into an era of more successful systematic exploitation. Cooperation and competition are the complementary aspects of a process that has created ever closer economic integration in the area. It has worked to make the local people efficiently interdependent and at the same time ever more skillful at utilizing the national bureaucracies and national businesses to serve their local needs. A corollary to this is competitive replacement, a process in which the more efficient managers of the environment come to dominate in the area. Bennett also enunciates what is perhaps his most interesting process, behavioral selection: given adaptations produce and are fostered by specific attitudes. Initial agrarian settlement produced "cautious, conservative, risk-avoiding" strategies coupled with close attention on the part of any one man to all forms of experimentation tried by his neighbors. More prosperous conditions have favored innovation and sophisticated technical adjustment to economic and ecological variables, and hence have led to a change in world view focusing on boldness and experimentation.

The initial period of settlement in marginal and variable agrarian environments involves high out-migration and a high rate of replacement followed by a leveling out of population much nearer the region's real carrying capacity. As a result, a demographic aspect of behavioral selection is high tolerance for migration. Carrying capacity is ultimately raised and population loss halted by cooperative, communal enterprises, perhaps funded federally or by a centralized church, but governed and owned locally. After creating this model, Bennett makes a number of suggestions for greater success in the region, largely centering around the last process. It is refreshing to see such an unpostured and balanced example of pertinent anthropology.

Northern Plainsmen has a number of shortcomings in its use of theory. Bennett correctly sees that cultural ecology must be linked to a consideration of adaptive processes to take advantage of the time span his laboratory provides. His effort is only partially successful. The volume is organized around particularistic accounts of the four cultures in the area, not around a thorough examination of the cultural processes behind the particular adaptive strategies. Cultural ecology could be linked here with concepts from systems theory so that more variables could be measured, the relations between causal variables and crucial events could be determined more accurately, and more precise predictions could be made. And last, Bennett is a cultural materialist and has written a book demonstrating the fruitfulness of that assumption and the research strategy based on it. A result of this, however, is conceptual poverty in the parts of the book dealing with cognition and ideology. Bennett has written a superb chapter on the Hutterites and yet does not consider the precise relationship that must exist between their world view and their economics. The same deficiency is found in the treatment of ranchers and farmers. The Hutterites have produced the most successful adaptation to the region. It is based on explicit notions of utopian socialism. Farmers and ranchers are moving to a more secure adaptation through cooperative and communal efforts also. Isn't it clear that religion and world view play more than a subsidiary role in these evolving and coinciding adaptive strategies? Isn't it clear also that evolutionists and cultural ecologists must begin to see these as variables in their analyses?

The book has a fine bibliography on all aspects of agrarian life that have been treated by the social sciences.

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Cortical Connections

The Bisected Brain. MICHAEL S. GAZZANIGA. Appleton-Century-Crofts (Meredith), New York, 1970. xiv, 172 pp., illus. $10. Neuroscience Series, vol. 2.

The author is one of the main contributors to the second decade of research on the remarkable effects of cutting the commissures joining the cerebral hemispheres. Begun by R. W. Sperry and his students in the early '50's (the group to which Gazzaniga later belonged), studies with the "split-brain" preparation demonstrated the critical role in integration played by horizontal connections, that is, those lying entirely within one level of the neuraxis. It is now clear that cortico-cortical connections between the hemispheres (and, by implication, within a hemisphere) transmit information important to perception, learning, memory, and motor control.

These discoveries came at a time when leading investigators were stressing the vertical organization of the nervous system and were questioning the earlier principle of levels of neural integration. Communication within a given level among cell groups belonging to separate vertical systems was considered to have little functional significance. This theoretical bias seemed to be supported by empirical results; not only did disconnections within a hemisphere appear innocuous, but section of the corpus callosum (the main fiber system between the hemispheres) failed to reveal any clear effect beyond that of preventing the spread of epileptic activity from one side of the body to the other.

The corpus callosum was thus considered to be a pathway playing no essential part in normal interhemispheric integration. The question was reopened by the Sperry group with a brilliant series of studies showing that in commissurotomized cats and monkeys interocular and intermanual transfer of learned discrimination habits is prevented if the training conditions are such that the sensory input is restricted to one hemisphere. During the later phases of this research, a series of epileptic human cases with surgical section of all endbrain connections between the hemispheres (including the anterior commissure, left intact in earlier patients) became available for study. The beneficial effects of the operation exceeded those that were expected, since not only were seizures confined to one side but their frequency was appreciably diminished, probably by reduction in reverberatory activity.

Conversely, however, deficit phenomena came to light which either were not present or were missed in cases studied previously. The existence and form of the disconnection syndrome in man are now firmly established, an old controversy in neurology being thereby settled. It is in the delineation of this syndrome that Gazzaniga has made his major contribution. In this book he describes and interprets, somewhat more completely than in the previously published reports, the deficits found in three of the newer cases, those with the least preexisting extracallosal brain damage and with uncomplicated recovery from the surgery.

