CAFFEINE CONSUMPTION ABOARD THE INTERNATIONAL SPACE STATION

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Introduction

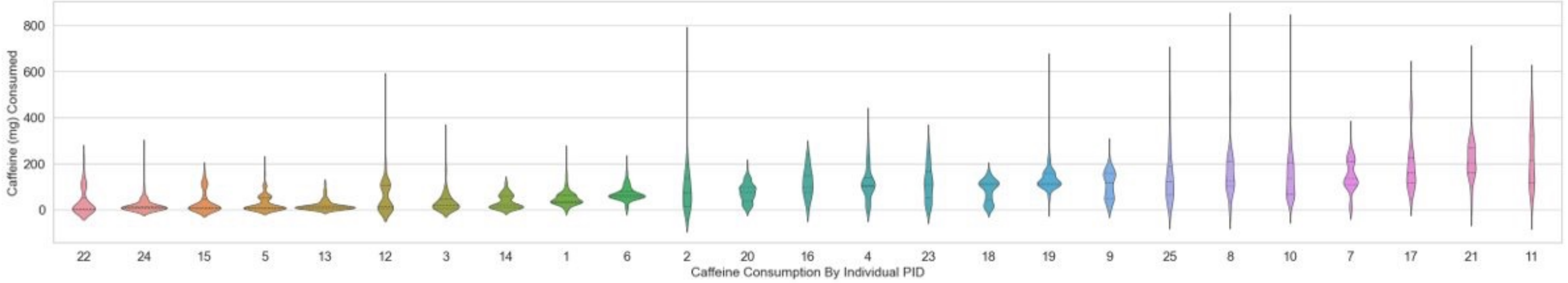
- Historically, humans average ~6h of sleep per night in space, which leads to reduced alertness and performance
- Caffeine is the most used drug in the world, as a countermeasure used to counteract sleepiness
- No previous relationship between caffeine and sleep duration

Methods

- **Secondary analysis** of existing datasets
- **Nutrient data**: N = 25 (11F) crewmembers
  - Food and beverage questionnaires
  - Caffeine intake (mg) derived from daily log
- **Sleep data**: N = 12 (7F)
  - Actigraphy-measured sleep
  - Sleep outcomes: sleep duration (h), sleep efficiency (%), number of awakenings (n), wake after sleep onset (min; WASO), and sleep latency (min)

