

# Heart Rate Variability Changes During an Auditory Reaction Time Task in a Simulated Driving Situation

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# Introduction

- The majority of studies use vehicle-based driving performance measures to assess the impact of the demands placed on drivers.
- Physiological variables can give additional information about the state of a person.
- Heart rate variability (HRV) ↓ with mental workload and may be a useful variable in driver distraction research.



- Investigate whether HRV measures are sensitive to changes in driver demand associated with dual task conditions.
- Use these results to aid with the interpretation of results from a more involved study.



# Method



# Method: Driving Simulator

- Driving performance measures used:
  - Speed, SD Speed, Lane position, SD Lane position, SD Throttle, SD Brake, SD Steering, No. of Steering Reversals, Percentage of time Over the Speed Limit, Mean Speed if Over the Speed Limit.



# Method: AX Task

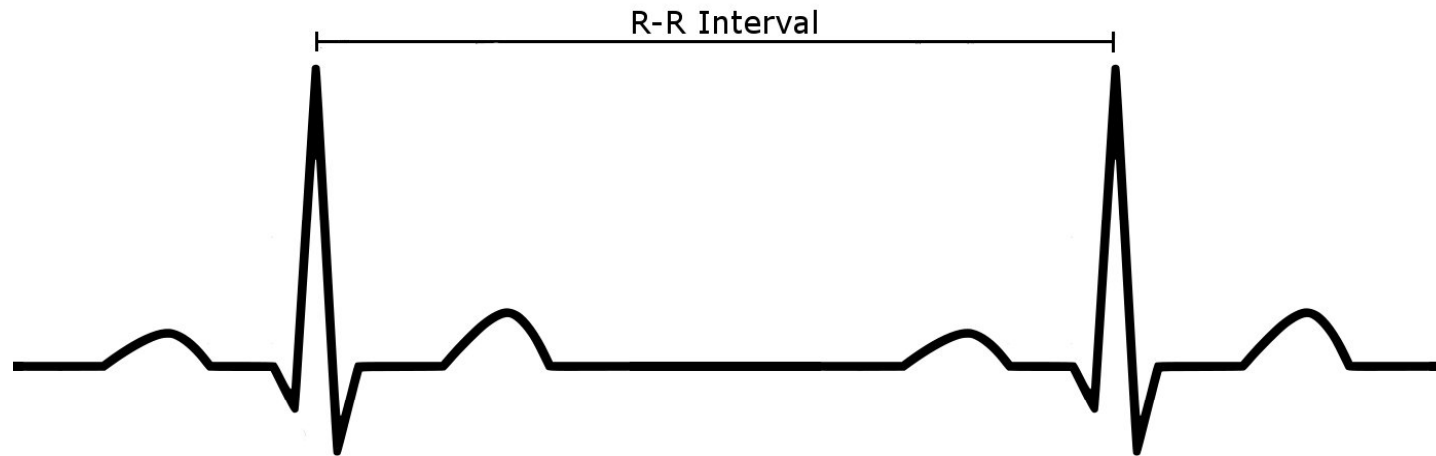
- Example of the AX task

... R A J A X W...

↑  
Response required

- 2 speeds: AX1 (slower) & AX2 (faster)
- Measures obtained
  - Reaction times, Correct responses, False positives & Missed targets

# Method: ECG



- ECG recorded continuously (sampled 512 Hz)
- Analysed with Kubios HRV 2.0 software
- Measures obtained:
  - Mean R-R, SD R-R, pNN50, Absolute LF power (0.1 Hz component)



# Method: Experimental Procedure

- Practice drive
  - Familiarisation of track and driving simulator
- Baseline AX
  - Performed both speed levels as a single task
- Driving task
  - 3 laps Baseline (No additional task)
  - 3 laps + AX1
  - 3 laps + AX2







