


Teens & Sleep

LINKING DISCOVERY, PRACTICE, AND POLICY

The biology of sleep and the human brain

Conrad Iber, MD
Professor of Medicine
University of Minnesota
Fairview Sleep Program Medical Director

SPONSORED BY THE
Center for Applied Research and Educational Improvement
in the College of Education and Human Development



UNIVERSITY OF MINNESOTA
Driven to Discover™

The biology of sleep and the human brain

What building blocks
do I need to as a
participant in this
conference?



Sleep

- is a biological imperative
- timing follows rules
- can be local and generalized
- enhances brain function
- balances mood



The Biological Imperative of Sleep

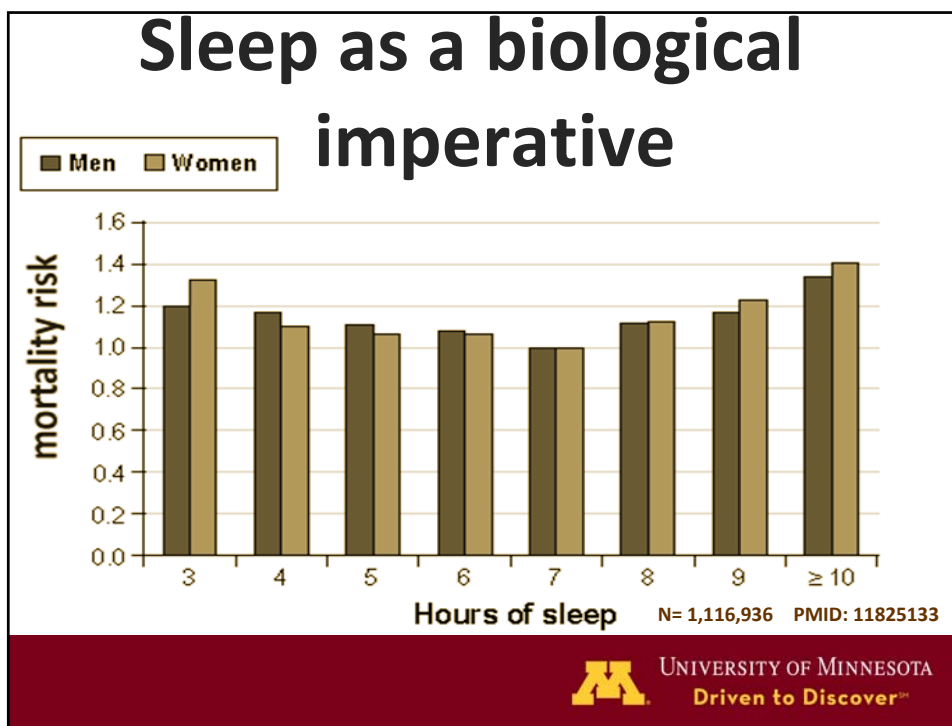
- Sleep clocks are found in animals, plants, fungi, and bacteria
- Sleep is found in all mammals
- The absence of sleep results in impairment, injury and death
- The average 80 year old has slept 24 years



Teens & Sleep

National Conference | October 3-4, 2013





Biological Clocks

Sleep clocks are ubiquitous in nature and have been recognized from antiquity

Plants/microbes

- 400 BC Androstheneas --Tamarind
- 1751 Linnaeus --Floral Clock
- 1832 Ortus --Free Running
- 1958 Hastings/Sweeney --Free Running [red tide]

Humans

- 1845 Davy --Temperature change
- 1866 Ogle --Free Running
- 1959 Franz Halberg --"Circadian"
- 1962 Ashoff/Weaver --Free Running
- 1971 Konopka--Clock Genes
- 1972 Anatomic Clock--SCN**

