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4. New Trends in Functional Neuroimaging: Imaging of Neuroreceptors

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Nerve signals pass from one neuron to the next via the synapse. This process is a chemical event in which neurotransmitters, upon release from presynaptic nerve terminals into synapse, act on postsynaptic receptor sites to produce either excitation or inhibition of the target neuron. This neurotransmission is then terminated when any excess neurotransmitters are removed from the synapse via reuptake sites (transporters) located on the membrane of presynaptic nerve terminals. With the advent of positron emission tomography (PET) and single photon emission computed tomography (SPECT), it has become feasible to measure certain critical components of neurotransmission such as presynaptic transporters and postsynaptic receptors in living human brain. These imaging techniques provide clinically and experimentally significant information. In particular, the recent progress toward the development of iodinated and technetium-labeled neuroligands promises to make SPECT imaging of the dopaminergic, benzodiazepine, and cholinergic systems a widely available clinical tool. The long physical half-life of ^{123}I or ^{99m}Tc can provide imaging opportunities of clinical significance that are not feasible with short-lived PET tracers. In addition, SPECT/PET imaging of neuroreceptors has been shown to be highly reproducible and hence it may be suited to use clinically to evaluate the significance of serial changes, for example, in the dopamine receptor or dopamine transporter status in patients with progressive extrapyramidal disorders.

The use of imaging techniques with PET or SPECT designed to evaluate the integrity of presynaptic (via transporters) and postsynaptic (via receptors) neurons has thus opened a door to an exciting area of clinically useful applications and research. However, the challenge to utilize these techniques for clinical and research use may be just beginning because neurotransmitter systems are composed of a number of diverse complex elements which are capable of dynamic interactions within the system or in response to changes that take place in another neurotransmitter system. For example, striatal dopamine receptors consist of two major receptor subtypes, D1 and D2 receptors, the latter modulates the presynaptic dopamine transporter density, which in turn is the major modulator of synaptic dopamine concentrations. The nigrostriatal dopaminergic transmission furthermore strives to maintain a balance with striatal cholinergic activity, which is in turn under the influence of corticostriatal glutamatergic activity. Therefore, future efforts may be needed to develop innovative techniques to delineate dynamic neurochemical changes *in vivo* concurrently in multiple neurotransmitter systems. The development of such techniques should not only expand their clinical applications but also further our understanding of neurochemical changes associated normal and disease states *in vivo*.