# Results





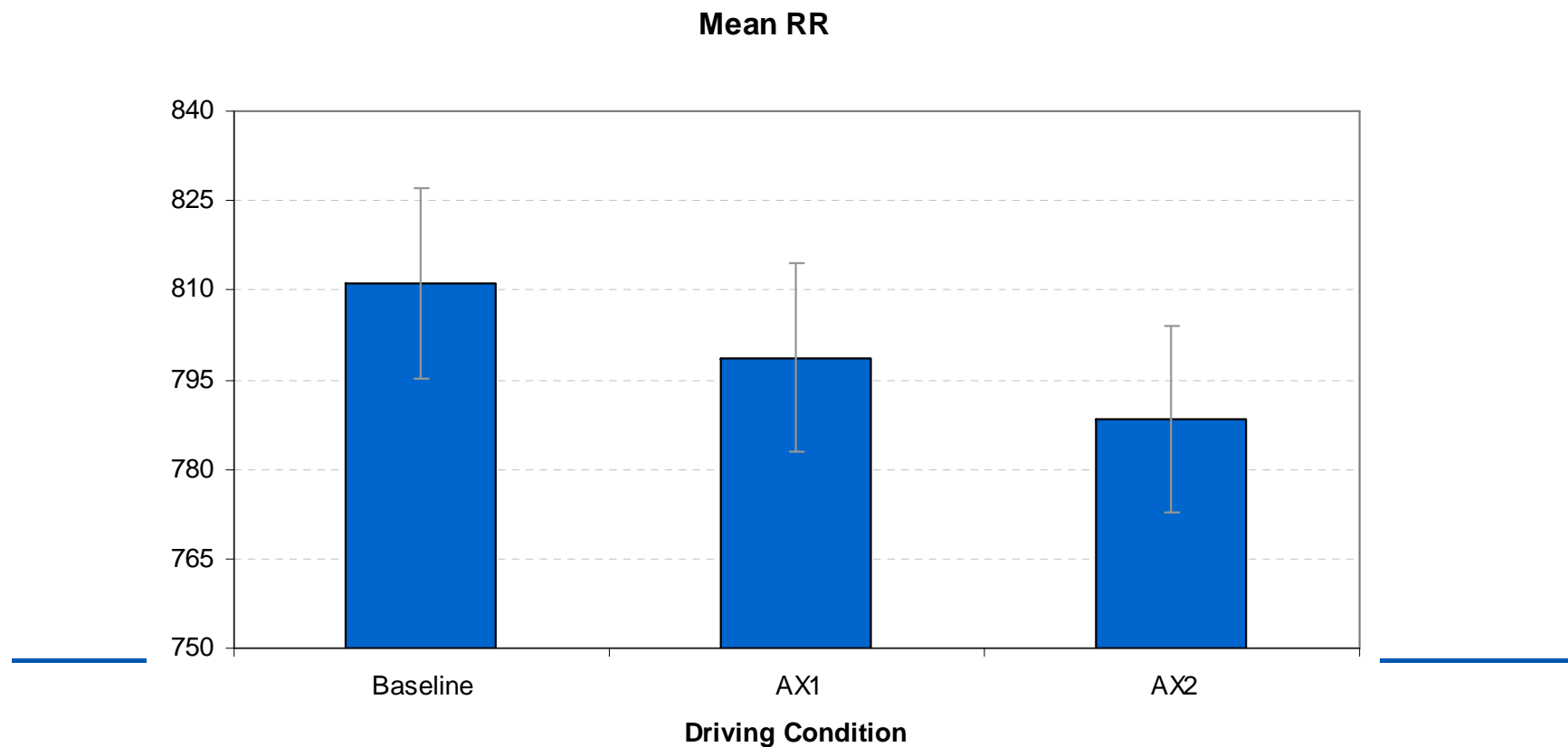
## Results: AX Task

- When driving, AX2 had shorter RTs, ↓ correct responses, ↑ false positives and ↑ missed targets compared to AX1.
- When performance of the AX task was compared from baseline (single task) to driving conditions correct responses ↓, false positives ↑ and missed targets ↑ for both levels of the AX task. No difference in RTs occurred.



