



Sandia
National
Laboratories

A Method of Developing Video Stimuli that are Amenable to Neuroimaging Analysis: An EEG Pilot Study

Dr. Michael C.S. Trumbo, Dr. Aaron P. Jones,
Bradley M. Robert, Dr. Derek Trumbo, Dr. Laura E.
Matzen



HCI International 2022

26 June-1 July • Virtual

Presented June 27, 2022

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.



Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

SAND#

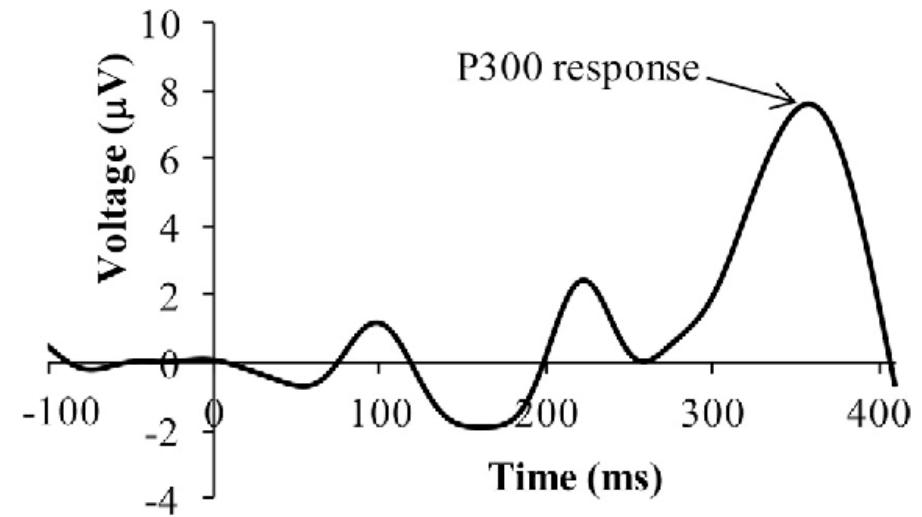
Introduction



- Creation of streaming video stimuli that allow for strict experimental control while providing ease of scene manipulation is desirable but difficult to achieve
- Video game modding tools are proposed as a method of creating research quality video stimuli
- 3 streaming video scenarios were created for a pilot study to test this methodology
- EEG data were analyzed for evidence of P300 ERPs

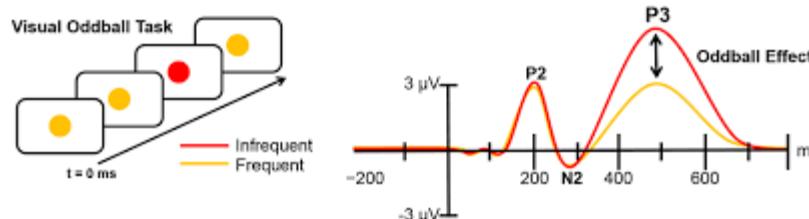
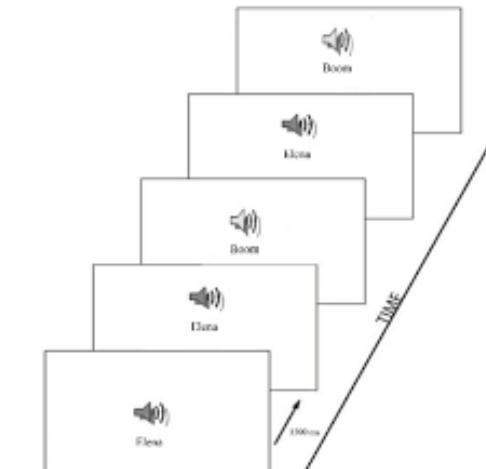
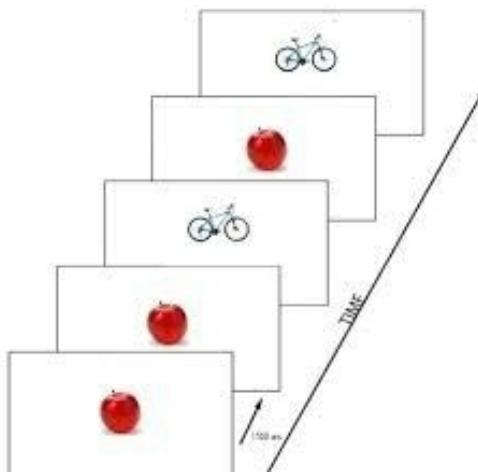
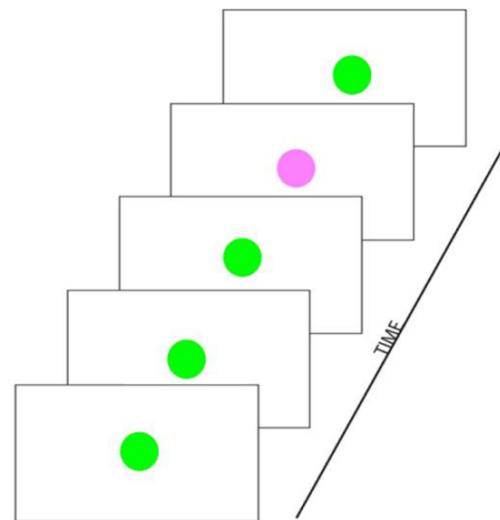


