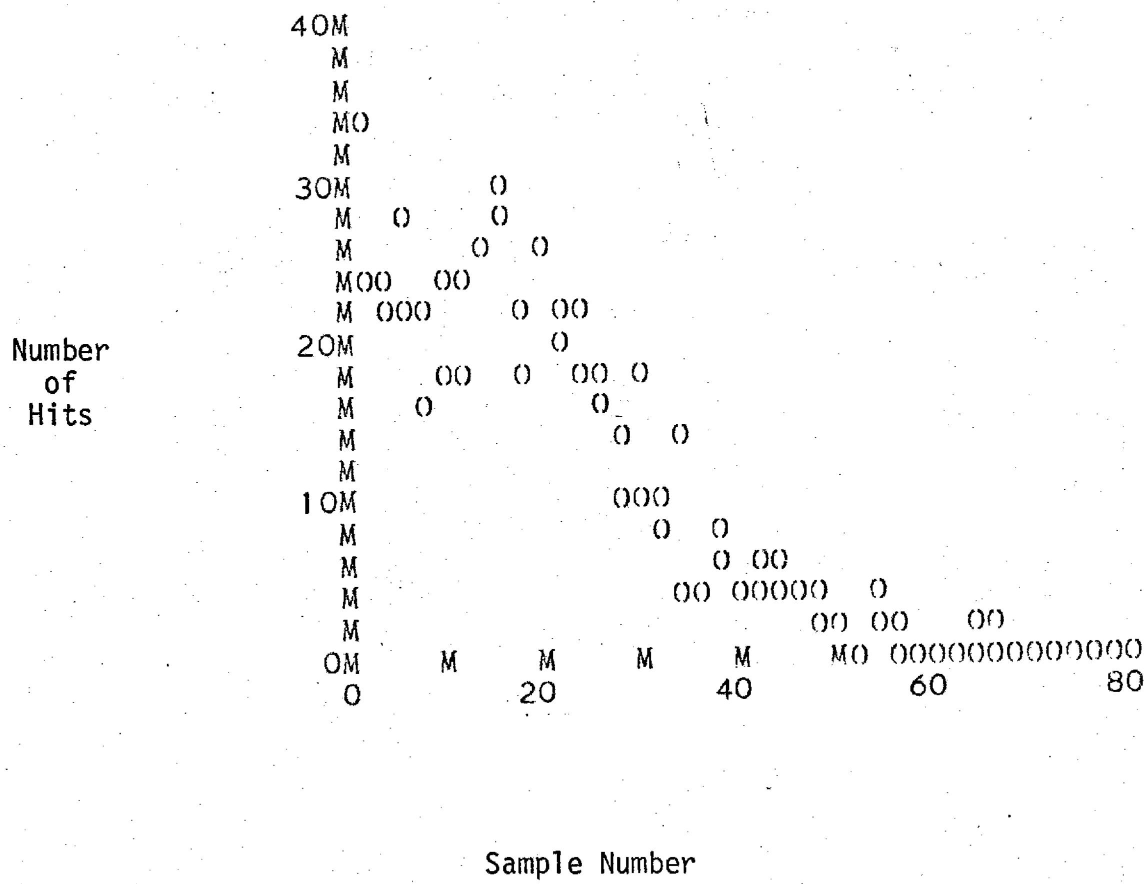


Figure 2.8 Total Number of Hits Within a Trial

Miscellaneous

Numerous arrays of data have been examined for the purpose of obtaining some insight into the data. Some of the data is being printed herein so that the data can be examined more closely if desired.

This first table is presented for use as a quick reference.

Day	Last Trial	Number of Tracks	Machine Used
1	8	8	2
2	16	8	1
3	24	8	2
4	36	12	2
5	44	8	2
6	52	8	1
7	56	4	1
8	64	8	1
9	68	4	1
10	72	4	1
11	76	4	1
12	80	4	1
13	84	4	2
14	88	4	2
15	100	12	2

The following displays are presented below with little commentary.

I. General trial summary (Figure 3.1). Each trial (25 choices) is listed with the following information.

   A. Machine used (1 or 2)

   B. Total number of machine states in each color (i.e., 6 yellow, 6 green ....) for each trial.

   C. Total number of subject choices for each color for each trial.

   D. Total number of hits for each trial.

   E. Total number of passes for each trial.

   F. Breakdown of hits by color.

II. Machine data for machine 1 and machine 2 separately (Figures 3.2, 3.3) Just by examining these displays it may be possible to glean meaningful information. For example, machine 1 was used for the first 8 trials during which the first state of each trial was a yellow or red. If the first sample of each trial is most memorable, perhaps this is responsible for the subject's obvious preference of yellow and red (see Section 2 - Analysis of S2 Data Responses). ?