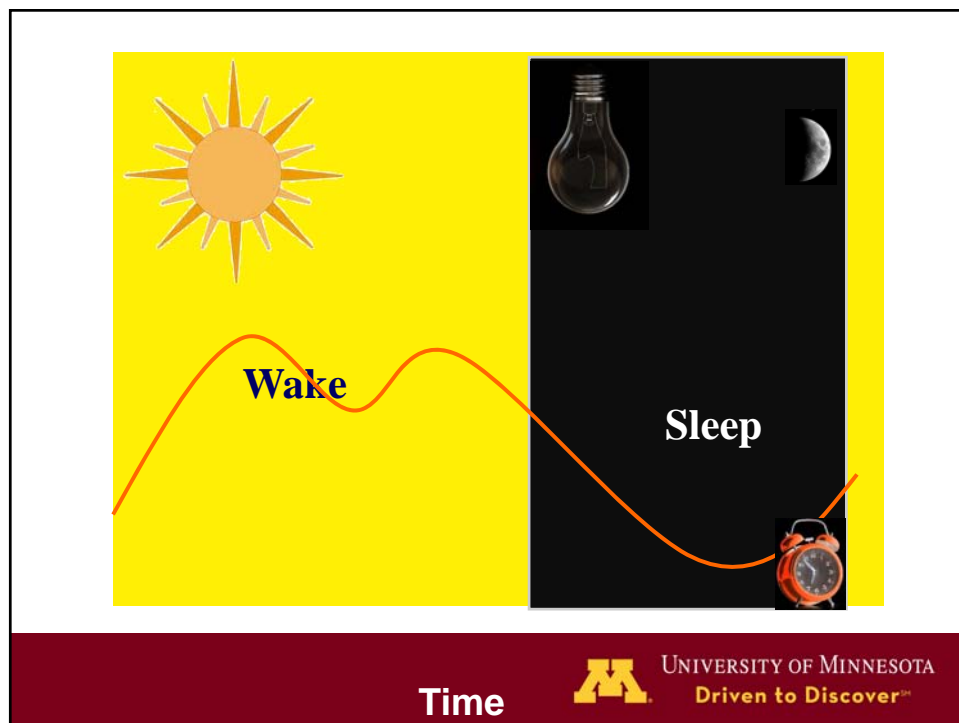
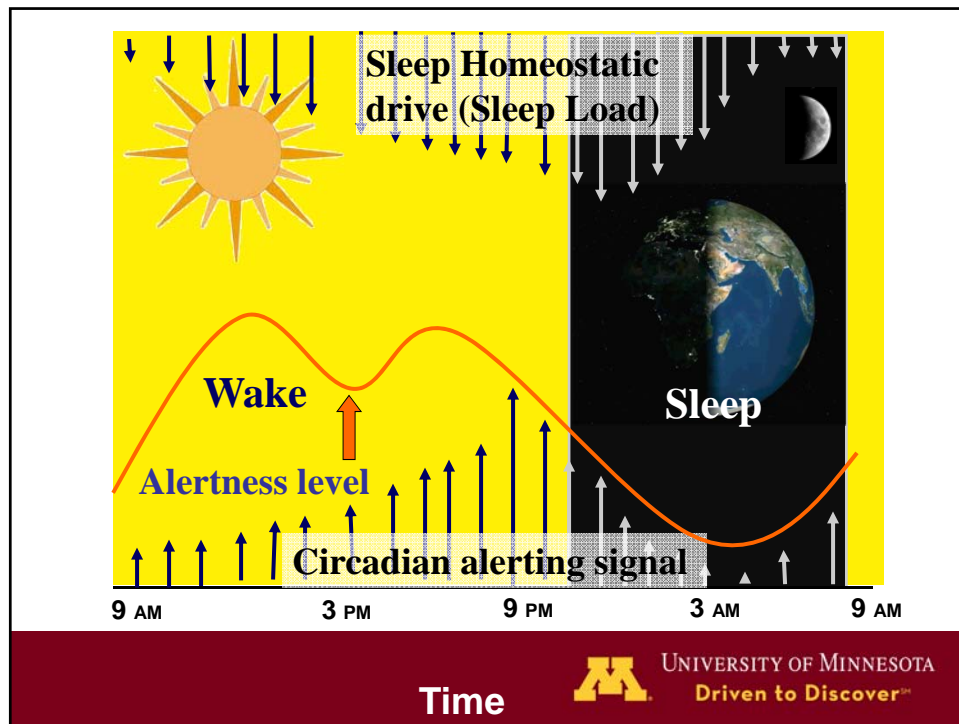


