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# From Bench to Bedtime: Entraining Policy to Science

Day 2

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# Course Schedule

## Day One

- What are circadian rhythms, and why do they matter?
- Autoinhibitory transcriptional networks allow for temporal gene regulation
- How environmental stimuli like light can “entrain” the circadian clock
- How the brain coordinates circadian rhythms in the periphery

## Day Two

- How does circadian biology impact shift workers?
- Shift work as a historical phenomenon
- How to leverage circadian biology to improve health outcomes in shift workers
- Exploring the broad implications of shift work

## Day Three

- How should future policies (DST, school start times) be informed by circadian biology?
- The current status of DST and school start times in the USA
- How to better support health and productivity outcomes using circadian biology

# Learning Objectives

At the end of Day 2, students can ...

- ❑ describe how how disrupting circadian rhythms can cause disease
- ❑ list a variety of common circadian rhythm disruptions and how they shift the clock
- ❑ predict how the the content, size, and timing of meals can impact entrainment of peripheral clocks in the gut
- ❑ describe the broad implications of non-standard work schedules

Predict. What is a disease or health issue you expect to be related to shift work? Discuss with a partner for 5 min and add your ideas to the Poll Everywhere!

Consider. How might shift work be similar or different from the genetic manipulations of peripheral clocks we discussed?

# What is a disease or health issue you expect to be related to shift work?



# Shift work and consequences



- In general, circadian perturbations have very effects similar to genetic perturbations!
- We will use shift work as a case study today to examine the downstream effects of circadian perturbations on our everyday lives



# The origins of shift work

## Why do we have shift work?

### Back then...

- Nomadic societies required **camp guards** and **shepherds** to be awake and vigilant when everyone else was sleeping
- Ancient Greeks and Romans started using **candles** to provide light at night.

### Same needs today

- Soldiers keeping watch
- Working at night (especially in areas where there is little daylight)
- Emergency medical cases



# The origins of shift work



## Now...

- With the advent of artificial lighting, we quickly became a “**24/7**” society
- The **19th century Industrial Revolution**, demanded the expansion of “non-essential” shift work → This is truly a RECENT phenomenon!
  - ***What are some examples of this non-essential shift-work?***
  - Transportation of goods during the night
  - Globalization of companies → people can communicate around the clock with others in different countries
  - Large factories working around the clock → production more **profitable \$\$\$**

**However, our changing society doesn't change the fact that 24/7 life really deviates from our natural biological rhythm!**



# Modern day shift work

## What is shift work?

*Shift work is an employment practice designed to make use of, or provide service across, **all 24 hours of the clock each day of the week**. The practice typically sees the **day divided into (3) shifts**, set periods of time during which **different groups of workers perform their duties**.*

- **15 million** American workers or roughly **16% of workers** work on night or rotating shifts (Bureau of Labor Statistics)
- Result in **misalignments** of the circadian-influenced physiology with the environment → “Shift work disorder”
  - Increased risk for metabolic syndrome, diabetes, cardiovascular disease, and **even cancer** (Figueiro MG, White RD. Health consequences of shift work and implications for structural design. J Perinatol. 2013 Apr;33 Suppl 1:S17-23. doi: 10.1038/jp.2013.7. PMID: 23536025.)

# Common shift work jobs

Morning



**4am to 8am**

- Construction workers
- Farmers
- Flight industry

Evening



**6pm to 10pm**

- Food services
- Retail workers
- Performing artists

**24/7**

- Healthcare workers
- Police officers / security

Night



**11pm to 3am**

- Late night entertainment (clubs, bars)
- Manufacturing and production
- Truck drivers

*Which are truly essential?*

# Bring it back to yourself...

- What are some disturbances (environmental or social factors) to your own circadian clock during your day?
- What are the downstream consequences?
- How do you address or manage these factors?