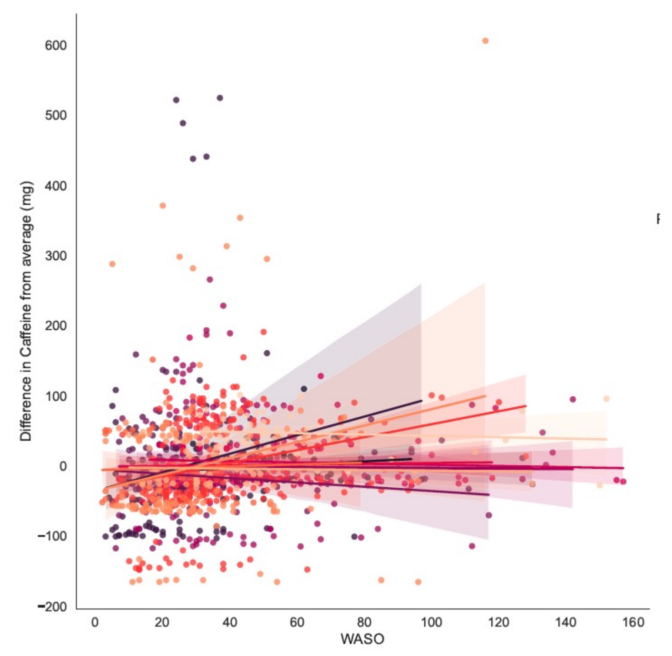
Results

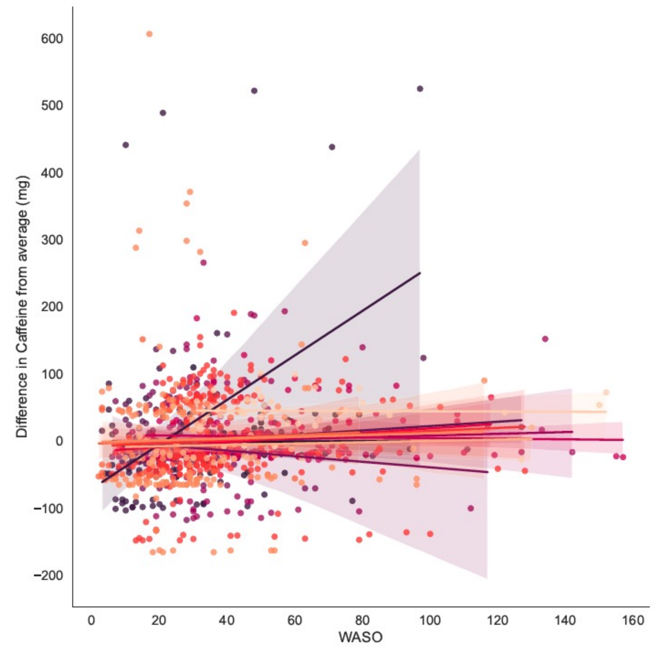
What percentage of crew used caffeine and how often did they use it?



Does caffeine negatively impact subsequent sleep?

Does poor sleep drive subsequent caffeine use?





Conclusion

- Caffeine consumed by all crewmembers in this study
- Caffeine impacts subsequent night’s WASO and WASO in turn affects caffeine intake
- Future study needed to understand source of caffeine

Introduction

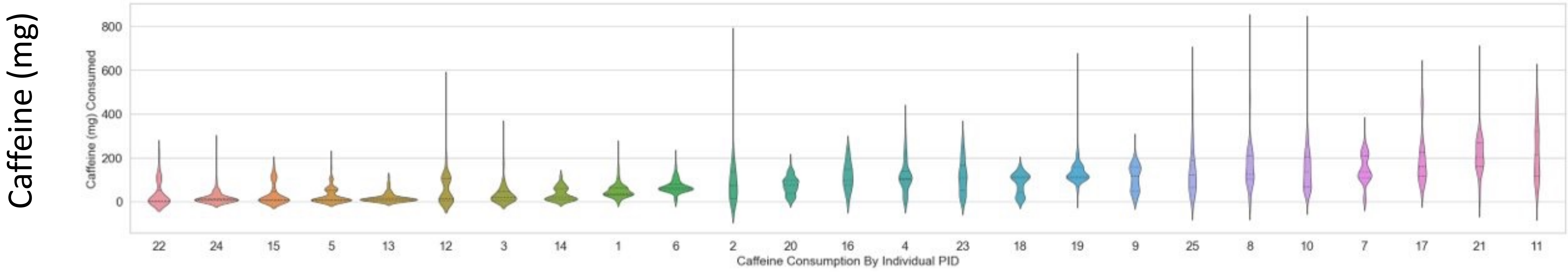
- Humans average approximately six hours of sleep per night in space, which has been associated with reduced alertness and performance
- Caffeine used as a countermeasure to counteract sleepiness: improves performance on cognitive tasks (Flynn-Evans et al., 2023)
- Bi-directional relationship between caffeine and sleep (Spaeth et al. 2014)
- Impact on sleep varies based on timing and dose (Drake et al. 2013)
- Caffeine metabolites still present 36 h after consumption of 150 mg (Lin et al. 2021)
- Evidence suggests caffeine also impacts the circadian pacemaker (Burke et al. 2015)
- Increased use over time inflight but no association between caffeine dose and sleep duration (Jones et al. 2022)

