

## HEREDITARY NATURE OF "HYPOTHESES"

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In attempting to get data on the factors responsible for the initiation of the various "hypotheses," some evidence was obtained in a previous study (1932a) which indicated that "hypotheses" were, in part at least, initiated by the animal, i.e., were not altogether forced upon him by the environment. Incidentally it appeared that the factors within the rat which initiated "hypotheses" could not be assigned to effects of training alone, but rather, in some degree, to hereditary differences among the rats. The data also suggested that these hereditary differences making for different "hypothesis"-behavior were the same as those responsible for differences in maze behavior.

This paper presents further data on this point. More specifically, the question we shall investigate is: Do differences in the genetic make-up of the individual rats make for differences in "hypothesis"-behavior and, if so, are these same genetic differences also responsible for differences in maze behavior? The method of obtaining relevant data was to submit individuals of two different races (races which have been successfully bred for differences in maze-learning ability<sup>1</sup>) to the same environmental situation and to note the kind of "hypothesis"-behavior displayed by them. The experimental situation was so set up as to allow each animal to "pick up" any one or more of eight possible "hypotheses," differing in kind and in mode.

### APPARATUS AND PROCEDURE

The same apparatus was used for this study as in the three previous studies (1932, 1932a, 1932b) to which the reader is referred

<sup>1</sup> These rats were obtained from Dr. Tryon's races of "bright" and "dull" rats. We wish to express our sincerest thanks to Dr. Tryon for making these animals available for the experiment.

for a detailed description. The method of procedure was to run the two groups of animals for a period of 14 days in the "insolvable situation" set-up. It will be recalled that this situation was one which did not allow the animal to set up any "correct" habit. Whatever systematic response the animal did adopt would always result in 50 per cent entrances into the true alleys and 50 per cent entrances into culs. The animals, however, could set up eight different "hypotheses." Four of these were "visual" and four "spatial." It should be pointed out that these eight different "hypotheses" were independent of each other. That is, the animal's responses in keeping with any *one* of the "hypotheses" outlined above were not, at the same time, *necessarily* in keeping with any *other* of the possible "hypotheses."<sup>2</sup>

As was stated above, the two experimental groups of animals were taken from Tryon's "bright" and "dull" strains of rats. That these two strains differ genetically as far as maze ability is concerned has been amply demonstrated by Tryon's evidence. From the records of eight generations of rats, consisting of 1320 animals, Tryon has shown that he has fairly well established "a race of bright and one of dull animals" (1932). There is almost no overlap of maze performance between the group of animals taken from the F<sub>8</sub> generation. However, it should be noted that no supposition is made that these two strains are *pure* strains. Our only assumption is that they *differ* markedly in genetic make-up.

*"Bright" group*

Thirteen previously untrained rats (eight pigmented and five albino) about three months of age were used for this group. These animals were from Tryon's F<sub>7</sub> generation of the "bright" strain. They were run, as has been indicated, for 14 days in the insolvable situation.

*"Dull" group*

Fourteen previously untrained rats (six pigmented and eight albino) about three months of age were used for this group.

<sup>2</sup> For a detailed analysis of this situation and the actual order of arrangement of stimuli see Krechevsky (1932a).

These animals also represent the F<sub>7</sub> generation, but of the "dull" race. They were also run for 14 days in the insolvable situation.

*Control group*

Data for a control, or "average" group of animals were already available from a previous study (1932c). It will be remembered that in that experiment a control group consisting of 20 colony albino rats, about three months of age, were run for 14 days in the insolvable situation. This group is one which exactly fulfills the conditions for a control group for the present experiment, since they were run under the same conditions and at about the same time as both the "bright" and "dull" groups. The animals of this group had not been bred for maze performance and therefore probably represented a "random," heterogeneous group as far as genetic structure was concerned and thus could be compared with a strain bred for maze brightness and with one for maze dullness to determine the effects of genetic differences on "hypothesis"-behavior. It will also be recalled that besides these 20 animals, 60 other albino colony rats were run in the previous experiment (1932c). The other 60 were also given (for the first part of the experimental period) the same training as was given the "bright" and "dull" strains. Experimental changes were introduced, for these 60 animals, only after they had adopted an "hypothesis." In the analysis of the data of the present experiment comparisons will be made among the "bright," the "dull" and the control groups on the basis of the nature of the first "hypothesis" adopted. For that analysis we shall be able to use the data of the entire 80 animals as the control data, since these data were obtained under the same conditions for the 60 animals as for the 20 regular control animals.