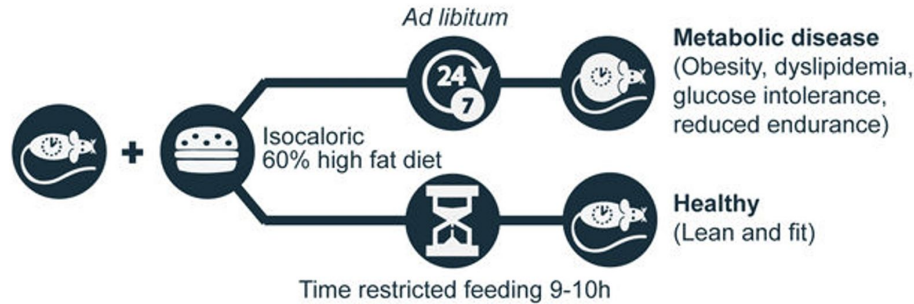
**Talk to your neighbors (5 mins), the person with the soonest birthday will share out!**

# How to protect shift worker health using circadian rhythms

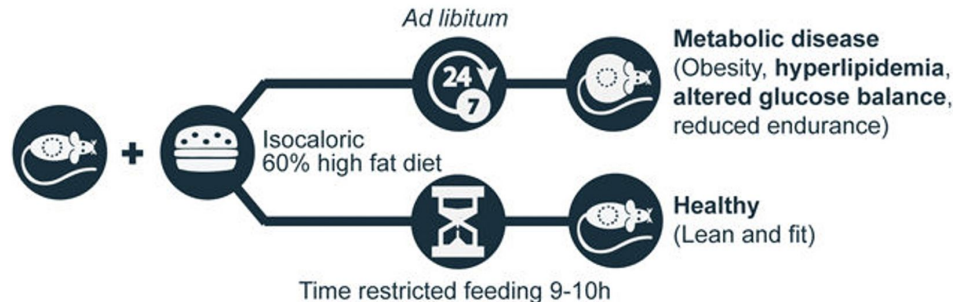
- How should we, as scientists, advise shift workers and people who manage them?
- Shift workers can stay consistent with natural light/dark cycles
  - Spread out shifts that disrupt circadian rhythms to minimize impact
  - Avoid bright light during the night
  - Eat only during daytime, or in an even shorter window (Time Restricted Eating)
- Shift workers can manage deviation from natural light/dark cycles
  - Supplements like melatonin advance circadian phase towards the end of daytime
  - Supplements like caffeine delay circadian phase towards the end of daytime
  - Judicious snacking can improve attention without delaying circadian phase

# Time-restricted feeding improves several health outcomes in mice without a circadian clock

## WILD TYPE

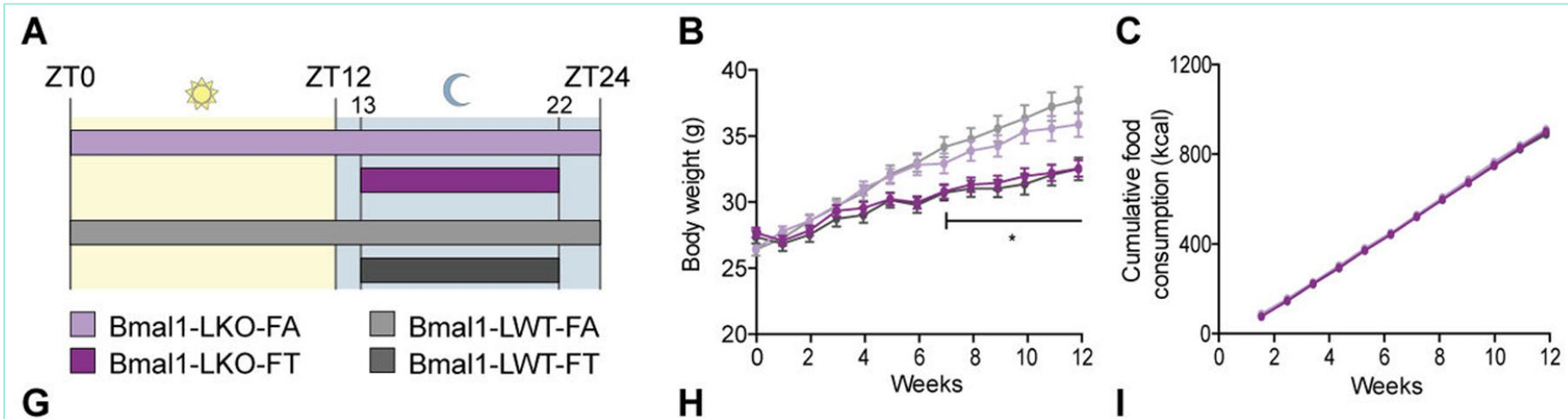


## CLOCKLESS



# Time-restricted feeding improves several health outcomes in mice without a circadian clock

- By knocking out critical clock genes (like Bmal1) in the liver, circadian biologists can test if time-restricted feeding provides a robust enough signal to entrain circadian clocks in the gut, resulting in better health outcomes



