

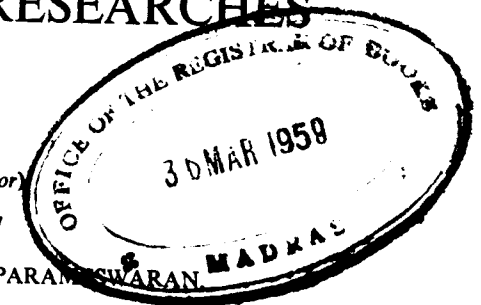
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Contributors are requested to be clear and concise. The length of the articles should not exceed 15 printed pages. The manuscript should be in a final form for the press. The introduction and reviews of literature should be restricted and closely pertinent.

The manuscript should be typewritten on one side of the page only, with double spacing, and wide margins, including titles, foot-notes, literature citations and legends. Symbols, formulæ and equations must be written clearly and with great care. Too many tables, graphs, etc., should be avoided. Each table should be typed on a separate sheet with its proper position marked in the text in pencil. *Two typewritten copies of the article should be sent.*

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Vol. IV

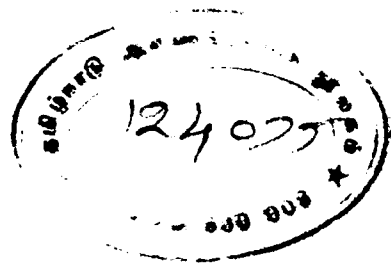
JANUARY 1960

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Efficiency of the Ishihara Plates in Distinguishing Defects of Colour Vision

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Indian Statistical Institute

Introduction

Defective Colour Vision has, apart from genetical interest, considerable importance in every-day life and industrial occupations. Consider automobile drivers who must distinguish the red "stop" traffic signal from the green "go" signal, or the inspectors in textile mills who must judge whether dyed cloth matches standards, or the lady selecting fabrics to decorate her home. In each of these cases, as in many others, defective colour vision may result in failure to make the correct decisions.

Although colour vision is important for successful performance of many jobs, minimum standards for colour vision have not been set for many occupations. Cavanagh (1) reports that, in England, the Metropolitan Police, British Railways, Merchant Navy, the Royal Navy and the Royal Air Force have set colour standards for jobs where colour discriminations are required. Selection of operatives in a linoleum factory in England, who were required to measure differences between products as manufactured and a standard sample, using a colour vision test, is discussed by Pickford (6). For any industry or service requiring colour discrimination, it will be necessary first to determine what types of defective colour vision are unacceptable, and second, to choose an appropriate device for screening out individuals possessing those types of defect.

Classically, the three receptor colour theory of Young and Helmholtz has served as the basis for defining types of defective colour vision (2). In terms of the number of primary colours required to match all colours of the visual spectrum, three main types have been isolated; anomalous trichromats, dichromats, and monochromats. While anomalous trichromats require 3 primary colours, they use them in amounts different from normal persons, dichromats require two colours, and monochromats require only one colour. Anomalous trichromats are subdivided into three classes: deuteranomals or partial deuteranopes, who require more green than the normal to match a given yellow; protanomals or partial protanopes, who require more red than the normal; and tritanomals, a relatively rare group requiring more blue or violet than the normal. Similarly, dichromats are subdivided into classes; the deuteranopes or green-blind; protanopes or red-blind; tritanopes, violet or blue-blind; and tetratanopes, for whom the whole spectrum appears in terms of red or green (1). Pickford (6) has pointed out that not only are the dichromats a risk in certain occupations, but that anomalous trichromats are also. This is of course even more clear in the case of monochromats or totally colour blind individuals.

After examining the occupations of a particular industry in terms of the defects of colour vision which are not acceptable, it is next appropriate to consider a test of colour vision to point out individuals with those defects.

A variety of colour vision tests have been developed. Their use and popularity have depended upon such factors as ease in administration, cost, and personnel required. The most widely used and popular type of test has used pseudo-isochromatic (apparently equal coloured) or poly-chromatic (many coloured) plates. In historical order, *Stilling's Pseudo-Isochromatic Plates for Testing the Colour Sense* were first developed, then Ishihara's *Tests for Colour Blindness* (based on Stilling's work), and later, the American Optical Company's *Pseudo-Isochromatic Plates for Testing Perception* (which is a selection of plates from the Stilling and Ishihara tests). Of these, the Ishihara test has been mostly widely used in industry, anthropological investigations, and psychological research (1).

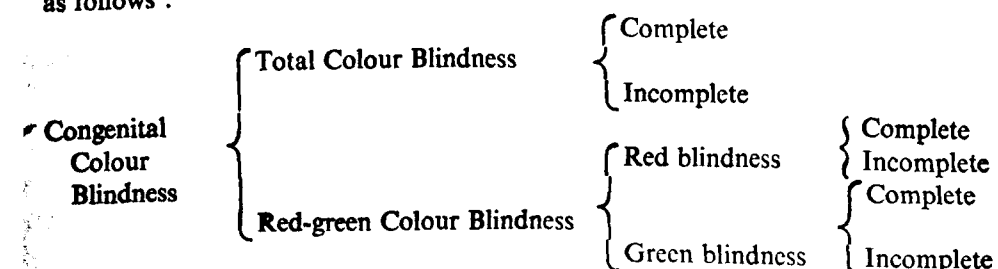
The Ishihara test consists of a series of plates, each consisting of coloured dots in patterns, with the dots varying in colour and diameter. In the 11th edition (3), there are 38 plates: for the first twenty-five, designed for literates, the pattern includes 1 or 2 digit numbers; and for the last thirteen, intended for illiterates, one or two winding lines. Canavagh (1) has pointed out that the plates belong to six series. Series 1 (plates 2-5 and 36-37) may be called a *transformation series* since the pattern as seen by normals is transformed to another one when seen by colour-defectives. Series 2 (plates 6-9 and 34-35) is also a *transformation series*, reversing background and pattern colours from those of series 1. Series 3 and 4 (plates 10-13, 32-33 and 14-17, 30-31 respectively) are of the *vanishing pattern* type, i.e., the patterns seen by normals are rarely seen by colour defectives. Series 5 (plates 18-21 and 28-29) contains a *hidden pattern*, which is seen only by colour defectives, and not by normal or totally colour blind individuals. Series 6 (plates 22-25 and 26-27) consists of *differential patterns* in which protanopes should see only one pattern, deuteranopes another, while those with normal colour vision see both.

Although the Ishihara tests have been widely used due to their convenience, and apparent ease in administration, they are subject to a number of sources of error. Among these are careless administration, faulty interpretation of results, expecting too much of the tests and disregard of the critical importance of illumination during administration (1). To correct the first error, a standard procedure, such as that given by Cavanagh (1), should be set up and consistently used. Control of the second error can be introduced by the standardisation of a scoring procedure and definition of critical scores for classification. The third error arises due to lack of familiarity with existing literature on the test, and also, to insufficient quantitative studies on the efficacy of classification by the test. As the plates are designed for use in 'average daylight,' or illumination with a colour temperature of 6500-6750°K, that illumination should be approximated in so far as possible to control the fourth error. It may be noted that fluorescent or 'daylight lamps' are preferable to ordinary or tungsten filament lamps.

Expecting too much of the Ishihara test is an error which has been attributed in part to the lack of familiarity with existing literature on its efficacy. It may be

of interest to point out some earlier studies in this context. Pickford (4) compared the results of normal and defective persons, as classified by the Ishihara test (8th edition), with their results on three other tests. He concluded that the Ishihara test was: (a) effective in distinguishing major defectives from normal and minor defectives; (b) useless for distinguishing different degrees of colour sensitivity among normal and minor defectives; and (c) almost useless for distinguishing types or degrees of defect among major defectives. In a further study, Pickford examined responses to plates 2-25 of the test (5). He concluded that the first two series were unreliable, that the next 2 series were more reliable; while plates in series 5 were rather easily read by normal persons, making them rather unreliable, and the last series of plates were unreliable. This evidence suggests that it is the overall classification provided by a large number of plates that is useful in screening colour defectives; however, Pickford proposes that a shortened form of the test can be used to separate defectives from normals. The item analysis indicates that neither the shortened or complete test can be used satisfactorily to classify individuals according to type of defect. These results suggest that further quantitative studies on the efficacy of classification would assist investigators and others using the Ishihara test.

Before proceeding to the study undertaken along these lines, it will be desirable to consider the classification of colour defectives given by Ishihara (3). This is as follows:



This system of classification has been criticised by Pickford (5). The test (3) claims to distinguish the following types: normal, red-green blind, total colour blind, red blind, green blind, and incomplete red-green blind; these types do not appear to exactly fit Ishihara's system of classification. Thus, while red blind and green blind may correspond to protanopes and deuteranopes respectively, red-green blind may include both, and incomplete red-green blind may refer to anomalous trichromats. Difficulties in interpreting the test may occur partly because of the lack of agreement between systems of classification proposed and that customarily employed.

Assuming that plates in the Ishihara test should properly classify individuals into the types proposed by Ishihara, an empirical investigation may be undertaken to determine:

(a) degree of wrong classification by plates; and

(b) average response pattern for the different classes of colour vision.

With these objectives in view, the present study was carried out.

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Materials and methods

Plates 1-25 of the 11th edition of the Ishihara test (3) were used in this study. They were administered in serial order by trained technicians under standard conditions. The seating arrangements and fluorescent lighting were constant for all subjects.

A standard proforma was developed to record responses to the test. Reference to Table 1 will show that the column in which a response falls indicates whether it is a colour-blind or normal response, etc. In administering the test, the administrator simply encircled the response given by the subject to each plate. If the response was not among those specified by Ishihara, it was recorded in writing in the column provided for that purpose.

After the test was completed, the number of encircled responses in each column of the record form was counted and entered in the bottom row. On the basis of the column totals, the protocols were diagnosed by the following convention :

- (a) If the total of columns 2, 6 and 9 was equal to or greater than 13, the subject was classified as normal ; if not, he was classified according to one of the succeeding steps.
- (b) If the total of columns 3, 5 and 9 was equal to or greater than 13, the subject was classified as red-green blind.
- (c) If the total of columns 4, 5 and 6 was equal to or greater than 13, the subject was classified as total colour blind.
- (d) If the total of columns 3, 5 and 7 was equal to or greater than 13, the subject was classified as red blind.
- (e) If the total of columns 3, 5 and 8 was equal to or greater than 13, the subject was classified as green blind.
- (f) If the response pattern could not be classified according to any of the above conventions, the subject was classified as colour deficient with no further specification possible.

