YOGA RESEARCH

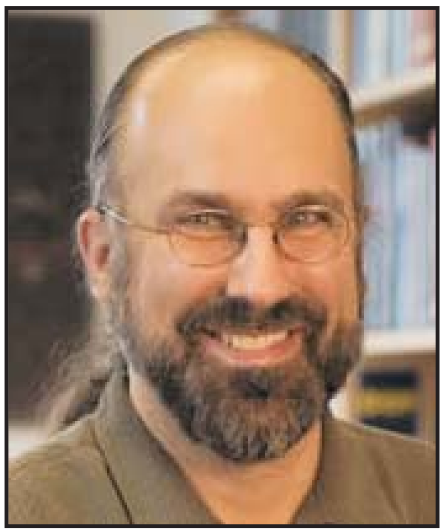
The Yoga Research Society Newsletter Number 46 March – August, 2011

The Compass of Pleasure

excerpted from the new book

The Compass of Pleasure: How Our Brains Make Fatty Foods, Orgasm, Exercise, Marijuana, Generosity, Vodka, Learning, and Gambling Feel So Good

by David J. Linden, Ph.D.



Montreal, 1953. Fortunately, Peter Milner and James Olds didn't have perfect aim. While postdoctoral fellows at McGill University, under the direction of the renowned psychologist Donald Hebb, Olds and Milner were conducting experiments that involved implanting electrodes deep in the brains of rats. The implanting surgery, conducted while the animals were anesthetized, involved cementing a pair of electrodes half a millimeter apart to their skulls. After a few days of recovery from the surgery, the rats were fine. Long, flexible wires were then attached to the electrodes at one end and to an electrical stimulator at the other, to allow for activation of the specific brain region where the tips of the electrodes had come to rest.

One fall day Olds and Milner were testing a rat in which they had attempted to target a structure called the midbrain reticular system. Located at the midline of the brain, at the point where its base tapers to form the brain stem, this region had previously been shown by another lab to control sleeping and waking cycles. In this particular surgery, however, the electrodes had gone astray and come to rest still at the midline, but at a somewhat more forward position in the brain, in a region called the septum.

The rat in question was placed in a large rectangular box with corners labeled A, B, C, and D and was allowed to explore freely. Whenever the rat went to corner A, Olds pressed a button that delivered a brief, mild electrical shock through the implanted electrodes. (Unlike the rest of the body, brain tissue does not have the receptors that allow for pain detection, so such shocks don't produce a painful sensation within the skull.) After a few jolts, the rat kept returning to corner A and finally fell asleep in a different location. The next day, however, the rat seemed even more interested in corner A than the others. Olds and Milner were excited: They believed that they had found a brain region that, when stimulated, provoked general curiosity. However, further experiments on this same rat soon proved that not to be the case. By this time, the rat had acquired a habit of returning often to corner A to be stimulated. The researchers then tried to coax the rat away from corner A by administering a shock every time the rat made a step in the direction of corner B. This worked all too well—within five minutes, the rat relocated to corner B. Further investigation revealed that this rat could be directed to any location within the box with well-timed brain shocks—brief ones to guide the rat to the target location and then more sustained ones once it arrived there.

Many years earlier the psychologist B.F. Skinner had devised the operant conditioning chamber, or "Skinner box," in which a lever press by an animal triggered either a reinforcing stimulus, such as delivery of food or water, or a punishing stimulus, such as a painful foot shock. Rats placed in a Skinner box will rapidly learn to press a lever for food reward and to avoid pressing a lever that delivers the shock. Olds and Milner now modified the chamber so that a lever press would deliver direct brain stimulation through the implanted electrodes. What resulted was perhaps the most dramatic experiment in the history of behavioral neuroscience: Rats would press the lever as many as seven thousand times per hour to stimulate their brains. They weren't stimulating a "curiosity center" at all—this was a pleasure center, a reward circuit, the activation of which was much more powerful than any natural stimulus. A series of subsequent experiments revealed that rats preferred pleasure circuit stimulation to food (even when they were hungry) and water (even when they were thirsty). Self-stimulating male rats would ignore a female in heat and would repeatedly cross foot-shock-delivering floor grids to reach the lever. Female rats would abandon their newborn nursing pups to continually press the lever. Some rats would self-stimulate as often as two thousand times per hour for twenty-four hours, to the exclusion of all other activities. They had to be unhooked from the apparatus to prevent death by self-starvation. Pressing that lever became their entire world.

We must now consider how the pleasure circuit functions naturally, in the healthy state, in the absence of artificial manipulations. We must experience basic behaviors such as eating, drinking, and

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A **YOGA RESEARCH** subscription is $5.00/year (two issues). Back issues are $3.00 each.

mating as pleasurable rewarding) in order to survive and procreate. This consideration is not unique to humans. Indeed, rudimentary pleasure pathways appear quite early in evolutionary history. Even the soil-dwelling roundworm, *C. elegans*, which is a millimeter long and has only 302 neurons in its entire body, has some basic pleasure circuitry. These worms typically feed on bacteria and are very good at following odor cues to find clumps of them. However, when a group of eight key neurons containing dopamine are silenced, the worms are mostly indifferent to this favorite food source (even though they can still detect odors). To anthropomorphize, the worms just don't seem to find eating bacteria to be that much fun anymore. This indicates that some aspects of the biochemistry of pleasure appear to have been conserved through hundreds of millions of years of evolution. In both modern roundworms and humans, dopamine-containing neurons occupy a central position in the pleasure circuit.

Human societies strictly regulate pleasurable activities, and most have a concept of vice that's applied to unregulated indulgence in food, sex, drugs, or gambling. Using a brain scanner, it has now become possible to observe activation of the brain's pleasure circuitry in humans. Not surprisingly, this circuit is activated by "vice" stimuli: orgasm, sweet and fatty foods, monetary reward, and some psychoactive drugs. What's surprising is that many behaviors that we consider virtuous have similar affects. Voluntary exercise, certain forms of meditation or prayer, receiving social approval, and even donating to charity can all activate the human pleasure circuit. There's a neural unity of virtue and vice—pleasure is our compass, no matter the path we take.

Dr. David Linden will present "Vice, Virtue & the Pleasure Circuits of the Brain" at the 37th Annual Yoga Research Society Conference.