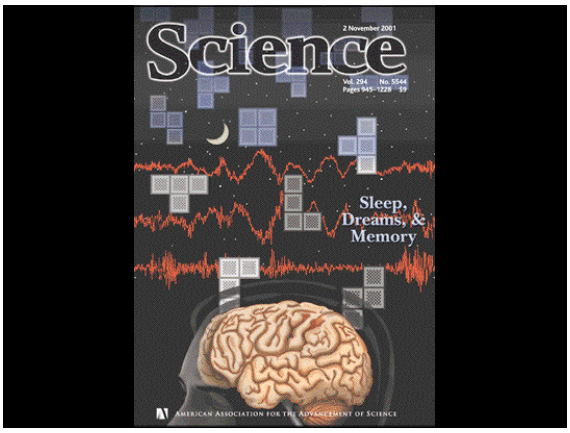
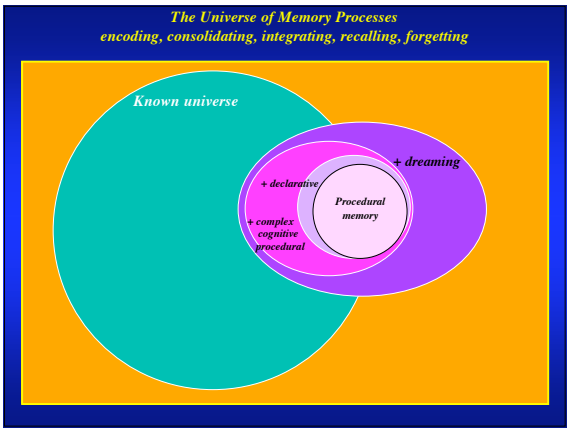
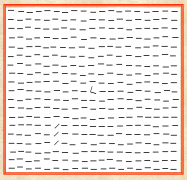




Sleep Consolidates Perceptual Learning



- Sara Mednick
- Vipul Patel
- Beth Schirmer
- Dana Whidbee
- LaTanya James

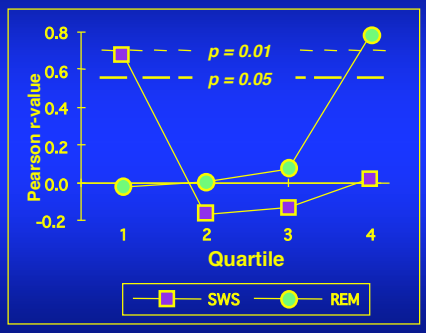
Summary

- No improvement is seen until after sleep
  - √ Improvement increases over days without intervening rehearsal
  - √ Sleep is required within 30 hrs of training

Summary

- No improvement is seen until after sleep
  - √ Improvement increases over days without intervening rehearsal
  - √ Sleep is required within 30 hrs of training
  - √ Improvement requires both SWS and REM

Learning Across the Night



Summary

- No improvement is seen until after sleep
  - √ Improvement increases over days without intervening rehearsal
  - √ Sleep is required within 30 hrs of training
  - √ Improvement requires both SWS and REM
- Performance deteriorates without sleep
  - √ Naps can stop deterioration
  - √ Naps with REM lead to improvement

Training

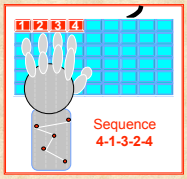
Stabilize

SWS

Enhance

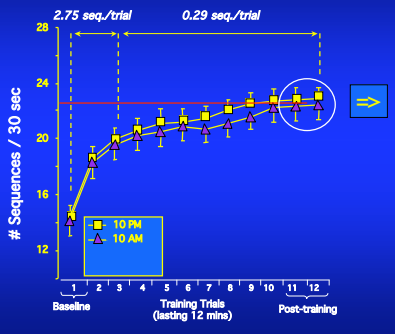
REM

Sleep Consolidates Motor Learning



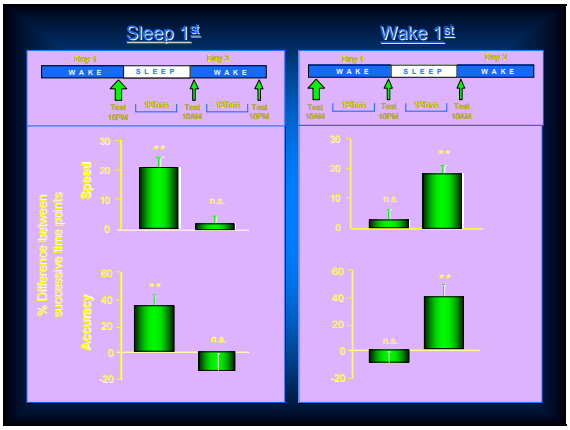
- Matthew Walker
- Tiffany Brakefield
- Alexandra Morgan

