

P300 Latency is Dangerously Lengthened for Dual Task when Sleepy

Timothy I Murphy, Melanie Pine, & Sidney J. Segalowitz

Brock University, St. Catharines, Ontario, Canada

Summary:

- We investigated the effect of sleepiness and distraction on objective and subjective behavioural performance, and on the P300 during an auditory oddball task performed in isolation (single) or simultaneously with a visual working memory task (dual).
- We found a significant interaction such that the increase in P300 latency in the dual task was not significant in the alert condition (awake 3 hours) but was significantly longer when the participants were sleepy (awake 20 hours), even though there were no significant differences in P300 amplitude, response time, subjective effort or performance based on sleepiness.
- We concluded that even though behavioural performance may be maintained after moderate amounts of sleep deprivation, the ERP correlates are significantly altered.

Background: Sleepiness¹ and distraction² are both known to reduce the amplitude and the increase the latency of the P300, but these two influences have not been studied simultaneously.

Purpose: To examine the effect of sleepiness and distraction on objective and subjective performance as well as cognitive processing as indicated by the P300.

Method

Participants:

17 females, 19 to 43 years (mean=26, SD=7)
normal sleep patterns, free of head injury, medications

Auditory Oddball Task:

Single Task: 40 targets (800 Hz), 160 non-targets (1000 Hz) ISI 1.3-1.6 s (mean 1.5 s)
Dual Task: identical to above task, performed while simultaneously performing a visual working memory task.

Conditions:

Alert: 3 hours of continuous wakefulness
Sleepy: 20 hours of continuous wakefulness

All analyses were 2(single/dual task) by 2 (alert/sleepy) repeated measures ANOVAs

Self-Report Measures

(100 cm Visual Analogy Scales measured after each task):

- Sleepiness
- Effort
- Performance

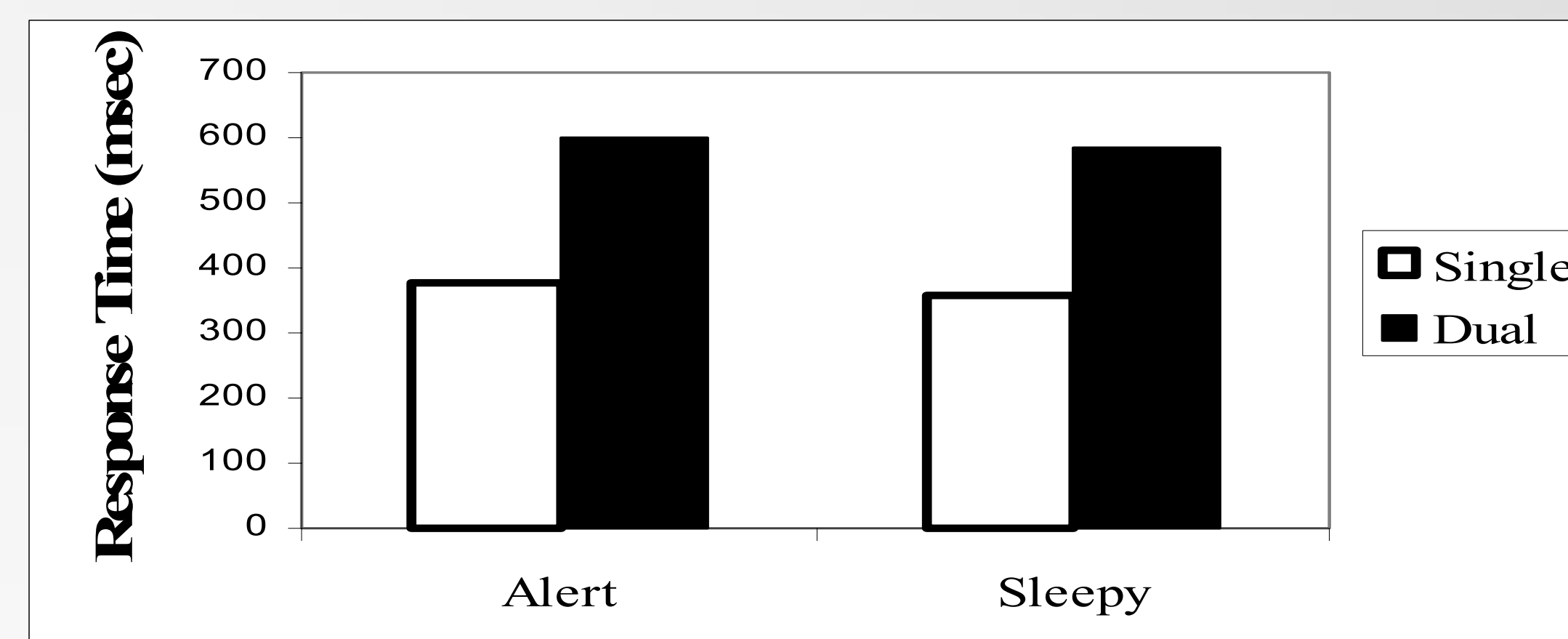
Electrophysiological measurements:

- 3 midline scalp sites scored: Fz, Cz, Pz
- All analyses based on Pz scoring
- ERPs were averaged time-locked to stimulus

Results (objective measures)

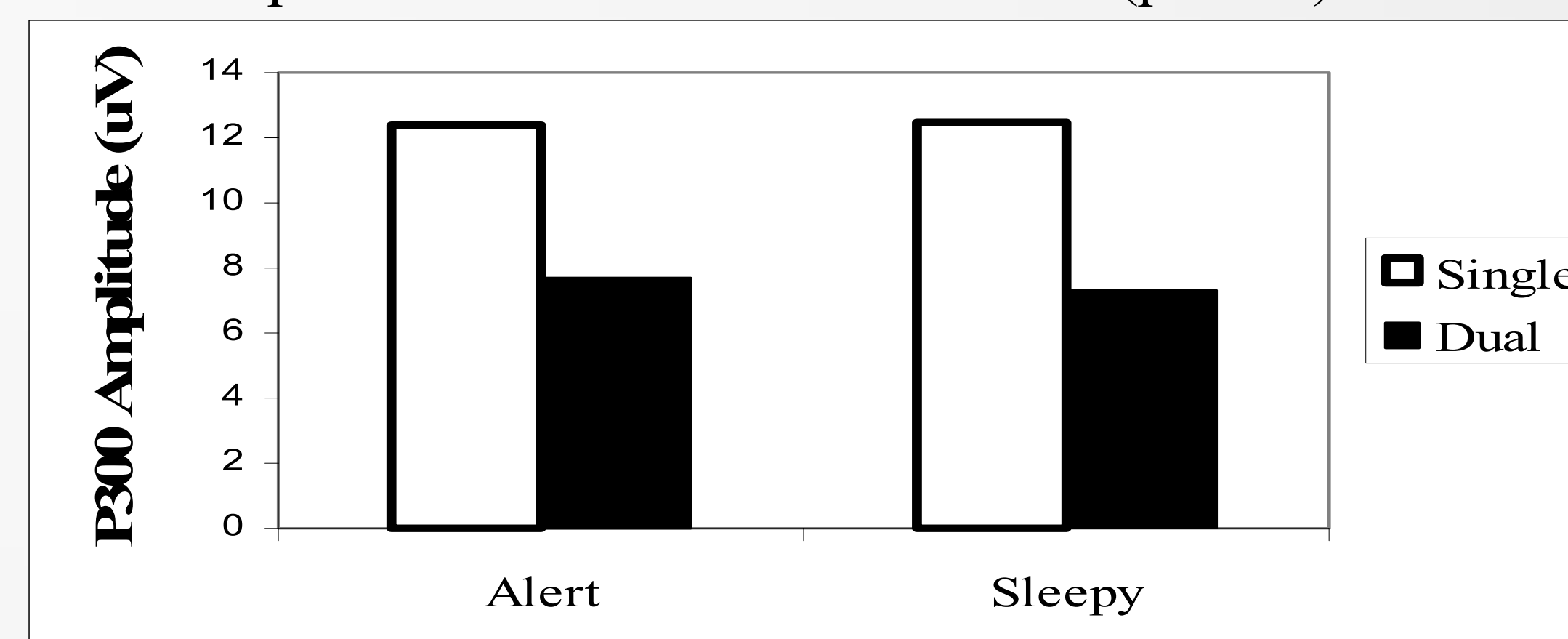
Response Times (main effect of task)

RTs were longer in the dual task ($p < .001$)