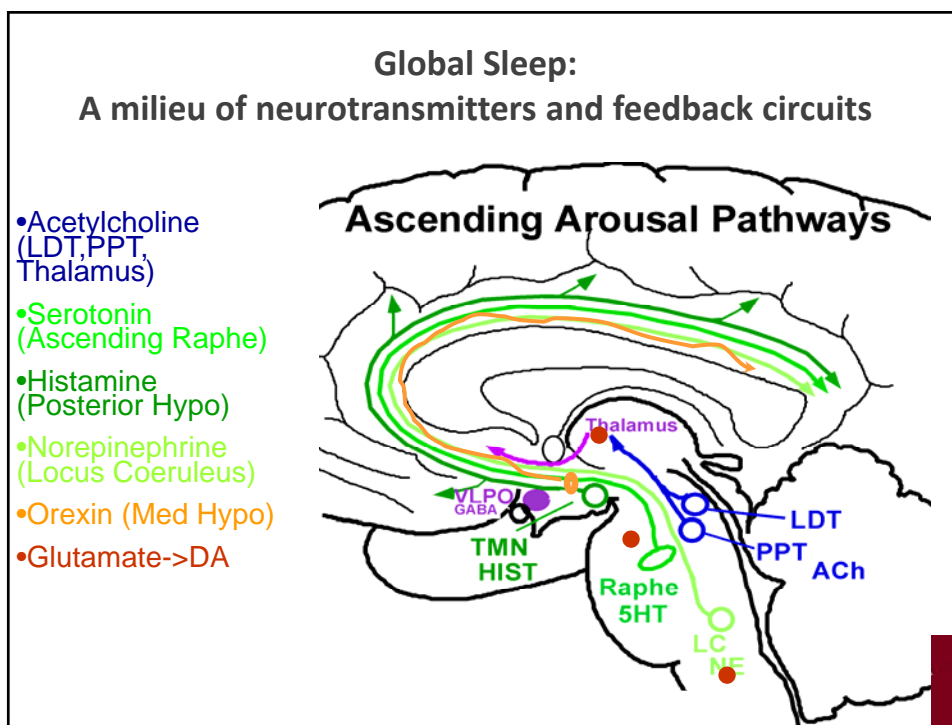
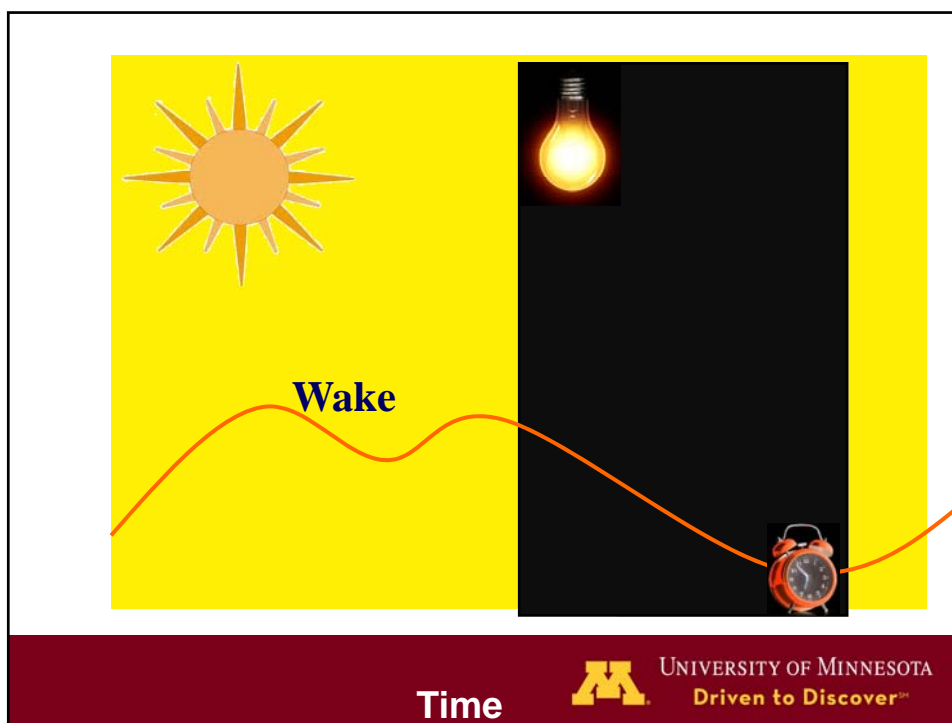