The method used for determining the presence or absence of an "hypothesis" was the same as used in the two previous studies where a complete description is given (1932, 1932a).

RESULTS AND DISCUSSION

As has already been pointed out, earlier evidence suggested that differences in "hypothesis"-behavior were determined by the

same genetic factors as were responsible for differences in maze-behavior. The evidence for this suggestion was obtained by noting the different kinds of "hypotheses" shown by four "dull" animals and five "normal" animals (1932a). While undoubtedly the number of cases was much too small to be of any except suggestive value, still it is of interest to note that three of the "dull" animals seemed to "prefer" *visual* "hypotheses" while the "normal" animals "preferred" *spatial* "hypotheses." In other words it seemed that "poor" maze rats (i.e., "poor" at spatial problems such as the maze) when given a difficult problem, attempted visual (i.e., *non-spatial*) "hypotheses," while normal rats (and presumably of average maze ability) attempted, when placed in the same situation, *spatial* "hypotheses."<sup>3</sup>

Only one measure of visual or spatial "preference" was used in the previous analysis. All that was noted was the difference in the number of days each animal persisted in spatial and visual "hypotheses."

In the present study more measures of "preference" were felt to be necessary. Furthermore, other possible differences in the "hypotheses" of "brights," "dulls," and normals besides that of "modal preference" (i.e., visual or spatial "hypotheses" preference) were also investigated.

Three measures of "modal preferences" were designed. (1) The first measure was to note merely the *first* "hypothesis" which the animal adopted. That is, we were first interested in knowing whether the "bright" animals try one mode of "hypotheses" first, and the "dulls" try another first. (2) The second measure was the one used in analyzing the previous bit of data referred to above. Each animal was given a visual<sup>3</sup> "hypothesis" score and a spatial-"hypothesis" score on the basis of the number of days he displayed these respective modes of "hypotheses." The specific *kind* of "hypothesis" (whether left-going, right-going,

<sup>3</sup> Unfortunately the four "dull" rats were pigmented animals and the five normal rats were albinos and so, at that time, it was also suggested that the difference in preference between the two groups may have been due to the better visual equipment of the pigmented animals rather than to the fact that they were "dull" spatial animals.

etc.) was not taken into account, merely the *mode* of the "hypothesis" (i.e., whether "spatial" or "visual"). Thus we determined whether visual or spatial "hypotheses" predominated during a period of 14 days. (3) The third measure was an attempt to get some finer indication of preference than could be given by either of the above two methods. In (1) and (2) the animal obtained a score only if he preferred any one response to the extent of at least three sigma away from chance expectation. Thus, for instance, for measure (2) the animal on any one day was given a score of one spatial "hypothesis" if on that particular day he exhibited that "hypothesis" with an efficiency of at least 75 per cent (i.e., about 50 per cent plus three sigma). If, on the other hand, he exhibited that "hypothesis" to a degree of 70 per cent he was given no score for the spatial mode. Obviously such an analysis alone is not sufficiently complete and is to some extent unjustified. For it is fallacious to assume that an animal who prefers,<sup>4</sup> let us say, a spatial "hypothesis" to a degree of 70 per cent for five successive days, and a visual "hypothesis" to the extent of 75 per cent for one day, "prefers" a visual "hypothesis." Yet that would be the result obtained by the second scoring method. What is needed is some method of weighting *every* response and according to the degree to which it is shown.

