Challenges for Data Collection in the Outdoor Environment

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Outdoor Environment Experiments

- The prime question is how do you make data meaningful?
  - No standard laboratory controls
  - No fixed observation point
  - Naturally variable lighting levels
  - Participant variability

Experimental Approach

- As in any experiment you need to be very careful about controlling variation
  - Select Materials in such a way to control variation
    - Eg. Luminaire choice
  - Be careful of defining variables and how they are changed
    - Eg. Spacing versus Uniformity
- Any variables you cannot control, you must measure a correlation variable
  - Speed Variation
  - Eye Glance Variation
  - Sleep Patterns
  - Participant Variability
- Use the “Investigating the Health Impacts of Outdoor Lighting” Project as an example

The Question

- What is the impact of Roadway Lighting on Melatonin Levels?
  - There is a threshold where Melatonin (DLMO) is no longer impacted
    - Laboratory based measurements (Full Field View)
    - This has never been measured in a Naturalistic Lighting Environment
- Consider impact on all roadway Users:
  - Drivers on a roadway
  - Pedestrians
  - those living close to the lighted area (Sleepers)

Experimental Design

Independent Variable	Luminaires to be tested
Lighting Type	
Exposure Time	

Dependent Variables

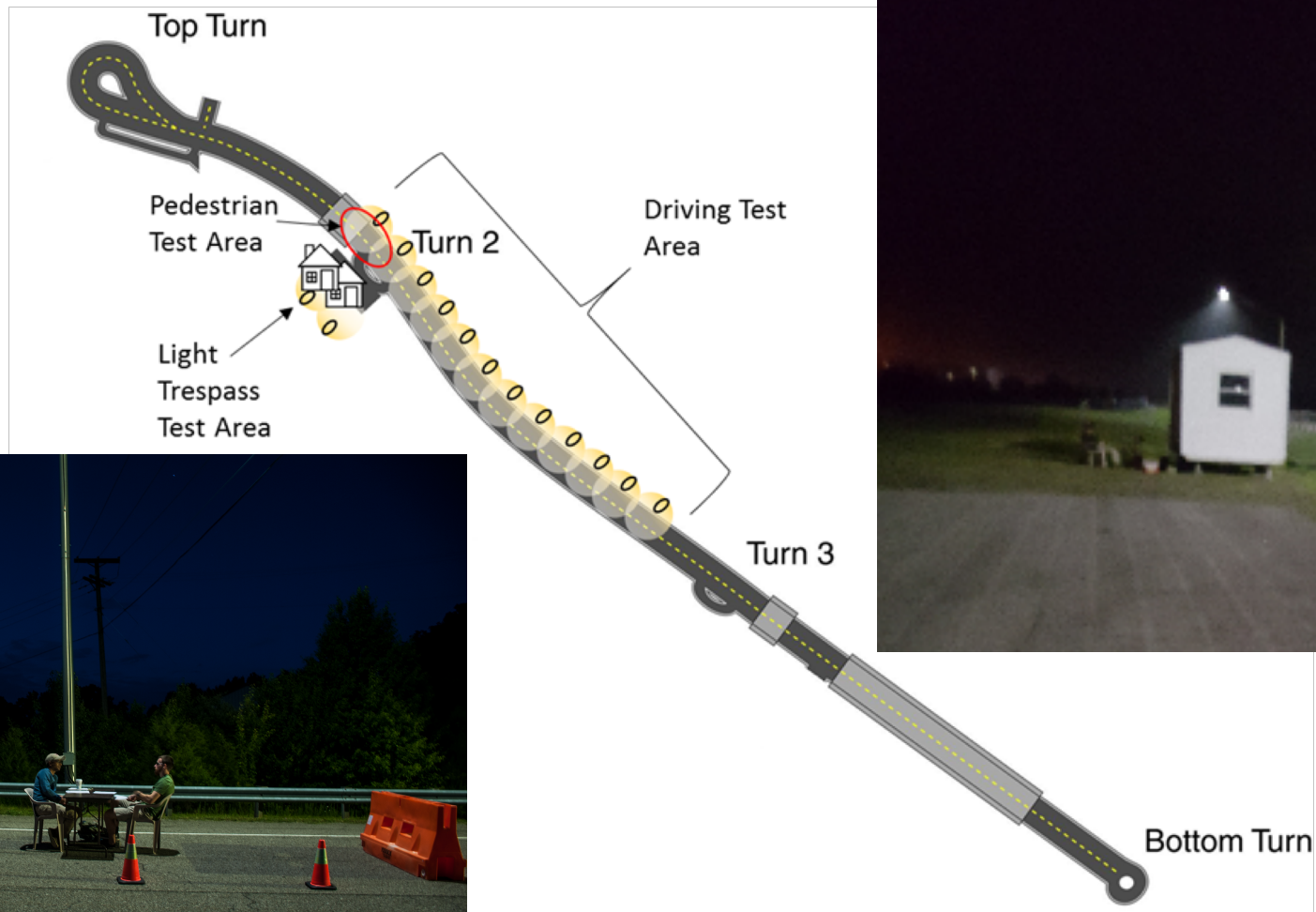
- Primary Data set:
  - Concentration of melatonin for the participant in each of the lighting conditions.
  - measured over an exposure time based on the participant type.

