Altered Brain Response to Verbal Learning Following Sleep Deprivation


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Previous Studies

- Being deprived of sleep for one night impairs performance on many cognitive tasks, and verbal learning is a critical cognitive function.
- Decreases in specific cognitive functions after sleep deprivation (SD) may be associated with impairments in the cerebral systems.
- In particular, SD has been reported to impair performance on cognitive tasks that are putatively dependent upon prefrontal cortex (PFC) involvement.
- Reduced cerebral metabolic rate in the PFC following SD
Hypothesis

- We predicted that the prefrontal cortex would be less responsive to cognitive demands following sleep deprivation.
Method-1

- fMRI
- 13 normal healthy subjects
- Mean age 27.2 years, range 21-35 years
- Mean education 16.5 years, range 14-18 years
Method-2

- a normal night of sleep (the rested state) and after 34.7 +/- 1.2 hours without sleep (the SD state).
Method-3

- Four experimental and five baseline blocks
- Five words were presented during each block
- Not memorize the baseline words, but to determine whether they were in all upper-case or all lower-case letters.
- Actively memorize the experimental words for later testing.
- Self rated the level of sleepiness, and concentration.
- paired-samples t-test
Result

- 4.7 +/- 4 words after normal sleep
- 2.8 +/- 2 words after SD, P<0.05
- Sleepiness scale (SSS) increased and concentration decreased
- Increased sleepiness was significantly correlated with activation in two bilateral PFC regions
- Better free recall in SD subjects: greater parietal lobe activation.
Temporal Lobes were Significantly Less Activated During the SD state

- Top: Rested State
- Bottom: Sleep Deprivation State
Left Middle Frontal Gyrus, Right Inferior Frontal Gyrus, and Parietal lobe

- Left: normal condition
- Right: sleep deprivation
Discussion

- Prefrontal lobe: compensate, responding to or reflecting sleepiness
- Parietal lobe: compensate
- Temporal lobe: result in poor memory.
- Task-specific
Strength and Limitations

Strength:
- Use same people for control and experimental group.
- fMRI

Limitations:
- 13 participants only
- Level of sleepiness and concentration is self-rated.