III. Plots of the number of passes made.

   A. Number of passes vs. trial number (i.e., trial is 25 or more samples) (Figure 3.4)

   B. Number of passes vs. sample number (Figure 3.5)

trial	mach	mach yell	mach gren	mach blue	mach red	sub yel	sub grn	sub blu	sub red	numb hits	num pas	hit yel	hit grn	hit blu	hit red
1	2	6	6	2	11	11	3	5	6	7	0	3	0	0	4
2	2	5	9	4	7	10	3	4	8	5	0	2	1	0	2
3	2	7	8	6	4	7	4	6	8	6	0	2	2	1	1
4	2	7	4	10	4	10	3	4	8	8	0	4	1	2	1
5	2	5	6	11	3	11	4	0	10	5	0	2	1	0	2
6	2	8	5	3	9	10	3	2	10	10	0	3	1	0	6
7	2	3	7	7	8	11	1	3	10	8	0	2	0	2	4
8	2	6	7	3	9	11	2	2	10	9	0	4	1	0	4
9	1	9	6	2	8	10	3	5	7	7	0	4	0	0	3
10	1	5	5	8	7	9	6	1	9	9	0	3	3	0	3
11	1	6	4	7	8	6	6	3	10	2	0	0	0	0	2
12	1	7	2	7	9	9	5	3	8	6	0	4	0	0	2
13	1	5	7	4	9	10	3	2	10	12	0	3	2	1	6
14	1	4	5	11	5	10	2	2	11	8	0	2	1	2	3
15	1	6	9	5	5	10	3	1	11	9	0	3	2	0	4
16	1	6	2	7	10	8	5	4	8	5	0	2	0	0	3
17	2	10	12	7	7	12	2	1	10	7	11	4	0	0	3
18	2	4	9	9	11	10	2	2	11	8	8	1	1	1	5
19	2	8	9	10	11	11	3	2	9	6	13	3	0	1	2
20	2	7	13	5	8	11	1	4	9	7	8	3	1	1	2
21	2	9	8	9	9	10	5	1	9	9	10	3	2	0	4
22	2	13	12	9	9	8	2	2	13	5	18	0	0	1	4
23	2	9	9	15	12	11	1	2	11	7	20	2	0	1	4
24	2	10	9	11	9	8	3	2	12	8	14	3	2	0	3
25	2	3	11	7	8	8	5	5	7	2	4	1	0	1	0
26	2	10	4	10	10	8	6	4	7	9	9	4	0	2	3
27	2	11	6	15	9	11	1	0	13	12	16	6	1	0	5
28	2	5	6	10	11	10	5	2	8	7	7	2	1	1	3
29	2	7	16	16	14	8	4	3	10	8	28	1	2	1	4
30	2	16	19	18	12	8	6	1	10	8	40	3	3	0	2
31	2	10	10	9	19	10	5	1	9	9	23	2	1	1	5
32	2	12	9	19	12	8	7	3	7	2	27	2	0	0	0
33	2	11	14	20	10	9	4	2	10	5	30	2	1	1	1
34	2	16	4	10	8	9	5	3	8	12	13	5	2	1	4
35	2	9	7	11	15	12	4	3	6	7	17	3	0	2	2
36	2	14	17	19	22	9	4	1	11	7	47	2	1	0	4
37	2	5	16	13	11	9	5	2	9	6	20	0	4	0	2
38	2	5	7	8	9	7	8	2	8	7	4	1	3	0	3
39	2	7	7	9	6	6	6	3	10	9	4	1	3	1	4
40	2	11	13	10	10	7	6	2	10	9	19	2	4	0	3
41	2	10	14	9	12	4	8	2	11	4	20	1	1	0	2
42	2	11	11	7	9	4	7	3	11	9	13	2	3	0	4
43	2	15	13	14	11	4	9	3	9	5	28	0	4	0	1
44	2	10	9	11	8	8	6	4	7	11	13	4	1	4	2
45	1	12	9	7	8	10	6	2	7	8	11	5	1	1	1
46	1	5	6	9	7	4	4	6	11	6	2	0	0	2	4
47	1	9	10	10	4	8	6	2	9	6	8	3	2	0	1
48	1	9	10	7	6	8	3	4	10	6	7	2	1	1	2
49	1	7	10	6	2	4	6	6	9	7	0	0	5	1	1
50	1	9	12	1	7	9	3	4	9	6	4	3	0	0	3

