Target Effects Based Requirements Generation

The Role of the ARDEC Target Behavioral Response Laboratory

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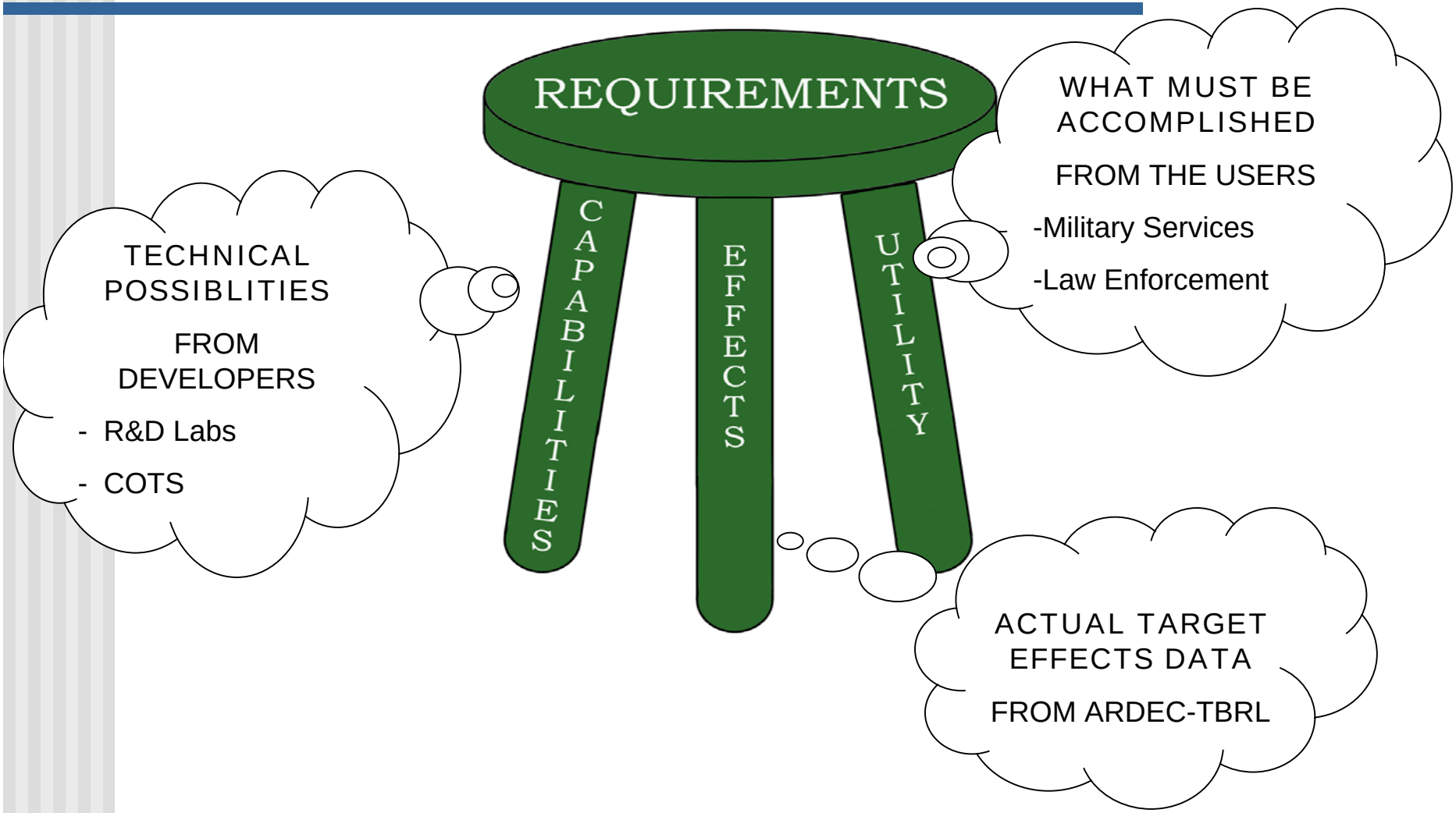
DEFINING SCALEABLE EFFECTS WEAPONS

ARDEC Target Behavioral Response Laboratory



UNDERSTANDING HOW PEOPLE RESPOND…

ARDEC TARGET BEHAVIORAL RESPONSE LABORATORY

SCIENCE

- *ARDEC PRINCIPAL INVESTIGATOR*
- *STRESS AND MOTIVATED BEHAVIORAL INSTITUTE*
- *ACADEMIC AFFILIATIONS*

TESTING

- *ARDEC BEHAVIORAL RESPONSE FACILITY*
- *NJHCS-EO (VA) MEDICAL CENTER*
- *UNIVERSITY LABS*
- *COMMERICAL FACILITIES*

APPLICATIONS

- *ADVANCED ENERGY SYSTEMS*
- *SCALEABLE EFFECTS*
  - NON-LETHAL TO NEAR LETHAL
  - LETHALITY ENABLERS
- *FULL RANGE OF SCENARIOS*
  - MILITARY TACTICAL
  - MILITARY FORCE PROTECTION
  - HOMELAND DEFENSE

CURRENT PROGRAMS

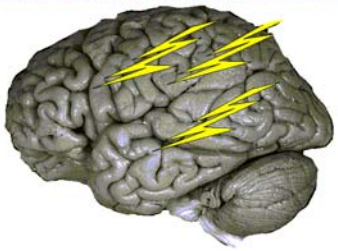
- *GRANT TO STUDY SUPPRESSION TECHNIQUES*
- *DEVELOP MATRIX OF POTENTIAL PERSONNEL EFFECTS FROM VARIOUS ENERGY SOURCE PILOT EXPERIMENTS*
  - STUN EFFECTS
  - OBSCURATION/ LIGHT SOUND
  - AVERSIVE ACOUSTIC EFFECTS
  - BLUNT IMPACT MUNITION EFFECTS

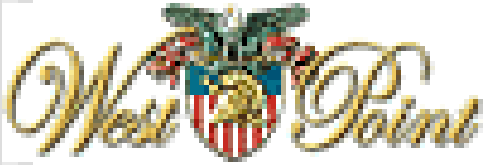
CAPABILITIES FOR FUTURE WORK

- *MULTI-LEVEL FACILITY OR AREA PROTECTION SYSTEMS*
- *TACTICAL FOG APPLICATIONS FOR MAN-PORTABLE AND NLOS DELIVERY*
- *CAPABILITY FOR STUDY OF CHRONIC STRESS, FATIGUE AND SUSTAINED PERFORMANCE*