Teens & Sleep

National Conference | October 3-4, 2013

UNIVERSITY OF MINNESOTA
Driven to Discover™





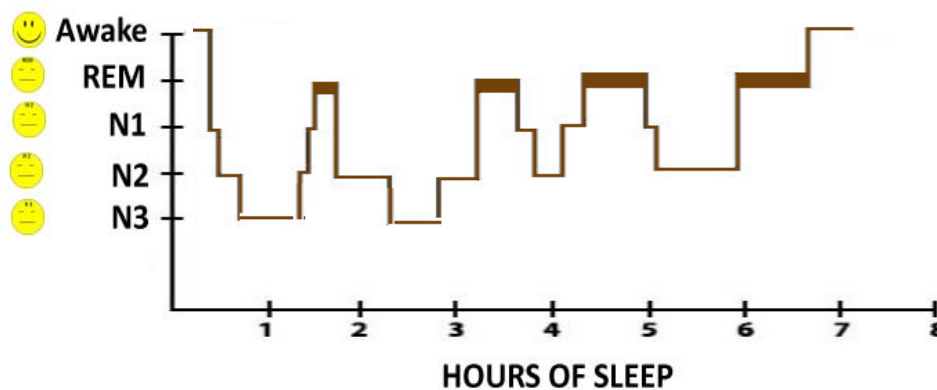
Sleep: General Process

- Wakefulness and stages of sleep have been defined
- Stages have biologic validity and natural progression

