# Drugs, Physiochemical Bonding, and Human Experience

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For years writers have been fascinated by the drug experience. Lewis Carroll's *Alice in Wonderland*, Thomas De Quincey's *Confessions of an English Opium Eater*, and William James's *Varieties of Religious Experience*, among many other important works, give dramatic testimony to the power of drugs to alter experience, and to lead us into a realm that is sometimes beautiful, sometimes frightening.

In the nineteenth-century fantasy novel *Alice in Wonderland* Lewis Carroll takes the heroine on a number of trips to various places. One of the trips is called "Down the Rabbit Hole," which he describes this way:

> Alice opened the door and found that it led into a small passage, not much larger than a rat-hole: she knelt and looked along the passage into the loveliest garden you ever saw. How she longed to get out of that dark hall, and wander about among those beds of bright flowers and those cool fountains, but she could not even get her head through the doorway; "and even if my head *would* go through," thought poor Alice, "it would be of very little use without my shoulders. Oh, how I wish I could shut up like a telescope! I think I could, if I only knew how to begin." For, you see, so many out-of-the-way things had happened lately, that Alice had begun to think that very few things indeed were really impossible.
>
> There seemed to be no use in waiting by the little door, so she went back to the table, half hoping she might find another key, or at any rate a book of rules for shutting people up like telescopes:

this time she found a little bottle on it ("which certainly was not here before," said Alice), and tied around the neck of the bottle was a paper label, with the words "DRINK ME" beautifully printed on it in large letters.

It was all very well to say "Drink me," but the wise little Alice was not going to do *that* in a hurry. "No, I'll look first," she said, "and see whether it's marked '*poison.*' . . ."

However, this bottle was *not* marked "poison," so Alice ventured to taste it, and, finding it very nice (it had, in fact a sort of mixed flavor of cherry-tart, custard, pineapple, roast turkey, toffy and hot buttered toast), she very soon finished it off.

* * * * *

"What a curious feeling!" said Alice. "I must be shutting up like a telescope!"

And so it was indeed: she was now only ten inches high, and her face brightened up at the thought that she was now the right size for going through the little door into that lovely garden.

(1865, pp. 8-11)

Alice was certainly not the first fictional or real person to have what might be considered a drug trip. She was preceded by many others, both in fiction and in fact, who had experienced the joys of drug use. For example, in 1823 in his influential book *Confessions of an English Opium Eater* Thomas De Quincey describes the euphoric state of consciousness that occurred when he took a narcotic medicine, tincture of opium, in an attempt to relieve a toothache:

I took it: and in an hour, oh heavens! what a



revulsion! what a resurrection, from its lowest depths, of the inner spirit! what an apocalypse of the world within me! That my pains had vanished was now a trifle in my eyes; this negative effect was swallowed up in the immensity of those positive effects which had opened before me, in the abyss of divine enjoyment thus suddenly revealed. Here was a panacea . . . for all human woes; here was the secret of happiness about which philosophers had disputed for so many ages at once discovered; happiness might now be bought for a penny, and carried in the waistcoat pocket; portable ecstasies might be had corked up in a pint-bottle, and peace of mind could be sent down in the mail. (1907, p. 179)

This medicine that De Quincey took has a very interesting formula: it consisted of two ounces of strained opium, one ounce of saffron, one dram of cinnamon and cloves all dissolved in a pint of canary wine. It was a rather common over-the-counter remedy in the nineteenth century, which could be bought by anyone for the relief of mild or severe pain.

Another author, the philosopher, psychologist, and educator William James also wrote on a similar topic. Although he didn't talk about drugs directly, he was speaking of them in an indirect way when he wrote about consciousness. In *The Varieties of Religious Experience: A Study in Human Nature*, James says "Our normal waking consciousness is but one special type of consciousness, whilst all about it, parted from it by the filmiest of screens, there lie potential forms of consciousness entirely different. We may go through life without suspecting their existence, but apply the requisite stimulus, and at a touch they are there in all their completeness. . . ."(1902, pp. 298)

The requisite stimulus of which James speaks could be any number of things, but for the purposes of this article we'll consider the requisite stimulus to be drugs. The bottle from which Alice

drinks, the bottle from which De Quincey drinks, the LSD which Timothy Leary ingested, the cocaine that current sophisticates snort, the pot that today's younger and older populations use, the alcohol so commonly accepted — all of these substances are drugs in one form or another. They have many other counterparts, and they provide the stimulus for going from one state of consciousness to another. Drugs enable human beings to alter experience, to have new experiences, to have some beautiful experiences, to have some frightening experiences. The question for science is how do these drugs, commonly called psychoactive drugs, exert their effects on the human organism. How can a substance small in quantity have such profound effects on human experience?