If any one animal was running in a purely non-systematic manner the situation is so set up that he would be making a 50 per cent score for each of the eight "hypotheses." The less random his behavior became the greater would his score differ from 50 per cent for some one "hypothesis." Thus, an animal receiving a score of 65 per cent (for one day) on a visual "hypothesis" and 70 per cent on a spatial "hypothesis" "prefers" a spatial "hypothesis," since he deviated from "chance" by 15 per cent as far as a visual "hypothesis" was concerned and 20 per cent with respect to a spatial "hypothesis." If, then, we determine for each animal the percentage deviation (from 50 per cent) for every "hypothesis" we can get a measure of his preferences which is based on *every* response made. Each preference will thus be

<sup>4</sup> By the terms "prefer" and "preference" we merely mean "a greater propensity towards."

appropriately weighted. If we sum all the deviations for all possible visual "hypotheses" and compare the total with the sum of the deviation of all the spatial "hypotheses" we can determine the extent to which the animal prefers visual to spatial responses or vice versa. This then was the third measure used.

Table 1 presents a summary of the comparison between the three groups by all three methods. In the first row is given the data relative to the first "hypothesis" shown by the animals. It will be seen that of the thirteen "bright" animals, eight first

TABLE 1  
*Summary of differences in modal preferences of "hypotheses"*

	"BRIGHTS" (n = 13)			CONTROL (n = 20; n' = 80)			"DULLS" (n = 14)		
	Visual	Spatial	t	Visual	Spatial	t	Visual	Spatial	t
First "hypothesis" shown . . . . .	5	8		9(38)	11(42)		10	3	
Average number of days for visual and spatial "hypotheses." . . . . .	3.3	8.4	3.211	4.4	5.6	.828	6.5	3.8	1.471
Average total deviation . . . . .	265.53	472.61	3.730	338.65	365.80	.648	361.21	287.92	1.542

adopted spatial "hypotheses" and five, visual. This difference of three in favor of spatial "hypotheses," while not very large, assumes more significance when it is compared with the results of the "dulls." Out of the 13 "dulls"<sup>5</sup> ten first adopted visual and only three spatial. The difference here is large enough to warrant some consideration and, furthermore, it is in the opposite direction from that of the difference among the "brights." This difference of seven in favor of *visual* "hypotheses" for the "dulls" should be compared with the difference of three in favor of the *spatial* "hypotheses" for the "brights." In the control group an

<sup>5</sup> The records of only 13 of the "dulls" are given for this particular measure, although 14 animals were run. The reason for this discrepancy is that one of the "dulls" picked up *both* a visual and a spatial "hypothesis" on the third day and therefore, *for this one measure*, his results are not counted.

almost perfect "chance" division of spatial and visual "hypotheses" obtain, nine of the 20 animals were visual and 11 spatial. Here, however, we can also call upon the data of 60 more animals (see discussion p. 12), where we again find an almost perfect chance distribution. Forty-two of the total of 80 animals preferred spatial and 38, visual. (The values in parentheses in the first row of table 1 present these data.) We must acknowledge that the *absolute* differences between spatial and visual preferences for the "dulls" and "brights" are not very high, but they are definitely in the direction expected on the assumption that a maze-"bright" rat prefers spatial "hypotheses" and a maze-"dull" rat prefers non-spatial "hypotheses."

This, however, is only the simplest measure. It does not take into account the possibility of an animal almost reaching a visual (or spatial) "hypothesis" on the first day and then changing to a spatial (or visual) "hypothesis" on the next day for what is counted as his *first* "hypothesis." A consideration of the other measures is therefore next in point.

