

## Stages of Sleep

One of the most pervasive misconceptions about sleep is that sleep is just a matter of our bodies “turning off” for several hours, followed by our bodies “turning back on” when we awake. In short most of us think of sleep as a passive and relatively constant and unchanging process. In fact, sleep is a very active state. Our bodies move frequently, as we roll about during the night, and, more importantly to the psychologist, our brain activity is even more varied than it is during the normal waking state. Before we begin talking about the characteristics of sleep it is useful to consider the tools researchers use to measure these stages of sleep.

### Sleep Stages: Measures

When a sleep researcher sets out to study the process of sleep he or she generally relies on three fundamental measures, as the basis for defining stages of sleep. First, **gross brain wave activity** is considered, as measured by an **electroencephalogram (EEG)**. This machine provides the summary of electrical activity from one area of the brain. Second, **muscle tone** is measured with a **electromyogram (EMG) machine**. Third, **eye movement** is recorded via an **electro-oculogram (EOG)**. As we will see, the EEG reading is the most important measure in differentiating between the stages, while the EMG and EOG are most important in differentiating rapid eye movement (REM) sleep from the other stages.

### Sleep Stages: Waking through Stage 2

(Figure 1 represents the relationship between sleep stages and EEG, EMG, and EOG patterns.) When awake, most people exhibit brain wave, (EEG) patterns that can be classified into two types of waves, beta and alpha. **Beta waves** are those associated with day to day wakefulness. These waves are the highest in frequency and lowest in amplitude, and also more **desynchronous** than other waves. That is, the waves are not very consistent in their pattern. This desynchrony makes sense given that day to day mental activity consists of many cognitive, sensory, and motor activities and experiences, and, thus, when awake, we are mentally desynchronous as well. During periods of relaxation, while still awake, our brain waves become slower, increase in amplitude and become more **synchronous**. These types of waves are called **alpha waves**. For example, such brain waves are often associated with states of relaxation and peacefulness during meditation and biofeedback. As we will see in future lessons, recent evidence indicates that activities that promote alpha wave activity, appear to have positive health benefits.

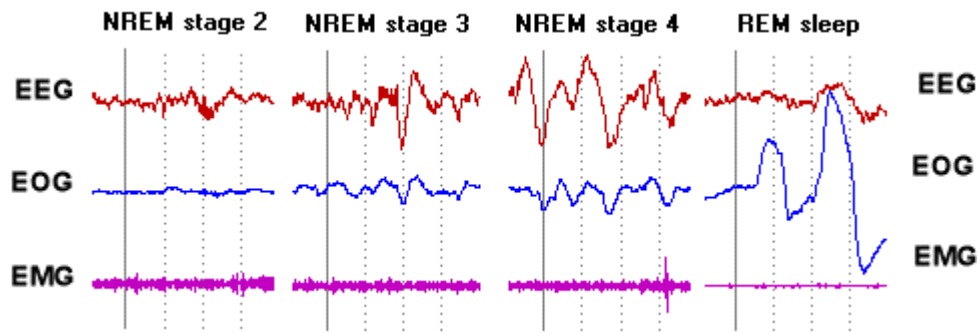


Figure 1. Sleep Stages and associated EEG, EOG, and EMG measures  
(picture from *Thinquest*, <http://www.thinkquest.org>)

The first stage of sleep is characterized by **theta waves**, which are even slower in frequency and greater in amplitude than alpha waves. The difference between relaxation and stage 1 sleep is gradual and subtle. As the sleeper moves to stage 2 sleep theta wave activity continues, interspersed with two unusual wave phenomena. These phenomena, which occur periodically every minute or so, and are defining characteristics of stage 2 sleep, are termed **sleep spindles** and **K complexes** (figure 2). The former is a sudden increase in wave frequency, and the latter is a sudden increase in wave amplitude. Stages 1 and 2 are relatively "light" stages of sleep. In fact, if someone is awoken during one of these stages, he or she will often report not being asleep at all.

