



Universität
Zürich UZH



ZNZ Zentrum für Neuronenforschungen | Zürich Neuroscience Center Zürich
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FORSCHUNGSZENTRUM
FÜR DAS KIND (FZK)

Comparative Physiology and Pharmacology of Sleep

Learning and sleep

Reto Huber

University Children's Hospital

Bio 333: HS 2012; 26.11.2012

Learning objectives

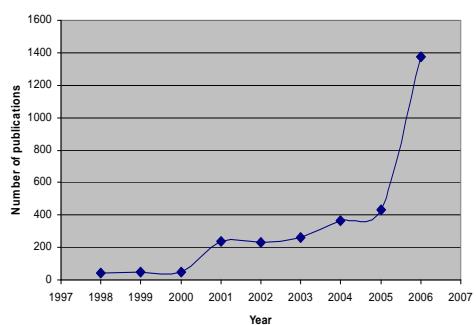
At the end of the lecture you should be able to:

- To answer the question if and how sleep affects learning
- To name important factors affecting the interplay between sleep and learning

Is it that simple?



Publication number ,sleep and learning'



Wer sich weiterbilden will, muss schlummern – sagen Hirnforscher
Tagesspiegel 28.11.2004

Wissen in den Kissen
Die Zeit 48/2002

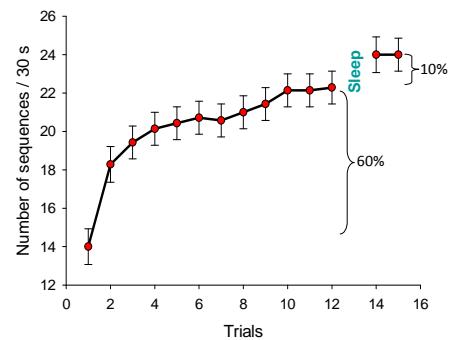
Lernen in der Wiege und im Schlaf
NZZ 6.11.2001

Example



Example: 4 1 3 2 4

Karni Test

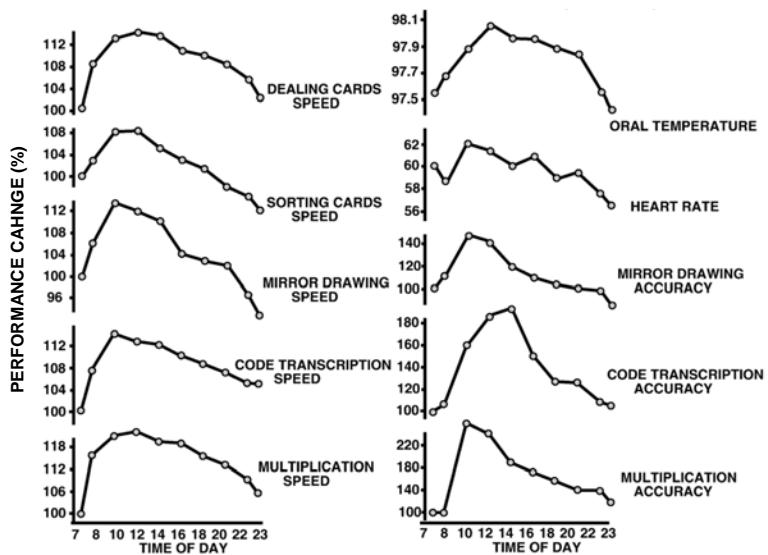


Walker et al., Neuron 2002

What are confounding variables?

