Small-n Design Project

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Project Statement

Course Project – Students will work as individuals or in small groups of 2 or 3 and conduct a research project during the semester, including design, data collection and analysis, and presentation. The project will utilize a small-n data collection design.

The theme of the project is on pedestrian safety. Design a method, device, policy or some other intervention that may be helpful in reducing the danger to pedestrians while walking along roads in the US. Be sure to do the following:

1. Review and cite relevant literature that supports your expectations about your design.

2. Build any prototypes or apparatus that you need to test your design.

3. Collect data with your device and conduct a small-n data analysis.

4. Create a presentation that presents your results, including the results of your data analysis. What are your conclusions and recommendations based on your analysis.

Turn in: the presentation (including references), the KNIT file from your data analysis, any materials used in testing your design (e.g., prototype, instructions, photographs, CAD images, etc.)

Background Literature Review

The Problem

- 75% of pedestrian fatalities occur at night, largely due to low visibility (Zegeer et al., 2002).
- Many pedestrians wear dark clothing and are not easily seen by drivers, increasing crash risk.

Prior Solutions & What the Research Shows

- Reflective clothing improves driver detection at night, especially when positioned on moving body parts like arms or ankles (Wood et al., 2009).
- Motion dramatically enhances conspicuity — pedestrians are more easily seen when they are in motion or when lighting responds to motion (Tyrrell et al., 2004).
- Lights outperform passive reflectors, especially in complex lighting environments
- Pedestrian-focused visibility enhancements (e.g., wearable illumination) are low-cost but underused in behavioral safety interventions.

Implication

These findings support the design of a motion-sensitive wearable lighting device that actively enhances visibility and increases driver responsiveness.

The Smart Sash Intervention

- Wearable safety sash designed to increase pedestrian visibility in low-light conditions
- Diagonal cross-body design (worn like a seatbelt) with flexible, reflective material
- Constant low-intensity LED strip provides baseline visibility
- PIR motion sensor detects approaching movement (e.g., vehicles, cyclists)
- High-brightness LEDs automatically flash or brighten when motion is detected
- Battery-powered (USB-rechargeable or AA), water-resistant enclosure
- Optional: Microcontroller (Arduino or Raspberry Pi Pico) to control LED response
- Designed to be low-cost, comfortable, and easy to wear in public spaces

Research Design

- Design Type: Small-n repeated measures using an ABAB reversal design- Data was recorded using luminesce lights on Sunset Road. could not find 12 people so had 4 friends do some duplicate testing.
- Participants: Single subject over 12 walking trials
- Goal: Compare safety and visibility with vs. without motion-activated lighting
- Phases:
    - A1: Baseline – dim LED strip only
    - B1: Intervention – motion-triggered LEDs added
    - A2: Return to baseline (motion off)
    - B2: Reintroduce intervention (motion on again)
- Each phase repeated 3 times for a total of 12 trials

