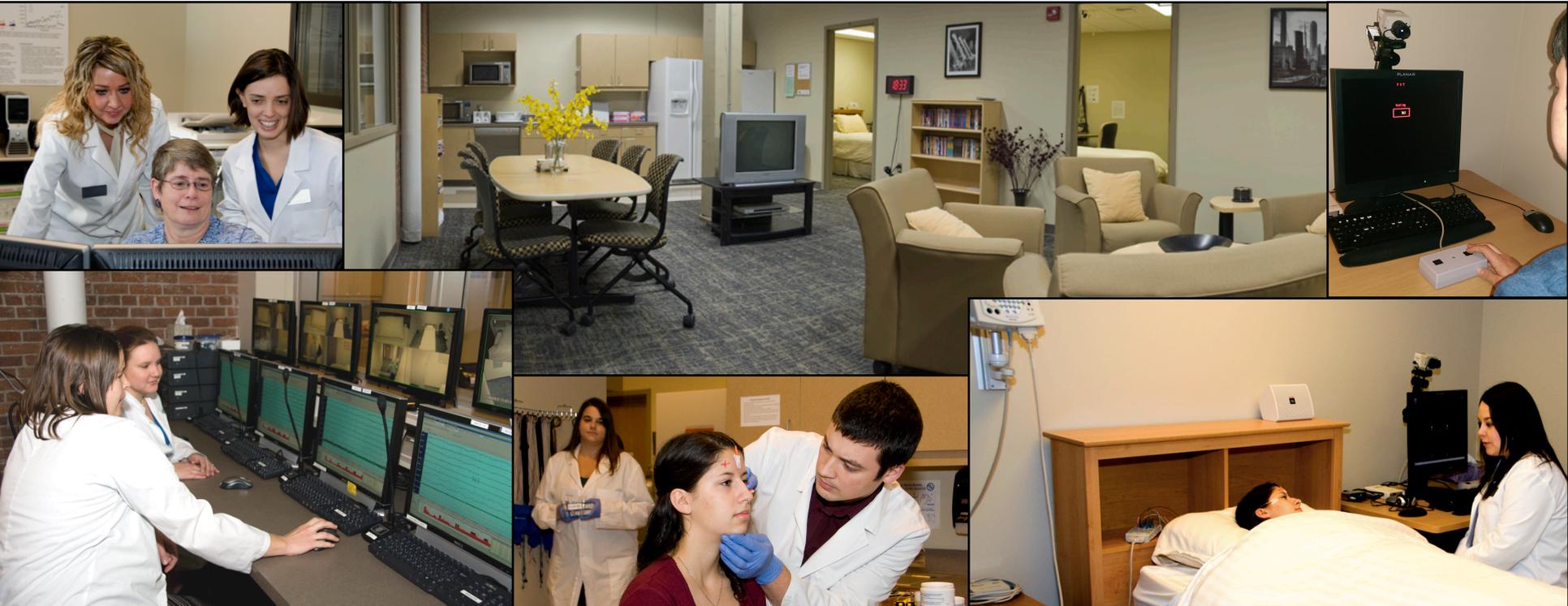




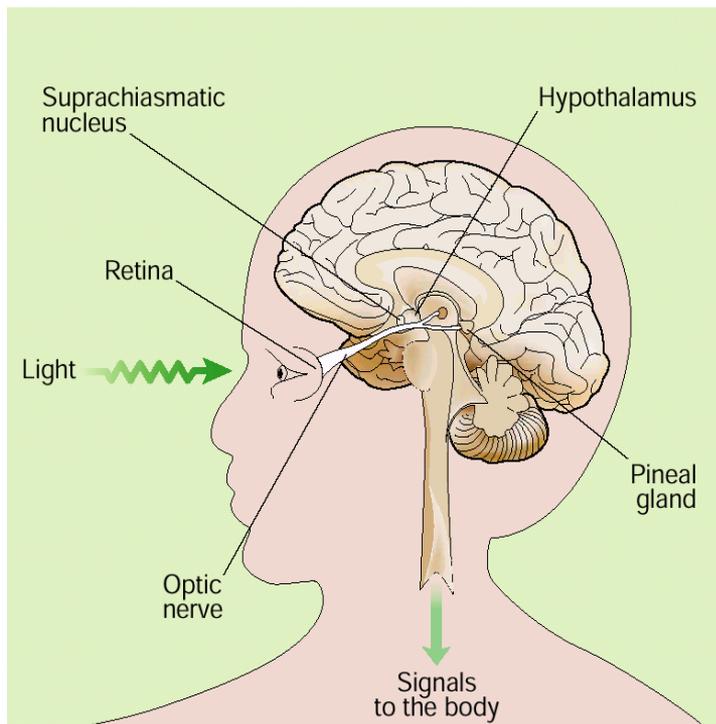
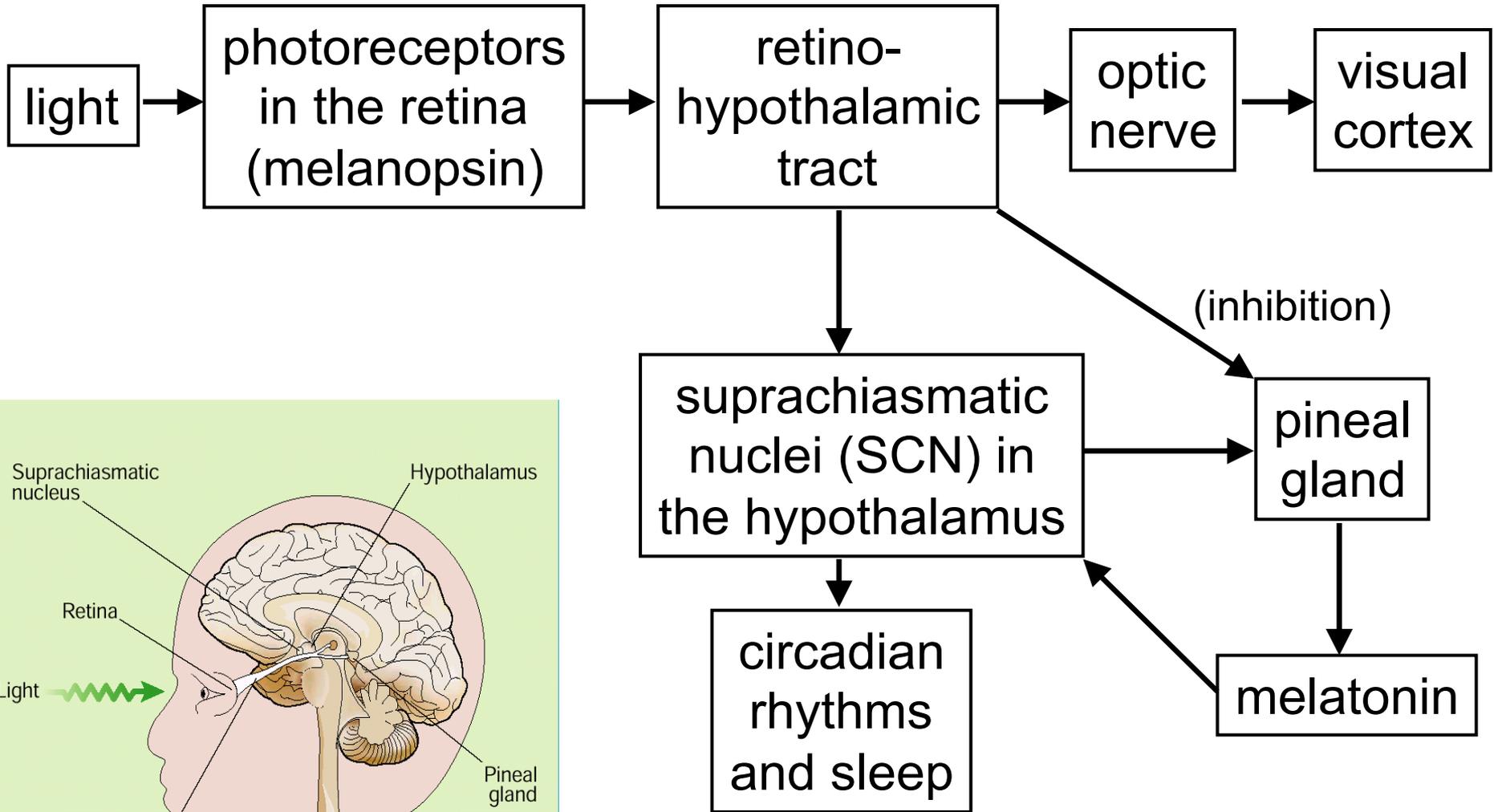
# Fatigue from Sleep Loss and Circadian Misalignment: A Fatigue Risk Management Framework for Emergency Medical Services