Figure 3.1 Selected Parameter Totals Listed by Trial Number

trial	mach	mach yell	mach gren	mach blue	mach red	sub yel	sub grn	sub blu	sub red	numb hits	num pas	hit yel	hit grn	hit blu	hit red
51	1	6	5	10	8	6	5	6	8	9	4	2	2	3	2
52	1	7	15	11	9	8	5	1	11	8	17	3	2	0	3
53	1	11	5	7	6	9	3	3	10	6	4	3	1	1	1
54	1	6	4	7	12	9	5	1	10	9	4	2	2	0	5
55	1	13	14	12	14	8	4	1	12	7	28	0	2	0	5
56	1	12	14	19	14	12	2	2	9	6	34	3	0	1	2
57	1	8	2	11	8	9	3	2	11	8	4	3	0	1	4
58	1	6	4	11	12	8	2	3	12	6	8	1	0	1	4
59	1	11	5	15	6	4	3	2	16	8	12	2	1	1	4
60	1	11	11	11	11	5	2	2	16	8	19	3	0	1	4
61	1	10	8	9	8	8	4	0	13	8	10	0	1	0	7
62	1	13	6	9	10	7	1	0	17	7	13	3	0	0	4
63	1	10	18	10	7	6	1	2	16	4	20	2	0	0	2
64	1	10	11	6	9	10	0	2	13	8	11	4	0	0	4
65	1	7	9	2	8	4	4	5	12	8	1	1	1	1	5
66	1	3	12	4	7	8	9	2	6	8	1	3	4	0	1
67	1	8	10	10	8	11	2	2	10	8	11	3	1	0	4
68	1	10	4	5	9	13	2	1	9	7	3	4	0	0	3
69	1	10	8	4	8	10	4	2	9	9	5	4	1	0	4
70	1	9	6	12	17	8	6	2	9	4	19	0	2	0	2
71	1	11	7	7	8	5	7	1	12	7	8	2	1	0	4
72	1	7	9	13	9	8	7	0	10	3	13	1	1	0	1
73	1	11	6	5	10	10	4	5	6	9	7	4	1	2	2
74	1	4	12	8	8	8	4	4	9	6	7	0	2	1	3
75	1	9	11	7	8	5	8	1	11	7	10	1	3	0	3
76	1	8	14	5	6	4	6	4	11	10	8	2	4	1	3
77	1	11	3	8	6	12	2	0	11	9	3	7	0	0	2
78	1	9	9	10	11	9	3	1	12	6	14	3	0	0	3
79	1	7	8	7	12	9	4	2	10	7	9	2	2	0	3
80	1	8	6	10	8	14	1	2	8	8	7	4	0	1	3
81	2	13	4	8	5	12	2	3	8	10	5	7	1	0	2
82	2	6	14	10	11	11	0	2	12	8	16	2	0	1	5
83	2	7	10	17	16	13	1	0	11	8	25	3	0	0	5
84	2	14	12	16	14	12	0	0	13	7	31	3	0	0	4
85	2	7	7	10	7	9	6	4	6	6	6	2	2	1	1
86	2	11	7	4	6	12	6	1	6	7	3	5	1	0	1
87	2	13	13	9	6	17	1	2	5	8	16	5	1	2	0
88	2	6	3	8	9	14	3	4	4	7	1	4	1	1	1
89	2	6	5	8	6	8	5	2	10	6	0	2	1	1	2
90	2	7	7	4	7	7	7	4	7	6	0	1	3	1	1
91	2	9	10	7	2	7	6	2	10	6	3	4	1	1	0
92	2	4	6	10	5	8	6	3	8	6	0	1	3	1	1
93	2	6	7	7	7	7	5	3	10	10	2	3	2	1	4
94	2	5	6	4	13	7	6	2	10	10	3	3	1	1	5
95	2	7	5	10	11	7	6	0	12	8	8	2	1	0	5
96	2	7	9	7	9	11	4	0	10	11	7	5	1	0	5
97	2	8	8	6	5	8	4	4	9	6	2	2	1	1	2
98	2	7	12	10	5	9	5	2	9	8	9	3	3	0	2
99	2	8	9	8	8	7	6	2	10	7	8	2	2	0	3
100	2	9	5	9	10	12	5	0	8	11	8	5	3	0	3

Figure 3.1 (Continued)

0031003121303211033331132
0113100111033230023033300
2232103103310123321302022
2203311021022233333312000
3030220232231003033033122
3131202300133133132213001
2221122313233202200312210
1221131110300132213003120
03221123202221101003203120123102330031
001122313200131033002212023000130131
130223130102313222122130302
211120010202223111321220321100300
233330300200212221111031210110120
3221121001210212010100131
11111330101033101300310231010
01202123323202222312033013130
103112123203303111022312321102211012313210
13310102231200200000123003322
32133133233120023230021303203
21131110302330311003000003013331333122220122211132022
322202323333310220120102313022322200233201313111112112200012
300210203222232132003022203323
1223230033213322212001303302233232
0222003302023212023123203010022221201
22121100300031311303030212303222031112021323
032213200002321120313222130301030211
10110332022100001033330021020223232303
033111022302000012112311223111211233110100121
020311131021101301033122001233320103
13133011310013013133020102
10103132133321232111110113
330201102012032131231212210032203113
1230200002033210310031203333
101130032201331300330301020121
30132032333032330033012022323213303123021212
112233022001200302031000123121033
13221230023032101331321221230112202203
10122031320033013313300100200233
33120221103320211133311121122013
31022132112201313120103131103032000
2310111122232011111031000311201303
0000223302302002321000233112
302310321323331121020131200010232130223
3313011313201303310123210320033222

Approved For Release 2003/04/18 : CIA-RDP96-00787R000200150011-4

Figure 3.2 Color states of machine 1 during the experiment
(0-yellow, 1 green, 2 blue, 3 red)

```
3030021330303023133311131
3323130101011332132210101
0303111222003203201112101
0220233110022220313200212
3230122322222001002111212
0323130003013313030203112
0121131322332323102110233
3000323233210023033221323
11131032012230301303101220011301220l
022322300312323333132311110312211
01323231132020102230201233321331131020
321301110321331100202112310033111
00232122130302000121301333121323021
11010201133020312020312002033100132111323 20
223222222001010001322110322323112331333301203
21213120133012031002021331300200222133
22023133332321021111311012311
2200211300320330002023133220232133
100230200001303212222132201322222203l3033
333230121120332221220301233l2303
130331122010022312333211221133123111213022021320l3322
0021212120121200311131223222323000221331120310112011301303201230 0
2201332032333313310323101033103001210320312331 23
1233013220323210222202330110000232023231211202021323
00321322310102331223223321211113221021032022021200121 20
3021202202023000300022200301100230l323
33022033233022303322230003312311311121 3020
230031110213332123232010333012233111313322001230203301100322113213222302
331100231210122132011131113222211223203321331
312110323322133003121232321 00
002031001321322121122330132 02
122012001301321032210311001012331102230333 21
210311120033110330112003302313112232211002313
131210223323103101003111003230002012l3
2002301120011320112121313010221000322331220303013 3022
221302023133023203102130123002 12
123000000103011020322022203203
11221232201333223210102133103111210131 03
22122330301301101323312132023302212233221322132330
3333020220200332100122012312112013121230330120320121330 2
130322010130233123302122220101 2
032333211001000101210230l030
113000233111001030012211121222013213020 00
20020333312320211230230 32
11023023232131222031020 30
21030100033332121103101 32
101102123021200112011120020 3
023222121122232032313101 20
0332310312111103020230122 32
113023033333230211113233300
20321320311133021332033002222230 3
3130301232013231211332011003201 2
2122033123002100010101313 21
032010230213122220110311111031221 2
1113032232123001023002303011221 13
```