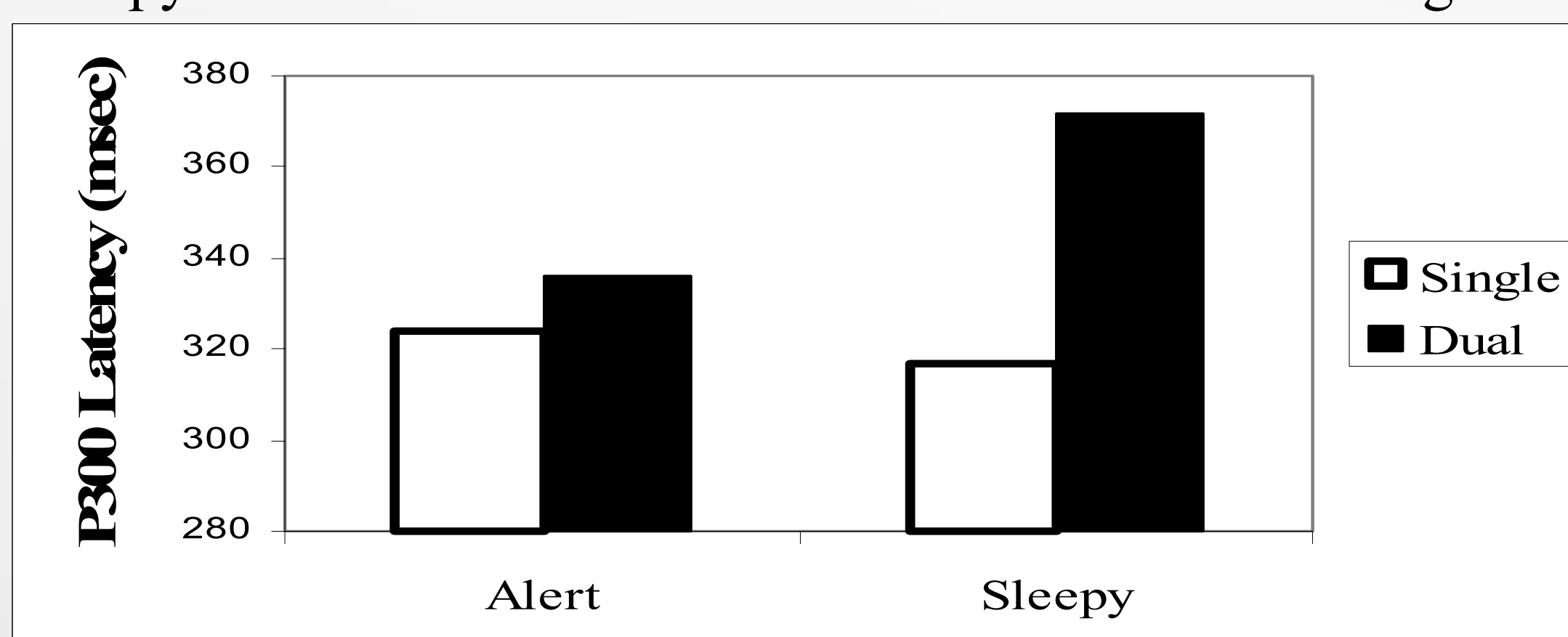
P300 Amplitude (main effect of task)

P300 amplitude was lower in the dual task ($p < .001$)