In the second row of table 1 is given the average number of days during which the three groups showed visual and spatial "hypotheses." The "brights" displayed visual "hypotheses" for an average of 3.3 days and spatial "hypotheses" for an average of 8.4 days. Here the difference in preference, on the part of the "brights" for *spatial* "hypotheses," is definite and clear-cut. The difference between averages (5.1 days) is highly reliable, the *t* of the difference being 3.211 which means that the probability of such a difference occurring by chance alone is much *less* than one in one hundred. The "dulls," almost as strikingly, show a preference for *visual* "hypotheses," the average number of days for spatial "hypotheses" being 3.8, and for visual, 6.5. The *t* for this difference is, however, not so significant as was the *t* in the case of the "brights." The probability of the difference being a chance one is about ten in one hundred. Another comparison to be made is that between the *visual* score for the "brights" and the *spatial* score for the "dulls" (i.e., a comparison of the non-preferred "hypotheses" of the two groups). The visual score for the "brights" is 3.3 and the spatial, for the "dulls," 3.8, a

difference of only .5 of a day between the two groups. The control group shows an even distribution. The average number of days for the visual "hypotheses" is 4.4, and for the spatial 5.6, a difference of 1.2 days. The  $t$  of this difference is .828 and the probability is that such a difference would occur slightly more than 40 times in one hundred as a result of chance alone.

The results of this second measure substantiate quite definitely the differences obtained by the first measure. Again we find that the "bright" rats prefer spatial "hypotheses," the "dull" rats visual, and the normal rats show no marked preference.

We still have to consider the third measure which should give us a finer analysis than either of the first two.

The third row of table 1 presents the average deviation scores for the visual and spatial "hypotheses" for the three groups. The differences confirm our other two measures. The average visual score for the "brights" is 265.53, the spatial score, 472.61. The difference here is highly reliable; the  $t$  of the differences is even higher than the  $t$  for the second measure. The results for the "dulls" are also consistent with our other data. For spatial preferences the score is 287.92, for visual, 361.21, an average difference of 73.29. But here again the statistical significance is not so great as for the difference among the "brights." The  $t$  is 1.542, which signifies a probability of between .1 and .2. If we again compare the two less-preferred modes of response for the two groups we get the same striking similarity as was obtained above. The *visual* score for the "brights" is 265.53 and the *spatial* for the "dulls," 287.92, the average difference being only 22.39.

The control group again shows an even division of its preferences; 338.65 is the average for its visual score and 365.80 for its spatial score. The  $t$  of this difference clearly indicates that it is statistically insignificant.

The last analysis (measure 3), however, is capable of more detailed treatment. It would be of interest to know the history of the preferences of the "brights" and "dulls" during the experimental period of 14 days. Tables 2 through 2<sub>b</sub> present the *daily* average preferences for the three groups. In the first row are



TABLE 2  
Average visual and spatial deviations from 50 per cent, "bright" rats  
(n = 20)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Spatial.....	18.81	24.52	27.95	27.64	31.07	41.27	44.09	36.86	34.12	37.47	37.85	35.18	37.77	33.28
Visual.....	16.22	20.10	24.90	20.35	15.46	15.23	15.31	18.05	19.38	20.33	19.57	18.89	19.11	19.49
Difference....	2.59	4.42	3.05	7.31	15.61	26.04	28.98	18.81	14.24	17.14	18.28	16.29	18.66	13.79

TABLE 2a  
Average visual and spatial deviations from 50 per cent, control rats  
(n = 20)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Spatial.....	14.70	23.45	24.25	25.30	28.90	25.85	23.85	28.50	26.70	27.70	31.15	30.10	27.25	27.50
Visual.....	18.55	18.70	21.50	21.90	23.60	26.15	28.35	26.15	28.25	26.00	25.85	22.50	25.60	25.85
Difference..	3.85	4.75	2.75	3.40	5.30	3.0	4.50	2.35	1.55	1.70	5.30	7.60	2.25	1.95

TABLE 2b  
Average visual and spatial deviations from 50 per cent, "dull" rats  
(n = 14)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Spatial.....	12.50	15.71	17.86	19.57	19.57	16.43	14.86	16.57	20.36	25.50	28.57	25.86	26.36	28.21
Visual.....	19.00	26.07	25.00	22.28	29.78	28.50	31.28	26.43	28.78	25.57	23.00	23.43	26.57	25.50
Difference....	6.50	10.36	7.14	2.71	10.21	12.07	16.42	9.76	8.42	.07	5.57	2.43	.21	2.71

given the average deviations from chance score for the four spatial "hypotheses," in the second row, the scores for the four visual "hypotheses" and in the third row the difference between the two. It will be seen that this last row (the difference between spatial and visual scores) gives us the degree of *preference* for spatial over visual or vice versa. When the difference is in the deviation of a greater *spatial* score than visual, the difference values are italicized; when the *visual* score is greater, the difference values are in plain type.