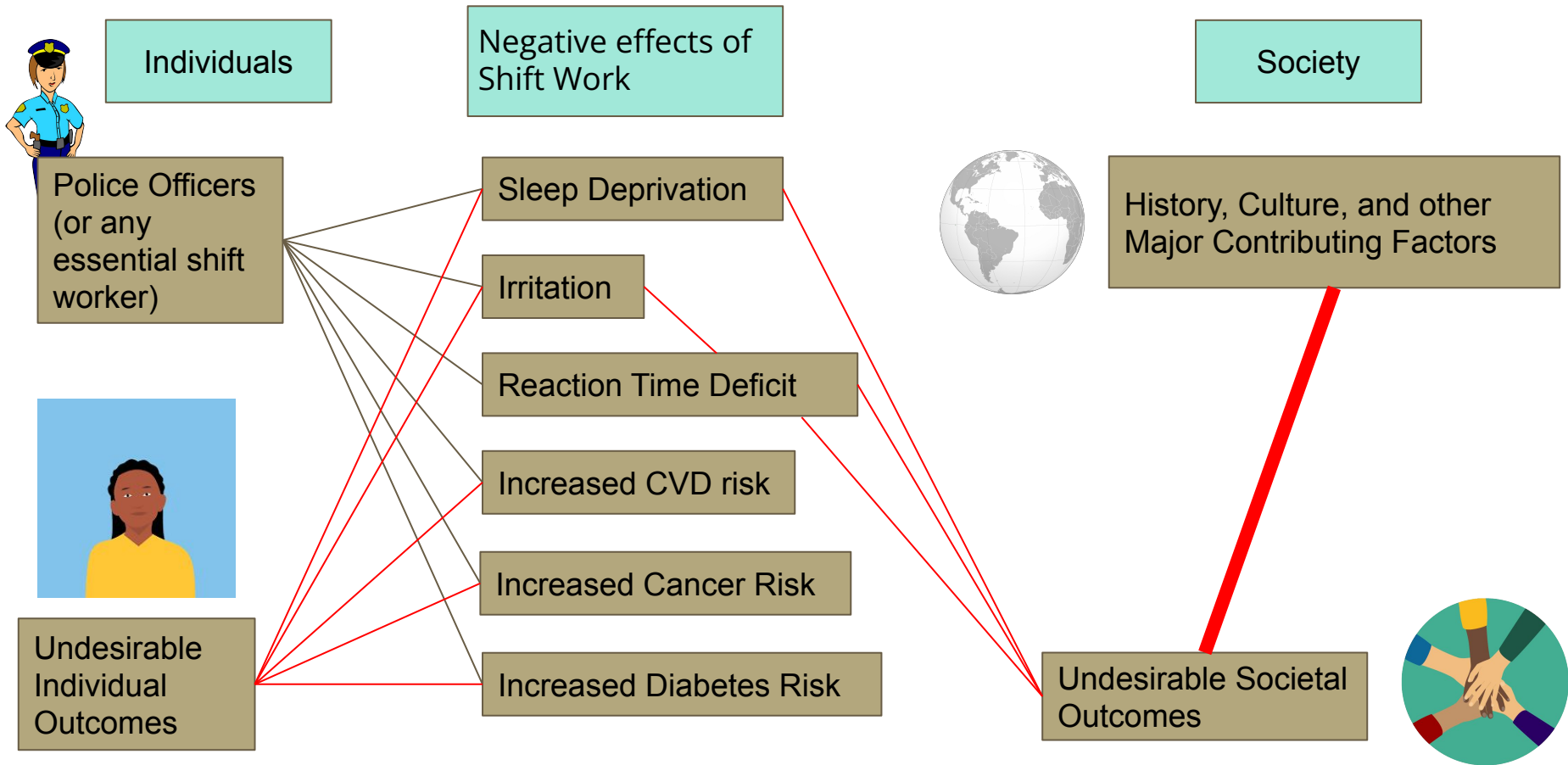
## Brainstorm: Benefits of TRE for shift workers

- We've discussed health problems that could result from shift work, but what about potential solutions?
- Based on what we've learned in class so far, why might time-restricted eating (TRE) be especially helpful for shift workers? Name one specific benefit shift workers might receive from TRE and use circadian biology to explain why.
- Were your benefits health benefits, or work performance benefits? Were they short-term or long-term?

