

Thinking Like a **PSYCHOLOGICAL SCIENTIST**

Neurotransmitters and Drugs

The synapse is where it's at when it comes to the effects of many drugs. Let's take a look at the roles of three key neurotransmitters (see **Table 4.2**) and see what happens when outside chemicals are added to the mix.

One neurotransmitter, *acetylcholine (ACh)*, triggers muscle contraction and affects both learning and memory (Alzheimer's disease is associated with low levels of ACh). ACh is present in every synapse of motor nerves. Certain drugs can disrupt the normal effects of ACh, however. Some South American Indians use such a drug, a poison called curare, to coat the tips of the darts they use in their blowguns. When these darts strike an animal, the result is paralysis. Why? Because the curare molecules fill the receptor sites on dendrites that normally receive ACh, but the curare molecules do not stimulate an action potential in the receiving neuron the way ACh would. This means that ACh is blocked from doing its job, and movement ceases. Substances such as curare that block the effects of a neurotransmitter are called **antagonists**.

Black widow spider venom also interacts with ACh, but not in the same way curare does. The venom fills

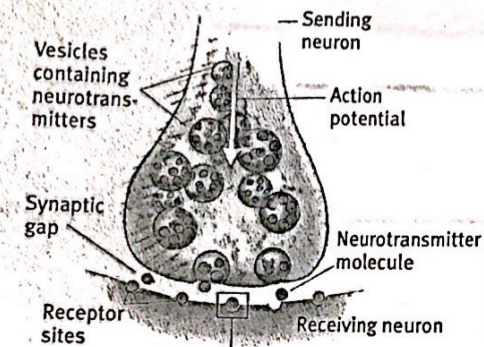
the ACh receptor sites, but its chemical structure is so similar to ACh that it mimics ACh's effect on the receiving neuron. So, now two substances, ACh and spider venom, are doing the same thing. The result is excessive and uncontrollable movement in the form of convulsions. The spider venom is called an **agonist**, a drug that boosts the effect of a neurotransmitter. **Figure 4.3** illustrates how antagonists and agonists interact with neurotransmitters.

Another neurotransmitter with interesting effects is *dopamine*, which influences learning, attention, and emotion. Schizophrenia, a serious illness that disrupts a person's sense of reality, is associated with high levels of dopamine. Drugs commonly prescribed for schizophrenia alleviate some of the symptoms by blocking the action of dopamine at the synapse. These drugs are dopamine antagonists.

Another disorder, depression, may be associated with low levels of the neurotransmitter *serotonin*, which affects hunger, sleep, arousal, and mood. Some medications, the most famous of which is Prozac, work to reduce depression by enhancing the availability of

SOME NEUROTRANSMITTERS AND THEIR FUNCTIONS

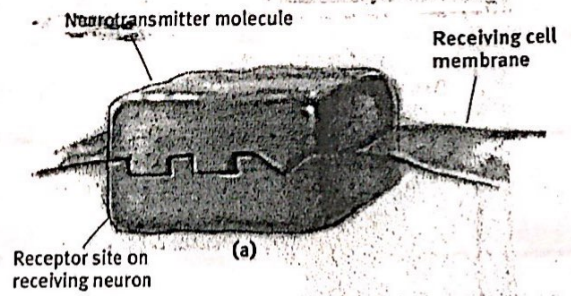
Neurotransmitter	Function	Examples of Malfunctions
Acetylcholine (ACh)	Enables muscle action, learning, and memory.	With Alzheimer's disease, ACh-producing neurons deteriorate.
Dopamine	Influences movement, learning, attention, and emotion.	Excess dopamine receptor activity linked to schizophrenia. Starved of dopamine, the brain produces the tremors and decreased mobility of Parkinson's disease.
Serotonin	Affects mood, hunger, sleep, and arousal.	Undersupply linked to depression; Prozac and some other antidepressant drugs raise serotonin levels.
Norepinephrine	Helps control alertness and arousal.	Undersupply can depress mood.
GABA (gamma-aminobutyric acid)	A major inhibitory neurotransmitter.	Undersupply linked to seizures, tremors, and insomnia.
Glutamate	A major excitatory neurotransmitter; involved in memory.	Oversupply can overstimulate brain, producing migraines or seizures (which is why some people avoid MSG, monosodium glutamate, in food).



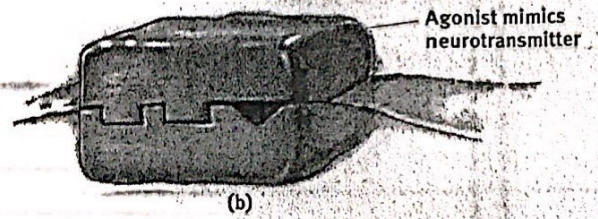
Neurotransmitters carry a message from a sending neuron across a synapse to receptor sites on a receiving neuron.

FIGURE 2.6
Agonists and antagonists

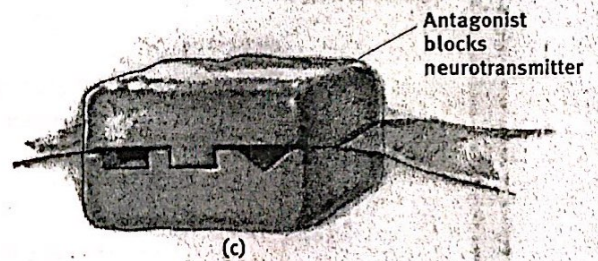
This neurotransmitter molecule fits the receptor site on the receiving neuron, much as a key fits a lock.



This agonist molecule excites. It is similar enough in structure to the neurotransmitter molecule to mimic its effects on the receiving neuron. Morphine, for instance, mimics the action of endorphins.



This antagonist molecule inhibits. It has a structure similar enough to the neurotransmitter to occupy its receptor site and block its action, but not similar enough to stimulate the receptor. Curare poisoning paralyzes its victims by blocking ACh receptors involved in muscle movement.



serotonin at the synapse. Prozac, therefore, is a serotonin agonist.

Prescribed medications are not the only substances that exert their effects at the synapse. All mind-altering chemicals, ranging from caffeine to cocaine, operate by influencing neurotransmission. A single drug, such as alcohol, might influence several neurotransmitters in different ways depending on the synapse it enters. Research on neurotransmitters is always in progress and brings fascinating and important results.

Figure 4.3
Antagonists and Agonists

When a drug *blocks* the effect of a neurotransmitter, it's called an antagonist. When a drug *boosts* the effect of a neurotransmitter, it's called an agonist.

antagonist A drug that blocks the effect of a neurotransmitter.

agonist A drug that boosts the effect of a neurotransmitter.