MURI: Training Knowledge and Skills for the Networked Battlefield
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Goals of Project

- Construct a theoretical and empirical framework for training
- Predict the outcomes of different training methods on particular tasks
- Point to ways to optimize training
3 Interrelated Project Components

(1) Experiments and data collection
   (a) Development & testing of training principles
   (b) Acquisition & retention of basic components of skill
   (c) Levels of automation, individual differences, & team performance

(2) Taxonomic analysis

(3) Predictive computational models
Organization of Present Symposium

(I) Introduction

(II) Progress, with Emphasis on Fifth Year
   (A) Experiments
   (B) Models

(III) Closed Meeting with Government Committee
MURI Principal Investigators and Co-Investigators

(1) University of Colorado (CU)
   Alice Healy, Principal Investigator
   Lyle Bourne, Co-Principal Investigator
   Bengt Fornberg, Co-Investigator

(2) Carnegie Mellon University (CMU)
   Cleotilde Gonzalez, Co-Investigator

(3) Colorado State University (CSU)
   Ben Clegg, Co-Investigator
   Eric Heggestad, Co-Investigator

(4) Purdue University (Purdue)
   Robert Proctor, Co-Investigator
MURI Research Associates and Assistants

(1) University of Colorado (CU)
  Bill Raymond, Research Associate
  Carolyn Buck-Gengler, Research Associate
  James Kole, Research Associate
  Michael Young, Graduate Student
  Shaw Ketels, Graduate Student
  Keith Lohse, Graduate Student
  Lindsay Anderson, Graduate Student
  Blu McCormick, Graduate Student
  Michael Overstreet, Research Assistant

(2) Carnegie Mellon University (CMU)
  Varun Dutt, Graduate Student

(3) Colorado State University (CSU)
  Lisa Durrance Blalock, Graduate Student
  Heather Mong, Graduate Student
  John Blitch, Graduate Student
  Robert Gutzwiller, Graduate Student

(4) Purdue University (Purdue)
  Motonori Yamaguchi, Graduate Student
  Dongbin Cho, Graduate Student
  Yun Kyoung Shin, Graduate Student
  Jim Miles, Research Associate
Meeting Presenters

(1) Overview and Coordination
   Healy and Bourne

(2) Experiments
   (a) Development & Testing of Training Principles
       Healy and Bourne
   (b) Acquisition & Retention of Basic Components of Skill
       Proctor
   (c) Levels of Automation, Individual Differences, & Team Performance
       Clegg and Heggestad

(3) Modeling
   (a) IMPRINT
       Raymond and Buck-Gengler
   (b) ACT-R
       Gonzalez

(4) Conclusions and Discussion
   Bourne
Development and Testing of Training Principles: Completed Experiments

(1) Tests of the generality across tasks of individual principles
(2) Tests of multiple principles in a single task
(3) Tests of principles in complex, dynamic environments
(4) Developing and testing new principles
Serial Position Principle

Retention is best for items at the start of a list (primacy advantage) and at the end of a list (recency advantage).
Procedure

• 48 trials
• 7-item sequences
• One optimal deployment location
• Free or serial recall
• No threat or threat
• Testing over 2 weeks
Procedure

• 48 trials
• 7-item sequences
• One optimal deployment location
• Free or serial recall
• No threat or threat
• Testing over 2 weeks
Imagine you are a military intelligence analyst. You are on the battlefield testing team for a new micro unmanned aerial vehicle (UAV, Figure 1).

Your mission is to monitor enemy forces in order to inform remote pilots of the best locations to deploy these UAV units.

You will see a grid representing a battlefield. After a green x flashes at the center of the grid, a series of square blips representing enemy forces will light up. These blips will appear and disappear one at a time on the screen.

Your goal is to choose a location on the battlefield at which to place the UAV from which it can gain the greatest amount of useful information possible about all enemies on the battlefield. Because the sensors on this UAV that are used for data gathering have a limited range, the closer the UAV is to an enemy location, the more information it can gain about it. Keep in mind that each scenario has a unique best location for UAV deployment.

To carry out your mission, pay close attention to the exact locations of enemies as they are presented on the screen one at a time. After seeing all of the enemies in a series, you must immediately make a decision as to the battlefield position that represents the single most useful UAV placement, and use the mouse to click on that location to inform battlefield commanders of your choice. You can only pick ONE placement per series of enemy locations, and, once selected, your choice cannot be changed.

Immediately after choosing what you believe to be the best UAV placement, you will see a screen with a star showing the actual location of most useful UAV placement for the series of enemy locations just
Design

Within-Subjects Variables

Serial Position (1-7)

Testing Block (1-3)

Between-Subjects Variables

Threat Condition (No Threat, Threat)

Recall Condition (Free, Serial)
Serial Position

5.0

5.2

5.4

5.6

5.8

6.0

6.2

Deployment Decision

Mean Distance from Location

No Threat

Threat

Serial Position

1 2 3 4 5 6 7
Recall

Proportion of Errors

Serial Position

Free
Serial
Principle of Training Compression

Training can be truncated by eliminating practice on known facts.

