Acquisition and Retention of Team UAV Skills

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Overview

- UAV operations and team coordination
- Studies on team skill acquisition and retention
- Ongoing efforts
- Conclusions & implications

UAV Operations and Team Coordination

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UAV Operations as a Team Task

Team Members

- Ground control station
  - Air Vehicle Operator/Pilot
  - Sensor/Payload Operator
  - DEMPC
- Maintenance
- Air Operations Center
- Intelligence

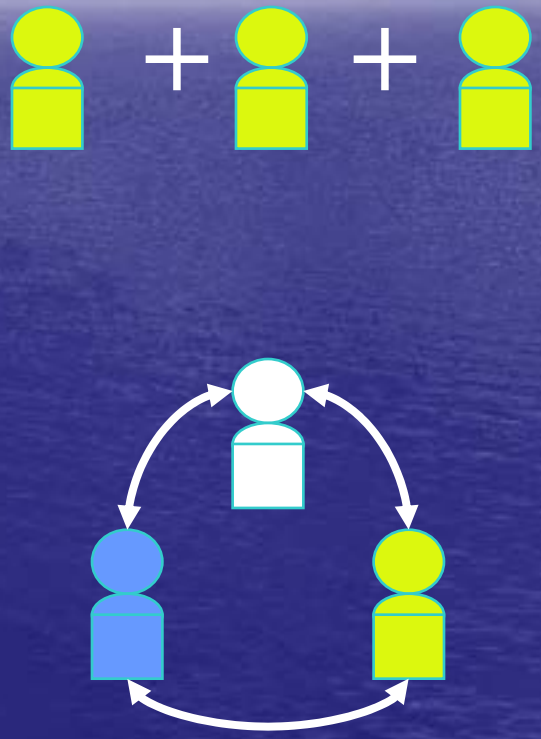
Characteristics

- Heterogeneous
- Teams of Teams
- Fast Tempo
- Distributed

Team Cognition in Practice

Emergent Team Cognition

- Focused on process (vs. product/knowledge)
- It is more than the sum of the cognition of individual team members
- It emerges (Gestalt - like) from the interplay of the individual cognition of each team member or cognitive entity
- Interaction, communication, coordination, push-and-pull of info. is team-level cognitive processing
- Team cognition (or team mind) is observable in the team's coordination behavior
- Poor coordination contributes to system-wide failure and can be improved through training and design



Team Cognition…

- Is *not in the heads* of the individual team members
- It is in the *interactions among team members*

Team coordination IS team cognition and a critical team-level skill

Coordination is Critical to UAV Team Effectiveness

RQ-1 Predator According to the accident investigation board report, the Predator experienced a fuel problem during its descent. Upon entering instrument meteorological conditions and experiencing aircraft icing, the Predator lost engine power. The two Predator pilots, who control the aircraft from a ground station, executed critical action procedures but were unable to land the aircraft safely. It crashed in a wooded area. According to the report, the pilots' attention became too focused on flying the Predator in icing and weather conditions they had rarely encountered. The report also cites *lack of communication between the two pilots* during the flight emergency as a cause of the accident.

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Studies on Team Skill Acquisition and Retention

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CERTT Lab Move

December 2004

5810 S. Sossaman, Mesa AZ

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CERTT Lab

Cognitive Engineering Research on Team Tasks

Unmanned Aerial Vehicle Synthetic Task Environment

In our UAV STE three operators must coordinate in order to maneuver their UAV to take pictures of ground targets

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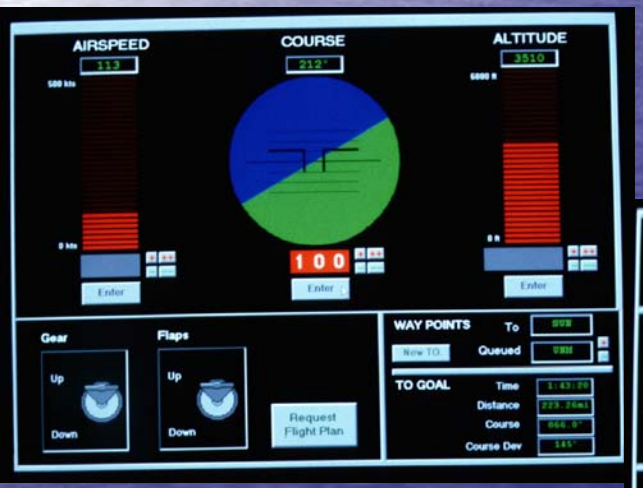
The Synthetic Task