- Sleep vs. waking
- Circadian effects

Circadian rhythm of performance

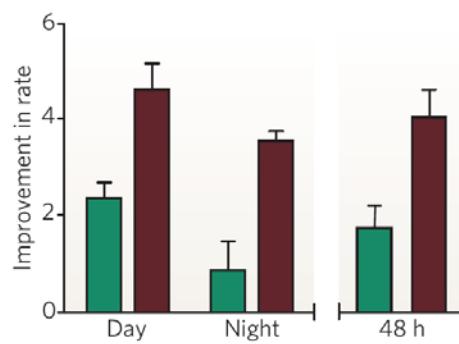


Blatter et al., Physiol & Behav 2007

Control experiment

Karni Test

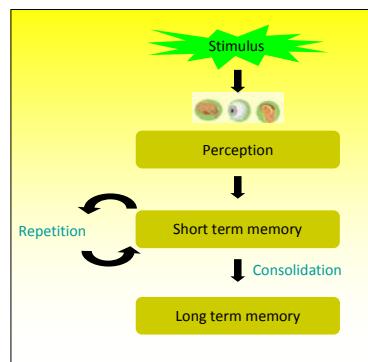
Without sleep With sleep



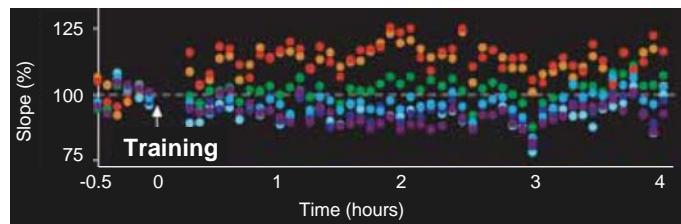
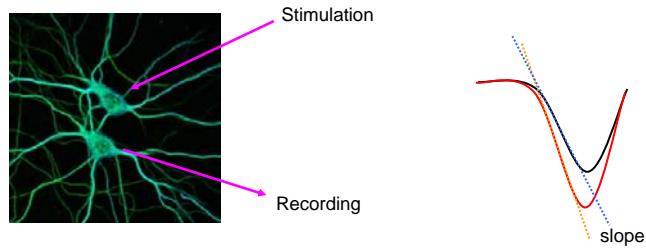
Stickgold et al., Nature 2005

How does this happen?

Learning basics I



Learning basics II



Bliss and Lomo, *J Physiol* 1971

Whitlock et al., *Science* 2006

Relationship to slow waves
during sleep?