Figure 3.3 Color states of machine 2 during the experiment

(0 yellow, 1 green, 2 blue, 3 red)

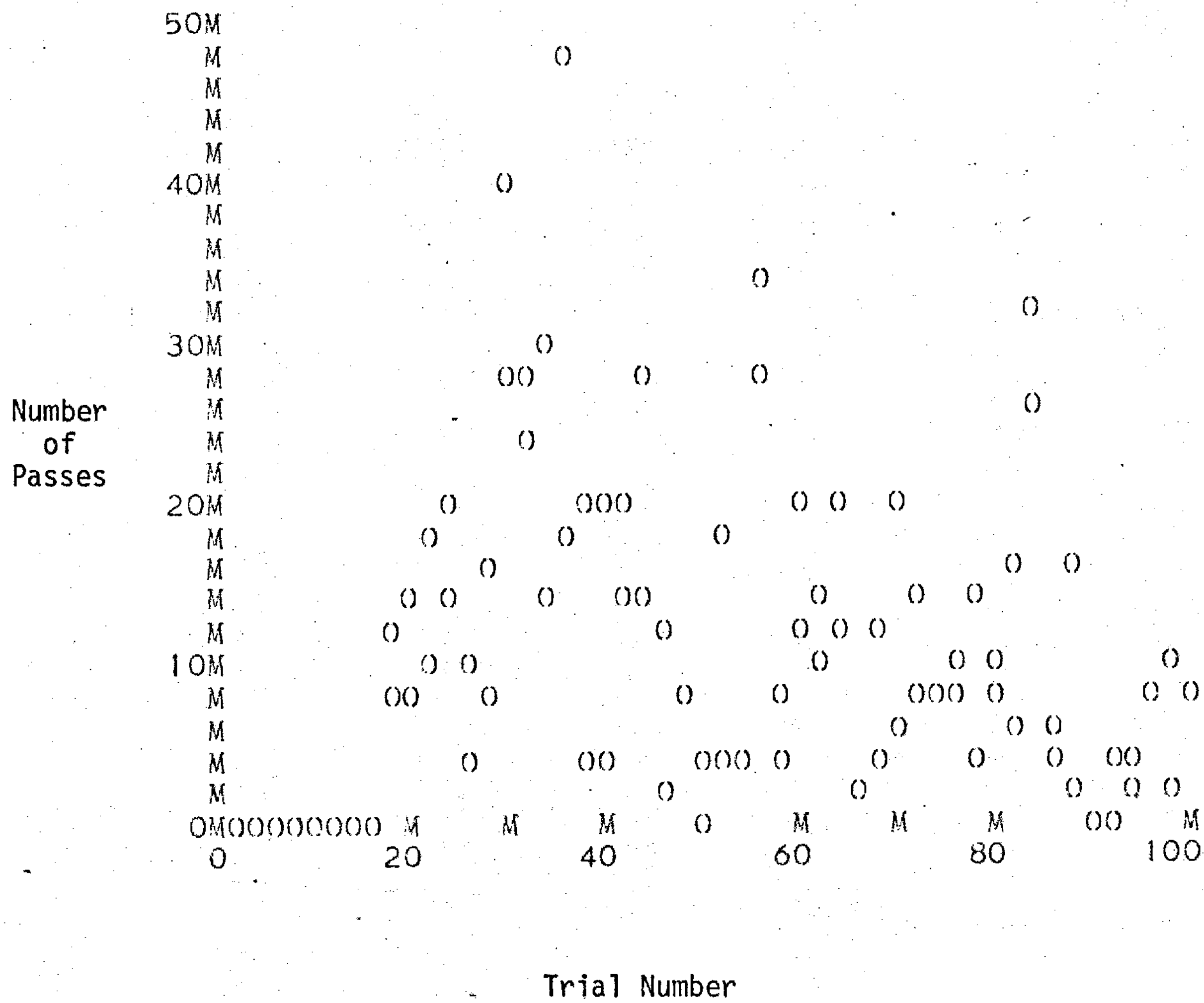