Air Vehicle Operator controls UAV airspeed, heading, and altitude and monitors air vehicle systems

Payload Operator controls camera settings, takes photos, and monitors camera systems

DEMPC navigator, mission planner, plans route from target to target under constraints



Based on a cognitive task analysis done on Predator operations at at Indian Springs, NV

Examples of CERTT UAV-STE Coordination

Good Coordination

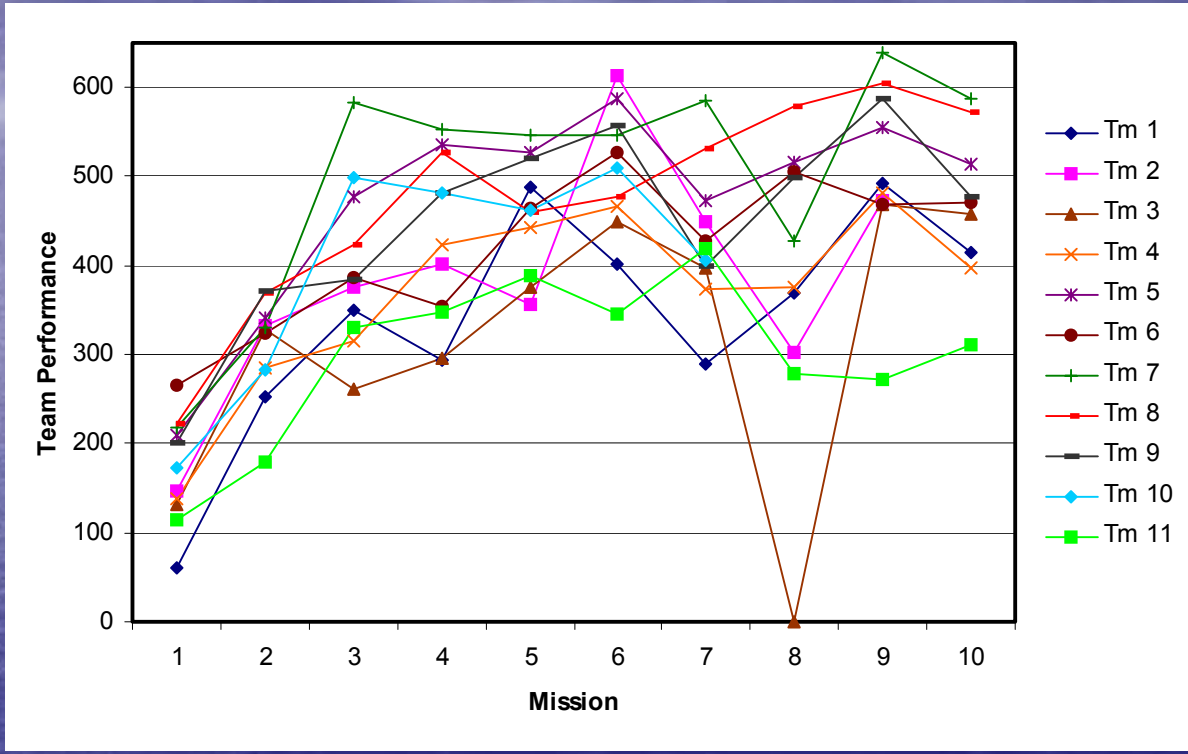
Poor Coordination

Six CERTT UAV Experiments

- Three team members (AVO, PLO, DEMPC) maneuver UAV to take reconnaissance photos
- Independent Variables: knowledge sharing, workload, dispersion
- Primary Measures: performance, process, cognition (teamwork knowledge, taskwork knowledge, SA)
  - Experiment 1: 11 teams, 10 missions
  - Experiment 2: 18 teams, 5 missions, shared vs. unshared
  - Experiment 3: 20 teams, 7 missions, 5-7 high workload, distributed vs. co-located
  - Experiment 4: 20 all-male teams, 5 missions, 5th high workload, distributed vs. co-located
  - Experiment 5: Benchmarking, 5 "expert" teams, 5 missions, 5th high workload
  - Experiment 6: Team member familiarity & retention interval, 40 teams, 8 missions

