

Comments on the Role of Psychophysics Today

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In choosing to comment on the role of psychophysics in the present age I am moved by having seen my friend *Eberhard Dodt* initiating and leading an important school devoted to the study of visual evoked potentials. I had a chance in 1976 of seeing something of the work going on in Frankfurt, enough to become fascinated by the new developments.

As a matter of fact, psychophysics is destined never to die in the field of vision. Sight is our major interpreter of the external world, and so, facts and mechanisms discovered in visual experimentation will in the end also raise questions about their role in conscious seeing. Some classical examples: *Aubert's* measurements of dark adaptation, *König's* demonstration that the absorption spectrum of rhodopsin agreed with the spectral distribution of sensitivity in the dark, his work in support of the trichromatic theory, *Hering's* ideas on opponent processes based on 'anabolism' and 'catabolism', all these are classic examples of the creative value of psychophysical thinking.

In my youth I was instructed by *Adnemar Gelb* of Frankfurt a.M. to read *Hering* and also followed his advice. Some years later *Sherrington* told me that *Hering's* basic idea of the two opposing processes held sway among the Cambridge physiologists of his own youth. *Sherrington* himself also thought in terms of opposing excitation and inhibition and, in his *Integrative Action of the Nervous System* [1906], he regularly referred to visual analogies of contrast in describing spinal reflexes and their interactions.

If in the past psychophysical observations and theories led to physiological experimentation, today a more common trend is in a reversed direction. The facts and ideas of electrophysiological and chemical exper-

iments now raise questions of their relevance for the act of seeing. Even though the 'physics' end then refers to neurons and nerve fibres instead of to the stimulus alone, its 'psycho' equivalent still represents a desirable final interpretation.

In the old days, so-called psychophysical parallelism was the goal of the experimenters. Even today this way of formulating a problem is not wholly abrogated. Thus, for instance, the Purkinje shift in the electroretinogram of man and other mammals and its occurrence in the spiking of the retinal ganglions of cat and frog is generally held to explain the perceived shift of spectral sensitivity in vision. The unique properties of the electrical responses to short wavelengths, described in *Zrenner's* monograph [1983], likewise have equivalents in perception. The many recent experiments on cortical evoked potentials to stimulation with different wavelengths of light (see the same monograph), also have their parallels in sensitivity as determined psychophysically.

The salient point in classical psychophysical parallelism is one of quantitative agreement between two modes of measuring. The amount of evoked potential, for instance, as determined by the interaction of excitation and inhibition, corresponds to a parallel variation of perceived sensitivity.

The picture alters when from general psychophysical conformity in terms of some measurable quantity one turns to the informational content of electrically recorded messages. Then we are back to the problems of 'editing', as *Adrian* once called it, meaning with this expression the neural treatment of the primary input. The 'editorial' activity of the neurons is of course a problem in its own right but it clearly has an informational goal.

The essential shift of attitude is thus from quantitative parallelism to qualitative teleology whenever an experimenter is asking for the purpose or relevance for seeing of the transformation that he has discovered. The modern notion of 'feature detectors' has no direct quantitative implications in perception. It is concerned with the quality of the message, the 'how' and 'why' of the micro- or macro-recorded event. Electrophysiology is loaded with questions concerning the role of given neural structures for the performance of the eye. Beginning with the significance of the specifically organized receptive fields of the retina, their reorganization, firstly at the level of the lateral geniculate body, secondly at the primary visual cortex, further at several sites of rerepresentation, it is evident that all these 'editorial' modifications raise the same 'why' problems. The individual

worker may well prefer to stop at the level of his localized interests, yet in the background there will always be looming the great teleological question of what any given transform signifies for the act of seeing.

It seems likely that any perceived quality of sight is based on a specific neural organization. If this structure were known we would at the same time have discovered a new kind of psychophysical parallelism in terms of quality. This goal may not be within the reach of scientific endeavor. At an intermediate level (area 17) feature detectors provide a first surrogate for a psychophysical parallelism of quality. I am thinking of the directionality of cortical receptive fields and of the responses to velocity [*Hubel, 1982; Wiesel, 1982*]. The teleological assumption is that such fields serve the equivalent perceptual features.

When, on the other hand, we find that neural time differences serve as cues for the localization of sounds, this is a salutary reminder of the fundamental ignorance as to what our creative brain may invent aided by its own internal resources. These have developed and expanded during millions of years and for this and other reasons may well be beyond scientific understanding.

It is not possible in this context to discuss ways and means of advancing the new psychophysics. My intention was only to make some general comments to a symposium, broad in its scope, yet in the end concerned with the interpretations of our physiological discoveries. I believe that *Eberhard Dodt* shares my inclination towards psychophysical explanations of visual performance as being one final goal. In this sense my words should be taken as a tribute to a friendship between us soon reaching four decades.

References

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