Sleep: Continuum of Consciousness
Different States of Consciousness

• Consciousness covers the many different levels of awareness of one’s thoughts and feelings. It might include creating images in one’s mind, following one’s thought processes, or having unusual emotional occurrences.

• [You can tell if your conscious, if you are aware of your existence and your own thoughts.]

• Continuum of Consciousness refers to a broad range of experiences, from being sharply alert to being completely unaware and unresponsive.
Controlled Processes

- Controlled Processes are actions that require full awareness, attention, and focus in order to complete your task. The focused attention required in completing controlled processes usually interferes with the execution of activities in action.
Assessment of sleep states

- behavioral analysis
- EEG analysis
- EEG: represent the summated activity of millions of cortical neurons. IPSPs and EPSPs and passive spread of electrical activity is the basis of EEG
Automatic Processes

- Automatic processes are activities that only need minimal focus, and do not distract you from the other activity that’s occurring—multi-tasking.
Daydreaming

- Daydreaming is when you fantasize or dream while you are awake. This state requires minimal alertness.
Altered States

- Altered states of consciousness are achieved when using psychoactive drugs, meditation, hypnosis or lack of sleep. These all create a state that is different from the usual consciousness.
Sleep and Dreams

• Sleep has five important stages that involve the many types of consciousness and awareness, etc.

• Dreaming occurs when we are asleep and is a type of consciousness. In our dreams, we witness a handful of surprising visual and auditory detailed images. These dreams can be related in odd ways and are usually in color.
Who sleeps?

- Mammals and birds
  - Opossums, sloths, bats: 19-20 hours daily
  - Cats, dogs, rodents: 12-15 hours daily
  - Ruminant herbivores: 2-3 hours daily

- Reptiles, amphibians, fish, and insects have cycles of inactivity: not sleep per se

- Note that sleep time does not correlate with waking activity levels, but does relate to waking vulnerability.
Rhythms of Sleeping and Waking
Stages of Sleep

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Awake

Alpha activity  Beta activity

Stage 1

Theta activity  K complex

Stage 2

Spindle

Stage 3

Delta

Stage 4

REM sleep

EEG

Stage

0 1 2 3 4 5

episodes with sudden eye movements

REM  REM  REM  REM  REM  REM  SWS

SWS  SWS  SWS  SWS

0 1 2 3 4 5 6 7 8 h

W

SWS
Sequence of Stages

• Usually REM occurs after the second stage of sleep.

• You go through the sleeping stages and REM, approximately 6-7 times a night.
Non-REM Sleep

- Non-REM sleep (80% of your sleep) is separated into stages 1, 2, 3, and 4.
- 1: The shift from being awake to sleep and lasts 1-7 minutes. You gradually lose alertness to your surroundings and experience drifting thoughts.
- 2: The start of sleep
- 3: You are asleep for 30-45 minutes
- 4: The deepest sleep occurs in this stage. [It is the hardest to be awakened from]
- Heart rate, respiration, temperature, and blood flow to the brain decrease by growth hormone.
REM Sleep

- Rapid eye movement, [REM], is when your eyes move from side to side, under your lids.
- It makes up the remaining 20% of sleep time.
- Dreaming takes place in this state.
<table>
<thead>
<tr>
<th>Slow Wave Sleep</th>
<th>REM/Paradoxical Sleep</th>
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<tbody>
<tr>
<td>EEG</td>
<td>Large Amplitude</td>
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<td></td>
<td>Low Amplitude (cf waking)</td>
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<td><strong>Slow Waves ~ 1 Hz</strong></td>
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<td><em>(but theta rhythm in hippocampus)</em></td>
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<td>MUSCLES</td>
<td>Reduced tone</td>
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<td>Total relaxation (e.g. in postural &amp; neck muscles)</td>
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<td>SPINAL REFLEXES</td>
<td>Some reduction</td>
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<td>Strong descending inhibition of motoneurons</td>
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<td>AROUSAL</td>
<td>to ‘significant’ stimuli</td>
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<td></td>
<td>Raised threshold (deep sleep)</td>
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<tr>
<td></td>
<td>but often waking from REM</td>
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<tr>
<td>PHASIC EVENTS</td>
<td>Muscle twitches</td>
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<td>Sudden eye movements <em>(REM)</em></td>
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<td>Sudden CNS discharges</td>
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<tr>
<td>REPORTS ON WAKING</td>
<td>‘dreams’ 0-50%</td>
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<td></td>
<td>‘dreams’ 80%-90%</td>
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<td>&amp; ‘thinking’</td>
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REM sleep phenomena