Team Skill Acquisition

Experiment 1

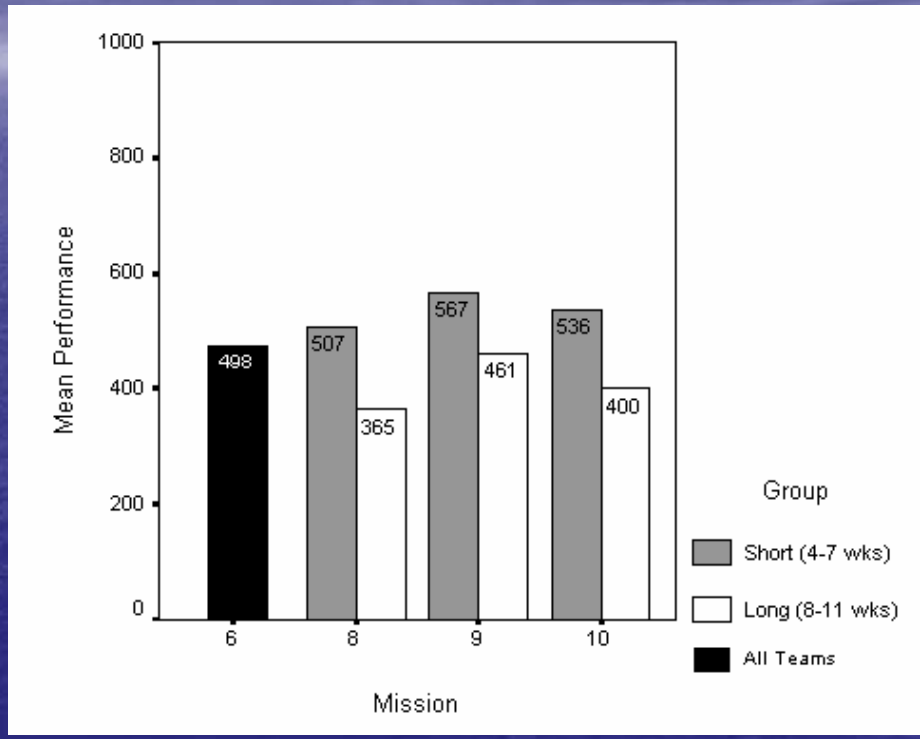


- Individuals are trained to criterion prior to M1
- Asymptotic team performance after 4 40-min missions (robust finding)
- Knowledge changes tend to occur in early learning (M1) and stabilize
- Process improves and communication becomes more standard over time

Team Retention

Experiment 1

Retention Interval Group	Mean (# of weeks)	Min	Max	N
Short (4-7 weeks)	5.86	4.71	6.57	4
Long (8-11 weeks)	9.63	8.71	10.86	5



The question of retention of C2 skill is of great practical importance, but little is known.