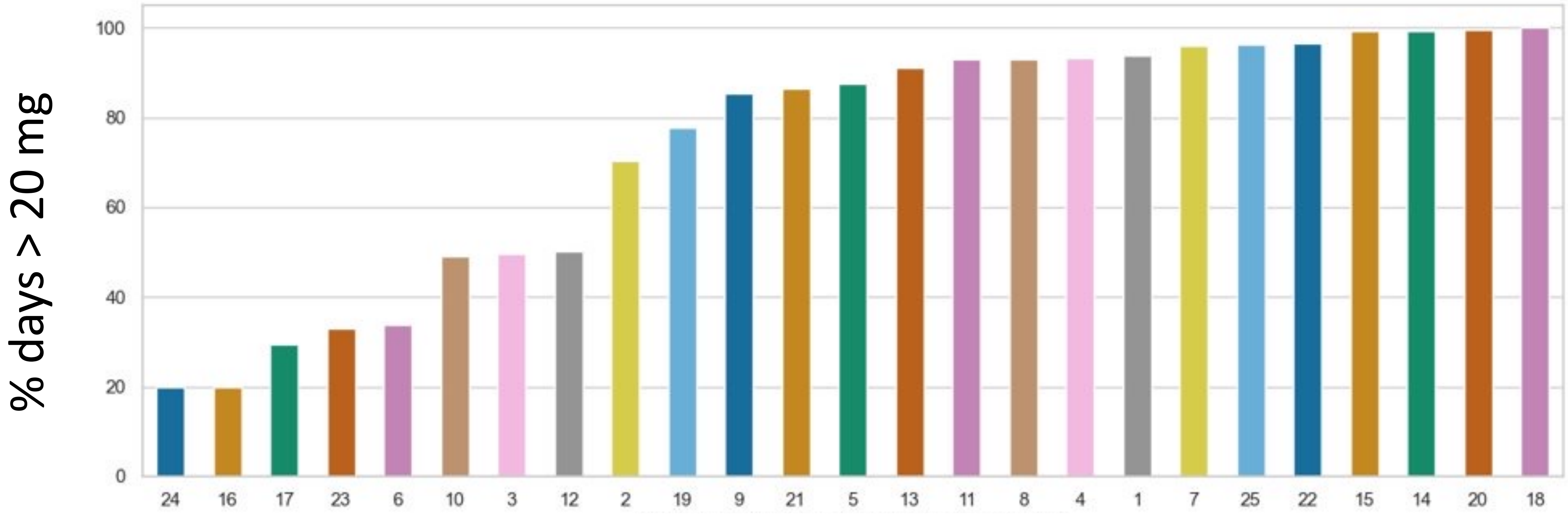
Methods

- **Secondary analysis** of existing datasets following formal request to Life Sciences Data Archive (LSDA)
  - Requires reconsenting all crew
- **Nutrient data**: N = 25 (11F) Crewmembers
  - Intake (in mg) derived from daily log (food and beverage questionnaires)
  - Variability in collection and reporting frequencies
- **Sleep data:** N = 12 (7F)
  - Actigraphy-measured sleep
  - Inflight data only on International Space Station collected either continuously or in 2-week increments
  - Nominal Sleep Schedule: 9:30 PM – 6:00 AM
  - <u>Sleep outcomes:</u> sleep duration (h), sleep efficiency (%), number of awakenings (n), wake after sleep onset (min; WASO), and sleep latency (min)

Photo credit: NASA

Results





- 100% of crew consumed caffeine on ISS
- Average caffeine use 99.38 mg/day
- 52% consumed at least 90 mg (e.g., a cup of coffee) on 50% or more of inflight days
- 24% had at least 90 mg on 90% or more of inflight days