**Hans P.A. Van Dongen, Ph.D.**

Director, Sleep and Performance Research Center  
Research Professor, Elson S. Floyd College of Medicine  
Washington State University Spokane



# Biological Clock and Circadian Rhythmicity



Light input keeps the biological clock synchronized to external day and night

# Sleep/Wake Regulation: Timing and Duration

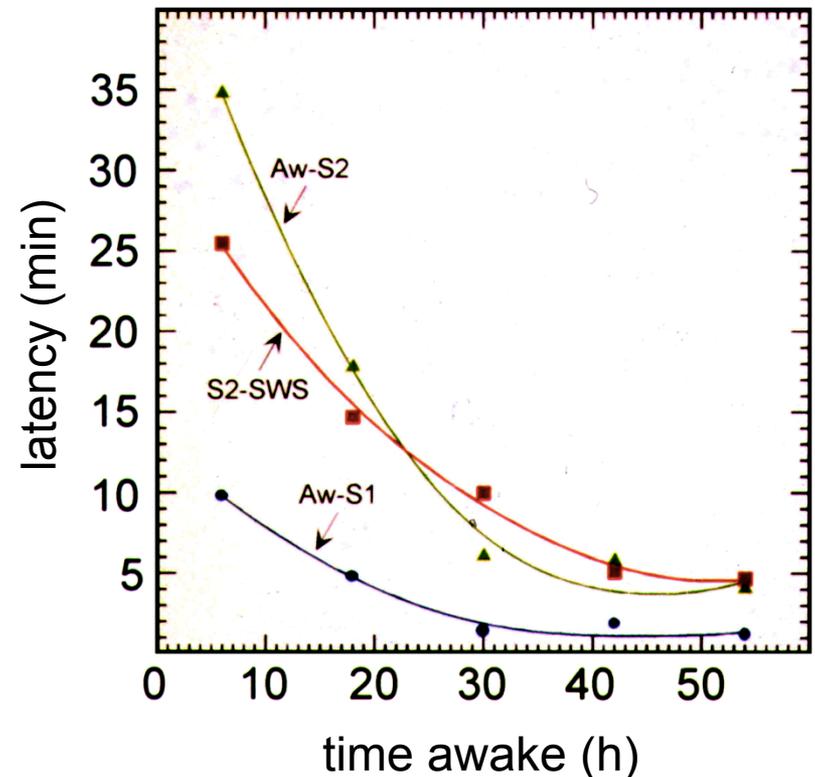
- Longer periods of wakefulness cause greater pressure for sleep
- Longer periods of sleep provide greater recovery from sleep pressure

## ➤ Homeostatic process

- There is greater pressure for sleep at night than during the day
- This is true even after sleep deprivation (“second wind”)

## ➤ Circadian process

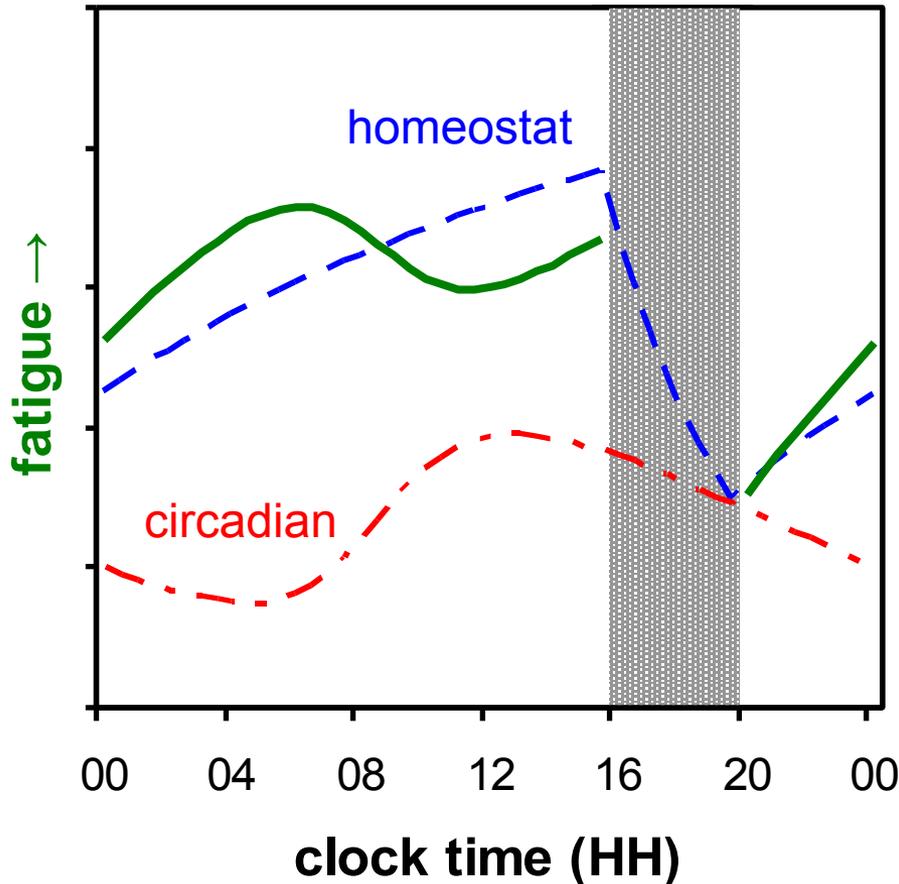
- The homeostatic and circadian processes interact, as formalized in the *two-process model of sleep regulation*



