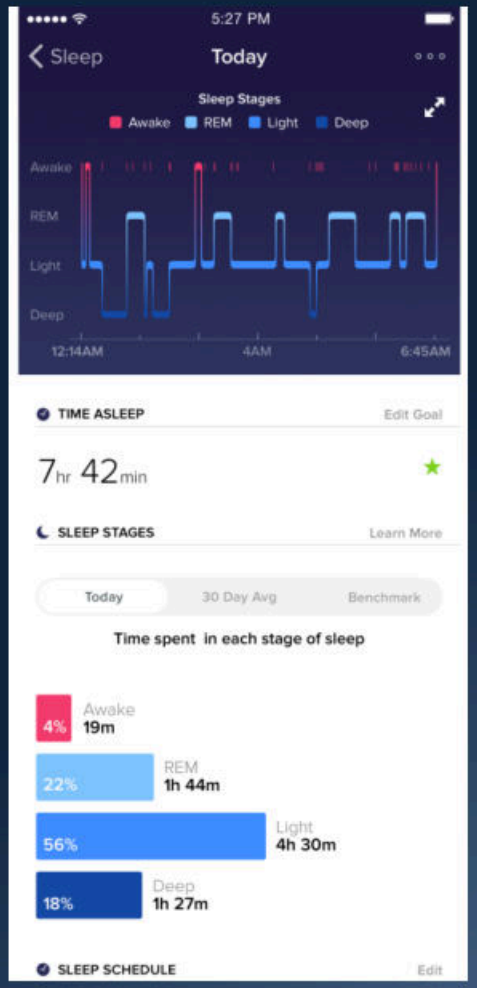
Parental, social, behavioral and cognitive factors in relation to sleep architecture in adolescents.

Natasha Giddens, M.D.



Advances in Technology





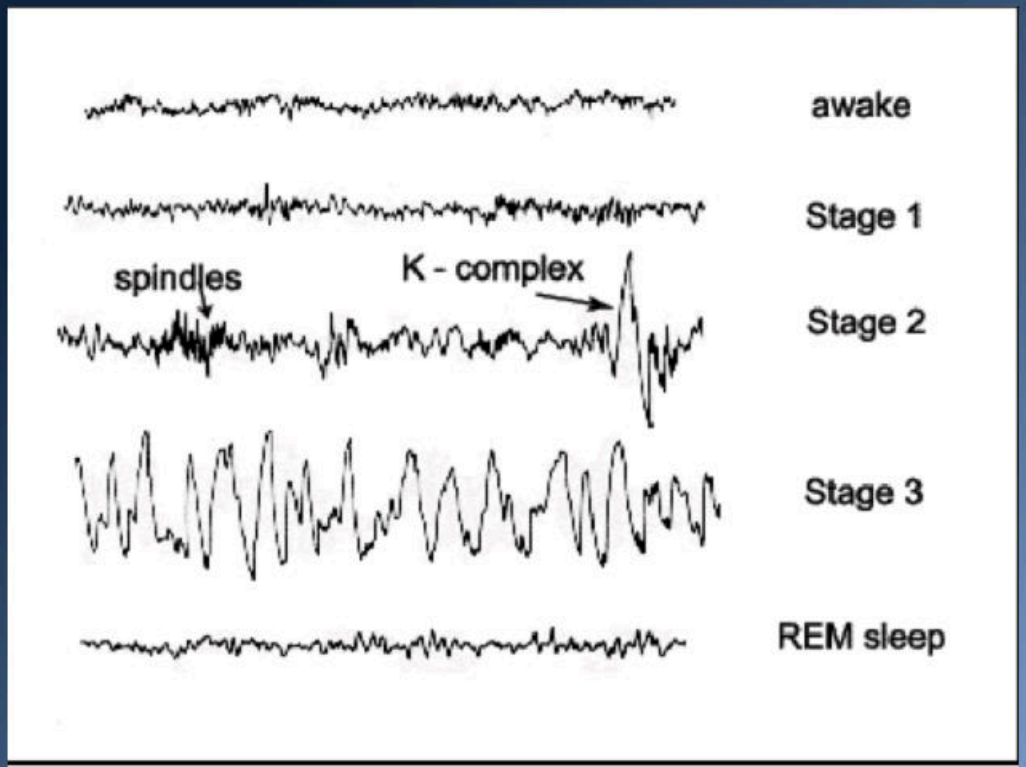
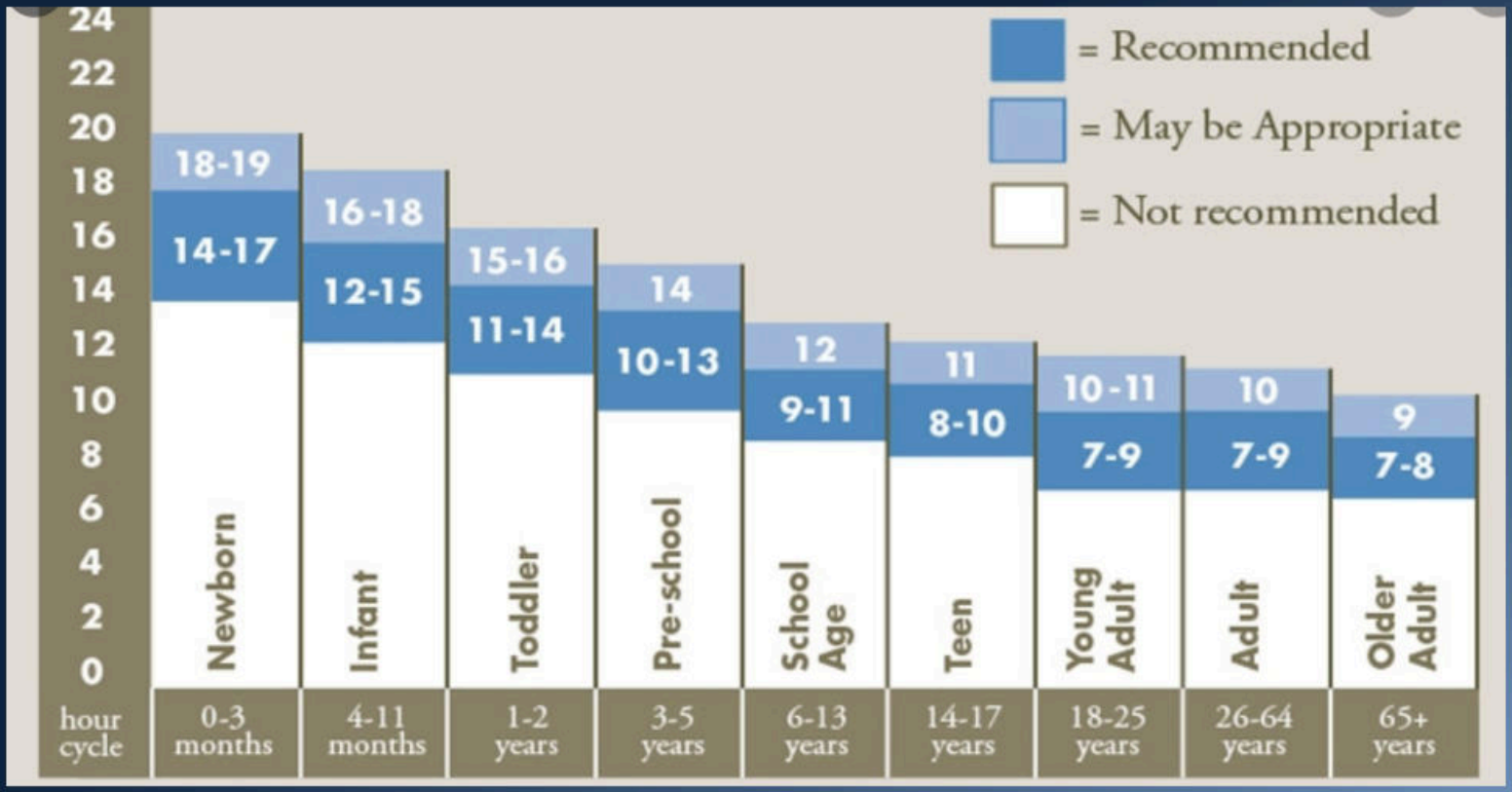


