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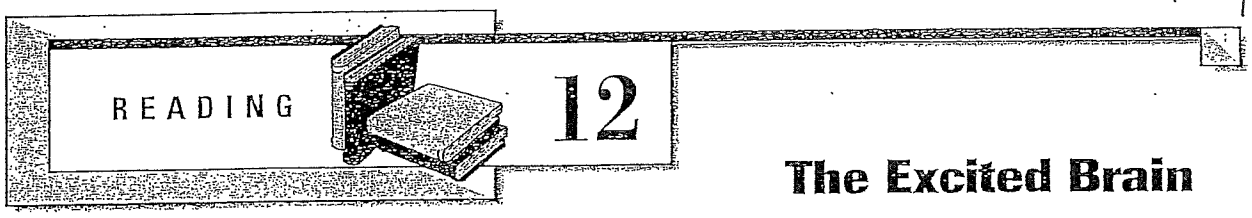

The Excited Brain

Directions: Read the following selection, then answer the questions that follow.

When you do not get enough sleep, what happens to your motivation? Do you lack the energy and drive to care about what is happening around you? Scientists and psychologists are discovering that our moods are largely regulated by chemical activity in the brain. Sleep deprivation affects the levels of these chemicals, and reduces our motivation.

The neuroscience of emotion is still in a fairly early stage of development. For thousands of years, people have been thinking about what sorts of things make us feel happy or unhappy, elated or depressed. While it is not known exactly how sleep and sleep debt help the brain create good feelings and bad, we are learning how the brain puts itself in an "up" mood and how addictive drugs create a "high" by stimulating the brain's pleasure centers. We also have a simple model of how the brain becomes activated and fully conscious during waking and dreaming activity. What we have found is that the biochemistry of wakefulness and sleep is intimately tied in with the state of the emotional part of the brain. The waking brain naturally excites and primes itself for vital interaction with the external world, while the sleep-deprived brain suppresses that natural buoyancy by damping the brain's neurochemical activity.

A brain circuit called the reticular activating system plays a major role in arousal. It is highly likely that the biological clock operates on this system to wake up the brain and keep it awake. The reticular activating system is a small collection of nerves that originates deep in the brain stem, the most ancient and primitive part of the brain. A relatively few cells in the brain stem reach out and touch nearly every cell in the brain. These cells carry neurotransmitters, that relay activating signals from the reticular activating system. These neurotransmitters are norepinephrine, dopamine, and acetylcholine. Norepinephrine is one of the key neurotransmitters for arousal, acting as the brain's form of adrenaline. Dopamine is known to be involved in body movement and pleasure. Acetylcholine also acts as a prime arousal chemical and is known to be important in carrying signals concerning muscle movements. Another neurotransmitter, serotonin, also has a strong effect on mood.

These excitatory neurochemicals prepare the brain's 100 billion nerve cells to react more quickly. It is also no surprise that they interface closely with the limbic system, which is sometimes called the emotional brain. This is because we must be wired not only to react quickly to challenge in a purely mechanical way but also to be motivated emotionally to face challenges. The reticular activating system sets the emotional brain on edge, as when runners ready to start a race get down on their hands and the balls of their feet. The activating system doesn't so much create feelings as set an emotional tone for any stimulus that filters into our brain.

The activity of the limbic system is like the background music in a movie. The screen shows someone creeping down a hallway at night toward a closed door. If the background music is tense, perhaps in a minor key, with a few discordant notes thrown in, we interpret the scene as suspenseful and feel anxious about what might lie behind the door. If the music is bouncy and jovial, like something out of an old Charlie Chaplin movie, we interpret the same scene quite differently. We are prepared for humor and might imagine the doorknob coming off when the person tries to open the door. If a monster does pop from behind the door, we might think "What a silly monster suit."