The test was administered to 194 male employees of a research institute (sample 1) and to 177 male employees of a factory (sample 2) in Calcutta. All subjects were able to read English ; their ability to read Arabic numbers was tested by Plate 1 of the test. (The results of Plate 1 were not analysed further.)

Results

According to Ishihara's notes, there are three possible responses to Plates 2 to 17 : normal, red-green blind, or total colour blind. In order to determine the degree of wrong classification by the plates, subjects were placed into two groups according to test diagnosis : normal or colour blind. The latter group included red-green blind, total colour blind, red or green blind, or colour deficient subjects. Responses to the plates were similarly classified as normal or colour blind ; the latter class included red-green blind and total colour blind results. The resulting

frequencies could be presented in fourfold tables, with 2 cells indicating "right" classification and the remaining two cells, "wrong" classification, as per the following model :

Test Diagnosis	Frequency of Item Response	
	Normal	Colour Blind
Normal	... "Right"	"Wrong"
Colour Blind	... "Wrong"	"Right"

To obtain the percentage of wrong responses, the following formula was used :

$$\% \text{ Wrong} = \frac{W}{W + R} \times 100$$

where W = total of frequencies in the "Wrong" cells
 R = total of frequencies in the "Right" cells.

The results for Plates 2 to 17 are presented in Table 2. The data have been analysed separately for the two samples of subjects.

Responses to Plates 18 to 21 distinguish red-green blind from normal and total colour blind subjects, according to Ishihara's notes. Frequency tables were made up comparing red-green blind, normal or total colour blind, and other responses for three groups of subjects : red-green blind, normal or total colour-blind, or colour deficient. The first class included subjects diagnosed as red or green blind, while the latter included only those whose defect could not be classified. The frequencies were presented in the following format to determine the percentage of wrong classification :

Test Diagnosis	Frequency of Item Response		
	Red-Green Blind	Normal or Total Colour Blind	Other
Normal or Total Colour Blind	"Wrong"	"Right"	"Wrong"
Red-Green Blind	... "Right"	"Wrong"	"Wrong"
Colour Deficient	... "Wrong"	"Wrong"	"Wrong"

Percentage wrong was computed by the same formula as given above, and the results are given in Table 3 for the two samples separately.

Plates 22 to 25 are supposed to differentially classify the total colour blind, red blind, green blind, and normal or incomplete red-green blind subjects. For these plates, frequency tables were prepared for three sets of responses : first, total colour blind, second, red blind, green blind, and normal or incomplete red-green blind, and third, other responses. Similarly, subjects were classified into three groups : normal or red-green colour blind, including red or green blind ; total colour blind ; and colour deficient. The frequency table, with its "right" and wrong" cells, which was designed was as follows :

Test Diagnosis	Frequency of Item Response			
		Normal or Red-green Blind	Total Colour Blind	Other
Normal or Red-green Blind	...	" Right "	" Wrong "	" Wrong "
Total Colour Blind	...	" Wrong "	" Right "	" Wrong "
Colour Deficient	...	" Wrong "	" Wrong "	" Wrong "

Percentage wrong was computed in the same way as above. The data are summarised in Table 4 for the two samples separately.

For each subject, the total number of each type of response (in columns 2 to 10 of the record form) had been computed to make the original diagnosis. To obtain the average response pattern for the different classes of colour vision, frequency distributions were prepared, one for each column of the record form and each class of colour vision. The means of these frequency distributions were computed, which gave the average total on the nine columns for each of the classes of colour vision. Table 5 gives the means for the two samples of subjects separately.

Discussion

The practical necessity for a test of colour vision which accurately but economically screens colour defective from normal individuals and which classifies individuals according to the type of defect has led to the development of a wide variety of colour vision tests. Pseudo-isochromatic tests, consisting of plates of apparently equally-coloured dots, present patterns which are supposed to appear differently to persons with normal and defective colour vision. Probably the most widely used test of colour vision, the Ishihara test (3), is based on the pseudo-isochromatic principle. Research on the Ishihara test in the past has suggested that (i) the plates are individually unreliable (5) ; (ii) the test is effective for screening colour defectives, particularly dichromats and monochromats (4) ; and (iii) different types of colour defect cannot be distinguished by the test (4). As detailed data have not been presented for the separate plates of the Ishihara test, nor the response patterns typical of different classes of colour vision, the present study was undertaken.

Considering first the broad classification of individuals into two classes : normal and colour blind, the effectiveness of the individual plates may be examined. Table 2 presents the percentage of wrong classification for Plates 2 to 17. Rather than combine the data from the two samples of subjects the results have been separately computed and presented. In this way it is possible to see whether the two independent samples have given similar estimates. Table 2 shows that Plates 2, 3, 4, 5, 8, 10, 11, 15 and 16 are consistently superior to the remaining plates in the table. While they do not achieve perfect classification, in terms of the overall test diagnosis, they are clearly superior to Plates 6, 7, 9, 12, 13 and 14 which are wrong in more than 20% of the cases. Plate 9 is particularly unreliable, misclassifying 67% and 70% respectively in the two samples. Suggesting a short and more accurate version of the Ishihara test, Pickford (5) has selected Plates 10, 11, 14 and 15 from among the first seventeen. His work was carried out, however, on the 8th edition, and differences in results from those of this study may have been due to printing errors. From this study, it would appear that nine plates out of the first sixteen would be sufficient for purposes of broad classification.

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The broad classification of individuals as red-green colour blind on the one hand, and normal or total colour blind on the other, is tested in Plates 18 to 21. Examination of Table 3 shows that in this study, none of these plates were satisfactory. Pickford (5) had recommended only Plate 18 of this series. Differential diagnosis is attempted by Plates 22 to 25. For the present analysis, the effectiveness of these plates in classifying individuals as normal or dichromatic, as opposed to monochromatic, was examined. Individuals classified as colour deficient were also treated separately, as they did not fall into these two classes of colour defect. Study of Table 4 reveals that, for this broader classification, Plates 22 to 25 are reasonably successful, and none need be rejected.

Empirical determination of the degree of wrong classification by individual Ishihara Plates has shown that, while none are perfect, for purposes of broad classification, thirteen (Plates 2, 3, 4, 5, 8, 10, 11, 15, 16, 22, 23, 24 and 25) were considerably more accurate than the remaining eleven. It is suggested that, in future studies, classification be made on the basis of these thirteen plates.

The response patterns typical of different categories of colour vision may also provide insight into the diagnostic efficiency of the test. Table 5 presents the mean number of responses of each type (e.g., normal, red-green blind) for four different categories : normal, red-green blind, total colour blind, and colour deficient. Due to the small number of cases in the latter three categories, the results may not be as representative as those of the first category. There is a fair amount of similarity, however, between the patterns of all categories for the two independent samples. The patterns obtained for the normal, red-green blind, and total colour blind categories are in agreement with the diagnostic scoring key which was employed ; and suggest that the patterning of response does somehow provide accurate diagnosis despite the unreliability of individual plates. The pattern for the colour deficient category has a high proportion of normal responses, though less than that of normals *per se*, and also of responses divergent from the scoring key, which suggests that

these individuals may be anomalous trichromats. Studies of the colour matches made by such individuals might reveal whether, in fact, they are anomalous trichromats.

Concluding from these results, it may be said that, while individual test plates of the 11th edition of the Ishihara test are unreliable, the response patterns do possess diagnostic significance. Using a selection of the plates, more accurate classification may be possible for use by industry and other organisations for proper placement of colour defective individuals.

Summary

1. Responses were recorded to individual plates of the 11th edition of the Ishihara test from two samples of male adults, respectively 194 and 177 in size.

2. In terms of overall test diagnosis, responses to individual test plates were analysed to determine the percentage of wrong classification. Thirteen plates (2, 3, 4, 5, 8, 10, 11, 15, 16, 22, 23, 24 and 25) were found to be more reliable than the remaining eleven.

3. Average response patterns were obtained for the different categories of colour vision. The results confirmed the use of the test for broad screening into three categories : normal, red-green blind, and total colour blind.

Acknowledgments

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TABLE 1
COLOUR VISION RECORD FORM
Examination : Ishiharas' Tests for Colour Blindness, 11th Revised Edition
Japan : Kanehara Suhppan Co., Ltd., 1954 (Plates 1-25)

Sex = Male
Female

1.1 Name..... 1.3 Examination Sl. No.....
1.2 Local address..... 1.4 Date.....
(Street and city).
District.....State..... 1.5 Signature of investigator.....

Plate num- ber	Nor- mal res- ponse	Red green blind res- ponse	Total colour blind res- ponse	Red- green or total colour blind	Normal or total colour blind	Red blind	Green blind	Normal or in- complete red- green build	Other res- ponse	Com- ments
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1	...	...	...	...	...	...	...	...	...	...
2	8	3	C.R.	...	...	...	...	...	...	...
3	6	5	C.R.	...	...	...	...	...	...	...
4	29	70	C.R.	...	...	...	...	...	...	...
5	57	35	C.R.	...	...	...	...	...	...	...
6	5	2	C.R.	...	...	...	...	...	...	...
7	3	5	C.R.	...	...	...	...	...	...	...
8	15	17	C.R.	...	...	...	...	...	...	...
9	74	21	C.R.	...	...	...	...	...	...	...
10	2	...	...	C.R.	...	...	...	...	...	...
11	6	...	...	C.R.	...	...	...	...	...	...
12	97	...	...	C.R.	...	...	...	...	...	...
13	45	...	...	C.R.	...	...	...	...	...	...
14	5	...	...	C.R.	...	...	...	...	...	...
15	7	...	...	C.R.	...	...	...	...	...	...
16	16	...	...	C.R.	...	...	...	...	...	...
17	73	...	...	C.R.	...	...	...	...	...	...
18	...	5	...	...	C.R.	...	...	...	...	...
19	...	2	...	...	C.R.	...	...	...	...	...
20	...	45	...	...	C.R.	...	...	...	...	...
21	...	73	...	...	C.R.	...	...	...	...	...
22	...	...	C.R.	...	...	6	2	26	...	...
23	...	...	C.R.	...	...	2	4	42	...	...
24	...	...	C.R.	...	...	5	3	35	...	...
25	...	...	C.R.	...	...	6	9	96	...	...
Col. Total										

NOTE : C. R. Stands for " Can't Read "

TABLE 2
Normal vs. Colour Blind Classification for Plates 2 to 17 :
Item Frequency Tables and Percentage of Wrong Classification