- Secondary Data sets :
  - For drivers, the detection distances of a series of visibility objects will be recorded as part of a visibility experiment.
  - For pedestrians, the perception of how safe it is for a person to cross the road in front of an opposing vehicle will be measured.

Controlled Variables

- Roadway Luminance were maintained at (1.0 cd/m^2)
- The experimental time, start time, duration and light exposure times were controlled
- The participant age, sleep cycle, and daily activity were monitored and controlled.
- The on-road and in experiment activities were controlled while the participants are in the experiment area.
- Light exposure from the beginning to the end of the experimental period were measured and controlled.

Smart Road Test Areas



Equipment – What to Control

- Lighted Environment
  - Lighting Level
    - Dimming control system to maintain lighting level between light source type (Even HPS within the range)
    - Vehicle Headlamps always on
  - Uniformity and Surround ratio
    - For 3 of the light sources (3000, 4000 and 5000K) were all donated by a single manufacturer
    - Same Distribution with varying spectral output
  - Exposure
    - Locations for objects and pedestrians adjusted to vertical illuminance levels
    - Light Fixtures for trespass changed

Correlation Variables

- Drivers performing a detection task
  - Although a driver is to control their speed, speed variations can occur
    - We measure it
- Eye glances
  - Although people are performing a task, eye glance variation is evident
    - We measure dose over the night
- Atmospheric Conditions
  - Moon Phase
  - Clouds / Sky glow
  - Background Luminance
  - All measured and monitored

Equipment – 2 Participants

Turner

Hooch

Vehicle Instrumentation

- Highly instrumented vehicles
  - Differential GPS
  - Headrest and Windshield mounted Illuminance Meter
  - Roof mounted Transmissometers
  - Vehicle Conditions
    - Brakes
    - Steering position
    - Signals
    - Wipers etc.
  - Headlamp voltage control for constant output

Other Equipment Needs

Papa Smurf

- Be prepared to have equipment available
  - Luminaire changes
    - Precise Measurement of Tilt and Roll (Match to road surface)
  - Controller adjustments
  - Etc.

Participants

- Our Goal was 10 participants recruited to participate in each of the study's three exposure experiments (a total of 30 participants).

- Lifestyle Control
  - Between the ages of 18 and 30 years, gender balanced, non-smokers
  - Maintain a normal sleeping schedule monitored using logs and actigraphy
  - Avoid substances containing alcohol (24 hours) and caffeine (after midday)
  - No napping after 6:00 p.m.
- Exposure Control
  - Roadway Luminance will be maintained at (1.0 cd/m^2)
  - The experimental time, start time, duration and light exposure times will be controlled
  - Use an eyeglass frame mounted light measurement system to record exposure

Participant Attrition

- Participants were with our experiment for at least 10 weeks
  - 2 weeks for orientation
  - 2 weeks for control experiments
  - 6 weeks on-road conditions
- They wore actigraphs and needed to maintain their schedule
- Out of the 30 required for the experiment, we recruited 37 with 8 leaving the experiment, 1 could not be replaced
- We screened over 300 people to find the participants

Methods to Retain Participants

- Payment
  - Participants were paid up to $1500 for their participation
- Incentive payments
  - $25 per hour with a bonus of $5 per hour if they finished the study
- Food, games, driving them to and from home