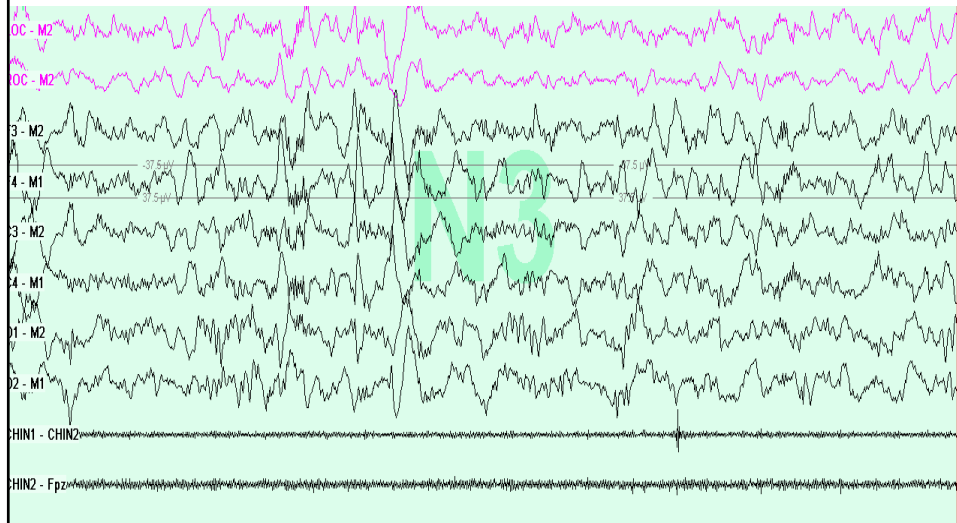


UNIVERSITY OF MINNESOTA
Driven to Discover™

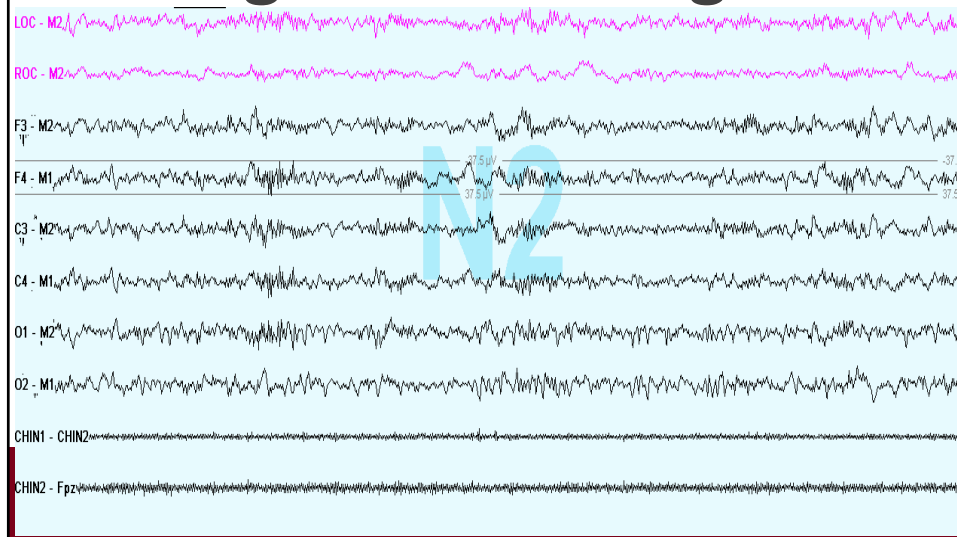
Sleep: Description of a General Process



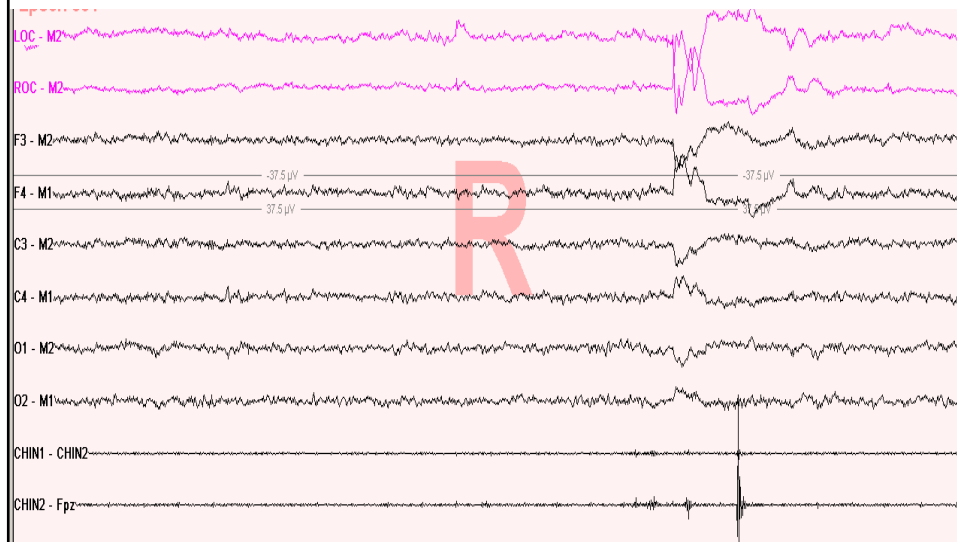
N3 Sleep: general process factual learning ?



N2 Sleep: general process refining task learning ?



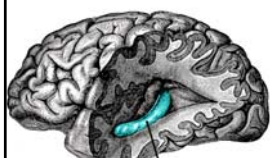
REM: general process memory valence ?



