large inter-individual differences in behavioral alertness and sleepiness when operating aircraft through the circadian nadir.[1] Factors associated with these differential responses to night schedules were systematically investigated using data from NASA studies of long-haul commercial airline pilots.

Methods: Using a B747-400 flight simulator, n = 44 male experienced long-haul pilots flew an uneventful 6-hr night flight (≈ 0200 – 0800 hr) from Seattle to Honolulu. Behavioral alertness during the night flight was operationalized by the increase from 0000 hr to 0600 hr in performance lapses on a 10-minute psychomotor vigilance task (PVT) administered hourly prior to, during, and after the flight. Three levels of response were identified: category 1 increase in lapses ≤ 1 (n = 14, mean lapse increase = 0.57); category 2 increase in lapses ≥ 3 but ≤ 8 (n = 16, mean lapse increase = 5.38); category 3 increase in lapses ≥ 11 (n = 14, mean lapse increase = 22.64). Five types of outcome were tested for discriminating the three lapse categories: (1) pilot ratings of sleepiness throughout the flight using the Karolinska Sleepiness Scale (KSS); (2) continuous EEG and EOG recordings throughout the flight, scored for theta activity and SEMs, as well as stages 2 and 3 NREM sleep; (3) background questionnaires containing information on demographics, sleep history, flying experience, etc.; (4) actigraphy recordings of rest-activity cycles 3 days prior to the night flight; and (5) flight crew performance operating the aircraft during the simulated night flight.

Results: Differences among the three categories of behavioral alertness were mirrored in KSS scores (p = 0.008), with category 3 (largest increase in PVT lapses) associated with significantly higher KSS scores than category 1 (lowest increase in PVT lapses)—KSS ratings from category 2 respondents were in between. Pilot age, BMI, EDS, the likelihood of apnea as assessed by the multivariate apnea index (MAP), and habitual sleep duration were not related to category of behavioral alertness. However, self-reported global morningness-eveningness discriminated category 1 from category 2 pilots (but not category 3 pilots), with category 2 pilots being more "morning" people than category 1 pilots (p = 0.05). Questions concerning difficulty sleeping, especially legs feeling jumpy or jerking at bedtime, discriminated category 3 pilots from both categories 1 and 2 (p = 0.009 and p = 0.002, respectively). Category 3 pilots also reported more frequent use of alcohol to help them sleep (p = 0.004), but not more frequent use of alcohol overall.

Conclusions: Results to date suggest that differential vulnerability to loss of behavioral alertness during night flights is associated with two factors. Habitual circadian phase preference contributes to relatively modest differences in behavioral alertness during night flights, while sleep disturbances from as yet unidentified causes—that do not appear to be associated with symptoms of sleep apnea—may underlie a more severe impairment of behavioral alertness at night in a subset of pilots. With completion of data reduction for EEG and EOG, actigraphy, and operational performance measures, hierarchical regression analyses will be performed to identify the combination of factors that optimally predict the level of behavioral alertness experienced by pilots during night flights.

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203.U

Evening Naps Reduce Daytime Sleep Time During a Week of Simulated Night Shifts

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Introduction: Napping is nearly universally recommended for night shift workers, with the rationale that additional sleep will reduce the associated sleepiness and performance deficits and improve safety. Indeed, night workers take naps before approximately 40% of their 8-hour night shifts.[1] The present study systematically examines the effects of napping before five consecutive simulated night shifts (5NAP), or before the first two of five consecutive simulated night shifts (2NAP), as compared to a no-nap group (0NAP). The impact of these conditions upon the main daytime sleep period is the focus of this report; the effects on alertness and various performance measures during night shift hours are presented in a companion abstract.[2] These reports are preliminary as additional subjects are being run and not all variables have been analyzed to date.

Methods: Subjects were screened clinically and by PSG for sleep disorders and were required to have a mean sleep latency > 5 minutes on a screening MSLT. All were free of medical and psychiatric illness, and psychotropic medications. Shift workers or individuals with usual rise times after 0800 were excluded. Thirty-three subjects (14 m, 19 f; mean age 47 ± 12.3) randomly assigned to one of the three nap conditions (N=11 for each) are included in this report. Sex representation was similar and mean age did not differ among groups. Each subject participated during five consecutive nights and the intervening four days. Evening naps were taken from 1930 to 2200. The simulated night shift, during which sleep was prohibited, began at 2300 and ended at 0735. All subjects left the laboratory from 0800 to 0830 during which time they were exposed to indoor sunlight. Daytime PSGs began at 0830 and ended with the subject's time-naïve request after 1430, or at 1630.