It will be seen that *on the very first day* the "bright" groups preferred spatial and the "dulls" visual. To be sure, the degree of preference on the first day is perhaps not statistically reliable, but it assumes significance when considered in relation to the fact that for the next 13 days, in the case of the "brights," and the next nine days, in the case of the "dulls," this preference persisted and grew stronger. In the case of the "brights" we have *no* day where a reversal took place, i.e., where a preference for *visual* "hypotheses" are shown. In the records of the "dulls" only three of the 14 days display reversals—the eleventh, twelfth, and fourteenth days. The control group again shows no definite preference. On ten of the 14 days a *slight* preference for spatial "hypotheses" is shown and on four days a preference for visual "hypotheses" is shown.

Figure 1 represents these data graphically. Only the curves representing the differences (i.e., degree of preference) are shown. In constructing the graph the mid-point is zero, i.e., when *no* preference was shown the locus of the value would fall on the zero line (represented by a horizontal line in the graph). The area *above* the zero line represents the locus of scores indicating a *spatial* preference and the area *below*, the visual preference. In drawing the curves cumulative scores rather than discrete scores have been plotted. This was done to smooth out some of the daily chance fluctuation. However the discrete scores are available in tables 2 through 2<sub>b</sub>.

Summarizing the results obtained by the three different methods we may say that there is a definite indication that the "bright" strain of animals, when placed in a difficult (non-solv-

able) situation, attempt spatial "hypotheses" in trying to solve the problem, the "dull" animals attempt non-spatial (visual) "hypotheses" and a non-selected group try about as many spatial as visual "hypotheses." In other words the kind of "hypothesis" which an animal can bring with him to a problem-situation is to some extent hereditarily determined.<sup>6</sup>

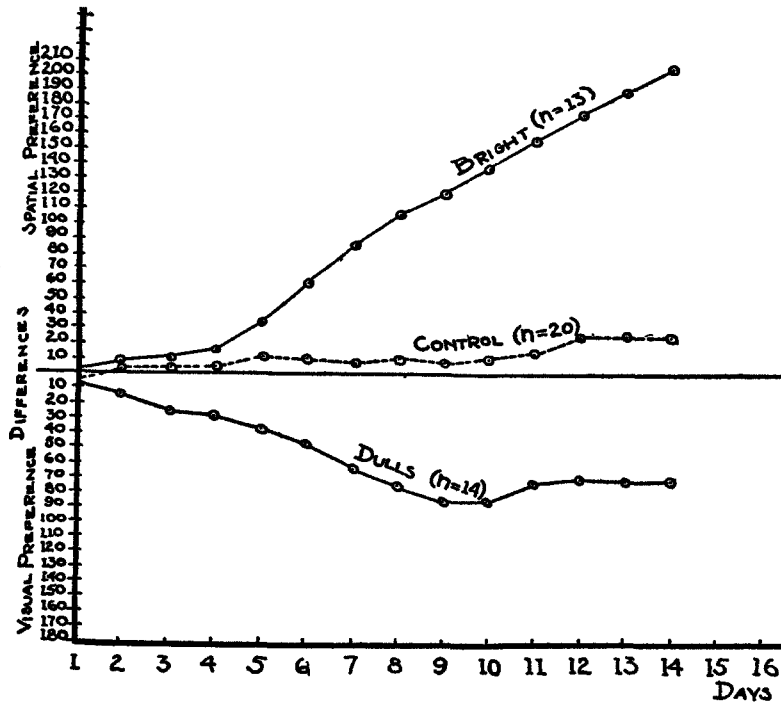


FIG. 1

However, the following fact cannot have escaped attention. By the first method of determining preferences the "dulls" quite distinctly preferred visual "hypotheses," but in the two other methods the preference of the "dulls" was not so clear-cut as that of the "brights." In neither of these two methods was the degree