Now consider the movie that constantly plays in your head—the images of the world around you that sensory stimulation tells you is "reality." The nerve cells sprouting out of the base of the brain are creating the mood music inside you by acting directly on all the other brain cells, making them more or less reactive to the scenes that are coming in from the outside world. When we get a good night of sleep, and the reticular activating system is priming the emotional brain properly, our norepinephrine and dopamine infusions create a positive, energetic "background music." The result is a feeling of mental and physical energy we call vitality and an internal psychological push called motivation. Without them we get depressed. (I should note that clinical depression is very different from feeling low or down. In clinical depression, the brain's natural biochemistry is seriously altered.)

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One major hypothesis about how sleep affects mood is that sleep somehow replenishes these excitatory neurotransmitters in the brain. Over the course of the day, neurotransmitters are released from nerve cells. Some are recycled back into the cell and others are lost. By keeping brain activity high, sleep deprivation may prevent the brain from replacing lost neurotransmitters. When nerve activity is decreased, alerting is impaired. Your thoughts don't flow as smoothly as they should. You feel down.

To counterbalance the brain's accelerators, other nerve cells and neurotransmitters act as the brain's brakes. The most widely distributed nerve cell receptor in the brain is GABA, the receptor that alcohol and benzodiazepine sleeping pills act on. An activated GABA receptor makes a nerve cell much less reactive to stimuli, slowing the rate of information processing, and uncocking the hammer in the emotional brain.

Another of the brain's primary braking mechanisms is adenosine. Adenosine is one of the molecules that results when the brain breaks down its primary energy source, adenosine triphosphate, or ATP. When the brain is very active and using a lot of energy, more adenosine is present in the brain. This surplus of adenosine acts as a natural governor, reining in brain activity so that it doesn't run too fast. Increasing adenosine concentration in the brain may be part of the reason we feel mental fatigue when we face emotional or mentally challenging situations. The increased brain activity may create a lot of free adenosine, which then depresses brain activity.

One school of thought holds that the sleep drive actively suppresses brain activity through this braking mechanism, thereby linking sleepiness and mood. The more time we are awake, the more the inhibitory circuits of the brain damp down the stimulation of the reticular activating system, as if the nerve excitatory and dampening systems are fighting for control of the brain. As various areas of the brain are slowed down by this braking action, the effects show up in how we act, think, and feel. The dampening of nerve activity of motor areas makes us less coordinated; the dampening of nerve activity in the cerebral cortex makes us slow in thought; and quenching nerve activity in the emotional brain makes us feel less vital, less motivated. To counteract this we can walk around, concentrate harder, and give ourselves a pep talk, but eventually the brain's sleep drive triumphs. At some point no mental trick will stimulate brain activity in the areas we need to stay awake—it's like trying to light wet sawdust with a match. We have to fall asleep.

After we sleep, the brakes are off again. Dopamine and norepinephrine release in the brain increases. We feel alive again. . . .

Source: **Dement, W.C., & Vaughan, C. (1999).** *The Promise of Sleep.* New York: Delacorte Press, pp. 278–281.

Understanding the Reading

Directions: Answer the following questions in the space provided.

1. What part of the brain plays a major role in motivation?

2. Which neurotransmitters control motivation?

3. How do the excitatory neurochemicals affect motivation?

4. What is the "emotional brain" and what does it do?

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5. What is one hypothesis of how sleep affects our moods?

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6. What are the two primary receptors that slow activity in the brain?

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7. As nerve activity slows in the limbic system, how do we feel?

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Thinking Critically

Directions: Answer the following questions in the space provided.

8. You are on the track team at your school. The state championships are being held on Saturday. Your coach insists that the entire team get a good night's sleep on Friday. The coach has even asked the team members' parents to set a 10 P.M. curfew for this Friday night. You and your date had planned to go to the late movie on Friday, but you know that if you are caught breaking curfew, you will not be allowed to compete. Why do you think your coach is insisting on the curfew? What should you do?

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9. Does this biological explanation of motivation contradict the other theories of motivation discussed in your textbook? Why or why not?

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10. Recall the last time you were in a bad mood. How much sleep did you get the night before? Did your mood become worse as you became more tired? Do you think there was a correlation between sleep and your mood in that instance? Explain.

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