Figure 3: Wave pattern of different sleep Stages

Semanticscholar.org

Sleep Architecture

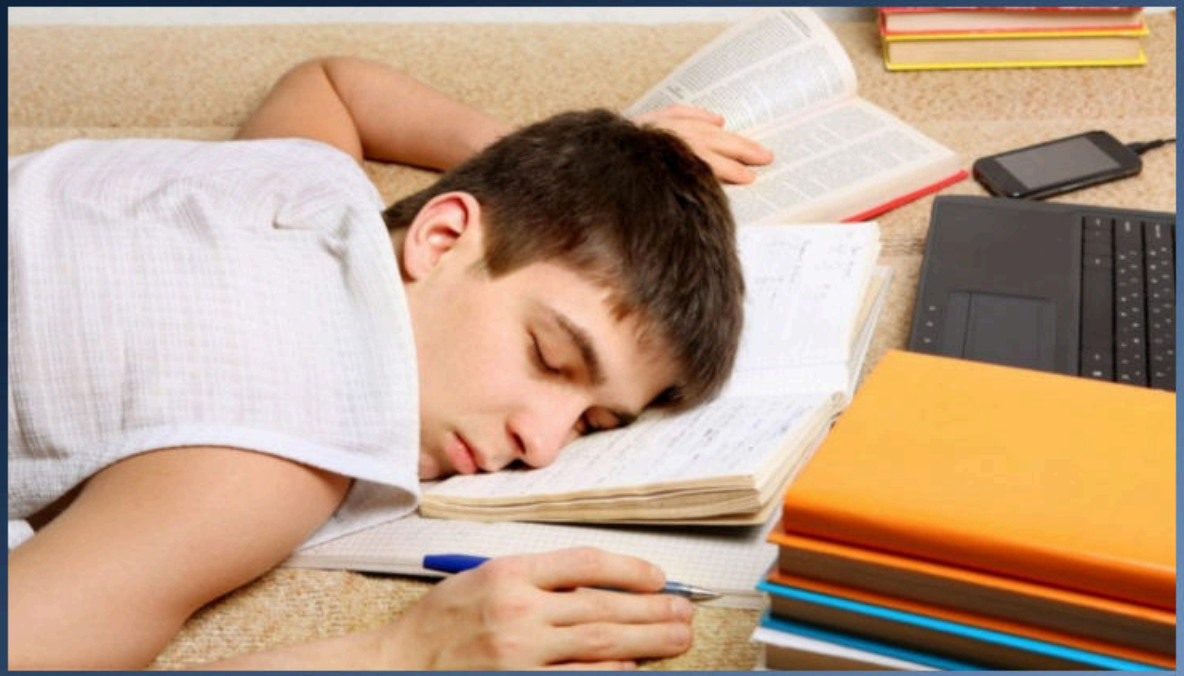


While sleep duration is undoubtedly important, it's not the only part of the equation. It's also critical to think about sleep quality and whether the time spent sleeping is actually restorative.

Sleep Architecture

Why Do the Sleep Stages Matter?

- allow the brain and body to recuperate and develop.
- Failure to obtain enough of both deep sleep and REM sleep[8] may explain some of the profound consequences of insufficient sleep on thinking, emotions, and physical health



Sleep Architecture

Stages of Sleep

Stage 1	Lightest stage of sleep (theta)	Transition from wakefulness to sleep Last 1-7 minutes Lose responsiveness to stimuli **Drifting thoughts & images**
Stage 2	"Real Sleep" (theta)	**Gradual decrease in: heart rate, respiration, body temperature, & muscle tension** Difficult to be awakened
Stage 3	Transition Stage (delta)	30-45 Minutes after drifting off to sleep
		Decrease in: Heart rate, respiration, temperature, & muscle tension Difficult to be from which to be awakened
Stage 4	"Slow wave sleep" (delta)	Deepest Stage of sleep Most difficult from which to be awakened May **sleepwalk, sleep talk, snack, night terror**
REM	Rapid Eye Movement (beta)	**Eyes move rapidly** back & forth behind closed lids Physiologically **body is very aroused** **Voluntary muscles are paralyzed** (if a nightmare, will NOT act out because) Pass though 5-6 times a night (15-45 min each time; 30-90 min between each period)

Sleep Architecture

Deep Sleep

- slow-wave sleep
- 10-20 percent of total sleep time, depending on your age
- brain waves slow. Heart rate and breathing slow, blood pressure lowers, muscles relax, and it becomes difficult to wake up.
- Deep sleep is a critical time for **physical restoration**.
- Repair occurs at the cellular level, restoring strength and function to tissue, muscle, and organs throughout the body.
- restores function to the immune system

Sleep Architecture

REM

- Brain significantly increases its activity levels compared to the other sleep phases
- eyes move rapidly in different directions heart rate and blood pressure increases, and breathing becomes fast, irregular, and shallow.
- dreaming
- critical phase of sleep for learning and memory, a time when the brain consolidates, processes, and stores information.
- mental restoration stage of sleep

Neurotransmitters and Neuromodulators

Amines and related compounds

Acetylcholine	**Excitatory transmitter** used by motor neurons and by all preganglionic and some postganglionic **autonomic neurons** (see Chapter 24). In the CNS, **acetylcholine is the transmitter or neuromodulator used by neurons in certain nuclei of the reticular formation** and in nuclei in the basal forebrain that project to the cerebral cortex.
Dopamine	Used by neurons in the **hypothalamus, substantia nigra, and ventral tegmental area** (see Chapters 11, 12, and 18). Modulatory actions in the corpus striatum, limbic system, and prefrontal cortex.
Noradrenaline (norepinephrine)	Transmitter used by most neurons of **sympathetic ganglia**; actions vary with the receptors on the innervated cells. Noradrenaline-producing neurons in the **locus coeruleus and other parts of the reticular formation have neuromodulatory effects throughout the brain** and spinal cord.
Histamine	**Excitatory transmitter** used by neurons in the tuberomamillary nucleus of the hypothalamus. **These neurons have long, branched axons that go to most parts of the brain and are believed to be involved in maintaining consciousness**.
Serotonin (5-hydroxytryptamine)	**Neuromodulator used by neurons in the midline of the brain stem with long branching axons going to all parts of the CNS. Various actions include involvement in sleep (see Chapter 9), mood (see Chapter 18), and pain (see Chapter 19)**