In order to understand how a drug has an effect on the human body or any other living organism one must look at the nature of cellular structures and drug molecular structures. The first basic principle of drug action is that a drug has an effect on living tissue only when it forms a physiochemical bond with a cell, or with a constituent of a cell. When this interaction takes place, drug effects occur. This interaction may be at a cell surface or cell membrane, or it may occur inside the cell. If it occurs at the cell surface, it may occur at a specific area called a receptor site or it may affect the whole cell membrane, or possibly have an effect on the transport mechanism at the cell site. If this drug-cellular bond occurs inside the cell it often has an effect on enzyme systems, which affect neurotransmitters in the cell.

There is a second basic principle which must be understood before one can appreciate the actions of drugs. A drug either mimics, facilitates, or antagonizes normally occurring neurological processes. This means that a drug may affect a cell in one of three ways: it may increase the activity of the cell, it may decrease the activity of the cell, or it may disrupt the activity of the cell. The magnitude of the drug effect depends upon the concentration of the drug at the site of action: that is, how much drug is present where this physiochemical bonding occurs.

It helps to understand the mechanisms of drug action if they can be visualized. Figure 1, a diagram of the nervous system neuron, shows the basic structure which is involved in neurotransmission. A



neuron or nerve cell is the structural and functional unit of the nervous system. In figure 1, notice the cell body, the projections coming into the cell body called dendrites, and the large fiber leaving the cell body called the axon. Very simply stated, a nerve impulse travels to the cell from some stimulus by the way of the dendrites, passes through the cell body, and exits by way of the axon. At the end of the axon you see little tendrils or finger-like projections, which are called axon endings or telodendria.

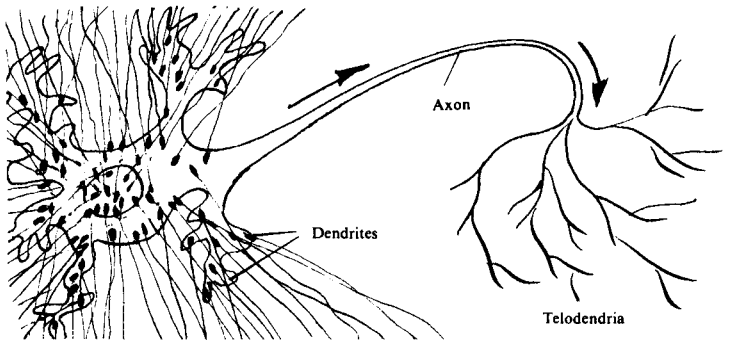


*Figure 1.* The dendrites and cell body of a motor neuron are covered with thousands of telodendria bringing neural information from other neurons. (Adapted from Rod Plotnick and Sandra Mollenauer, *Brain and Behavior: An Introduction to Physiological Psychology* [San Francisco: Canfield Press, 1978].)

Neurons are three dimensional structures resting in a warm salt water solution in the organism in which they exist. In that warm salt water solution and also in the interior of the neuron are positively and negatively charged substances. Examples of positively charged substances are sodium and potassium; examples of negatively charged substances are chlorine and protein structures. A look at figure 2 shows the placement of positively charged ions on the

outside of the neuron and negatively charged ions on the inside of the neuron. When a neuron is at rest there exists a difference in electrical potential between the inside and the outside of the neuron. The inside of the neuron is electrically negative when compared to the outside of the neuron, although positive and negative charges are in both areas.