Principle of Testing

A test can strengthen a person’s knowledge of material as much as, or possibly even more than, can further study.
Procedure
Experiment 1

• Facts about unknown plants
• 64 facts about plants; each fact specific or general
  • “A tree that is native to southern India is Pawthra”
  • “A tree that comes from Asia is Pawthra”
• Multiple-choice test; 4 alternatives
  • “A tree that is native to southern India is ___”
• 4 study-test training rounds
• 1st and 4th rounds involve all 64 facts; 2nd and 3rd rounds involve fewer facts in some conditions
• Full-study, Dropout, Yoked, Clicker conditions
• Immediate test and retention test 1 week later
Procedure

Experiment 1

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Design
Experiment 1

Between-Subjects Variable

Training Condition
(Full-Study, Dropout, Yoked, Clicker)

Within-Subjects Variables

Test
(Immediate, Retention)

Training Format
(General, Specific)

Test Format
(General, Specific)
Procedure
Experiment 2

• Facts about unknown plants
• 64 facts about plants; each fact specific or general
  • “A tree that is native to southern India is Pawthra”
  • “A tree that comes from Asia is Pawthra”
• Multiple-choice test; 4 alternatives
  • “A tree that is native to southern India is ___”
• 4 study-test training rounds
• 1st and 4th rounds involve all 64 facts; 2nd and 3rd rounds involve fewer facts
• Immediate test and retention test 1 week later
• Study-Test, Study-Study, Test-Test conditions
Design

Experiment 2

**Between-Subjects Variable**

Training Condition
(Study-Test, Study-Study, Test-Test)

**Within-Subjects Variables**

Test
(Immediate, Retention)

Training Format
(General, Specific)

Test Format
(General, Specific)
Test Experiment 1

Test Experiment 2
Principle of Optimal Modality Use

Learning is better when information is seen than when it is read, and it is best when the information is both read and seen.

Optimal Modalities:

(1) Both Read & See (2) See (3) Read
Design

**Between-Subjects Variable**

**Condition**
(Single, Double, Mixed)

**Modality**
(Words, Symbols)

**Within-Subjects Variables**

**Block**
(1-6)

**Message Length**
(1-6 commands)
Left two squares
Down two levels
Forward one step
Condition | Proportion Correct
---|---
double | 0.75
mixed | 0.65
single | 0.50
Proportion Correct

Message Length

Symbols Double
Words Double
Words Single
Symbols Single
Principle of Positive Focusing

Regularities obeying complex rules can sometimes be best appreciated with only positive exemplars, rather than both positive and negative exemplars.
Design

**Between-Subjects Variable**
Grammar (*Same, Different*)
Acquisition Condition (*All Positive, Blocked, Mixed*)

**Within-Subjects Variables**
Week (*Week 1, Week 2*)
String Type (*Ungrammatical, Grammatical*)

**Dependent Variables at Test**
Number Correct (*out of 15*)
Confidence Rating (*1-6*)
The bar chart shows the mean total number correct across different acquisition conditions.

- **All Positive**: The highest mean total number correct, slightly above 9.5.
- **Blocked**: A lower mean total number correct, around 8.5.
- **Mixed**: Similar to Blocked, with a mean total number correct around 8.5.

The error bars indicate the variability around each mean.
Acquisition

All Positive | Blocked | Mixed

Mean Confidence Rating (1-6)
Development and Testing of Training Principles

(1) Tests of the generality across tasks of individual principles
(2) Tests of multiple principles in a single task
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(4) Developing and testing new principles

- Serial Position Principle
- Principle of Training Compression
- Principle of Testing
- Principle of Optimal Modality Use
- Principle of Positive Focusing
Other CU MURI Presentations at RMPA


McCormick, B., & Healy, A. F. Words and symbols use different working memory resources in a navigational task.

Overstreet, M. F., & Healy, A. F. Item and order information in semantic memory: Students’ retention of the CU fight song.

Young, M. D., Healy, A. F., & Bourne, L. E., Jr. Artificial grammar learning: Retention and transfer.
Significant Publications Based on MURI Research Over the Last Year

(1) 21 submitted manuscripts

(2) 19 peer-reviewed journal publications

(3) 8 chapters published in books or conference proceedings

(4) 36 presentations at professional meetings

(5) 1 doctoral dissertation
Significant Meetings Related to Army Training over Last Year

(1) **Healy & Proctor**, Workshop to Explore Issues and Mitigation Strategies for Long Term Retention of Military Expertise
   **October, Mesa, AZ**

(2) **MURI team**, RMPA Convention, Ellis-Battig Memory Symposium
   **April, Denver, CO**

(3) **MURI team**, Human Factors and Ergonomics Society Meeting, Proctor Proposed Symposium
   **September, San Francisco, CA**