Because of specialization of the hemispheres in the human brain (the left for speech and the right for spatial organization of function), the effects of disconnection in man are bizarre. For example, the patient cannot describe an unseen object held in his left

hand, because the necessary information is contained within the right hemisphere and has no access to the speech mechanisms of the left. Nor can he make accurate representational drawings with his right hand, because the motor activity of this hand is directed by the left hemisphere and lacks guidance from the spatial mechanisms of the right. Effects such as these have been observed in many different kinds of tests which vary the sensory channel through which the stimuli are received and the particular response required of the subject.

There were situations in which the expected disconnection effects did not occur, however. These exceptions led to several important hypotheses relating, first, to the capacity of the right hemisphere for mediating a limited comprehension of words; second, to the type of information transmitted by the ipsilateral sensory pathways from the trunk and limbs; and third, to the role of peripheral "cross-cuing" strategies by which one hemisphere can be apprised of what the other is experiencing.

Gazzaniga places great emphasis on such cross-cuing as an explanation of apparent "leakage" of information in the bisected brain and offers some experimental evidence showing that patients do use strategies of this kind. For example, the presence and gross location of a stimulus in the left visual field (projected to the right hemisphere) can be signaled to the left hemisphere by an orientation response of the head and eyes. Or an emotional response elicited by stimuli to the right brain-half can indicate to the left that something arousing has occurred. Gazzaniga suggests that proficiency at cross-cuing may explain why cases with agenesis of the corpus callosum do not show most of the deficits found in patients with surgical disconnection of the hemispheres performed in adulthood.

But this suggestion, based largely on a finding of disconnection effects on one test in one case of agenesis, leads him to further proposals which are at best speculative in the extreme. Extending his notion to the well-documented finding that early brain lesions produce markedly less decrement than later ones, he concludes that the difference is likely to be more apparent than real, that is, that the spared performances are being carried out by unusual strategies. This view implies that as the organism matures there is no shift of function from lower to higher centers but rather a diminution in the variety of strategies available to it for achieving a given goal. Against this view, however, is evidence indicating that the animal that is ontogenetically or phylogenetically advanced is capable of employing more rather than fewer alternative strategies than a younger or lower form. Gazzaniga's argument is therefore not convincing.

Much the same can be said of his attempted explanation of how the left hemisphere becomes dominant for speech. He proposes that the young child has essentially a split brain. This postulated condition, together with a tendency toward right-handedness, is said to result in an ever-increasing formation of "engrams" in the left hemisphere rather than the right. Even assuming the validity of these propositions (although there are many reasons to doubt them), their relevance to the preeminent role attained by the left hemisphere in the speech code is never made explicit, and the parallel question of how the right hemisphere becomes preeminent in spatial organization is not dealt with at all. An adequate theory must surely encompass both questions.

The book closes with a section on future directions in split-brain research. Gazzaniga sketches a few interesting examples of how the commissurotomized animal might be used to illuminate some of the perennial issues in physiological psychology. To this reviewer, it seems that one of the more promising avenues is that of combining a split with a unilateral ablation. Such a preparation, when contrasted with one having a corresponding bilateral removal but intact commissures, might further sharpen current notions of the part played by horizontal connections in behavioral organization. It has been urged by researchers on the split brain that one of the advantages of their approach is that only unilateral ablations need be made to uncover the deficits that usually appear only after symmetrical bilateral removals, and Gazzaniga seems to adhere to this view. Yet the assumption is open to question that the effects of bilateral lesions on performances carried out, say, with one hand can be mimicked by contralateral lesions combined with commissurotomy. Recent work (R. K. Deuel, M. Mishkin, and J. Semmes, *Experimental Neurology*, in press) on the frontal and temporal lobes, undertaken to test this hypothesis, has not confirmed it. Not only do bilateral lesions produce a kind of deficit that unilateral lesions plus commissurotomy fail to produce, but the converse is also the case. These results are indicative of a difference in function between the vertical and the horizontal connections to and from these lobes. In most lesion work the different functions are confounded, but the split-brain approach makes it possible to tease them apart and hence to arrive at a better understanding of the contribution to performance of particular neural circuits.

In sum, the book deals with a method of research which has provided, and undoubtedly will continue to provide, new insights into how the brain works. The speculations to which the author has been led, although perhaps hasty and incautious, may indicate just how stimulating the split-brain approach can be.

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The Biochemical Parameter

Chemical Ecology. Based on a series of lectures, Syracuse, N.Y., 1968. ERNEST SONDHEIMER and JOHN B. SIMEONE, Eds. Academic Press, New York, 1970. xvi, 336 pp., illus. $16.50.

This volume comprises 11 chapters, each based upon a lecture by a visitor to the College of Forestry at Syracuse University, presented particularly for the benefit of students in the fall of 1968. With coordination by C. M. Williams, an impressive list of authors has presented a less than thoroughly integrated series, perhaps making up in depth in some areas what it lacks in breadth.

The ecologist reader should be warned at the outset that the subject of chemical ecology as dealt with by most of the contributors is narrow in scope. There will doubtless be a consequent tendency for various groups of readers to provide their own emendations of the volume's title to fit the material included. Prominent omitted material falls almost entirely within the subjects of community processes: the functioning of the ecosystem, the multifactorial environmental complex, and most other holistic ecological phenomena. This is more an indictment of ecologists for not accommodating the biochemical parameter in the environmental complex than it is a criticism