

III. Concluding Remarks from a Psychophysical Perspective

One intention of this symposium was to promote a fruitful dialogue between exponents of psychophysical and physiological approaches to the study of vision. The choice of color vision as the topic was clearly a good one for this purpose, because studies of color vision using either of the two approaches have tended to suggest a relatively uncomplicated and well-defined mechanistic basis for it.

The reports and discussion during this symposium made it clear that the most precise and convincing convergence of evidence between physiology and psychophysics is to be found at the earliest stages of the visual pathway. Estimates of the cone spectral sensitivities made using different psychophysical approaches agree well with one another, as reported by Estevez, Pokorny, and MacLeod; and they are in similarly satisfying agreement with objective estimates such as those made using microspectrophotometry by Harosi and others.

This gratifying consonance between different investigators and approaches gave way to ambiguity and debate when postreceptoral color coding began to be considered. Despite impressive agreement among the physiologists reporting on color coding in the fish retina, it proved difficult to establish firm connections between physiology and psychophysics at this level of the system. Part of the problem was due to species differences, which are clearly profound; this left the human psychophysicists frustrated at seeing so much beautiful and productive work being lavished on systems that could only be compared in the most broad terms with the mammalian one. But the success achieved with preparations like the carp retina encouraged psychophysicists to hope that the organization of the primate system, being basically simpler, will eventually be elucidated just as completely by the physiologists.

At postreceptoral levels there was increasing use of more or less speculative models, which ideally would be able to explain both psychophysical and physiological observations on the same species. The general notion of a recoding of receptor outputs into chromatic (or opponent) and achromatic (or nonopponent) pathways was already persuasively proposed by the psychophysicists of several generations ago,

and it is encouraging that physiology has since arrived at the same general picture. But during the symposium basic ambiguities emerged in considering the anatomical identification of the elements of the psychophysical model, or the visual roles of electrophysiologically characterized cell types. Ingling's presentation provocatively advocated a somewhat heretical view giving the psychophysicists' achromatic system a dual substrate: nonopponent Y cells for tracking rapid stimulus changes, opponent X cells for fine spatial resolution. Very different alternatives also found some support in discussion, however, for instance the possibility that the substrate of the psychophysical achromatic system, whether isolated with flicker or with spatial resolution tasks, might always be the recently described class of nonopponent X cells, or even opponent X cells whose outputs would be assumed to converge at a later stage of processing not yet exposed to comprehensive electrophysiological investigation. Other psychophysicists (Ikeda, Yaguchi) meanwhile reported advances in the quantitative refinement of abstract models of chromatic organization, without risking specification in terms of known cell types. Conversely, some reported refinements of physiological knowledge (such as the unsymmetrical connections of primate short-wavelength cones mentioned by Gouras) still await psychophysical studies or insights to suggest their relevance to vision.

The dialogue also proceeded in other ways besides model building. For instance, Ikeda described analytical techniques for investigating additivity of chromatic interactions that might perhaps be useful in physiological investigations; and other psychophysicists (Hasegawa, Indow, Nayatani) pointed to new or neglected phenomena potentially amenable to physiological investigation.

The symposium itself could be approximately modeled by a scheme with profuse lateral connections between the different types of visual scientist involved, connections that (as was evident during the symposium) are happily excitatory, reciprocal, and rapidly developing rather than fixed.

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