Borbély AA. Hum Neurobiol 1982, 1: 195-204.

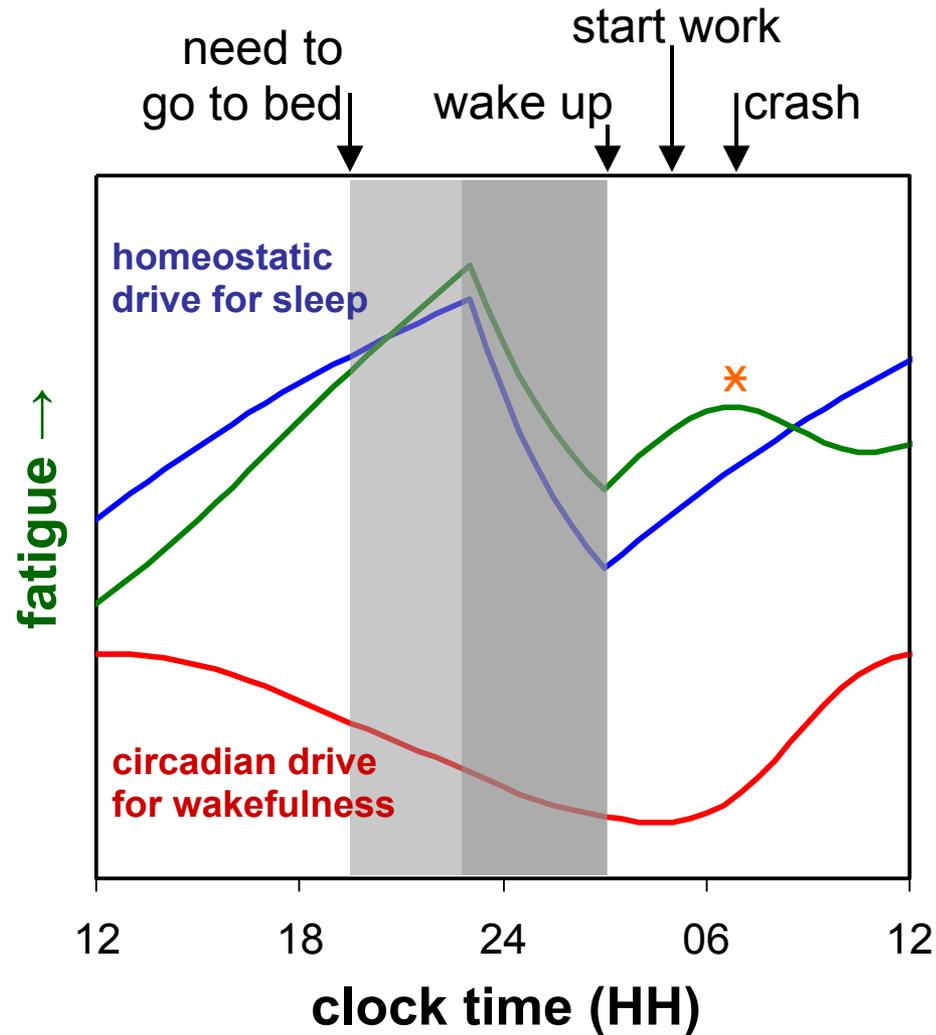
Dinges DF. Electroencephalogr Clin Neurophysiol 1986, 64: 224-227.