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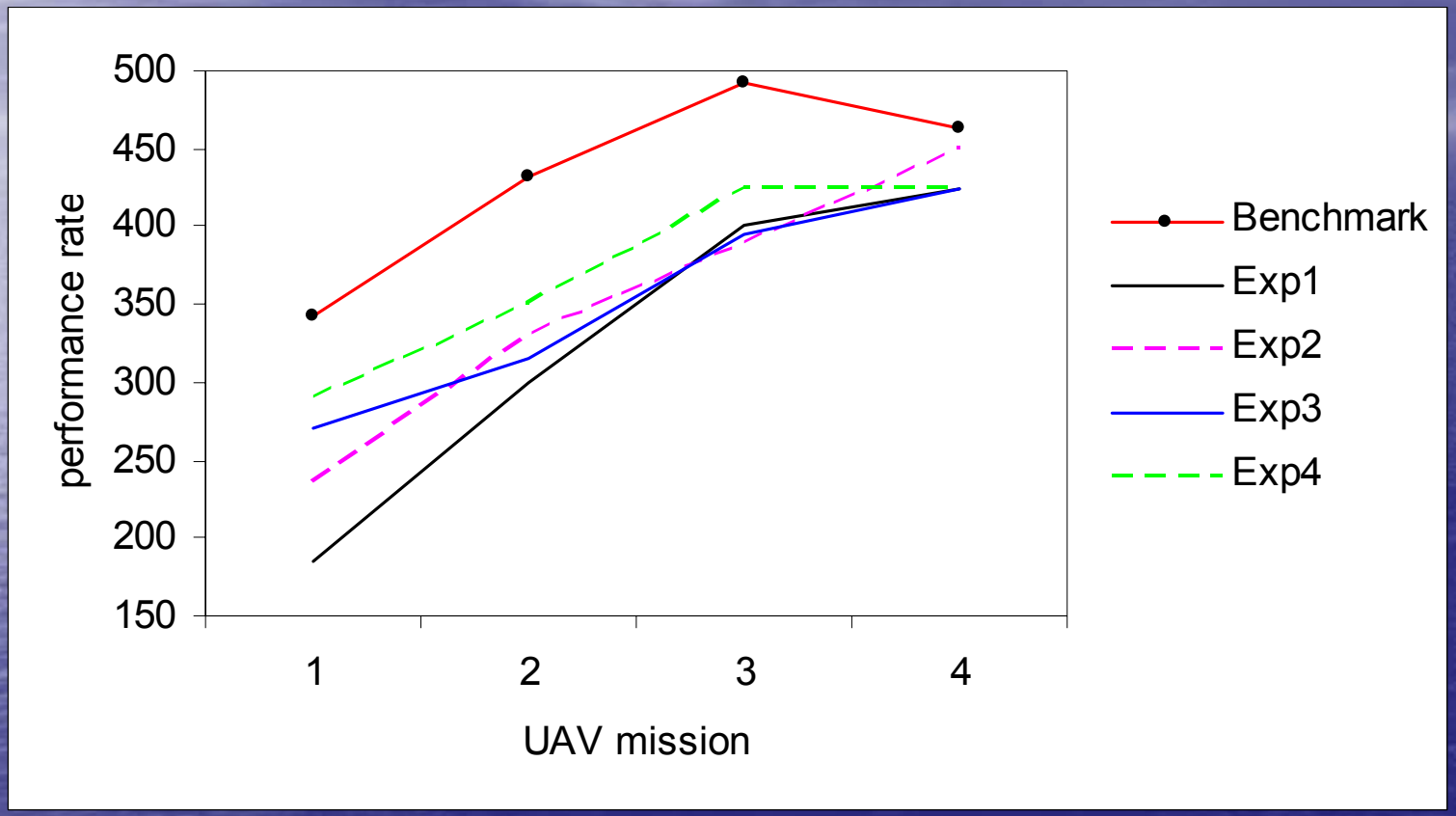
Expert Teams & Skill Acquisition

Experiment 5



Teams take four 40-minute missions (post individual taskwork training) to reach asymptotic performance. Experienced teams reach the same level in 1-2 missions.

Conclusion from Studies

- Coordination involves the timely and adaptive passing of information among cognitive entities in a system
- Teams acquire team skill over time and development of coordination seems critical to this process
- Performance (coordination skill) declines over periods of nonuse
- Coordination skill may transfer across tasks

But…

- Coordination not directly measured (just communication and process)
- Team familiarity confounded with coordination skill at another task

Ongoing Efforts

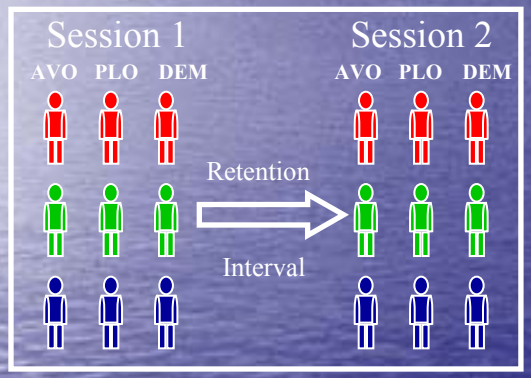
Project Objectives

- Collect empirical data on acquisition and retention of team coordination
  - Little/no existing team retention data
  - Will also manipulate team member familiarity
- Will model optimal coordination at local target waypoints and derive a metric by which to quantify coordination
- Will model development of coordination over time and under various conditions
- Will use data and model to inform intervention to improve retention of coordination