Figure 3.4 Total number of passes summed over a trial

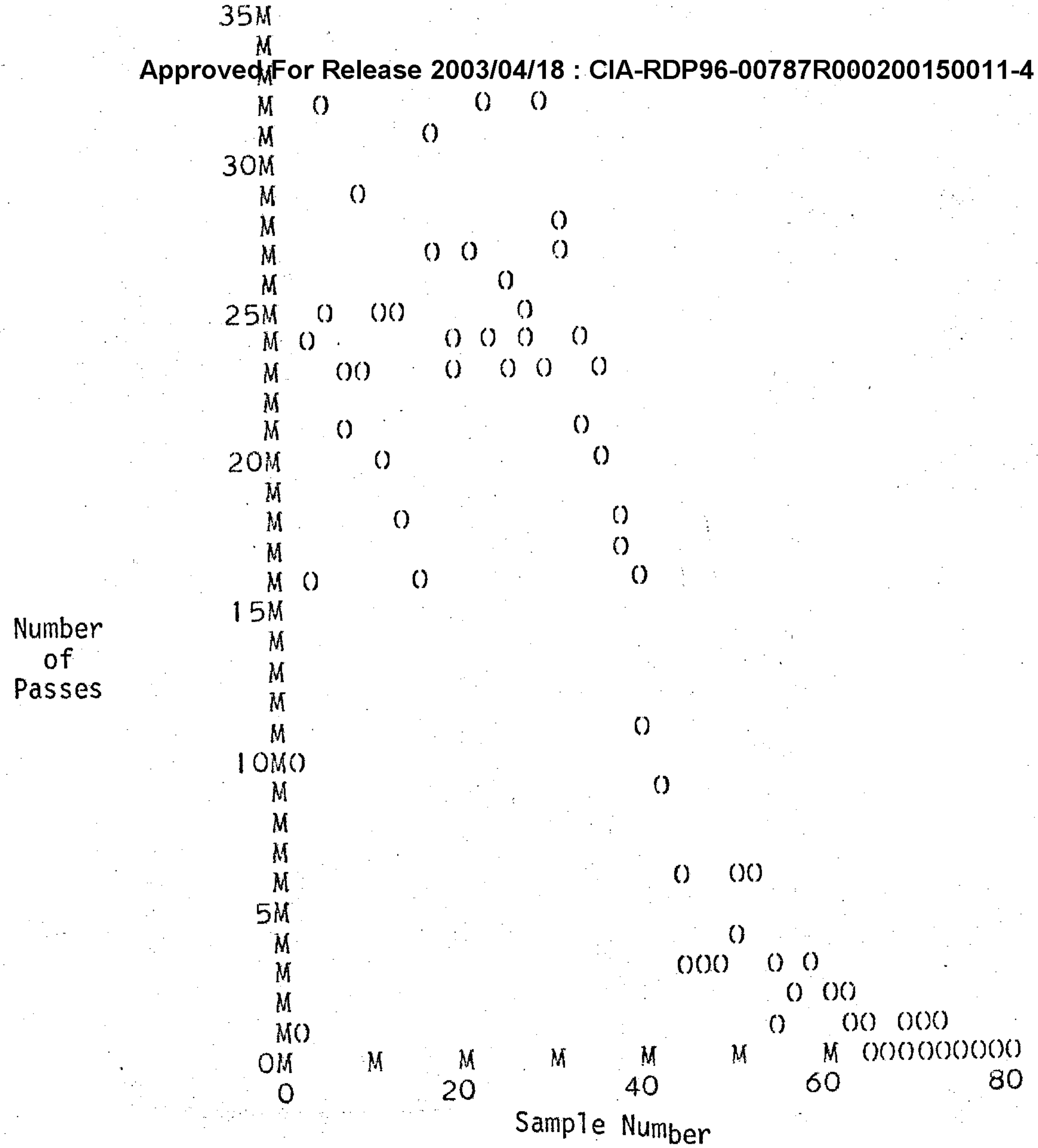
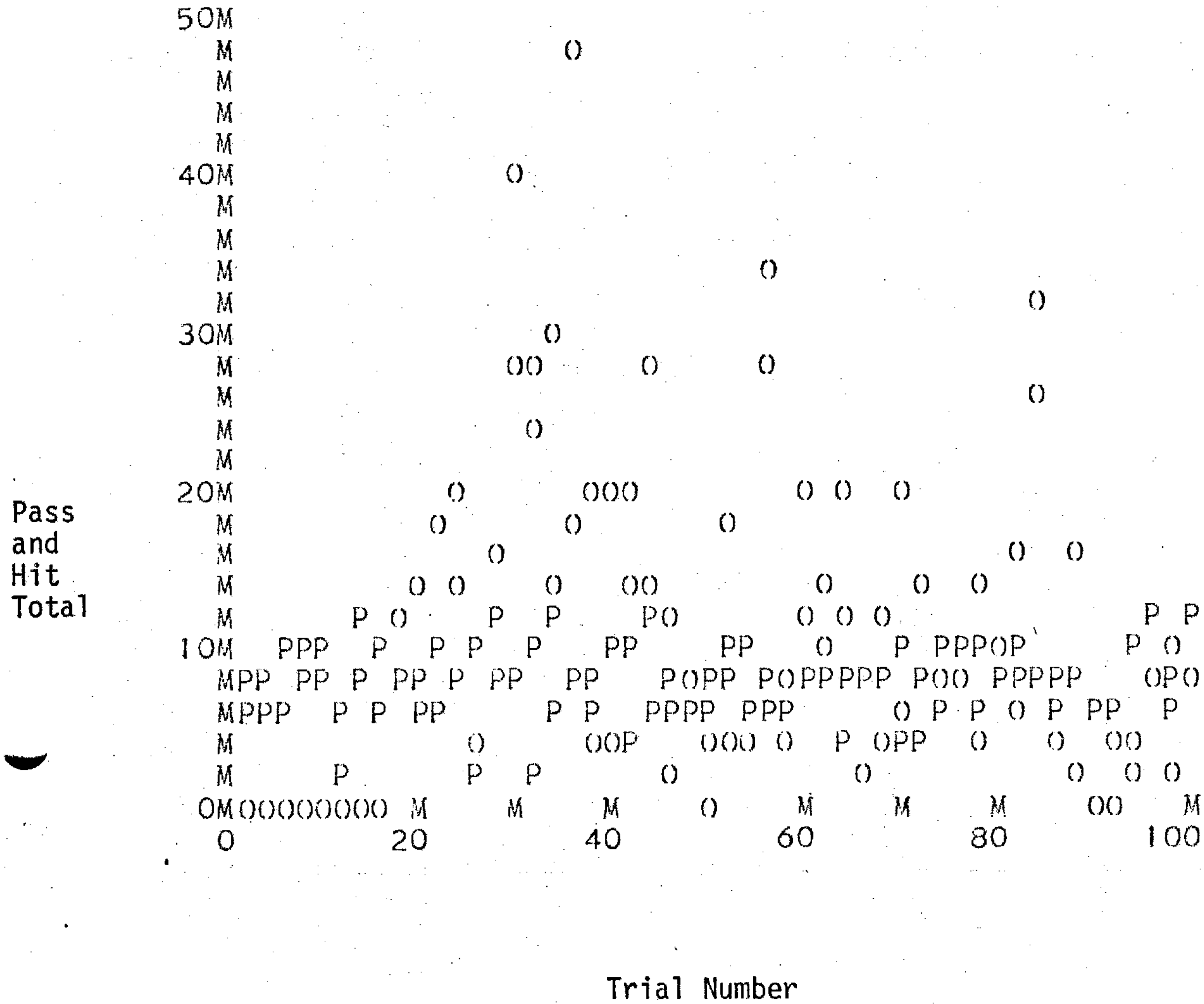