Neurotransmitters and Neuromodulators

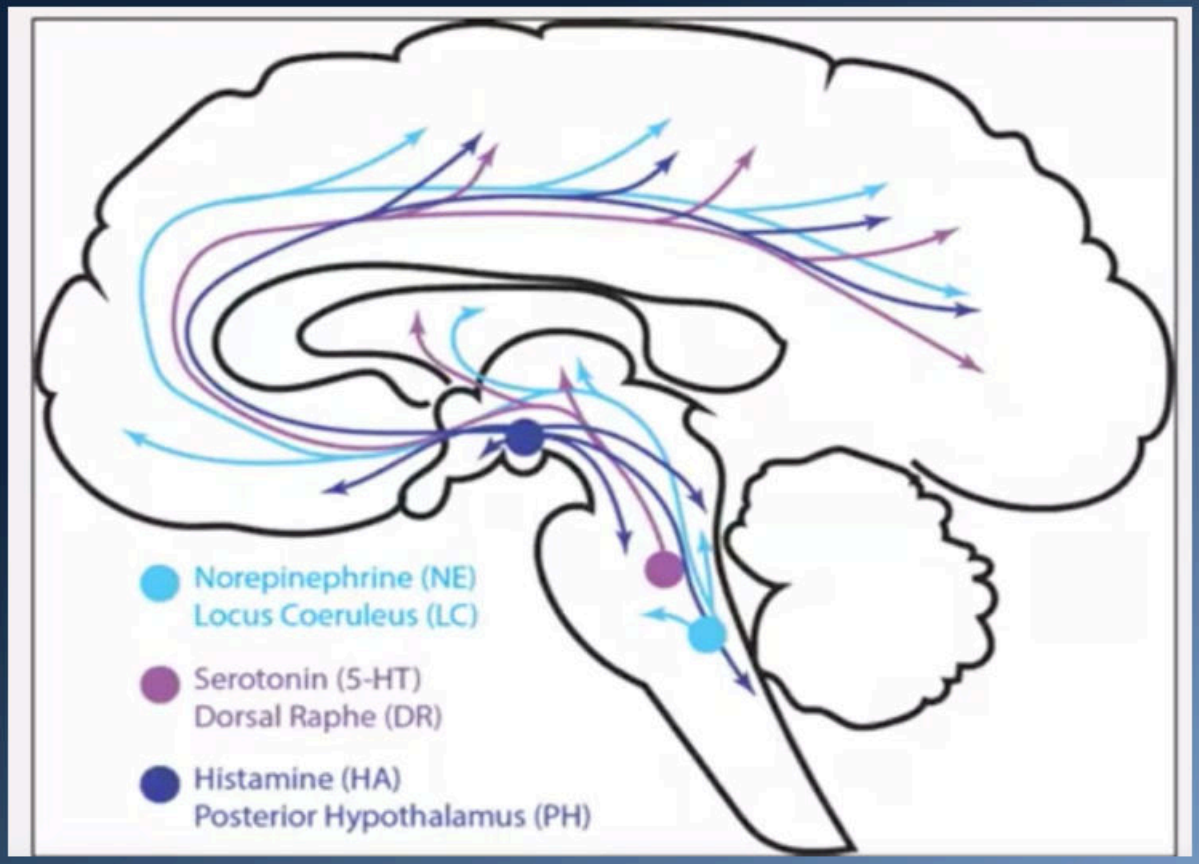
Compound & Occurrence /Functions

Amino acids

Glutamate	**Excitatory neurotransmitter in all parts of the CNS**
GABA	Inhibitory neurotransmitter in all parts of the CNS
Glycine	Inhibitory neurotransmitter in spinal cord and brain stem

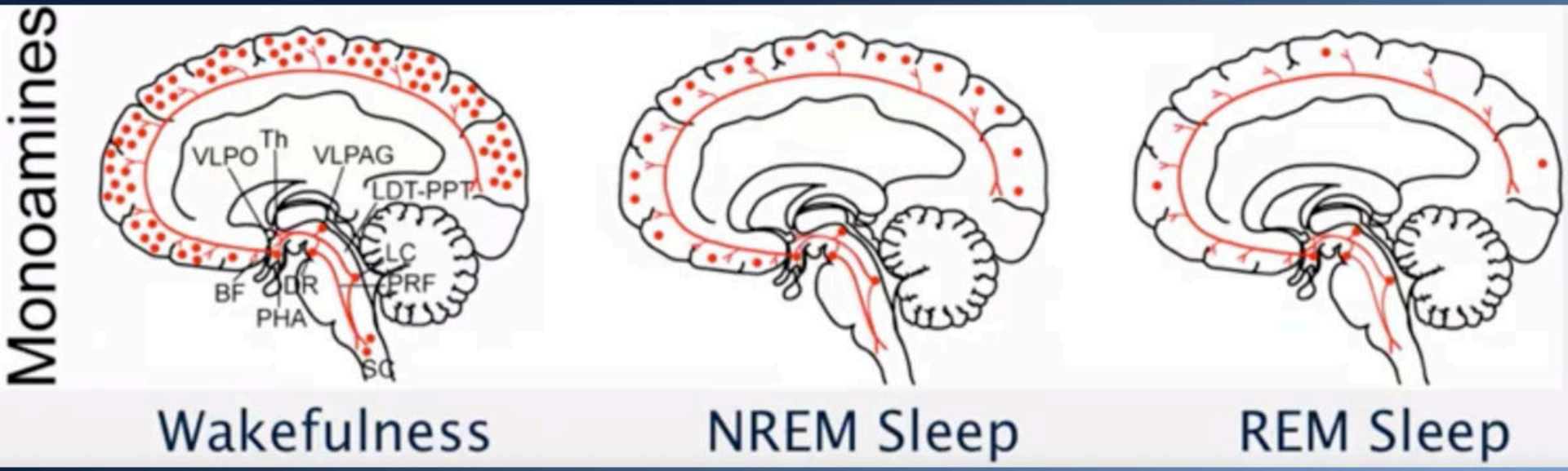
Neurobiology of Sleep: REM and Awake

Monomonergic components of the
Ascending Reticular Activating System



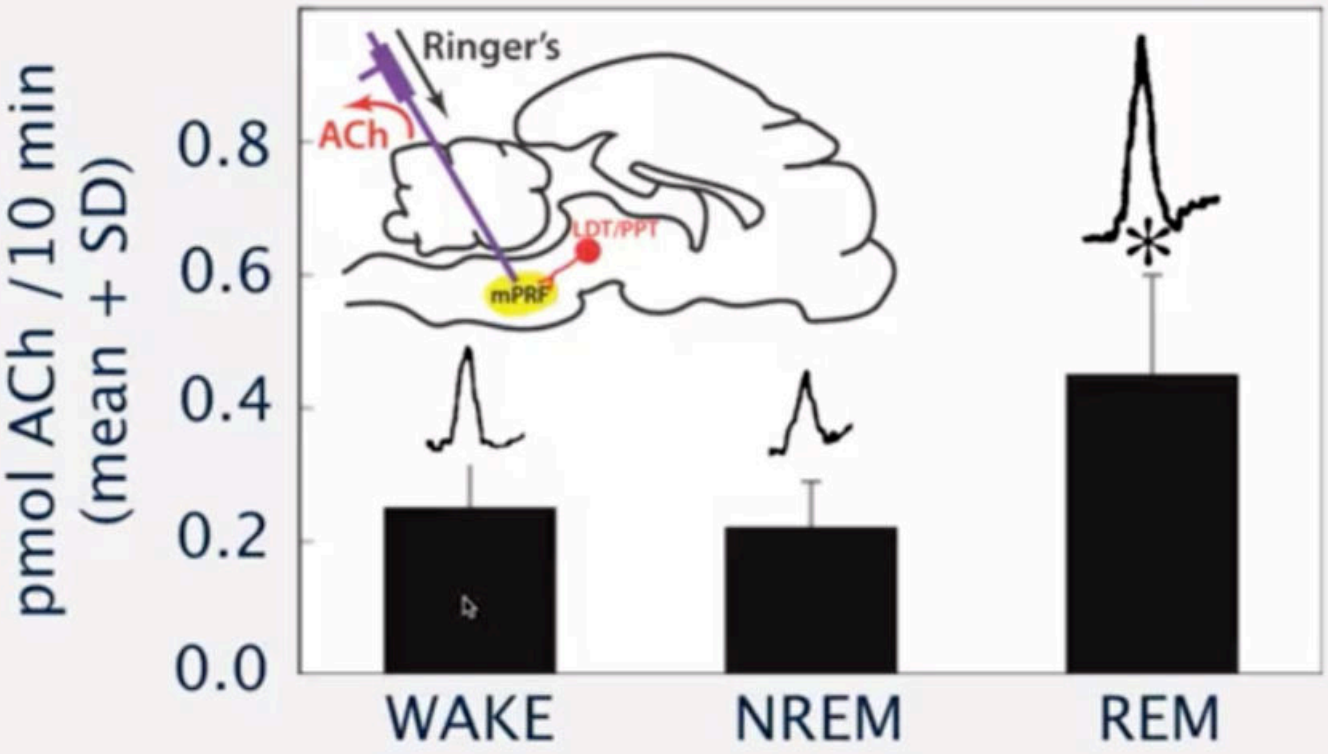
Neurobiology of Sleep: REM and Awake

State specific changes brain levels of monoamines
In every brain region, levels of serotonin, NE, and histamine
are greater during wakefulness than during sleep