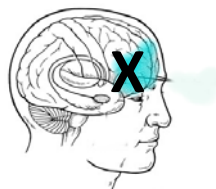
Sleep: General vs Local

- Topography suggests slow wave generation occurs locally
- Consciousness is determined by the extent of local (interneural) communication
- Areas of local sleep occur when falling asleep or waking up
- Sleep deprivation promotes local sleeping and can produce dual consciousness “awake dreaming”

Brain Local Geography



hippocampus
temporary memory



sleep
frontal cortex
executive



amygdala
emotion



UNIVERSITY OF MINNESOTA
Driven to Discover™

Local Sleep

Imagery and locomotion
without executive control



UNIVERSITY OF MINNESOTA
Driven to Discover™

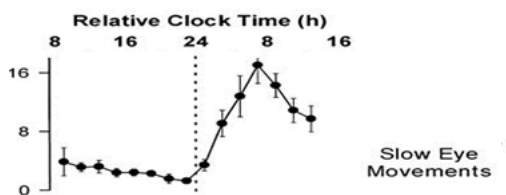
Local Sleep

Imagery and locomotion
without executive control



UNIVERSITY OF MINNESOTA
Driven to Discover™

Local Sleep



Sleeping rat



UNIVERSITY OF MINNESOTA
Driven to Discover™

Why do humans need sleep?