Results: Mean minutes of sleep during each of the nap opportunities did not differ within or between the nap groups: 92 and 103 minutes for the 2NAP group and 84, 79, 77, 67, and 63 minutes for the 5NAP group. Daytime sleep data are presented in the table. ANOVA indicated that daytime total sleep time (TST) differed significantly among groups (mean TST across 4 days was 374.5 min for 0NAP, 336.8 min for 2NAP, 292.8 min for 5NAP; p<.01). Post-hoc analyses showed that TST was significantly greater for 0NAP than for 5NAP for all sleep periods (p<.05); there was a trend for a difference in the same direction between 0NAP and 2NAP on day sleep periods 1 and 2 (p=.06). When 24-hour TST was calculated by adding minutes of sleep during the evening nap to TST for the subsequent daytime sleep period, no differences were found among groups; however, there was a linear decrease in TST across days (p<.01). Sleep efficiency (SE) was lower for 5NAP (73.0%) as compared to 0NAP (85.8%; p<.01). SE for 2NAP was lower than that for 0NAP for day sleep period 1 (p<.05) and there was a trend for SE to be lower on days 2 and 4. The longer TST for 0NAP, compared to 5NAP, was the result of significantly more stage 2 and REM.

Table 1

Group	Daytime Sleep Period	TST (min.)	SE (%)
0NAP	1	385	86.1
	2	382	85.9
	3	369	85.9
	4	362	85.4
2NAP	1	324	73.8
	2	316	74.5
	3	368	84.7
	4	339	76.2
5NAP	1	312	73.7
	2	296	71.9
	3	283	72.7
	4	280	73.9

Conclusions: Evening naps of approximately 60-90 minutes duration appear to significantly interfere with sleep on the subsequent day. Uncontrolled studies have suggested that shift workers who nap have reduced daytime sleep quality, as compared to non-nappers.[1,3] This may reflect a lower homeostatic drive, or may be related to social/behavioral influences. The significantly lower SE for daytime sleep following nights with naps, combined with the equivalent 24-hour TST for the three groups, suggest that there is a reduced homeostatic drive for sleep during the day following evening naps.

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204.U

Effects of Call and Gender on Medical Resident Driving Simulator Performance

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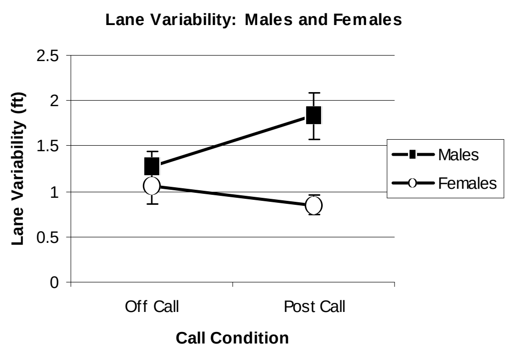
Introduction: Sleep deprivation among residents often receives too little attention from the medical community. Typically, the risks associated with resident sleep deprivation are expressed as a greater safety concern for the patient rather than the resident. Samkoff, et al., (1991) performed a literature review of studies that examined the effects of sleep deprivation on resident performance. Most studies were only concerned with performance outcomes that would affect patient safety rather than resident safety. In addition, there were few that looked at gender differences as a potential contribution to this problem. This study used a driving simulator to measure the effects of being on-call.

Methods: 23 medical residents signed the IRB approved consent form agreeing to complete a 60-minute trial in a PC-based driving simulator after a night on-call and after a night off-call. They wore actigraphs for at least 24 hours prior to both tests. The tests, completed between 12 and 3 p.m., were at least one week apart. The simulator consisted of a steering wheel, gas and brake pedals, 50 x 50 in. projection screen, and sound. Subjects completed a 10-minute practice drive through a city scenario followed by a 60-minute drive designed to replicate a highway driving scenario. Lane position variance (ft) was continuously sampled. Periods of inactivity were counted (zero counts) for the hours of call (5 p.m. to 8 a.m.) on both nights prior to testing. Subjects reported estimates of sleepiness as measured by a VAS, caffeine, and total sleep time.

Results: The 19 residents who completed the task were counterbalanced to call condition (12 males and 7 females). Overall, for the on-call condition, subjects had more activity ($p = .004$), reported less sleep ($p < .001$), poorer quality sleep ($p < .001$), more sleepiness ($p < .001$), and more caffeine use ($p = .027$). The lane variability measure indicated that call impaired the driving of the males but not the females ($p = .012$, See Figure). The amount of caffeine used during the 24 hours prior to the post-call test correlated with post-call driving performance ($r = .657$, $p = .003$) i.e., the more caffeine used, the poorer the driving performance.

Figure 1



Conclusions: Call impairs next day performance for male residents. The absence of a performance effect for females post-call may be due to reduced sensitivity because of fewer female subjects. There may also be gender differences in maintaining alertness and driving ability. Previous studies have found differences in sleep deprived residents with simulated patient monitoring tasks that require a response to specific events (Denisco, et. al., 1987). This type of task design may more readily unmask the performance deficits associated with sleep deprivation. Therefore, future driving performance studies will include environmental variables that require driver response (e.g. brake reaction times) to assess situation awareness as a function of fatigue.

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205.U

Sleep and Stress: The Mediating Role of Coping Style

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Introduction: Research on the relationships between stress and sleep have provided two seemingly contradictory patterns of findings (1). In many studies sleep is associated with sleep difficulties and fragmented sleep as intuitively expected but in many other studies stress is associated with deeper sleep or higher arousal threshold. We hypothesized that there are two factors explaining this incompatible findings: (a) the nature of the stress; and (b) the coping style of the individual. In the present study we assessed the mediating role of personal coping style.

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