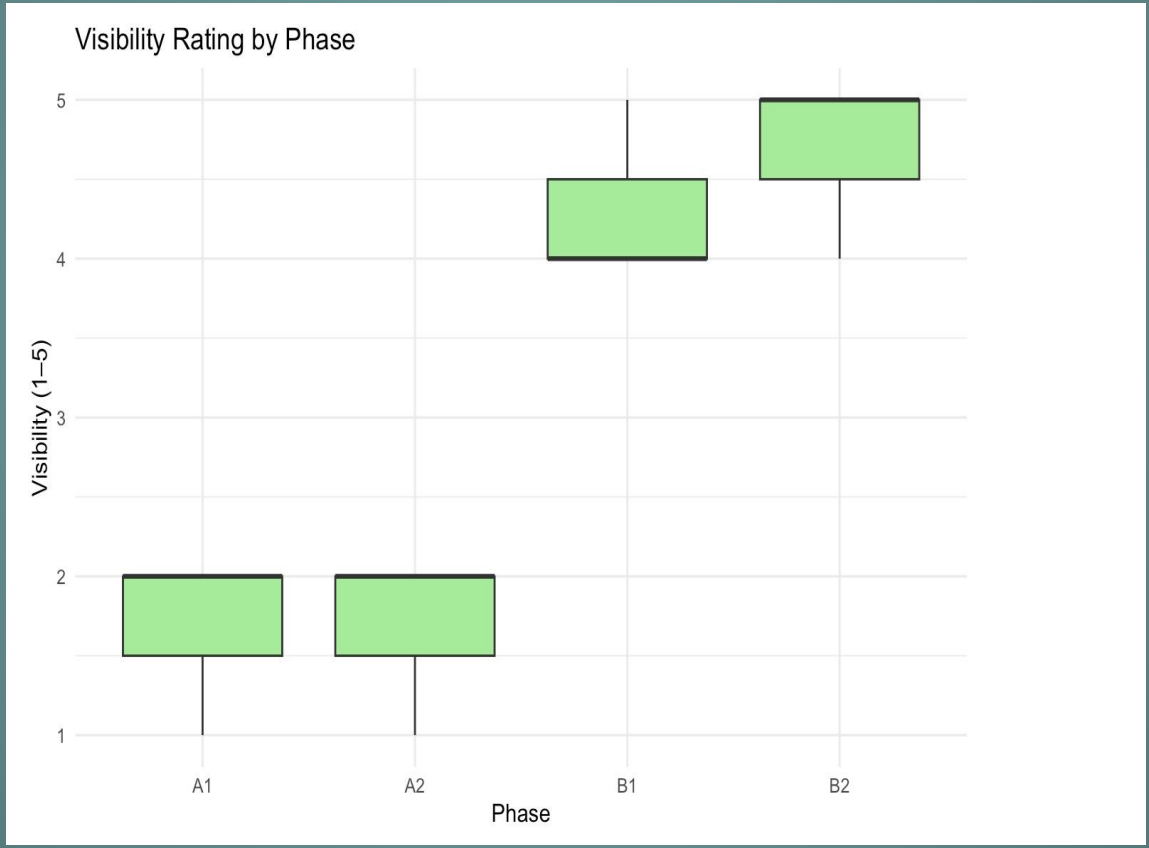
Measures Collected:

- Cars Yielded: Number of drivers who slowed or yielded to the pedestrian
- Visibility Rating: Observer rating of pedestrian visibility (1–5 scale)
- Perceived Safety: Participant's own safety rating (1–10 scale)