***TRE helps shift workers stay entrained to natural light/dark cycles***

# Addressing the broad implications of Shift Work





**The Compressed Workweek Schedule  
(CWW) allows employees to squeeze a  
traditional 35-40 hour work week into  
less than 5 days**

**5 Days (8-Hour Shifts) - 4 Days (10 Hour Shifts) - 3 Days (12 Hour Shifts)**

# A brief history of Compressed Work Weeks in Policing

- Ca. **1980's** Louisiana State Police pilot of 4 day 10hr shifts reported increases in arrests, reductions in department expenditures (eg. unscheduled overtime, sick leave, compensatory time accrual), and improved employee morale however, also reported concerns over fatigue. <sup>1</sup>
- By 1981, CWW adoption occurred department wide and was being referenced by other departments (Fournet 1983).

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1. (Amendola et al., 2011) - <https://www.ojp.gov/pdffiles1/nij/grants/237330.pdf>

# Initial Studies Generally Supported the Adoption of the Compressed Work Week

Arguments that support CWW adoption:

- Increase morale
- Improve recruitment ability
- Reduce costs
- Reduce absenteeism
- Reduce turnover

Arguments against CWW adoption:

- Increased fatigue
- Increased OT usage
- Decreased Alertness
- Job safety concerns
- Productivity concerns

# Questionable Rigor Among Early Studies Used to Support CWW Adoption

## Early studies on CWW adoption in Policing

- Often relied heavily on survey data
- Small Samples
- “Peculiar Designs” - e.g. Lack of a control group
- Anecdotal data
- Conflicts of Interest - e.g. Studies conducted and interpreted by the departments themselves
- Overstated or Over interpreted results

# The Impact of Shift Length in Policing on Performance, Health, Quality of Life, Sleep, Fatigue, and Extra-Duty Employment (Amendola et al., 2011)

## Performance and Safety

No Change in CWW v. Control

## Health

No Change in CWW v. Control

## Quality of Work Life

Higher QOwL in CWW (10 Hour) v. Control

No Change in Quality of Personal Life in CWW v. Control

## Sleep and Fatigue

Higher Quality of Sleep in CWW (10 Hour) v. Control

## Off Duty Employment and OT usage

Less OT usage in CWW (10 Hour) v. Control

## Study Design

- January 2007 - June 2009
- Detroit, MI & Arlington, TX
- Sample Size ~250
- 6 month experimental period
- Data collected from
  - Performance Simulations in a Lab Setting
  - Daily Statistics
  - Surveys and Self report instruments
- Data was collected prior to the beginning of the study and at the end of the study (pre/post)

# The Impact of Shift Length in Policing on Performance, Health, Quality of Life, Sleep, Fatigue, and Extra-Duty Employment (Amendola et al., 2011)

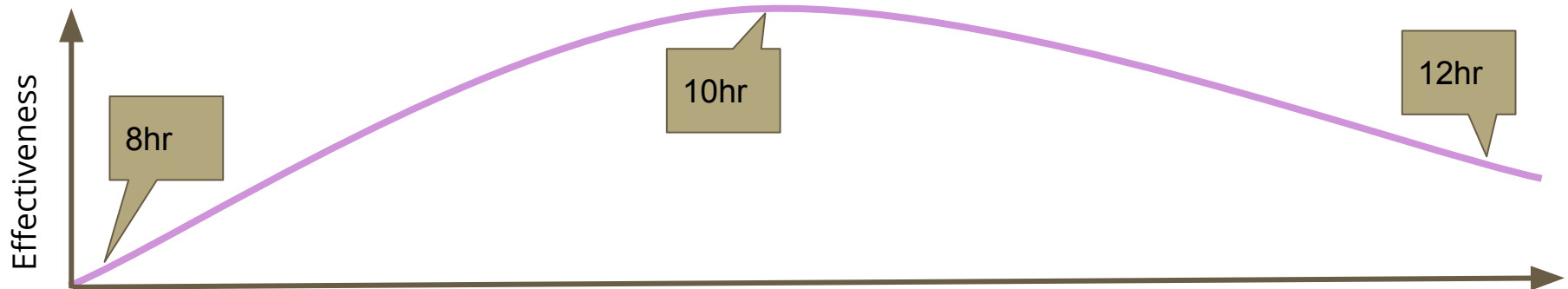
## 8hr Employees (CTRL)

