

Eliminating the Speed-Accuracy Tradeoff With Highly Reliable Automation in a UAV Task

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Today's Talk

Research Question

How can human-automation performance be improved?

Automation

Using machines to do the work of humans

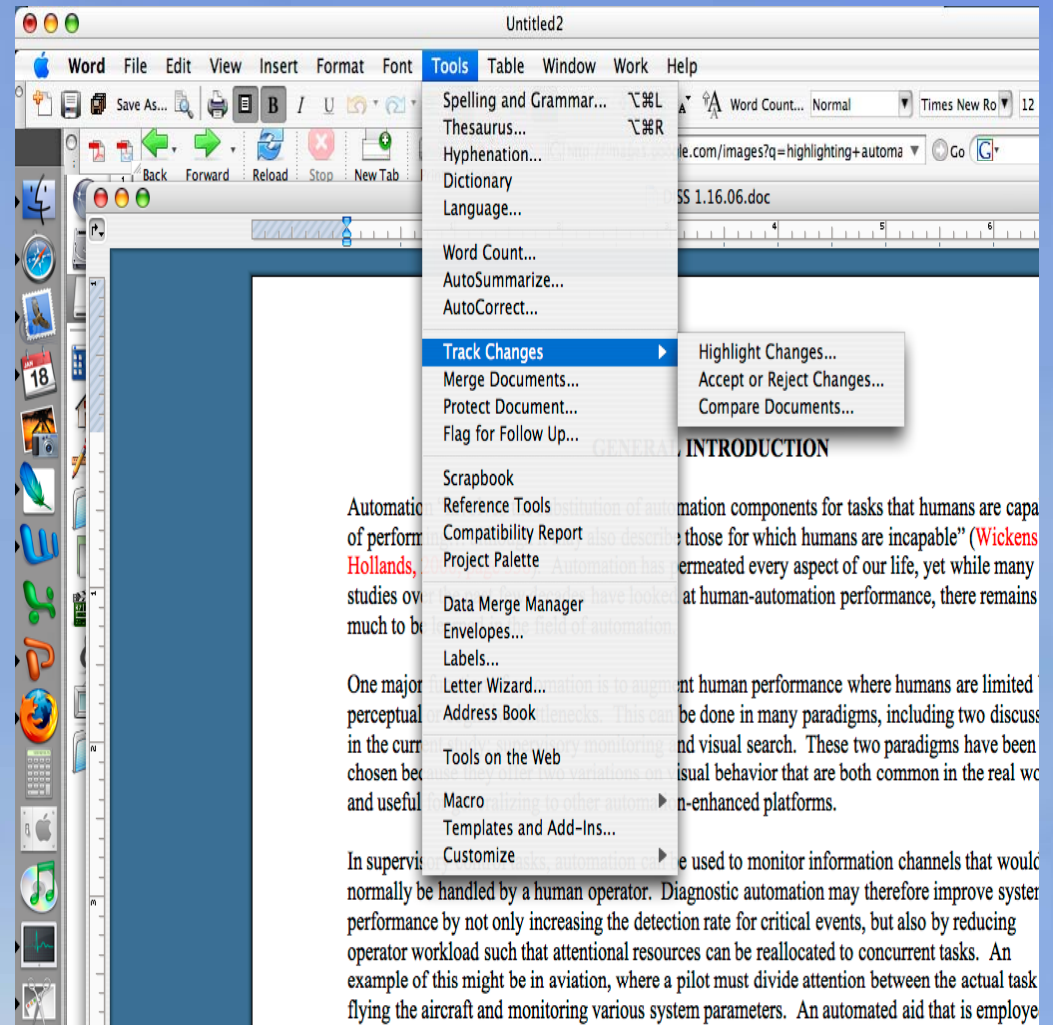
- Automation can be used to replace or *augment* human performance

The Problem

Human-Automation performance often less than expected

Four stages of automation

1. Synthesize data
2. Diagnostic
3. Select responses
4. Execute responses



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Current Study: Diagnostic Automation

- Alerts can be used to signal the operator to an event or target.
- Decision is still left to the human operator.
- Human must decide whether or not to heed automated alert.

Imperfect alerting systems

- Used to predict an event based on ambiguous or unreliable data.
- Given this imperfection, the system will produce 2 kinds of errors: False Alarms and Misses.
- Current study focuses on FA's, since misses can be catastrophic

		State of the World	
		Failure	No Failure
	Alert	Hit	FA
	No Alert	Miss	CR

Diagnostic Automation

Highly reliable aids can improve performance but often less than might be expected

e.g. Dixon & McCarley (under review)

- 95% reliable diagnostic aid benefited overall performance relative to baseline levels
- Participants appeared to agree with the automation less often than was optimal
- Resulted in unnecessary human errors that were not caused by the automation's recommendation.