Results: impact of caffeine on subsequent sleep

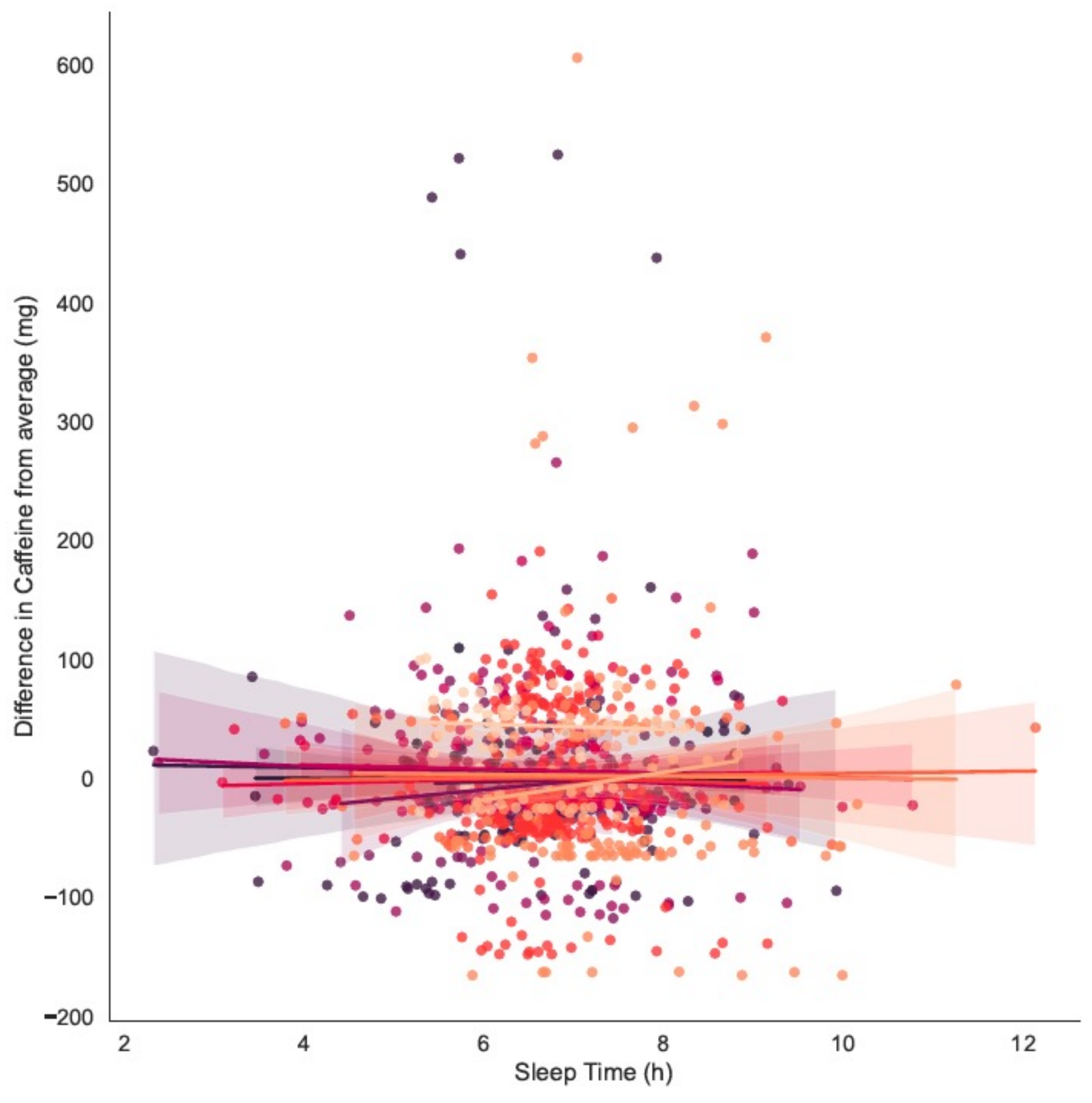
→ 60 mg of caffeine today increases WASO by 15 minutes tonight

