

# The Incidence of Inherited Defects of Colour Vision in Madhya Pradesh, India

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## Introduction

The investigation into the occurrence of the sex-linked recessive type of defective colour vision was undertaken among the students of Madhya Pradesh, a centrally situated state of India. The present paper deals with the frequency of defective colour vision in a few male and female population samples of Madhya Pradesh.

## Material and methods

During December 1964 - January 1965, the present authors had the opportunity of investigating into the deficiency of colour vision among 608 school students, comprising 251 males and 357 females. The test was carried out among the Brahmin, Jain, Kayastha, and Lodhi communities in four different localities, namely, Damoh, Saugor, Deori, and Gadarwara of Madhya Pradesh.

The school students, who were all unrelated, were tested with the Ishihara (1960) 3rd edition isochromatic plates under adequate natural indoor light. Fortunately, all the subjects who were asked to read the plates numbered 1 to 17 could easily read the Ishihara figures on the plates. The range of age of the males and females varied from 10 to 22 years and 11 to 20 years respectively. The subjects were admitted into the examination room one after the other, and never one was tested in front of another. The test was conducted all through strictly abiding the guide literature accompanying the Ishihara (1960) plate book.

## Results and discussion

The distribution of normal trichromates and colour-blinds of 608 students is furnished in Tab. 1, in terms of origin, sex, and locality. It may be seen that eight boys, out of 251 males tested, are red-green colour-blind. Significantly, none of the females shows defective colour vision. Examination of the Brahmin males has revealed 2.88% colour-blind; further, of the colour-blindness 28.6% is protanoid. The detection of one deuteranoid among the eight Lodhi tested, rather appears a chance occurrence

Tab. 1. The distribution of normals and colour-blinds in Madhya Pradesh

Population	Locality	Sex	Sample size	Normal		Protanoid		Deuteranoid		Total colour blind	
				f	%	f	%	f	%	f	%
Brahmin	Damoh and Gadarwara	♂	243	236	97.12	2	0.82	5	2.06	7	2.88
Brahmin	Saugor, Deori and Gadarwara	♀	304	304	100.00	—	—	—	—	—	—
Jain	Deori	♀	47	47	100.00	—	—	—	—	—	—
Lodhi	Damoh	♂	8	7	87.50	—	—	1	12.50	1	12.50
Kayastha	Saugor	♀	6	6	100.00	—	—	—	—	—	—

Tab. 2. Subtyping of red-green colour vision deficiency \*

Subject number	Sex	Ishihara 3rd edition (1960) plate numbers																	Diagnosis
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
17	♂	12	8	29	5	3	15	74	6	45	5	7	16	73	x	x	26	42	Normal
48	♂	12	8	29	5	3	15	21	8	28	5	2	10	x	x	x	2(6)	4(2)	Mildly deuteranomalous
93	♂	12	3	70	2	3	15	21	x	x	x	x	x	x	5	45	2	4	Deuteranomalous
100	♂	12	3	70	2	5	17	21	x	x	x	x	x	x	5	45	6	2	Protanope
104	♂	12	3	70	72	13	15	21	x	x	x	x	x	x	5	45	2	4	Deuteranomalous
171	♂	12	8	29	5	5	15	81	6	x	x	x	x	x	5	45	2	4	Deuteranomalous
181	♂	12	3	70	2	5	17	21	x	x	5	x	x	x	5	45	6	2	Protanomalous
247	♂	12	3	70	2	5	17	21	x	x	x	x	x	x	5	45	2	4	Deuteranope
		12	8	70	2	5	17	21	x	x	x	x	x	x	5	45	2(6)	4(2)	Mildly deuteranomalous

\* The mark x shows that the plate could not be read. The numeral in brackets shows that it could be read, but comparatively unclear.

in such a small sample-size and, naturally, does not merit consideration than mere recording. When the Madhya Pradesh males are considered as a whole, they exhibit the defective colour vision frequency of 3.19%; furthermore, the classification shows that the deuteranoid is exactly three times greater than the protanoid.