- Stage 1 EEG: Paradoxical sleep
- EOG (and corneal bulge) show frequent eye movements, as if scanning a visual field.
- EMG shows loss of muscle tonus due to downward inhibition of $\alpha$ motor neurons, although muscles moving hands and feet may twitch.
- Many brain structures function as if awake.
More REM phenomena

- SNS is partially activated: Increases blood pressure, respiration, and heart rate.
- Involuntary genital response
- Narrative dreaming
  - CBF is high to visual cortex, low to inferior frontal cortex (Madsen, 1991)
  - Eye movements match dream events
  - One EEG waveform is unique to REM and wakeful scanning
Children and Dreams

- Almost the entire state of being before we're born is REM sleep (18 hours in a 24 hour period)

- Children have to reach a certain level of intellectual maturity, around the age of 8 or 9, before their dreams resemble adults’

- Children dream about animals more often than adults and are more likely to report being victims than aggressors

- Children are also more likely to have "fantastic" dreams, while adults' dreams tend to contain more elements of reality
  - A typical fantastic dream from a 10-year-old studied included a cat asking for directions to the "cat bathroom." Similarly, an 11-year-old boy dreamed that a snake wanted to go up a ski lift
Unconscious and Implicit Memory

- Unconsciousness is the lack of sensory awareness and alertness, that can be induced by disease, trauma, anesthesia and or a blow to the head.

- Implied and unspoken, implicit memory involves mental and emotional processes that we are not conscious of. These processes affect feelings, actions and thoughts in a bias way.
DREAMS

• External stimuli may be incorporated into a dream.
• Dream events happen in real time.
• Sleep-walking and talking are non-REM.
Dream amnesia

Given that unconscious wishes are noxious to our consciousness, they are actively repressed via censorship processes. Dream amnesia is anything but arbitrary: our memory reproduces the dream not only incompletely but also untruthfully, in a falsifying manner.

Dream amnesia largely stems from a state change; aminergic de-modulation and deactivation of dorsolateral prefrontal cortex in REM sleep create a brain state reducing memory. This also explains why humans forget moments of brief awakenings during sleep;

Dream amnesia is primarily related to a cognitive state and lack of context. To remember, one needs an external narrative to which internal events can be tied;

Dream amnesia cannot be explained by a state change because dreaming can occur at any state (NREM sleep and wake).
Nuclei of certain known chemical neuro-modulatory systems

- AcetylCholine: Tegmentum [PGO]
- Noradrenaline: Locus Coeruleus [Arousal]
- 5HT (serotonin): Raphe [Arousal, SWS]

Arousal and Neuro-modulatory Systems

Diffuse projection from RETICULAR ACTIVATING SYSTEM (R.A.S.) -> arousal

‘Specific’ sensory signals to thalamus and cortex

‘Non-specific’ collaterals of sensory axons go to RETICULAR ACTIVATING SYSTEM (R.A.S.)
FACTS

• Humans spend about 6 years dreaming
• Dreams are generated in the forebrain
• Most common emotion experienced during dreaming is anxiety
• The U.S. ranks the highest amongst industrialized nations for aggression in dreams with 50% of U.S. males reporting aggression in dreams, compared to 32% for Dutch men
• Men generally have more aggressive feelings in their dreams than women, and children's dreams do not have very much aggression until they reach teen age
• This parallel much of the current research on gender and gender role comparisons in aggressive behavior
• This supports the view that there is a continuity between our conscious and unconscious styles and personalities
• In men's dreams 70 percent of the characters are other men, while a female's dreams contain an equal number of men and women
Timeline | Milestones in the modern history of dream and REM research

1850: D’Hervey de Saint-Denis studies the visual psychedelic elements of dreaming and hypnagogic hallucinations at sleep onset [2]

1867: Maury, Müller, Purkinje, Wundt & Strumpell believe that dreams are a brief reaction to peripheral stimuli triggering illusions of sensation [1]

1900: Freud’s *The Interpretation of Dreams*: Dreams represent wish fulfillment related to egoistic impulses. Unconscious latent wishes appear as bizarre manifest content [3]

1929: Berger’s discovery of the electroencephalogram (EEG) allows measurement of human brain activity across the scalp in wake and sleep [4]

1949: Moruzzi and Magoun discover the **Reticular Activating System** in the brainstem, suggesting that sleep and waking are subject to active control [5]

1953: Dement confirms that REM sleep is highly correlated with dreaming and establishes that REM sleep occurs in cats as in humans, paving the way for animal models [7]

1958: Jouvet establishes that muscular atonia in REM is caused by active inhibition from the pontine brain stem, leading to the concept of **paradoxical sleep** [8]

