An Event-Related Potential (ERP) Analysis of Different Sleep Effects in False Memory

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Introduction

Background: Previous studies on the effect of sleep on false memory have shown inconsistent results. Using Deese-Roediger-McDermott (DRM) paradigm, prior studies have demonstrated that false memory was enhanced both by sleep and sleep deprivation. One possibility reason of the inconsistent results is that the behavioral measures used in previous studies could not distinguish the different processes of familiarity and recollection in recognition memory.

Event-related potential (ERP) can provide additional information about the cognitive processes. ERP to old response was more positive than that to correct rejection response (new response to new words), and this difference was called ERP old/new effect. If recognition was based on familiarity process, the N400 old/new effect would be significant. On the other hand, if recognition was based on recollection process, the LPC old/new effect would be significant (see Figure A).

Study Aim: The present study thus measured ERP components that reflect the processes of familiarity (N400) and recollection (late positive complex, LPC), to clarify this issue.

A. N400 & LPC old/new effect

B. Procedure of this study
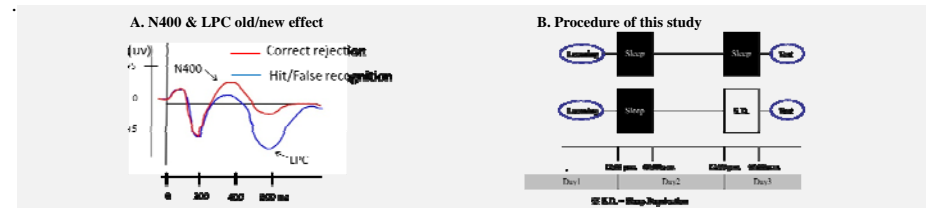
Methods

Participants: 30 healthy participants (16 males, 14 females, mean age=21.4)

Materials: 48 DRM lists were used. Each list consisted of 15 semantically related words with the strongest associate for theme word. 32 lists were used in the learning phase and the other 16 lists were used as the new words in the test phase.

Procedure: All subjects went through 3 sessions, including learning phase, sleep manipulation and test phase (Figure B). In learning phase, subjects were asked to memorize 32 visually presented DRM lists, and then went home for a night of regular sleep. In the following night, participants of sleep deprivation group stayed awake at laboratory, whereas those of sleep group slept at home following the regular sleep schedule. Three types of words including studied words (list words), unrelated lures (new words), and critical lures (theme words), were then presented for the subjects to make old/new judgment. ERPs were recorded during the recognition test.
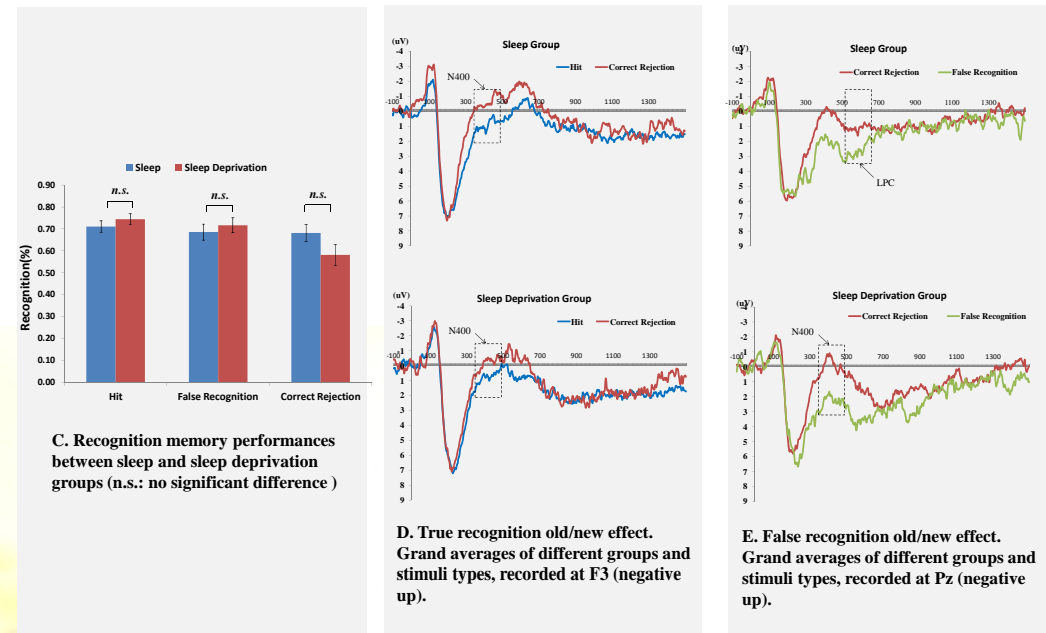
Statistical Analysis:

Behavioral Data: The hit rates (old responses of studied words), false recognition rates (old responses of critical lures), and correct rejection rates (new responses of unrelated lures) are respectively compared between groups using t-tests for independent samples.

ERP Data: ERP old/new effects to true and false recognition were analyzed. ERPs to hit and false recognition responses were compared to the ERPs to correct rejection responses. In each group, peak amplitudes of N400 (300-500 ms) and LPC (500-800 ms) were respectively analyzed. By one-way (hit or false recognition vs. correct rejection) repeated-measure analysis of variance (ANOVA).

Results

Behavioral Data: The hit rates, false recognition rates and correct rates between sleep and sleep deprivation group did not reach significant differences, respectively. [$t_{(28)}$= - .97, P= .34; $t_{(28)}$ = - .63, P= .54; $t_{(28)}$= -1.63, P= .11]

ERP Data: ERPs for true memory showed significant N400 old/new effects both on sleep and sleep deprivation groups. [Sleep: all $Ps < .01$; SD: all $Ps < .05$] Amplitude of hit response was more positive than correct rejection. Both groups did not show significant LPC old/new effects.

For false memory, ERP waveform of LPC for false recognition was significantly more positive than correct rejection only on sleep group [P3/4/z: $Ps < .001$], whereas N400 for false recognition was significantly more positive than correct rejection only on sleep deprivation group [P3/4/z: $Ps < .01$].

C. Recognition memory performances between sleep and sleep deprivation groups (n.s.: no significant difference)

D. True recognition old/new effect. Grand averages of different groups and stimuli types, recorded at F3 (negative up).

E. False recognition old/new effect. Grand averages of different groups and stimuli types, recorded at Pz (negative up).

Conclusions

- The significant N400 old/new effects for true recognition on both groups showed that equivalent level of familiarity process was involved in true memory retrieval after sleep and sleep deprivation.
- Both sleep and sleep deprivation may facilitate false memory but with different processes:
  - ✓ The sleep deprivation group only had significant N400 old/new effect. The result indicated that recollection process may be impaired after sleep deprivation.
  - ✓ The result of significant LPC old/new effects for false recognition on sleep group indicated a process of false recollection. This may arise from the enhance consolidation process after two night sleeps.