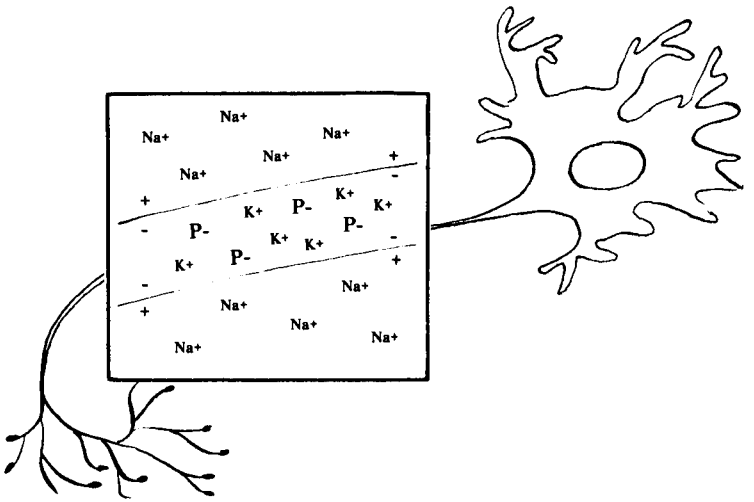


*Figure 2.* An axon in the resting state. Sodium (Na+) ions are kept outside the membrane by the sodium pump. Potassium (K+) ions are more concentrated inside the membrane. There are also large protein (P-) ions that carry negative charges. The resulting membrane potential results because there are more negative charges inside the membrane than outside. (Adapted from Plotnick and Mollenauer.)

When a stimulus is applied to the neuron, whether that stimulus be mechanical or physical or chemical, it causes the membrane of the neuron to become permeable to the positively charged ions floating in the fluid outside of it. The positively charged ions flow across the



membrane, changing the electrical nature of the inside of the neuron so that now it becomes more positive on the inside when compared to the outside. This flow of positively charged ions across a neural membrane is what is called the nerve impulse, and it can be measured electrically with fairly sophisticated equipment. This electrical impulse travels along the neuron and goes to the end of the axon to the telodendria, where a connection is made with another neuron. The neurons do not actually touch each other; there is a small space between the telodendria of one neuron and the dendrites or the body of a second neuron. The junction at which one neuron interacts with another, including the space between them, is called the synapse. (Figure 3 shows the connections between neurons.) The electrical current in the first neuron, which is called the presynaptic neuron, does not simply jump over the space to the second neuron, which is called the postsynaptic neuron. A number of chemical events occur in order for one neuron to communicate with another, thus neural transmission is considered to be an electrochemical activity.

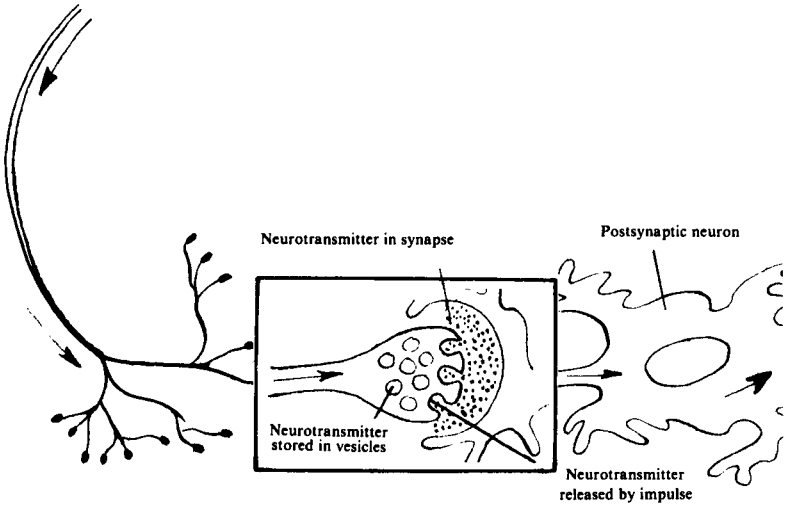


*Figure 3.* The telodendria of a presynaptic neuron contain neurotransmitters that are secreted upon arrival of the impulse. The neurotransmitters move across the synapse and act on the postsynaptic membrane. (Adapted from Plotnick and Mollenauer.)

Each end point on an axon is slightly enlarged or bulbous in shape. Electron microscope studies have indicated that these bulbous areas called synaptic knobs have within them little structures called vesicles which contain chemicals called neurotransmitters. While approximately thirty neurotransmitters have been identified, only a few are discussed with any degree of certainty. Among these are acetylcholine, norephinephrine, dopamine, and serotonin. There is another well-known neurotransmitter called GABA, which stands for gamma amino butyric acid. All of these neurotransmitters, regardless of their chemical nature, seem to behave in approximately the same way when a stimulus travels down a neuron, through the axon, and causes the release of the neurotransmitters.