EEG & the P300



- Records millisecond-level electrical activity of the brain
- Analyze relationships between specific patterns in EEG data and cognitive processes
 - Depth of encoding
 - Level of processing
 - Leading indicators of decisions
- ERP component elicited in process of decision making
- Attention dependent cognitive component
- Reproduceable and ubiquitous
- Positive going amplitude peaks ~300 ms
 - Varies in latency from 250 – 500 ms

Oddball Paradigm



- Sequences of repeated stimuli (non-targets) are infrequently interrupted by rare stimuli (target)
- P300 is larger after rare stimuli
 - Amplitude varies by rarity of target stimuli
 - Latency varies with difficulty of discriminating target from standard stimuli
- How can we make this paradigm more ecologically valid?

Modding



Popularized as an artful method of modifying an existing game to create new content within that gaming environment

- Increasingly contributes to commercial success of games, adding value to titles by adding depth to the original work
- Mutual interest between gamers and developers results in tools for accessible modding



Garry's Mod is a physics-based sandbox game with no set objectives that allows creation of simulated environments containing both static and dynamic elements within defined physical spaces

Goal: Leverage readily available tools to adapt game scenarios to create ecologically valid streaming stimuli amenable to neuroimaging analysis

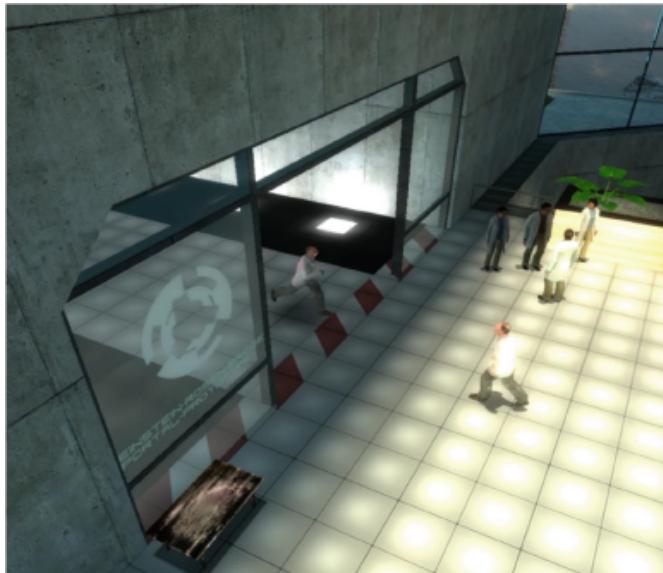
- Script events (i.e. frequent non-target and infrequent target events)
- Implement strict control of timing and duration of stimuli

Scenario Development



Three video scenarios were created to reflect monitoring tasks common in the physical security domain:

Scenario 1: Hallway
Hazardous situation



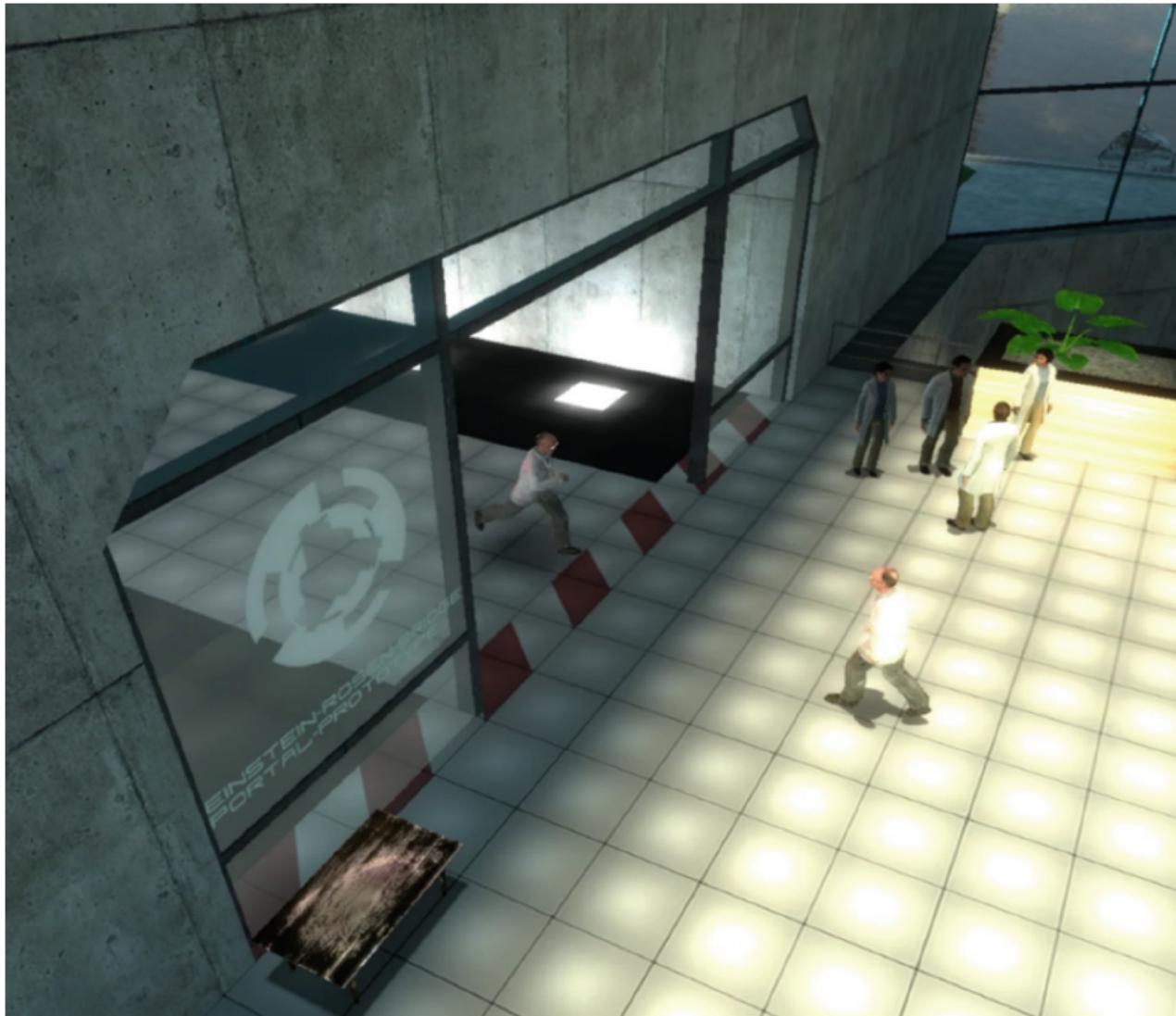
Scenario 2: Parking Lot
Potential theft



Scenario 3: Fence
Suspicious behavior



Scenario Development



Scenario 1: Hallway

Scientists entering a fictional research facility

- **Non-Target:** walking models
- **Target - No Threat:** running into building
- **Target - Threat:** running out of building

Scenario Development



Scenario 2: Parking Lot

Civilians entering and exiting a convenience store

- **Non-Target:** entering store
- **Target - No Threat:** exiting store
- **Target - Threat:** pause to peer in car window