Plate Number.	Test Diagnosis		Sample 1			Sample 2		
			Frequency of Item Response		Percentage Wrong	Frequency of Item Response		Percentage Wrong
			Normal	Colour blind		Normal	Colour blind	
(1)	(2)		(3)	(4)	(5)	(6)	(7)	(8)
2	Normal	...	166	0	12.37	153	0	9.61
	Colour Blind	...	24	4		17	7	
3	Normal	...	166	0	11.86	152	1	11.30
	Colour Blind	...	23	5		19	5	
4	Normal	...	148	18	13.92	136	17	12.99
	Colour Blind	...	9	19		6	18	
5	Normal	...	165	1	10.31	50	3	7.91
	Colour Blind	...	19	9		11	13	
6	Normal	...	101	65	33.51	90	63	37.29
	Colour Blind	...	0	28		3	21	
7	Normal	...	140	26	19.07	103	50	32.77
	Colour Blind	...	11	17		8	16	
8	Normal	...	161	5	9.79	144	9	9.61
	Colour Blind	...	14	14		8	16	
9	Normal	...	31	135	70.10	35	118	67.23
	Colour Blind	...	1	27		1	23	
10	Normal	...	155	11	10.83	143	10	11.30
	Colour Blind	...	10	18		10	14	
11	Normal	...	157	9	9.79	146	7	9.04
	Colour Blind	...	10	18		9	15	
12	Normal	...	117	49	25.26	103	50	31.07
	Colour Blind	...	0	28		5	19	
13	Normal	...	138	28	18.56	122	31	19.77
	Colour Blind	...	8	20		4	20	
14	Normal	...	138	28	18.56	122	31	19.77
	Colour Blind	...	8	20		4	20	
15	Normal	...	166	0	10.31	151	2	9.04
	Colour Blind	...	20	8		14	10	
16	Normal	...	159	7	9.28	146	7	8.48
	Colour Blind	...	11	17		8	16	
17	Normal	...	132	34	21.65	122	31	19.21
	Colour Blind	...	8	20		3	21	

TABLE 3
Normal and Total Colour Blind vs Red-Green Blind Classification for Plates 18 to 21 :
Item Frequency Tables and Percentage of Wrong Classification

Plate Number	Test diagnosis	Sample 1				Sample 2			
		Frequency of item response				Frequency of item response			
		Red-green Blind	Normal or Total Colour Blind	Other	Percentage Wrong	Red-green Blind	Normal or Total Colour Blind	Other	Percentage Wrong
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
18	Normal or Total Colour Blind.	69	90	9	50.00	47	100	11	39.55
	Red-Green Blind.	7	0	0		7	0	0	
	Colour Deficient.	11	8	0		9	3	0	
19	Normal or Total Colour Blind.	56	83	29	55.67	30	107	21	37.29
	Red-Green Blind.	3	2	2		4	0	3	
	Colour Deficient.	8	6	5		4	3	5	
20	Normal or Total Colour Blind.	59	81	28	54.64	29	95	34	42.94
	Red-Green Blind.	7	0	0		6	2	0	
	Colour Deficient.	9	9	1		8	3	1	
21	Normal or Total Colour Blind.	18	114	36	39.69	4	122	32	28.81
	Red-Green Blind.	3	1	3		4	1	2	
	Colour Deficient.	4	7	8		2	4	6	

TABLE 4
Normal and Red-Green Blind vs. Total Colour Blind Classification for Plates 22 to 25 :
Item Frequency Tables and Percentage of Wrong Classification

Plate number	Test diagnosis	Sample 1				Sample 2			
		Frequency of item response				Frequency of item response			
		Normal or Red-Green Blind	Total Colour Blind	Other	Percentage Wrong	Normal or Red-Green Blind	Total Colour Blind	Other	Percentage Wrong
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
22	Normal or Red-Green Blind.	164	3	6	14.95	154	1	5	12.43
	Total Colour Blind.	1	1	0		4	1	0	
	Colour Deficient.	13	0	6		10	0	2	
23	Normal or Red-Green Blind.	168	3	2	12.89	157	1	2	10.73
	Total Colour Blind.	1	1	0		4	1	0	
	Colour Deficient.	19	0	0		10	0	2	
24	Normal or Red-Green Blind.	167	2	4	13.40	155	2	3	12.43
	Total Colour Blind.	1	1	0		5	0	0	
	Colour Deficient.	16	0	3		11	1	0	
25	Normal or Red-Green Blind.	170	2	1	11.86	157	1	2	11.30
	Total Colour Blind.	0	1	1		4	0	1	
	Colour Deficient.	18	0	1		10	1	1	

TABLE 5
Average Response Pattern for Different Classes of Colour Vision

Col. number	Type of Response	Diagnosis							
		Normal		Red-Green Blind		Total Colour Blind		Colour Deficient	
		Sam-ple 1	Sam-ple 2	Sam-ple 1	Sam-ple 2	Sam-ple 1	Sam-ple 2	Sam-ple 1	Sam-ple 2
	n*	No. 166 (3)	No. 153 (4)	No. 7 (5)	No. 4 (6)	No. 2 (7)	No. 5 (8)	No. 19 (9)	No. 12 (10)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
2	Normal.	13.66	13.25	2.14	2.00	3.00	4.60	8.68	8.42
3	Red-Green Blind.	1.57	1.06	6.86	8.25	2.50	1.40	2.32	2.83
4	Total Colour Blind.	.22	.28	1.86	1.50	5.00	3.20	.84	1.33
5	Red-Green or Total Colour Blind.	.11	.18	7.14	7.00	7.50	6.40	1.37	1.33
6	Normal or Total Colour Blind.	2.20	2.67	.43	0	2.00	3.00	1.58	.58
7	Red Blind.	0	0	0	.50	0	0	0	0
8	Green Blind.	0	0	1.00	1.00	0	0	0	0
9	Normal or Incomplete Red-Green Blind.	3.96	3.96	1.14	0.50	1.50	2.60	3.53	3.42
10	Other Response.	2.28	2.35	3.29	2.25	2.50	1.40	3.79	4.50

n* = Number of subjects.

Origin of Sociometric Rejection

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Among the important aspects of the structure of a group are internal conflict, hostility and rejection. There have been many studies in recent years which throw light on their origin and nature. There is variety in terminology, no doubt, because of the variety of interests in the field. But there is also some consensus of opinion. Such impression is given by the studies of Schachter, Back and others (1, 3, 15, 16). However, there appear to be two basically different approaches to the problem. The difference has not been recognized, if noticed at all, probably because it is difficult to isolate the phenomena of rejection from the general body of hypotheses and verified theory of the group-process; and also, probably, the assumption of multiple causation, so frequently met with in the field of behaviour has made many investigators overlook this discrepancy. It will be fruitful, however, to recognize and analyse the differences and, if possible, to seek an integration of the two. That is the aim of this paper.

According to the first of these two conceptions, conflict and rejection in the group is a direct result of experiences of the individual members. The explanation is anchored in the individual; it is a variant of the frustration-aggression hypothesis.

Working in a group entails frustration for the individual, in so far as the group goals do not satisfy the needs of all the members equally well, nor do they meet all the needs of the members. Even in the field of means employed there is a possibility of frustration. The individual is subjected to a restriction of the "field of free movement" (10). There is a "need for autonomy" which is frustrated (18). There will be frustration if this need persists; but not if this is given up (11, p. 501). The members' space of free movement is determined by many aspects of the group, such as the physical and material limitations, the kind of leadership, the personalities, needs and perceptions of members as well as their culturally conditioned orientation toward the face-to-face group situation.

Among the studies that utilise this kind of explanation, the study of Lewin, Lippitt and White (10) is most illustrative. The investigation of J.R.P. French (8) is also relevant in this connection. M. E. Wright (19) arrives at slightly different conclusions; but he also offers an explanation for conflict that is anchored in the individual. In a more recent study, Crossack (4) gives another explanation, but this is again rooted in individual psychology.

Intra-group aggression appears to have other characteristics that can be explained by the frustration-aggression hypothesis. For example, frustration arising in the group situation can be channelised in many ways. It may be expressed against other members or the leader or an outside group or against the material

equipment, against the experimenter or even against psychologists in general (8, 15). Aggression can also be completely or temporarily suppressed (10).

Another feature further supporting this view has come to light recently. This is concerned with the cathartic value of substitute activities in reducing inter-personal aggression. If hostile communication is permitted, then the level of hostility in the group is reduced (17). Evidence is also available to indicate that the catharsis of hostility increases the attractiveness of a team toward which hostility was directed (14, p. 199).

The second approach to this problem is the social control or the deviation-rejection hypothesis. Roughly, it can be stated as follows: all groups in the course of some work or merely in course of time, develop norms or standards or expectations along certain dimensions of behaviour. Subsequently, any deviation of members from these norms is resented, and deviating members are subjected to various kinds of pressure, including rejection. Sociometric rejection and expression of hostility are conceived as parts of the group process. For the purpose of group locomotion or as a reference point in social reality, there is a pressure in the group toward uniformity in opinion and conduct (6, p. 191), and rejection is one of the mechanisms which will enforce it. Rejection may produce uniformity within the group in three ways: (1) the threat of rejection may function as a deterrent to deviation; (2) actual rejection may function as a punishment for deviation; and (3) through rejection the deviate is refused group membership; and this makes the rest of the group uniform. "Dissident elements—individual or sub-groups—may be forced out of the group altogether, thus achieving more harmony within the group." (9, p. 395).

This approach, tracing its origin to the group-norm studies of Sheriff and others, has found more or less general favour with most of the recent workers in the field. As we shall see later, certain circumstances in which the relationship does not show itself have been recognised. Certain variables in the group situation which will govern the relationship have been identified. But the deviation-rejection hypothesis, in its basic outline, has found universal approval. The classical study of Schachter (16) is a very good example of this line of thinking. The more recent study of Berkowitz and Howard (3) echoes the same results, although the deviation-rejection relationship is demonstrated to be regulated through member's *affiliation need*.

The implications of this hypothesis are many and some have been experimentally verified. For example, more cohesive the group more intense the rejection of the deviate; more relevant the issue on which deviation is shown, the more intense the rejection (16).

Thus, in recent literature, we have two hypotheses regarding origin of hostile relations between members of a group, both of which have been fruitfully employed in experimental studies. There does not appear to be any study expressly designed to examine their relative merits.

There are two ways to explore this question. (1) We can investigate the motivation of the rejectors. This can be done by a follow-up of the sociometric rejection

study. (2) The other method is to study conditions under which rejection increases or decreases ; that is, its relation to type of group structure. The origin of rejection might be to some extent understood by the way groups with different structure respond to the sociometric test. The data given here, from a sociometric study of two groups, one co-operative and the other competitive, might help us to answer our problem.¹

The subjects were free to make as many rejections as they liked on each of the three criteria used in the sociometric test. Tables 1 and 2 give the average number of rejections actually exercised in the co-operative and competitive groups in the pre- and post-experimental tests.