Compliance

Compliance - What the operator does when the automation gives an alert (Meyer, 2001; 2004)

– Compliance = agreement when automation provides a true hit, a FA, or CR

High Compliance - the operator responds immediately to an automation alert

- Higher FA rate → lower compliance
- Extreme FA rate → “cry wolf” effect

Increasing Compliance & Performance

- Training
 - Can be costly
 - Often ineffective
 - Mixed results when effective
- Pilot Study found no benefit of four popular types of training
 - Goal implementation, information, reminders
- However, a positive correlation was found between speed and accuracy (faster = better)

How could one encourage more optimal patterns of human interaction with automation?

- Can time pressure increase compliance?
 - Heuristic decision making: rapid automatic processing (different from analytical or deliberative)
 - Speeded instructions = heuristic processing
- Can the speed-accuracy tradeoff (SAT) be effectively eliminated with highly reliable automation?
- Will speed improve human-automation performance?

Experiment 1: Predictions

- Low reliability aid & speeded instructions=
decreased accuracy
 - Via high FA rate coupled with speed
- High reliability aid & speeded instructions=
increased accuracy
 - Via increased compliance

Experiment 1

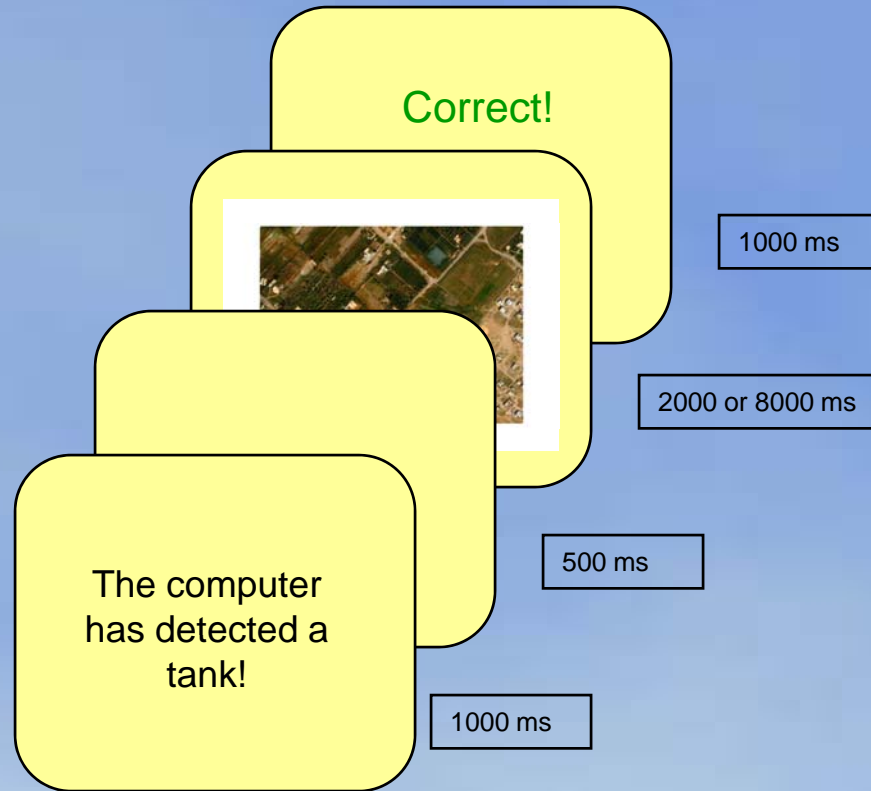
- 150 participants from NMSU community
- Paid \$8 per hour
- Simulated Ground Vehicle Search
 - Locate tank within visual field
- 50 target present and 50 target absent images were counterbalanced across participants