Scenario Development



Scenario 3: Fence

Military installation with a fence separating the installation from public space

- **Non-Target:** soldiers running inside fence
- **Target - No Threat:** civilian walking by the fence without pausing **or** security guards stopping to check fence*
- **Target - Threat:** civilian stopping at fence **or** security guard failing to stop at fence*

* Conjunction consideration required (character model + action)

Participants:

8 SNL employees (5 female; age 24-59)

Procedure:

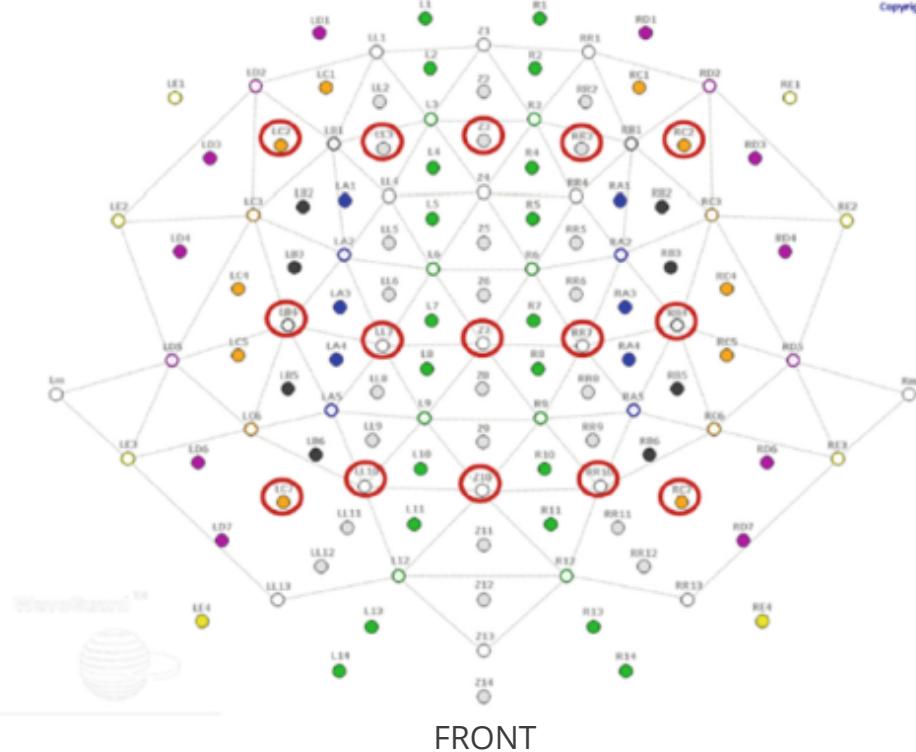
EEG: 128-channel Advanced Neuro Technologies
250 Hz