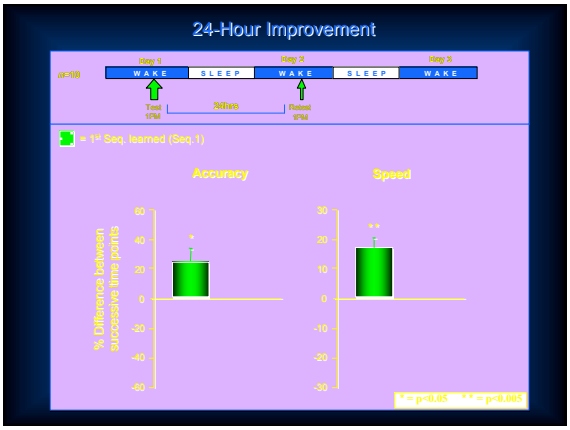
Learning Rate Saturates Rapidly



Summary

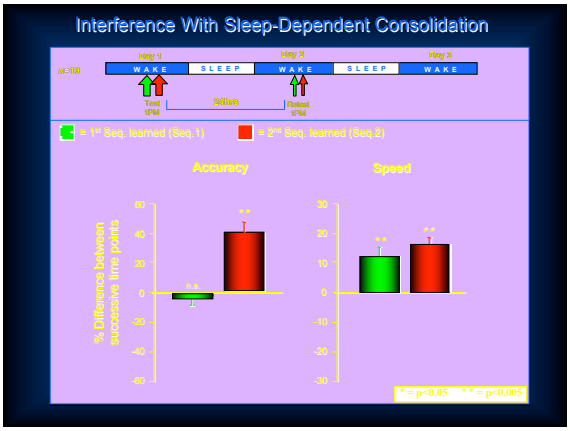
- Improvement is seen after sleep
  - √ Seen over 12, 24, or 48 hr if there is a night of sleep
  - √ Is not seen after 12 hr without sleep, or after 48 hr with no sleep the first night

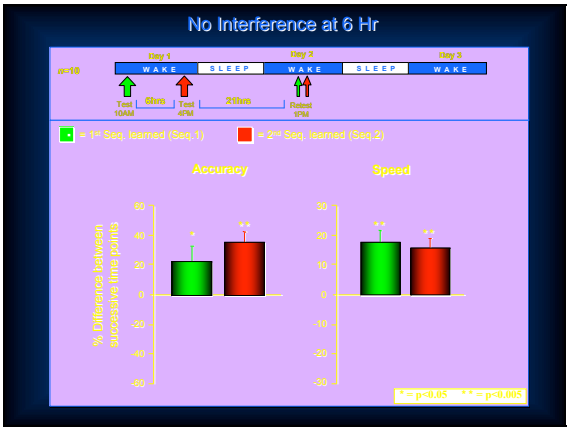


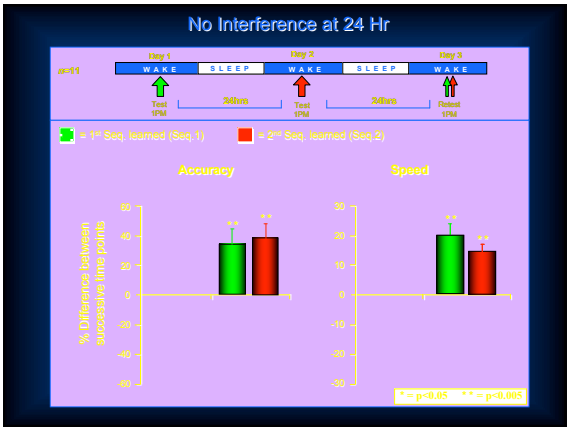


Summary

- Improvement is seen after sleep
  - √ Seen over 12, 24, or 48 hr if there is a night of sleep
  - √ Is not seen after 12 hr without sleep, or after 48 hr with no sleep the first night
- New sequence can produce interference
  - √ Only affects overnight improvement
  - √ Seen at 10' but not at 6 hr or 24 hr