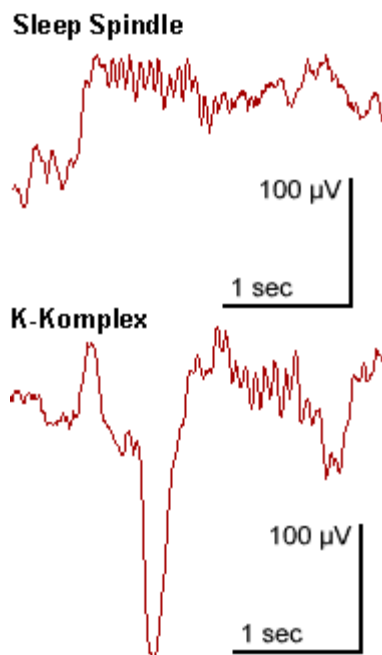


Figure 2. EEG patterns for Sleep Spindles and K-Komplexes  
(picture from *Thinquest*, <http://www.thinkquest.org>)

## Sleep Stages: Delta Sleep, REM, and the Sleep Cycle

During a normal night's sleep a sleeper passes from the theta waves of stage 1 and 2, to the **delta waves** of stage 3 and 4. Delta waves are the slowest and highest amplitude brain waves. There is no real division between stages 3 and 4 except that, typically, stage 3 is considered delta sleep in which **less** than 50 percent of the waves are delta waves, and in stage 4 **more** than 50 percent of the waves are delta waves. Delta sleep is our deepest sleep, the point when our brain waves are least like waking. Consequently, it is most difficult stage in which to wake sleepers, and when they are awakened they are usually sleepy and disoriented. Interestingly, delta sleep is when sleep walking and sleep talking is most likely to occur.

Besides these four basic stages of sleep, another, unique, stage of sleep exists, REM. This stage gets its name from the darting eye movements that accompany it (rapid eye movement), as indicated by the EOG. Interestingly, it is also characterized by a sudden and dramatic loss of muscle tone, which is measured by the EMG. In fact, the skeletal muscles of a person during REM sleep are effectively paralyzed. This stage is also, associated with a unique brain wave pattern too, in that during REM sleep a sleeper's brain waves demonstrate characteristics that are similar to waking sleep, a combination of alpha, beta, and desynchronous waves (see Figure 1). Most importantly to psychologists, this is the stage of sleep most associated with dreaming. When a sleeper in a research lab begins to exhibit the physiological indices of R.E.M sleep, and they are awakened, the great majority of the time they will report that they were having a vivid, story-like, dream. During other stages, on the other hand, they normally do not report dreaming.

Interestingly enough, it was not until 1953, that Dement and Kleitman discovered that the fact that this unique stage of sleep was associated with dreaming. This was very exciting and profound to the researchers, since dreams were so important a subject in the study of psychology. Dement describes it as follows:

*The vivid recall that could be elicited in the middle of the night when a subject was awakened while his eyes were moving rapidly was nothing short of miraculous. It [seemed to open] ... an exciting new world to the subjects whose only previous dream memories had been the vague morning-after recall. Now, instead of perhaps some fleeting glimpse into the dream world each night, the subjects could be tuned into the middle of as many as ten or twelve dreams every night.*

(Dement, 1978, p. 37; quoted in Pinel, 1993)

In a normal night's sleep, a sleeper begins in stage 1, moves down through the stages, to stage 4, then back up through the stages, with the exception that stage 1 is replaced by REM, then the sleeper goes back down through the stages again. One cycle, from stage 1 to REM takes approximately ninety minutes. This cycle is repeated throughout the night, with the length of REM periods increasing, and the length of delta sleep decreasing, until during the last few cycles there is no delta sleep at all. (Figure 3 illustrates this cycle.)

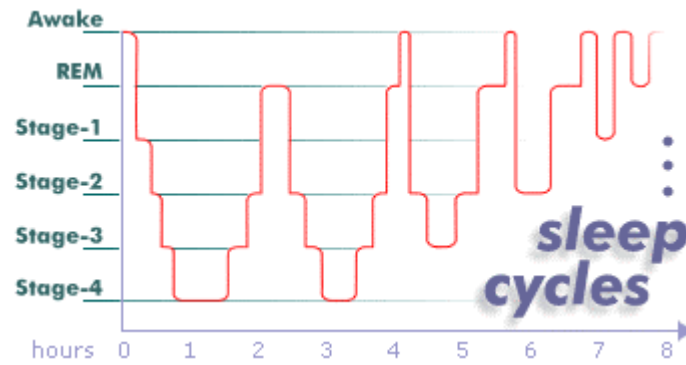


Figure 3. The Sleep Cycles Associated with on night's sleep  
(picture from *Thinquest*, <http://www.thinkquest.org>)

#### References

- Dement, W.C. (1978). *Some must watch while some must sleep*. New York: W.W. Norton.
- Pinel, J.P.J. (1992). *Biopsychology*. Needham Heights, MA: Allyn & Bacon.