cholesterol in human beings is interesting in the light of the knowledge that cholic acid and cholesterol in the diet can influence the synthesis of liver cholesterol in animals. Lynen's group has now shown that bile acids are very effective inhibitors of cholesterol biosynthesis (*Arch. Biochem. Biophys.*, **133**, 11; 1969). Rats fed a semisynthetic diet produced much less liver cholesterol than rats fed a normal laboratory diet. But incorporation of labelled acetate into sterols in liver slices was much increased when the animals received with semisynthetic diet a resin which prevented the reabsorption of bile acids. When the rats were fed cholic acid, cholesterol synthesis was more effectively inhibited than when they were fed cholesterol.

This work revealed a diurnal rhythm in cholesterol synthesis depending on the synthesis of new enzymes. At all times, however, cholesterol synthesis could be reduced by feeding 1 per cent cholic acid to the rats. There was no inverse correlation between concentrations of cholic acid and the diurnal variation in cholesterol synthesis. The concentration of bile acids therefore is not responsible for the diurnal variation, but it can act as a powerful inhibitor of cholesterol synthesis. A comparison of the absorption of cholic acid and cholesterol in human beings might therefore be very instructive.

VISION

Periodic Psychophysics

from a Correspondent

A NEW idea in the application of Fourier theory to physiological optics has established the existence of channels in the brain that are selectively tuned to the size of stimulus elements. This effect was discussed briefly as a property of neurones in neurophysiological work about ten years ago, but further work has required the application of a technique which allows the same type of measurements to be made in human observers as are made on single nerve cells in animals.

F. W. Campbell and his colleagues in the physiological laboratory at Cambridge University have applied Fourier methods to the visual systems of cats, monkeys and men. Their method depends on the theorem, familiar in acoustics and electronics, that a signal which is expressed as a function of time can be described by the sum of its frequency components. Similarly a black and white pattern can be described either as a function of space, or of spatial frequency. A thin, bright, straight line can be considered to be made up of all spatial frequencies of sinusoidal variation of brightness extending sideways from the straight line. Only the single line is seen because, except in that region, the sinusoids all cancel. The description of a visual pattern in terms of its spatial frequency content is no less real than any other; it merely happens to be convenient for some types of mathematical manipulation. Just as it may be convenient to discuss an electronic circuit in terms of the frequencies it will transmit, so, too, it is often convenient to discuss an optical system in terms of its spatial frequency response.

Campbell and his colleagues have applied this kind of thinking to the visual system. In outline, their method has been to produce gratings in which brightness varies sinusoidally in one direction. A spatial pattern varying sinusoidally in the horizontal direction, for example, has the appearance of equally spaced vertical stripes with soft blurred edges. When described in the spatial frequency domain this is a very simple stimulus. The visual system confronted by such a pattern responds better to some spatial frequencies than others and a frequency response curve, known as the contrast sensitivity function, can be plotted.

Experimentally this transmission characteristic of the system is determined by finding the depth of sinusoidal modulation of some average level of brightness that an observer can just distinguish from a homogeneous field. Treated in this way the system behaves like a band-pass filter. Maximum visibility is in the region of four cycles per degree subtended at the eye. Both lower and higher frequencies are progressively attenuated.

Several of the papers in which this approach has been expounded, including the most recent (Campbell, Carpenter and Levinson, *J. Physiol.*, **204**, 283; 1969), present evidence that the visual system is sufficiently linear to be treated in this way. Thresholds for visibility of non-periodic patterns were predicted by computing their contrast sensitivities, assuming linearity. Experimental determination of contrast sensitivity functions gave excellent agreement with linear theory particularly for frequencies greater than ten cycles per degree. While not implying that the brain does a Fourier analysis of visual patterns, these results indicate that at near threshold levels, spatial information is transmitted without distortion and that Fourier methods provide an appropriate mathematical representation of the visual system.

This technique certainly seems to be as powerful as any more conventional method applied in vision. Campbell and his colleagues have, for example, confirmed the well known findings of Hubel and Wiesel that neurones in the visual cortex respond best to stimuli oriented in their own preferred direction. More important than mere confirmation, however, is that they have been able to plot orientational selectivity curves using the same spatial frequency response technique for both the rate of firing of single neurones in a cat, and for psychophysical determinations by human observers. It seems likely that the role of such neurones in perception will only be understood when physiological and psychological approaches are integrated in some such way as Campbell's.

As well as showing how orientation sensitive units might be involved in human vision, this group has also investigated what seem to be channels selecting particular spatial frequencies (Campbell and Robson, *J. Physiol.*, **197**, 551; 1968; Blakemore and Campbell, *J. Physiol.*, **203**, 237; 1969). When an observer, without fixating any particular spot, inspects a high contrast grating for about one minute, his threshold for seeing a test grating of the same and neighbouring frequencies is substantially raised. The explanation, again backed up by electrophysiological evidence (Campbell, Cooper and Enroth-Cugell, *J. Physiol.*, **203**, 223; 1969), seems to be that neurones tuned for stimuli of a particular size or width become adapted to the high-contrast grating. This property of width selectivity may well be as important in perception as orientational selectivity. Understanding the role of either type of tuning in pattern recognition, however, may have to await psychophysical experiments more cunning even than these.