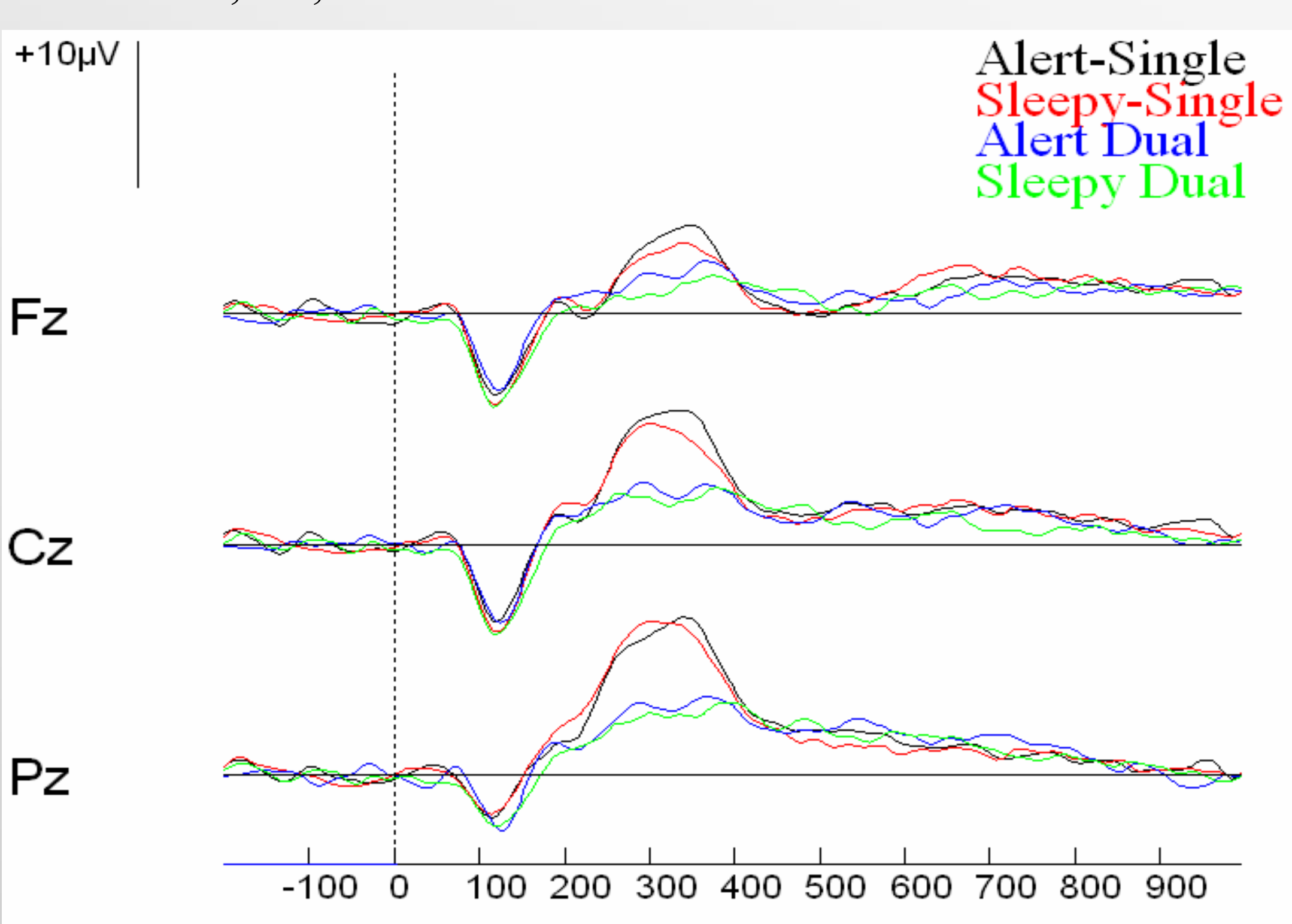
P300 latency (interaction)

The P300 latency was significantly longer in the dual task during the sleepy condition but there were no differences in the single task ($p < .01$)