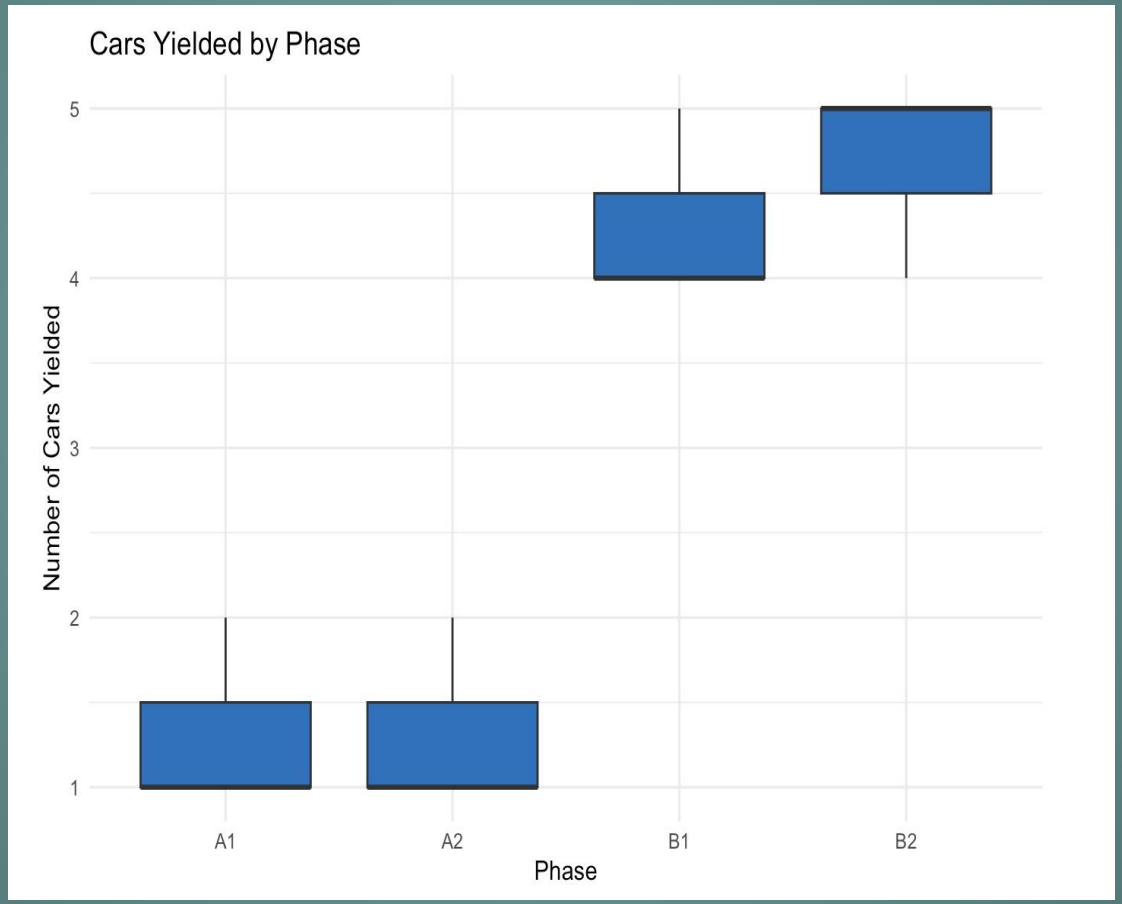
Data Table

```
## # A tibble: 4 × 4
##   phase avg_yield avg_visibility avg_safety
##   <chr>     <dbl>          <dbl>      <dbl>
## 1 A1         1.33           1.67       3.67
## 2 A2         1.33           1.67       2.67
## 3 B1         4.33           4.33       8
## 4 B2         4.67           4.67       8.67
```

