

Event-Related Potentials during a Test of Working Memory Differentiate Sleep Apnea Patients from Healthy Subjects

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Introduction:

Event-Related Potentials (ERPs) recorded during cognitive tasks track the neurophysiological correlates of information-processing. Because Sleep Apnea (SA) patients frequently suffer from impaired memory, ERPs were recorded during a test of working memory to determine whether there are differences between SA patients and healthy subjects. The memory task required the temporary maintenance of a group of 20 images in short-term memory storage, serving as a test of working memory. The paradigm offers a method for calculating an ERP-memory effect by sorting the ERPs in response to remembered images (Old) vs. New images.

Methods:

Twenty-eight healthy subjects (15 males; 13 females; mean age=37, range 23-63) and twenty-seven patients (18 males; 9 females; mean age=43, range 22-65) diagnosed with SA (mean Respiratory Disturbance Index (RDI)=43, range 13-122) performed the working memory task three times between 8:00AM and 12:30PM. For each task, 20 images were presented sequentially twice during the training period ("Old" images) and then randomly interspersed with 80 "New" images presented for 100 ms. with a 2-second inter-stimulus-interval (ISI) between images. Subjects were required to identify each image as Old or New while EEG recordings were acquired from Fz and PO referenced to the left earlobe.

Average stimulus-locked ERPs from the correct responses, screened for excessive artifact, smoothed with 20 Hz low-pass filter and detrended for DC/linear offsets, were computed separately for each subject to 1,500 ms post stimulus. The maximum amplitude (MA) and mean positive amplitude (PM) in the ranges 105-220, 260-440, and 410-610 ms were computed. Data were stratified into healthy, Low<40 RDI and High \geq 40 RDI SA patients and the Old vs. New ERPs compared.

Results:

One-way ANOVA revealed significant between-group differences in overall amplitudes in the P200 region at PO for both Old and New (Old: PM-F=3.702,p=0.031, MA-F=4.258,p=0.019, New: PM-F=4.276,p=0.044, MA-F=5.741,p=0.02) (Figures 1). As expected, the amplitude of the Late Positive (P300/P3b) component (peak at 500ms.) for the Old images was significant larger than the New images for healthy subjects (PM-F=9.112,p=0.004, MA-F=11.618,p=0.001) (Fig. 1.a.) and SA-Low RDI patients (PM-F=5.211,p=0.03, MA-F=6.562,p=0.016) (Fig. 1.b.). This memory effect was not significant in the SA-High RDI patients (Figure 1.c.).

Conclusions:

The late positivity (P300) or "memory effect" was clearly identified in the healthy subjects and Low-RDI patients but not in the High-RDI group. These data confirm previous results in healthy subjects reporting larger P300 for remembered items (1,2) and extend the application of ERPs to assess the neurophysiological correlates of impaired memory performance in SA patients. The functional significance of the group differences in the P-200 and the possibility of group differences in an early P300 (P3a) require further investigation. ERPs can be applied as probes to assess the neural correlates of memory and may have applications in the diagnostic assessment and treatment outcome evaluation of SA and other neurological disorders where memory is impaired.

1. Pineda JA, Herrera C, Kang C, Sandler A: *Effects of cigarette smoking and 12-h abstention on working memory during a serial-probe recognition task.* Psychopharmacology(Berl),1998;**139**(4):311-21.

2. Fabiani MD, Karis E, Donchin, E: *P300 and recall in an incidental memory paradigm*. *Psychophysiology*, 1986. **23**(3):298-308.

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Figure 1. ERP's from site PO resulting from Old and New stimuli during working memory task for:
 a) Healthy Controls (n=28), b) SA RDI < 40 (n=16) and SA RDI ≥ 40 (n=11). Vertical lines identify ranges for 105-220, 260-440, and 410-610 ms, conventionally analyzed for P200, P300-a and P300-b components..