TABLE 1
Average number of rejections made

Group	Pre-experimental	Post-experimental	t*
Co-operative ...	2.0	3.1	1.79
Competitive ...	1.8	1.7	0.31
Control ...	2.3	2.1	0.55

TABLE 2
Average number of persons rejected

Group	Pre-experimental	Post-experimental	t*
Co-operative ...	1.80	2.00	0.717
Competitive ...	1.77	1.07	1.25
Control ...	1.76	1.50	1.95

The difference can be explained on the basis of higher inter-dependence of members in the co-operative group leading to frustration and its expression in the form of rejection ; it can also be explained on the basis of greater pressure toward uniformity which will result in stronger rejection of deviates. Thus the number of rejections fails to help us choose between the two hypotheses. A close study of distribution of rejection-scores among the various members is found to be more suggestive. For this purpose, let us first examine the distribution of rejections expected according to the two theories.

(a) If sociometric rejection is an expression of frustration of the members in the group situation, no particular member is responsible for this frustration ; therefore, the reaction to frustration in the form of rejection does not have any particular single direction. It can be expressed toward any member. If all the

¹ The study was made at the University of Mysore, under the guidance of Mr. M. Abdul Hafeez ; see also (5).

* t for correlated means—significant at .01 and .05 levels ; 2.977 and 2.145.

members are frustrated to some degree and if all of them react to it by showing aggression in different directions, the resulting distribution of rejection-scores will be very uniform and have low variability.

(b) On the other hand if rejection is not an expression of tension within the persons, but is a form of pressure on the members deviating from the group norm, we expect a different form of distribution. Since in a group there can be only a few deviates, all rejections are concentrated on this small number of members ; others are relatively free from rejection. Thus we expect higher variability in rejection-scores. See Table 3.

TABLE 3
Standard Deviation of rejections scores (persons)

Group	Pre-experimental	Post-experimental	F*
Co-operative ...	1.046	2.121	4.134
Competitive ...	1.075	0.814	1.744
F* ...	1.056	6.827	...

The variability of rejection scores increases in the co-operative group. The S.D. of the rejection scores in the post-experimental test of the co-operative group is significantly higher than that of the competitive group ($p < .01$). This difference was not significant on the pre-experimental test.

Thus, there is a tendency for sociometric rejection in the post-experimental test in the co-operative group to concentrate on one or two individuals. Such a tendency is not present in the competitive group. The rejection pattern of the co-operative group appears to agree with the deduction made above from the deviation-rejection hypothesis rather than with the frustration-expression theory. As for the competitive group, it is possible that the rejection pattern follows the frustration-aggression hypothesis. It is also possible that the rejection pattern is caused by a chance distribution—the characteristics of the recipient of rejection not being group relevant. There is some data to suggest that the distribution of rejection-scores in the competitive group in the post-experimental test, agrees somewhat closely with the normal distribution. This is indicated in Table 4 showing the skewness of the rejection distributions.

TABLE 4
Skewness of rejection-scores

Group	Pre-experimental	Post-experimental
Co-operative ...	+ 0.622	+ 1.060
Competitive ...	+ 0.988	+ 0.062

* F. Significant at .01 level ($df_1 = df_2 = 14$) is 3.80.

Further evidence strongly suggesting that deviation is the basis of rejection is found in the sociograms. The sociograms are based on rejections obtained using three criteria ; rejection between two members could be on one, two or three criteria. In the sociograms no distinction is made among these because the interest is in the number and distribution of negative links.

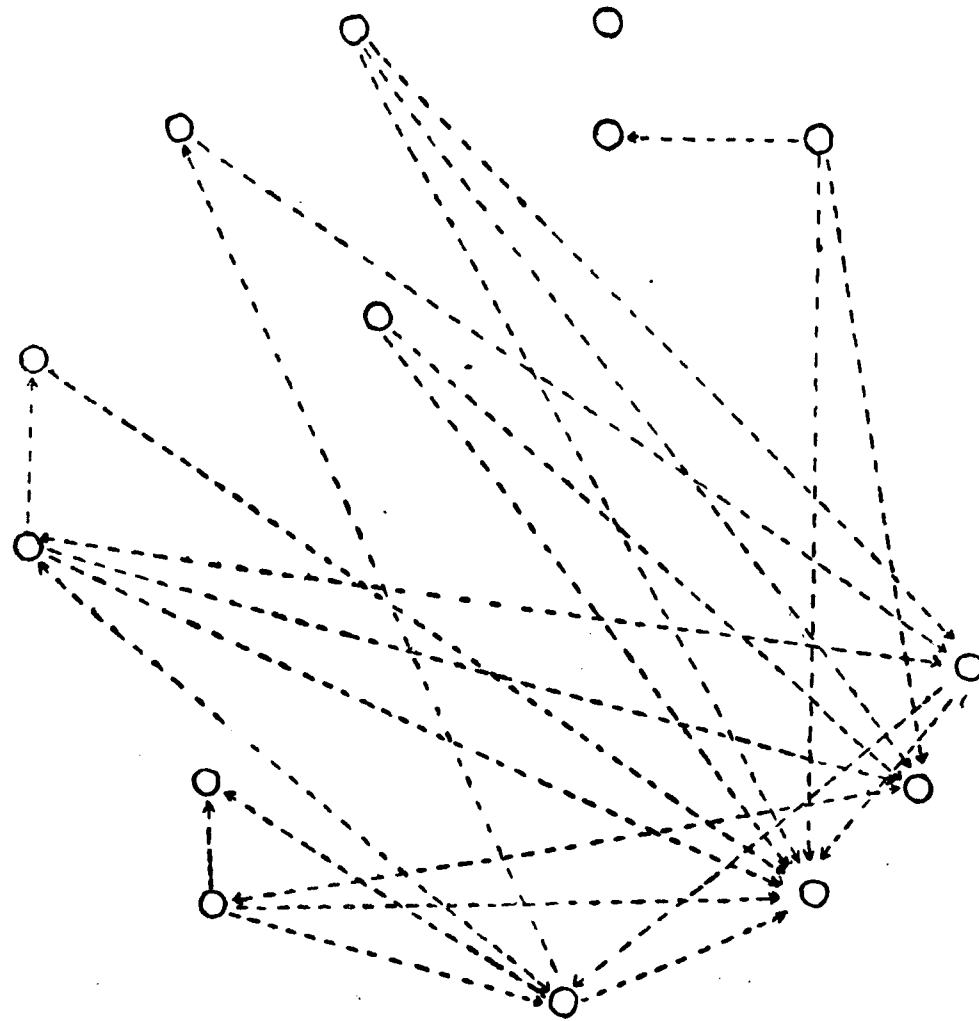


FIG.1. SOCIO METRIC REJECTION
POST-EXPERIMENTAL TEST;
CO-OPERATIVE GROUP

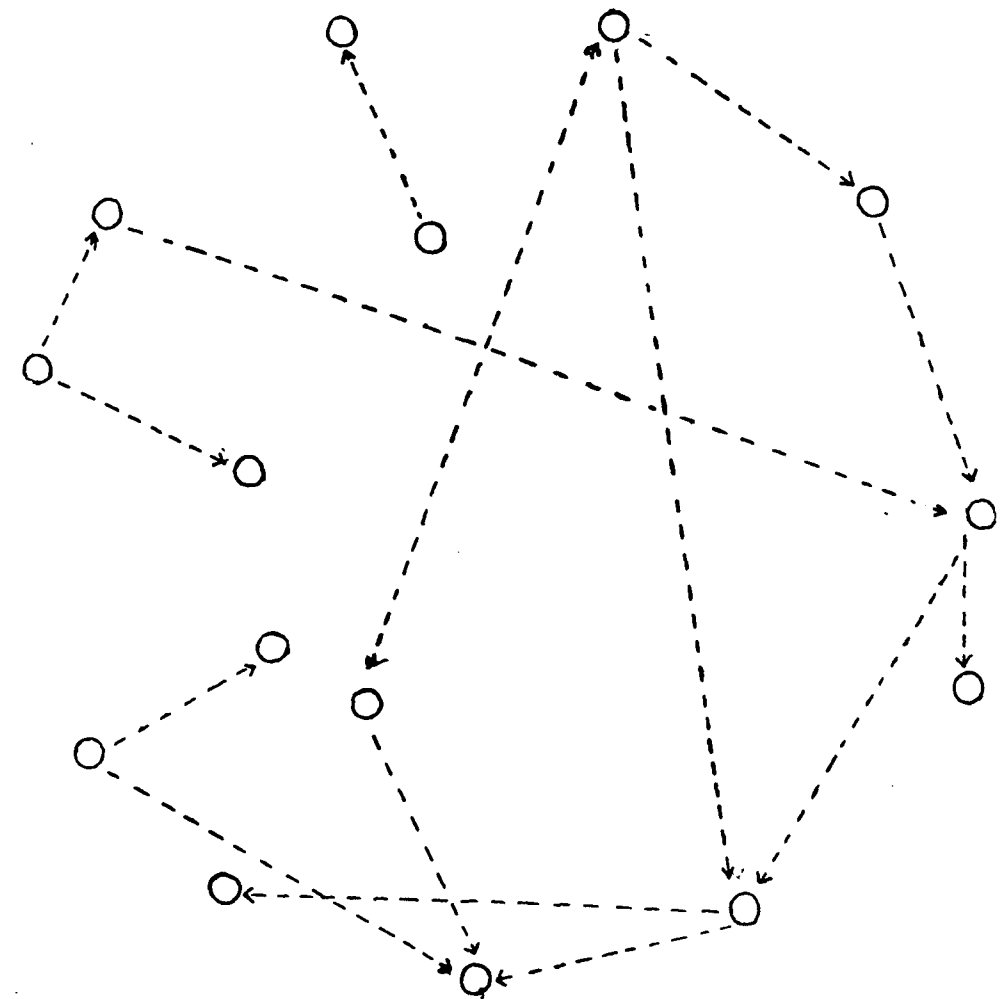


FIG.2. SOCIO METRIC REJECTION
POST-EXPERIMENTAL TEST;
COMPETITIVE GROUP

It can be seen readily that in the co-operative group there are two members who receive a large portion of the rejection. They are the deviates and very probably, the group is trying to rid itself of deviation by rejecting them.