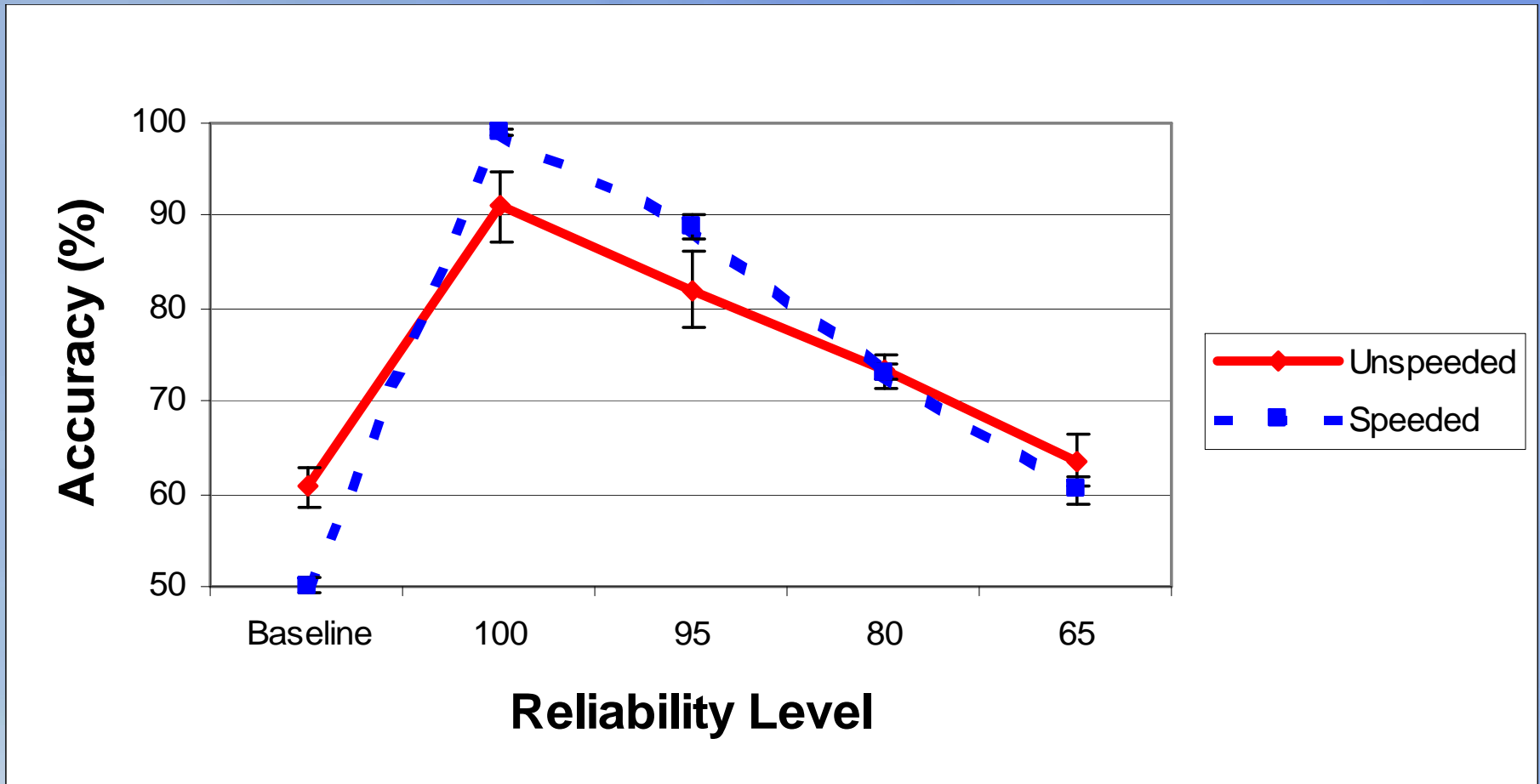
Methods

- 4 Automation Reliability Conditions:
 - Told that the aid would or would not assist them
 - 100, 95, 80, 65% reliability
- Erred by FA only (i.e. aid was always correct on target present trials (no misses))
- Recommendation was semi-randomized.
- 100 trials
- In sum, 5(Reliability: 100%, 95%, 80%, 65% or None) X 2 (Speeded: speeded vs. unspeeded)

Methods



Accuracy—Experiment 1



Experiment 1

- Speeded instructions increased compliance
- This benefited performance in the highly reliable conditions
- Harmed performance in the lowest reliability condition
- However, the task was difficult