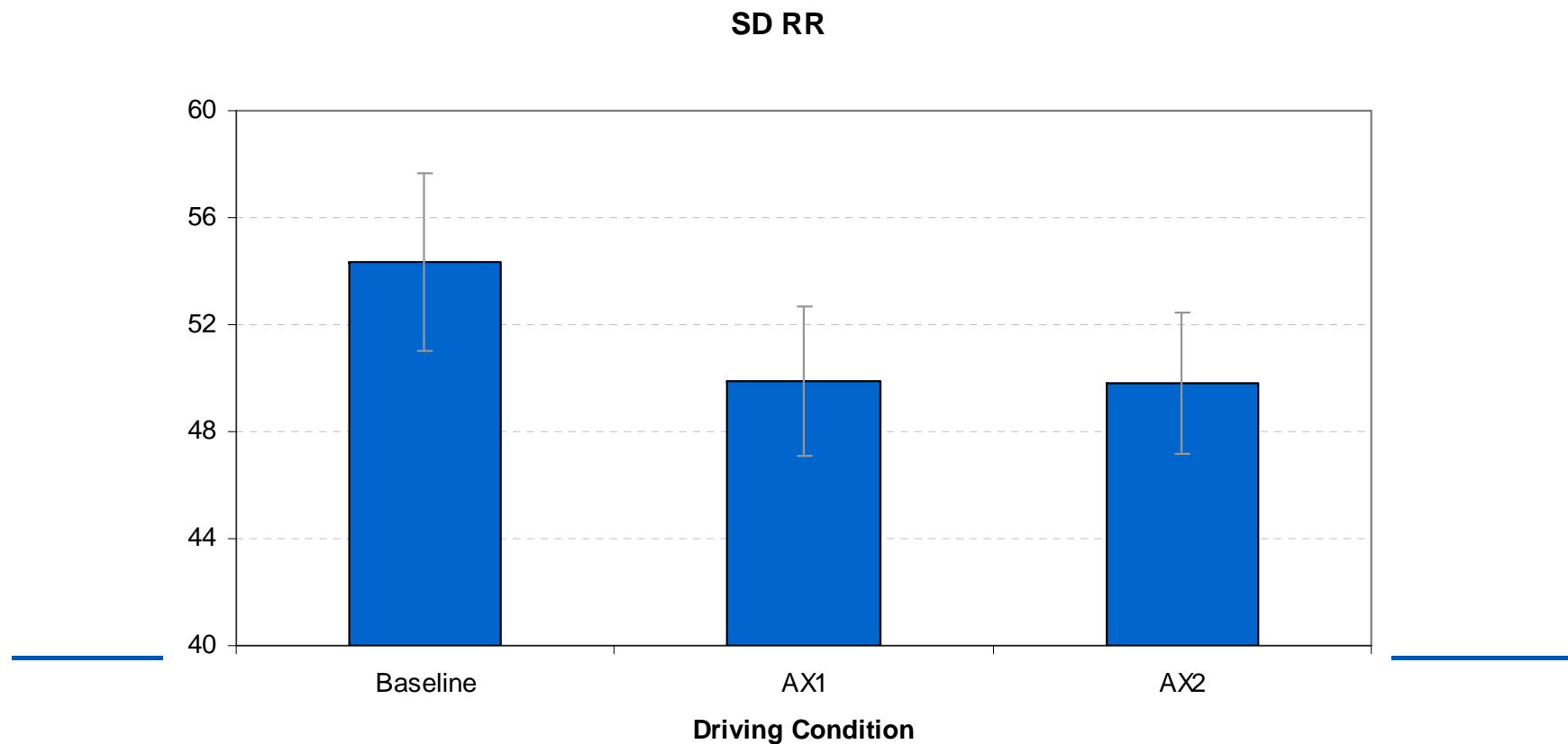
# Results: HRV

- Significant effect of driving condition on Mean RR
  - Decrease from Baseline to AX1 and from AX1 to AX2 were both significant ( $p = 0.00$ )