Linear mixed-effects models using participant as random effect

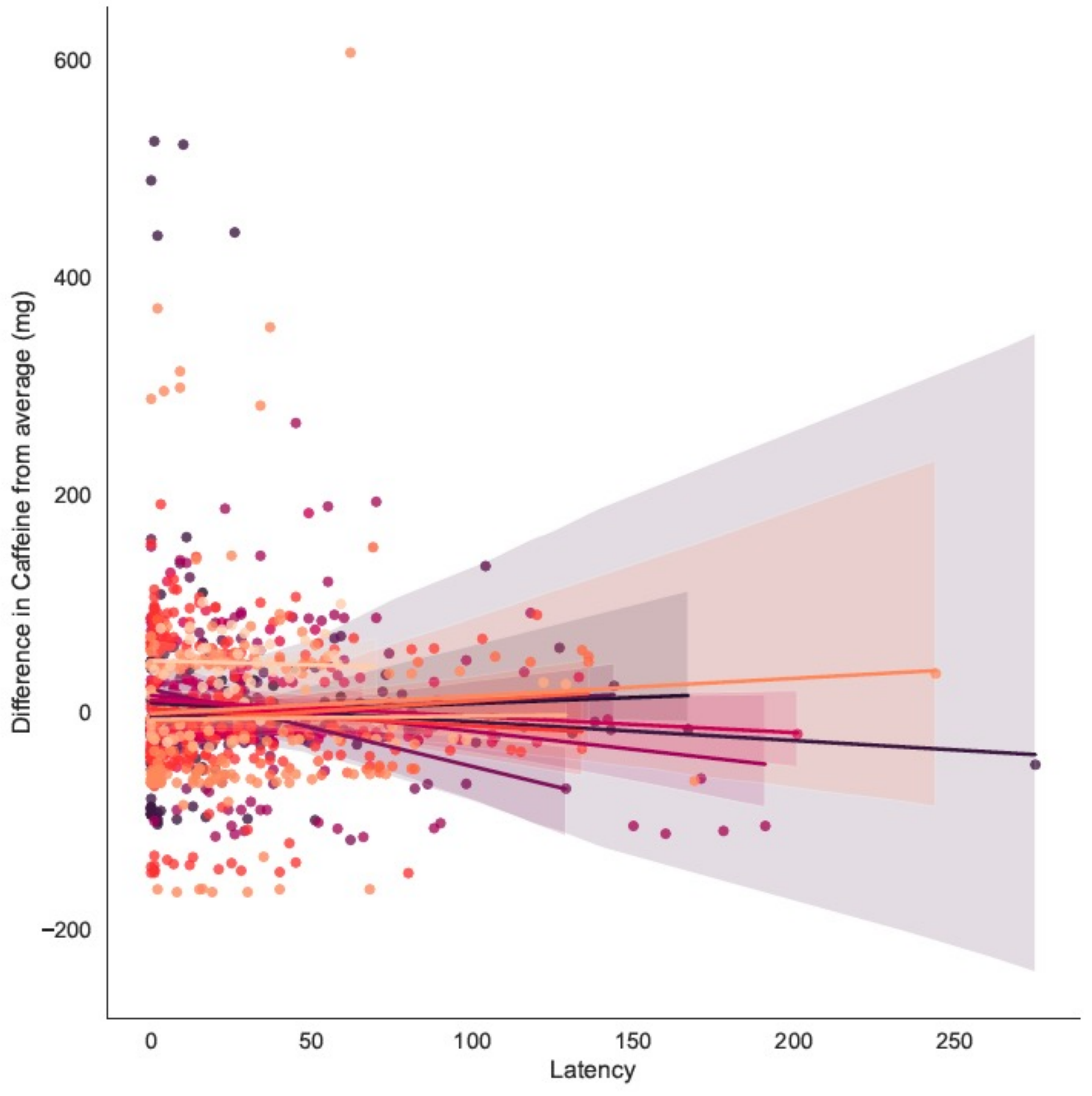
Results: impact of sleep on next day caffeine use