Stimulus locked ERP waveforms

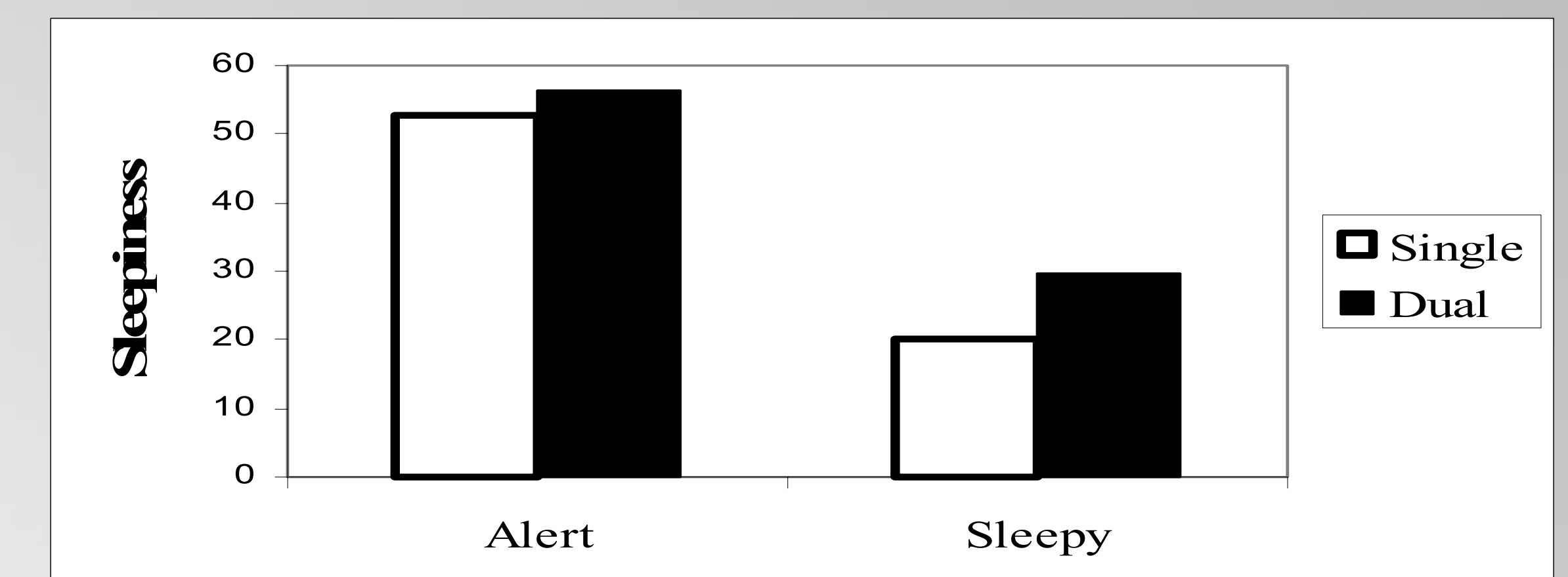
P300 at Fz, Cz, Pz for both conditions and both tasks



Results (subjective measures)

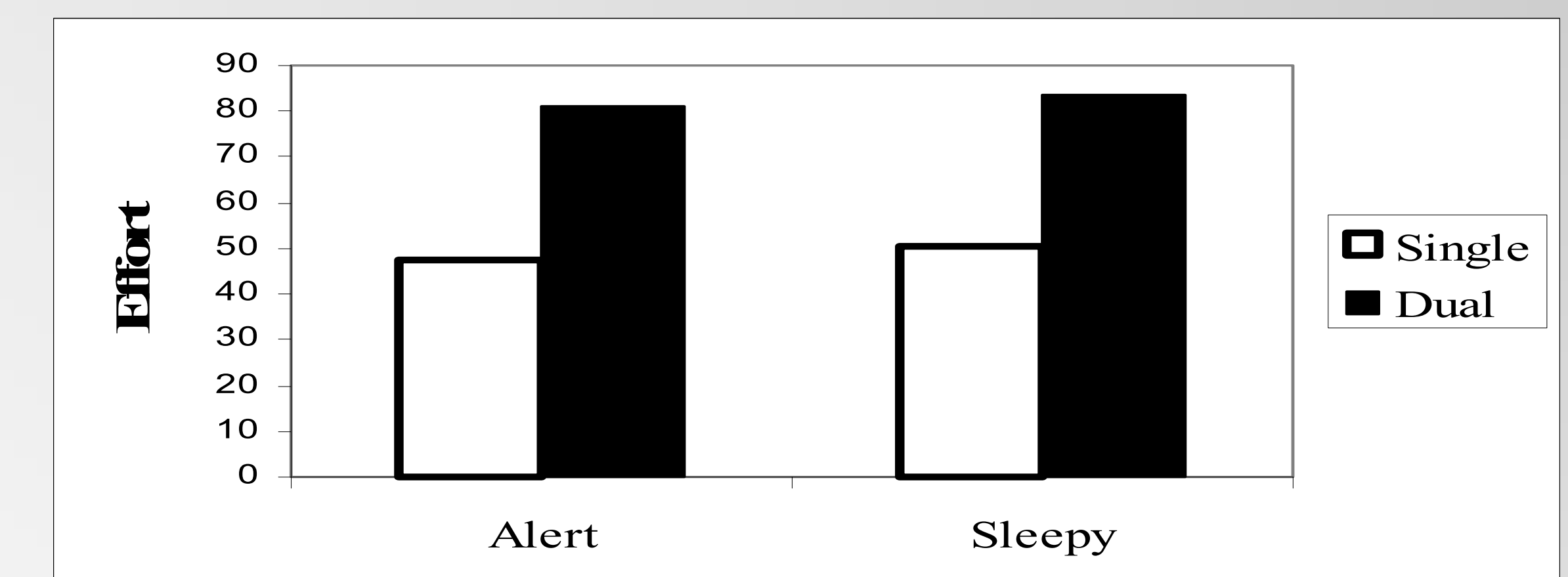
Subjective sleepiness (main effect of condition)