We have further tried to evaluate the nature of colour vision deficiency in the affected persons by attempting the differential diagnosis of the subtypes involved. The subtypes of the eight colour-blind males are presented in Tab. 2. According to Ishihara, the normal trichromates read figure 26 on plate 16 and figure 42 on plate 17. In protanopia and strong protanomaly only figures 6 and 2 are read on plates 16 and 17 respectively. In the case of mild protanomaly, both numerals on each plate are read; but figures 6 and 2 on plates 16 and 17 are more clearly seen than the other numerals. In deuteranopia and strong deuteranomaly only numerals 2 on plate 16 and 4 on plate 17 are read, while in the case of mild deuteranomaly, both the numerals on each plate are read; but figures 2 and 4 on plates 16 and 17 respectively are clearer than the other figures.

Thus, following Ishihara, we find that among the eight colour-blinds (cfr. Tab. 2), there is one each having protanopia or strong protanomaly and deuteranopia or strong deuteranomaly. While other one is protanomalous, the rest five is deuteranomalous including two cases being affected by its mild form.

For the purpose of comparison, the frequencies of colour-blindness in the available 12 male samples of the Brahmin community, drawn by different investigators from the different and distant areas, are presented in Tab. 3. It is seen from the comparative material that the variation of defective colour vision (pooling together protans and deutans) in the samples of the Brahmin community ranges from none at all to 10% with an over-all mean value of 4.39%. It becomes evident that the rate

Tab. 3. Frequency distribution of colour-blinds in the available Indian Brahmins (males)

Population sample	Locality	Sample size	Total colour-blind		Source
			f	%	
1. Brahmin	Madhya Pradesh	243	7	2.88	Present study
2. Desasth Brahmin	Maharashtra	102	3	2.94	Basu 1964
3. Desasth Brahmin	Madras	153	0	0	Iyer & Ramamurthy, 1956
4. Vadanagar Nagar Brahmin	Maharashtra (Bombay)	100	10	10.00	Sanghvi & Khanolkar, 1949
5. Desasth Rigvedi Brahmin	»	100	3	3.00	»
6. Desasth Yajurvedi Brahmin	»	100	3	3.00	»
7. Koknasth Brahmin	»	100	5	5.00	»
8. Audichya Brahmin	»	100	9	9.00	Vyas <i>et al.</i> , 1958
9. Brahmin	Andhra Pradesh	83	5	6.02	Dronamraju & Meerakhan, 1961
10. Brahmin	Orissa	186	8	4.30	Dronamraju, 1963
11. Rarhi Brahmin	West Bengal	217	15	6.91	Bhattacharjee, 1956
12. Vadanagar Nagar Brahmin	Benares	86	1	1.16	Sirsat, 1956

of abnormals in the Brahmin sample of Madhya Pradesh (2.88%) is relatively very low. In respect of abnormals, however, this Brahmin sample is found to be practically indistinguishable from the Desasth (2.94%), Desasth Rigvedi and Desasth Yajurvedi (having 3% each) Brahmin samples of the neighbouring Maharashtra state. Notably, the wide diversity in the frequencies of deficient colour vision between the two samples of the Vadanagara Nagar Brahmin residing in widely apart regions, one in Bombay and the other at Benares, deserves mentioning. While the sample from Benares (1.16%) displayed the lowest occurrence of abnormals, the other sample representing the same section of Brahmin from Bombay (10%) expressed the highest rate. Again, no person having the defective colour vision was detected in the sample representing the Desasth Brahmin of Madras. But, a comparison of the relative frequencies of defective colour vision, eliminating the Madras Brahmin for having no abnormals and Benares Brahmin for having a negligible prevalence, in the various Brahmin samples, reveals no statistical heterogeneity ( $\chi^2 = 15.310$ , D. F. = 9,  $P > 0.05$ ).

An inspection of Tab. 4 immediately reveals that barring M. P. Brahmin X Bombay V. N. B., M. P. Brahmin X Bombay Audichya Brahmin, Bombay V. N. B. X Bombay D. R. B., Bombay V. N. B. X Bombay D. Y. B., and Bombay V. N. B. X Orissa Brahmin, none of the samples differs significantly from one another at 5% level of probability.