Stress & Motivated Behavior Institute

NeuroBehavioral Research Laboratory

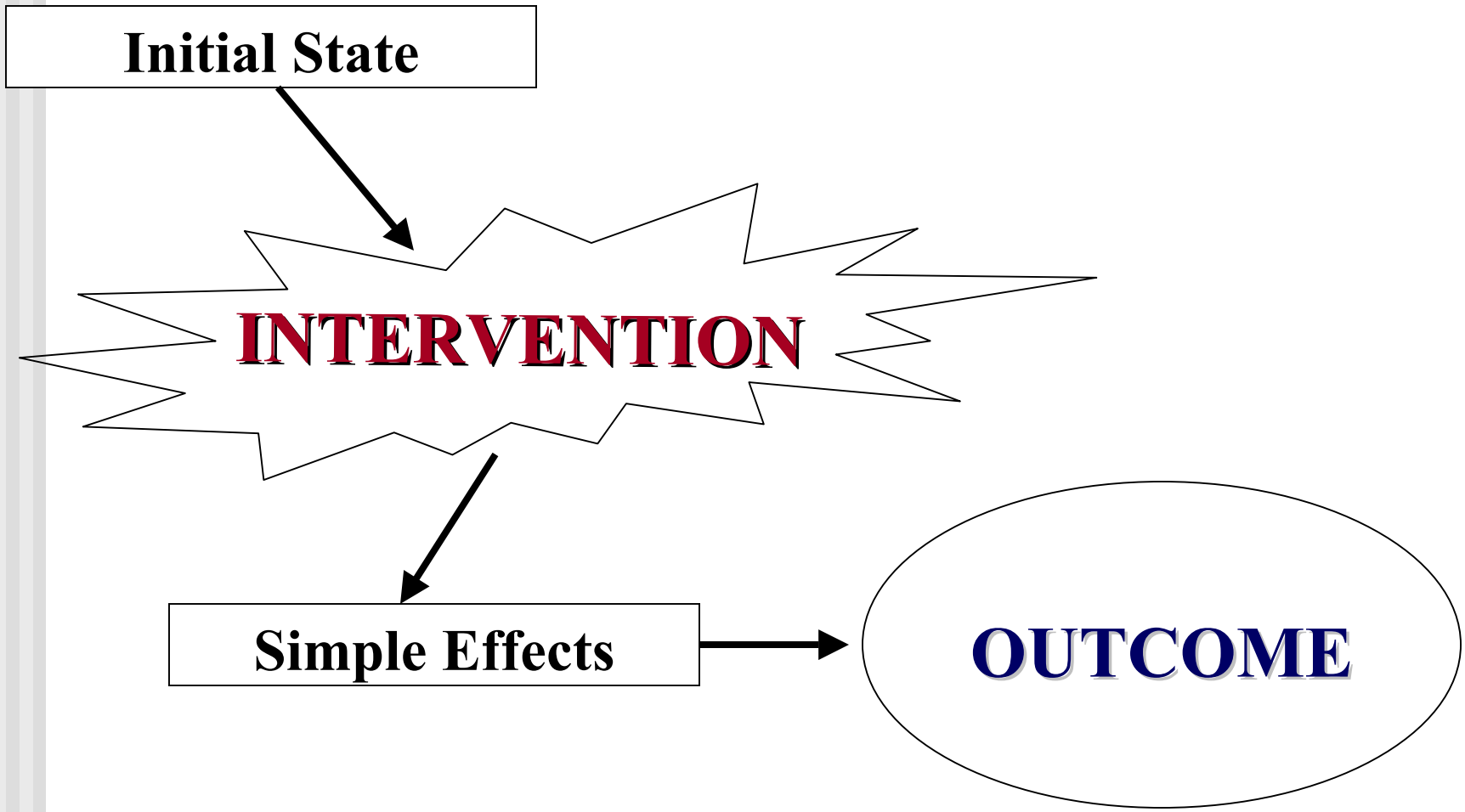




SUPPRESSION:

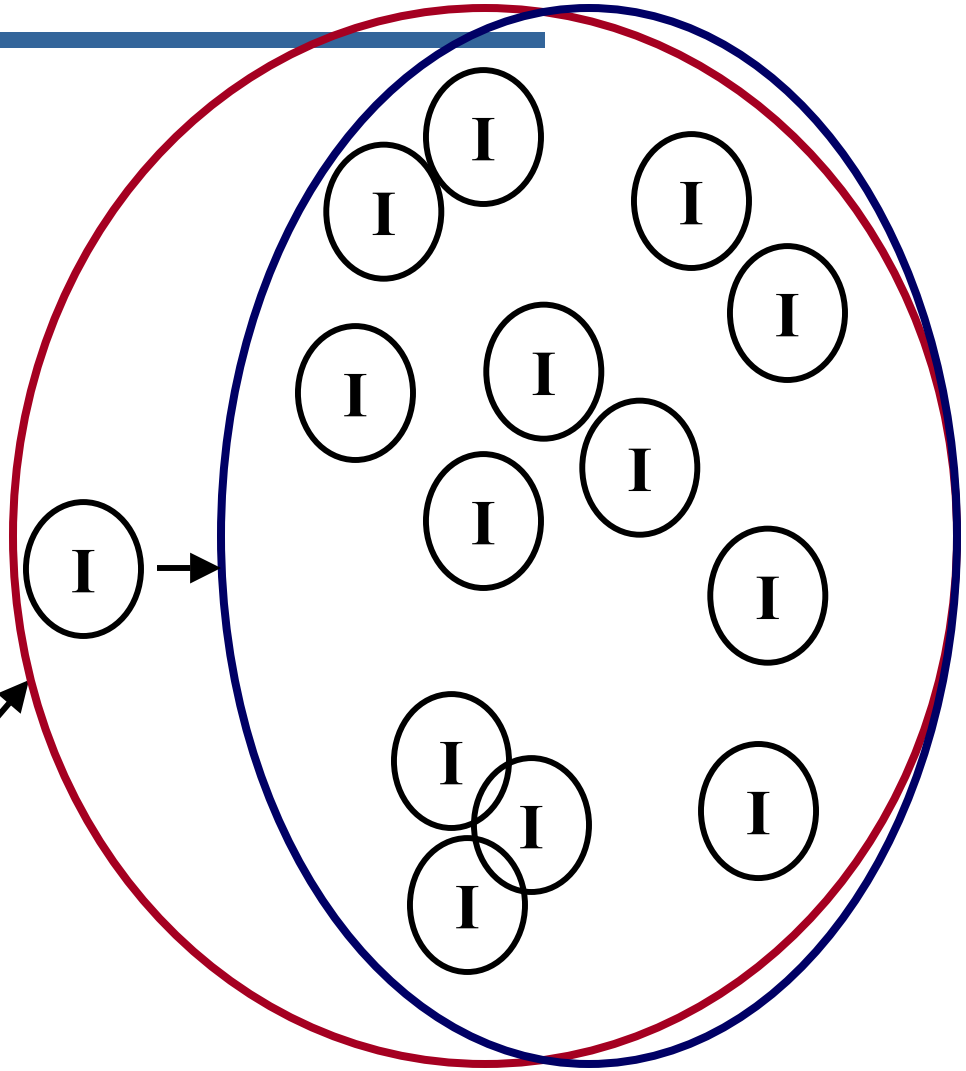
The degree of inability to carry out a task effectively because of a physical or psychological response.

Suppression: Heuristic



Effects

- Sensory
  - Primary Senses
  - Pain
  - Perception
- Cognitive
  - Concentration
  - Command
  - Communication
  - Attention
- Emotion
- Motor Activity



Outcomes

- Accumulation of Simple Effects
  - Accretive
    - Additive
    - Multiplicative
  - Negating
- Metrics
  - Proportion
  - Degree
  - Latency
- Evaluated with Respect to Task Goal
  - Drive away
  - Make remain
  - quiet

Program Directions

Technologies → Simple Effects = Outcome

Technologies → **Σ Simple Effects = Outcome**

Critical Needs:

Empirical Data

Experimental analogs

- Specific to different initial states
  - Problem without bounds?
- Individual behavior
- Crowd behavior

Ethics

- Human
- Animal

Setting

The TBRL Laboratory Team

- The Target Behavioral Response Laboratory (TBRL): ARDEC personnel collaborating with scientists and MDs
- Collaborations currently established with the VA New Jersey Health Care System-East Orange and other institutions
- The TBRL will provide effects DATA to:
  - Use in development of requirements
  - Support effectiveness, modeling, safety and training issues
  - Support weapon development, testing and fielding

Effects: Collaborating Labs

- **Scientific experiments "fill the gaps" in knowledge of basic effects**
  - **No specific relationship to "weapons"**
  - **Single individuals**
  - **Environments and manipulations limited to institutional laboratories**
    - **VA NJHCS-EO**
    - **Affiliated institutions**

Effectiveness: ARDEC Site

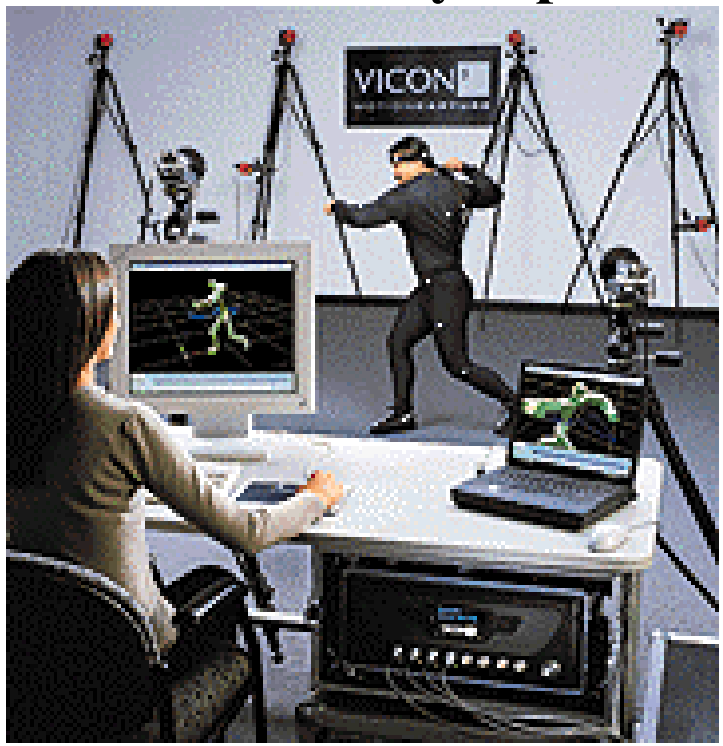
Application experiments at ARDEC

- **Addresses OUTCOME of effects through demonstrations and experiments**
- **Up to groups of 20-30 people**
- **Significant environments and manipulations possible (within limits of approved protocols)**
- **Closer to realistic situations**
- **Protocol approval through the Medical Research and Materiel Command at Ft. Detrick**