Neurobiology of Sleep: REM and Awake

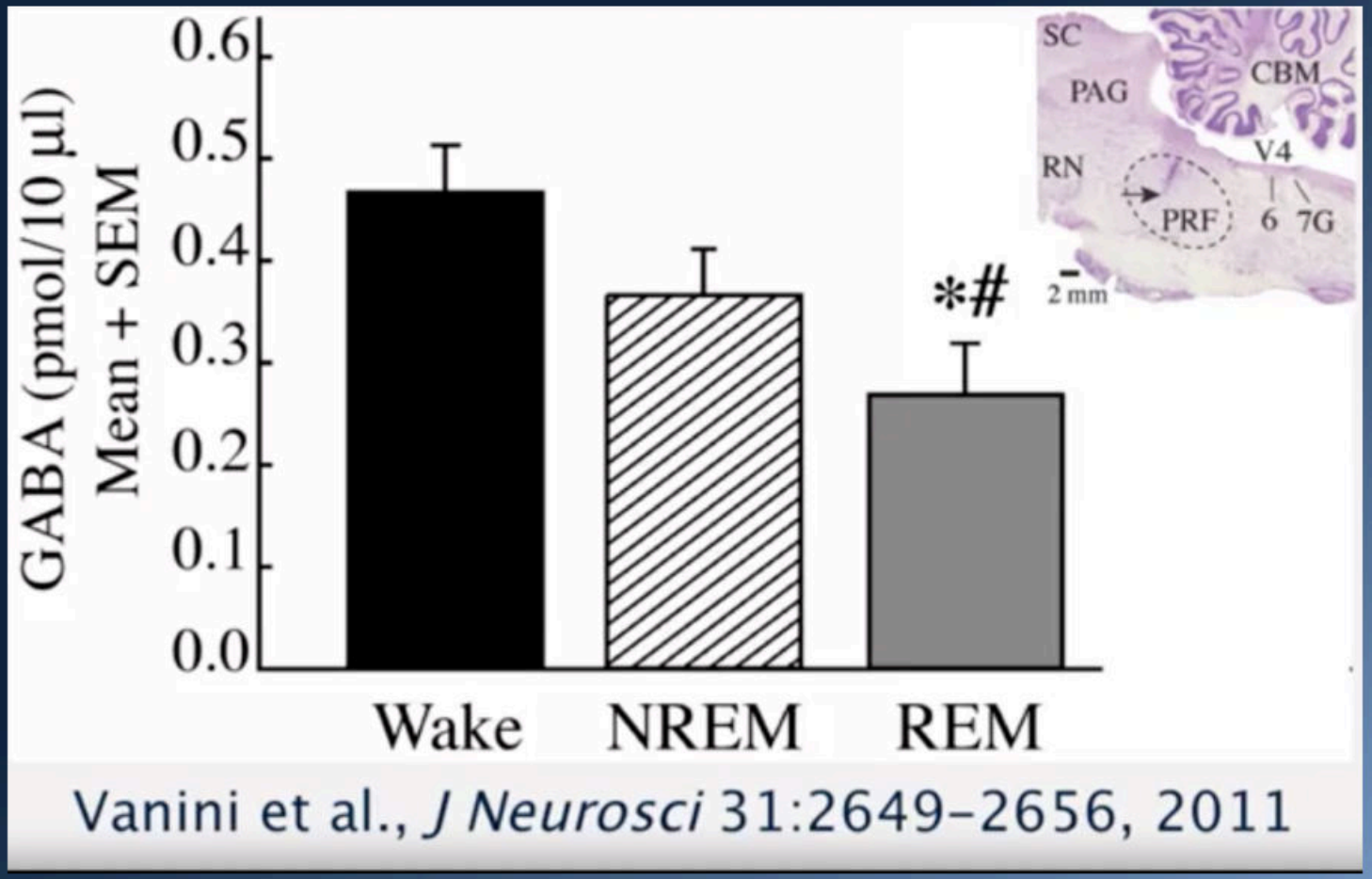
Ach release is greatest during REM sleep



Leonard and Lydic, *Neuroreport* 6:1525–1529, 1995
Kodama et al., *Neurosci Lett* 114:277–282, 1990

Neurobiology of Sleep: REM and Awake

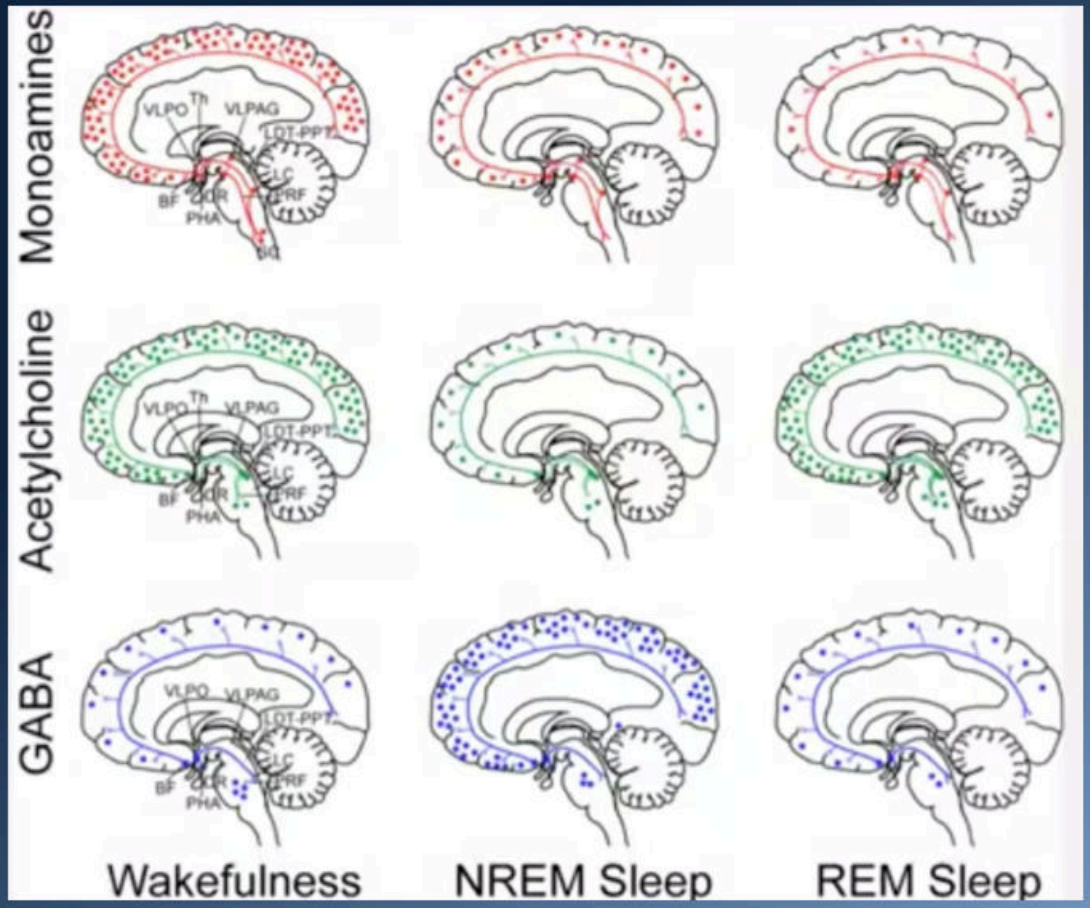
GABA Levels in the Pontine Reticular Formation are Greatest in Wakefulness



