The mammalian fast and slow muscles show a slight deviation from this trend. The mouse biceps brachii with an intrinsic speed of 11.8 lengths sec^{-1} appears more efficient than the same muscle in the hamster despite the latter's slower speed (10.5 lengths sec^{-1}). The reason for the slight deviation may lie in the different proportions and disposition of non-contractile material in these muscles.

The present results suggest that a comparative study of the energetic and dynamic properties of different muscles may lead to a clearer understanding of their role in locomotion and in the maintenance of posture. It seems that it is not only advantageous to use slow fibres for maintaining posture (isometric contraction) but also for isotonic movements providing they are required to shorten slowly. The reason why slow muscles have a higher maximum efficiency for doing work is not known. However it may be that the longer engagement time of the cross-bridges and the slower movement of the actin filaments permit each cross-bridge to develop more force (over a longer period) for each molecule of ATP used.

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Summing properties of the surround response mechanism of cat retinal ganglion cells[1]

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Summary. Evidence is presented that, in the cat retina, the region in the visual field over which the surrounds of type X ganglion cells pool adaptive information corresponds to the region over which they pool signals.

As a means to account for the results of many psychophysical studies Rushton[3] proposed the existence of signal and adaptation summation pools within the retina. The signal pool was thought to integrate spatially the effects from photic stimuli that contribute to the detection of that stimulus by the observer. Similarly, the adaptation pool was thought to sum the desensitizing effects from steady light in the visual field.

The activity of the ganglion cell, the output neuron of the retina, is believed[4-6] to be controlled by 2 spatially overlapping response mechanisms, a center mechanism and surround mechanism. A response mechanism is an aggregate of photoreceptors and retinal interneurons whose activity affects the neural discharge of the ganglion cell. The results of a number of studies provide evidence that both the center response mechanism[7-13] and surround response mechanism[14] have signal and adaptation pools. In addition, in the cat's retina there is evidence that for the center mechanism, the retinal region over which signals are physiologically pooled, the signal pooling area, and the retinal region over which the desensitizing effects from steady light flux are pooled, the adaptive pooling area, are spatially coextensive[9,10,12]. The present study sought to determine if a similar spatial relationship exists for the surround's signal and adaptive pooling areas.

The action potentials of 43 optic tract fibers in adult cats were monitored by tungsten microelectrodes. The animals were anesthetized with urethane (40 mg/kg/h). Flaxedil (40 mg/h) was infused through the femoral vein in order to immobilize the eyes. The infusion mixture also contained Ringers with lactate (3.0 ml/h) and atropine sulfate (0.05 ml/h). EKG, femoral arterial blood pressure, EEG, body temperature, and Pco_2 were continuously monitored during the experiments. Pco_2 was held between 4% and 5%, and body temperature maintained at 38 °C. Corneal contact lenses (3.8-mm pupils) were fitted to prevent corneal drying. An 8.0° bipartite contrast reversal stimulus[15,16] was used to classify ganglion cells as type X or Y. The surround mechanism was isolated using the method described by Bishop and Rodieck[17].

The adaptive and signal pooling areas were assessed by comparing area-adaptation curves with area-sensitivity curves. The stimuli used were annuli whose outside diameter was constant and whose inside diameter varied. In order to determine area-sensitivity curves the luminance of each (temporally) modulated annulus was varied until a weak (20–70 spikes/sec peak firing rate) suprathreshold response of constant magnitude and time course was produced. Henceforth this response will be referred to as the criterion response. The area-sensitivity curve is defined, therefore, as the function relating inside diameter (target size) and the log of the reciprocal of the luminance required to produce the criterion response.

The modulated annuli used to determine the area-sensitivity curves served as unmodulated field adapting stimuli to determine area-adaptation curves. These adapting stimuli were presented in conjunction with a modulated test annulus.