Motion Tracking System

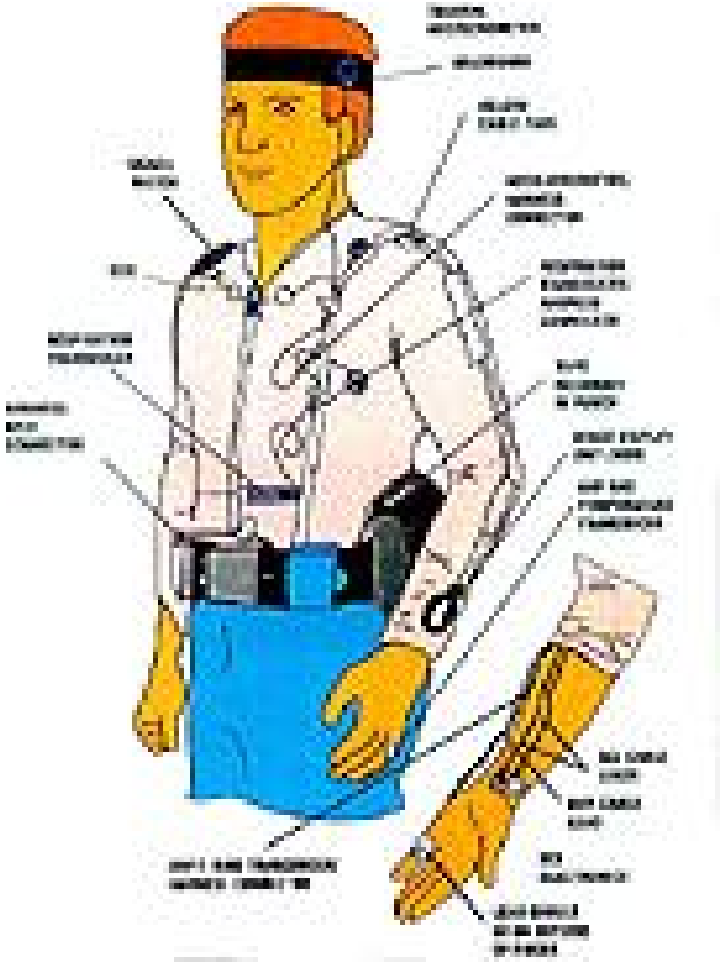
Vicon Motion Systems

- Small lightweight markers
- Tracked and recorded in 3D space
- accurate joint angles are quickly and conveniently reported.



Physiological Data Collection

- Electrophysiology
  - Electrocardiogram (ECG)
  - Electroencephelogram (EEG)
- Respiration
- Temperature
- Skin Conductance
- Blood Pulse Volume (BPV)
- Blood Pressure



Current Experiments

- **Customer Projects**
  - Stun for USMC (predates TBRL formation)
  - Blunt Impact Target Effects for PM-CCS (first TBRL effort)
- **ARDEC-funded Pilot Projects which were recommended from the initial SMBI studies**
  - Aversive Acoustic
  - Obscurants w/Light & Sound

Paintball Marker Array

An array: a horizontal linear mounting of 8 semi-automatic paintball markers, computer controlled:

- **Synchronous Fire**
- **Random Fire**
- **Cued Fire**
- **Single or Semi-automatic**

Synthetic Fog:

- Deionized water, propylene glycol, and glycerol
- Produced by an electro-mechanical unit that contains a heating exchanger
- Rate: 30,000 feet^3/min

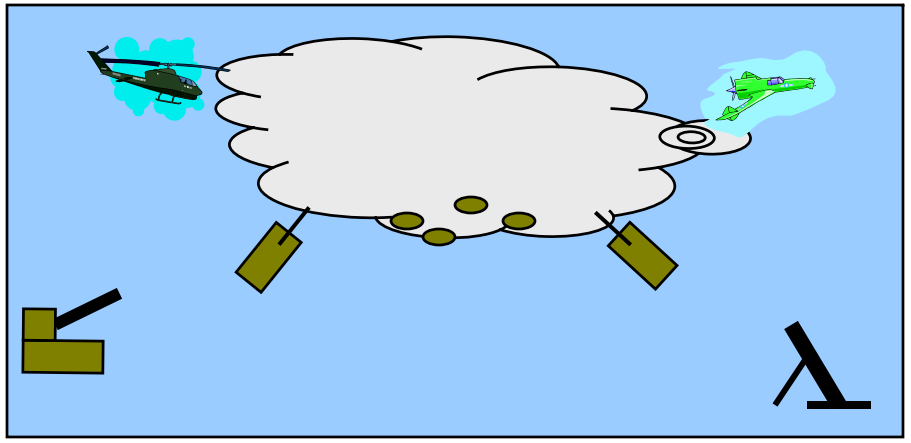
A large room fills in 30 sec

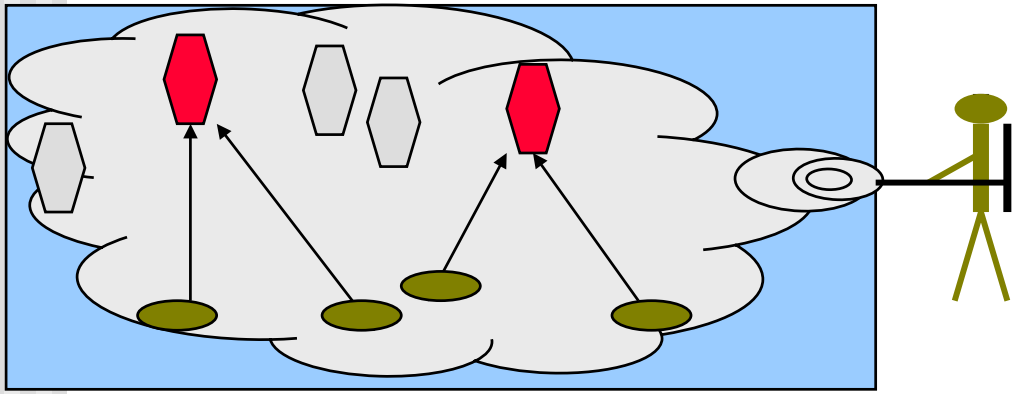
Strategy

- **Phase Ia - Determine the *safety* of synthetic fog for extended period**
- **Phase Ib – Determine changes in perception of light and sound in fog**
- **Phase Ic - Determine the physics of fog and its interaction with varying levels of light and sound**
- **Phase II - Determine *psychophysiologic* impact of synthetic fog in combination with light and sound**

TACTICAL FOG- A Non-Toxic obscurant for tactical and training use

Indirect-fire-delivered tactical fog cloud is placed immediately on a group of mixed combatants and non-combatants severely limiting their capability to maneuver and shoot





Man-portable tactical fog cloud is placed into an enclosed space on a group of mixed combatants and non-combatants severely limiting their capability to maneuver and shoot.

Individuals are easily separated and put under control.

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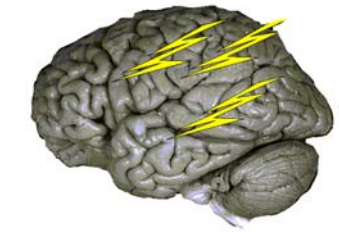

UMDNJ
University of Medicine & Dentistry of New Jersey

NJIT
New Jersey Institute of Technology

Stun Effects of Flash-Bang Munitions: After Images on Saccadic Eye Movements

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Tara Alvarez, Ph.D.
Rick Servatius, Ph.D.

