Anatomical evidence for the overlapped distribution of ipsilaterally and contralaterally projecting ganglion cells to the lateral geniculate nucleus in the cat retina: a morphologic study with fluorescent tracers. Naomichi Terao, Akihiro Inatomi, and Toshihiko Maeda.

The question of the nasotemporal overlap of ganglion cells in the central retina, which project to the ipsilateral and contralateral lateral geniculate nucleus, was reexamined in the cat by means of a retrograde fluorescent double-labeling technique. The horizontal separation between the ipsilateral and contralateral decussation lines, which corresponded to the width of the median strip of overlap, was approximately 0.2 mm. This is the first direct confirmation of the extent of such overlap in the cat retina by means of filter mirror systems U and G, respectively. Filter mirror system U provides excitation light at 334 nm and 365 nm wave length, with which primuline-labeled neurons showed bright golden granules, while Evans blue-labeled neurons showed red fluorescence under filter mirror system G, which provides excitation light at 550 nm wave length. The injection sites of the two fluorescent dyes were also examined.

**Results.** The central retina of one of five cats (PEW-4) successfully labeled by the two dyes is shown in Fig. 1. When the retina was observed under filter mirror system B, which provided an intermediate excitation wave length, the ipsilaterally and contralaterally projecting cells labeled with two different dyes were simultaneously visualized.

The site of peak cell density for ipsilaterally and contralaterally projecting cells was clearly determined as a central area of each concentration of the singly labeled cells. Thus the separation of each of the two peak density areas was directly measured and was found to be 280 μm. The vertical decussation lines for ipsilaterally and contralaterally projecting cells were determined by the visual inspection of the double-labeled retina (Fig. 1, arrows). The line of contralaterally projecting cells was found to run just across the peak density area for ipsilaterally projecting cells labeled with Evans blue (red). On the other hand, the ipsilateral line was located not at the peak density area for contralaterally projecting cells (yellow), but more temporal to it. The distance of the overlap between the two decussation lines was thus estimated as to be approximately 200 μm, or about 100 μm less than the separation of the two peak density areas for ipsilaterally and contralaterally projecting cells to LGN.

**Discussion.** The present study aimed to reexamine the question of the overlapped distribution of ganglion cells of either the nasal or temporal hemiretina in the area centralis. To our knowledge this is the first anatomic study to directly examine the extent of the nasotemporal overlap by separately establishing the distribution pattern of ipsilaterally and contralaterally projecting cells in the same retina.

Materials and methods. Adult cats of both sexes were used in this study. Three large injections (usually 5 to 8 μl) of either of the two fluorescent dyes, i.e., primuline (10% in saline) and Evans blue (10% in saline), were made in each LGN through a Hamilton syringe implanted stereotaxically. The cat was allowed to survive for 2 to 4 days and was then perfused transcardially with Krebs-Ringer solution followed by 4% paraformaldehyde in 0.1M phosphate buffer (pH 7.4). The retinas were processed as previously reported. Finally, the flat-mounted retinas were examined under a fluorescent microscope equipped with a filter mirror system (Olympus Co., Tokyo). The ipsilaterally projecting cells labeled with Evans blue and the contralaterally projecting cells labeled with primuline were observed in the same retina by means of filter mirror systems U and G, respectively. Filter mirror system U provides excitation light at 334 nm and 365 nm wave length.
Fig. 1. Fluorescent micrograph of central cat retina. Ipsilaterally projecting ganglion cells are labeled by Evans blue (red), and contralaterally projecting ganglion cells are labeled by primuline (yellow), as observed by filter mirror system B. The lines of peak cell density (asterisks) and decussation lines (arrows) are indicated. T, Temporal; N, nasal. (bar = 100 μm.)

Using the degeneration pattern of retinal ganglion cells in which one optic tract was sectioned, Stone and Fukuda\(^1\)\(^2\) showed that the width of nasotemporal overlap (vertical median strip) was about 0.2 mm in the cat retina. After labeling one hemiretina by a unilateral injection of the retrograde tracer, horseradish peroxidase, into LGN, Cooper and Pettigrew\(^3\) obtained results similar to those reported by Stone and Fukuda.\(^1\)\(^2\) The nasotemporal overlap was further studied in the retina of the monkey by Stone et al.\(^4\) and by Bunt and Minckler.\(^5\) They reported a similar value (about 1\(^\text{st}\)) for the nasotemporal overlap. In any studies the two isodensity contour maps of labeled ganglion cells obtained in the flat-mounted retinas for each eye were superimposed to produce an isodensity map that had a single peak density for a given retina.