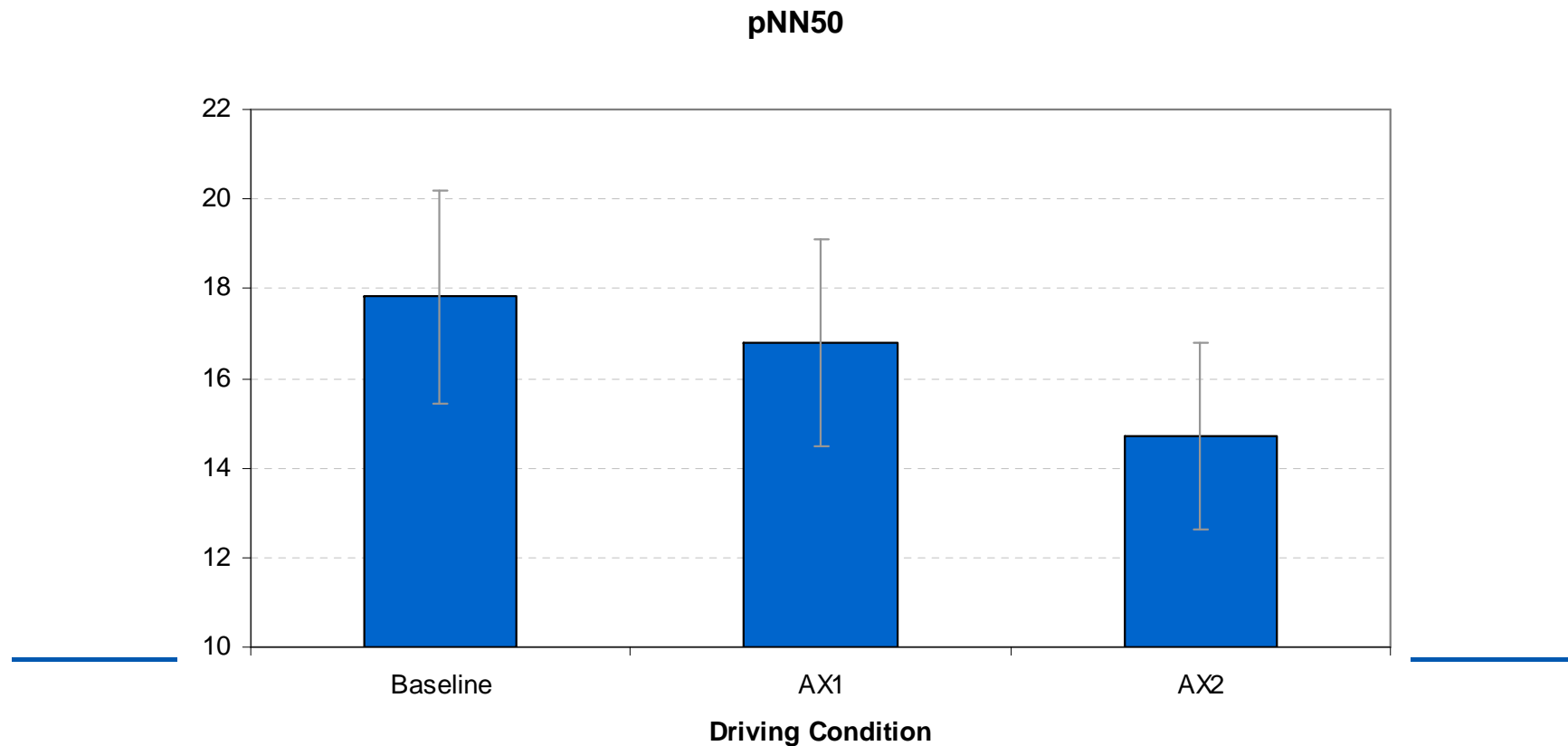
# Results: HRV

- Significant effect of driving condition on SD RR
  - Decrease from Baseline to AX1 was significant ( $p = 0.00$ ) but the decrease from AX1 to AX2 was not ( $p = 0.94$ )