Vanini et al., *J Neurosci* 31:2649–2656, 2011

Neurobiology of Sleep: REM and Awake

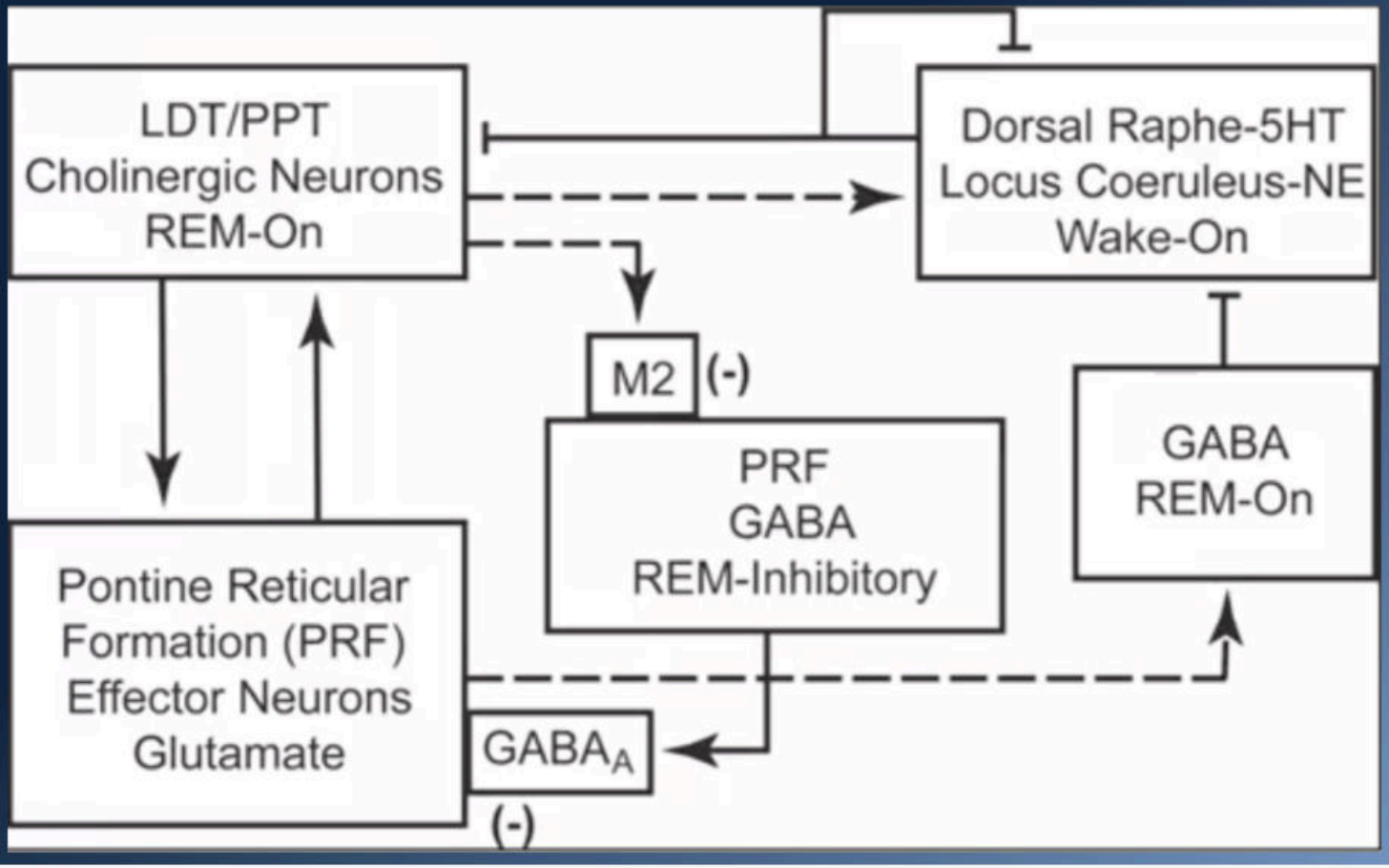
State Specific Transmitter Release



Baghdoyan & Lydic, in *Basic Neurochemistry* ed: Brady et al., Elsevier, 2012, p. 985

Neurobiology of Sleep: REM and Awake

Brain Stem Control of REM Sleep



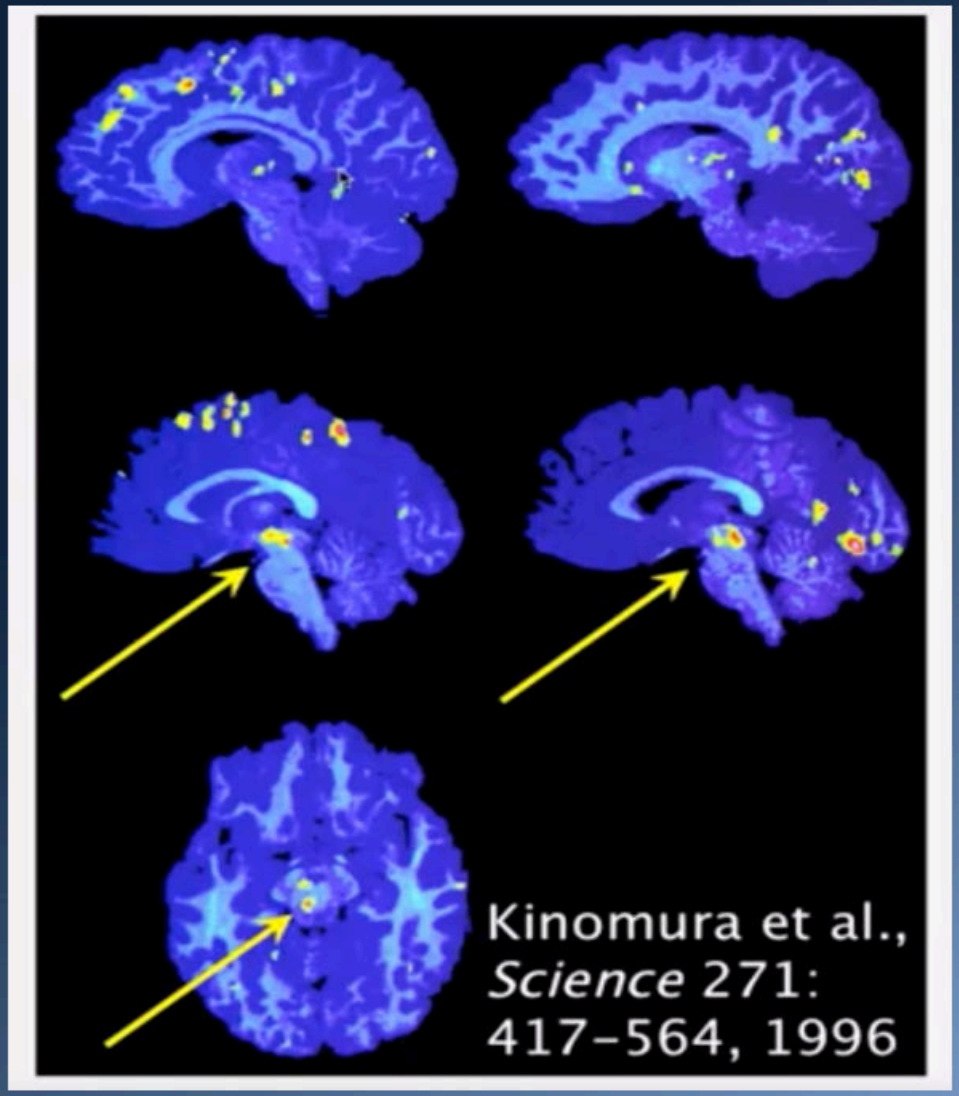
Hobson et al., *Science* 189:55–58, 1975; McCarley & Hobson *Science* 189:58–60, 1975; McCarley & Massaquoi, *J Sleep Res* 1:132–137, 1992; McCarley et al., *Sem Neurosci* 7:341–354, 1995; Steriade & McCarley, 2005

