Sleep and Cognitive Aging

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Overview

- Introduction: What is cognitive aging?
- Risk factors for sleep disturbances
- Sleep and normal cognitive aging
- Sleep and Alzheimer’s Disease
- Intervention
What is cognitive aging?

- **Successful cognitive aging:**
  - Absence of cognitive impairment
  - Multi-dimensional cognitive structure → maintain social connectedness and sense of purpose
  - Abilities → function independently, permit functional recovery, cope with residual cognitive deficits
  - Operationalization: thresholds (ex: MMSE > 24), normative comparisons, comparison with past performance

- **Severe cognitive aging:**
  - Cognitive impairment and dementia (ex: Alzheimer’s disease)
Determinants of successful cognitive aging:

- Genetic influences
- Stress and resilience
- Wisdom
- Lifestyle behaviours (physical activity, nutrition/dietary restriction, cognitive stimulation)

Role of sleep?
How does sleep change in lifespan?

Risk Factors for Sleep Disturbances in Older Adults: Evidence from Prospective Studies (Smagula, Stone, Fabio, & Cauley, 2015)

- Clinical Review on PubMed
- 21 studies included
  - Self-reported sleep complaints/insomnia symptoms (n=13)
  - PSQI assessed subjective sleep (n=6)
  - Objective measured sleep characteristics (n=2)

Results:
- Female Gender
- Depressed Mood
- Physical Illness
- Other potential factors: lower economic status, widowhood, marital quality, loneliness and perceived stress, preclinical dementia, long-term benzodiazepine and hypnotic use, etc.

- No significant age effect
Sleep deprivation causes cognitive impairment in young and middle-aged adults, but not in older adults.

In older adults:
- Inter- and intra-variability in sleep without relation to cognitive functioning
- No retention of cognitive impairments only by improving sleep

Longitudinal Studies:
- Significant association between short and/or fragmented sleep and cognitive functioning in middle-aged adults

http://sharpbrains.com/tags/alzheimers-disease/
Some examples:
- Increased wake time/poor sleep duration → increased cognitive complaints/poorer cognitive performance 2 years, 22 years, and 28 years later
- Poor sleep at baseline → later development of cognitive disorders (mild cognitive impairment and Alzheimer’s disease)

Whitehall II Study (Ferrie et al., 2011)
- Sleeping well in middle age promotes sustained cognitive integrity

BUT: in cross-sectional studies sleep is not a strong predictor!
- Some studies even showed opposite results
Impact of Sleep on the Risk of Cognitive Decline and Dementia (Spira, Chen-Edinboro, Wu & Yaffe, 2014)

- Sleep disturbance ...
  - Sleep duration (short and long)
  - Sleep quality
  - Use of hypnotic medication

... is a potential cause of cognitive decline, dementia and Alzheimer's disease pathology
Sleep and Alzheimer Disease
What is Alzheimer disease?

- Most frequent form of dementia:
  - Preclinical stage ➞ neurological changes and sleep disturbances
  - Clinical stage

- How do amyloid plaques appear?

In which brain regions do Aβ form?
How can sleep modulate neuronal activity (thus, reduce the release of Aβ)?

http://aviationknowledge.wikidot.com/aviation:understanding-sleep
http://hyperphysics.phy-astr.gsu.edu/hbase/biology/acmpot.html
Sleep quality and preclinical Alzheimer disease (Ju et al., 2013)

Participants
- cognitively normal
- minimal age = 45 years old
- 50% have family history of AD
- 2 groups: high vs low amyloid deposition

Sleep measurement
- Actigraph wearing
- Quality of sleep: sleep efficiency (%)
  - WASO
- Quantity of sleep (total sleep time)
- Nap frequency (‘nap days per week’)

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### Results I

#### Sleep measures and nap characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>All N = 142</th>
<th>Aβ42 &gt;500 pg/ml N = 110 Low Aβ deposition</th>
<th>Aβ42 ≤500 pg/ml N = 32 High Aβ deposition</th>
<th>95% confidence interval of group differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep Efficiency (%)</td>
<td>82.9 (6.2)</td>
<td>83.7 (5.6) &gt;</td>
<td>80.4 (7.7)</td>
<td>(0.8, 5.7)</td>
</tr>
<tr>
<td>WASO (minutes)</td>
<td>56.1 (22.6)</td>
<td>54.0 (21.8) &lt;</td>
<td>63.1 (23.9)</td>
<td>(-17.9, -0.21)</td>
</tr>
<tr>
<td>Total sleep time (minutes)</td>
<td>402.6 (44.6)</td>
<td>403.0 (47.3) =</td>
<td>401.3 (49.0)</td>
<td>(-16.0, 19.5)</td>
</tr>
<tr>
<td>Time in bed (minutes)</td>
<td>486.4 (49.8)</td>
<td>482.3 (47.3) =</td>
<td>500.6 (55.8)</td>
<td>(-37.9, 1.23)</td>
</tr>
<tr>
<td>Nap days per week&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.4 (1.7)</td>
<td>1.3 (1.6) =</td>
<td>1.9 (1.9)</td>
<td>(-1.3, 0.1)</td>
</tr>
<tr>
<td>Frequent Naps ≥3 days per week (number (%)&lt;sup&gt;a&lt;/sup&gt;)</td>
<td>26 (18.4%)</td>
<td>16 (14.7%) &lt;</td>
<td>10 (31.2%)</td>
<td>(-0.32, -0.01)</td>
</tr>
</tbody>
</table>

All data show mean (SD) unless otherwise stated.
Results II

Sleep efficiency as predictor of amyloid deposition

OR=5.6, but n.s
Discussion

- Association amyloid - sleep quality, but not sleep quantity
- Sleep ➔ Alzheimer's
- Alzheimer's ➔ sleep

| ↓ exercise  
| ↓ daylight exposure  
| Medications  
| OSA  

Sleep ➔ Alzheimer's
To sum up:

- Decrease in sleep quality
- Several risk factors (illness, gender...)
- Potential cause for dementia
- Sleep is a predictor for amyloid deposition
**Intervention**

- SWS for memory consolidation
- Decrease of SWS
- Decrease of cog. functions
**Intervention**

- SWS for memory consolidation

Decrease of cog. functions ➔ Decrease of SWS
Electric stimulation

- Applying current at SW frequency

- Enhancement of SW

Westerberg et al (2015) applied this to a sample of older adults.
“Memory improvement via s.o stimulation during sleep in older adults” (Westerberg et al, 2012)
Results

Fig. 2. Percent recall improvement (postnap recall–prenap recall) on the word-pair recall test for slow-oscillatory stimulation (SOS) and sham-SOS sessions. Error bars indicate standard error of the mean.
Future Research

- Side effects?
- Individual differences
- What about REM?
- Need for prospective studies
Other possible intervention

- Pharmacological treatment
- CBT (Stimulus control...)
- Cricadian rythm (Avoid naps...)

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Take home message

- Sleep quality predicts cognitive decline
- Memory complaints secondary to sleep disturbances
- Mechanism unclear
- Intervention possible
THANK YOU FOR YOUR ATTENTION!

Questions
References