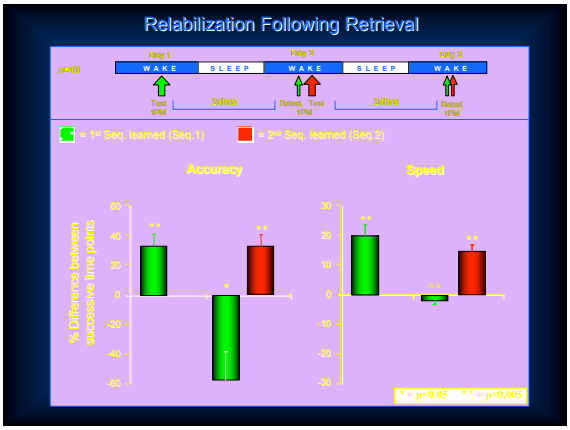






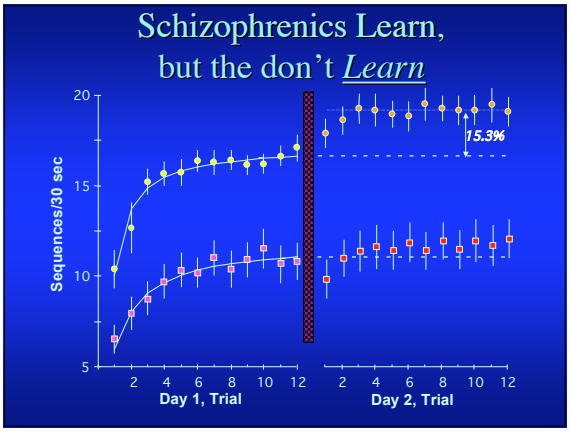
Summary

- Improvement is seen after sleep
  - √ Seen over 12, 24, or 48 hr if there is a night of sleep
  - √ Is not seen after 12 hr without sleep, or after 48 hr with no sleep the first night
- New sequence can produce interference
  - √ Only affects overnight improvement
  - √ Seen at 10' but not at 6 hr or 24 hr
  - √ Seen at 24 hr with reactivation, but effect only seen over next night



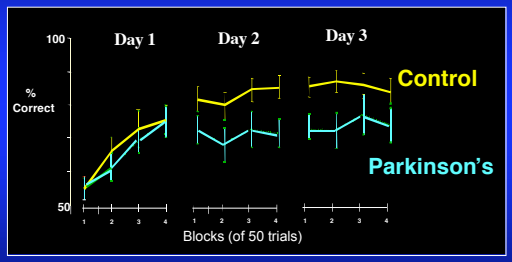
Sleep and Memory Disorders

- Dara Manoach
- Ed Pace-Schott
- Bob Malison



Is Category Learning Sleep-Dependent?

n=12; PD mild, medicated, no dementia



(Shohamy, Gluck et al)

Associative Memory is Altered During Sleep

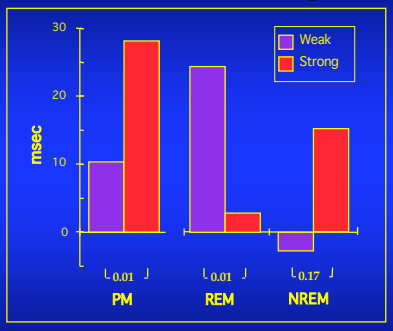
Attention Randy O'Reilly: Top-down biasing on posterior cortex tasks??

Semantic Priming

paper →	wrong	(600 ms)
thief →	wrong	(580 ms)
right →	wrong	(560 ms)

- Cindi Rittenhouse
- Jen Holmes
- Beth Schirmer
- Lauri Scott

Semantic Priming



Episodic Memories are *NOT* Replayed in (most) Dreams

Two-week dream journals

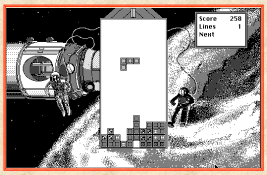
- Magdelena Fosse
- Roar Fosse

Dream Sources & Episodic Replay

Criterion	Subjects	Reports	Elements
All reports with content	29	299	-
Elements with waking sources	27	194	364 (100%)
Episodic sources	22	104	147 (40%)
+ conserved location	17	31	38 (10%)
+ other conserved features	9	11	12 (3%)
+ judged episodic replays	4-6	5-8	5-8 (1-2%)