Scenarios presented in random order using E-Prime
3.0 software

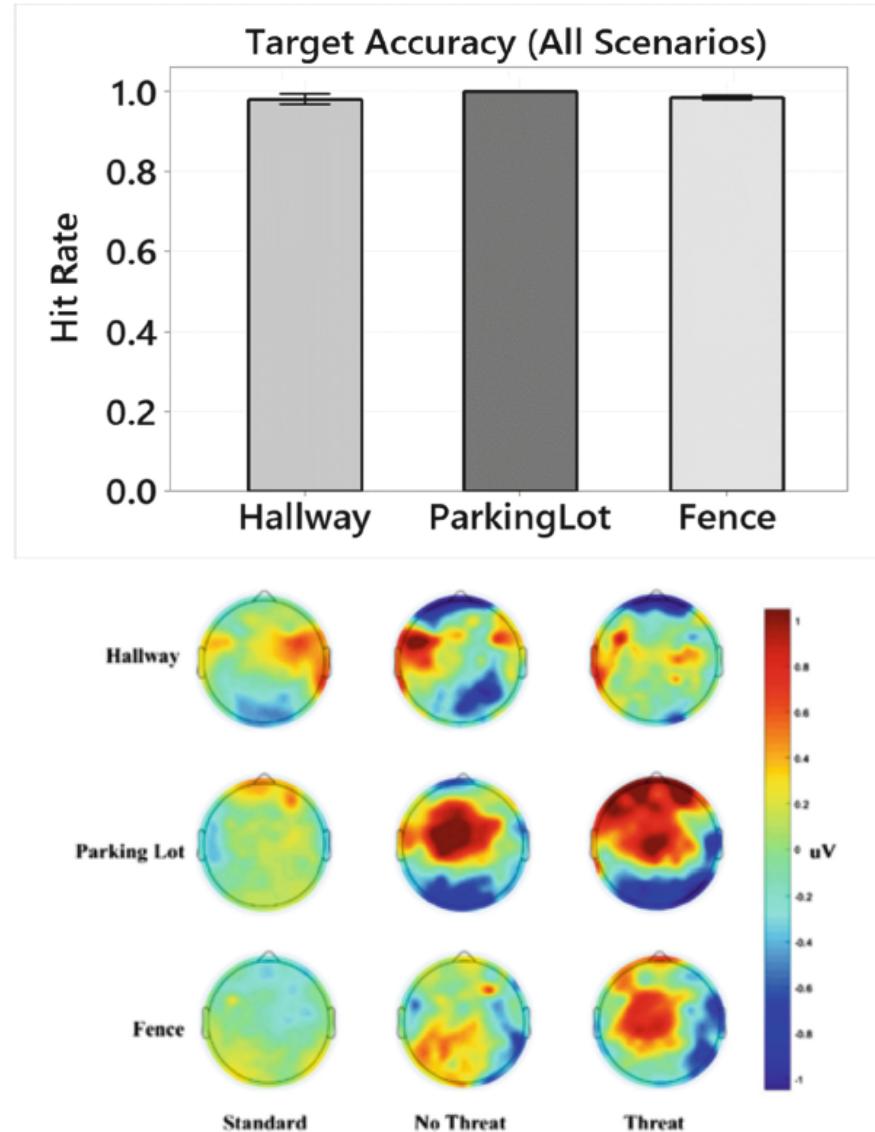
Participants responded via button press on a controller to rare types of stimuli threat or non-threat

EEG Preprocessing/P300 Measurement
EEGLAB v2019.1^[1] using FASTER toolbox^[2] in MATLAB
2017b^[3]

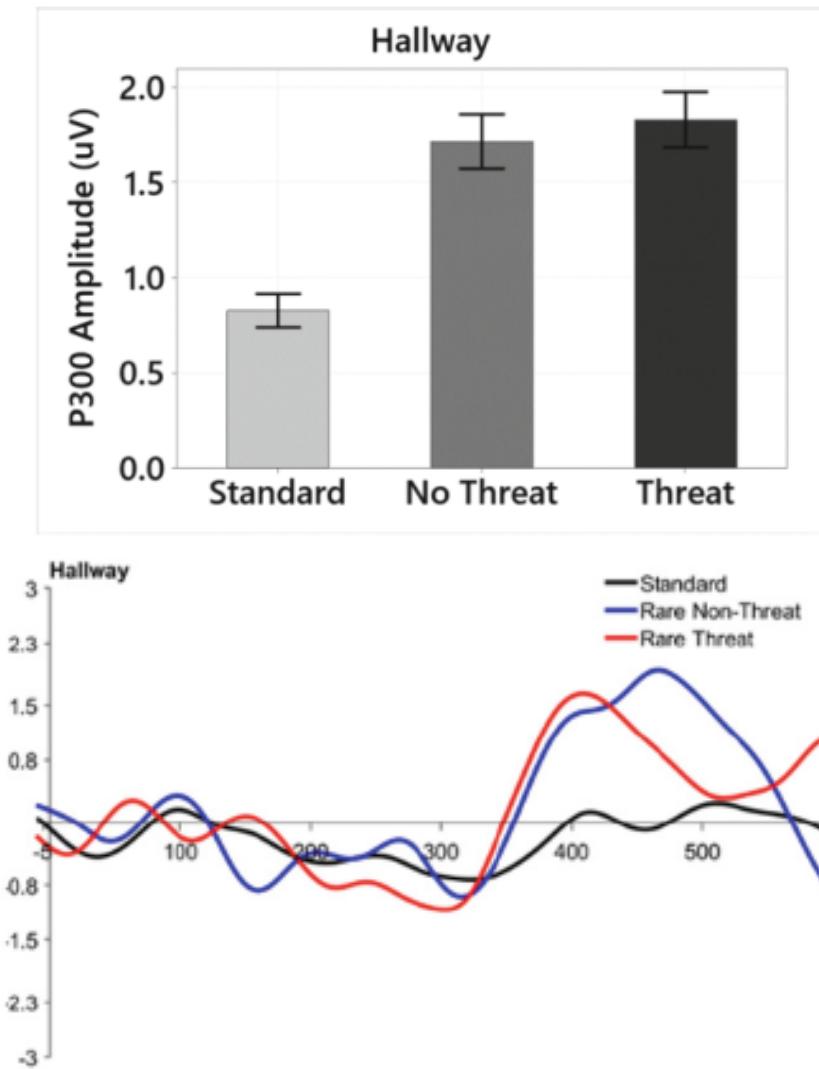
P300 amplitude = peak amplitude 250-500 ms