<sup>6</sup>The author wishes to take advantage of the galley proof to add that this experiment has been reported by him with ten "dulls" and ten "brights" of the  $F_2$  generation (i.e., the next generation) and the same differentiation between the two races has appeared as here indicated.

of preference quite great enough to assure us that either (considered independently) showed reliably a visual preference for the "dulls."

Three possible explanations suggest themselves for this difference in results between the "brights" and the "dulls."

1. This difference may be due to a fault in the experimental set-up. It will be remembered that the data for each rat was analyzed for eight different "hypotheses," four spatial and four visual. Since there are four of each mode it was assumed that

TABLE 3  
*Frequency of the various "hypotheses"*  
(n = 107)

"HYPOTHESES"	SPATIAL				VISUAL			
	Simple		Complex		Simple		Complex	
	Right	Left	Alternating spatial	Perseverative spatial	Dark	Light	Alternating visual	Perseverative visual
27 "brights" and "dulls" (for entire 14 days).....	10	13	7	0	16	4	0	0
80 controls (first "hypotheses")...	19	16	5	2	30	7	0	1
Total.....	29	29	12	2	46	11	0	1
Grand total.....	58		14		57		1	

the "visual animal" had as many opportunities to display visual "hypotheses" as the "spatial animal" had spatial "hypotheses." But while that may be so theoretically, actually the "spatial animal" had *more* opportunities for spatial "hypotheses" than did the "dull" animal for visual ones. Some of the "possible" visual "hypotheses" were apparently beyond the range of the rat's ability. The four "hypotheses" for each mode can be very easily divided into two classes—the simple and the more complex. By simple we mean right-going and left-going *spatial* "hypotheses" and dark-going and light-going *visual* "hypotheses." By

complex we refer to alternating-spatial and perservative-spatial for one mode, and the alternating-visual and perseverative-visual for the other.<sup>7</sup> Table 3 gives the frequency of occurrence of these various "hypotheses" in 107 rats.<sup>8</sup> It will be seen that while the two classes of *simple* "hypotheses" show about the same frequency, the *complex* "hypotheses" show a much greater frequency in the spatial mode than in the visual mode, the actual frequencies being 14 to 1. In other words, the two "complex" visual "hypotheses" are extremely difficult for any rat. In all probability the reason the "brights" show their preference for spatial so much more strongly than do the "dulls" their preference for visual is that the "dulls" are not given so great an opportunity to display their "visual-hypothesis" propensity as are the "brights" to display their "spatial-hypothesis" ability.<sup>9</sup>

2. The second possible explanation derives partly from the probable genetic differences between the "brights" and "dulls" and partly from the experimental situation used in this study. It is to be remembered that the "brights" had been bred for a positive factor (maze ability or spatial ability) and the "dulls" for a negative factor (*lack* of spatial ability). Now, when placed in the insolvable situation, we would expect the "brights" (if our thesis is correct) to display a great preference for spatial responses and the "dulls" to prefer anything *but* spatial responses. The

<sup>7</sup> A "spatial-perseverance" "hypothesis" was one where the animal consistently went to the alley which was on the *same side* as the open alley of the just preceding unit; a spatial-alternating one was where the animal went to that alley which was on the *opposite* side of the open alley of the just preceding unit. A visual-perseverance "hypothesis" was one where the rat always went to that alley which was of the *same brightness* as the open alley of the just preceding unit and a visual-alternating "hypothesis" where the animal always went to that alley which was opposite in brightness to the open alley of the just preceding unit.

<sup>8</sup> These 107 rats were the 80 colony, the 14 "dull" and the 13 "bright" rats.