# Working Nights: Dual Sleep and Fatigue Challenge

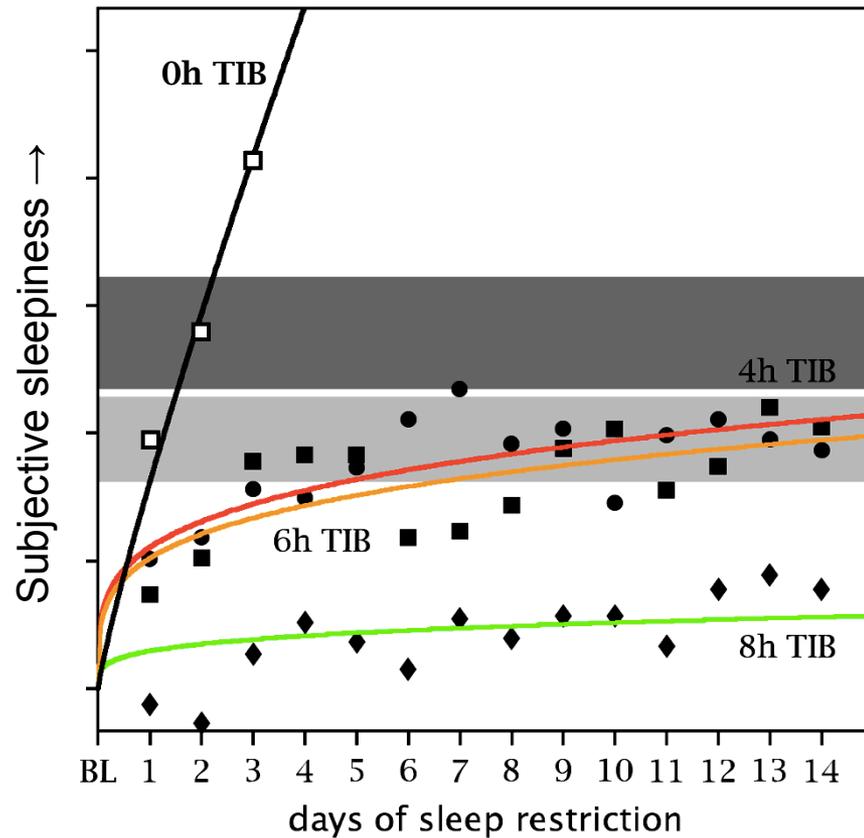
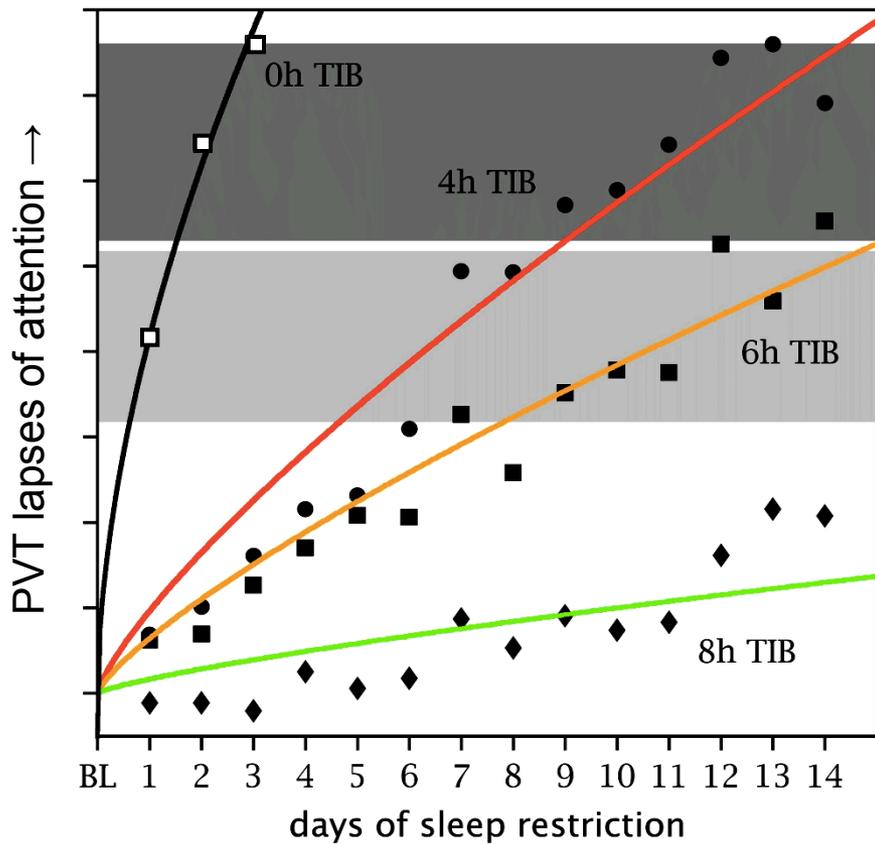