Local increase in slow-wave activity

Rotation learning

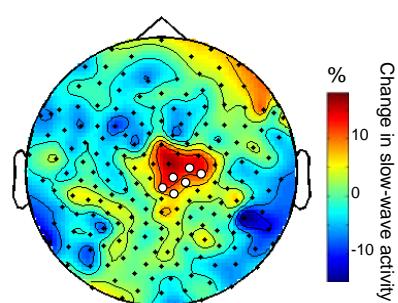
Motor control

Sleep EEG

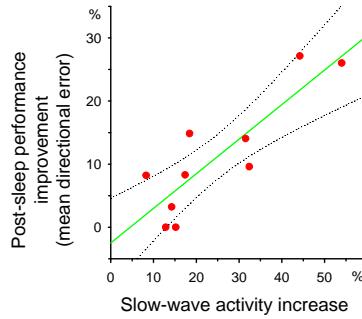
Retest

12 pm

8 am



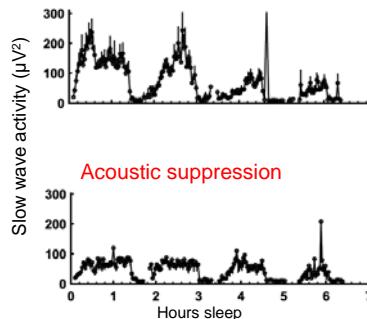
Change in slow-wave activity
%



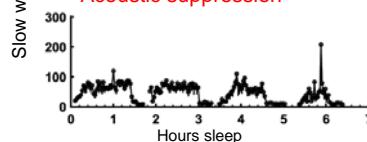
Huber et al., Nature 2004

Slow wave suppression

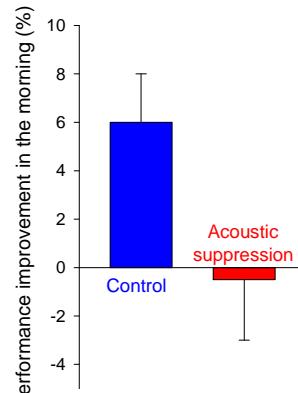
Control



Acoustic suppression

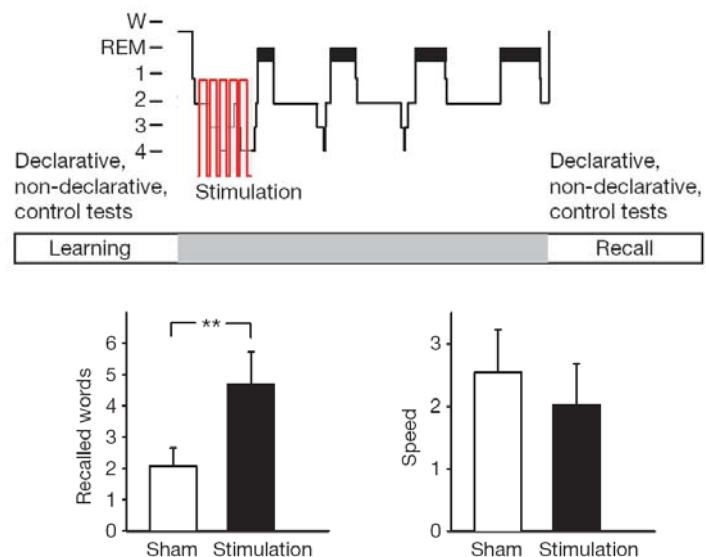


Performance improvement in the morning (%)



Landsness et al., Sleep 2009

Induction of slow waves

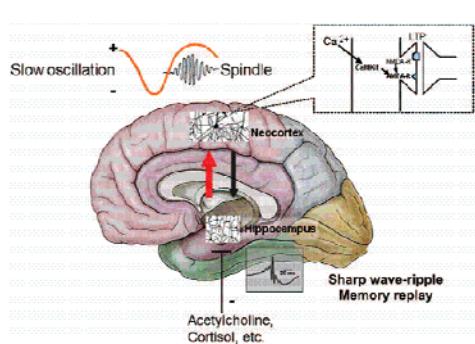


Marshall et al., Nature 2006

Two hypotheses

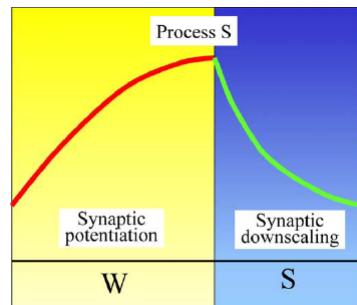
Replay vs. Re-normalization

Replay



Born et al.,
Neuroscientist 2006

Downscaling



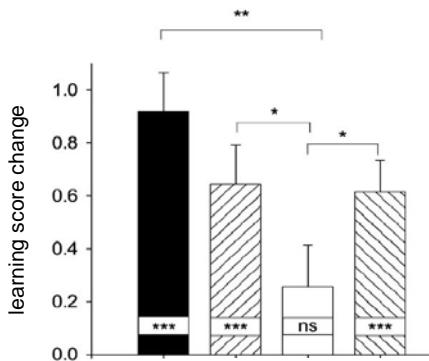
Tononi and Cirelli,
Sleep Med Rev 2006

Important aspects to consider:

- Interference
- REM sleep
- Sleep deprivation

Interference

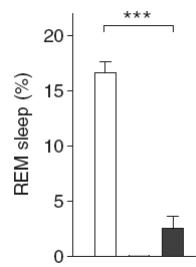
Auditory sequence learning



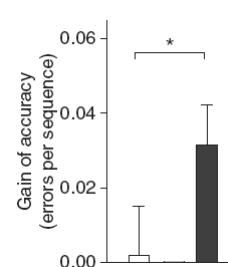
Gottselig et al., *Neurosci* 2004

REM sleep

Serotonin re-uptake inhibitor



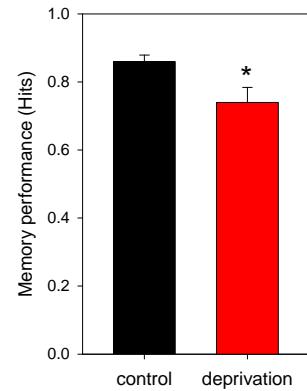
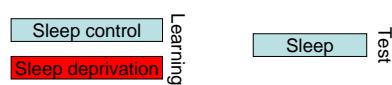
Karni test



Rasch et al., *Nat Neurosci* 2009

Sleep deprivation

Picture recognition

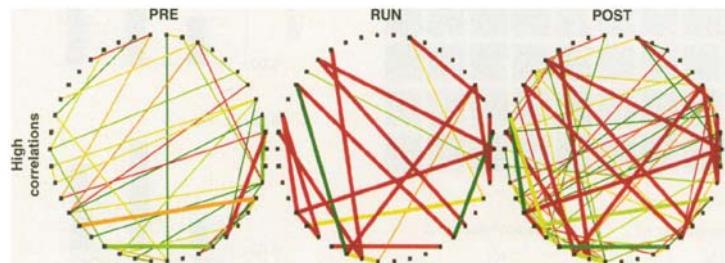


Yoo et al., Nat Neurosci 2007

What is the relevance of
'reactivation during sleep'?