In the present study, using a double-labeling method for the two hemiretinans, we could directly measure the horizontal separation (about 300 μm) of the two peak density areas for ipsilaterally and contralaterally projecting cells. However, the tracer injections did not involve the whole retinal projecting system but was restricted to the LGN projecting system. There remains, therefore, a possibility that the two peak density areas would be located more closely than those of this experiment, provided that ganglion cells projecting to other nuclei were added.

It is of great interest that the vertical zone (about 300 μm) between the two peak density areas did not exactly correspond to the densely overlapped zone that was called the median strip of overlap by Stone and Fukuda.\(^1\)\(^2\) The median strip of overlap was narrower than 300 μm and measured about 200 μm as a vertical zone between the two decussation lines. The peak density area for ipsilaterally projecting cells could be safely included in the median strip of overlap, while the contralateral peak density area was observed to be about 100 μm nasal to the ipsilateral decussation line and to be situated out of the median strip. The ipsilateral decussation line can be sharply drawn because of a steep decrease of ipsilaterally projecting cells toward the nasal side. Therefore there should not be a wide difference in the localization of the ipsilateral decussation line between the previous studies\(^1\)\(^3\) and ours.

Thus the present results have confirmed previous findings\(^1\)\(^3\) by a direct method that the width of the median strip of overlap of ipsilaterally and contralaterally projecting cells is about 200 μm. Further findings in the present study are that the two peak density areas for ipsilaterally and contralaterally projecting cells to LGN are separated
Abnormal retinal projections in cats with the Chediak-Higashi syndrome. DONNELL CREEL, LINDA L. COLLIER, AUDIE G. LEVENTHAL, JOHN W. CONLEE, and DAVID J. PRIEUR.

The Chediak-Higashi syndrome (CHS) occurs in mammals, including humans and cats. The CHS is characterized by decreased ocularcaneous pigmentation, enlarged cytoplasmic granules, increased susceptibility to infections, and a hemorrhagic tendency. Ocular anomalies include pale irides and albinotic or subalbinotic fundi. Cats with CHS also have photophobia and prolonged postrotatory nystagmus. Since hypopigmentation of the pigment epithelium is correlated with misrouting of retinal ganglion cells in mammals, visual projections of CHS cats were examined by autoradiographic techniques to determine whether they exhibit abnormal retinogeniculate projections. In CHS cats, misrouted optic projections fragment layer A1 of the dorsal lateral geniculate nucleus into several islands, similar to the disruption of this lamina reported in the Siamese cat. (Invest. Ophthalmol. Vis. Sci. 23:798-801, 1982.)

The Chediak-Higashi syndrome (CHS) is an autosomal recessive genetic disorder that was first described in humans. This syndrome was initially recognized as a disorder of leukocyte morphology in which neutrophils and monocytes contained giant cytoplasmic granules. Subsequently, most types of granule-containing cells have been shown to contain enlarged cytoplasmic granules. All mammals with CHS exhibit a non-e locus form of partial albinism. Their apparent hypopigmentation is due to the aggregation of abnormally large melanosomes along with some reduction in pigment. The syndrome is further characterized by prolonged bleeding times resulting from defective platelet function and increased susceptibility to infection. Homologous conditions have been described in mink, cattle, mice, a killer whale, and cats.

Humans and cats with CHS have pale irides and albinotic or subalbinotic fundi and photophobia. Humans with CHS usually have some form of strabismus or nystagmus; cats with CHS have prolonged postrotatory nystagmus similar to that observed in Siamese cats. Histologic examination of the eyes of CHS cats revealed less than normal amounts of melanin in all the pigmented intraocular structures. Of particular interest to this study was the observation that the pigment epithelium of CHS cats contained few melanin granules and that these were rounded or irregular in shape and much larger than the more numerous elongated melanosomes of normal cats. The greatly enlarged pigment granules were apparently produced by coalescence of normal-sized melanosomes and premelanosomes.

Anatomic and electrophysiologic studies have shown that mammals with congenital hypopigmentation of the pigment epithelium demonstrate chiasmal misrouting of optic fibers. Studies of albino mammals from rodents to humans indicate that the axons of many retinal ganglion cells in temporal retina erroneously decussate at the optic chiasm and terminate in visual centers of the contralateral hemisphere rather than the ipsilateral hemisphere. Hypopigmentation of the pigment epithelium is the principal prerequisite for misrouted central optic projections. Mammals affected with CHS have hypopigmentation of their