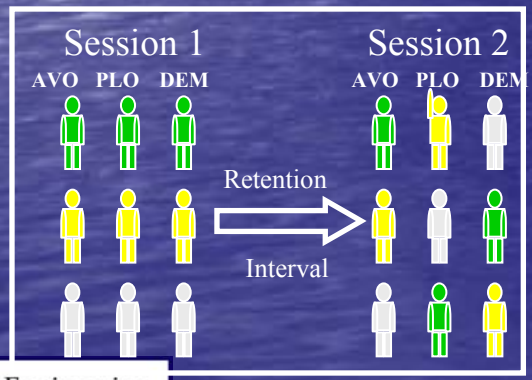
Empirical Study of Acquisition and Retention of Team Coordination

- 120 unfamiliar individuals assigned to 40 UAV teams and a role
- Intervals and familiarity randomly assigned
- Team members will be unfamiliar with one another

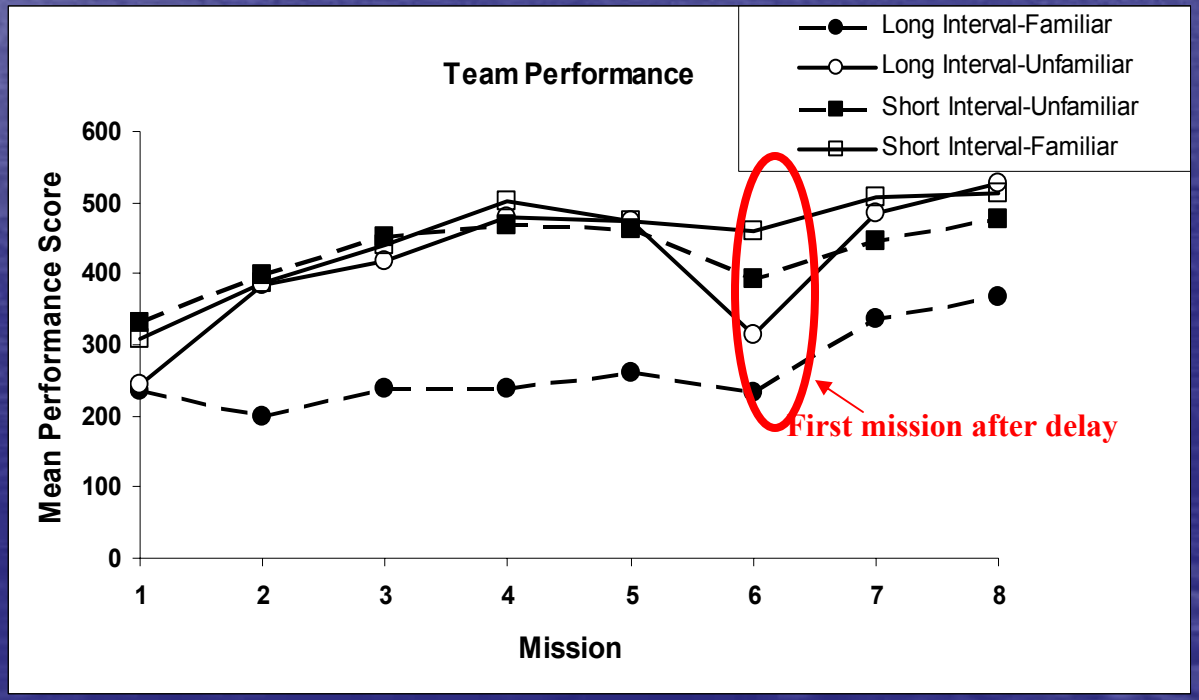
Familiarity	Retention Interval: 3-6 weeks	Retention Interval: 10-13 weeks
Familiar	10 Teams Current N = 4 Teams	10 Teams Current N = 2 Teams
Unfamiliar	10 Teams Current N = 5 Teams	10 Teams Current N = 5 Teams



Familiar Condition



Unfamiliar Condition



Mean Performance Scores Based On Current Data Collected (N = 16 Teams)

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Local Coordination Metric

The Coordination Logger was developed by CERI in order to record the interaction dynamics of specific UAV task elements.

