Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
15 NOV 2010	**Conference Poster Presentation**	**00-00-2008 to 00-00-2010**

4. TITLE AND SUBTITLE
Targeting of Convoy Vehicles is Not Disrupted by a Green Laser: Moving, Predictable Targets in Bright Lighting Poster Presented at the 2010 Directed Energies Professional Society Meeting, 15-19 November 2010.

5a. CONTRACT NUMBER
5b. GRANT NUMBER
5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Kenneth Short; Gordon Cooke; John Riedener

5d. PROJECT NUMBER
5e. TASK NUMBER
5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Army, ARDEC, Target Behavioral Response Laboratory,RDAR-EIQ-SD,Building 3518,Picatinny Arsenal,NJ,07806-5000

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)
11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
Protecting military convoys from sniper fire is a priority. A fielded green laser was evaluated for its capacity to interfere with the ability of a shooter to hit moving outdoor targets, both while the laser was on and again just after termination. We tested each subject???s ability to locate, identify, and hit a target using rifle-like armaments, during trials with or without laser exposure. Impairment was defined as fewer target hits during laser trials, compared to no-laser trials. Two trucks traveling in a convoy served as targets. Eight subjects shot during 14 trials. On laser-exposure trials, Target 1 was presented concurrently with the laser, and Target 2 was presented immediately after removal of both Target 1 and the laser. Target 1 & 2 accuracy on laser trials did not differ from no-laser trials. On non-exposure trials, no target accuracies differed. Shooter skill did not affect impairment. Under bright lighting conditions, shooting at moving (but predictable from extrapolation), brief-exposure targets, the maximum eye-safe green laser exposure did not impair targeting success while on the shooters eyes nor afterward. Perceptual mechanism and situational contributors to effectiveness are discussed.

15. SUBJECT TERMS
laser, shooting accuracy, impairment, human behavior, suppression

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Public Release**	**1**	

2007 Malcolm Baldrige National Quality Award Recipient

The Armament Research Development & Engineering Center

Innovative Armaments Solutions for Today and Tomorrow

Targeting of Convoy Vehicles is Not Disrupted by a Green Laser: Moving, Predictable Targets in Bright Lighting

Target Behavioral Response Laboratory

Kenneth Short, Ph.D.; Gordon Cooke, MEME; John Riedener, MSSE

The Problem

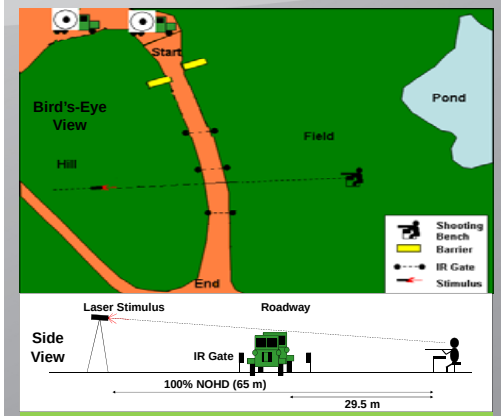
- Protecting military convoys from sniper fire is a priority.
- Soldiers would like to use non-injurious lasers in civilian settings to impair potential shooters to keep convoys safe.

Specific Objectives

- Determine effectiveness of a green laser under eye-safe conditions against the ability of a shooter to hit a target.
- Test laser effectiveness during laser exposure and immediately after laser exposure.

General Method

- Test human volunteers shooting outdoors under daytime lighting at moving convoy vehicles
- Compare shooting accuracy on laser-exposure trials with that on non-laser trials.



Convoy Protection Test-Bed Layout

Figure 1: *Viewed from above (Upper Panel) and from side (Lower Panel). Note the laser path relative to the truck target. The B.E. Meyers GBDIII-C laser was shone on the subject's face from the Nominal Ocular Hazard Distance (NOHD) to remain eye-safe.*

Convoy Path and Targeting Area

Figure 2: *Convoy targets were visible during their approach to the targeting area. Shots at targets were allowed only when targets were between the white reflector posts. The pink dot on the forward truck's target constitutes a "hit."*