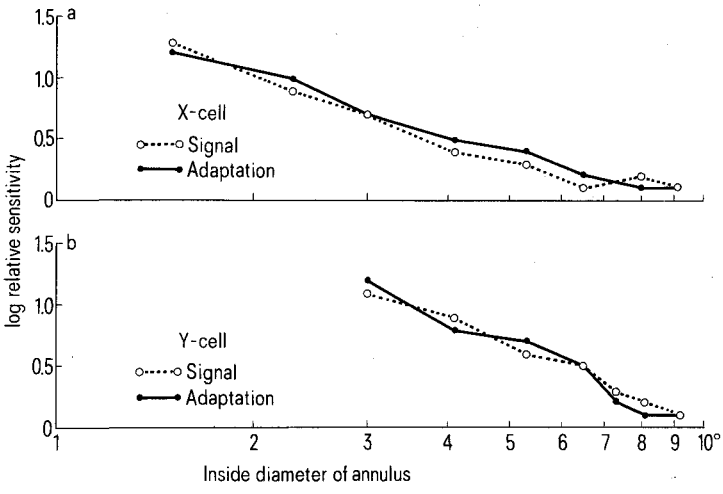

Figure 1. Area-sensitivity (signal) and area-adaptation curves for X-cell (a) and Y cell (b). Outside diameter of modulated annuli for area-sensitivity study and unmodulated annuli for area-adaptation study was 10.3°. Stimuli: (a) X-cell, luminance of 0.3° adapting spot, 8 candles/m^2; luminance of 2.5°×5.0° modulated annulus for adaptation curve, 5.1×10^{-1}° candles/m^2; background luminance, 3.5×10^{-2} candles/m^2; (b) Y-cell, luminance of 1.0° adapting spot, 28 candles/m^2; luminance of 2.5°×5.5° modulated annulus for adaptation study, 7.5×10^{-2} candles/m^2; background luminance, 9.7×10^{-3} candles/m^2. All modulated stimuli for X and Y cell had duration of 500 msec at 0.3 Hz.

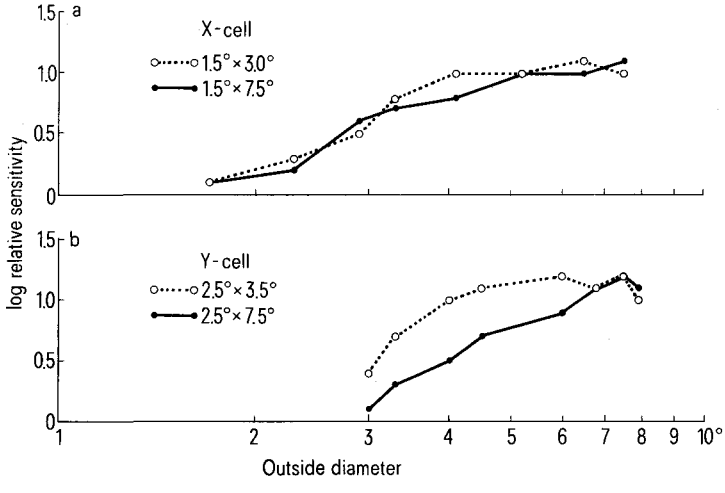

Figure 2. Area-adaptation curves for small and large test annuli. Stimuli: annuli had variable outside diameters and constant inside diameters. (a) X-cell, luminance of 0.3° central adapting spot, 28 candles/m^2; test annulus luminance, 3.4×10^{-2} candles/m^2; inside diameter of adapting annuli 1.5°; background luminance 9.7×10^{-3} candles/m^2; (b) Y-cell, luminance of 0.8° central adapting spot, 52 candles/m^2; test annulus luminance, 6.5×10^{-2} candles/m^2; inside diameter of adapting annuli 2.5°; background luminance 9.7×10^{-3} candles/m^2; all modulated annuli had duration of 500 msec at 0.3 Hz.

The procedure for generating area-adaptation curves was as follows. First, the luminance of the modulated test annulus, presented without a field adapting target, was varied until the criterion response was produced. Test annulus luminance was then increased by 0.7 log units. A field adapting annulus was then positioned in the receptive field surround and its luminance was varied until the cell produced the criterion response. This procedure was repeated for the other adapting annuli.

Figure 1 shows typical results for this experiment. As can be seen the 2 curves are essentially the same for both the X and Y cells. One consistent difference between the X and Y cell results was that the area-sensitivity and area-adaptation curves extended further into the receptive field surrounds of Y cells; otherwise the results were essentially the same.

The fact that area-sensitivity and area-adaptation curves are similar for cat retinal ganglion cells, does not, in itself, provide conclusive evidence that the signal and adaptive pooling areas are the same size. These results indicate that the adaptive pooling area is not larger than the signal summing area but they do not exclude the possibility that the adaptive pooling area is smaller than the signal pooling area.

Green, Tong and Cicerone[13] suggest that a size disparity in the 2 summing areas can be detected by comparing area-adaptation curves determined in the presence of large and small test targets. We utilized their method by measuring area-adaptation curves with annuli whose inside diameter was constant but whose outside diameter varied. 2 test annuli were used. Both had an inside diameter that corresponded to the inside diameter of the adapting annuli but one was considerably smaller than the other one. If the surround's adaptive pooling area is smaller than its signal pooling area, adaptive sensitivity to the small adapting annuli should be greater when the small test target is used because the small adapting annuli would stimulate more of the photoreceptors stimulated by the test target.

The 11 X cells tested in this experiment yielded results similar to those shown in figure 2a: adaptive-sensitivity was not affected by the size of the test annulus. In contrast to this, 9 of the 12 Y - cells tested gave curves that were similar to the Y-cell shown in figure 2b: for these cells the adaptive pooling area is smaller than the signal pooling area.

The similarity of the adaptive and signal pooling areas of X-cells provides evidence that adaptive effects and signals are physiologically pooled at the same point in the retinal circuitry. The lateral extent of spatial summation of adaptation and signals suggests that the amacrine cell is one of the retinal elements within the surround response mechanism. The size of the summing area of the horizontal cell is rather small relative to the size of most receptive fields surrounds[18] and the space constant of horizontal cells is too small[19] to allow for the electrotonic spread of signals over distances comparable to those reported in the present study and those published in other laboratories.