The presence of the electrical charge in the synaptic knob causes the vesicles to release their contents, whatever the neurotransmitter may be, into the space between the two neurons. The space is filled with a warm salt water solution which contains the positively and negatively charged ions, and the neurotransmitter travels through this fluid to a receptor site on the postsynaptic neuron. There the neurotransmitter, with the exception of GABA, causes the post-synaptic neuron membrane to become permeable to the positively charged ions, and allows the positively charged ions to enter the neuron creating an electrical impulse and generating a new neural charge. GABA, on the other hand, on being released from the vesicles, causes the postsynaptic neuron to become less permeable to positively charged ions, making it more difficult to fire. This type of neurotransmitter is called inhibitory. The neurotransmitters, having done their job, are broken down by enzymes also existing in this intercellular fluid and the breakdown products are taken back up into the synaptic knob re-synthesized into neurotransmitters and stored back in the vesicles.

If one thinks about this system very carefully, and observes the sequence of events from a physiological viewpoint, it is very easy to see how behavior can be controlled. If it is possible to control the mechanism which allows one neuron to communicate with another, it is possible to control behavior, to control experience, to control anything that occurs in a living organism. This is where drugs enter the picture.



There are a great many drugs of the psychoactive variety which produce their physiological effects by physiochemical bonding with neural cells. Psychoactive drugs are generally described as substances which have an effect on mood or thought. These drugs may be characterized as stimulants (e.g. amphetamines), depressants (e.g. barbiturates and alcohol), anti-psychotics (e.g. Thorazine), anti-depressants (e.g. Elavil), tranquilizers (e.g. Valium), narcotics (e.g. opium and morphine), hallucinogens (e.g. LSD), and so on; all produce their behavioral effects by altering physiological activities at the synapse. For example, Thorazine has been found to fit into the receptor sites of the excitatory neurotransmitter dopamine, preventing that transmitter from stimulating the postsynaptic neuron. Patients receiving the drug eventually experience less agitation and fewer disturbed thought processes. Conversely, anti-depressants may increase the activity of a neurotransmitter and by so doing increase the mental and sometimes physical activity of depressed patients. Elavil is such a drug. This finding has contributed to the theory that some forms of psychological depression may be due to a low level of excitatory neurotransmitter activity at the synapse.

The major point to be made is that much, if not all, of our experience is due to the electrochemical events which occur at the synapses where neurons communicate with one another. If this communication is disturbed by psychoactive drugs our experience of the world will be altered. The nature of that altered experience will depend on many factors including, but not limited to, the chemical properties of the drug itself, our physiological state at the time of taking the drug, the dose taken, our past drug experience, and our expectations. These drug effects occur in sickness and health, but more and more often the effects are sought in time of health.

As an increasing number of individuals seek drug effects for recreational purposes, we are faced with new questions about decision making with regard to drug taking. As Aldous Huxley puts it:

> we have at our disposal hallucinogens and tranquilizers whose physiological price is amazingly

> low, and there seems to be every reason to believe that the consciousness-changes and tension relievers of the future will do their work even more efficiently and at even lower cost to the individual. Human beings will be able to achieve effortlessly what in the past could only be achieved with difficulty, by means of self-control and spiritual exercises. Will this be a good thing for individuals and for societies, or will it be a bad thing? . . . all that one can predict with any degree of certainty is that it will be necessary to reconsider and re-evaluate many of our traditional notions about ethics and religion, and many of our current views about the nature of the mind, in the context of the pharmacological revolution. It will be extremely disturbing; but it will also be enormous fun. (1957, pp. 683-84)

Thomas Szasz, on the other hand, puts it very simply when he writes "Sooner or later we shall have to confront the basic moral dilemma underlying this problem: Does a person have the right to take a drug, any drug, not because he needs it to cure an illness, but because he wants to take it?" (1972, p. 79). While many people have already decided to answer that question in the affirmative in their personal lives, others have awakened us to some larger dimensions of the problem.

Writing in the book *Psychotropic Drugs in the Year 2000: Use by Normal Humans*, Nathan Kline talks about altering life patterns in the future with drugs. Among the possibilities he mentions are reducing the need for sleep, use of short-acting intoxicants, regulation of sexual responses, control of affect and aggression, increasing or decreasing reactivity, prolonging or shortening memory, provoking or relieving guilt, deepening our awareness of beauty and our sense of awe. With all of this the question remains — who will exercise control over drug use in these areas? There is no ready answer, but it is a question we all must consider, for the consequences for good and evil are enormous.



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