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Targeting Success is Disrupted by a Green Laser: Static, Unpredictable Targets Under Low Light

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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 targets, both while on and 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. Eight subjects each shot during 56 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 accuracy was significantly lower on laser trials (one-third as many hits) than on no-laser trials. Accuracy at Target 2 immediately following laser exposure did not differ from non-exposure trials. On non-exposure trials, no accuracies differed. Targeting impairment was not related to targeting skill of the shooter. Under dark shooting conditions at stationary, unpredictable, brief-exposure targets, an eye-safe green laser exposure impaired targeting success only while the laser shone on the shooter???s eyes, without residual effect. Lasers caused more performance interference here than in other reports. Interference mechanisms and situational contributors to effectiveness are suggested.

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

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- 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.

- 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
  - immediately after laser exposure.

- Test human volunteers
  - shooting indoors
  - under low ambient lighting
  - at static targets
  - in unpredictable locations
- Compare shooting accuracy
  - laser-exposure trials vs. non-laser trials

- One target at a time
- In one of 4 positions
- Target 2 appears immediately after Target 1 is hidden
- Each target is shown for 1.4 sec
- Laser aimed at shooter on half the trials
  - Shone through opening
  - Situated near all targets

- B.E. Meyers GBD-III-C Laser
- For laser trials:
  - On with first target
  - Off with second target
- Situated outside building, shone indoors onto face

- At maximum eye-safe exposure (max time, min distance, pause between)

- Shooter's bench
- Paintball marker
- Opaque screen between trials
- 8 healthy subjects
  - Good eyesight
  - Trained to criterion
- 1.4 sec shooting window before target disappears

- 56 trials, 2 targets/trial, 112 targets total
- Recorded Hits (e.g., left) and Misses (right)
- Compared hits: laser trials vs. no-laser trials
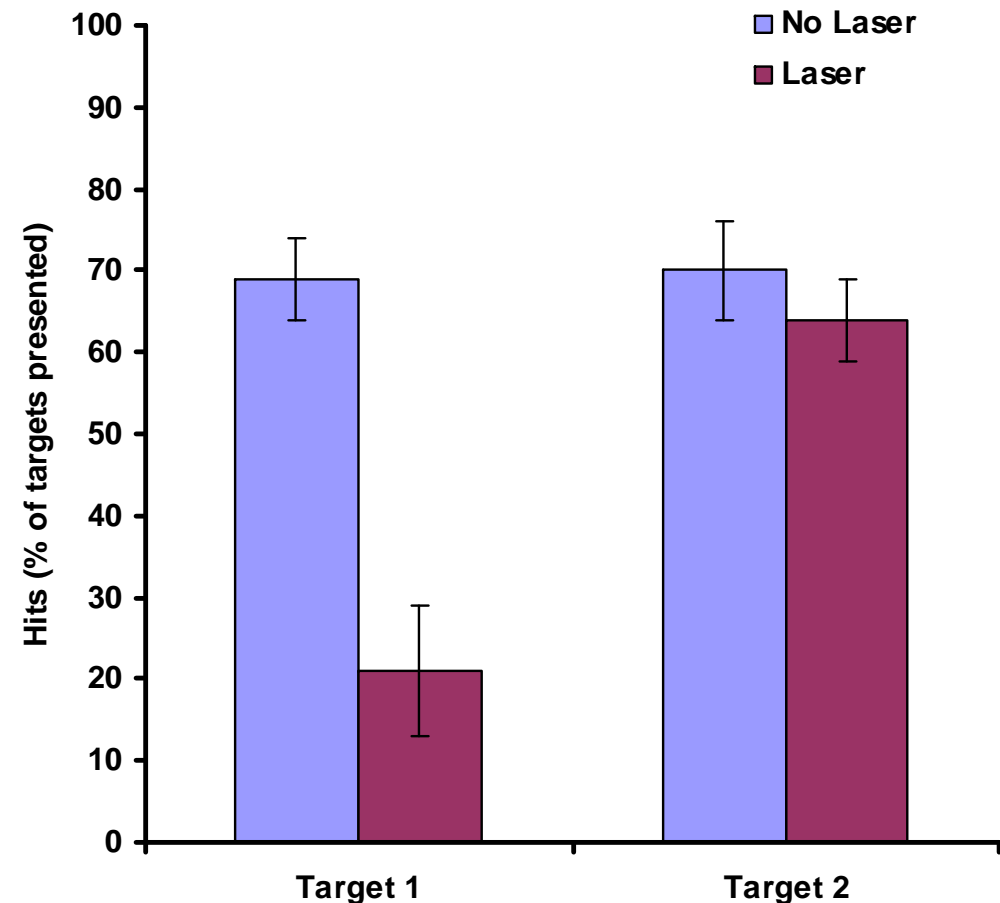 - Laser effects (Target 1) & aftereffects (Target 2)