The deviation-rejection hypothesis is, therefore, assumed to be supported by our data for the co-operative group. The competitive group which in our experiment tended toward the individualistic (cf 12, p. x), does not conform to this pattern. This would suggest that the group must have a minimum of cohesiveness or co-operativeness before the deviation-rejection relationship operates.

There are a few difficulties in the way of drawing definite general conclusions on the basis of the above analysis. In the first place, the above evidence at best is indirect, as the study was not specifically designed for this purpose. Secondly, the concentration of rejection might also have been a scape-goat phenomenon. The two star-rejectees may not be deviates, but victims of concerted expression of aggression arising out of frustrations of the various members. This is one of the expedients in tension-reduction (9, p. 396).

Finally, the deviation-rejection relationship is mediated by certain other variables in the group situation. "It is possible that not all groups reject (the deviate) to the same degree and that rejection is a consequence of deviation on only certain kinds of issues," (16 p. 191). The group may attempt to influence the deviate (7). This pressure is specially likely to be expressed in the form of rejection under certain situations, for example, "relatively little dependence on a person and at the same time, relatively high pressure to change him" (16, p. 197). In other words, the position of the deviate in the structure of the group will determine the likelihood of his being rejected. Similarly, the affiliation need of a member will determine whether he will reject the deviate or try to influence him (18).

Before concluding, we may take note of another recent line of thought (2). If a person likes the members of a group, he may also develop a liking for the opinion or norm held by the group. Conversely, if he dislikes the opinion held by a member or by a sub-group, he is likely to dislike the member or the sub-group. This theory with a perceptual orientation is a modification of Newcomb's principle of strain toward symmetry in the social situation (13).

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An Investigation of Depressive Character-Traits and Symptoms in Adult Neurotics

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1. Introduction

It is the purpose of this research to investigate certain manifestations of depressive character traits and symptoms in a clinically neurotic sample of patients. Clinical analysis of neurotic patients (Freud 1909, Fenichel 1945) has revealed that a patient complaining of only a few symptoms shows upon closer examination a deeper and more widespread disturbance of his personality than that indicated by the presenting symptoms. Thus, for example, Freud's "Rat-Man" came for consultation complaining of only two prominent symptoms; namely (a) Fear that something might happen to his father and to his lady-love and (b) an almost irresistible impulse to cut his throat with a razor. However, when analysed, he proved to be a case of well-developed obsessional neurosis. In clinical practice, neurotic patients are often given such diagnostic labels as hysteria, neurasthenia, depression, etc., even though there is no exact agreement on the meaning of the concepts used. Thus, two patients complaining of different symptoms (for example, one complaining that he wakes up very early in the morning and worries about a lot of things, and the other complaining that thoughts of taking his own life sometimes cross his mind), may be classified clinically into the same group and labelled 'depressive.' It is implied by this that certain depressions can be grouped together under one heading and that the etiology or pathology of any of them is the same as that of any of the others in the group.

This study is an attempt to determine, using a psychological test and statistical methods, an underlying order in statements which neurotic patients have made about themselves and to see whether in fact depressive symptoms and character-traits are independent of one another or whether they group themselves into a clinically meaningful pattern or set of patterns.

2. Aim and method of investigation

(A) *Aim*: The specific aim of this study is to discover (1) whether the depressive behaviour pattern is a complex of traits or whether it is a simple trait or dimension containing a single common general factor. (2) Whether, if one general factor is insufficient to account for the observed inter-relationships between the various traits and symptoms, these traits and symptoms can be classified according to a division between symptoms on the one hand and character traits on the other. In other words, do the symptoms form one 'cluster' and the character-traits another?

The investigation reported was carried out at the Tavistock Clinic, London, and the author is grateful to the director, for all the facilities provided.

(B) *Method*: In most of the studies of depression, the initial material consists for the most part of statements made by patients about themselves. These statements might be responses to direct questions or the spontaneous utterances or free associations made by patients in the clinical interview. The raw material used in this research consists of the responses of 100 neurotic patients to items of a comprehensive psychiatric Inventory known as the Tavistock Self-Assessment Inventory.

The Tavistock Self-Assessment Inventory (Sandler 1954 *m*) developed at the Tavistock Clinic, London, both as a clinical diagnostic instrument as well as a research tool contains 876 items. Of these, 42 items relating to depressive character-traits and symptoms were selected on an *a priori* basis as referring to phenomena which can be labelled 'depressive.' These forty-two items, hereafter to be called the test items, are listed below in Table 1.

TABLE 1

The 42 Test Items

1.	9	I sometimes fail to cope with simple tasks which others seem to do easily.
2.	I. 12	I often feel that I am an unhappy person.
3.	I. 40	I sometimes have to put thoughts of death out of my mind.
4.	I. 52	It is harder for me to be cheerful than it is for most people.
5.	I. 81	I usually think of my own death when someone I know dies.
6.	I. 82	I find it difficult to have any sort of pleasurable feeling.
7.	II. 17	My mind dwells a good deal on death.
8.	II. 59	I sometimes contemplate taking my own life.
9.	II. 65	I believe that success depends more upon good luck than on hard work.
10.	II. 101	I believe that to be hopeful about things just lays one open to disappointment.
11.	II. 106	I have a feeling that some part of me is wicked.
12.	II. 148	I feel, I never get what I really want.
13.	III. 2	I usually feel that life is full of misery, pain, hardship and very little else besides.
14.	III. 3	I cannot seem to get any satisfaction out of the things I do.
15.	III. 7	I feel that success and failure seem to alternate in my life.
16.	III. 31	I feel lonely most of the time even if there are people about me.

17. III. 49 I believe that the more one wants something the less one gets it.
18. III. 53 I feel, I have no real friends.
19. III. 75 I find it difficult to lead a happy life because of mental conflict.
20. III. 103 There are times when I feel that life is just not worth living.
21. IV. 1 Sometimes I feel so depressed that thinking is difficult.
22. IV. 3 Thoughts of taking my own life sometimes cross my mind.
23. IV. 13 I consider that I am unsuccessful in my work.
24. IV. 17 I feel frustrated because I cannot make my life what I want it to be.
25. IV. 51 I feel I am a bad person.
26. IV. 85 I sometimes weep or cry without any real cause.
27. IV. 120 Sometimes I feel I were dead.
28. IV. 121 I sometimes feel that my conscience is not as strong as it ought to be.
29. IV. 148 I always seem to be having bad luck.
30. V. 12 Others have little or no idea of how much I suffer.
31. V. 27 I feel that I do not live up to the standards of my own conscience.
32. V. 31 I believe it is no use trying to go against one's destiny or fate.
33. V. 47 I believe that the world may come to an end soon.
34. V. 74 I feel depressed today.
35. V. 101 I sometimes get depressed, because I feel I have done wrong.
36. VI. 8 I am sometimes depressed, sometimes happy without any apparent reason.
37. VI. 24 I sometimes feel without knowing why that something terrible is going to happen.
38. VI. 62 Sometimes, I feel just miserable.
39. VI. 83 I feel that I have never been given a real chance in life.
40. VI. 85 I sometimes picture myself dead.
41. VI. 98 There are times when I feel that in some ways I enjoy being depressed.
42. VI. 116 I sometimes get a feeling of impending death.

(C) *Subjects* : Hundred patients, 50 men and 50 women, have been used in this study. They were all neurotics in the sense that each one had some sort of a psychological problem. These adult patients were referred to the Tavistock Clinic either by a general medical practitioner or by some social agency. The Tavistock Clinic is an out-patient clinic which admits for diagnosis and treatment patients suffering mainly from the various psychoneuroses. On this basis, it can be assumed that the population under investigation was composed of adult neurotics, although the possibility that some suffered from psychosis cannot be excluded. The ages of these patients ranged from 16 to 54, with a mean age of 30 years.

(D) *Method of Test-Administration* : The self-assessment inventory printed in six booklets was administered to the patients coming to the Tavistock Clinic, in groups of about 6-8 patients. Certain precautions were taken to motivate the patients to answer each item of the inventory as accurately and truthfully as possible. An attempt was made to show the patients how the inventory was related to their attendance at the clinic and to their motives for attending. They were told explicitly that their answers to the items of the inventory would be useful for the doctor in the diagnosis and treatment of their illness. Against each item of the inventory the letters T and F were printed. An empty space was also left to the right of the letter F. Each patient was instructed to underline T if the statement concerned was true as applied to him, to underline F, if it was false as applied to him and to put a question mark in the empty space, if he had difficulty about his answer.

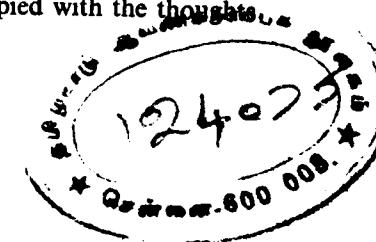
(E) *Method of scoring* : If on the answer sheet, against the number of each item, only the letter T was marked, it was scored as one. If T was marked as indicated above, and a question mark was also put in the blank space, this was also scored as one. Any other kind of marking or even no marking at all, was scored as zero.

3. Results

(A) *Statistical Procedure* : The forty-two test items were inter-correlated (in respect of answers made to each of them by the 100 patients) using phi coefficients. This gave a 42×42 . Correlation matrix. Thurstone's (1947) Centroid Method of factor analysis was applied to reduce the 42 items to a smaller number of common factors. After two factors* were extracted, it was decided to stop factoring at this point. Further trials at factoring provided relatively small factors and the difficulty in obtaining a positive residual matrix was considerable. It is probable that further factors can be extracted, but as a broad classification was obtained through the extraction of two factors, factor analysis was stopped at this point.

(B) *The two factors* : Factor I was a general factor accounting for 20.43% of the total variance. It was identified as a general factor of depression, representing a general tendency in the neurotic patients to show depressed and dejected mood ; to feel that life is full of unhappiness, misery, pain, hardships, sufferings, failures, disappointments and is not worth living, and to remain occupied with the thoughts of death.

* Factor saturations are given in the appendix.



Factor II was a bipolar factor accounting for 4.5% of the total variance. It was identified as a classifying factor dividing twenty-four items referring to *symptoms* of depression from the remaining eighteen most of which referred to *depressive character-traits*. In this factor, depressive symptoms such as having thoughts to commit suicide, pre-occupation of the mind with the ideas of death, feelings of impending catastrophe etc., are contrasted with depressive character-traits such as dissatisfaction with life, feelings of loneliness, feelings of worthlessness of life etc. The results of the factor analysis have certain bearings on the two hypotheses of this research. The hypothesis that the depressive behaviour pattern is a simple trait or dimension containing a single common general factor can be rejected because one factor was not sufficient to account for all the inter-correlations between the tests and it has been possible to extract a second meaningful factor.