Results



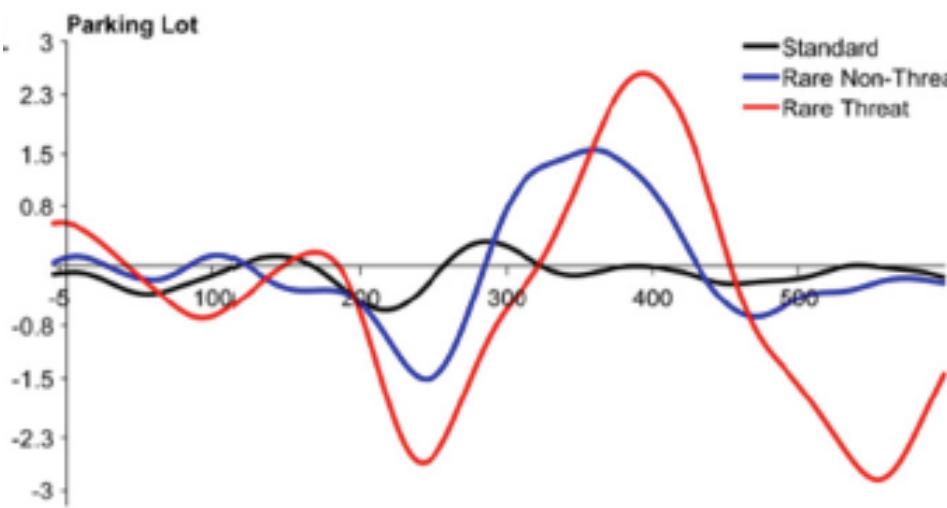
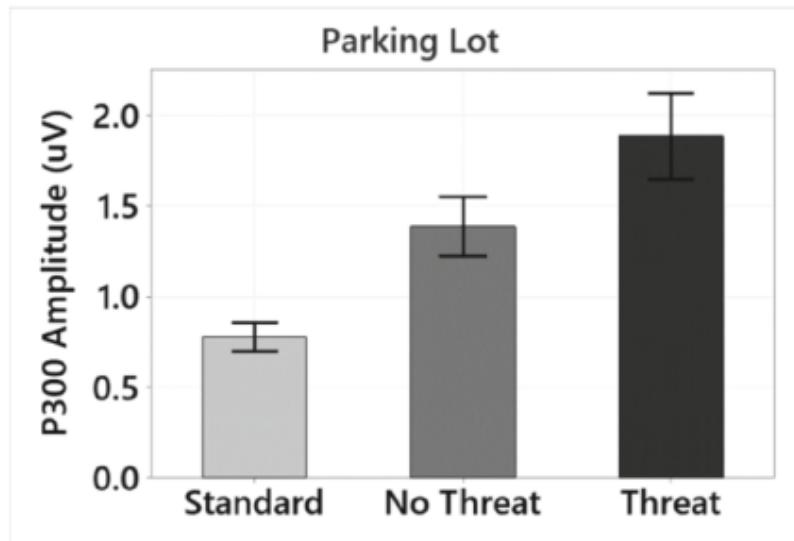
Scenario 1