## 10hr (v. 8hr) Employees

- (-) OT usage
- (+) Sleep and Sleep Quality
- (+) QOL (work)

## 12hr (v. 10hr) Employees

- (+) OT usage
- (-) Sleep and Sleep Quality
- (-) QOL (work)
- (+) Sleepiness and Fatigue (v. 8hr)
- (-) Alertness (v. 8hr)



**Work scheduling policies  
have broad implications  
for the workforce and  
society**





Up until 2020 - Boston Police Department employed 8hr shifts



At present - Atlanta Police Department employs 8, 10, and 12 hour schedules

# Work scheduling policies have broad implications for the workforce and society

**Officers who work longer consecutive hours than would be legal in other industries experience fatigue at rates six times higher than shift workers in other industries.<sup>1</sup>**

**Concerning stress management for law enforcement officers, shift work was named as a specific stress factor.<sup>2</sup>**



From: <https://www.phillyvoice.com/leave-sleeping-cops-alone/>

1. Villa, Bryan J, et al. "Evaluating the Effects of Fatigue on Police Patrol Officers: Final Report." *Evaluating the Effects of Fatigue on Police Patrol Officers: Final Report* | Office of Justice Programs, Feb. 2000, <https://www.ojp.gov/ncjrs/virtual-library/abstracts/evaluating-effects-fatigue-police-patrol-officers-final-report>.
2. Anderson, W., et al. "Stress Management for Law Enforcement Officers." *Stress Management for Law Enforcement Officers* | Office of Justice Programs, 1995, <https://www.ojp.gov/ncjrs/virtual-library/abstracts/stress-management-law-enforcement-officers>.
3. American Academy of Sleep Medicine. "Study of police officers finds fatigue impacts tactical social interaction: Results lay foundation for addressing impact of shift work-related fatigue on officer-public interaction." ScienceDaily, 8 June 2016. <[www.sciencedaily.com/releases/2016/06/160608174300.htm](http://www.sciencedaily.com/releases/2016/06/160608174300.htm)>.
4. Schuster, Karl. "Fatigue in Law Enforcement." *Benchmark Analytics*, 10 Nov. 2021, <https://www.benchmarkanalytics.com/blog/fatigue-in-law-enforcement/>.

# Work scheduling policies have broad implications for the workforce and society

Officers who work biologically normal shifts perform much better than those working abnormal shifts ... much less likely to have encounters that escalate to violence.<sup>3</sup>

Shift Length, Policies, Regularity, and Staffing Shortages Significantly Contribute to Officer Fatigue<sup>4</sup>



From: <https://www.cbsnews.com/news/viral-photo-atlanta-on-duty-police-officer-sleeping-in-car/>