Research supported by the Department of Defense

Questions

Flash-bang grenades cause momentary stun effects

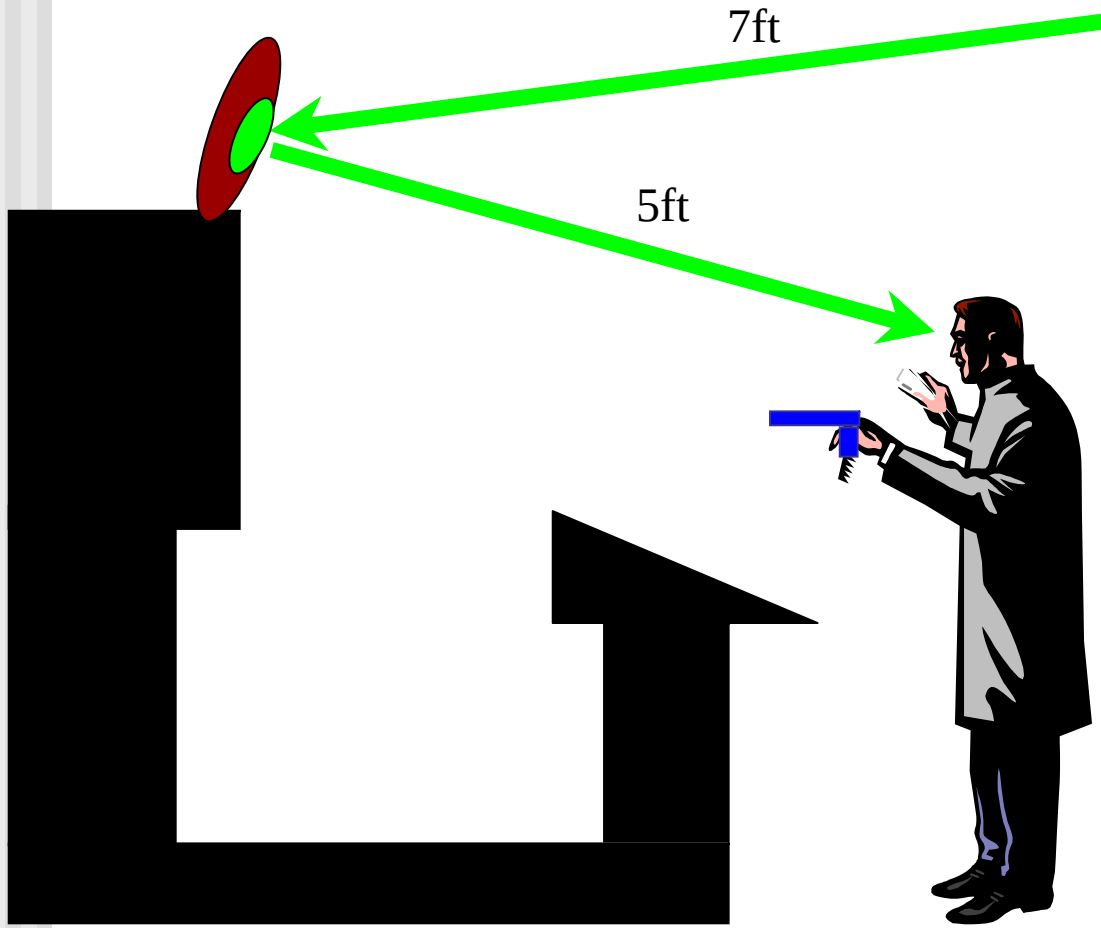
What energies produced by flash-bang grenades cause changes in behavior that could be produce a "stun-like" reaction?

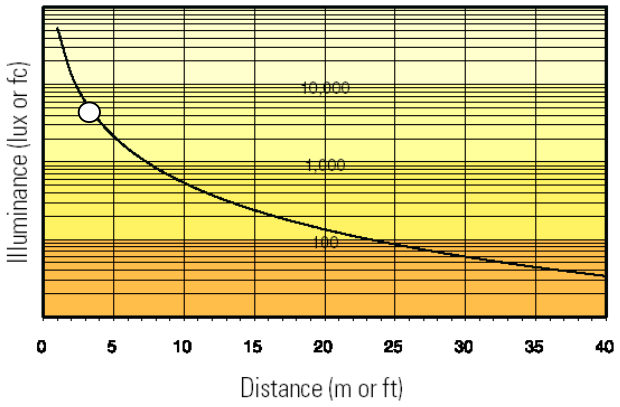
Are there other means of causing similar suppression in behavior by changing the energy characteristics of the stimuli?

How does the stun occur?

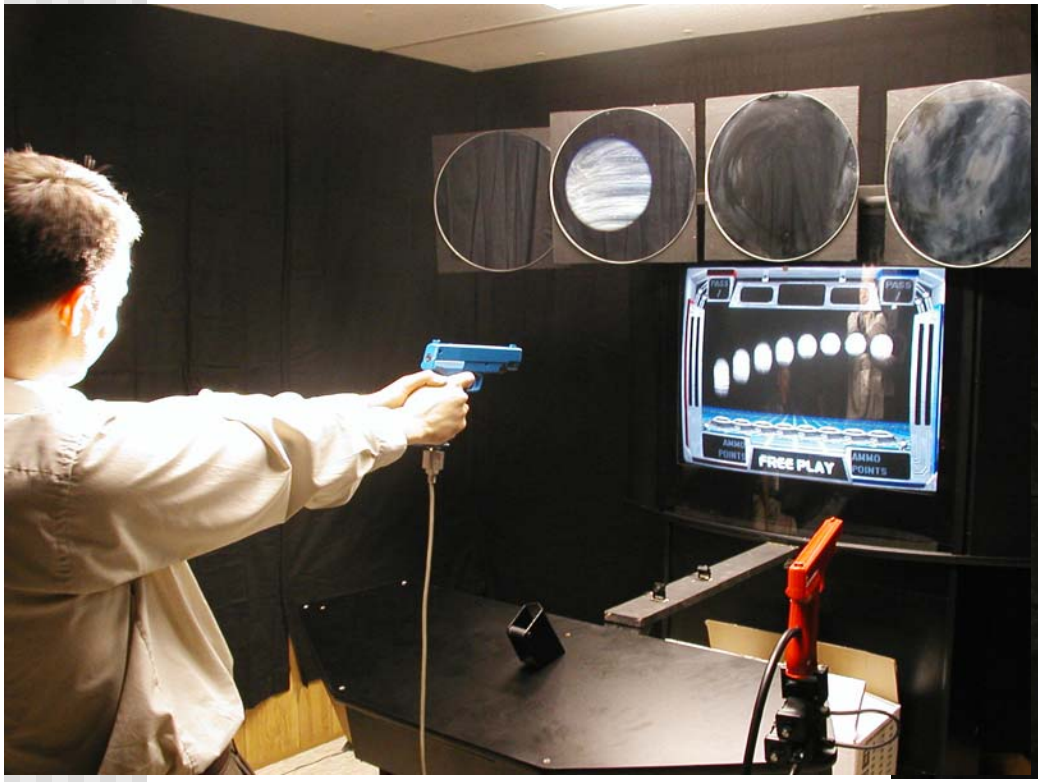
Light Exposure: No Sound

Martin Professional:
MiniMac Profile
(150 W / 1950 lumens)



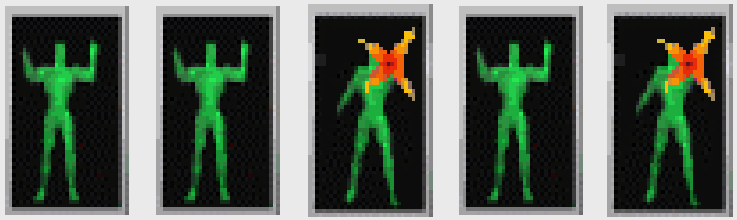


Light Flashes: Varying Locations

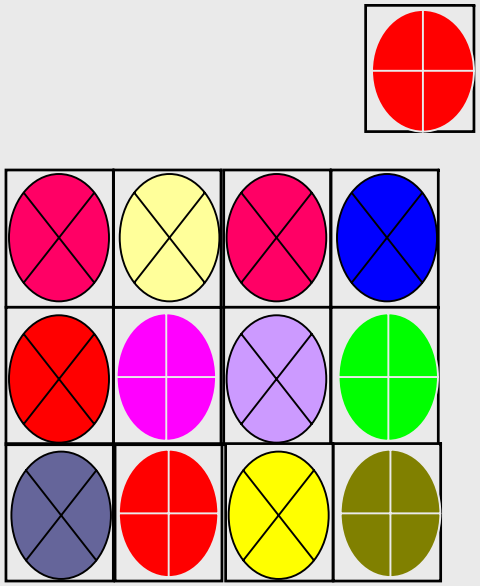


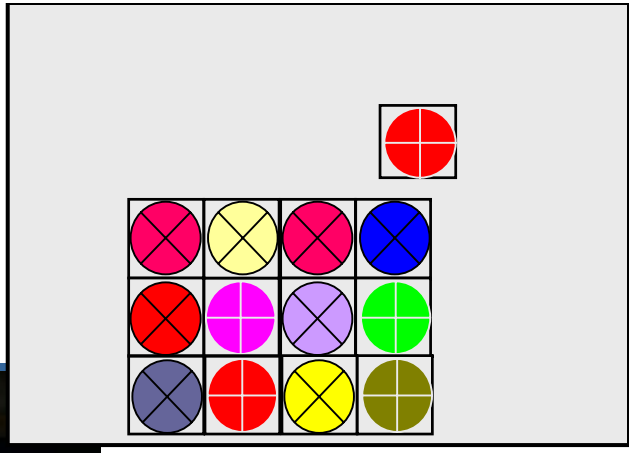
Video Games

Accuracy to hit specific stimulus-classes



Accuracy to hit a specific stimulus-type






PASS
0/ 6
30 AMMO
0 POINTS

Outcomes:

Performance was diminished by white light flashes:

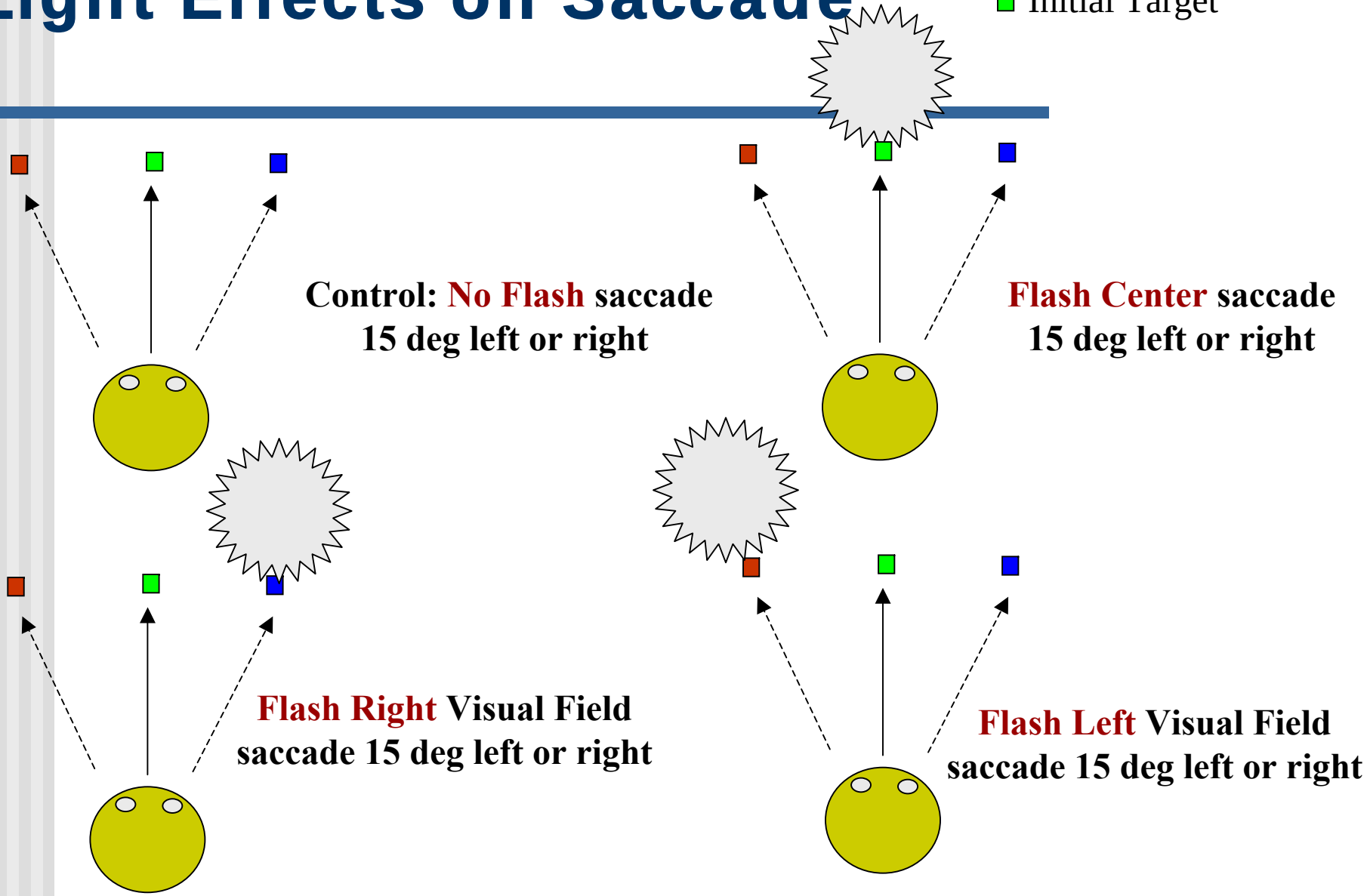
Latency to shoot when "flashed" with white light was increased more than 50% in 7 / 20 volunteers

Accuracy was reduced in the dynamic class identification task from 38.5% to 20% (4 out of 20)

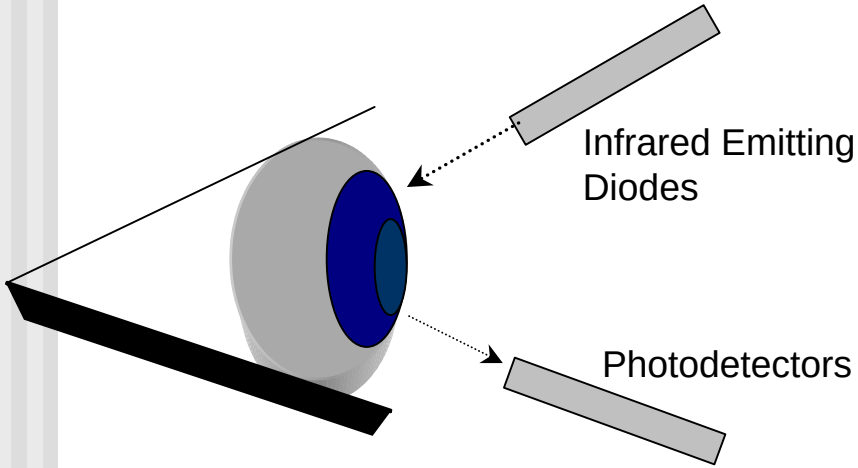
Hypothesis: Visual Tracking Is Disabled by Flash (i.e., WHY?)

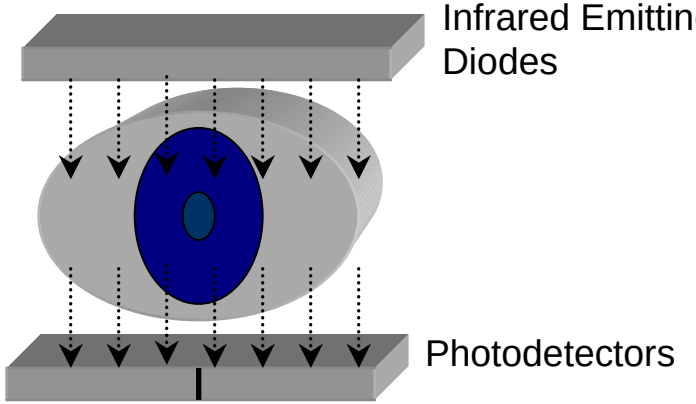
- Eyes must fixate on a target when aiming
- If a light flash changes the timing or speed characteristics of visual tracking movements this will yield information to improve devices that disrupt or stun human performance.
- The goal of this line of research is to understand these changes to promote increased delay and/or decreased speed in target acquisition.

