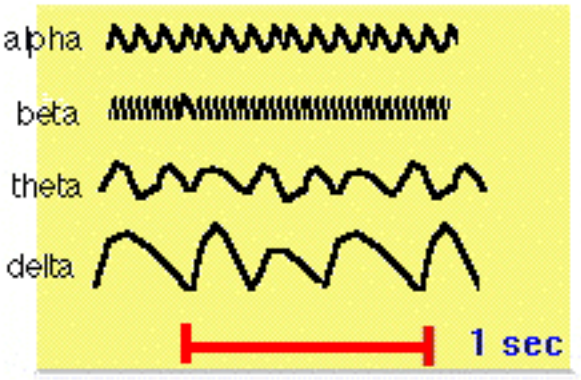
Stages of Sleep

When you log onto the site for this week's internet activity, you will be able to replicate one of the early experiments in sleep research. In the early experiments participants were fitted with electrodes on their skulls to measure brain activity (electroencephalogram - EEG), on their muscles to measure muscle activity (electromyogram - EMG), and above and below the orbits of the eye to measure eye movement (electro-oculogram - EOG).

Monitoring an individual's EEG provides a window into the activity of their brain and their state of consciousness. This is what the four most prominent EEG waves look like:



Notice that the waves vary in terms of their amplitude (the height of the wave) and their frequency (the number of peaks and valleys in a one-second interval). Alpha activity is indicative of an awake, relaxed state and is characterized as slow in frequency and moderately high in amplitude. Beta waves occur when a person is awake, alert, and thinking or processing information. These waves are high in frequency and low in amplitude. In contrast, theta waves, often seen in the early stages of sleep, or when a person is drowsy, are slow in frequency and high in amplitude. During deepest sleep, stages 3 and 4, Delta activity is prominent; it is slowest in frequency and greatest in amplitude among the four brainwave patterns.

During a normal night's sleep an individual passes through four stages of sleep: two stages of theta activity, stages 1 and 2, and stages 3 and 4, during which Delta activity is prominent. In addition to these four stages of sleep there is another stage called REM sleep because of the presence of rapid eye movements. In 1953, Dement discovered that this unique stage of sleep was associated with dreaming. This was an exciting discovery, because this finding occurred during the peak of the psychoanalytic school of thought for whom dreams and their analysis were important, because they believed that dreams could reveal the workings of the unconscious. Here is how Dement described his finding:

> *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)

REM sleep, the period when dreams occur, is often called paradoxical sleep, because the EEG activity present during REM sleep looks like beta activity, that is, like the activity of an alert, awake brain. This

presented a puzzle; how could sleep researchers determine whether a person was alert, but with their eyes closed, or sleeping and dreaming? The answer appears in other measures of physiological activity: the movement of the eyes and the amount of tension in the muscles of the body. When a sleeping person enters REM sleep and begins to dream, their eyes move back and forth rapidly. The movement of the eyes appear as spikes in the EOG record. (EOG stands for electro-oculogram, the recording of electrical activity in the muscles of the eye.) While the eyes are moving back and forth during dreaming, the muscles of the body become flaccid, that is, there is no tension in the muscles (or muscle tone) and the EMG record appears as a near flat line. (EMG stands for electromyogram, the recording of electrical activity in the muscles of the body.) Note the changes in the EEG, EMG, and EOG records in the various stages of sleep in the figure shown below. Note that NREM refers to non-REM sleep.

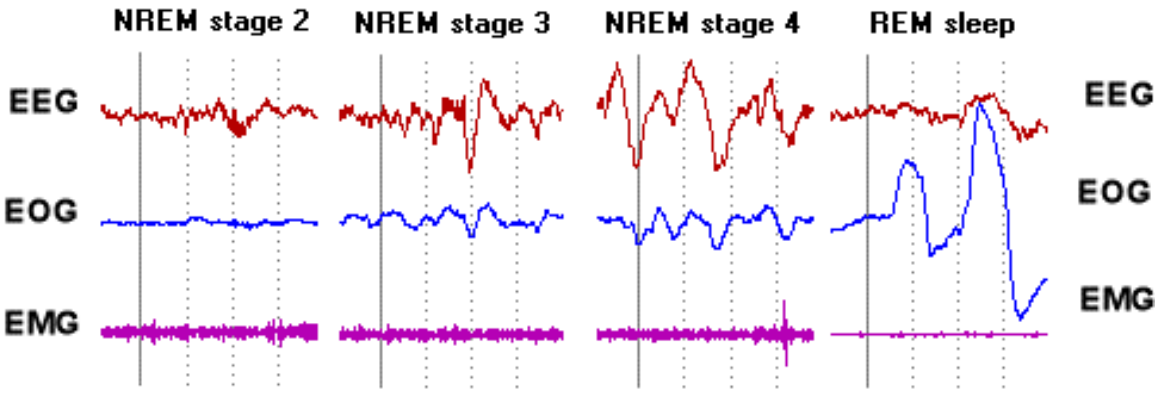


Figure 1. Sleep stages and associated EEG, EOG, and EMG measures. (picture from http://web.umr.edu/~psyworld/sleep_stages.htm)

Notice the EEG in NREM stage 2. At the very beginning of the record the EEG looks like the low amplitude, high frequency brainwave activity that is indicative of an awake brain, but the later portion of the record is beginning to show the beginning of some Theta activity. In the latter half of stage 3 you see the appearance of high amplitude, slow frequency. In stage 4, high amplitude, slow frequency Delta waves are present. In the last window, which displays REM sleep, the brain waves look like those of an alert brain, that is, low amplitude and fast frequency. Observe the changes in the EOG record during the different stages of sleep. You can see that there are large movements of the eyes in the REM stage. Notice, also, how the EMG record goes flat in REM sleep, which indicates that there is no muscle activity present.

With this information, you are ready to proceed to the Internet Activity. Watch the EEG, EOG, and EMG records generated by the “sleeping man.” See if you can “waken” him during a dream, that is, see if you can detect a REM stage on the basis of the physiological records. What happens when you awaken him in other stages of sleep and wakefulness?

Have fun pretending to be one of the early sleep researchers.