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Dantrolene and the effect of temperature on the spontaneous release of transmitter at the frog neuromuscular junction

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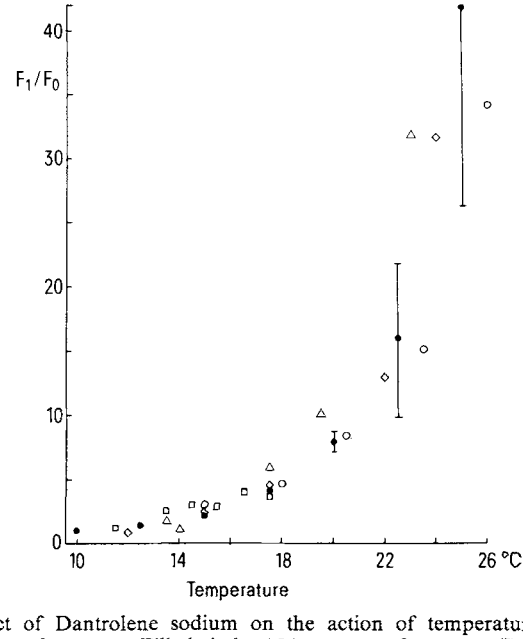
Summary. The characteristic effect of temperature on m.e.p.p. frequency at the amphibian neuromuscular junction is unaltered by the presence of Dantrolene (an agent that is believed to reduce the efflux of Ca^{2+} from intracellular stores) or by changes in $[Ca^{2+}]_o$. It is concluded that temperature affects the release system directly, with a transition temperature at about 16 °C.

The action of a number of agents on the spontaneous release of transmitter (as measured by the frequency of miniature endplate potentials, m.e.p.p.s) at the amphibian and mammalian neuromuscular junction are explicable in terms of altered concentration of intracellular free calcium ($[Ca^{2+}]_i$) at the presynaptic terminals. Experimental results suggest that raising $[Ca^{2+}]_i$ by accelerating Ca^{2+} influx or by releasing Ca^{2+} from intracellular storage sites causes a rise in m.e.p.p. frequency[2,3]. M.e.p.p. frequency at the frog neuromuscular junction is also particularly sensitive to raised temperature, especially above 15 °C where a high Q_{10} and activation energy were recorded[3,4]. The same temperature sensitivity was found in low extracellular Ca^{2+} ($[Ca^{2+}]_o$ buffered at 5×10^{-7} M) and it was therefore suggested that it was possible that the main effect of raised temperature (apart from increasing the activity of the Ca^{2+}-pumps which would serve to lower $[Ca^{2+}]_i$) might be to promote the release of Ca^{2+} from intracellular storage sites[3]. We have now studied the effect of temperature on spontaneous release of transmitter in the presence of Dantrolene sodium (DaNa), an agent that is believed to reduce the steady state level of $[Ca^{2+}]_i$ at amphibian presynaptic terminals by reducing Ca^{2+}-efflux from intracellular stores and which therefore depresses m.e.p.p. frequency markedly[5].

Electrophysiological recordings of m.e.p.p.s were made from the cutaneous pectoris nerve-muscle preparation of the frog *Rana pipiens* by conventional techniques[6]. Preparations were equilibrated in saline containing DaNa (10 μg ml^{-1}) for 40 min at 10 °C, and m.e.p.p. frequency fell to 30%; the effect of varying temperature in the range 10–26 °C was then determined.

The results are shown in the figure, where m.e.p.p. frequency is expressed as a ratio of the control frequency at 10 °C in presence of DaNa (so permitting direct comparison with experiments in the absence of DaNa[3]). It can be seen that DaNa does not markedly modify the characteristic effect of temperature on m.e.p.p. frequency, i.e. spontaneous release is still little affected by temperature change below 16 °C, but is highly temperature-sensitive about this point.

A single experiment was also carried out in which the effect of temperature was studied in the presence of DaNa and in which $[Ca^{2+}]_o$ was buffered at a low level of 5×10^{-7} M. Low $[Ca^{2+}]_o$ also reduces m.e.p.p. frequency, but does not alter the normal overall effect of temperature[3], and the figure shows that this finding is also true in the presence of DaNa.



Effect of Dantrolene sodium on the action of temperature on m.e.p.p. frequency. Filled circles (●) represent frequency (F_1) as a ratio of the frequency at 10 °C (F_0), $[Ca^{2+}]_o = 1.8$ mM, mean of 13 separate experiments ± SE of mean where this exceeds the diameter of the points (data from Duncan and Statham[3]). Open symbols represent results of 4 separate experiments carried out in the presence of Dantrolene sodium (10 μg ml^{-1}); $[Ca^{2+}]_o = 1.8$ mM except triangles (△), where $[Ca^{2+}]_o = 5 \times 10^{-7}$ M.