Linking the quality of sleep and cognitive performance in stroke patients

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INTRODUCTION

The goal of our study is to examine correlations between individual characteristics in the sleep process and cognitive performance in patients after acute cerebrovascular accident (stroke). It is well known that targeted patients are strongly vulnerable to sleep disturbances that often lead to deficits in their day-time cognitive and attentional performance.

Sleep deprivation, whether from disorder or lifestyle, whether acute or chronic, poses a significant risk in day-time cognitive performance, excessive somnolence, impaired attention or decreased level of motor abilities. Sleep deprivation is closely related to sleep fragmentation often associated with short several second long arousals.

To test cognitive performance we created computerized versions of standard psychological tests adjusted for our experimental sample consisted of a group of elderly people after stroke. We focused on fine motor skills assessment, working memory capacity and subtypes of attentional networks as they are the most common after-stroke complications.

Although limited studies of partial sleep restriction and sleep fragmentation have revealed important sleep indices leading to cognitive deficits, a challenging question how a typical, good quality, structure of sleep should look like remains open. To improve

METHODS

Design

- Sleep EEG
  - measured within a week after stroke
  - The AASM sleep scoring model [1]
  - Probabilistic sleep model (PSM) [2]
- Cognitive Testing
  - administered the very next morning
  - lasting approx. 1 hour

Statistical analysis

- Spearman rank correlation (α = 0.05)

Subjects

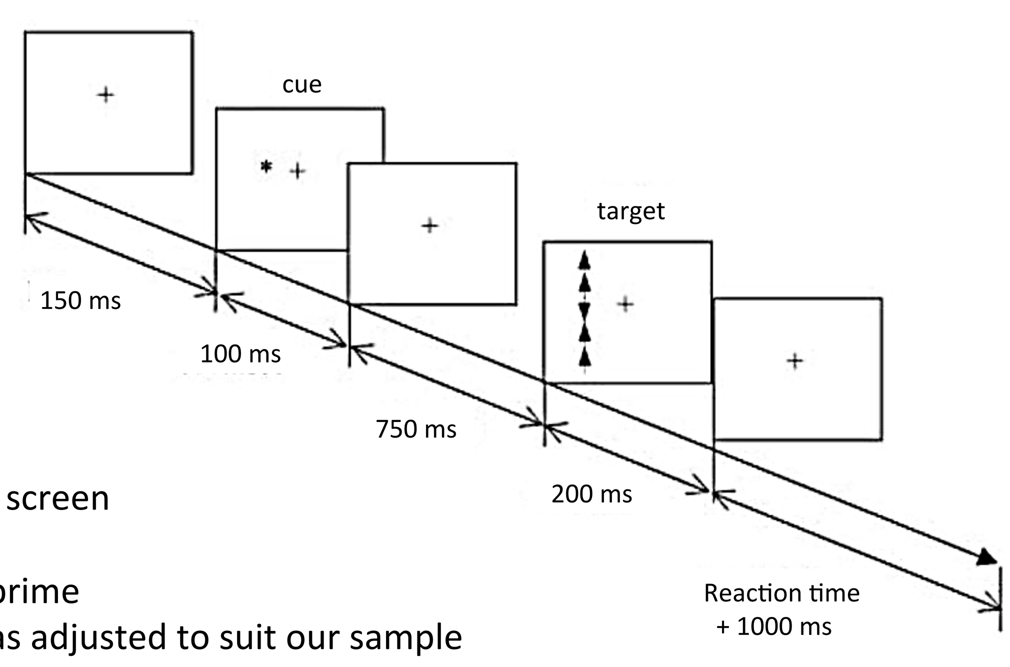
- 21 stroke patients (16 males, 5 females)
  - age 58 ± 13 years (mean ± SD)
  - self-reported right-handed
- different stroke location:
  - supratentorinal (cortical, subcortical)
  - subtentorinal (cerebellar, brain-stem)
- inclusion criteria:
  - intact fatic (speech) functions
  - motor impairment enabling participation

COGNITIVE TESTS

Lateralised attention network test (LANT) [4]

- Separately measures 3 independent behavioural components of attention [5]:
  - spatial **Orienting** (the benefit or cost of spatial pre-cues) which has the benefit or facilitatory component of a valid spatial cue **Of** and the cost or inhibitory component of an invalid spatial cue **Oi**
  - **Alerting** (the benefit of temporal pre-cues) **A**
  - **Conflict** resolution (ability to overcome distracting stimuli) **C**
- Task: 5 arrows briefly flashed in the left or right visual field
  middle arrow = target
  4 surrounding arrows = distractors (with congruent or incongruent orientation to the target)
  presentation side is indicated by a pre-cue * (valid, invalid, no-cue or double-cue)
- Goal: to determine the orientation of the target (middle arrow)

LANT stimuli and timing of one trial. (adapted from [5]).