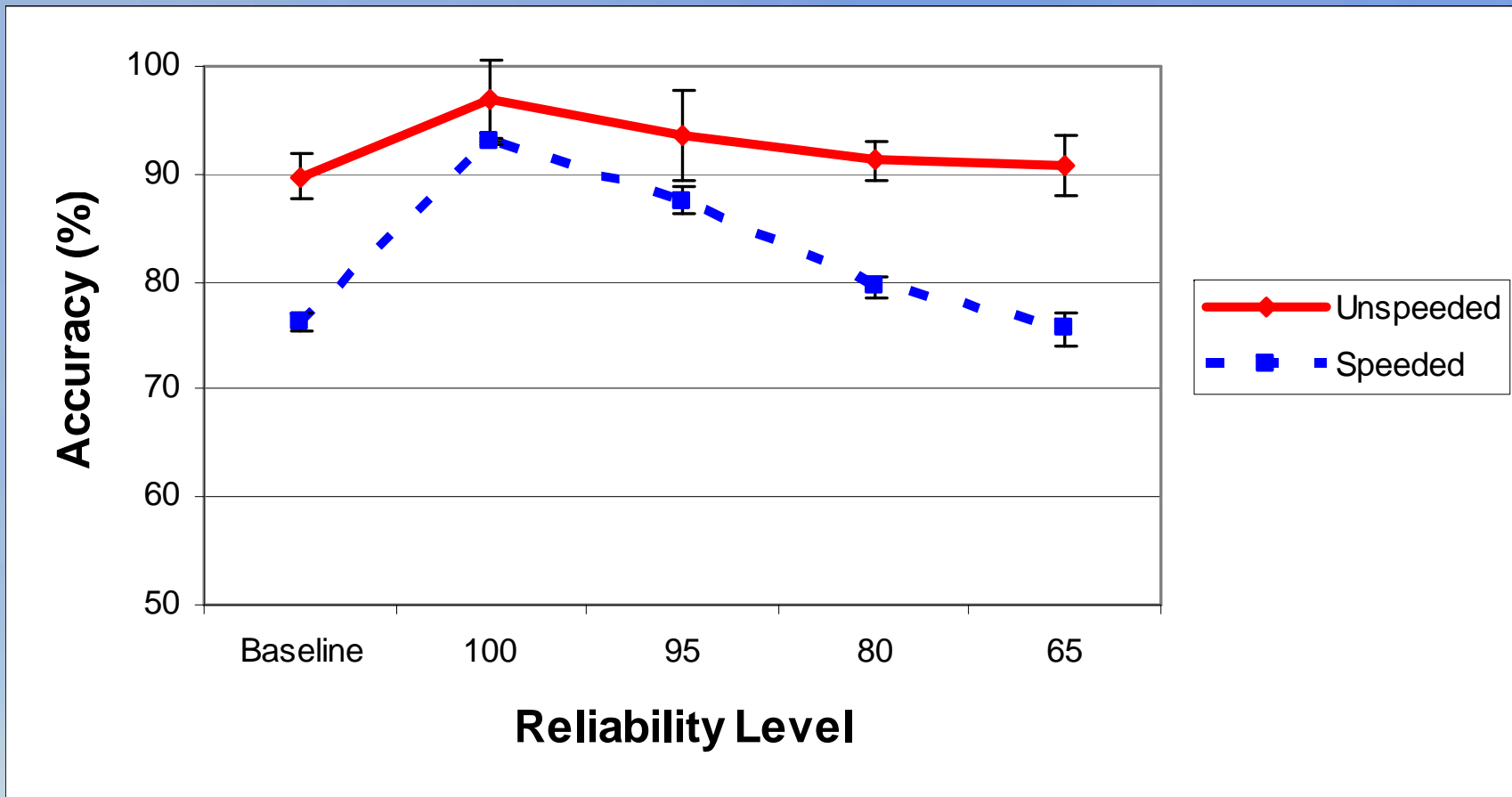
Experiment 2

- Experiment 1 task was very difficult
- Increased compliance improved performance because unaided performance was so low?
- Would compliance rates change with a relatively easy task?
 - Automation failures on easy tasks decreases trust more than on difficult tasks (Madhavan, Wiegmann, & Lacson, 2003)
- Prediction: When unaided performance is high, compliance should be reduced, resulting in a smaller (or negative) performance effect.

Methods – Experiment 2

- 139 participants, paid \$8 per hour
- 100 trials
- Replicated experiment 1 with an easy task
 - Tanks were not as difficult to find
 - Less camouflage

Accuracy – Experiment 2



Experiment 2

- Speeded instructions did not increase compliance
 - Operators relied on their own judgment more often and speeded instruction interfered with decision making.
- Speed-accuracy tradeoff reinstated with an easy task

General Discussion

- Time pressure can increase compliance with automation
- This produces a benefit in some situations
 - Highly reliable automation
 - Difficult task
- Benefits can be eliminated or reversed in other situations
 - Low reliable automation
 - Easy task

Future Research

- Do benefits of time pressure carry over after speeded instructions are removed? (Dixon, et al. 2007)
- What other types of instructions can produce similar effects?
- How can these results be applied to real-world situations? (Dixon, et al., in preparation)