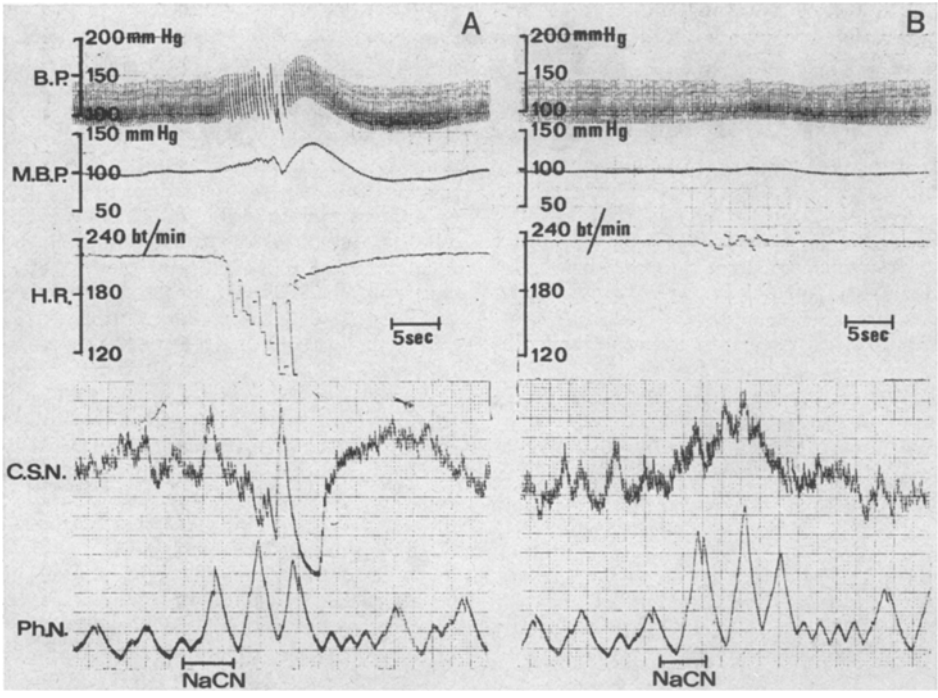

Effect of carotid chemoreceptor stimulation on the cardiac sympathetic nerve discharge. At the signal 0.2 ml of a NaCN solution (50 μg/ml) was injected through the right thyroid artery. Cat: urethane (250 mg/kg) and chloralose (30 mg/kg) anaesthesia, open chest, artificial ventilation. A) control; B) heart electrically paced, blood pressure kept artificially constant. Traces from above: arterial blood pressure (B.P.), mean arterial pressure (M.B.P.) heart rate in beats per min (H.R.), integrated discharge activity of the right cardiac sympathetic nerve (C.S.N.) and of the right phrenic nerve (Ph. N.).

and opposite-sign to those of the arterial pressure. We believe the first abrupt increase of the sympathetic discharge was due to the effect of the chemoreceptor stimulation; subsequently such an effect was hidden and counteracted by the pressoreceptor influences, every time there was a change in the arterial systemic blood pressure level.

In a successive trial (Figure B), both the arterial blood pressure and the heart frequency were kept constant (see methods) in order to make evident the pure effect of the same chemoreceptor stimulation on the cardiac sympathetic activity. In this situation, the sympathetic discharge showed a significant increase, lasting approximately the same time as the respiratory activation.

The comparison of the two trials shows that the phase of bradycardia shown in Figure A and the increase in sympathetic nerve discharge observed in B were both happening at the same latency from the cyanide injection and synchronously with the increase of the phrenic discharge. This means that, during carotid chemoreceptor stimulation, both parasympathetic and sympathetic supply to the heart were activated at the same time.

At the end of the experiments, the Hering nerve ipsilateral to the side of NaCN injection was cut. Baroceptor and chemoreceptor activity was recorded from the peripheral end of the nerve. The NaCN administration produced a clear increase of chemoreceptor activity and did not modify the baroreceptor discharge; the same injection had no effect whatsoever on blood pressure, heart rate and respiratory activity. This proves that the effects observed on these parameters before cutting the Hering nerve were due to the pure stimulation of carotid chemoreceptors, and neither direct stimulation of central structures nor of other chemoreceptor areas was involved.

These data show clearly that carotid chemoreceptor stimulation produces a general activation of both the cardioactivatory and the cardioinhibitory medullary centres.

Retinal Blur and Midbrain Cell Response[1]

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Summary. The responses of certain photically responsive cells of the superior colliculus were found acutely dependent on the focal condition of the retinal image.

Although refractive errors are by far the most common anomalies of the visual system[2], little is known of their effects directly on visual pathway coding. An approach explored here was to induce, through refractive error, known degrees of retinal image blur and to compare the resulting pathway responses with those associated with optically best (i.e., no refractive error) conditions.

Material and method. The responses cited are from among a cumulative sample of more than 300 neurons now studied within the rabbit mesencephalon and visual

[1] This work was supported by U.S.P.H.S. Grant No. EY01325.