H-AREA

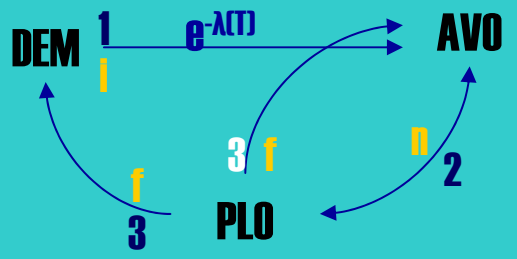
	YES	ASKER A	ASKER P	ASKER D	PASSER A	PASSER P	PASSER D	NO	IMP	RE-PASS		
1. AVO was told restrictions	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. AVO was told radius	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. AVO was told it is target	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. PLO was told radius	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
5. PLO was told it is target	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
6. PLO/AVO coordinate altitude	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
7. PLO/AVO coordinate airspeed	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
8. AVO was told good pic	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

COMMENTS | PROCESS | ?

Experimental observations are fed into an optimal coordination model in order to measure distance from optimal

What is optimal?

F (ordering, timing, mode) =

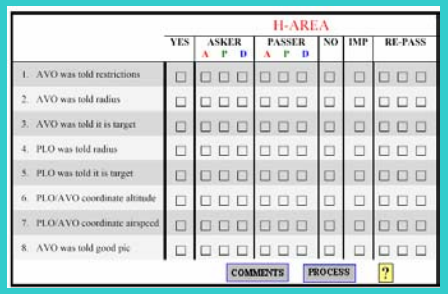


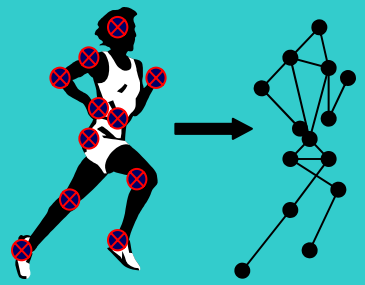
Local optimal modeling

Coordination metric

Dynamical Systems Model of Team Coordination Over Time

Observe team coordination (x) over time

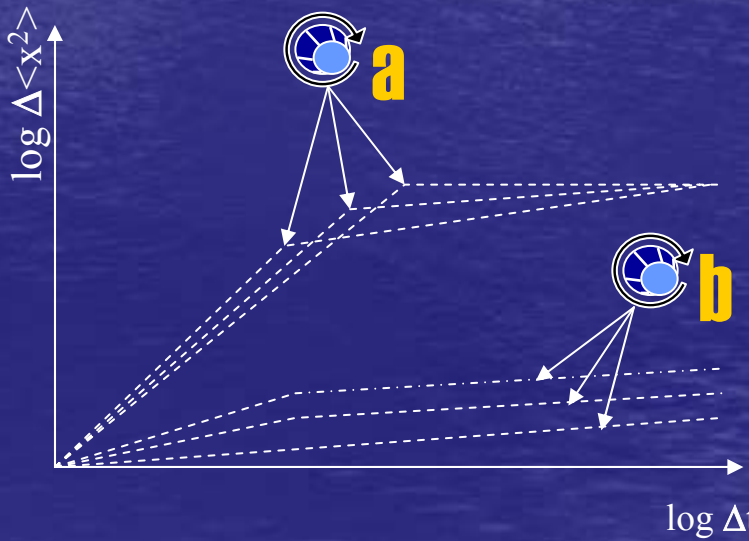




Model with controls for…

a) Retention interval

b) Familiarity



Conclusions and Implications

Conclusions

- Coordination involves the timely and adaptive passing of information among cognitive entities in a system
- In the context of our synthetic UAV operations task, coordination is key to effective team performance
- Teams acquire team skill over time and development of coordination seems critical to this process
- Performance (coordination skill) declines over periods of nonuse
- Coordination skill may transfer across tasks
- Ongoing studies are measuring coordination directly and manipulating team member familiarity

Implications

- Design of UAV technology needs to consider coordination requirements (don't forget the communication function)
- Staffing of UAV ground control needs to consider the need to coordinate and relevant factors such team member familiarity
- Training for UAV ground control also needs to consider appropriate training regime for preserving coordination over planned retention interval
- Coordination metrics, if embedded and automated in the operational or training environment, can facilitate monitoring, assessing, and improving team performance

Questions or Comments?

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