- The homeostatic drive for sleep builds up steadily over time awake
- At the same time, the circadian drive for wakefulness diminishes across the night and early morning
- Thus, the two effects amplify each other, and cognitive performance degrades across the work period
- In addition, the circadian process restricts sleep duration during the early evening, making it difficult to get enough sleep

# Early Shift Start Case Study: MetroNorth Train Crash NY, Dec. 2013



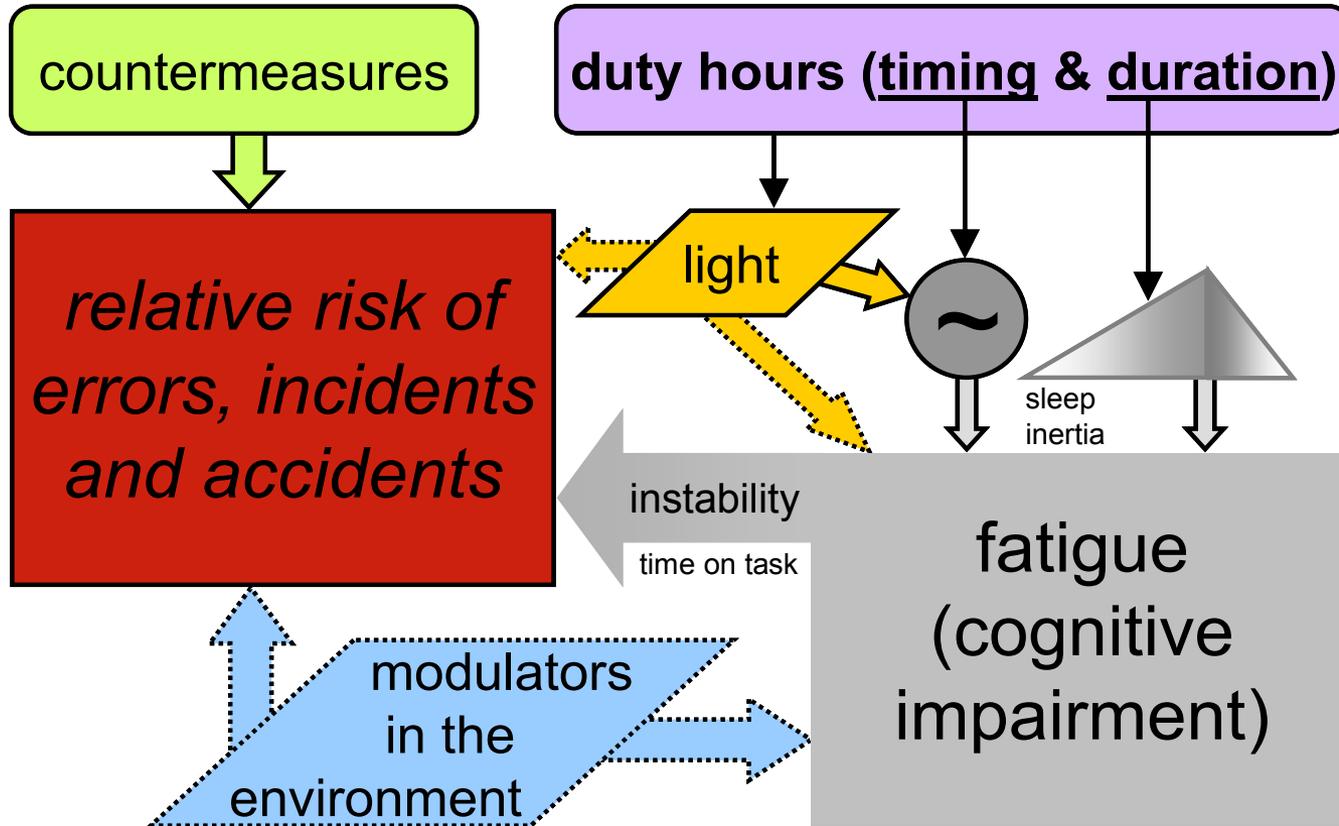
# Cumulative Fatigue from Chronic Sleep Restriction



Graphs show  
daytime averages



# Duty Hours, Sleep/Wake Regulation and Fatigue Risk Management in EMS Settings



- *Neurobiological comes with the individual*
- *Operational comes with the task at hand*