Physiological Aspects of Clinical Neuro-Ophthalmology

EDITED BY

C. Kennard and
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Preface

About half of all the afferent fibres projecting to the brain are from the eye, a fact which indicates the primacy of vision amongst the special senses. It is not surprising, therefore, that study of the visual system, including eye movements, has received considerable attention from basic neuroscientists. This relatively recent escalation of interest has been matched by an ever-increasing volume of research into aspects of altered visual function encountered in pathological states in man. For this reason, there is an increasing need for clinical neurologists and basic neuroscientists to discuss areas of common interest and such an international group was invited to attend a meeting in July 1986 to discuss 'Physiological Aspects of Clinical Neuro-Ophthalmology' at the Medical Society of London, funded by the Mansell Bequest. Participants were asked to prepare a chapter in their area of expertise emphasizing neuro-anatomical and neurophysiological aspects and, where possible, relate this to pathophysiological mechanisms involved in clinical disease.

The resulting compilation, which covers a wide area dealing both with visual processing and the control of eye movements, will be of interest to ophthalmologists and neurologists in training, practising neuro-ophthalmologists who wish to update their knowledge of the basic mechanisms underlying many of the common conditions which they routinely examine, and basic neurobiologists in the visual sciences.

C. Kennard

F. Clifford Rose

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Part I

The Visual Pathways

CHAPTER 1

Visual acuity and visual field tests: psychophysical versus pathophysical objectives

LARS FRISÉN

1.1 Introduction

Clinical use of acuity and visual field tests dates back more than one century. The principles laid down by the early pioneers, Frans Cornelis Donders (1818–89), Albrecht von Graefe (1828–1870), Herman Snellen (1834–1908), Edmond Landolt (1846–1926) and Jannik Bjerrum (1851–1920), have been manipulated, permutated and refined in innumerable ways, but the original ideas have stood the test of time remarkably well: these early investigators would easily feel at home with today's clinical routines. Even the recent entry of computers onto the clinical scene has not really changed the nature of acuity or visual field tests.

What has changed, of course, is clinical experience, and the clinical database is still growing briskly. Understanding has also been broadened by the immense advances in experimental physiology, at least in a general sense. Unfortunately, the techniques used by experimental physiologists have little in common with clinical techniques. Experimental studies on disturbances comparable to those encountered in man are, as yet, very few, and further, species differences hamper direct transfer of knowledge from experimental animals to man.

A much closer bond exists in the field of experimental psychophysics, i.e. the quantitative study of links between various physical stimuli and

perception but, again, there are many important differences in favoured techniques, and the major role in psychophysics of advanced (and sometimes contested) mathematical modelling handicaps fruitful exchange. Psychophysical tools like Fourier transforms in space and time domains, mathematical filtering procedures, and abstract channel concepts, are presently worlds apart from the clinician's morphologically centred background. However, the psychophysicist's reliance on statistical logic for unambiguous definition of results could and should find its place also in clinical routines.

The clinician usually performs his examinations with other questions in mind than an improved understanding of what governs normal perception: his principal interest is detecting and monitoring any injuries or lesions. Consequently, his measurements should directly reflect the actual degree of damage sustained by the visual system. Hence, the goal of clinical examinations is not really a psychophysical one, even if the tests themselves can be labelled psychophysical. It may be useful to introduce a specific term to emphasize the quite specialized clinical objectives, namely 'pathophysics', to designate the quantitative assessment of injury by psychophysical measurements of function.

1.2 A pathophysics preamble

The difference between psychophysical and pathophysical viewpoints can be illustrated as follows.

Both acuity and visual field tests furnish quantitative information on the visual performance of the tested subject, as reflected by his responses to sets of test targets. The measurements are obtained under carefully defined conditions, at least nominally. Hence, acuity and field tests meet minimum criteria for psychophysical tests. But, what bearings have the results on the state of the visual system? For instance, what is the meaning of an acuity measurement of, say, 0.5 (20/40)? This is easily identified as an abnormal result, but how severely affected is the visual system? Is 0.25 (20/80) twice as bad? Or, in the case of visual field measurements, what is the meaning of, say, a 10 degree localized bulge in a perimetric isopter, or a 5 dB increase in a static threshold? Again, these are easily recognized as abnormal results but what do they tell about the severity of the underlying lesion? Is a 20 degree bulge or a 10 dB threshold elevation the consequence of twice the amount of damage? Providing answers to these types of questions is the task of pathophysics.

A potentially controversial aspect of the pathophysical concept is the definition of severity of lesions. Is it actually possible to quantify all different pathogenetic mechanisms, and to compare, quantitatively, their