→ 15 minutes of WASO last night increases caffeine use by 0.42 mg today

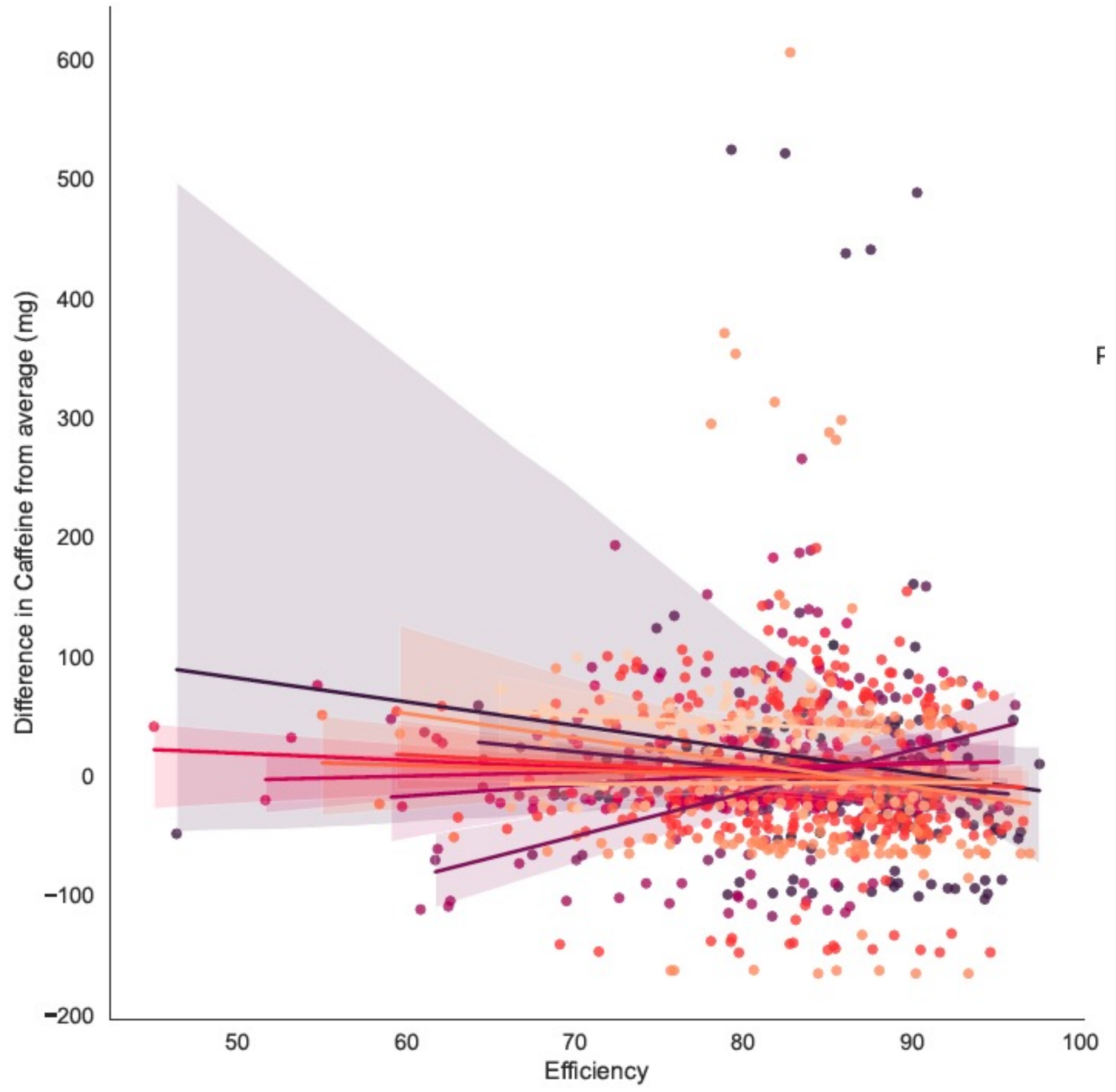
Caffeine (deviation from mean)