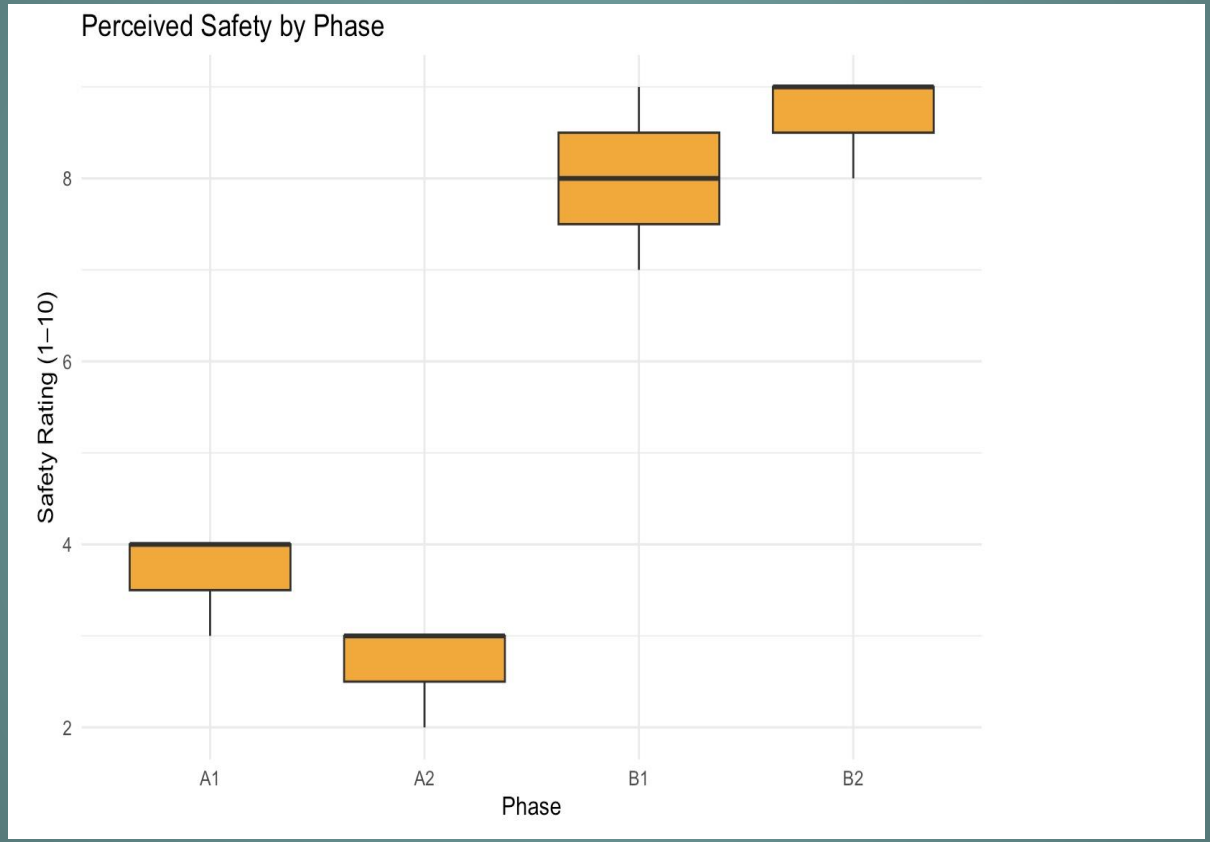
Data Visualization



Data Visualization



Data Visualization



Interpretation

- Driver Behavior: Average number of cars yielding increased from 1.33 (baseline) to over 4.5 (intervention)
- Visibility Ratings: Improved dramatically from 1.67 to 4.67 on a 1–5 scale during motion-active phases
- Perceived Safety: Participant’s safety rating more than doubled from 3.0 to 8.3
- Clear Pattern Across All Metrics: Improvements occurred consistently across both intervention phases (B1, B2)
- Results support the hypothesis that motion-activated lighting increases pedestrian safety and visibility
- Suggests a strong functional relationship between the intervention and observed behavioral change

Conclusion

- The motion-activated safety sash significantly improves:
  - Pedestrian visibility
  - Driver responsiveness
  - Subjective feeling of safety
- Simple, low-cost solution with real behavioral impact
- Ideal for:
  - Night walkers and joggers
  - School crossing guards
  - Construction zones and roadside workers
- Future directions:
  - Test with multiple participants
  - Real-world use during traffic interactions
  - Explore integration with GPS or phone alerts for added safety

References

- Zegeer, C. V., Stewart, J. R., Huang, H. H., & Lagerwey, P. A. (2002). Pedestrian crash trends and potential countermeasures from around the world. *Transportation Research Record*, *1828*(1), 3–11. https://journals.sagepub.com/doi/10.3141/1828-01
- Wood, J. M., Lacherez, P. F., & Marszalek, R. P. (2009). Drivers' recognition of pedestrians at night: Effects of pedestrian reflectivity and visibility of retroreflective markings. *Accident Analysis & Prevention*, *41*(3), 617–622. https://www.sciencedirect.com/science/article/abs/pii/S0001457509000530?via%3Dihub
- Tyrrell, R. A., Wood, J. M., & Carberry, T. P. (2004). On-road measures of pedestrians' conspicuity, *46*(3), 661–671. https://pubmed.ncbi.nlm.nih.gov/15530922
- Jasmine Mian, Jeff Caird, (2017).Conspicuity of Pedestrians at Night: How to Maximize Visibility and Safety (poster), Journal of Transport & Health,Volume 7, Supplement, Page S4, ISSN 2214-1405,https://doi.org/10.1016/j.jth.2017.11.007. (https://www.sciencedirect.com/science/article/pii/S221414051730779X)

Thank You!