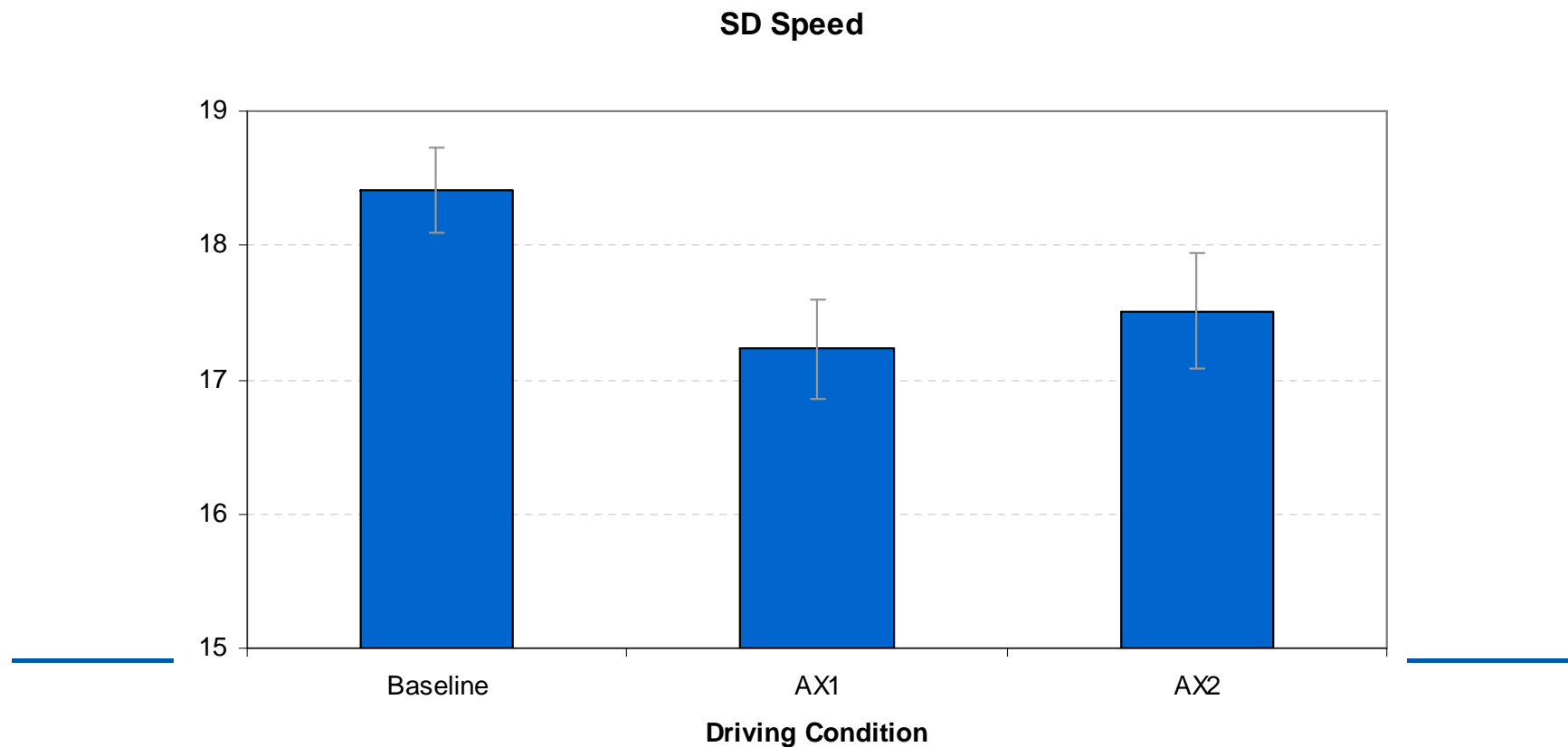
# Results: HRV

- Significant effect of driving condition on pNN50
  - Decrease from Baseline to AX1 and from AX1 to AX2 were both significant ( $p = 0.04$  and  $p = 0.00$  respectively)