The way in which the items have tended to group in the second factor, *i.e.*, most of the items referring to depressive symptoms forming one group and most of those items referring to depressive character-traits forming another, has supported our second hypothesis, *viz.*, that if one general factor is insufficient to account for the observed inter-relationships between the various traits and symptoms, these traits and symptoms can be classified according to a division between symptoms on the one hand and character-traits on the other.

4. Implications of the factor analysis

The results of the factor analysis have certain important implications. The fact that the forty-two items relating to typical depressive character-traits and symptoms have been found to be positively inter-correlated, and that a general factor underlies them, shows that the individual symptoms and traits of depression do not have a completely separate existence in the population investigated. Where they appear, they will tend to appear together. It follows that a patient who presents himself with a single depressive character-trait or symptom will tend to have others.

The existence of a second factor implies that although depressive symptoms and character-traits are inter-correlated and share together a general factor, there is a tendency for the symptoms of depression to constitute one cluster and for the character-traits to form another. It follows that a patient who has a high tendency to 'general depression' may manifest this either in reactive character traits or symptoms of the type described earlier, or, and this is the most common case, he may show a mixture of the two. It might be possible to describe the two forms of depressive tendency described above as to directions or streams through which the general depressive tendency manifests itself.

5. Summary and conclusions

This research was designed to investigate (a) whether the depressive symptoms and character-traits are independent of one another or whether they group themselves into a clinically meaningful pattern or set of patterns; (b) whether depressive behaviour pattern is a complex of traits or whether it is a simple trait or dimension containing a single common general factor; (c) whether the depressive symptoms

and character-traits can be classified according to a division between symptoms on the one hand and character-traits on the other?

Forty-two items of the Tavistock Self-Assessment Inventory referring to depressive traits and symptoms were inter-correlated during phi coefficients of correlation and factor analysed. Two factors were extracted. Factor I was identified as a general factor of depression. Factor II happened to be a bipolar factor dividing one group of items referring mostly to depressive symptoms from the other group, most of which referred to depressive character-traits.

The following conclusions have been drawn :

- (1) The various depressive character-traits and symptoms are within themselves highly inter-correlated and share together a common general factor.
- (2) The depressive behaviour pattern is not a simple trait or dimension containing a single common general factor, but appears as a complex of traits containing more than one independent factor.
- (3) Although depressive character-traits and symptoms are inter-correlated, two-distinct clusters were identified, the first made up of symptoms, the second of character-traits.
- (4) Depression is virtually a general complaint in neurosis and as such is present to some degree in every neurotic patient in the sample studied.

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APPENDIX

Results of Centroid Analysis

Factor Saturations —				Factor Saturations —			
Item	I	II	h^2	Item	I	II	h^2
1	.562	.249	.439	22	.651	.140	.444
2	.414	— .187	.206	23	.40—	— .159	.188
3	.392	.249	.216	24	.558	.073	.316
4	.388	— .290	.235	25	.265	.076	.076
5	.296	.465	.304	26	.175	— .132	.048
6	.465	— .082	.223	27	.679	.059	.464
7	.480	.226	.281	28	.385	— .031	.149
8	.651	.123	.439	29	.403	— .370	.299
9	.331	— .285	.191	30	.420	— .069	.181
10	.403	— .204	.204	31	.418	— .072	.180
11	.541	.084	.300	32	.228	— .225	.103
12	.631	— .290	.482	33	.227	.184	.086
13	.536	— .200	.327	34	.393	— .233	.208
14	.468	— .430	.404	35	.383	.116	.160
15	.256	.124	.081	36	.205	.075	.048
16	.535	— .179	.318	37	.345	.275	.195
17	.394	— .075	.161	38	.452	.079	.210
18	.479	— .076	.235	39	.480	— .327	.337
19	.537	.132	.035	40	.409	.083	.174
20	.702	.029	.494	41	.470	.290	.308
21	.484	.609	.239	42	.311	.265	.167
h^2			8.580	h^2			10.425
$h^2\%$			20.43	$h^2\%$			24.83

Intelligence and Family Size of Secondary School Pupils in Rajasthan

PRAYAG MEHTA

Various studies have been published showing inverse relationship between intelligence and the size of family. The correlations between family size and tests of intelligence ranged between—.18 to —.23 (Lentz, 1927 ; But, 1946 ; Damrin, 1949 ; Scottish Council, 1953a). The purpose of the present investigation was to study the above for secondary school pupils in Rajasthan.

Procedure

A random stratified sample of about 1,600 secondary pupils between 12–14 years, reading (in year 1956) in school grades VII and above, spreading over 32 schools in various parts of Rajasthan, was obtained. Sociological data, regarding family size occupational class, occupancy rate, etc., were collected through a questionnaire. Mean family size was computed per child. It came to be 5 for every occupational class. The pupils took a verbal group test of intelligence standardised by the author (1954, 1959, 1959a). The maximum test score was 60 with a time limit of 18 minutes. The raw scores were tabulated for each family size for the entire sample, for each of six occupational classes¹ and for the number of earning members in the family. Girls were only few in number ; they were, therefore, not separated. The compact sample, as such, consisting of all three age groups was studied for each family size.

Results

Table 1 records mean test scores by family size. Table 2 shows these when broken down for occupational class.

TABLE 1
Mean Test Score by Family Size

	Family Size									
	1	2	3	4	5	6	7	8	9	10* Total
Mean test score.	33.8	29.3	31.7	29.8	30.0	32.2	30.5	30.2	29.6	28.4 30.3
S.D. ...	10.7	10.9	10.4	9.3	9.4	8.8	9.0	10.6	10.2	7.6 9.2

* The identifying numbers alone would be used to denote the occupational class, hereafter.

1. For discussion regarding occupational class and other sociological data being mentioned in this paper, the reader is referred to an earlier paper by the author (1958) shown in the references.

TABLE 2
Mean Test Score by Family Size for Occupational Class

Occupational class	Family Size									
	1	2	3	4	5	6	7	8	9	10*
1. Professional*	...	41.5	34.7	34.2	36.1	32.6	35.7	28.3	40.5	...
2. Salaried Employees.	35.0	31.2	30.6	34.4	30.7	32.6	30.5	30.2	31.0	26.0
3. Business People.	33.1	28.2	30.3	30.2	32.0	32.9	29.2	31.8	27.0	25.5
4. Skilled Workers.	...	29.7	27.4	30.0	30.1	28.0	29.0	...	...	...
5. Farmers	...	23.8	27.2	25.5	24.3	29.9	27.9	28.0	...	...
6. Unskilled Workers.	...	25.2	25.5	19.5	24.0	30.3	32.0	28.2	...	...

—entries omitted where the number was too small to ascertain the mean test-score.

Inspection of Table 1 suggests no inverse relationship between the mean test-score and the rise in the size of family.

Pupils with family size 2 showed a mean test score of 29.3 whereas it was 32.2 for those with family size 6. A similar trend is revealed by Table 2 where the occupational class is held constant. For instance, with the professional class, pupils with family size 2 showed a mean test score of 34.7 whereas it was 40.5 for those with family size 9. Evidently the behaviour of the mean test scores was quite erratic^a. This was corroborated by the results recorded in Table 3.

TABLE 3
Correlation of Intelligence with Family Size for Occupational Class

	Occupational Class						Total sample
	1	2	3	4	5	6	
N	218	338	536	120	200	68	1480
Product moment correlations.	— .072	— .088	— .020	— .003	— .101	— .187	.005

* The identifying numbers alone would be used to denote the occupational class hereafter.

In view of the above results and the social background of the Rajasthani Pupils (Mehta, 1958), it was decided to control the number of earning members in a family and then study the relationship of intelligence test scores and the size of family. Tables 4, 5 and 6 summarise the relevant results.

TABLE 4
Mean Test Scores by Earning Members

		Number of earning members in the family			
		1	2	3	4
Mean Test Score	...	30.5	29.9	29.4	31.5
S.D.	...	9.0	10.1	9.0	11.0
N.	...	791	420	182	87

TABLE 5
Mean Test Score by Family Size for number of earning members

Earning members in a family	Family Size									
	1	2	3	4	5	6	7	8	9	10*
1	34.0	33.9	32.2	30.6	29.4	32.9	28.6	27.5	26.0	30.5
2	...	34.8	34.6	30.2	29.3	28.9	27.7	26.6	25.5	29.9
3	...	...	33.0	32.6	31.2	29.3	25.3	27.8	26.8	29.4
4	...	...	...	...	...	...	30.7	27.9	...	31.5

—entries omitted where the number was small to ascertain the mean score.

TABLE 6
Correlations of Intelligence with Family Size for Earning Members

	Earning members			
	1	2	3	4
Product moment correlations*	...	— .201	— .221	— .386
				— .276

Table 4 suggests that pupils from families with more earning members did not show better mean test scores. However, the negative trend in the mean scores, as the size of family rises and the earning members are held constant, is visible in Table 5. This was corroborated by the correlations recorded in Table 6. All the correlations were negative and significant at .01 level.

* all significant at .01 level.

2. A vertical inspection of Table 2 reveals interesting results. For each family size, the mean test scores go down for occupational class. This shows the latter's effect on intelligence test scores. This and such other points have been discussed in a separate paper; 'Father's Occupational and Educational Class and Intelligence of Secondary School Pupils,' *Journal of Educational & Vocational Guidance*, August 1959 (in press).

Discussion

The investigator could not find any such published reference or any other study, conducted under Indian conditions, for comparison. The results could be properly understood only in the general context of the social conditions of the State discussed elsewhere (Mehta, 1958). Mostly, children, irrespective of their father's occupation, are nurtured by the values of a joint family system. The general social conditions and the family structure present a picture which is positively dissimilar to that prevailing in the West. In the West, the family is usually unitary, children depending upon the income of their parents. Here, the position was different. Firstly children belonged to families which were comparatively bigger (as compared to the Western Standard) and secondly, some of the earning elder brothers and other relatives were also living with the family and contributing to the upkeep of children. In other words the increase in the size of family did not necessarily mean the lowering of the standard of living. The expenditure per child might not diminish when the size of family went up. It meant, other things being equal, the children from smaller families might not be enjoying better life than those from bigger families. In such a situation the effect of the size of family on the intelligence test scores might not be negative.