Participants felt more sleepy during the sleepy condition ($p < .01$)



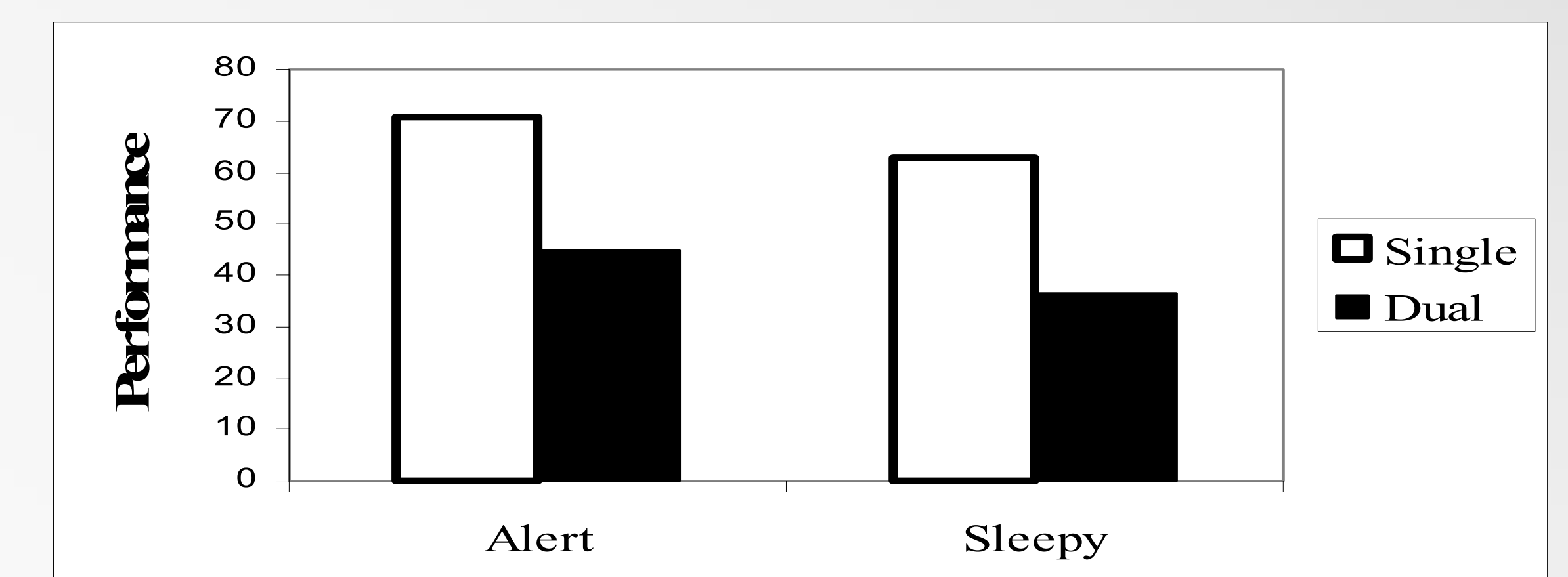
Subjective effort (main effect of task)

Participants reported higher effort during dual task ($p < .001$)



Subjective performance (main effect of task)

Participants reported performing worse during the dual task ($p < .001$)



Conclusions

- 1) Behavioural Performance, P300 amplitude, Subjective Effort and Subjective Performance show only task effects and are relatively unaffected by moderate sleep loss (<20 hours).
- 2) That the P300 was delayed ONLY during the dual task while sleepy indicates the effects of moderate sleep loss on cognitive functioning may be especially sensitive to multitask situations and this has profound implications regarding the safety of performing complicated or dangerous tasks while sleepy.

References

- 1 Lee et al. (2004) Auditory event-related potentials and psychological changes during sleep deprivation. *Neuropsychobiology*, 50, 1-5
- 2 Singhal & Fowler (2004) The differential effects of Sternberg short and long term memory scanning on the late Nd and P300 in a dual task paradigm. *Cognitive Brain Research*, 21, 124-132.

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Please address all correspondences to Tim Murphy, E-mail: Tim.Murphy@BrockU.ca
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