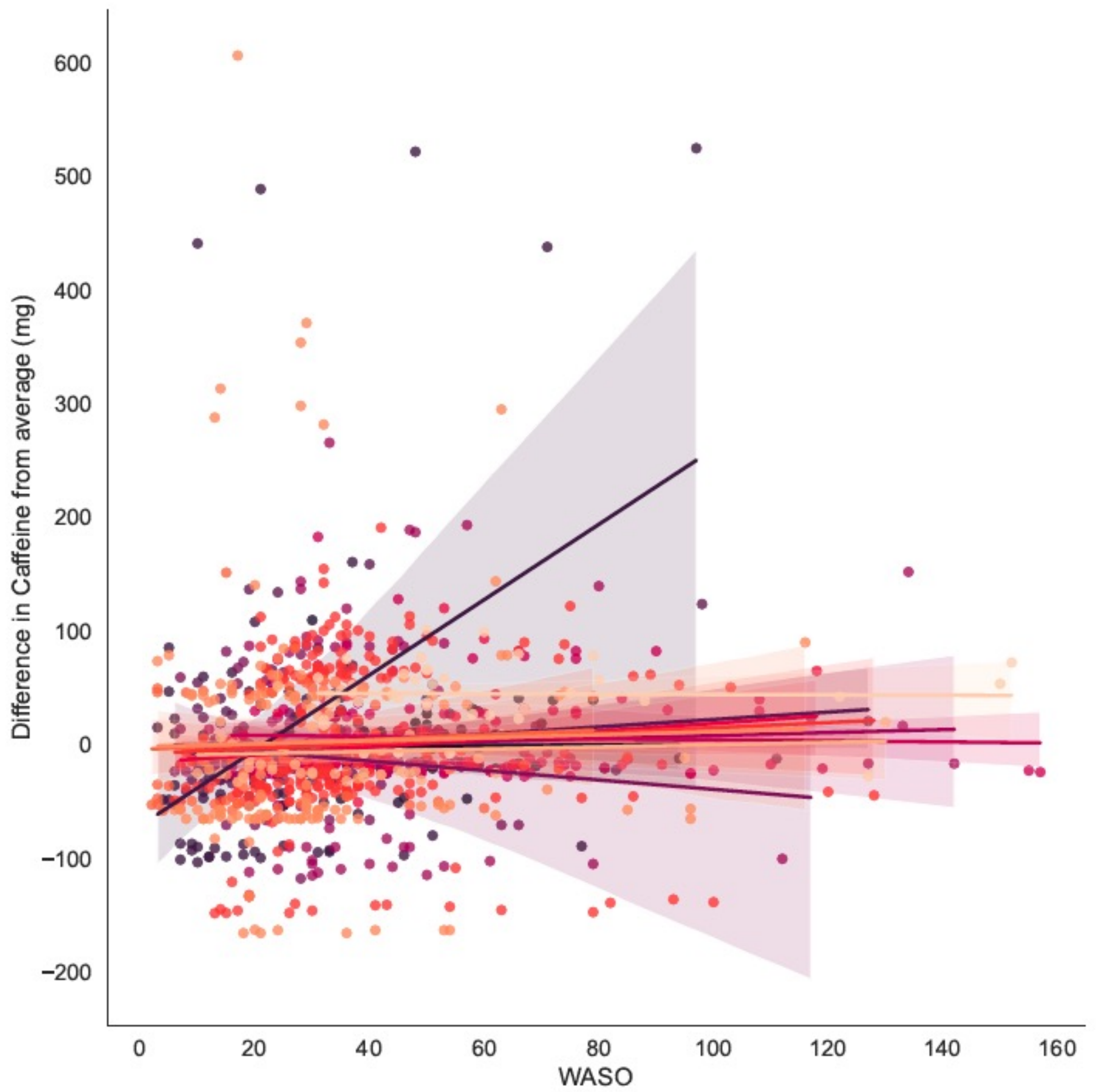
Sleep Duration



Latency



Sleep Efficiency



WASO

Future Directions

- Examine sleep choices in relation to caffeine use: *Do crewmembers choose to sleep later when they have consumed caffeine?*
- Evaluate dietary sources of caffeine: *How much consumption is habitual vs. strategic vs. unintentional?*
- Obtain additional sleep data from other studies through LSDA
- Obtain and evaluate performance data (e.g., Cognition test battery data)

Photo credit: NASA

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References

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