The size of family is not an isolated phenomenon. It is inseparably associated with the family structure. The rearing up practice may prove to be an important factor in this regard. This, in turn reflects the cultural differences. Thus, for example, as Murphy remarks, "in many parts of India, a child may be nearly as close to aunts as to its mother" (1953, p. 30). There may be other family members and relatives to look after children and the increase in the size of family may not make much difference in this regard. Then, the elder brothers and sisters also lend a helping hand in bringing up the younger ones. Lois B. Murphy observes about Indian children, that "young boys are quite as apt to care for the baby or a small child as are girls of five years or over" (1953, p. 44). A similar observation was made by Knapen (1958) about the Belgian Congo children. Such rearing up practices and social customs are bound to have their impact on the psychological development of children in many ways. "The development of personality under such conditions will be on different lines as compared with the development of personality in Western culture" (Knapen, 1958 p. 228).

What characteristics of the joint family structure helped the children was not certain. The present data were not sufficient to answer this question. It might be a constant and larger contact with adults or it might be economical. When the earning members were held constant it was more the number of persons rather than income, which was controlled. But, the expenditure per child might not be same for all these groups earning member groups. The expenditure per child in a professional family, specially the expenditure on child's education and such cultural activities, might be more than that in a farmer's or even a business family. The significant differences between mean scores of children belonging to these different classes gave support to this view.³ So as compared to the family's own norm, when the number of earning members is controlled the expenditure per child may

3. *ibid.*

tend to decrease with the rise in the size of family. This may be so whatever the income of the family is. It was perhaps, this economic phenomenon which gave rise to the inverse correlation of size of family with the intelligence test score when the "earning members" were held constant (see Tables 5 and 6).

The negative trends might become more visible in time to come. The State (i.e., Rajasthan) is passing through a transitional period and with progress in industry etc., some type of unitary family system is likely to emerge, at least among the urban "white collar" and industrial workers. In such a case, with rise in a given size of family the expenditure per child might tend to diminish. This may make the inverse relationship, between the family size and intelligence test scores, more prominent. It again, of course, would depend upon many other social factors.

Summary

The paper reports a study of family size and intelligence test scores on a verbal group test for secondary school pupils in Rajasthan. The results revealed no relationship as such. But the mean test scores showed negative trend when the number of earning members in a family was controlled. This suggested the importance of economic factors. The psycho-socio-economic aspects of the problem have been discussed.

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A comparative study of the effect of group pressure on visual estimations with and without reference to actual values of the presented stimuli

BY

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Introduction

In the past three decades of the history of Group Dynamics many experiments of group influence on individual actions and judgments have been reported. The facts gathered from these experiments have not only enriched psychological knowledge, but have also revealed the consequence of various interactional operations between individuals and groups which bear much practical value for social and industrial situations. Two main facts that are apparent from these experimental findings unequivocally corroborate that (i) the group pressure induces some form of psychological change in the situational structure and (ii) the individuals always submit to the group forces.

The pioneer experiments of Asch cast doubt about the unequivocality of the finding (ii) cited above. He is of opinion that generally, for all practical purposes, a large mass of individuals do maintain their independence in daily communicational life. There are, hence, many things to be considered before accepting the position of the "slavish submission of individuals to the group forces." According to him, mere unconditional invariable forms of unified group pressure do not influence the normal individuals. The influence of the group depends upon : (i) the nature of the stimulus (ii) structure of the group forces and (iii) personality of the individuals. Generally, in any situation these factors operate conjointly with varying degrees of education. Experimentally considering each one of the above factors as independent variables, Asch has shown their specific contributions for different interactional operations.

In consideration for the nature of the stimulus, besides their physical attributes, it is hypothesised in the present paper that in various decision-making situations, in group-atmosphere, the stimulus-field itself appears as cues. Isomorphically, if other factors remain invariable, simple group influence does not distort the individuals' evaluation of their surrounding set. In another sense, the stimulus field, in a condition of intellectual set supports maintenance one's individuality as an independent factor even in a situation of maximal group-opposition.

Experimental model

The experimental model is formulated in such a fashion that the *critical subjects* (C.S.) as described by Asch are placed in a situation which is more provocative to

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them to hold a balanced position between a clear majority pressure in the form of opposition and objective support to their own estimations. Generally, in any experimental set-up, the force of the objective support is always greater as it comes from the experimenter. This situation is tackled by adhering closely to probabilistic hypothesis.

Subjects : Ten male students of the post-graduate first year class are introduced into this experimental setting to act as C.Ss. They are of about equal age and educational standard. They have no prior knowledge regarding the nature and purpose of this experiment. Moreover, their sittings for the experiment are arranged in such a manner that there is minimum of possibility of conversation and discussion about this experiment within themselves. •

Twenty more male students of the post-graduate second year class are admitted into this experiment to act as instructed group members. (I.G.M.) They are fully explained about the purpose and intricacies of the present experiment ; also their role and functions are explicitly defined. Finally they are ardently requested not to discuss anything about this experiment.

Of these 20 subjects, 5 groups are formed consisting of 4 members each. At first 5 members of the C.Ss., are introduced separately to the members of the 5 IGs. This introduction is made in such a way that one CS meets with only the 5 members of one IG during the actual experiment.

After having a set of experimental readings, the IGMs are shuffled and a fresh set of 5 groups of 4 members are composed again. They are then introduced to the remaining 5 CSs. as above.

Instrumental Setting : Five electrically operated colour-mixer wheels are placed on a table at a distance of 3 meters from the subjects. On these are mounted black and white discs graduated in degrees and are super-imposed over each other. They are cut radially to make possible to expose required amount of segments of one disc to mix with the other during rotation. Initially these are exposed in the following order :

1st wheel : $0^\circ \text{BK} + 180^\circ \text{W}$; 2nd wheel : $90^\circ \text{BK} + 270^\circ \text{W}$; 3rd wheel : $180^\circ \text{BK} + 180^\circ \text{W}$; 4th wheel : $270^\circ \text{BK} + 90^\circ \text{W}$; 5th wheel : $360^\circ \text{BK} + 0^\circ \text{W}$.

During rotation they appear as different shades of greys according to the proportions of exposures of the black-contents. The subjects are informed of these in percentages as : 0%, 25%, 50%, 75% and 100% mixtures of black respectively.

All through the experiment the 1st and the 5th wheels are fixed as reference points. All others are varied in pre-arranged haphazard order upto the limits of next higher or lesser segments of the exposure wheel. When variations are made in any one wheel all others are kept constant to their initial exposures of black-content. These are conceived as *anchorage points* in the stimulus fields. The subjects are asked to estimate the percentage of black-content of a particular exposure with reference to the known exposed percentages. For example, when ($100^\circ \text{BK} + 260^\circ \text{W}$) is exposed in the 2nd W, the subjects are asked—"What is the percentage

of black in this mixture if the 1st is of 0% and 3rd, 4th, 5th are 50%, 75%, 100% respectively?" In this way varied presentations are made. The estimations are recorded by the CSs themselves to their respective answer-blanks, supplied by the experimenter and in the order of the exposed stimuli.

Experimental Variations: The experiment is conducted according to the following phases:

Phase I. Taking 5 CSs at a time, two initial discussion groups are formed. Each group is separately initiated in the experiment and instructed to estimate the black-contents in percentages as they see the particular exposures in the wheel. Before writing their estimations, they are allowed to discuss about these for $\frac{1}{2}$ mins. Their estimations are tabulated in Table I in accordance with the actual stimulus value of exposures. Respective means, mean variations and standard deviations are calculated for these individual responses.

Table I

Standard Values	5 per cent	10 per cent	15 per cent	20 per cent	25 per cent	30 per cent	35 per cent	40 per cent	45 per cent	50 per cent	
Estimations of the critical subjects (%) without any Group-influence											
Mean	...	5.33	9.30	15.30	19.45	26.60	32.25	33.42	43.92	44.33	47.45
Mean Variation.	0.43	0.70	0.50	0.55	1.60	2.25	1.58	3.92	0.67	2.55	
Standard Devia- tion	...	0.43	0.65	0.53	0.50	1.75	2.55	1.70	3.49	0.77	2.54

Standard Values	55 per cent	60 per cent	65 per cent	70 per cent	75 per cent	80 per cent	85 per cent	90 per cent	95 per cent	100 per cent	
Estimations of the critical subjects (%) without any Group-influence											
Mean	...	53.47	58.49	65.75	68.43	43.45	83.32	84.45	87.32	98.12	98.25
Mean Variation.	1.53	1.51	0.75	1.57	1.55	3.32	1.45	2.68	3.12	1.75	
Standard Devia- tion	...	1.47	1.50	0.77	1.69	1.60	3.37	1.46	2.65	3.22	1.80

As the estimations are free for all practical purposes, they are assumed to obey the normal probability function.

Phase II.—In this phase each of the critical subjects are allocated with 4 other subjects of the I.G. so as to form a small group of 5 members. As stated earlier, the I.G.Ms are to give more or less unanimous judgments following the lead of the first man within the group. The first men of such groups are selected by the experimenter previously. They are instructed to advance incorrect judgments of a particular range for a particular exposure value during the discussion period. Hence the critical subjects participating in these discussions face the unanimous group-pressure of the majority.

After the experiment, a questionnaire is presented to all to record their experiences during the experiment. The answers of the critical subjects are only considered for the subjective evaluation of the situation.

Table II

Standard Values	5 per cent	10 per cent	15 per cent	20 per cent	25 per cent	30 per cent	35 per cent	40 per cent	45 per cent	50 per cent	
Estimations of the critical subjects (%) with Group-influence											
Mean	...	4.30	12.30	19.05	23.55	29.50	24.90	39.60	47.35	46.37	45.40
Mean Variation.	0.70	2.30	4.05	3.55	4.50	5.10	4.60	7.35	1.37	4.60	
Standard Devia- tion	...	0.72	2.45	4.10	3.80	4.55	5.25	4.75	7.44	1.39	4.50

Standard Values	55 per cent	60 per cent	65 per cent	70 per cent	75 per cent	80 per cent	85 per cent	90 per cent	95 per cent	100 per cent	
Estimations of the critical subjects (%) with Group-influence											
Mean	...	58.35	55.40	68.32	71.43	77.45	85.39	89.35	98.32	92.32	90.72
Mean Variation.	3.35	4.60	3.32	1.43	2.45	5.39	4.35	8.32	2.68	9.28	
Standard Devia- tion	...	3.32	4.65	3.47	1.49	2.40	5.50	4.50	8.35	2.70	9.25

The Means, Mean Variations and Standard Deviation in Table II point to the fact that the estimations are not consistent at all: Mean Variation range from 9.25 to 0.72 where the intensity-intervals of the subsequent exposures of the segments are only 5 units apart. It leads to the inference that group pressures distort individual estimations. The responses from the questionnaire corroborate this conclusion subjectively.