First indications

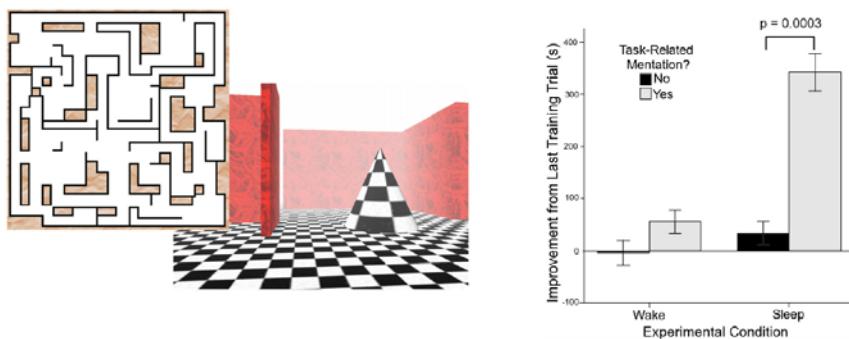
rats ('place cells')



Wilson and McNaughton, *Science* 1994

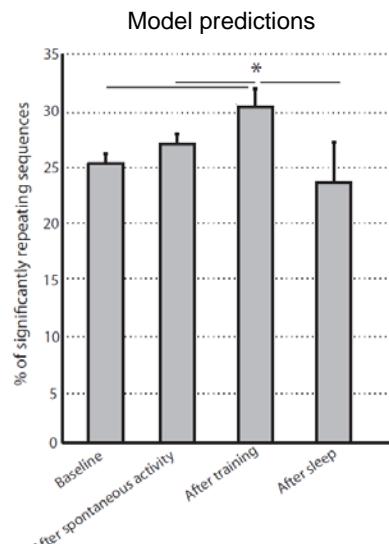
Recent evidence

Dream recall



Wamsley et al., *Current Biology* 2010

Critical consideration



Olcese et al., J Neurophysiol 2010

Conclusions

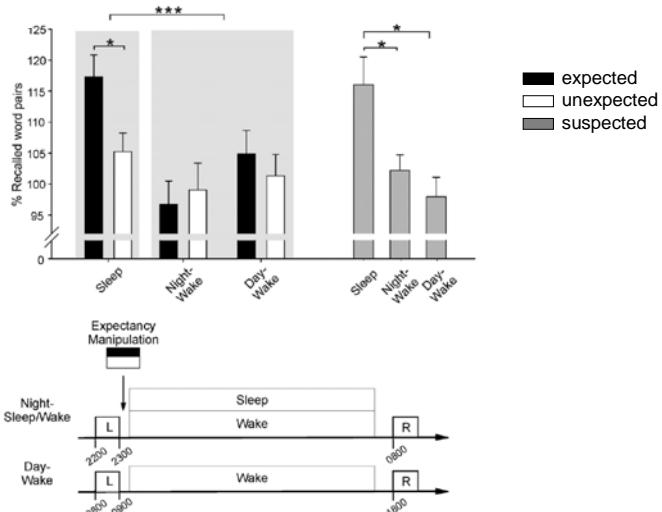
Good evidence for an active role of sleep in learning processes.

Replay and re-normalization are two possible mechanisms.

Many factors may affect sleep dependent performance improvements.

Last examples I

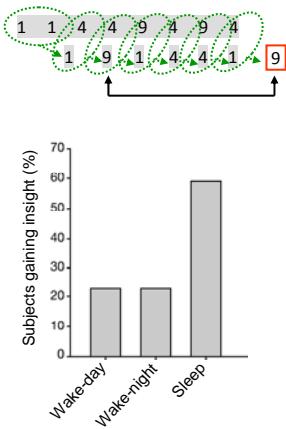
Consolidation of relevant memories



Wilhelm et al., J Neurosci 2011

Last examples II

Insight



Wagner et al., Nature 2004