Neurobiology of Sleep: REM

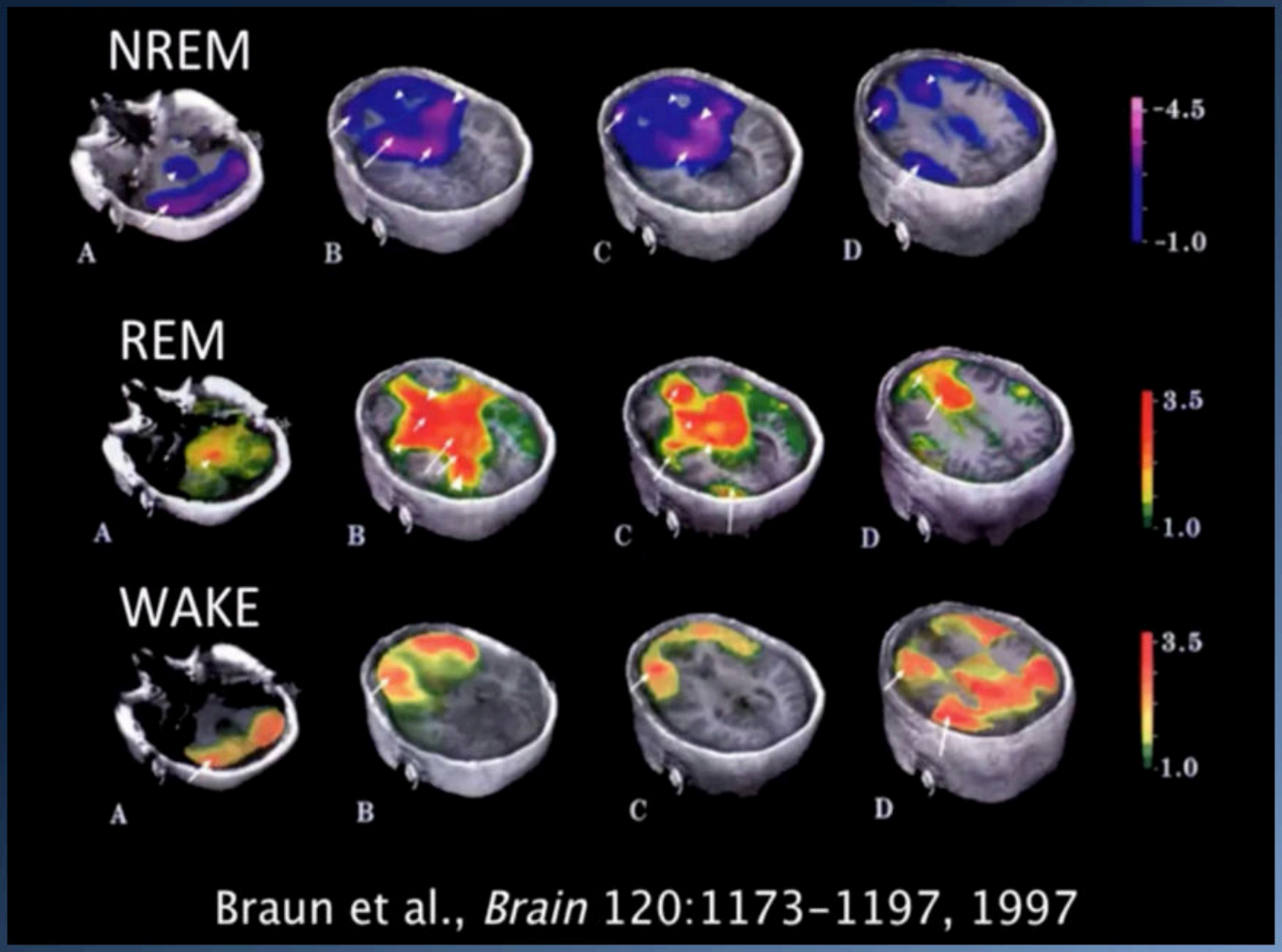
Stress Hormones

- The order in which they arrive
- Epinephrine: immediately
- Stimulates glycolysis, glycogenolysis and gluconeogenesis
- Glucagon: within 20 minutes
- Cortisol: within 2 to 4 hours
- Helps you make more glucose by breaking down proteins
- GH: after 24 hours
- Helps you make more glucose as well

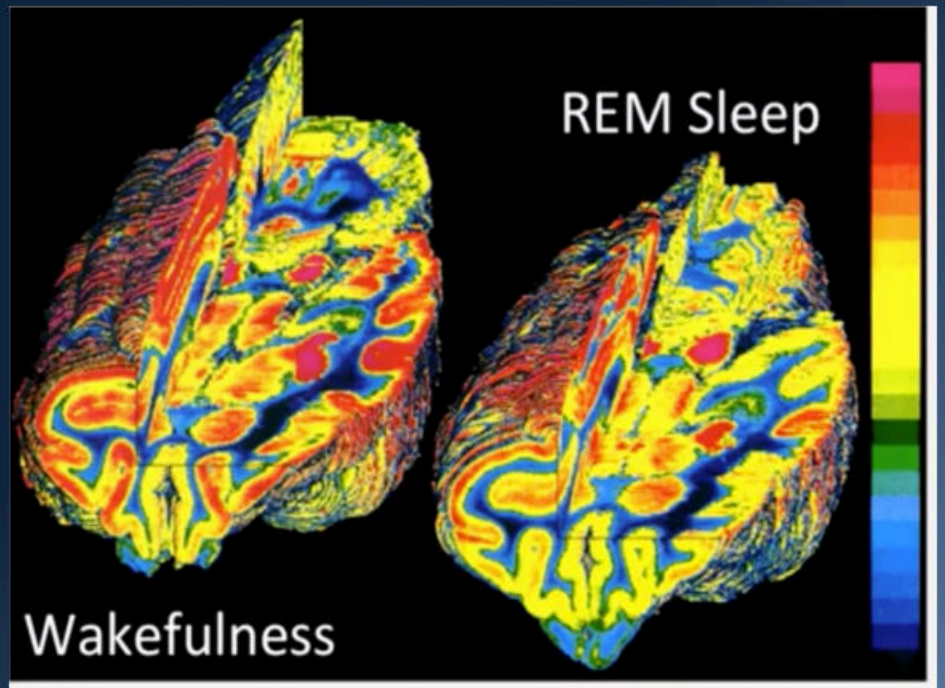
Neurobiology of Sleep: REM



Neurobiology of Sleep: REM



Neurobiology of Sleep: REM



Lydic et al., *J Comp Neurol* 304:517–529,1991

Variables Known to Impact Sleep

Family stressors and poor parent – child relationships can have negative effects on children's sleep as indexed by longer sleep onset latency, more frequent awakenings, and increased nightmares than is typical[5]

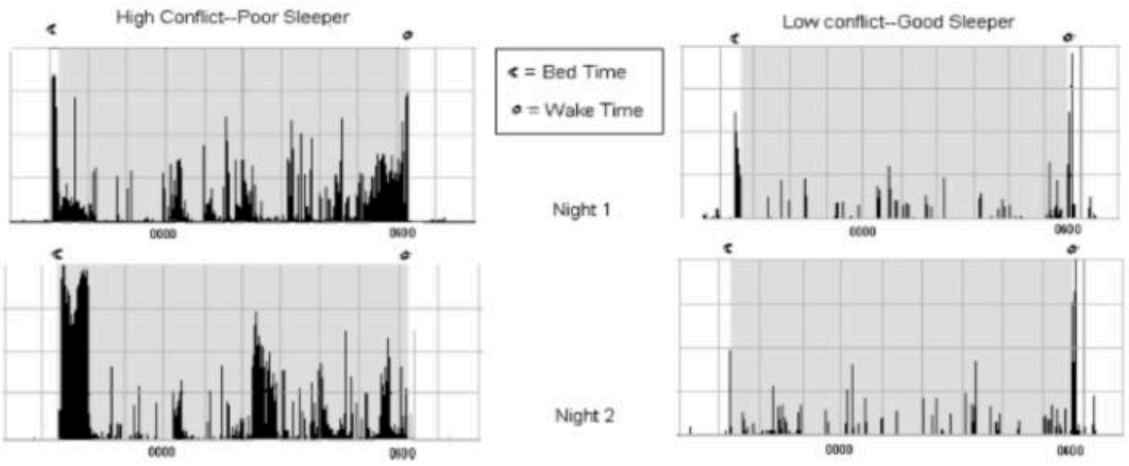


Figure 1. Raw nocturnal actigraphy data for 2 nights of sleep. All times are on a 24-hr clock, and midnight and 6:00 a.m. are depicted on the *x* axis. Sleep data on the left of the panel are for a child from a higher conflict home whereas those on the right of the panel are for a child from a lower conflict home. Dark areas on the graph indicate increased activity level related to wakefulness (either before sleep onset, after sleep end, or during night wakings). The child from the lower conflict home exhibits more consolidated sleep with less activity than the child from the higher conflict home, who exhibits more fragmented sleep with longer and more frequent night awakenings.