Phase III.—In this phase the procedure of Phase II is repeated with the change-over for the critical subjects to other members of the I.Gs. Here, after recording 2/3 estimation like Phase II, the values of the exposed stimuli at that time are announced by the experimenter without any reference that they are correct ones before the beginning of the $\frac{1}{2}$ min. discussion.

This procedure is undertaken on the apprehension that if the experimenter tells that those are really correct values, it might have provoked the critical subjects to shift their concentrations to the exposures only, ignoring the real situations of the estimations within the group. Further it might have lead the critical subjects to refuse bluntly to pay heed to the group opinions and thereby evading all experimental controls.

To control the critical subjects further, the I.G.Ms. in this situation are particularly asked to respond *naturally* to about 50 per cent of the presentations of the stimuli. Here the experimental situation becomes exactly like Phase I. It is assumed that this procedure helps to efface the doubts that are likely to arise in the critical subjects about the sincerity of the I.G.Ms. (In the treatment of the statistics, these are not considered).

Table III

Standard Values	5 per cent	10 per cent	15 per cent	20 per cent	25 per cent	30 per cent	35 per cent	40 per cent	45 per cent	50 per cent
Estimations of the critical subject (%) with Group-influence when Standard Values exposed										
Mean	5.40	11.43	17.30	20.90	26.67	29.45	36.40	42.35	43.90	47.00
Mean Variation.	0.40	1.43	2.30	0.90	1.67	0.55	1.40	2.35	1.10	3.00
Standard Deviation	0.38	1.49	2.35	0.98	1.90	0.59	1.45	2.39	1.15	3.05

Standard Values	55 per cent	60 per cent	65 per cent	70 per cent	75 per cent	80 per cent	85 per cent	90 per cent	95 per cent	100 per cent
Estimations of the critical subjects (%) with Group-influence when Standard Values exposed										
Mean	54.45	59.92	66.45	72.49	76.88	70.45	83.40	89.90	97.35	97.95
Mean Variation	0.55	0.80	1.45	2.49	1.88	9.55	1.60	0.10	2.35	215.
Standard Deviation	0.59	0.10	1.95	2.75	1.90	9.45	1.67	0.15	2.32	3.35

It is evident from Table III, that the responses are not consistent (range of Standard Deviation amounts to 0.10 to 9.45 units). In comparison with the results shown in Table II, the response statistics in Table III are not very different. To consider this situation more critically, *t*-test for all the responses for all the experimental phases are done :

Table IV

Test of significance of mean differences between the readings of the experimental phases.

Standard Values	5 per cent	10 per cent	15 per cent	20 per cent	25 per cent	30 per cent	35 per cent	40 per cent	45 per cent	50 per cent
<i>t</i> -Phase I and II	3.71	3.53	2.57	5.12	1.80	3.77	3.68	1.25	3.86	1.19
<i>t</i> -Phase II and III	4.03	0.91	1.11	3.12	3.31	2.59	1.94	1.92	4.14	0.88
<i>t</i> -Phase I and III	0.39	3.90	2.25	3.91	0.04	3.21	4.00	0.41	0.93	0.34

Standard Values	55 per cent	60 per cent	65 per cent	70 per cent	75 per cent	80 per cent	85 per cent	90 per cent	95 per cent	100 per cent
<i>t</i> -Phase I and II	4.03	1.90	2.16	4.00	4.17	0.96	3.10	3.77	4.14	2.40
<i>t</i> -Phase II and III	3.45	2.92	1.41	1.01	0.56	4.11	3.74	3.03	4.23	2.27
<i>t</i> -Phase I and III	1.85	2.85	1.00	3.76	4.17	3.86	1.42	2.93	0.66	3.05

The statistics in Table IV show that the means of the differences between the Phases I and II hold good for 60 per cent of the responses and are significant at 0.01 level of significance ; between the Phases II and III they are significant for 50 per cent cases and between I and III 45 per cent of the responses are significant for 50 per cent cases and between I and III 45 per cent of the responses are significantly different. It can be inferred from these findings that the influence of group over individual estimations, non-specific influences of the estimations within a situation of group opposition with and without support from the stimulus-field

and finally a near similarity between the individual's natural estimations and estimations within group opposition with the support from the stimulus-field are predominantly apparent.

Discussion and remark : In this experiment the exposition of the correct values in the Phase III is a form of *indirect support* to the estimations of the critical subjects. Facing the unanimous opposition from the majority of the group members in the Phase II, critical subjects lose in due course all the intellectual hold over themselves. Almost all of them report tension, confusion and finally a feeling of submission to the unanimous group-decisions. In comparison with this phase to the Phase III, where chance indirect supports are given to the critical subjects, they appear to have maintained a kind of *uniqueness* which is proved statistically (inferences from Table IV, show that 50 per cent of the responses bear significant differences between the readings in the Phases II and III and also 45 per cent between I and III) and psychologically significant. Hence, surely here lies one of the clues about individuals maintaining independence in a group-situation. This situation can be compared with the situation where a *compromise-partner* in the face of a group-opposition is present. It also acts as a form of support to maintain one's individuality. But here the support is not so direct and compromising, as it is defined. Stated more specifically, the results show that in an individual's decision-making situation where group-opinions act as a form of oppositions as these do not corroborate the *perceived fact*, the presence of an operational support which resembles by any chance his own estimations, he adheres to his own than accept the group-decisions.

It can be remarked in fine that some form of environmental positive support though minimum by itself in the midst of confusion helps to maintain one's individuality in an intellectual situation.

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A Note on the Madras Intelligence Test

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An intelligence test suited to the age-group 10-15, was developed by the Psychology Department, University of Madras in 1956-58. The population consisted of Tamil-medium children in the Madras City Schools. It is in the form of separate tests for the age-group 11, 12 and 13 and one test for 14 and 15. At the time of standardization, the investigators worked with an assumption concerned with the relation between age of the child and its school-grade. It was assumed that for each age there is a corresponding grade. Children of that age in any other grade were supposed to be either retarded or too accelerated. Therefore, they were not used for standardization, and in the later validation studies. The final tests, therefore, cannot be used for children not studying in the corresponding class.*

Apart from the logical and statistical questions, the test has limited applicability because of this. The limitation is very serious for at least two reasons. First, any given grade actually contains large proportion of children who do not fall into the appropriate age-group. The test cannot be used for them. Secondly, the guidance and counselling problems of the scholastically backward child urgently call for a good intelligence test, that can be used without reference to present school achievement.

In order to examine the extent to which the grade-requirements are indispensable for the administration of the test, a small number of children of 11, 12, 14, 15 and 16, were given the Intelligence test appropriate to their age-group, but without reference to the class in which they were studying. The subjects were girls from three schools in the City. The averages of their intelligence quotients are given in Table A. The six corresponding S.D's are 17.52, 19.32, 18.38, 19.20, 18.4 and 9.06. The differences between eleven-year-olds and twelve-year-olds in the II form ; twelve-year-olds in II form and in III form ; fourteen-year-olds and sixteen-year-olds in V form are statistically significant ($P < .01$).

Table A : Average I.Q's.

Class	Age				
	11 (n = 40)	12 (n = 38, 26)	14 (n = 17)	15 (n = 22)	16 (n = 15)
II	107.8	93.44	...	...	...
III	...	113.4	...	...	...
V	...	...	111.4	101.3	98.21

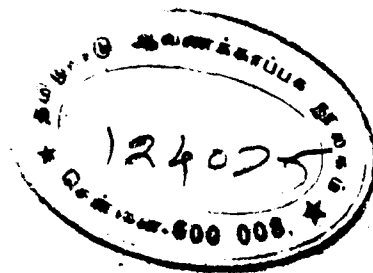
* The grades accepted as normal for ages 11 to 15 are Forms II to VI in that order. The data for this investigation was collected by Miss M. V. Vijayalakshmi.

According to these results, the class is an essential consideration in the usefulness of the Madras University Intelligence Test. At any rate, it is safer to conform to the age-grade combination set forth in the Manual. Within the same class, with the same test booklet (14 and 15 years), the average I.Q. decreases as age increases. Similarly, there is difference between the average I.Q. for the 11 and the 12 year olds in the same class.

The differences can be explained by assuming that children older than the expected norm for the grade, are "mentally retarded". But in fact there tends to be variability in age in any class, and only about half of the children conform to the age-grade scheme required (see Table B). This makes the interpretation untenable and logically undefendable. Very probably, the differences obtained in our groups are due to the selection of subjects at the standardization stage, which was guided by the assumption mentioned at the beginning.

Table B : Illustrative age-grade distribution in one girls' school (percents)

Class	Age							above 16
	below 11	11	12	13	14	15	16	
I (n = 127)	24	41	25	7	2	1	...	...
II (n = 167)	2	32	35	15	10	5	1	...
III (n = 121)	...	8	37	29	13	7	3	3



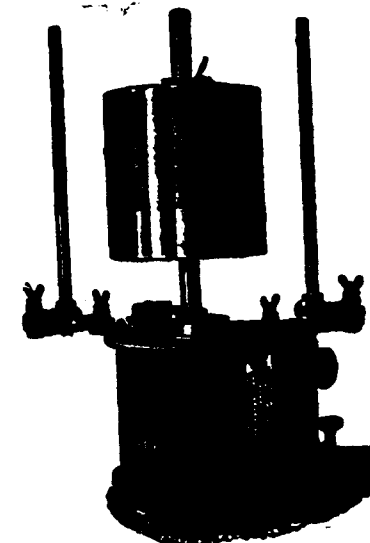
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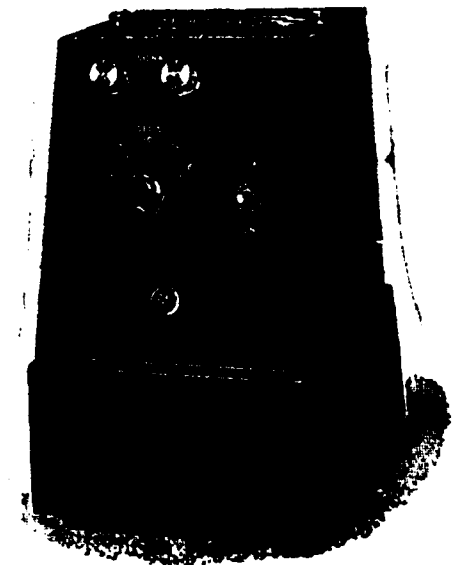
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