- Mean ± Standard Error for hit rate
- On laser-exposure and non-exposure trials
- For the first target and second target in each

- Moderate difficulty task on non-laser trials
  - ~70% success
  - Not much variation

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 were significantly lower than hit rates when laser was off.
  - 21% ($\pm$ 8 SEM) vs. 69% ($\pm$ 5 SEM) difference, respectively, was reliable
  - Analysis of Variance: $F_{1,15} = 25.42$, $p < .001$

Shooting After Laser Is Turned Off:

Question:

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

Findings:

• Hit percentages for Target 2 post-laser did not differ from no-laser trials. There was no residual effect.
  - 64% ($\pm$ 5 SEM) vs. 70% ($\pm$ 6 SEM) difference, respectively, was not reliable
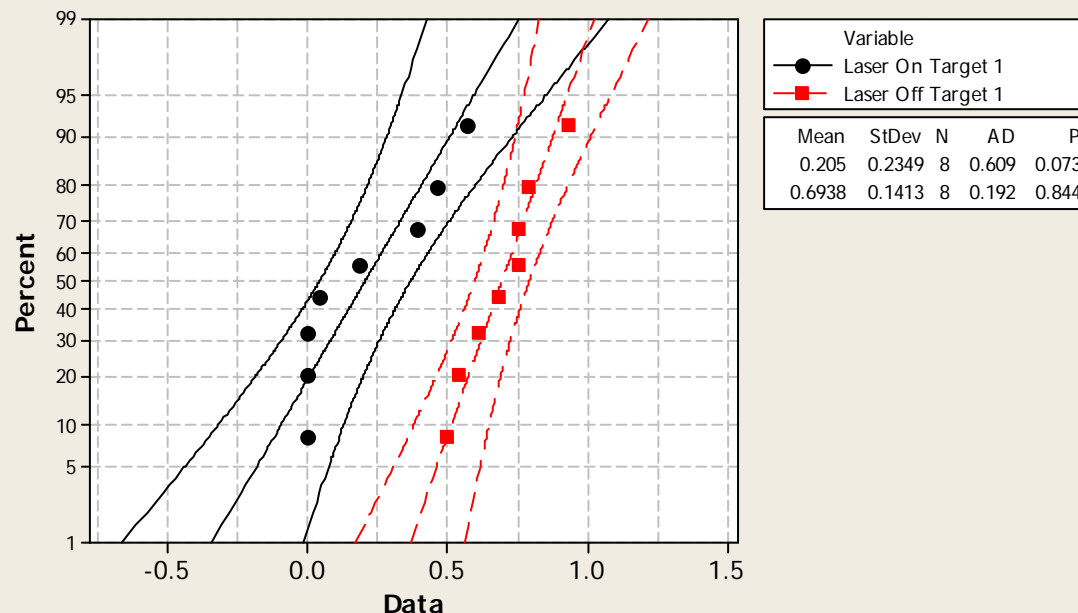 - Analysis of Variance: $F_{1,15}= 0.55$, $p=.471$