Variables Known To Impact Sleep

- parents of children with inadequate sleep were more likely to report frequent **child depressive symptoms, high parental stress, and violent family conflict style.**[6]
- children's reactions associated with exposure to war-related violence have included, sleep disturbances, and other symptoms that, in the extreme, have come to be associated with posttraumatic stress.[7]
- Independently, **ethnicity/race and SES** have been found to be associated with sleep disturbances, and the effects of each are still evident after adjusting for the other Particularly for sleep, the experience of discrimination may heighten individuals' alertness and disrupt sufficient and quality sleep
- **most of the existing evidence comes from studies conducted on adults and only a few studies examined the role of discrimination in sleep among adolescents**

Sleep and Psychiatric Disorders



Image courtesy of r. nial bradshaw

https://www.flickr.com/photos/zionfiction/7484820084/in/photolist-9yLMH7-Mf3wF-4h1sNF-54cb7f-bCnzW-7n4MH9-7oPxSG-cppEf9-gA6EPx-5Qhtrn-4qJ2TP-atsyfQ-55KEnM-7hRtac-751gL5-uh4B5-4igYka-iK8st-hgcJ7u-i6DtLq-i6DsUX-oC4KaZ-oC5bjh-69B8Yr-5dToVh-pdmUMd-oXUBa6-pdn7bA-pdmUnL-pfoPq4-oUi6LP-3iu73D-p9odNM-oC5ak3-oUi7q4-oC5pWL-oC5H38-9nwqUd-9KyvSh-7NspfG-6yE6wa-8vVjRL-7re3ji-8RL4bf-9XbRRD-oGrjm5-opYHrE-oGt4Yg-opYHCS-bqT2cC/player/

Safari

- Depression

Sleep and Psychiatric Disorders

Clinical Sleep Disturbances in Depression

- Insomnia Pattern
- Hypersomnia Pattern
- Sleep disturbances may be present before, during, and after an episode of illness

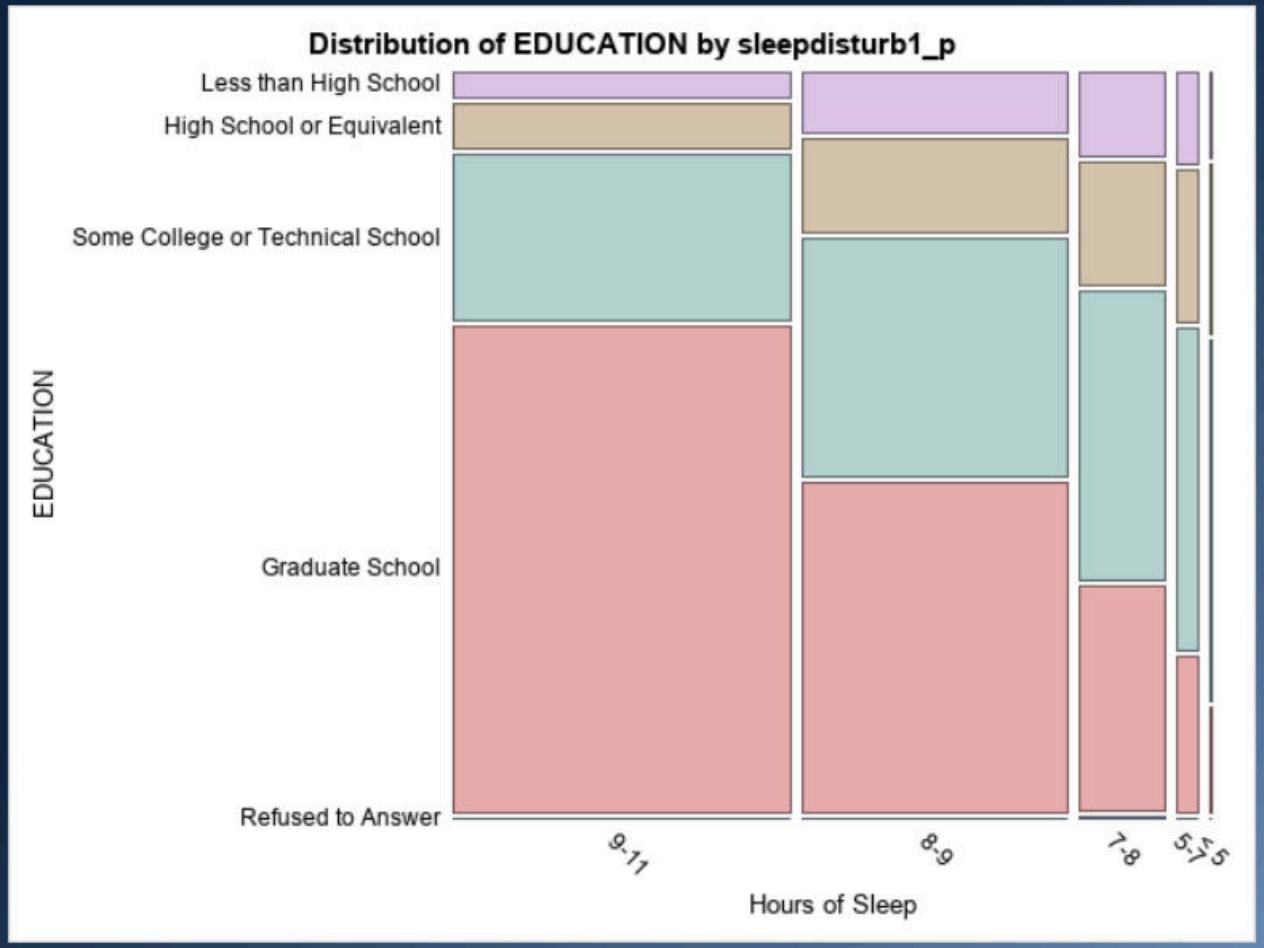
- EEG Sleep Alterations in Depression
- REM sleep
  - Short Rem latency
  - Increased phasic REM sleep
  - Increased first REM period duration
  - Increased REM percent