Figure 3.5 Total number of passes summed over sample number

Approved For Release 2003/04/18 : CIA-RDP96-00787R000200150011-4

C. Number of passes and the number of hits vs. the trail number on one plot. Investigation of the hits/passes relationship was dropped when the coefficient of correlation between the two was computed at -.114



O - passes per trial

P - hits per trial

Figure 3.6 Plot of number of hits per trial and number of passes per trial

IV. Tables of state transitions which reflect the influence of the subject on the machine. For color choices of the subject the table shows the number of colors the machine has on the next sample. For example on the first table, when the subject picked yellow, on the next sample 197 times the machine state was yellow.

MACHINE STATES ON FOLLOWING SAMPLE

	Yellow	Green	Blue	Red	
Yellow	88	77	87	95	
Green	38	46	39	47	Machine 1
Blue	27	28	24	24	
Red	120	105	99	112	
Pass	84	83	98	81	
Yellow	109	124	128	141	
Green	58	47	58	66	Machine 2
Blue	25	32	42	30	
Red	121	125	136	102	
Pass	146	162	161	168	
Yellow	197	201	215	236	
Green	96	93	97	113	Both Machines
Blue	52	60	66	54	
Red	241	230	235	214	
Pass	230	245	259	249	

Figure 3.7 State Transitions from Subject Choice to Future Machine State

V. Because of the possibility that the subject was learning the state of machine 2 the distribution of the colors are plotted in Figures 3.8, 3.9, 4.0, and 4.1. The only states used are those in which the subject didn't pass. Therefore there is a total of 25 for each trial.

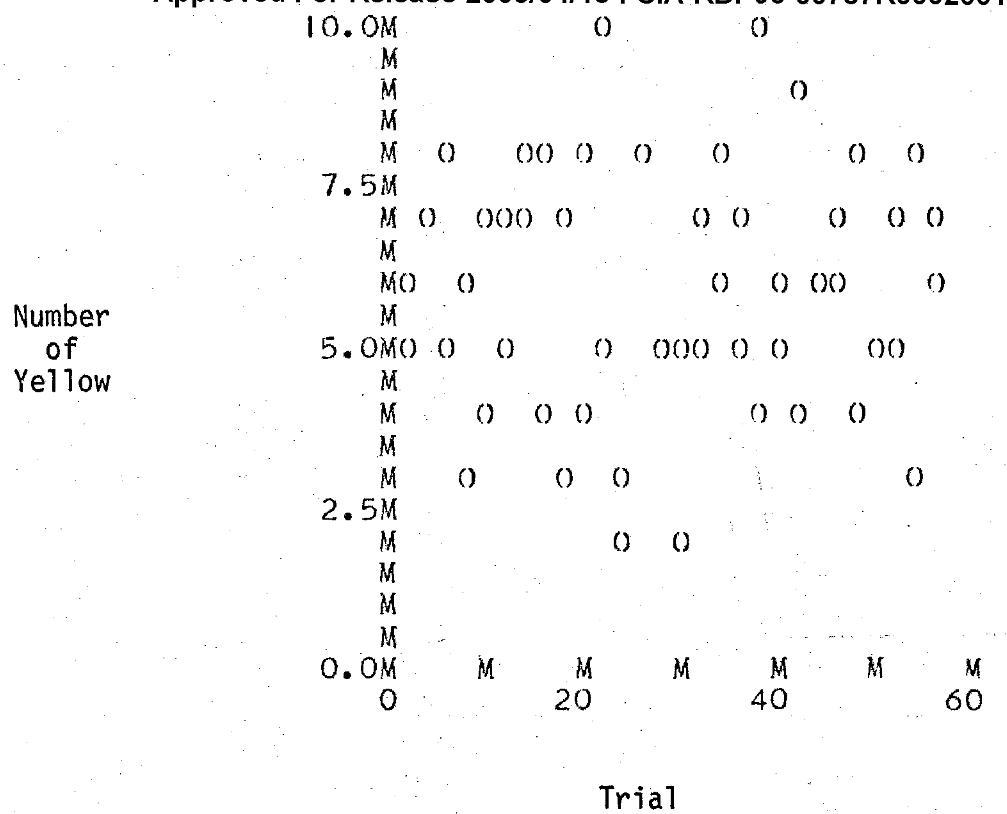
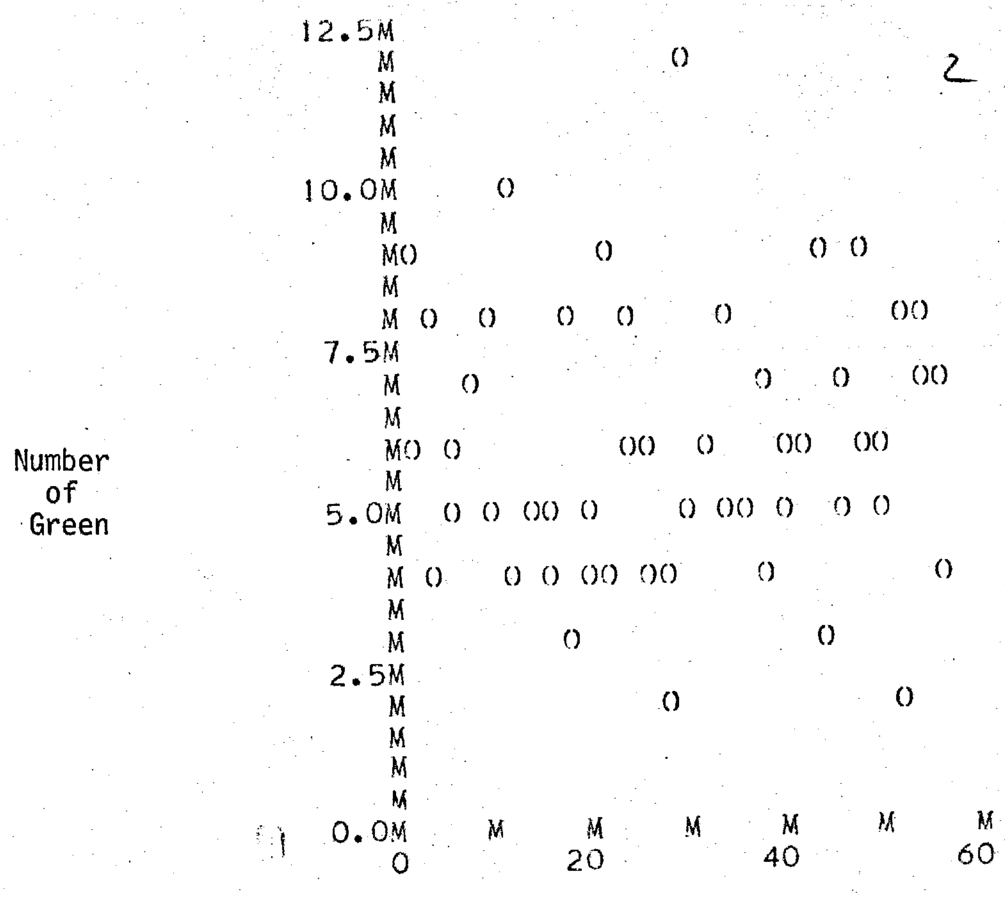


