CC/NUMBER 45
NOVEMBER 11, 1985

This Week's Citation Classic®

Blakemore C & Campbell F W. On the existence of neurones in the human visual system selectively sensitive to the orientation and size of retinal images. *J. Physiology* 203:237-60, 1969.
[Physiological Laboratory, University of Cambridge, England]

This paper describes how, in the human, exposure to a high-contrast grating raises the threshold for a test grating of the same spatial frequency. By varying the spatial frequency of the test, the bandwidth of the spatial frequency filters can be measured. The evoked potential induced by the test frequency is decreased with adaptation. A direct link is therefore established between the neurophysiology of the visual cortex of the cat and monkey with the human. [The *SCI*® indicates that this paper has been cited in over 540 publications since 1969.]

Fergus W. Campbell
Physiological Laboratory
University of Cambridge
Cambridge CB2 3EG
England

September 12, 1985

The popularity of this paper goes back to Fourier (1768-1830), who introduced the concept that any event in time or space could be represented by the sum of sine and cosine algebra. Ernst Mach (1838-1916) realised that it could be a powerful mathematical approach for the study of the human visual system. He then lost interest in vision and turned to physics. By 1955 the Fourier approach was becoming popular for the study of optical, television, and photographic systems.

In 1957 John G. Robson took over my tiny laboratory to undertake his PhD research on "muscle tremor." He got his degree, but the results were never published! After three years of acrimonious argument, we ultimately published a paper in 1968 that neither of us had set out to produce. It was titled "Application of Fourier analysis to the visibility of gratings."[1]

The idea that there were neurones in the visual system selective to spatial frequency (and orientation[2]) provided a mathematical tool to replace a verbal vacuum about how we see objects. Perception psychologists quickly adopted this quantitative approach and abandoned the verbal approach. The Physiological Laboratory then attracted numerous forward-thinking experimental psychologists to work in Cambridge. Robson and I in turn visited neurophysiological laboratories to initiate the search for these neurones. By 1970 international research was widespread. The fusion-reaction of (Fourier) mathematics, optical-physics, psychophysics, neurophysiology, and neuroanatomy then exploded in the domain of visual science.

Colin Blakemore, now at the University of Oxford, returned from California in 1968 to take up his junior lectureship in my laboratory. He threw his very considerable energy into the spatial-frequency activity under way in Cambridge.

This paper summarised most of the previous work and provided objective evidence (using evoked-potentials from my own scalp) that the neurones in the cat and monkey could be similar to those in *Homo sapiens*. In the paper's discussion section, future lines of research were also outlined. The 1980s are noted for the substantial clinical interest in the Fourier approach to eye disease.[3]

A very important mother-figure for Robson and me was Christina Enroth-Cugell at Evanston, Illinois—a superb neurophysiologist who nursed her two difficult "sons" with tolerance. She always arranged that Robson and I were not in her laboratory or her home simultaneously. In several key papers by Robson and me, a coauthor was Christina.

"Mother Nature" will answer all your questions if you ask her the right question at the right moment in the evolution of technology.

1. **Campbell F W & Robson J G.** Application of Fourier analysis to the visibility of gratings. *J Physiology* 197:551-66, 1968. (Cited 555 times.)
2. **Hubel D H & Wiesel T N.** Functional architecture of macaque monkey visual cortex. *Proc Roy Soc London Ser B* 198:1-59, 1977. (Cited 210 times.)
3. **Hess R F & Plant G T,** eds. *Optic neuritis.* Cambridge, England: Cambridge University Press. To be published, 1986.

 ©1985 by ISI® CURRENT CONTENTS®