1962: Hubel and Everts: single-cell recordings in visual and motor cortices establish that neuronal firing levels during REM can be as high as during waking [9,10]

1964: Hobson and McCarley’s reciprocal interaction model: REM is controlled by an interplay of REM-On cholinergic mechanisms and REM-Off aminergic mechanisms [12]

1966: Foulkes provides a thorough account of the development of children’s dreams and its relation to the development of other cognitive skills [15]

1967: Hall and Van de Castle establish a rigorous system of content analysis of dreams, showing that dream content is consistent over time and continuous with waking emotional concerns [11]

1975: First PET study of REM sleep and dreaming by Maquet and colleagues begins functional neuroimaging investigations [13]

1996: Solms examines the relation between brain lesions and dreams in great detail, indicating that dreaming primarily depends on cortex and white matter [14]

1999: Hobson and colleagues introduce the AIM (activation, input source, modulation) model of dreaming and conscious states [16]
Interpretation of dreams

• Manifest content is symbolic of latent desires (Freud)
• Activation-synthesis theory: cf. incorporation of external events into dreams.
• Lucid dreams: Have you had one?
Lucid Dreaming

- Lucid dreaming occurs when dreamers realize that they are dreaming (lucid dreaming can occur with varying levels of awareness and dream control).
- The dreamers are sometimes capable of changing their dream environment and controlling various aspects of their dream.
- The dream environment is often much more realistic in a lucid dream, and the senses heightened.
- The realization is usually triggered by the dreamer noticing some impossible or unlikely occurrence in the dream.
- Two types of lucid dreaming: dream-initiated lucid dreaming and wake-initiated lucid dreaming.
- Dream-initiated lucid dreaming: Starts off as a normal dream until the dreamer realizes that they’re dreaming.
- Wake-initiated lucid dreaming: The dreamer goes from a normal waking state directly into a dream state with no apparent lapse in consciousnes.
- Time passage appears to be the same during lucid dreaming as when awake.
What is the purpose of dreams?

- The Ontogenetic Hypothesis of REM sleep states that this sleep phase is particularly important to the developing brain, possibly because it provides the neural stimulation that newborns need to form mature neural connections and for proper nervous system development.

- Studies investigating the effects of Active Sleep deprivation have shown that deprivation early in life can result in behavioral problems, permanent sleep disruption, decreased brain mass (Mirmiran et al. 1983), and result in an abnormal amount of neuronal cell death (Morrissey, Duntley & Anch, 2004).

- REM sleep is necessary for proper central nervous system development (Marks et al. 1995). Further supporting this theory is the fact that the amount of REM sleep decreases with age, as well as the data from other species.
What is the purpose of dreams?

• Zhang hypothesizes that the function of sleep is to process, encode and transfer the data from the temporary memory to the long-term memory.
• Numerous studies have suggested that REM sleep is important for consolidation of procedural and spatial memories.
• A recent study (Marshall, Helgadóttir, Mölle & Born, 2006) shows that artificial enhancement of the REM sleep improves the next-day recall of memorized pairs of words.
• Freud proposed that dreams protect sleep, which might be disturbed by the arousal of unacceptable wishes.
• There have also been analogies made with the cleaning-up operations of computers when they are off-line. Dreams may remove parasitic nodes and other "junk" from the mind during sleep.
• Dreams may also create new ideas through the generation of random thought mutations.
Health issues

- Dreams provide clues to the nature of more serious mental illness.
- Schizophrenics, for example, have poor-quality dreams, usually about objects rather than people.
- According to one study, "good dreamers," people who have vivid dreams with strong story lines, are less likely to remain depressed.
- It is thought that dreaming helps diffuse strong emotions. Dreaming is believed to be a “mental-health activity.”
- However, no one has yet been able to say that REM sleep or dreaming are essential to life or even sanity.
- MAO inhibitors, an older class of antidepressants, essentially block REM sleep without any detectable effects, although people do get a "REM rebound"—extra REM—if they stop the medication. That's also true of selective serotonin reuptake inhibitors (SSRIs) like Prozac, which reduce dreaming by a third to a half.
FACTS

• Sexual dreams show up about 10% of the time and are more prevalent in young to mid-teens
• Approximately 70% of women have recurring dreams and 65% of men
• The most common themes are: situations relating to school, being chased, sexual experiences, falling, arriving too late, a person now alive being dead, flying, failing an examination, or a car accident
• Twelve percent of people dream only in black and white
• In general, more introverted, psychologically oriented people naturally remember their dreams and practical, concrete thinkers don’t
The Introduction to Cognitive Neuroscience

That's it!