Figure 3.8 Distribution of Yellow for Machine 2



2

Figure 3.9 Distribution of Green for Machine 2

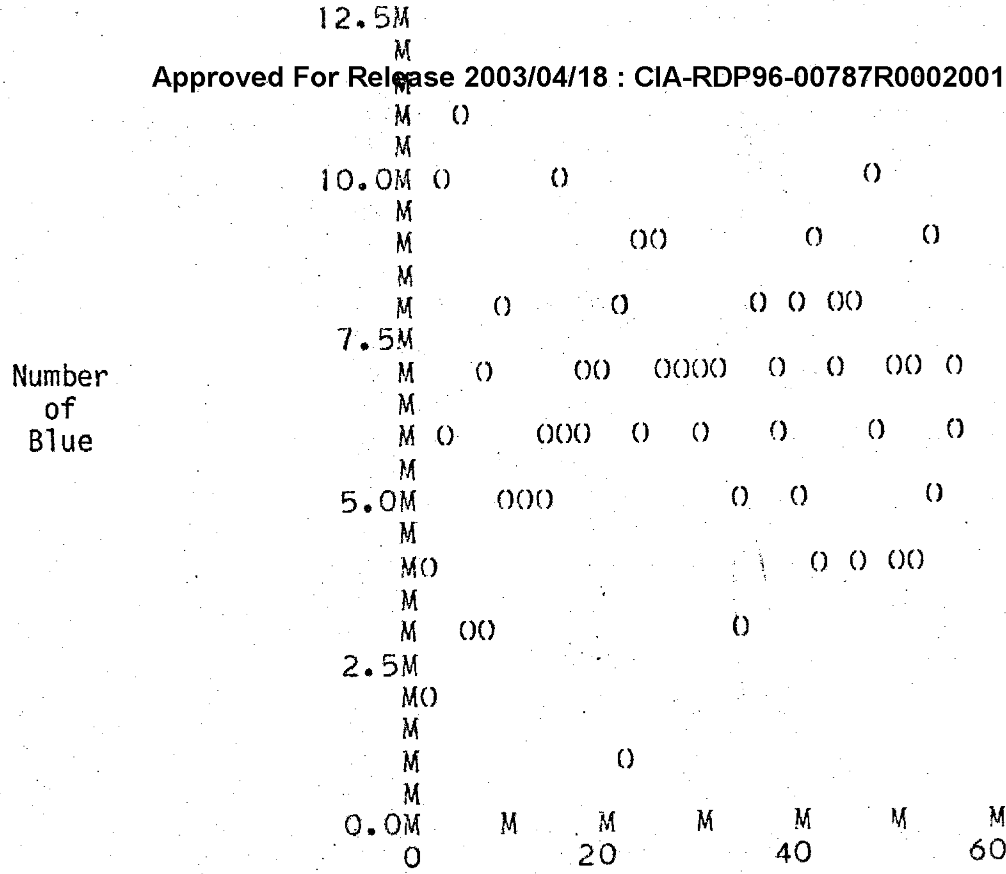
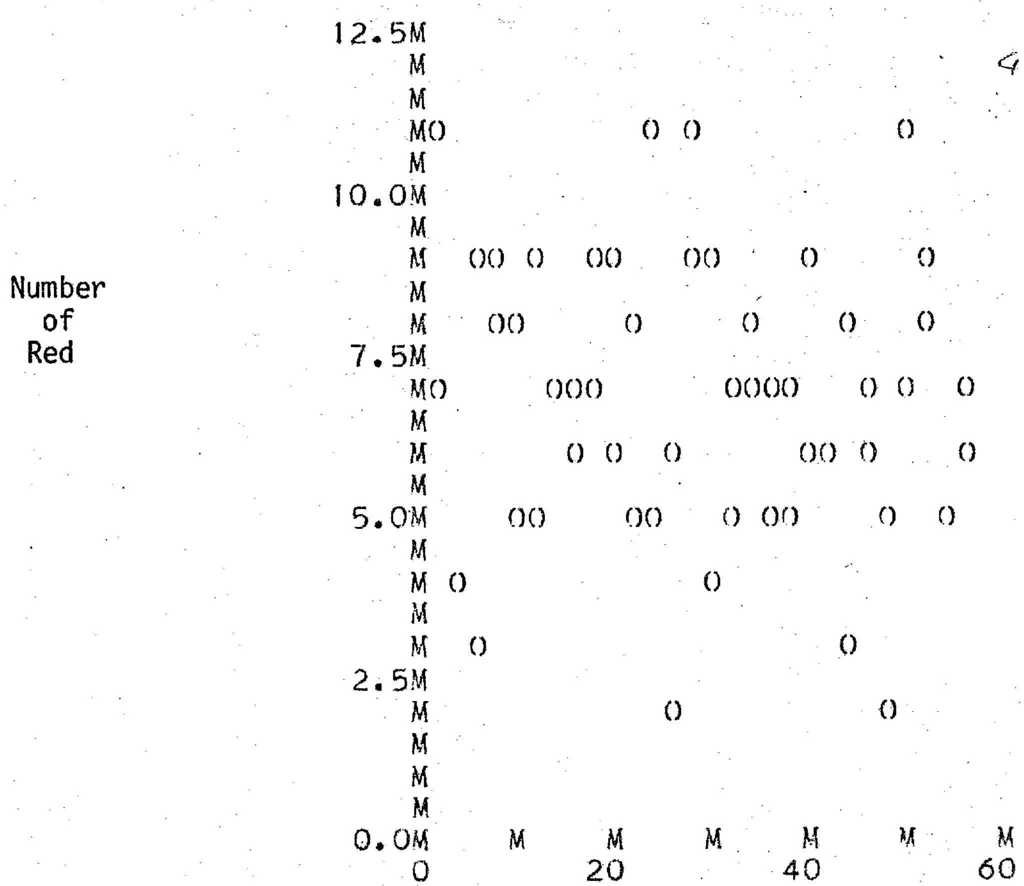