Convoy Targets in Targeting Area

Figure 3: *Truck targets were closely spaced while passing through the targeting area so the second target entered range as the first target left. Targets were available to hit for about 1.4 sec. The B.E. Meyers GBD-III-C laser is mounted on a tripod on the bed of the stationary truck in the background, and shone over the top of the first truck-mounted target.*

Experimental Design & Procedures

- 8 healthy subjects with good eyesight participated
- Subjects were trained to criterion on shooting task with an FN-303 less-lethal launcher
- On each trial, subjects shot at targets mounted on two moving convoy vehicles closely following one another
- Experiment consisted of 14 trials consisting of two targeting opportunities each, for 28 total targeting opportunities.
  - 7 of the 14 trials began with laser exposure during Target 1 presentation; no laser was presented during the other 7 trials
  - For each laser trial, a subject was exposed to the laser for the duration that the first target was in range and available to be hit.
  - The laser appeared to originate from immediately above Target 1 (0.5° visual angle)
  - When the first target had passed, the laser was terminated simultaneously and immediately the second target was available to be hit.

Shooting While Laser Is On Eyes:

Question: Does the laser interfere with hitting the target while it is on the eyes?

Findings

- Hit percentages for Target 1 when laser was on did *not* differ from hit percentages when laser was off.

Shooting After Laser Is Turned Off:

Question: Does the laser cause residual interference with targeting after it ends?

Findings

- Hit percentages after the laser did not differ from no-laser trials. There is no residual effect.

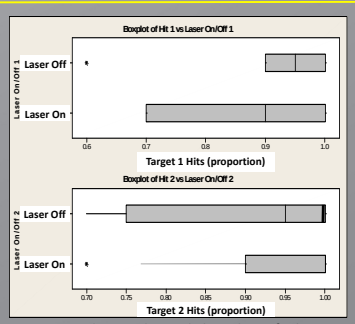


Figure 4: *Medians and quartile boundaries for hit rates on laser-exposure and non-exposure trials for the first target (top plot) and second target (bottom plot) in each trial.*

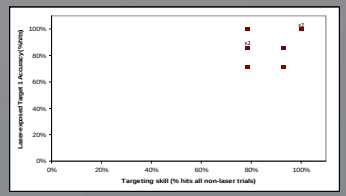


Figure 5: *Performance on non-laser trials, compared to impaired performance during laser exposure on Target 1 shots. Skill was not related to laser-induced impairment, predicting less than 6% of variance (R^2=.056).*

Laser Aimed On Shooter's Face

Results Summary & Conclusions

- Targeting ability for Target 1 was not affected by concurrent laser exposure.
  - Subjects hit the first target on average 95% of the time when no laser interference was present, and 90% of the time when the laser was present.
  - The very small difference in Target 1 hits was not reliable according to a Kruskal-Wallis test [$H_{1,15}$= 0.45, p=.502]
- There were no differences in targeting success for Target 2 between the laser-exposure trials and the non-exposure trials.
  - Any decrement in targeting accuracy on these trials would be expected to result from lingering effects of the laser, such as afterimages due to photo-pigment depletion or photoreceptor or other retinal cell fatigue, confusion, or undefined residual incapacitation.
  - On non-laser trials, subjects hit the second target 95% of the time, while on laser-exposure trials they hit 100% of the time.
  - The small difference is not reliable, according to a Kruskal-Wallis test [$H_{1,15}$= 0.34, p=.558].
- On the non-exposure trials, targeting success for the first target and the second target were identical (95% hits).
  - Suggests that the difficulty of the two targeting tasks was similar.
    - Any difference in targeting accuracy between the two targets on the laser-exposure trials cannot be attributed to differential difficulty.

Discussion

- Predictability of the target location may have kept the laser from interfering with targeting.
  - Trucks moving at constant speed could be anticipated prior to laser onset.
  - In another experiment (Short et al., 2007), static targets were presented for a similar duration but in an *unpredictable* manner, and the same green laser was *highly* effective.
- Alternatively, the relevant feature may be high level of ambient light during task (so laser had low temporal contrast).
  - Light-acclimated (2782 lux ± 306 SEM) subjects would have low sensitivity
  - Same laser was *highly effective* in *dim* light, laboratory targeting test (Short et al., 2007).

Gather empirical data on real human behavior in response to non-lethal weapons and systems using real people in tactically relevant situations