<sup>9</sup> Another fact to be observed from the table is that while both the right and left preferences have about equal frequencies, the dark and light seem to be clearly unequal. The dark is preferred much more than is the light. This is in accordance with the results obtained in studying antagonistic visual habits in the rat. There it was discovered that the animal could much more easily break a light-going habit and adopt a dark-going one than vice versa (1932b). Apparently the reason for the results obtained in that study is to be found in the original "hypothesis" propensities of the rat.

only other outstanding cue *happened* to be a visual one, but there is no good reason to suppose that the "dulls" are better *visual* animals than the "brights"; they may merely be *worse spatial* animals. In other words, there was no positive propensity among the "dulls" to use visual cues, but there was among the "brights" for spatial cues. Therefore we would expect the "brights" to show a preference for the spatial "hypothesis" to a much greater degree than we would expect the "dulls" to prefer visual. Had we also given the "dulls" an opportunity to respond to olfactory, auditory and many more *non-spatial* cues the "dulls" might also have shown just as definite preferences as the "brights."

3. The last explanation (and perhaps the most suggestive for further experimental work) is that in this experimental situation the "brights" were much less plastic, less docile than were the "dulls." That is, the "brights" may be very good spatial animals, but by that very token, relatively bad "other" animals. They may have been bred for one specific ability and so well bred for that that they would be at a loss in a situation which could *not* be solved spatially (i.e., as in a discrimination box).<sup>10</sup>

If we now assume that the "brights" and "dulls" are not two equally pure strains, but rather that the "brights" are more pure than the "dulls" we would expect the "brights" to "fixate" on spatial "hypotheses" and nothing else—it would be too difficult for them to leave their bred-in-mode of response; while the dulls, on the other hand, might try a visual "hypothesis" and having found that of no avail could, without too great effort, leave that mode and try spatial "hypotheses." Such an assumption then might explain our results.

Fortunately we have some data on the question whether or not the "brights" are less plastic and docile in respect to "modal shifts" than the "dulls." Table 4 presents these data. Here we have the number of *different* modes of "hypotheses" shown by the three groups over the period of 14 days. No attention has been paid to the duration of any one "hypothesis" and these data are not to be interpreted as indicating preference for either visual or

<sup>10</sup> It should be pointed out here that Tryon himself has never suggested that his "brights" are anything else but specifically "bright" for maze ability.

spatial "hypotheses." For instance, if a "dull" animal persisted in a visual "hypothesis" for 13 days and then adopted a spatial "hypothesis" for one day he would be given a score of one spatial and one visual. These data merely present the number of changes in "hypotheses" made by the three groups. It will be seen that the "brights" showed 18 spatial and only eight visual "hypotheses." In other words, when they did change it was a change to *another spatial* "hypothesis" and only eight times did they try a visual "hypothesis." The "dulls" on the other hand appear to be just as free in their changes as the controls: twelve visual and 12 spatial "hypotheses" for the "dulls" and 11 visual and 10 spatial for the controls. This plasticity, despite the fact that the "dulls" actually preferred visual "hypotheses" (as has

TABLE 4  
"Plasticity" of "brights," "dulls" and controls

	"BRIGHTS"		CONTROLS		"DULLS"	
	Visual	Spatial	Visual	Spatial	Visual	Spatial
Number of different "hypotheses" . . . . .	8	18	11	10	12	12

been shown by the measures of preference used), is highly suggestive. It is quite probable that the "brights" are much more limited in response abilities than "dulls" or "controls" and therefore we would expect a more clear-cut preference on the part of the "brights" than on the part of the "dulls." However, this should merely be interpreted as a suggestion.

So much for differences between "brights" and "dulls" with respect to the mode of "hypothesis" preference. We must now turn to an examination of other, more "general" differences. Four such possible "general" differences have been investigated. These data are presented in table 5.