Figure 4.0 Distribution of Blue for Machine 2



Approved For Release 2003/04/18 : CIA-RDP96-00787R000200150011-4

Figure 4.1 Distribution of Red for Machine 2

Test	Description	Scoring					
		S1	S2	S3	S4	S5	S6
Halstead Category Test	Nonverbal test requiring abstraction of conceptual relationships. Score: Total errors.	7	14	33	26	6	28
Tactual Performance Test	Requires placement of 10 geometrically shaped blocks in their correct locations on a formboard while blindfolded. Separate RT, LT, and bimanual trials. Score: Total time (min.).	16.4	11.8	7.7	7.7	11.4	6.9
Speech Perception Test	Discrimination of non-word speech sounds. Score: Total errors.	4	2	0	2	5	3
Seashore Rhythm Test	Discrimination of nonverbal rhythms. Score: Number correct.	27	25	28	29	26	29
Finger Tapping Test	Measure of finger oscillation rate for 10-sec. period, both RT and LT hand trials. Score: No. taps/10 sec.	RT/LT 53/50	RT/LT 53/49	RT/LT 48/47	RT/LT 54/53	RT/LT 47/47	RT/LT 48/43
Trail Making Test (Part A)	Requires connecting numbered circles in order from 1 to 25. Paper and pencil task. Score: Total times (sec)	40	16	18	19	30	27
Trail Making Test (Part B)	Requires connecting alphabetic and numbered circles by alternating 1→A→2→B, etc. Score: Total time (sec)	56	50	55	50	54	53
Knox Cube Test	Measure of attention span and immediate visual memory. Score: Number correct.	13	14	13	16	17	17
Raven Progressive Matrices	Nonverbal intelligence test involving spatial matrices. Score: Number correct.	39	53	49	55	60	54
Verbal Concept Attainment Test	Requires abstraction of verbal conceptual relationships. Score: Number correct.	22	24	27	23	21	24
Buschke Memory Test	Requires learning a 20-word list in a maximum of 12 trials with repetition of words omitted after each trial. Score: Max. no. words correctly remembered; List: no. words consistently remembered	Total: 14/20 List: 8/20	17/20 14/20	18/20 11/20	19/20 16/20	20/20 15/20 (8 trials)	20/20 16/20 (7 trials)
Grooved Pegboard Test	Requires insertion of 25 pegs in their holes in a pegboard. Both RT and LT hand trials. Score: Total time (sec).	RT/LT 76/74	RT/LT 69/70	RT/LT 58/67	RT/LT 59/67	RT/LT ~~70/48~~ 72/70	RT/LT 48/50
Spatial Relations Subtest of the PMA	Requires mental rotation and identification of figures rotated in 2 dimensions. Score: no. correct - no. errors.	-	-	-	-	60	52
Gottschaldt Hidden Figures Test	Requires tracing outline of simple figure hidden within lines of more complex figure. Score: Time and no. correct.	Poor	Avg.	-	v.good	outst.	outst.