New Experiences are Replayed at Sleep Onset

Hypnagogic dreams



- April Malia
- Denise Maguire
- David Roddenberry
- Karen Emberger
- Laura Babkes

Alpine Racer II

Skiing imagery

- 14 out of 16 players (88%)
- 42% of first night reports contain skiing imagery
- 3 out of 3 controls who only watched

Kinesthetic imagery

- 11 players (69%)
- 1 control (33%)

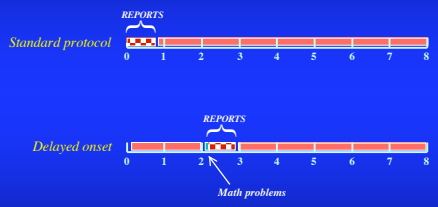
Alpine Racer Images

"I keep seeing all the places where I fall- like, hit the walls. It's kind of annoying; and then my legs fly up in the air." (SEC)

"I can sort of feel the motions of the game but more not really seeing it." (MLC)

"I envisioned myself skiing, and for a second there it felt like I was skiing backwards - something I used to attempt when I was younger." (CMD)

Delayed Onset Reporting



Delayed Onset Reports

"I felt as though I was **falling downhill**. And I was dreaming about like instructions to a young king or something." (JAV, rpt 4)

"I felt like I was sort of **sliding downhill** again. And, um ... there were instructions and a person and uh, I don't know." (JAV, rpt 6)

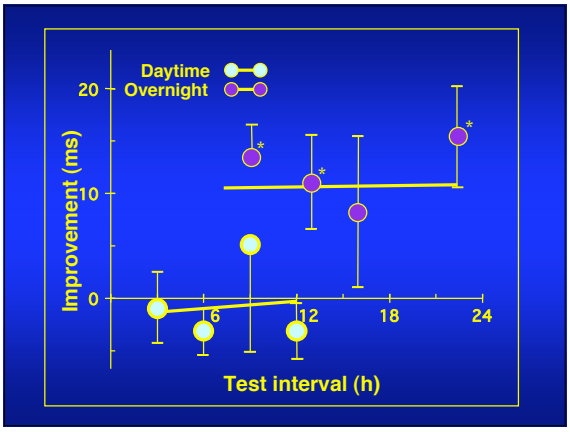
"I was having a rather vivid image as though I was moving forward through **some kind of a forest**... I was moving forward very stiffly. Um, my entire **upper body** was **incredibly straight** ... it felt almost as if I was **moving forward** on a conveyor belt, and, **without my legs actually moving**." (MAM, rpt 8)

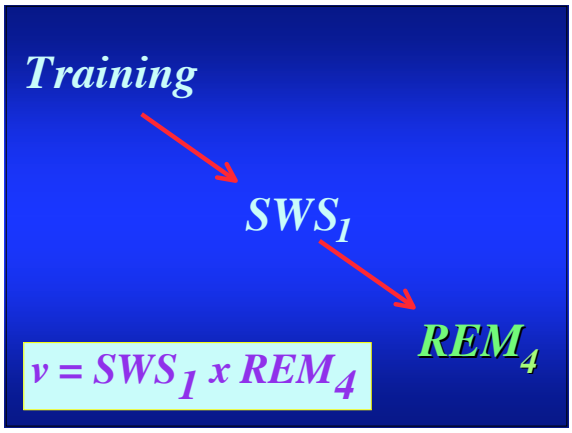
"There was a squirrel making **skiing motions**"

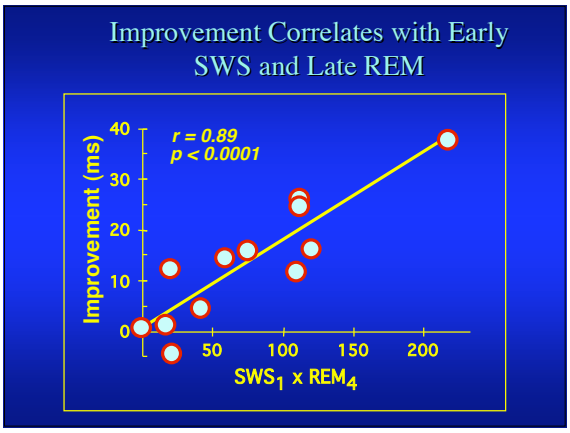
Conclusion

I used to glibly say that everyone knows sleep is involved in memory processing, except people studying sleep and people studying memory. This has changed,but often begrudgingly.