The first difference is in the speed of appearance of "hypotheses." Are the "brights" *faster* in picking up their preferred "hypothesis" than the "dulls?" In the first row of table 5 are presented the average day of the first appearance of an "hypothesis" for the three groups. It will be seen there is very little

difference among the groups. The largest difference, between the control and the "bright" group, is only .8 of a day, and is not very reliable since the  $t$  (given in the table as "BC" under the  $t$  column) is 1.251 which means that there are more than 20 chances in one hundred for such a difference to occur by chance alone. The difference between the "bright" and "dull" group is even smaller, .4 of a day with the probability of such a difference occurring by chance only slightly less than 50 in one hundred.

TABLE 5  
"General" differences between groups

	"BRIGHTS" (n = 13)	CONTROL (n = 10)	"DULLS" (n = 14)	$t$ 's
Average day of appearance of first "hypothesis".....	2.3	3.2	2.8	BD = .623; BC = 1.250; DC = .441
Average number of different kinds of "hypotheses".....	2.00	1.80	1.71	BD = 1.124; BC = .750; DC = .321
Average number of days showing "hypotheses"-behavior.	11.7	10.2	10.3	BD = 1.050; BC = 1.231; DC = .122
Average day of appearance of second "hypothesis".....	6.2	6.7	6.2	BD = .015; BC = .472; DC = .362

As far as the rapidity with which "hypotheses" are adopted no difference is discernible between the "brights" and "dulls."

The second difference to investigate is the average number of different "hypotheses" shown by the three groups. Do the "brights" show more kinds of "hypotheses" (of *any* mode) than the "dulls?" The second row in table 5 presents the average number of "hypotheses" for the three groups during a period of 14 days. Again the differences are very slight and not statistically reliable. The greatest difference, between "brights" and "dulls" is an average of .29 of an "hypothesis," with the probability of its occurring as a chance event slightly less than 30



times in one hundred. Again no significant difference obtains between the "brights" and "dulls."

A third difference might be present, i.e., the average presence or absence of "random" behavior among the three groups. That is, on how many days of the 14 did the "brights" show "hypotheses" as compared with the "dulls?" Again no differences are found, as can be seen from the average number of days on which each group showed "hypotheses" (third row of the table). The "dulls" differ from the "brights" by 1.4 days, which is probably a chance difference ( $t$  equals .05 and the probability of its being a chance difference is 30 in one hundred).

The last difference is really one of docility. It might be supposed that a "bright," having adopted one "hypothesis," might discover its inefficiency and give it up for a different "hypothesis" sooner than would a "dull" rat. However, no such difference exists. The fourth row presents the average day upon which the *second* "hypothesis" appeared. The differences between the "brights" and "dulls" is almost zero (0.2 of a day) and so are the differences between any of the three groups.

Summing up the results of all four of these measures we might say that no "general" difference is apparent among the "bright," the "dull" and the control rats.

The only difference found is in the mode of "hypotheses" preferred.

#### SUMMARY AND CONCLUSIONS

Thirteen "bright" rats and 14 "dull" rats about three months of age and previously untrained (taken from Tryon's F<sub>7</sub> generation of "maze-bright" and "maze-dull" rats), and 20 "average" unselected rats were run for 14 days in an insolvable situation. The "hypotheses" attempted by these animals in this situation have been observed. From an analysis of these data and other data obtained from 60 more colony rats, the following points are made:

1. The modes of "hypotheses" preferred by the rat are partly a function of the heredity of the animal.
2. The "bright" rats seem to prefer spatial "hypotheses"

while the "dull" rats prefer non-spatial "hypotheses" (visual in this case) and the control rats show no preference.

3. The difference in preference of mode of response is the only one apparent—no "general" difference in "brightness" or "dullness" has been found among these animals. From this fact it is suggested that "maze-brightness" is a specific response ability.<sup>11</sup>

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<sup>11</sup> Since this was written a correlation study by Commins, McNemar and Stone (1932) has appeared in which the authors, after investigation some 60 intercorrelations between various measures of ability, conclude that maze-habit ability is not correlated at all with either problem box ability or discrimination-box ability.