The Nature of Interhemispheric Communication

The human brain is organized so that two potentially independent mental systems exist side by side. When separated by the slice of a surgeon’s knife, each resulting half-brain possesses its own capacities for learning, emoting, thinking, and acting. Yet, with the forebrain commissures intact, these potentially independent neural spheres work together to maintain mental unity.

In this chapter, we explore the fascinating role of the corpus callosum and the anterior commissure in the maintenance of mental unity. Our goal is to specify the essence of commissural function by elucidating the “what,” “why,” and “where” of interhemispheric communication. We begin this quest billions of years ago in the sea.

WHAT TRANSFERS AND WHY?

A paleoniscid swims in its prehistoric aquarium in search of food. A suitable prey is detected in the right visual field, moving rapidly to the left. Before the primitive vertebrate can change its course, the prey crosses the visual midline and enters the left visual field. Because the optic projections of the fish are crossed, the right visual field is seen by the right eye and the left half-brain,
and vice versa. Does this mean that when the prey moves out of one visual field and into the other, the neural control over the chase switches from an informed to a naive half-brain? Hardly!

The commissural system (which is more accurately called a system of decussations in nonmammals) provides each half-brain with a copy of the sensory world directly observed by the other hemisphere. It is by way of this incredible feat of neural engineering that the integrated organism responds to sensory stimulation selectively channeled to one half of the brain. This ancient vertebrate blueprint is as relevant for the fish as it is for man.

Consider case D.H. Prior to surgery, D.H. could, without the aid of vision, find an object with one hand that had only been felt by the other. After surgery, however, he could no longer accomplish this simple task. Tactual information in the left hand and the right hemisphere remained isolated from the right hand and the left hemisphere. Yet, when a visual stimulus, such as the picture of an apple, was lateralized to either hemisphere, either hand could manually retrieve the apple, unaided by visual exploration. This unique phenomenon is attributable to the fact that D.H.'s anterior commissure was intentionally spared by the surgeon. Because this interhemispheric bundle contains visual fibers but not somatosensory fibers, D.H. was tactualy split but not visually split. So, regardless of which hemisphere saw the apple directly, both ulti-

FIGURE 5. The specificity of functions in the fully developed cerebral commissures is quite remarkable. Surgical section of the corpus callosum in case D.H. found visual information transferring through the remaining anterior commissure. Tactile information does not transfer. Predictably, however, visual-tactile matches can be carried out (see text).