Soldier Decision-Making for Allocation of Intelligence, Surveillance, and Reconnaissance Assets

Jonathan Bakdash
Human Research and Engineering Directorate, U.S. Army Research Laboratory

Diego Pizzocaro & Alun Precee
School of Computer Science and Informatics, Cardiff University, UK

ICCRTS 2014
Intelligence, Surveillance, and Reconnaissance is the “hub” of 21st century military operations

(Lt General Deptula, US Airforce, AAAI Keynote, 2010)

Hard information sources: Physical sensors

Objective Soldier decision-making ISR allocation
Allocation decisions and sensor platform capabilities

- Identify the license plate
- Detect a vehicle
- Identify the vehicle as a four door sedan

Sensor Capabilities

High

Low
Decision-Making Theories

- Heuristics and biases (Kahneman and Tversky)
- Naturalistic decision-making (Klein)
- Statistical (actuarial) judgments (Meehl)
1) Complete information on sensor capabilities will result in greater allocation decision accuracy

2) Even with complete information, decision accuracy will be less than 100%
Objective decision-making tasks
- Identify a license plate
- Moving car, jeep, or Humvee

Ground truth: National Imagery Interpretability Reconnaissance Scale (NIIRS)

Unclassified/open-source sensor ratings
Set 1
Sensor assignments based on prior knowledge and experience

Set 2
Sensor assignments based with the NIIRS scale and sensor ratings provided

- 5 ISR platforms with visible, infrared, and/or radar sensors
- 8 detection/identification tasks
- 208 allocation decisions (104 for each set) per Soldier
Soldiers

- Recruitment
  - Operational experience with ISR
  - Umbrella Week
  - 10 Soldiers

- Background and Rank
  - 7 out of 10 Intel Analysts
  - Rank: Sergeant to Captain
  - Echelon: Most Battalion to Brigade
Decision Accuracy

$p < 0.05$

$d = 0.59$ (95% CI: 0.04 - 2.84 percentile bootstrap)
$p < 0.001$

d = 1.77 (95% CI: 1.42 - 4.23 percentiles bootstrap)
Decision-making accuracy for allocation of ISR under was 100%, despite complete information and no time pressure.

Exploratory results:
- Accuracy comparable across ISR assets
- Moderate confidence in sensor assignments
- Most relied on NIIRS information in Set 2
Limitations

- Unclassified sensor capabilities
- No SIGINT
- Small sample size
- Simplified task: Only sensor assignments
Discussion

- **Automation**
  - Algorithm limitations
  - Complacency
  - Human supervisory control
  - Transparency

**Flying lawnmowers:**
Loud acoustic signature of some UAVs
Human and intelligent system work towards a common goal (Terveen, 1995)

Optimal weather forecasting accuracy: Human plus adjustable computer models (Silver, 2013)
Human Computer Collaboration for ISR

Research grade prototype technology for ISR
(Pizzocaro et al. 2011; Preece et al. 2013, 2014)
Empirical evidence for a technology gap

Technology cannot completely replace human decision-making for ISR

Need for technology?
Acknowledgments

Supported by the Network and Information Sciences International Technology Alliance (ITA): U.S. Army Research Laboratory and U.K. Ministry of Defence

We thank:

- Soldier SMEs for their time and expertise
- Geeth de Mel for his knowledge of NIIRS and for providing unclassified/open-source ratings of sensor capabilities
- Paul Sullivan regarding task instruction wording
- Ellen Haas, Debbie Patton, Diane Ungvarsky, and several anonymous Soldiers for their expert advice and assistance in finding SMEs
- Mark Gatlin for his assistance editing the paper