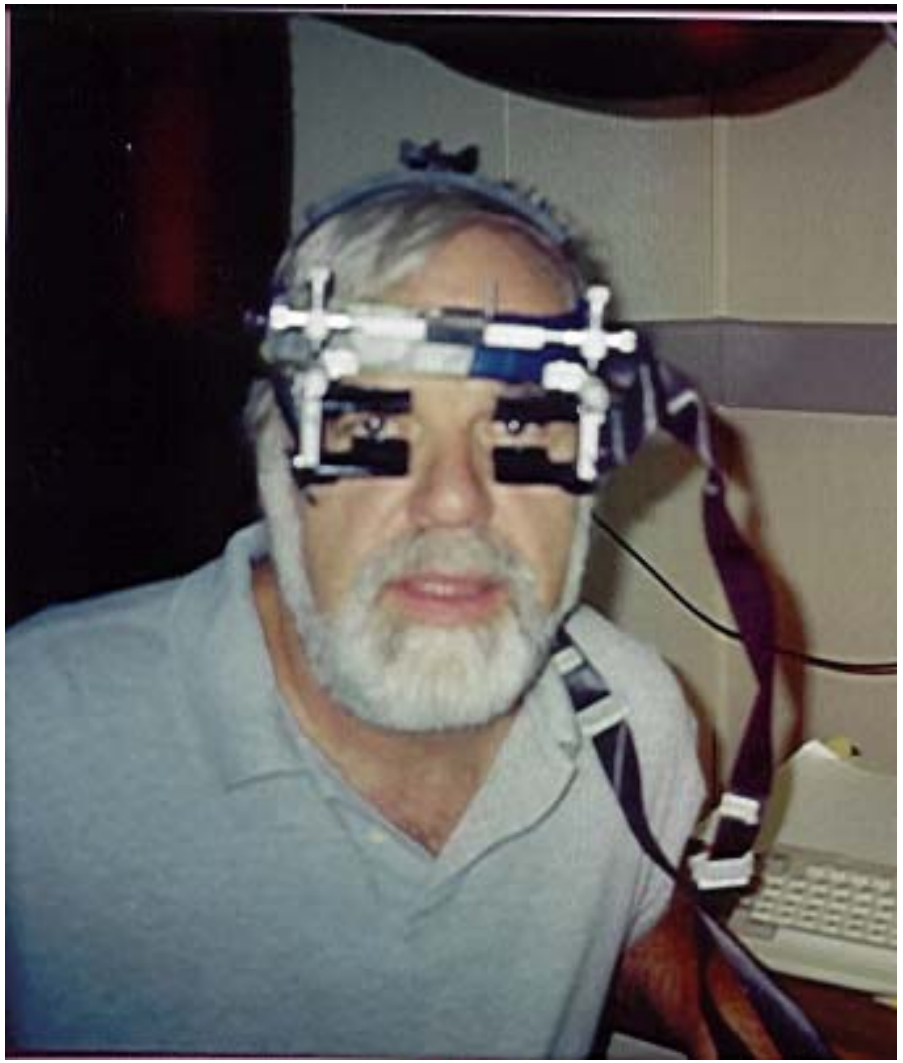
Experiment:
Light Effects on Saccade



Limbus Infrared Eye Movement Monitor

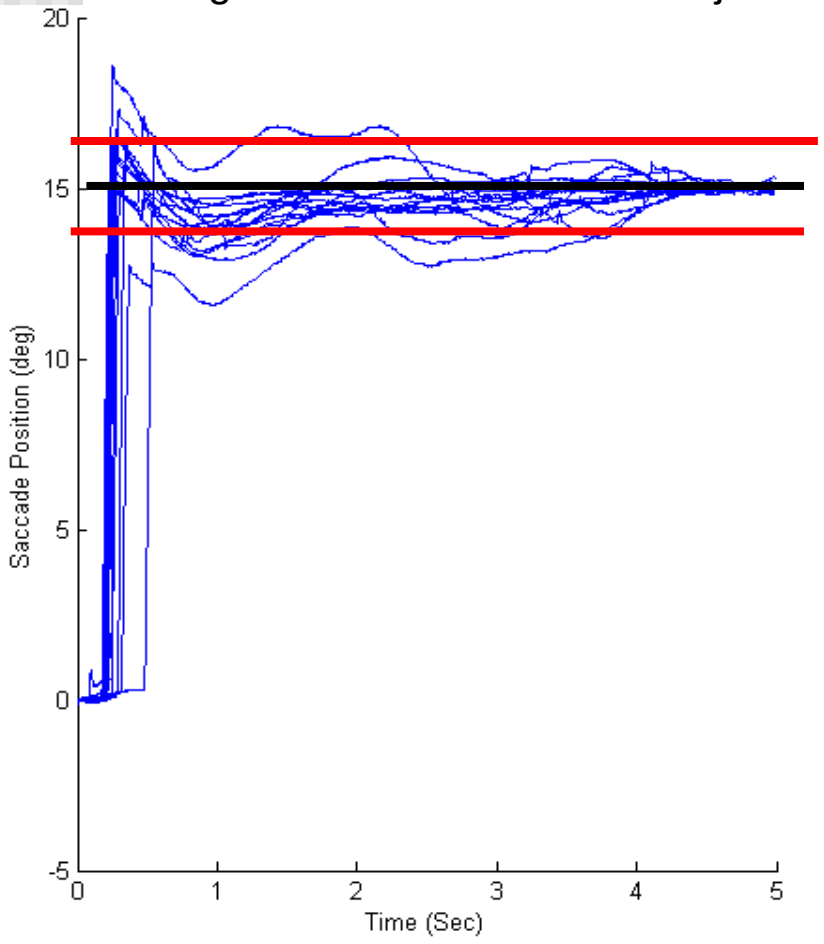




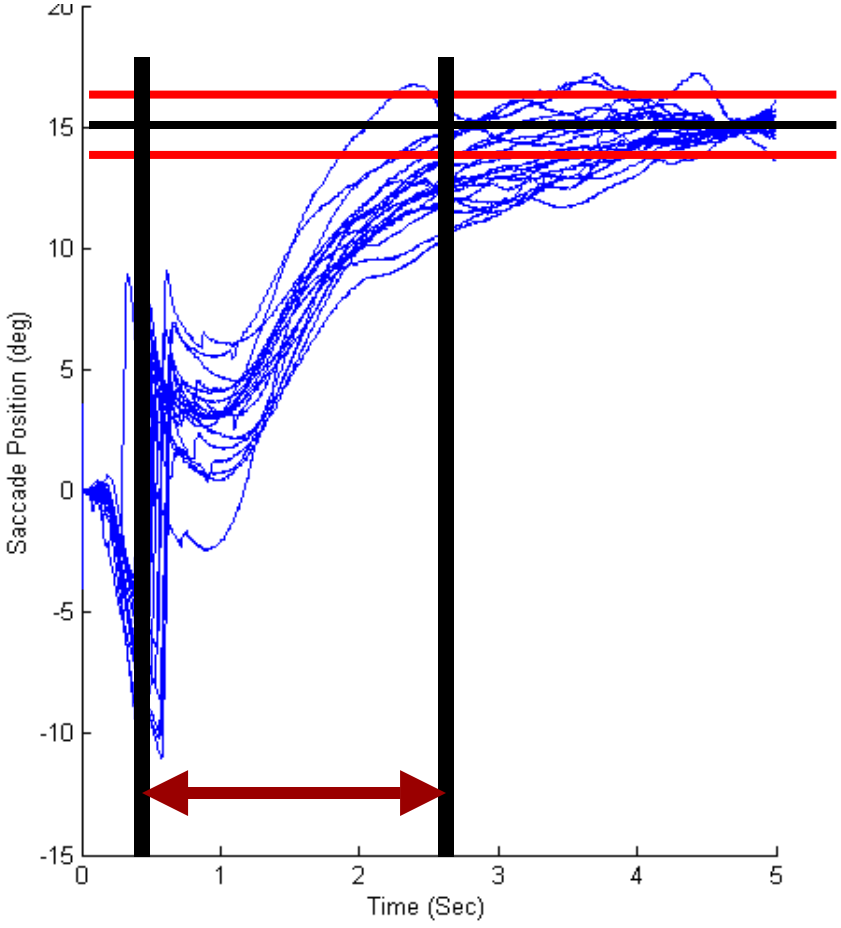


Time to ± 1 deg of Target

Right Saccade No Flash Subj:001



Right Saccade Right Flash Subj:001



Subjective Reports

- **"Targets Disappeared" when the flash was to the side where target movement occurred**
- **Report of "disappearance" of target increased for multi-flash compared to single flash stimuli.**
- **One subject S004 who does not show substantial changes stated he plays a lot of "first person shooter" video games that have a "flash bang" device.**

Outcome

White flash(es) affect the amount of time for subjects to acquire target within +/- 1 deg of stimulus.

Stimuli with flashes required approximately 2 seconds to be within +/- 1 deg of stimulus target where controls required only 1 second.

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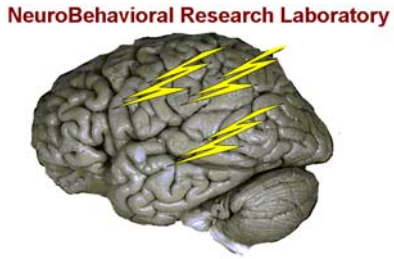


Development of Aversive Audible Sounds

J.B. Crabbe, Ph.D.
Bronya Vaschillo, M.D.
Evgeny Vaschillo, Ph.D.
Rick Servatius, Ph.D.

Research supported by the Department of Defense

Main Goal

Develop universally aversive sounds for use as a non-lethal weapon against terrorists, to disperse a crowd etc.

Universally Aversive Sounds

- Should be stressful enough to elicit an escape response (terminate the sound).
- Should elicit an escape response in at least 80 % of exposed people.

