II

Language processing does not take place in a single brain region, but in several brain regions that constitute a larger language network. Chapter 1 described the different regions within the network and their particular function. During language processing, however, these regions have to cooperate. And the question is: How do they do it?

In this part of the book I will describe the neural basis that may make cooperation and exchange of information within the language network possible. Transmitting information from one brain region to another region should be based on a neurophysiological principle that can bind the relevant regions, preferably if possible at the structural and functional level.

The available data suggest that the language-related regions are part of a larger network within which information is exchanged. The different language-relevant parts are connected by a large number of white matter fiber tracts responsible for the transmission of information from one region to another. In chapter 1 we have seen that the language-relevant brain areas are distributed over the left hemisphere involving the frontal and temporal lobe and even partly involve the right hemisphere. These brain areas are connected by particular long-range white matter fiber tracts. These fiber tracts together with the language-relevant brain regions constitute the larger structural language network. Within this network different subparts either connect brain areas processing syntactic information or brain areas processing semantic information. These structural connections will be discussed in chapter 3, at the end of which I propose a neuroanatomical pathway model of language.

In order to guarantee language processing these areas also have to constitute a functional network. This means that neuronal ensembles creating the neural activation in different brain regions must find a way to communicate with each other. Neurons and neuronal ensembles send electrical signals through the white matter fiber tracts, but the communication from one neuron to the next is based on neurotransmitters guaranteeing the transmission of a nerve impulse. We will see that at this microscopic neurotransmitter level it can be demonstrated that the cortical language regions constitute a network even at this level. The regions within the larger language are receptorarchitectonically more similar than those outside the language the network. At a macroscopic level we can observe the cooperation between brain regions by means of functional connectivity and oscillatory activity reflecting the simultaneous activation of different brain regions. These functional aspects will be discussed in chapter 4, at the end of which I propose a model describing the functional neural language circuit.

At present it is an open question to what extend functional connectivity and structural connectivity map onto each other. This is because functional connectivity only tells us whether two brain regions are activated simultaneously. This could be mediated by a direct structural connection (i.e., a direct fiber tract between these two regions), or by an indirect way mediated by subcortical structure such as the thalamus or the basal ganglia. Future research will have to solve this open question.