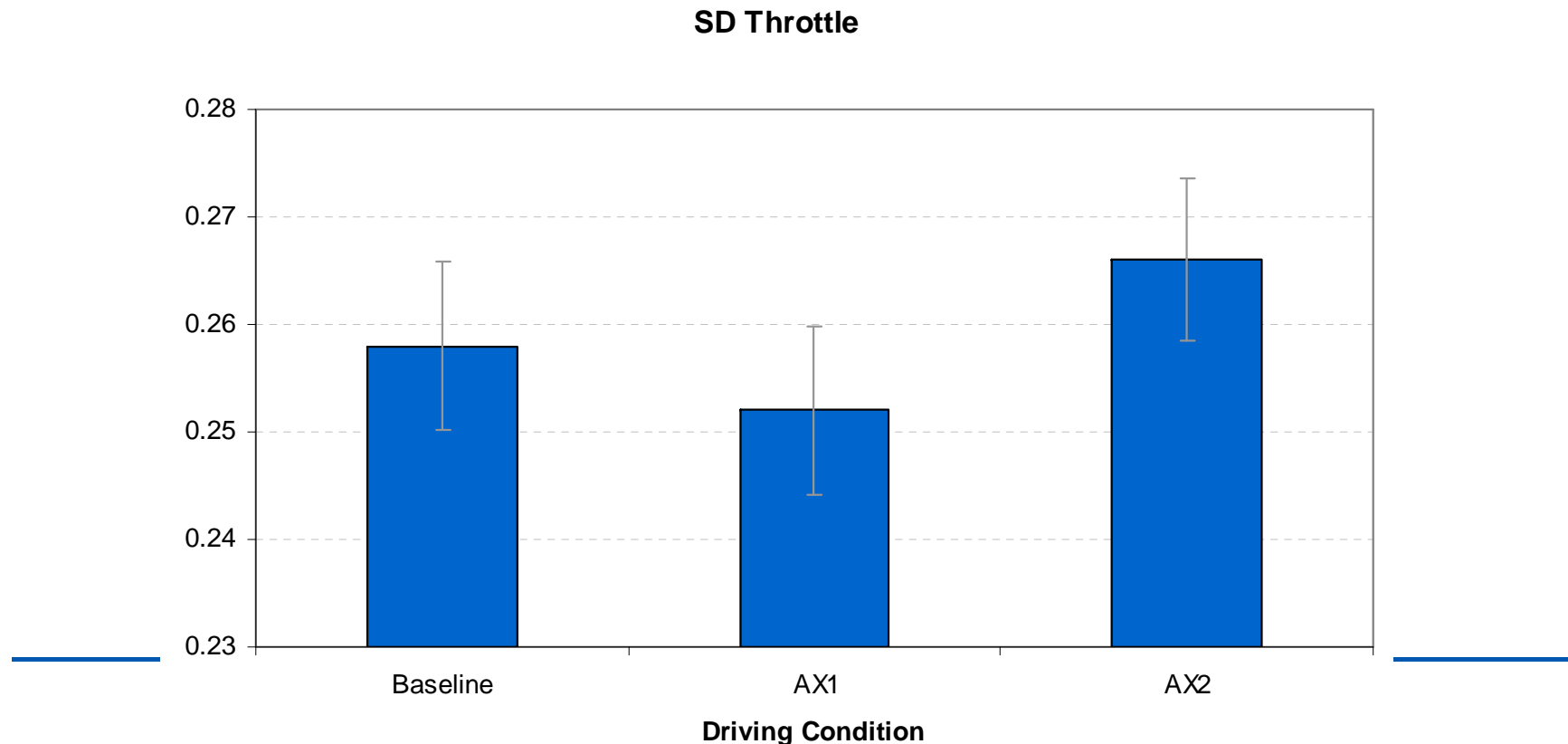
# Results: Driving Performance

- Significant effect of driving condition on SD speed
  - Decrease from Baseline to AX1 was significant ( $p = 0.00$ ) but there was no difference between AX1 and AX2 ( $p = 0.37$ )



# Results: Driving Performance

- Significant effect of driving condition on SD throttle
  - No difference between baseline and AX1 ( $p = 0.20$ ), however the increase from AX1 to AX2 was significant ( $p = 0.00$ )





# Discussion

- Participants ability to cope decreased despite the use of low demand driving and secondary tasks
- Increased errors on the AX task when performed during driving compared to baseline indicates an inability to handle both the driving and AX task simultaneously, with AX2 being more difficult than AX1.
- Time domain measures of HRV indicated changing driving demands where as the 0.1 Hz component of HRV did not.







# Discussion

- Driving performance remained relatively stable despite the concurrent secondary task
- Secondary task performance was sacrificed to maintain driving
  - HRV measures paralleled task difficulty and discriminated between conditions better than driving performance measures





# Discussion

- HRV measures indicate increased sympathetic nervous system activity
  - Evidence of higher cognitive demand or stress placed on the driver caused by the secondary task
- Benefit to using HRV measures
  - HRV is related to easily understood physiological control systems
  - HRV can be measured easily without contributing to driver demand
- Indicates a potential benefit to assessing HRV measures during real driving





# Conclusion





# Conclusion

- Even simple tasks (i.e. AX task) performed during driving can affect cognitive load.
- Reliance on driving performance measures to indicate the cognitive changes in this study would be fruitless.
- HRV measures were much more sensitive to the small changes in demand in this study.



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