Escape response determines sound aversiveness

- **Press Button Rate:** % of subjects who stopped the sound
- **Latency:** Time passed before terminating

Initial Goals

- Understand what features of a sound make it aversive
- Investigate and characterize behavioral, psychological, and physiological responses to pleasant, unpleasant and aversive sounds
- Investigate physical structure of sounds.

25 Sounds / 2 Sets

Set 1: 16 environmental sounds (pleasant, neutral, and unpleasant).

Set 2: 9 synthetic sounds chosen as the most unpleasant from 362 sounds created in our lab.

All 25 sounds played through headphones at the intensity of 82 dB.

Examples of Sounds

 Dentist Drill Reversed

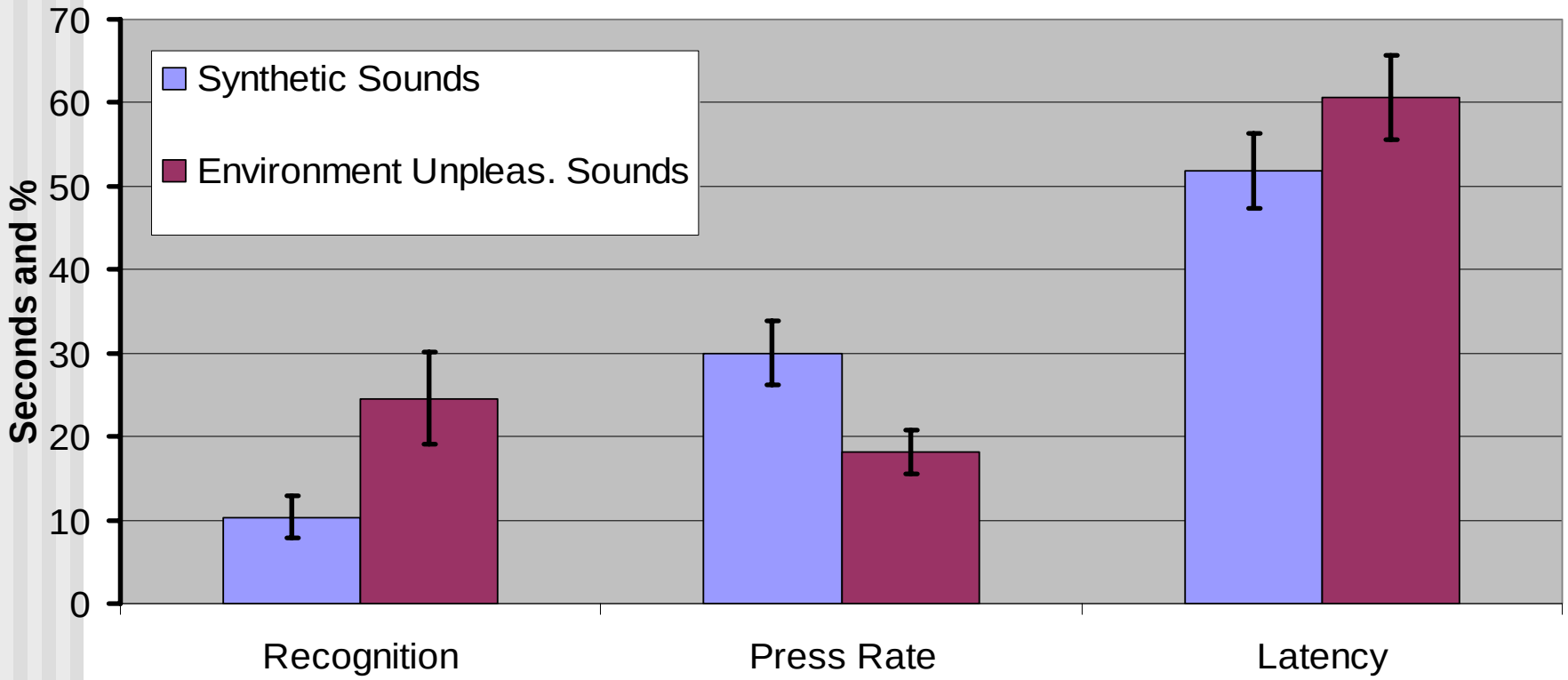
Examples of Sounds

Synthetic

Methods

- Sixty-five participants
- Instructed to listen to the sound for 120 seconds
- Could terminate the sound at any time for any reason
- Recorded behavioral, psychological, and physiological responses to define the features of aversive sound

Results



Synthetic sounds were significantly less recognizable, had significantly higher press button rate and shorter latency than environmental unpleasant sounds.

Some Initial Conclusions

- Sounds with lower recognition had higher aversiveness.
- Sounds with infrasound components were most aversive
- Aversive behavior does not necessarily relate to unpleasantness rating

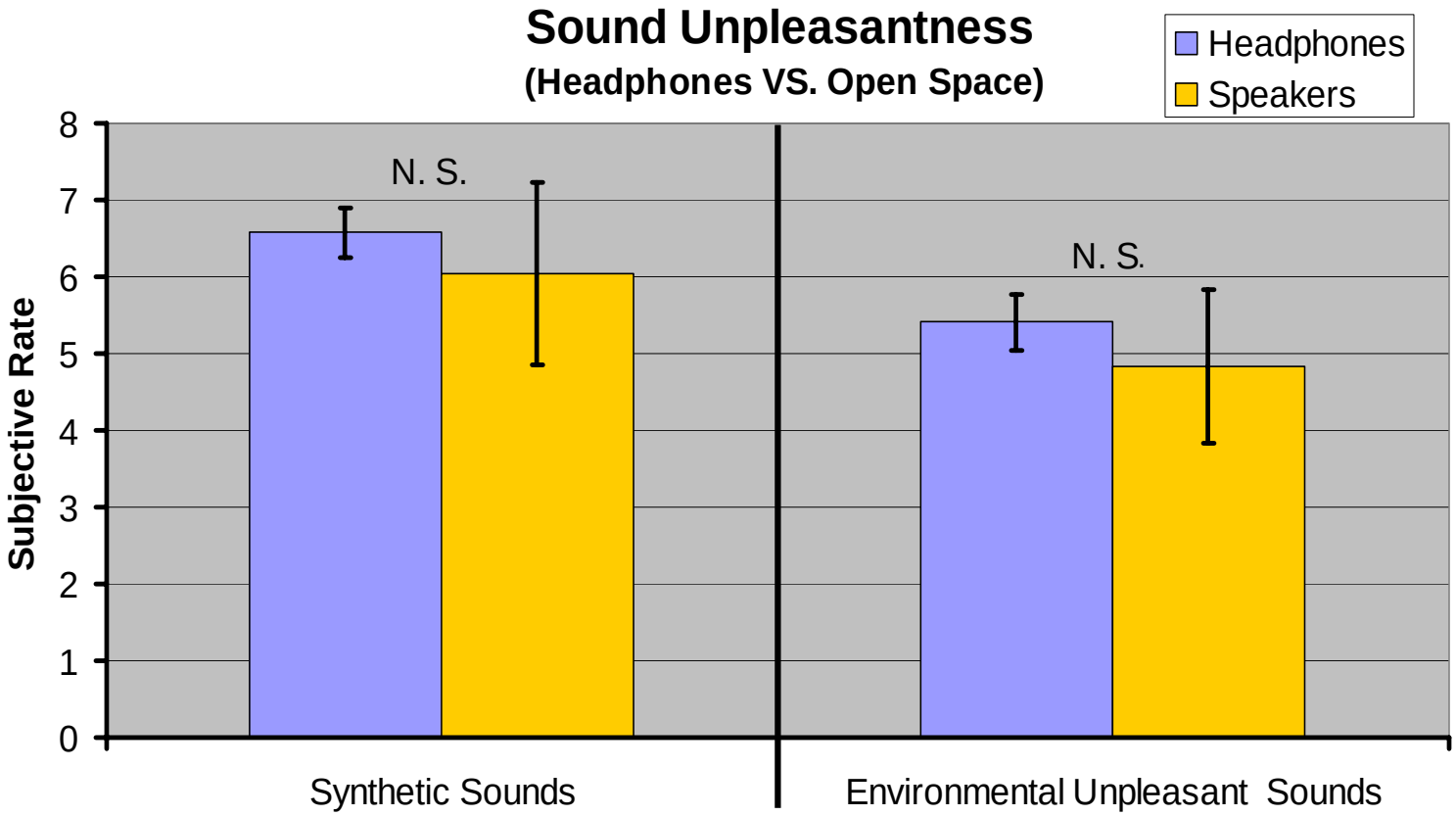
Next Step

- **Evaluate aversive sounds in *open* space.**
- **Determine the differences in responses to sounds between headphone and speaker presentation**