However, considering the origin of at least two known sections of Brahmin community, certain samples shown in Tab. 3 may be combined for further analysis. For example, the Vadanagara Nagar Brahmin population who migrated and ultimately settled at Benares about three centuries ago, had originated from the Vadanagara

**Tab. 4.  $\chi^2$  values for inter-sample differences of Brahmin with respect to colour vision deficiency (1 D. F.)**

Sample serial numbers (refer to Tab. 3)	1	2	4	5	6	7	8	9	10	11
1		0.130	6.186*	0.025	0.025	0.297	4.669*	0.925	0.279	3.254
2	0.103		3.088	0.152	0.152	0.152	2.322	0.433	0.066	1.377
4	6.186*	3.088		5.265*	5.265	2.595	0.233	1.554	4.613*	1.374
5	0.025	0.152	5.265*		—	0.130	2.216	0.401	0.049	1.294
6	0.025	0.152	5.265*	—		0.130	2.216	0.401	0.049	1.294
7	0.297	0.152	2.595	0.130	0.130		0.695	0.005	0.323	0.162
8	4.669*	0.322	0.233	2.216	2.216	0.691		1.068	3.478	0.777
9	0.925	0.438	1.554	0.401	0.401	.0005	1.068		0.840	0.003
10	0.279	0.066	4.613*	0.049	0.049	0.323	3.478	0.840		0.830
11	3.254	1.377	1.374	1.294	1.294	0.162	0.777	0.003	0.830	

\* Significant at 5% level of probability

Nagar Brahmin stock of Bombay. Likewise, the ancestry of the Desasth Brahmin who are now residing in the neighbouring districts of Bombay and further away to Madras state, could also be linked-up with the original Desasth section of Bombay; the migration of the Desasths from their home, according to the historical evidence, was effected during the period of Shivaji.

Following the reasoning given above, two samples of the Vadanagara Nagar Brahmins are combined into one group and the other four Desasth Brahmin samples into another in Tab. 5. This pooling together of the samples reveals that the frequencies of colour-blindness in Vadanagara Nagar Brahmin and Desasth Brahmin are 5.91% and 1.98% respectively. Now, the Brahmin communities show a range of abnormal incidence from 1.98% to 9% (Tab. 5), and, finally, they are found to

**Tab. 5. Showing the pooled frequencies of abnormals of certain Brahmin samples having common origin, and the values of  $\chi^2$  for inter-Brahmin differences (1 D. F.)**

Population	Sample size	Total colour-blind		$\chi^2$ values for inter-Brahmin variations of M. P. Brahmin $\times$ others, and probabilities	
		f	%		
Madhya Pradesh Brahmin	243	7	2.88	—	
Desasth Brahmin	455	9	1.98	0.244	0.70 < P < 0.50
Vadanagara Nagar Brahmin	186	11	5.91	3.225	0.05 < P < 0.02
Koknasth Brahmin	100	5	5.00	1.675	0.20 < P < 0.10
Audichya Brahmin	100	9	9.00	7.421	0.01 < P < 0.001
Andhra Brahmin	83	5	6.02	2.725	0.10 < P < 0.05
Orissa Brahmin	186	8	4.30	1.121	0.30 < P < 0.20
Bengalee Rarhi Brahmin	217	15	6.91	5.025	0.05 < P < 0.02

be quite heterogenous ( $\chi^2 = 17.473$ , D. F. = 7,  $P < 0.02$ ) with respect to colour-blindness. But, we have seen earlier that without combining certain different samples of the Brahmin community having a common origin, the various samples revealed no statistical heterogeneity ( $P > 0.05$ ).

However, it seems worth to examine the variations in respect of the defective colour vision from the present Brahmin sample of Madhya Pradesh with other Brahmin communities by the application of  $\chi^2$  test for significance to  $2 \times 2$  tables. By scanning the column of  $\chi^2$  values given in Tab. 5, it may be appreciated that M. P. Brahmin  $\times$  Vadanagara Nagar Brahmin (3.225,  $P < 0.05$ ), M. P. Brahmin  $\times$  Maharashtra Audichya Brahmin (7.421,  $P < 0.01$ ) and M. P. Brahmin  $\times$  Bengalee Rarhi Brahmin (5.025,  $P < 0.05$ ), differs significantly at 5% and even a lower level of probability.

