

**BEHAVIOUR OF MECHANISMS OF COLOUR VISION
UNDER TRANSIENT ADAPTATION**

BY
MAHESH CHANDER

THESIS SUBMITTED TO THE INDIAN INSTITUTE OF TECHNOLOGY
HAUS KHAS, NEW DELHI-29, FOR THE AWARD OF THE DEGREE OF
DOCTOR OF PHILOSOPHY
1972

SUPERVISORS

PROF. P. K. KATTI*
INDIAN INSTITUTE OF TECHNOLOGY
NEW DELHI-29

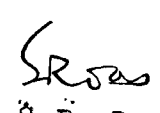
PROF. S. R. DAS
NATIONAL PHYSICAL LABORATORY
NEW DELHI-12

At present Director, Instruments Research and Development Establishment, Dehra Dun.

This work has been done by Mr. Mahesh Chander as a thesis project under our joint supervision in the Optics Division of the National Physical Laboratory, New Delhi. He has not received any assistance other than the usual laboratory facilities in executing this project.


Dr. P.K. Katti

Instruments Research and
Development Establishment,
Dehradun.


Dr. S.R. Das

National Physical Laboratory,
New Delhi-12.

A C K N O W L E D G E M E N T S

The author thanks the following persons

- Dr. S.R. Das and Prof. P.K. Katti for suggesting the problem and for supervision and guidance;
- Mrs. S. Manrai and Mrs. S. Mallela for helping as experimenter in the experiments;
- Dr. K.C. Joshi and Dr. V.D.P. Sastri for going through the manuscript and suggesting corrections;
- Mr. S.B. Mammohanam for making the spectrophotometric recordings of the filters;
- Mr. K.S. Sarma for helping in the calibrations and photometric measurements;
- Mr. R.D. Goel for helping in research work;
- The Director N.P.L. and the C.S.I.R. for support;
- All the members of the Optics Division for their co-operation.



(Mahesh Chander)

P R E F A C E

It is a common experience that under normal viewing conditions the retina is continually adapted to changing backgrounds, i.e. it is subjected to changing adaptations. Therefore, the study of the foveal mechanisms involved in the changing states of adaptation becomes important from practical view point. This thesis presents the results of some experiments done with various types of transient adapting situations.

Two - colour threshold techniques are used in all the experiments. A review on the underlying fundamental mechanisms of colour vision known as II-mechanisms is made in the first Chapter. In the second Chapter the experimental setup and calibrations are mentioned. In the third, fourth and sixth Chapters are presented experiments the results of which demonstrate that the discrimination between different mechanisms of colour vision comes out better in transient adaptations than in static adaptations. The results of transient adaptation study in the fifth Chapter yield the retinal sensitivity peaks more or less at the same spectral positions as already known. Thus the transient adaptational techniques give a further support to the trichromacy of colour vision.

C O N T E N T S

<u>CHAPTERS</u>	Page
I Preamble	1
1.1 Review of the selected literature on fundamental mechanisms of colour vision.	6 6
1.1.1 Static Adaptation of Retina ...	6
1.1.2 Transient States	18
1.2 Summary of Review	24
1.3 Present Research Proposals	25
II Experimental Arrangement	27
2.1 The Experimental setup of the Adapto- meter — (A)	28
2.1.1 Constructional Features	28
2.1.2 Modification of Adaptometer to obtain a second channel for conditioning field	32
2.1.3 Components in the optical path.	34
2.2 Stray Light	43
2.3 Recording System	43
2.4 Calibrations — (B)	45
2.4.1 Field Luminance Measurements...	45
2.4.2 Neutral Density Wedge and Filter Calibrations	47
III Foveal Increment Threshold in Transient Adaptation	48
3.1 Apparatus and Procedure	49
3.1.1 Apparatus	49
3.1.2 Procedure	49

	Page	
3.2	Increment Threshold in light and dark Adaptation	53
3.2.1	Results and Discussions	53
3.3	Instantaneous Threshold and the II- mechanism	60
3.3.1	Results and Discussions	60
IV	Foveal sensitivity and the Transient Adaptation	72
4.1	Apparatus and Procedure	73
4.1.1	Apparatus	73
4.1.2	Choice of Adapting field radiance	73
4.1.3	Procedure	78
4.2	Foveal Recovery in Colour Fields — Section A	80
4.2.1	Results and Discussions	80
4.2.1a	Visual efficiency in mixed fields	92
4.2.1b	Loop in the Recovery Curve ...	95
4.3	Initial Stages of Foveal Adaptation — Section B	99
4.3.1	Results	100
4.3.1a	Rise of Initial Threshold	100
4.3.1b	Drop of Initial Threshold	102
4.3.2	Discussion of the Results ...	103
4.3.3	Factors influencing the Tran- sient Factors	108
V	Trichromacy of Colour Vision under Tran- sient Adaptation	115
5.1	Foveal Sensitivity Curves	117
5.1.1	B→R and R→B Adaptation ...	122

		Page
	5.1.2 G \rightarrow B and B \rightarrow G Adaptation	126
	5.2 Conclusions	129
VI	Foveal Recovery in Composite Adaptation ..	132
	6.1 Apparatus and Procedure	133
	6.2 Green and Blue pair of Adapting Condition — Section A	135
	6.2.1 Fixation of the level of Field Radiances	135
	6.2.2 The Stages of the Transient Adaptation	138
	6.3 Red and Green pair of Adapting Fields — Section B	141
	References	148