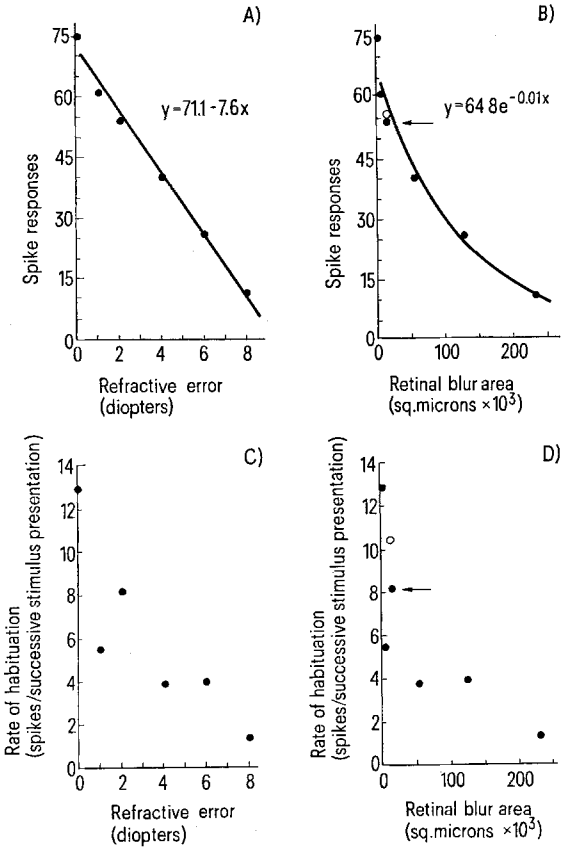
[2] S. Duke-Elder and D. Abrams, *Systems of Ophthal* (C. V. Mosby Co., St. Louis 1970), vol. 5, p. 234.

cortex. The animals were maintained under light urethane anesthesia (6 ml/kg body wt. of a 20% solution, a dosage level found from earlier work to be no more detrimental to cell responsiveness than 'encéphale isolé' techniques). This was commonly supplemented with 3.3 mg/kg body wt./h of gallamine triethiodide to prevent eye and body movements, the animal being artificially respirated during such periods.

The animals were supported stereotaxically, the stimulated eye in each case being fitted with a contact lens to protect the cornea from drying and refracted (by retinoscopy) to bring the retinal image into conjugacy with the 57 cm distant testing plane. Stainless steel micro-electrodes were introduced into the superior colliculus through an agar sealed skull aperture.

Once localized, the receptive field of each cell was mapped through the neutralizing refractive correction for that axis in visual space, using the most commonly optimal stimulus conditions (a flashing 1 sec on, 1 sec off, 1° diameter, 40 cd/m² light spot against a 0.03 cd/m² background). Occasionally, when a cell was found to be more responsive to other stimuli, e.g., movement of bright edge against that background, those more optimal stimuli were used. The receptive field was then replotted for each of a series of (spherical: plus power to induce myopia, minus power to induce hyperopia; or astigmatic: equivalent sphere and cylinder combinations designed to position the most contained blur area of an astigmatic focal interval in the retinal plane) refractive errors by centering the inducing lenses on the receptive field axis.

Recording sites were later confirmed by Prussian blue reactions localized in frozen serial sections made of each brain.



Responsiveness of a midbrain cell to a light spot flashed at the most sensitive point within its receptive field: in A) showing its decreasing responsiveness to an initial flash when viewed through increasing steps of spherical refractive error; in B) those same responses when plotted against a linear scale of those blur areas constituting each point in the retinal image associated with each refractive error case in A (the open point and arrow pertain to an astigmatic case, see text); in C) the rates of habituation (decreasing responsiveness to trains of flashes) of this cell associated with increasing steps of spherical refractive error; and in D) those same responses plotted against a linear scale of those blur areas constituting each point in the retinal image for each refractive error case in C (the open circle and arrow pertain to an astigmatic case, see text). This cell was located in the superior colliculus at the boundary of the stratum griseum and stratum opticum; its receptive field projected 14° inferior and 34° nasal to the optic axis, and it responded only to bright spot or bar stimuli, either statically flashed or moving.

Results and discussion. As the midbrain is well known to contain highly developed retinotopic maps of visual space[3,4], it is not surprizing to find that the responsiveness of certain photic cells of the superior colliculus can be acutely dependent on the focal quality of the retinal image. Just how dependent this can be is illustrated in A of the Figure by the precipitous decline of an 'on' cell's responsiveness to single light flashes occurring in its visual space, when 'viewed' through increasing steps of spherical refractive error. Those same responses plotted in relation to corresponding retinal image blur areas (as estimated for each finite point composing that retinal image, based on calculations for the standard eye[5]) are shown in B. The open point response on that graph is to an astigmatically induced blur area equivalent (within 4%) to that produced by 2 diopters of spherically induced refractive error (indicated by the arrow). Responses for the two cases were within 6% of one another.

When subjected to trains of stimuli (1.0 sec on, 1.0 sec off), progressively reduced responses resulted from each flash beyond the first[6]. The rate at which such habituation took place also appeared to be a function of such retinal image quality as shown in C and D of the Figure. The open point in D is again due to the astigmatic system described above and should be compared, in terms of equivalent retinal blur area, to the 2 diopter spherical response marked here too with an arrow.

Although underlying neural mechanisms are still being investigated, the following observations can be noted for such cells: 1st, that their initial responsiveness can be almost linearly related to a dioptric scale of refractive error, but appears better described by an exponential function in relation to those corresponding areas of blur composing each finite point in the retinal image; 2nd, that rates of habituation to repeated stimuli will appear dependent on the focal state of the retinal image, as should be expected, since all responses from the first onward will be proportionally smaller than under best focus conditions; and 3rd, that equivalent blur areas (relative to each point in the retinal image) induced by spherical and by astigmatic systems can be shown to produce nearly equal responses.

[3] R. M. HILL, Nature, Lond. *211*, 1407 (1966).
[4] A. HUGHES, *Documents Ophthal.*, Vol. 30, Symp. Proc. of 18 June 1970 on 'Vision in the Rabbit' in Rotterdam (Dr. W. Junk, n.v. Publisher, The Hague 1971) p. 65.
[5] R. M. HILL and G. A. FRY, Vis. Res. *14*, 1037 (1974); and Vis. Res. *15*, 757 (1975).
[6] G. HORN and R. M. HILL, J. exp. Neurol. *14*, 199 (1966).