### Summary

1. Sex-linked type of defective colour vision among 608 unrelated students, including 251 males and 357 females belonging to different communities residing in Madhya Pradesh of India, was investigated. Males were found to have 3.19% de-

fective colour vision; again, of the defectives the deutans were found to be exactly three times greater than the protans. Significantly, none of the females was colour-blind.

2. Brahmin of Madhya Pradesh displayed a comparatively low value of abnormal incidence being 2.88% among the other Brahmin samples. The occurrence of green-blind was found to be a little more than double of the red-blind in the sample.  $\chi^2$  test for significance in respect of the total incidence of colour-blindness in various samples of Brahmin shows no heterogeneity ( $P > 0.05$ ). But, when certain Brahmin samples having a common origin are combined, some significant differences are brought out showing a clear statistical heterogeneity ( $P < 0.02$ ).

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## RIASSUNTO

È stata compiuta una ricerca sulla discromatopsia legata al sesso in 608 studenti non consanguinei (251 maschi e 357 femmine) provenienti da diverse comunità di Madhya Pradesh. Nei maschi è stata rilevata una frequenza di discromatopsia del 3,19%; fra questi la deutanopia è risultata essere tre volte maggiore della protanopia. In maniera significativa, nessuna delle femmine è risultata essere affetta da cecità per i colori.

I Bramini di Madhya Pradesh presentano una frequenza relativamente bassa dell'anormalità, che è di 2,88% fra gli altri campioni di Bramini. La cecità per il verde è risultata essere poco maggiore del doppio di quella per il rosso. Il test del  $\chi^2$  rispetto alla frequenza totale della cecità per i colori nei diversi campioni di Bramini, indica assenza di eterogeneità ( $P > 0,05$ ). Ma quando certi campioni di Bramini di origine comune vengono considerati insieme, si evidenziano differenze significative che indicano chiaramente eterogeneità statistiche ( $P < 0,02$ ).

## RÉSUMÉ

Une recherche sur la dyschromatopsie liée au sexe a été effectuée chez 608 étudiants non consanguins (251 mâles et 357 femelles) tirés de différentes communautés du Madhya Pradesh. Les mâles ont démontré une fréquence de 3,19% et chez eux la deutanopie est résultée trois fois plus fréquente que la protanopie. Significativement, aucune femme n'est résultée atteinte.

Les Brahmins du Madhya Pradesh présentent une fréquence relativement peu élevée de l'anomalie, tandis que les autres Brahmins ont une fréquence de 2,88%. La cécité pour le vert a une fréquence plus que double de la cécité pour le rouge. Le test du  $\chi^2$  pour la fréquence totale de la dyschromatopsie chez les divers échantillons de Brahmins indique absence d'hétérogénéité ( $P > 0,05$ ). Toutefois, si l'on considère ensemble certains échantillons d'origine commune, des différences significatives indiquent hétérogénéité statistique ( $P < 0,02$ ).

## ZUSAMMENFASSUNG

608 nicht blutsverwandte Studenten (251 Jungen und 357 Mädchen) aus den verschiedenen Gemeinden von Madhya Pradesh wurden auf die geschlechtsgebundene Dyschromatopsie untersucht. Bei den Jungen betrug des Vorkommen der Dyschromatopsie 3,19%; darunter war die Deutanopie dreimal höher als die Protanopie. Bedeutungsvoll ist, dass keine der Mädchen an Farbblindheit litt.

Die Brahmanen von Madhya Pradesh weisen ein relativ geringes Vorkommen der Anomalie auf, das bei den anderen Brahmanenserien als doppelt so oft wie Rotblindheit vertreten. Mit der Gesamtfrequenz der Farbenblindheit 2,88% beträgt. Grünblindheit war etwas mehr bei den verschiedenen Brahmanenserien verglichen zeigt der  $\chi^2$  Test keine Heterogenität an ( $P > 0,05$ ). Wenn man hingegen gewisse Brahmanenmuster gemeinsamer Herkunft zusammen betrachtet, so treten bedeutungsvolle Unterschiede zutage, die ganz deutlich eine statistische Heterogenität beweisen ( $P < 0,02$ ).