FACULTY FOCUS

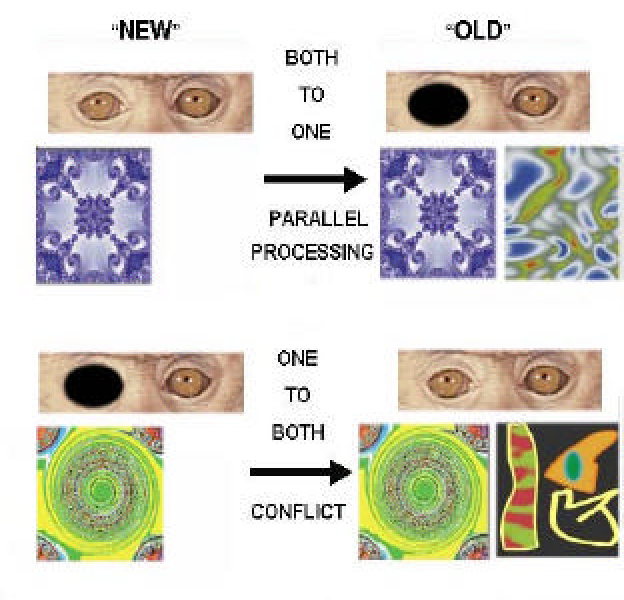
This month the Department of Neurobiology and Anatomy Focuses on...

ROBERT W. DOTY

After a distinguished military career during WWII, Dr. Doty attended the University of Chicago (University of Chicago, Physiology B.S.-1948; M.S.-1949; Physiology, Ph.D – 1950), and was subsequently a post-doctoral fellow at Illinois Neuropsychiatric Institute (W.S. McCulloch, sponsor). In 1951 he was made an Assistant Professor in the Dept. of physiology at the University of Utah, and then in 1956 took a position in the Dept. of Physiology at the University of Michigan. In 1961, he (and family) moved to the University of Rochester as a Professor in Departments of Physiology and Psychology, and the Centers for Brain Research and for Visual Science. From 1996 to the present he has had his primary appointment in the Dept. of Neurobiology and Anatomy.

Doty was a member of the Founding Council of the Society for Neuroscience and in 1976 was the president of that organization. He continues his scientific career which has extended through five decades and includes publication of over 150 peer-reviewed articles, book chapters and reviews. His current research efforts focus on understanding the various features of interhemispheric processing and its relevance to numerous clinical, practical, and philosophical concerns. Below is a brief description of this work.

Two Monkeys (People) in One Head



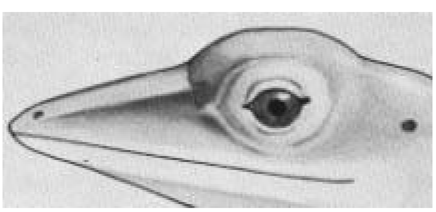
For present purposes the significant parameter by which the fellow at the left differs from us is that he no longer has his forebrain commissures (corpus callosum and anterior commissure), and the optic chiasm has been cut so that each eye goes to the corresponding cerebral hemisphere, i.e., a split-brain macaque. Thus, there is a right monkey and a left monkey, joined only by body and brainstem. Now, in the top left picture (Kavcic et al. ***Behav Brain Res***, in press) the two monkeys view different pictures at the same time, "NEW" (for only 200 msec), and later one of the monkeys is asked whether it remembers the picture that it saw , "OLD". Can it do so equally as well as if the "other monkey" had not also been trying to remember a picture at the same time? The answer is that, indeed, it can - but usually not as accurately as if another image had not been seen at the same time by the other hemisphere. In other words, the two "isolated" hemispheres can achieve simultaneous, "parallel" mnemonic processing, but it usually suffers in accuracy compared to the situation when either monkey/hemisphere acts entirely alone on each occasion. Thus, there is general evidence that what one hemisphere is doing may detract something from the ability of the other when the “doings” are concurrent.