If I could convince you of one thing today, it would be that the cutting edge of memory research is now bound up with the question of sleep. This is not the only place where exciting memory research is occurring, but it represents an area where finding questions are being answered that we didn't even know to ask. And this is the best kind of place to be.



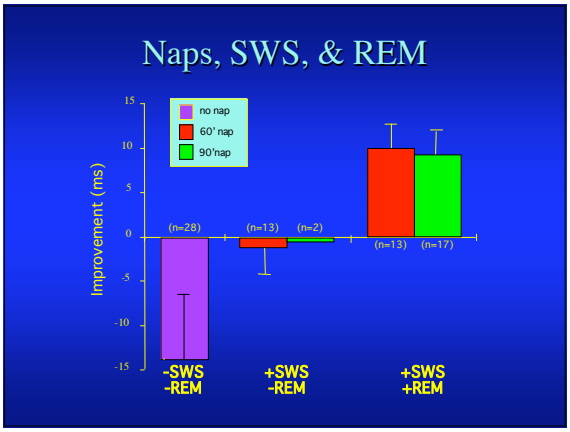




Fatigue and Napping

Overtraining on TDT

- Dan Luskin
- Sara Mednick
- Neha Pathak
- Alicia Levin



Big Ones

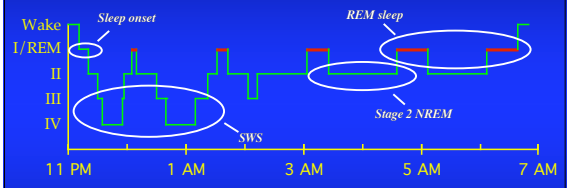
- How are episodic and other declarative memories processed during sleep?
- What roll do emotions play in regulating sleep-dependent memory processes?
- How are associative memory networks altered, both temporarily and more permanently during sleep?
- What roll does sleep play in the development of hippocampus-independent memories?
- How are emotionally charged memories selectively reactivated *prior* to sleep onset ?
- And what about dreams?

Dreams

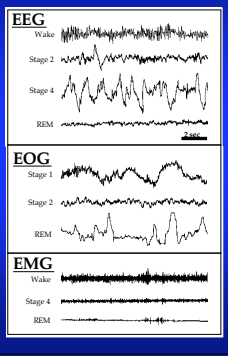
- How does dreaming (and/or the biological processes subserving it) affect memory systems?
- What classes of memories are activated during dreaming?
  - √ Why aren't episodic memories reactivated?
  - √ Does a failure of this suppression contribute to PTSD?
- How are memories selected and how are associated memories subsequently used to construct a dream?
- What function(s) are the brain pursuing during dreaming?
  - √ What happens when we "sleep on a problem?"
  - √ How dependent is the maintenance of our larger memory systems on these brain processes which produce dreaming?

The Chemistry and Physiology of the Brain Change Across the Night

A Good Night's Sleep



Sleep Physiology

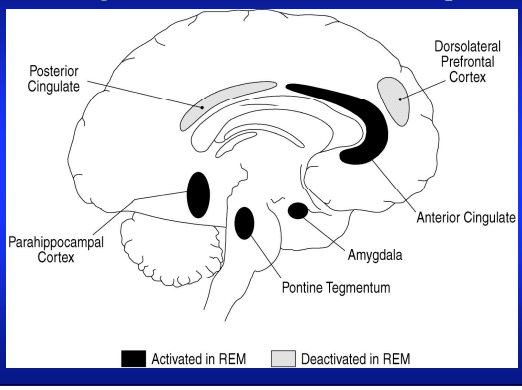


Neuromodulation Varies Across the Wake-Sleep Cycle

	Active Wake	Quiet Wake	SWS	REM
ACh	++	+	–	+++
NE 5-HT	++	+	+	–

Ach: acetylcholine
NE: norepinephrine (noradrenalin)
5HT: serotonin

Regional Activation in REM Sleep



Hippocampal-Neocortical Dialog