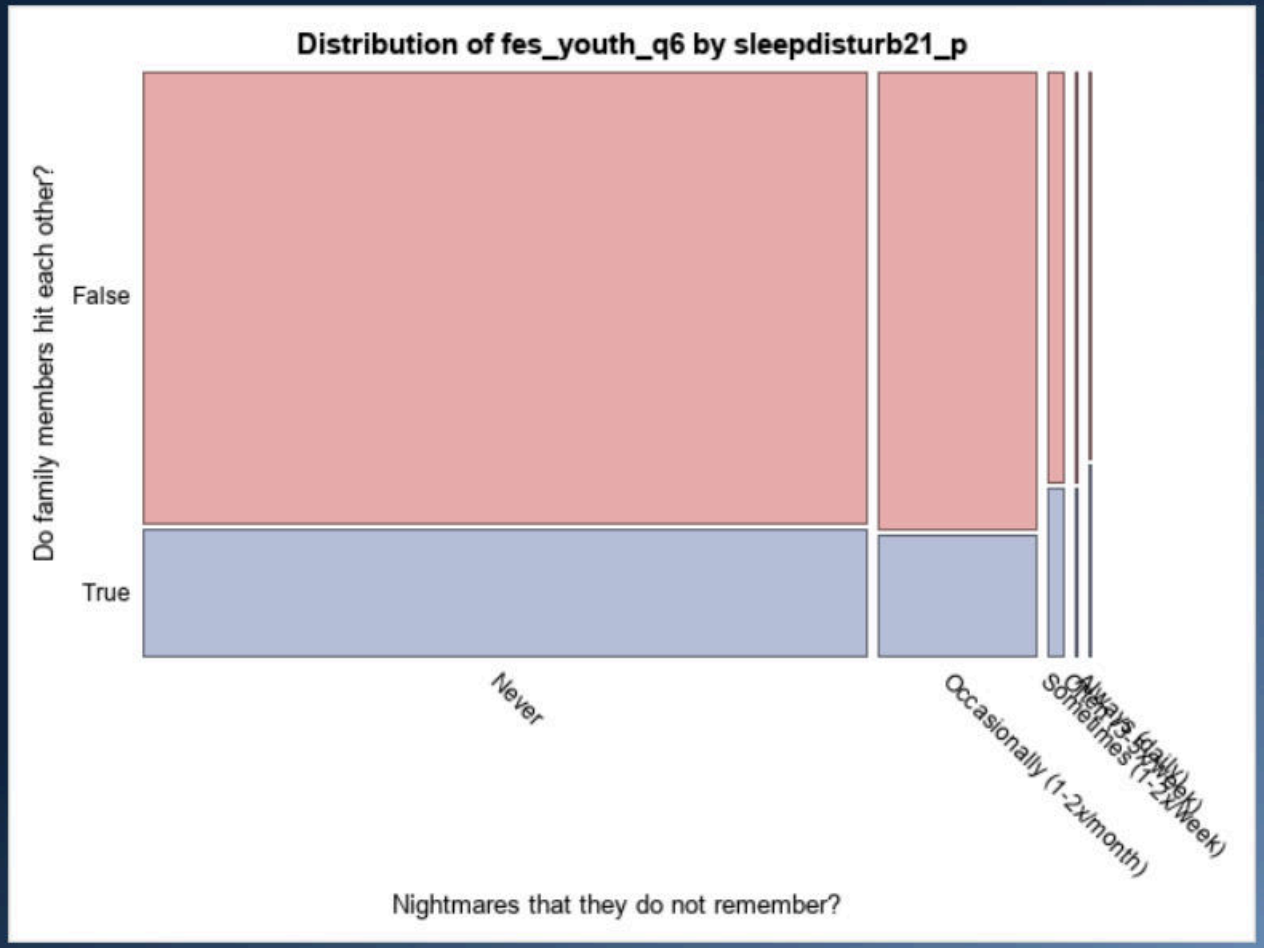
Cluster	Variable
Parent Psychopathology	
	Parent Depressed
	withdrawn
	Somatic complaints
	thought problems
	attention problems
	aggressive behavior
	rule breaking behavior
	intrusive
Social Demographics	Parent Report Demographics from PhenX Toolkit
	RACE
	parental highest education
	household annual income
	marriage status
	Economic insecurity
	grand total uniform crime report
	Area Deprivation Index by scaled weighted sum
	ABCD youth discrimination measure
Proximal Environment	Safety from Crime items from PhenX Toolkit- used to
	Parent report neighnorhood safety
	Child Report Neighborhood Safety
	School Environment
	School Involvement
	(school disengagement)
Social Interactions- marital conflicts	
	Child Report Marital Conflict
	youth family conflict subscale modified from fenx
	ABCD Parent Family Environment Scale-Family Confli
	parental acceptance
	parent reportconflict w child
	Child report conflict w parent

CHILD	
Child Psychopathology	parent report of Child Behavior Checklist (CBCL)
	Aggressive behavior
	anxious/depressed
	attention problems
	rule breaking behavior
	somatic complaints
	social problems
	thought problems
	withdrawn/depressed
	mania
	psychosis
Child behavior	Child impulsivity
	negative urgency
	positive urgency
	lack of planning
	lack of perseverance
	sensation seeking
BAS/BIS	BAS: reward responsiveness
	BAS: goal direced behavior
	BAS: fun seeking
	Behavioral Inhibition system: worry, fearfulness
Child Cognition	Picture Vocabulary
	Oral Reading recognition tasts- reading decoding
	List Sorting working memory
	Flanker- inhibitory control
	card sorting-cognitive flexibility
	pattern comparison- processing speed
	picture vocabulary (vocabulary comprehension)
	picture sequencing- episodc memory
	LMT accuracy- visual spacial processing
	RAVLT Delayed memory
	matrix reasoning
	cash choice- delayed gratification
	grades/school performance- parent report
3	grades and attendence
	bullying
traumatic events	
	parent report about child- PTSD
	parent report of child
	Child report of themselves

ABCD 3.0

fit_ss_first_inbed_minutes	String	30	Recommended	First Minute that the participant was identified as being in-bed (but not necessarily asleep)	All data is offset by 12 hours so that 00:00=noon; 23:59=11:59A	fitbit_ss_first_inbed_minutes
fit_ss_first_sleep_minutes	String	30	Recommended	First Minute that the participant was identified as being asleep	All data is offset by 12 hours so that 00:00=noon; 23:59=11:59A	fitbit_ss_first_sleep_minutes
fit_ss_outbed_minutes	String	30	Recommended	First Minute that the participant was identified as being out-bed (but may have woken up prior to this)	All data is offset by 12 hours so that 00:00=noon; 23:59=11:59A	fitbit_ss_outbed_minutes
fit_ss_wakeup_minutes	String	30	Recommended	First Minute that the participant was identified as being awake	All data is offset by 12 hours so that 00:00=noon; 23:59=11:59A	fitbit_ss_wakeup_minutes
fit_ss_total_sleep_minutes	Integer		Recommended	Total time within the sleep window (including wake periods) as calculated by 30 second sleep record		fitbit_ss_total_sleep_minutes
fit_ss_sleepperiod_minutes	Float		Recommended	Total time in sleep (light plus deep plusREM)		fitbit_ss_sleepperiod_minutes
fit_ss_wake_minutes	Float		Recommended	Total number of Minutes (in 30 second increments) identified as being awake during the sleep window	Does not include any Minutes anotated as awake prior to the first Minute of sleep (i.e. does not count latency)	fitbit_ss_wake_minutes
fit_ss_light_minutes	Float		Recommended	Total number of Minutes (in 30 second increments) identified as being in "light" sleep stage during the sleep window		fitbit_ss_light_minutes
fit_ss_deep_minutes	Float		Recommended	Total number of Minutes (in 30 second increments) identified as being in "deep" sleep stage during the sleep window		fitbit_ss_deep_minutes
fit_ss_rem_minutes	Float		Recommended	Total number of Minutes (in 30 second increments) identified as being in "REM" sleep stage during the sleep window		fitbit_ss_rem_minutes
fit_ss_wake_count	Integer		Recommended	Total number of unique awakenings during the sleep period (excludes final awakening)		fitbit_ss_wake_count
fit_ss_avg_hr_wake	Integer		Recommended	Average heart rate during Minutes that were classified as awake	In the event that the two (2) 30-second epochs within the Minute under review did not agree regarding sleep stage the HR for that Minute was not included.	fitbit_ss_avg_hr_wake
fit_ss_avg_hr_light	Integer		Recommended	Average heart rate during Minutes that were classified as light sleep stage	In the event that the two (2) 30-second epochs within the Minute under review did not agree regarding sleep stage the HR for that Minute was not included.	fitbit_ss_avg_hr_light
fit_ss_avg_hr_deep	Integer		Recommended	Average heart rate during Minutes that were classified as deep sleep stage	In the event that the two (2) 30-second epochs within the Minute under review did not agree regarding sleep stage the HR for that Minute was not included.	fitbit_ss_avg_hr_deep
fit_ss_avg_hr_rem	Integer		Recommended	Average heart rate during Minutes that were classified as REM sleep stage	In the event that the two (2) 30-second epochs within the Minute under review did not agree regarding sleep stage the HR for that Minute was not included.	fitbit_ss_avg_hr_rem


Distribution of EDUCATION by sleepdisturb1_p
Less than High School
High School or Equivalent
Some College or Technical School
Graduate School
Refused to Answer
EDUCATION
9-11
8-9
7-8
5-7
<5
Hours of Sleep


Distribution of fes_youth_q6 by sleepdisturb21_p
Do family members hit each other?
False
True
Never
Occasionally (1-2x/month)
Sometimes (1-2x/week)
Always (daily)
Nightmares that they do not remember?

Application of a longitudinal model

- Set of predictors, see how they influence REM and Deep Sleep in minutes.
- Longitudinal model that allows me to incorporate this feature of the date
- Generalized Linear Mixed Effect Model
- Given that time can be highly skewed because there are no negative values, the data will be skewed to the right
- 2 salient features
  - 1. Time and skewed feature
  - Looking at a child over time, there is variability within a single child and between two different children