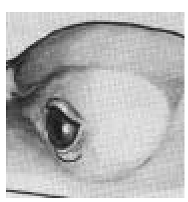
What makes the situation even more intriguing, however, is the fact that, if the two hemispheres, as in the example above, view ***different*** images, the deleterious effect of initial, simultaneous viewing is augmented, compared with the case where the two hemispheres view ***identical*** images.

Another question that can be asked of these “two monkeys” is which will win when the choice is ambiguous. This situation is illustrated by the two lower pictures. On the left, the left hemisphere views an image (in the right visual field, and since the chiasm is cut sees nothing in the left visual field). Thus, when both hemispheres view the images shown at the right of the lower pair of pictures, the left hemisphere sees its image for the second time, i.e., it is OLD; but the right hemisphere sees “its” image for the first time, i.e., it is NEW. How “the monkey” responds is a matter of “metacontrol”, i.e., which hemisphere can command the motor apparatus. This turns out to be a matter of which hemisphere is “dominant” in this situation and, since we always rewarded a response of OLD, “the monkey” is unable to maximize “its” reward if one hemisphere is so dominant that it controls the response on every trial. Since the trials are equally divided, consistent dominance is correct on only half the trials. One animal, however, was somehow able to solve this conflict between the hemisphere to attain, 85-89% “correct” (a rewarded response of OLD); but only if the two hemispheres on the conflict trial were ***looking at the same image***. When they each viewed ***different*** images, this animal achieved only 60-66% “correct”.

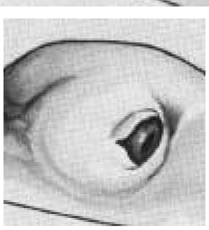
Thus, again, the viewing of ***different*** images by the two hemispheres yields distinctly different results compared to each hemisphere viewing the ***same*** image. This suggests that despite the “split”, something in the brainstem is endeavoring to unify the images being received from each eye; and when this is impossible, some degree of confusion ensues.

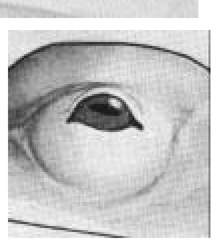
This is not just a phenomenon of split-brain macaques. At the left are two “Kanizsa” figures, that are “illusory” in the sense that there are no actual lines to define the hexagon and pentagon that one perceives. Marcel (***Brain 121:***1565,1998) showed these Figures to patients lacking striate cortex projections to one hemisphere; yet when the right half of these Figures fell within the blind field, the patients nevertheless experienced the normal perception. In other words, subcortical processes were able to complete the induction of the illusion ***in the seeing field*** even though there was no direct visual cortical projections to accomplish it.





Why should subcortical visual processes be devoted to unifying input from the two eyes or fields? Consider the chameleon, as illustrated here from Esther Bohlman’s lovely drawings of *Anolis carolinensis* (Polyak/Klüver ***The Vertebrate Visual System,*** U Chicago, 1957, p 842).





Unlike most vertebrates with laterally placed eyes, many species of Old and New World lizards have extreme mobility of their exquisitely foveate eyes, ***and can move them independently***. Thus, the lizard has two visual modi operandi, one with unfused images from each eye, and a second with binocular fusion to gain depth perception when about to strike their prey. Presumably, each hemisphere and optic tectum can analyze “its” visual world; and then when a target is identified, switch to a cooperative, unified mode in which diplopia is dissolved in favor of a singularity of the visual world. Primates, on the other hand, have chosen to use diplopia only in so far as it provides stereoscopic vision and, with the help of the forebrain commissures, maintains a unified visual scene. Presumably, this transition to unity has been so fundamental (at phylogenetic level of the lizard brain) that it incorporates subcortical mechanisms in its achievement. Thus, our experiments, and those of Marcel, tap an ancient vertebrate process for unifying the visual world - at the cost of being unable to watch the television with one eye/hemisphere while doing homework with the other, but being always able to tell how far away is the next branch one wishes to leap to.