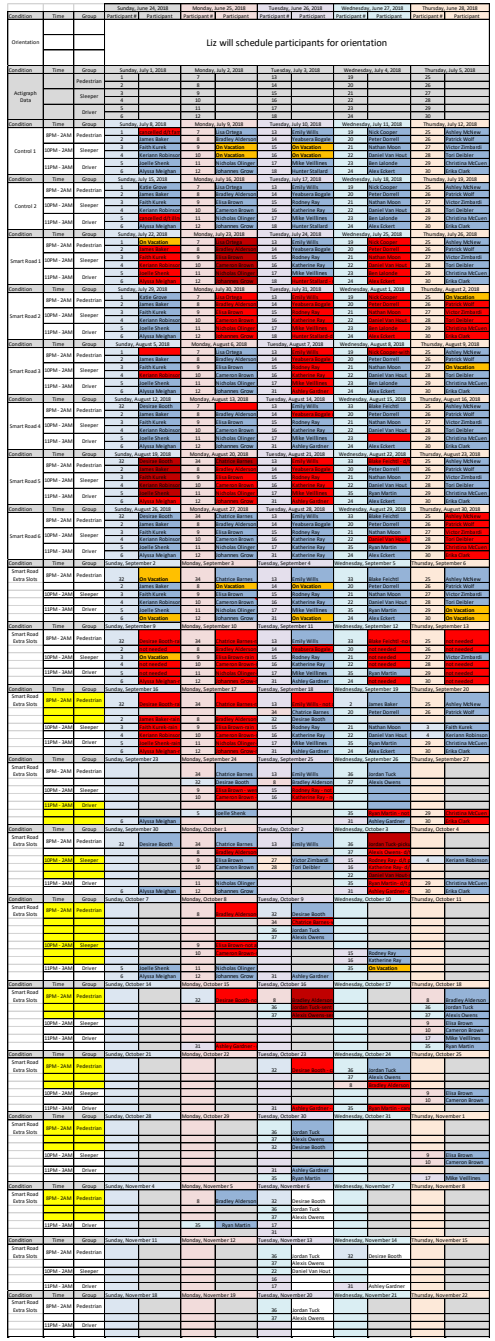
Institutional Review Board

- You will need to allow time for the IRB process
  - An experienced IRB will be more open to this type of study
  - The concept of cars driving, pedestrians and blood/saliva sampling may be difficult for an IRB to understand

Logistics

- Participants came in once per week for the exposure
  - Cancel and reschedule for rain
  - Cancel and reschedule for Temps below 40F
  - Cancel and reschedule for sleep schedule deviations

  - 2018 was the rainiest in history in southwest virginia



Scheduling

- 10 Weeks turned into 20 Weeks
  - Weather
  - Vacations
  - Participant drop outs
  - Participants Misbehavior
- All Saliva, Plasma and Secondary Data have been collected for this study

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Plan to Fail

- A complete analysis of safety issues and solutions must be analyzed by your team
  - Like NASA you must plan to fail
  - Note: IRB only protects participants it is your responsibility to protect experimenters

Risks and Mitigation Strategy

Potential Issue	Mitigation	Probability	Severity	Severity
Mechanical				
Vehicle Failure	In-Vehicle experimenters will stop the experimental session and participants will be removed from the roadway	1	1	2
Light Trespass Booth Failure \ Leaking	The building will be inspected before the experimental sessions. On-site Experimenters will remove participants from the scene in case of failure.	1	1	2
Exposure Booth Failure	The building will be inspected before the experimental sessions. In Building Experimenters will remove participants from the scene in case of failure.	1	1	2
Human Issues				
Participants				
Blood Draw Issues: Fainting, Bleeding, difficulty with finding a vein	We have hired an EMT who is experienced with fitting an IV and performing blood draws. They can also deal with unexpected health events. We are purchasing blood draw materials that the phlebotomist is most comfortable with to ease access	2	3	5
Participant Trip and Fall in the Dark	Participants will be escorted by an experimenter when they are in the dark areas.	3	3	6
Pedestrian Trip and Fall	The pedestrians area will be cleaned and inspected before the experimental session. Trip and Fall hazards will be moved	3	3	6
Vehicle Crashes	The vehicles will always have an in-vehicle experimenter to provide guidance. The driving task is relatively simple.	1	3	4
Vehicle Pedestrian Collision	The pedestrian and vehicle areas will be separated by barrels.	2	3	5
Infection Potential for Participants	Proper laboratory practices will be used for the blood draws	1	3	4
Accidental Catheter removal	The Phlebotomist will be available in the test area to deal with any issues with the catheter	2	3	5
Choking hazard on the Salivettes	Participants will be warned of the possibility that the salivette and that they must be careful. Staff will be present whenever the Salivettes will be used and prepared for any issues	2	2	4
Allergic Reaction to Medical supplies	Participants will have the option to leave the study	2	2	4
Claustrophobic	Participants will have the option to leave the study	2	2	4
Fear of Darkness	Participants will have the option to leave the study	2	2	4
Comfort with light exposure	Participants will have the option to leave the study	2	2	4
Migraines	Participants will have the option to leave the study	2	2	4
Potential discomfort with dosimeter	Participants will have the option to leave the study	2	2	4
Potential discomfort with actigraph	Participants will have the option to leave the study	2	2	4