Methods

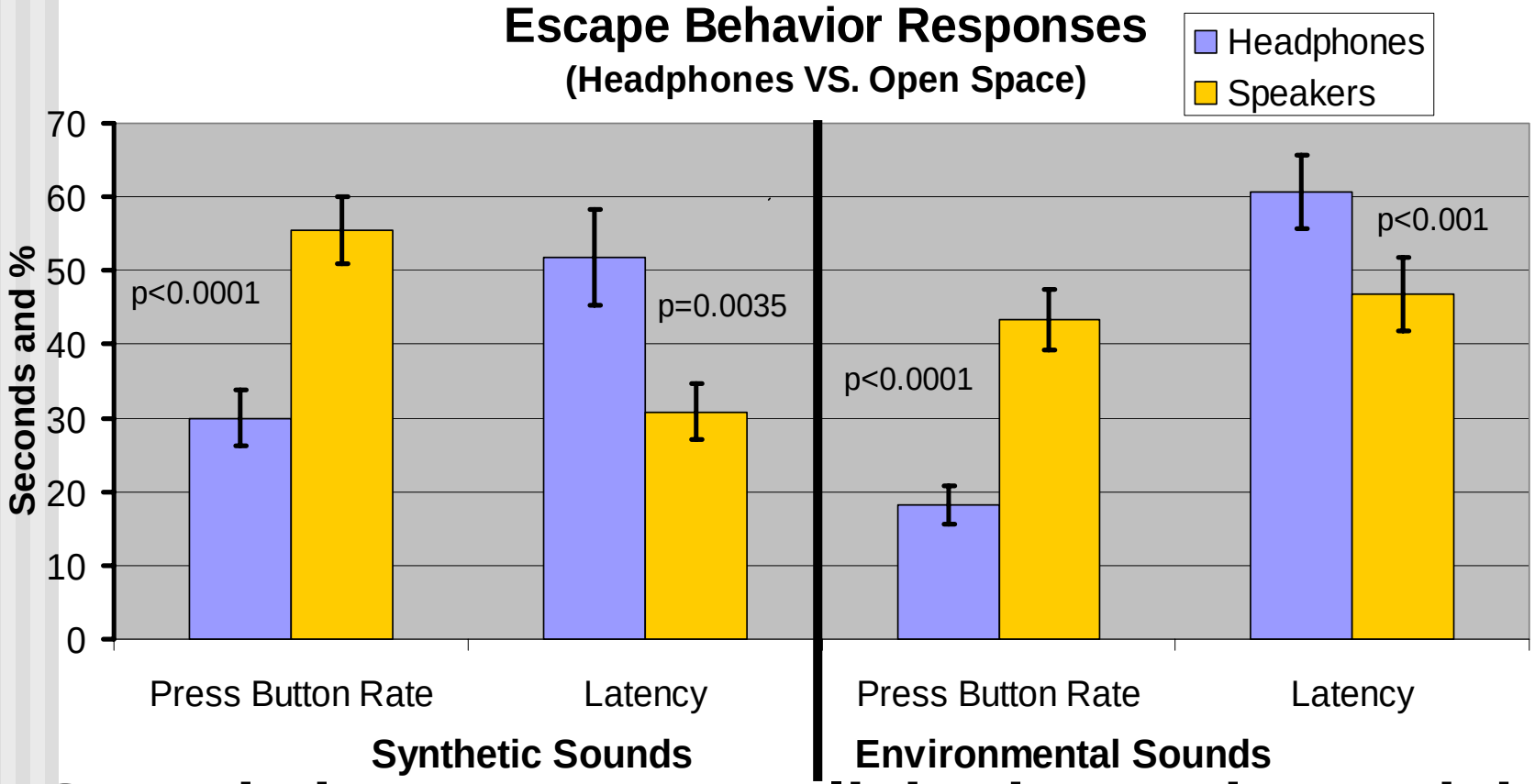
- Twenty-two participants
- Presented the same 25 sounds at 82 dB via
- Four speakers placed around the subject at the same distance and at head level.

Results



Headphones and open space sounds were rated by subjects as equally unpleasant

Results



Sounds in *open space* elicited aversive activity almost *twice as much* as the same sounds via *headphones*

Conclusions

- **The same sounds in open space were more aversive than from headphones**
- **Most aversive sound presented in open space, press button rate was *63 %*, latency was *25.7* s.**
- **The same sound emitted from headphones, press button rate was *40 %*, latency was *48.2* s.**

Future Directions

- Sound intensity (102 dB)
- Infrasound (brain waves)
- Effect on task cognitive and physical performance
- Effect on physiological processes, e.g., cardiovascular

Thank You

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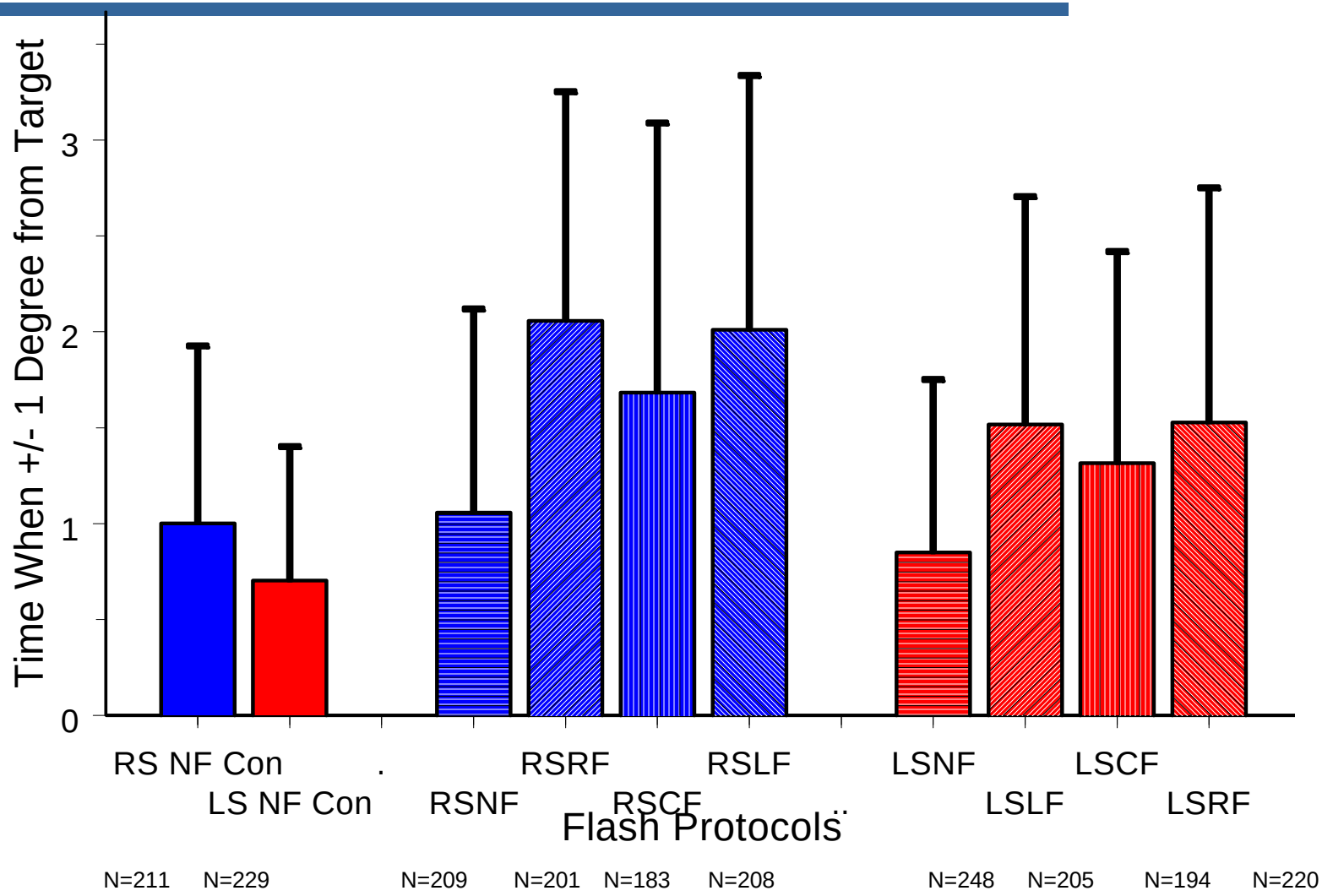
Additional Slides

Single White Flash Time (sec) when person is within +/- 1 deg of target

All Subjects



Multi White Flash Time (sec) when person is within +/- 1 deg of target

All Subjects