- Administered on the computer screen
- Responses indicated by mouse
- Application implemented in E-prime
- Original version of the LANT was adjusted to suit our sample

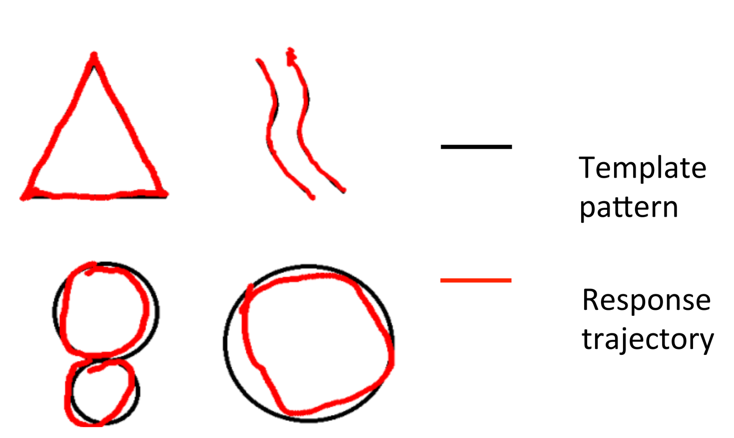
- C (conflict) = difference in the reaction times to Congruent stimuli and Incongruent stimuli
- Of (Facilitatory component of Orienting) = difference in reaction times to Valid cue and Double cue
- Oi (Inhibitory component of Orienting) = difference in reaction times to Invalid cue and Double cue
- A (Alerting) = difference in reaction times to Double cue and No cue

Fine motor task

The most common consequences of stroke involve motor system impairment. We used a drawing test to assess fine motor functions.

- Goal: to retrace (redraw, contour) template patterns of basic shapes

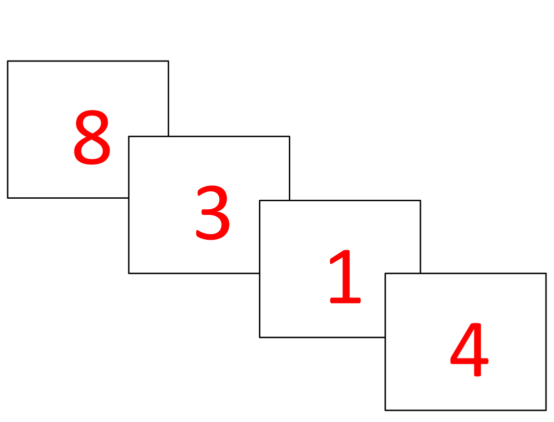
- Administered on computer screen
- Drawing using the Wacom drawing tablet
- Score = % of correctly retraced pixels
- Application implemented in MS Visual C++



Example of extremely high (90 and 84%) and low (11 and 27%) accuracy of responses in Motor task.

Working memory test

- Standard Digit Span task (part of the Wechsler Adult Intelligence Scale [3])
- Digits shown in a sequence
- Goal: 1st part: repeat the sequence in the same order
  2nd part: repeat the sequence in the reverse order
- After correct answer the length of the sequence increases
- After incorrect answer the length of the sequence decreases



- Administered on computer screen
- Responses indicated on external numerical pad
- Application implemented in E-prime
- Memory capacity = the length of the longest sequence participant was able to repeat correctly

RESULTS

LATERALISED ATTENTION NETWORK TEST (LANT)

- **Orienting facilitatory (Of)**

We found that Of is significantly related to wake periods during the night. The strongest correlation was found for the **number of awakening** ($r_s(21) = -0.694$, $p < 0.005$) during the night and it was positively correlated with the **total sleep time** ($r_s(21) = 0.685$, $p < 0.005$). In addition, Of is also positively correlated with the entropy of slow wave sleep (SWS) estimated from the PSM ($r_s(21) = 0.52$, $p < 0.05$). Overall, these findings indicate that patients with more sleep benefit better of the spatial pre-cue orienting.

- **Orienting inhibitory (Oi)**

The **sleep latency to N2** is the major sleep component which correlates with Oi ($r_s(21) = 0.507$, $p < 0.05$). The significant correlations of the N2 and SWS entropy computed from the PSM supports this finding ($r_s(21) = 0.55$, $p < 0.05$).

- **Alerting (A)**

According to our findings, A positively correlates with **SWS** ($r_s(21) = 0.6$, $p < 0.05$). The more time patients spent in SWS the better they benefit of temporal pre-cue alerting.

- **Conflict (C)**

We found no significant correlation between sleep and C. It suggests that there is no relationship between the considered sleep measures and this behavioural LANT component.

Considering the effect of sleep on laterality of attentional networks we found a few significant but small correlations. Although this rises interesting speculations about the existence of relationships between sleep and laterality effects, it needs to be confirmed by considering a larger data sample.

WORKING MEMORY & FINE MOTOR TASK

No significant correlation was found between sleep measures and working memory performance or fine motor skills.

CONCLUSION

Our results indicate that there may exist an association of certain sleep characteristics of stroke patients with a specific behavioural component of attention measured in the morning following the examined sleep night. Besides the standard AASM scoring, the PSM brings complementary information about the relationship between sleep and cognitive performance.
Our continuous ongoing data collection will support or correct presented pilot results and findings.

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