- Energy and space conservation
- Restoration
- Learning, memory and abstraction



Teens & Sleep

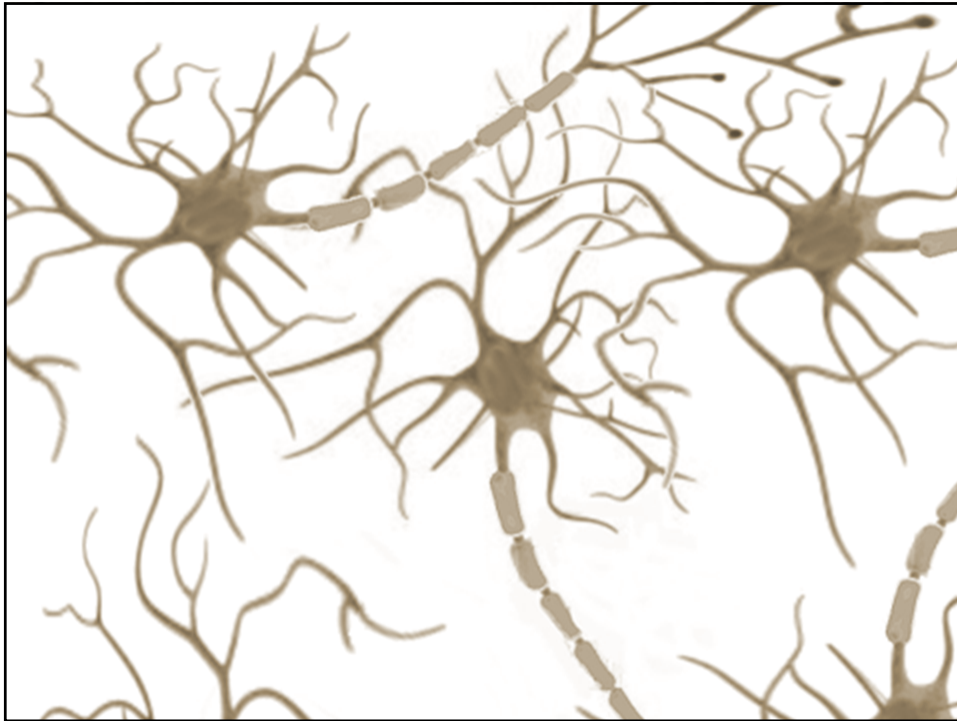
National Conference | October 3-4, 2013

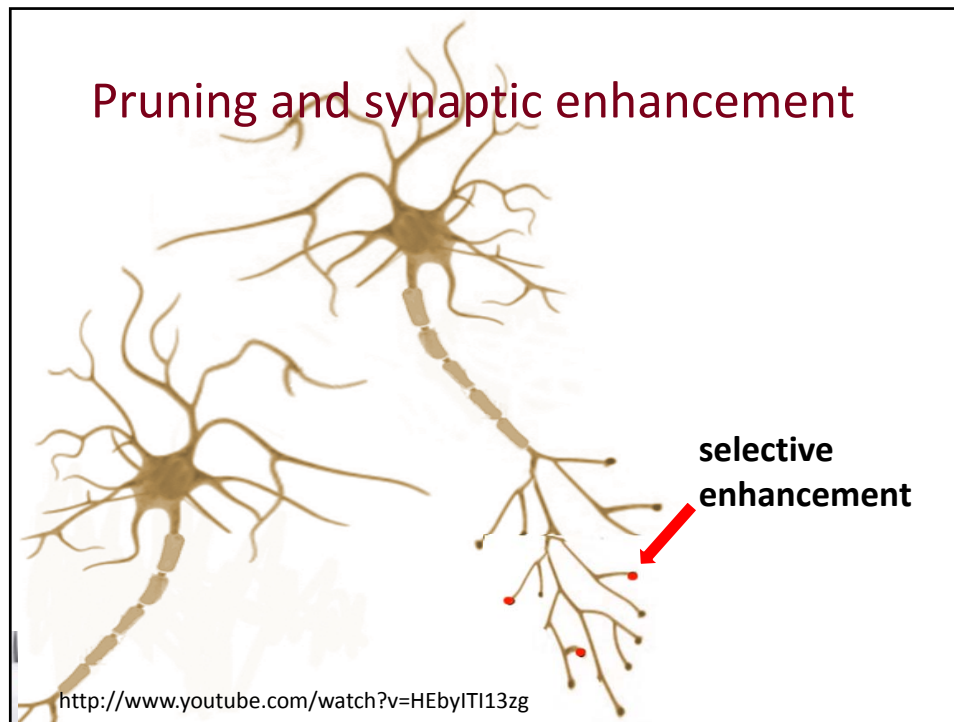


UNIVERSITY OF MINNESOTA

Driven to Discover™

The Human Brain:
100 billion neurons
100-500 trillion synapses





Synaptic plasticity and homeostasis

Why SHY?

- Space limitations-there is an 18% increase in synaptic connections each day
- Energy conservation-the brain constitutes 2% of the body weight and 20% of energy consumption
- Selectivity- selection of valued synapses and pruning of unnecessary



Teens & Sleep

National Conference | October 3-4, 2013



UNIVERSITY OF MINNESOTA
Driven to Discover™

Sleep and Brain Enhancement

PMCID: PMC2891532

- **Unitization** the ability to transform packets of memory into a unitary entities – from 539 75 214 to 53975214
- **Assimilation** placing new spoken words in a family of similar phonemically related words
- **Abstraction** the ability to recognize embedded rules in nonsense information



Teens & Sleep

National Conference | October 3-4, 2013



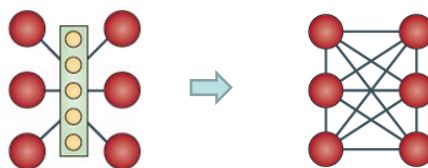
UNIVERSITY OF MINNESOTA

Driven to Discover™

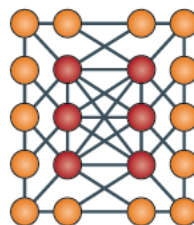
Sleep and Memory

PMCID: PMC2891532

Unitization



Assimilation



Teens & Sleep

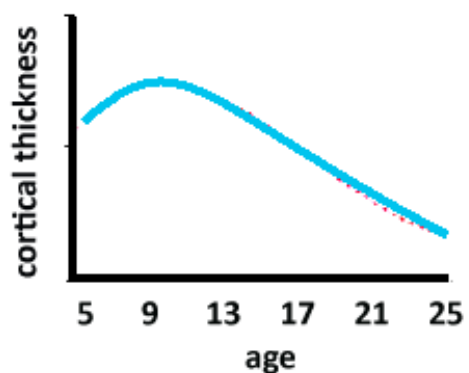
National Conference | October 3-4, 2013



UNIVERSITY OF MINNESOTA

Driven to Discover™

The additional dynamic-development



PMID 22178817



Teens & Sleep

National Conference | October 3-4, 2013



UNIVERSITY OF MINNESOTA

Driven to Discover™

Building blocks for the next talks

Sleep and its timing are biological imperatives

Sleep is an active and structured process

The active brain during sleep leverages plasticity to improve brain performance

Sleep is a structured process of nightly brain performance enhancement



Teens & Sleep

National Conference | October 3-4, 2013



UNIVERSITY OF MINNESOTA

Driven to Discover™