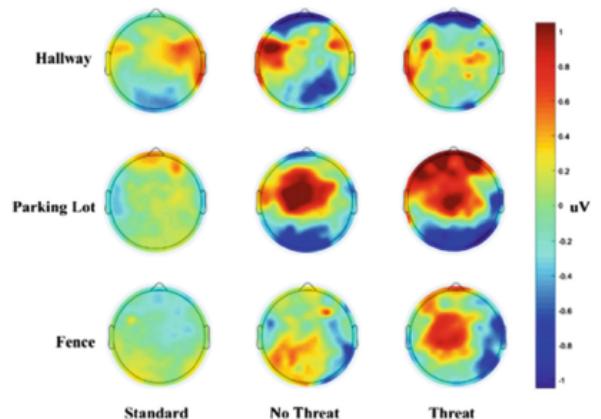
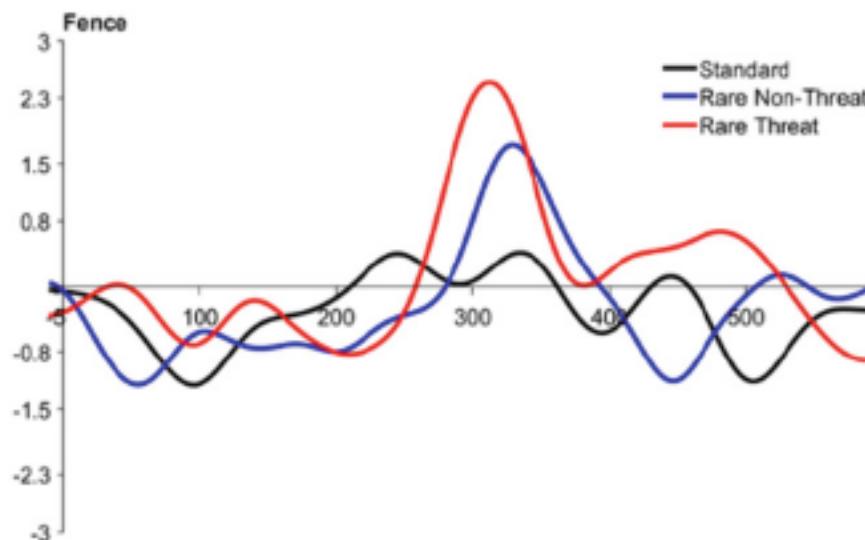
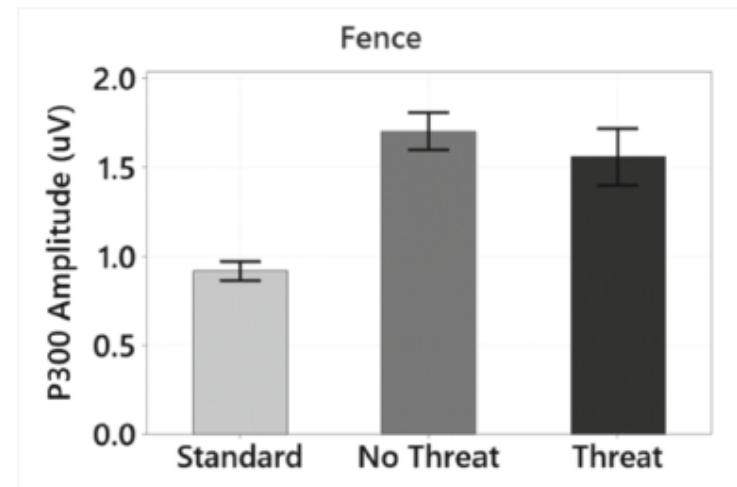
Results



Scenario 2



Scenario 3



Discussion



- Evidence of a P300 found in all scenarios between standard and both types of rare stimuli
 - Amplitudes observed were smaller on average than other studies
 - Amplitude related to stimulus probability – probability of occurrence was not manipulated here
 - Amplitude can be influenced by a range of factors: age, inter-individual variance, attentional load
- Trend effect of threat vs non-threat stimuli not consistent across scenarios
 - Ambiguity of threatening stimuli
- Proposed method of stimulus creation results in sufficient experimental control to allow for ERP analysis

Future Directions/Conclusion



- Evaluate and compare other tools to optimize methods for given needs
- Improved realism
 - Garry's Mod released in 2006
- More participants, Longer experimental sessions
- In this study, we demonstrated the feasibility of using existing modding tools to create video scenarios amenable to neuroimaging analysis
 - Emphasis here on scenarios relevant to physical security but this methodology could be expanded to a wide variety of domains