Probability Plot of Laser On Target 1, Laser Off Target 1
Normal - 95% CI

Variable
Laser On Target 1
Laser Off Target 1

Mean	StDev	N	AD	P
0.205	0.2349	8	0.609	0.073
0.6938	0.1413	8	0.192	0.844

- Target 1 Hit percentages were normally distributed despite bounded nature of data
- Analysis of Variance is therefore justified for assessing reliability of impairment in these data
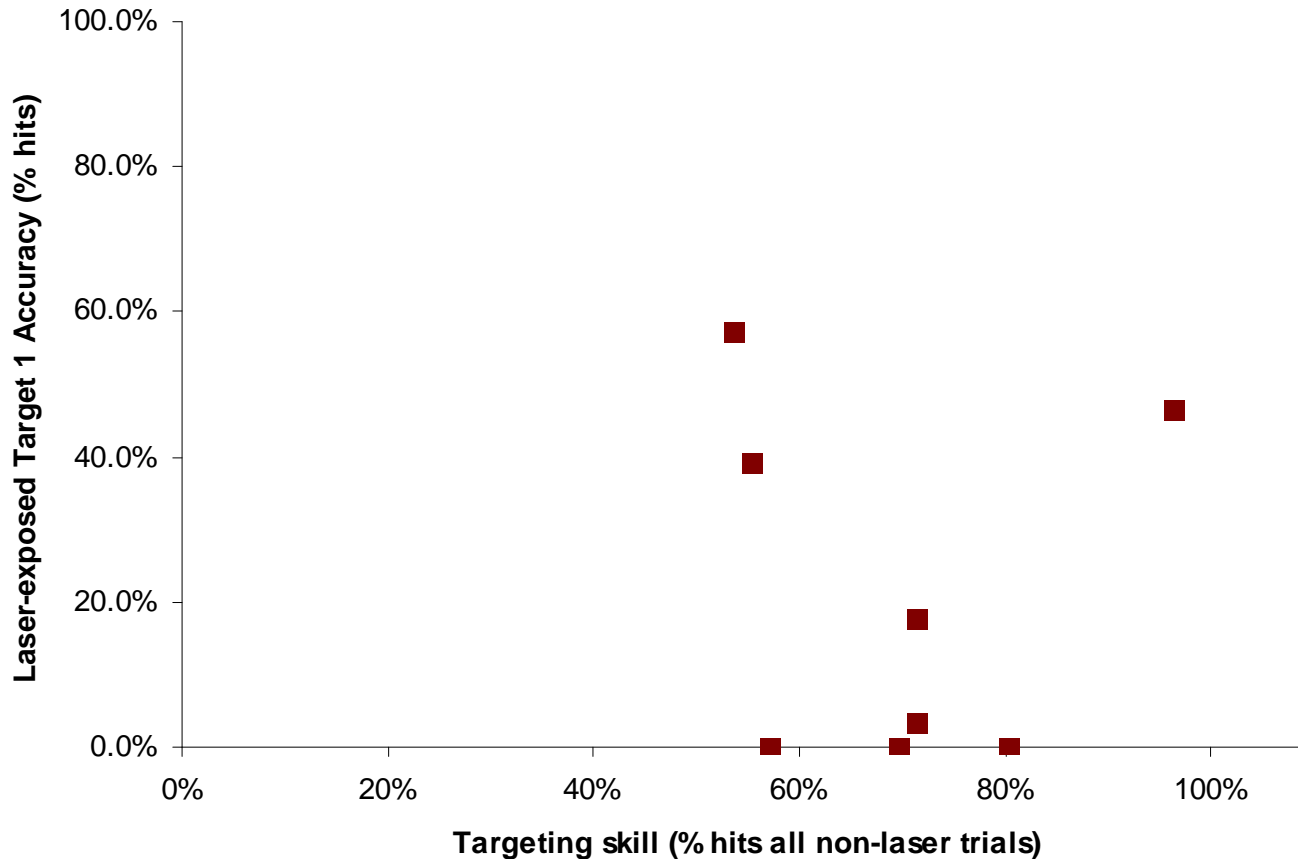
- On non-exposure trials:
    - Targeting success for the first target (69.2% hits) and the second target (69.6% hits) were not reliably different
    - Suggests that the difficulty of the two targeting tasks was similar.
    - Any difference in targeting accuracy between the two targets on the laser-exposure trials cannot be attributed to differential difficulty.

- Skill was not related to laser effectiveness

  - predicted less than 1% (R^2=.005) of the variance

- Unpredictability of the target location may have been essential for the laser to be able to interfere with targeting.
    - Could not anticipate the location of target on any given trial due to randomized/counterbalanced presentation
    - In another experiment (Short et al., 2007), moving targets were presented for a similar duration but in a *predictable* manner, and the same green laser was *not effective*

- Alternatively, the relevant feature may be low level of ambient light during task
  - Therefore laser had high temporal contrast
  - Dark-acclimated (7 lux) subjects would have high sensitivity to laser
  - Same laser was ineffective in daylight, more operational targeting test (Short et al., 2007)