1. Villa, Bryan J, et al. "Evaluating the Effects of Fatigue on Police Patrol Officers: Final Report." *Evaluating the Effects of Fatigue on Police Patrol Officers: Final Report* | Office of Justice Programs, Feb. 2000, <https://www.ojp.gov/ncjrs/virtual-library/abstracts/evaluating-effects-fatigue-police-patrol-officers-final-report>.
2. Anderson, W., et al. "Stress Management for Law Enforcement Officers." *Stress Management for Law Enforcement Officers* | Office of Justice Programs, 1995, <https://www.ojp.gov/ncjrs/virtual-library/abstracts/stress-management-law-enforcement-officers>.
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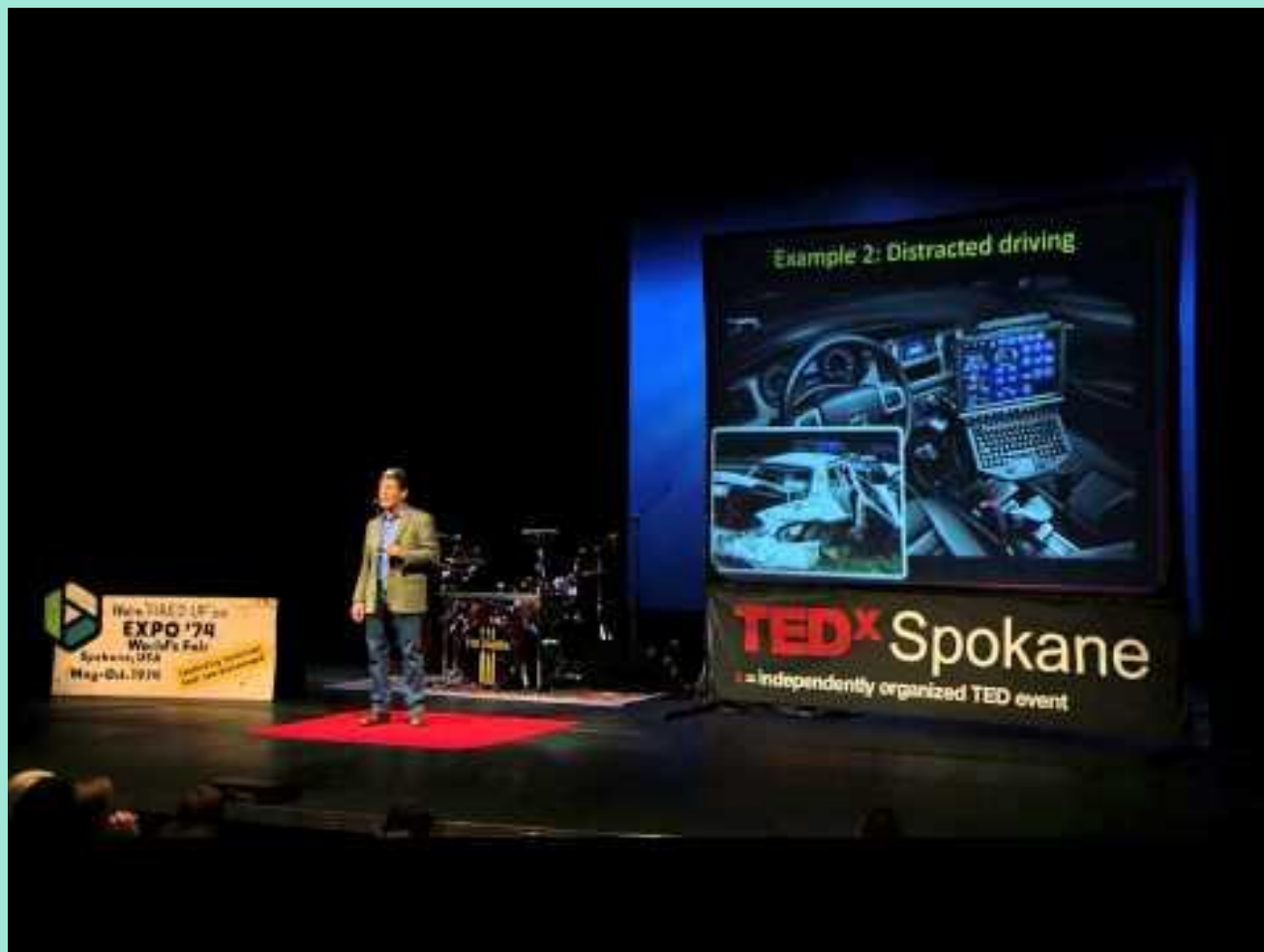
# Fatigue on Performance and Safety

*"A much higher proportion of officers who later were involved in on-duty accidents and/or injuries during the project's study period ... were substantially more likely to have reported "always" or "usually" being tired at the beginning of their work shifts."<sup>1</sup>*

*"[The] combination of excess work and reduced sleep perilously heightens the risk of officer injury, compromised public safety, and the possibility of significant civil liability damage awards for avoidable accidents."<sup>2</sup>*



1. Villa, Bryan J, et al. "Evaluating the Effects of Fatigue on Police Patrol Officers: Final Report." *Evaluating the Effects of Fatigue on Police Patrol Officers: Final Report* | Office of Justice Programs, Feb. 2000, <https://www.ojp.gov/ncjrs/virtual-library/abstracts/evaluating-effects-fatigue-police-patrol-officers-final-report>.
2. Senjo, Scott. (2011). Dangerous fatigue conditions: A study of police work and law enforcement administration. *Police Practice and Research: An International Journal*. 12. 235-252. 10.1080/15614263.2010.497659.



### Example 2: Distracted driving



**TED<sup>x</sup> Spokane**  
= independently organized TED event

WORLD'S FAIR  
**EXPO '74**  
World's Fair  
Spokane, WA  
May-Oct. 1974  
*Spokane City Historical Society*



Question 1: Many factors must be considered in researching the adoption/adaptation of non-standard work scheduling practices. **What kinds of questions might you ask as a researcher studying shift work optimization?**

Question 2: In the context of policing, **what are some obstacles that may stifle the implementation of healthier policies? Be creative!**