Staff				
Blood Management issues - Splashing, spilling	Have taken training on blood borne pathogens, hazardous materials and lab procedures. Have set up the blood space in cleanable floors, and appropriate disposal and management supplies according the EHS requirements	3	2	5
Infection - Touching blood and Saliva	The staff have been trained on Blood Borne Pathogens and Dealing with Hazardous waste. Safe Laboratory procedures and PPE will be used	1	3	4
Trip and fall for target and pedestrian staff	Staff will be trained and oriented to the test location in Daylight as well as trained in the nighttime. Experience	3	2	5
collision with participant vehicle	Staff have been trained that their own safety is paramount and are free to move to ensure their safety	1	3	4
Frostbite issues with frozen samples	Staff will be provided with PPE if they need to handle frozen samples	1	1	2
Centrifuge Failure - Blood and Capsule Breakage	Safe Laboratory Practices will be adhered to. All staff have been trained in the hazardous material handling and labor oratory processes.	1	1	2
Weather				
Adverse Weather	We will not run in the rain for the adverse. The session will be rescheduled	1	1	2
Cold Exposure	Will cancel when the temperature less than 40 degrees	1	1	2
Infrastructure				
Potholes / Ditches	Participant will not be alone on the road. Staff will be trained of which areas to avoid and will areas are free for walking. Site inspections will be made before the experimental session to ensure no changes or obstacles have been made	1	1	2
Installation of Luminaires - Dropping, bucket truck issues	Staff will be trained and will use the appropriate PPE	3	3	6
Electrical Issues	Staff will be trained and will use the appropriate PPE	2	2	4
Procedural				
Pedestrians and Driver Collisions	The areas for the drivers and pedestrians will be separated by cones and barriers	2	3	5

Unexpected Events				
Deer Strikes	The roadway area will be monitored for potential animal hazards	1	2	3
Wildlife Interactions	The roadway area will be monitored for potential animal hazards	1	2	3
Trespasser interactions	The roadway area will be monitored for potential unexpected human interaction	1	2	3
Experimental Equipment				
Exposure Booths Collapse	The booths will be inspected before the experimental sessions. In Building Experimenters will be removed from the scene in case of failure.	1	3	4
Lights contact participants	Stands will be used to ensure this has a limited possibility. The luminaire are light and will be able to be moved	3	1	4
Light Overheat	The luminaires will be monitored and the exposure booths will be vented as required	2	1	3
In Vehicle Equipment becomes loose	Vehicles will be inspected before the experimental sessions. In-vehicle Experimenters will ensure fix points and repair in case of failure.	3	1	4
Lighting System Failure	The building will be inspected before the experimental sessions. On-site Experimenters will be removed from the scene in case of failure.	1	1	2
Potential collision with in Vehicle Head illuminance Meter	Illuminance Meter mount will be padded and inspected	3	2	5

It takes a village

- Up to 12 staff per night
  - 3 with participants
  - 2 in the lab dealing with the blood
  - 1 shuttle driver
  - 2 in-vehicle Experimenters
  - 2 on-road Experimenters
  - 1 Phlebotomist (must be an EMT)
  - 1 On-Call (Lead Experimenter or Center Director)

Staff Training

- All Experimenters
  - Safety
    - On-Road
    - CPR
    - First Aid
    - Blood Bourne Pathogens
  - Fire Extinguisher
  - Vehicle Operation
- Technical Support Staff
  - Electrical Awareness
  - Aerial Lift Safety
  - Bucket Truck Operation
  - Fall Arrest
  - Commercial Drivers License (Only Bucket Operators)

Project Status

- All samples have been collected
  - Waiting for melatonin analysis
- Analysis is ongoing
  - Visual performance
  - Melatonin will start when data is available
- Write up and completion in August/September

Questions

- Nighttime researchers during the day…..