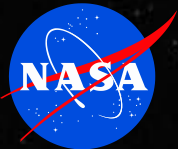


Training for Mars

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Introduction

NASA has been studying the long term retention and transfer of trained skills using two tasks:

- **A memory task**
- **A data entry task**

While this research is on going, we report here one completed study using undergraduate university students as subjects. This study was conducted in collaboration with Alice Healy, Vivian Schneider and Carolyn Buck-Gengler at the University of Colorado, Boulder and with James Kole at the University of Northern Colorado.

A Brief History of Spaceflight Training

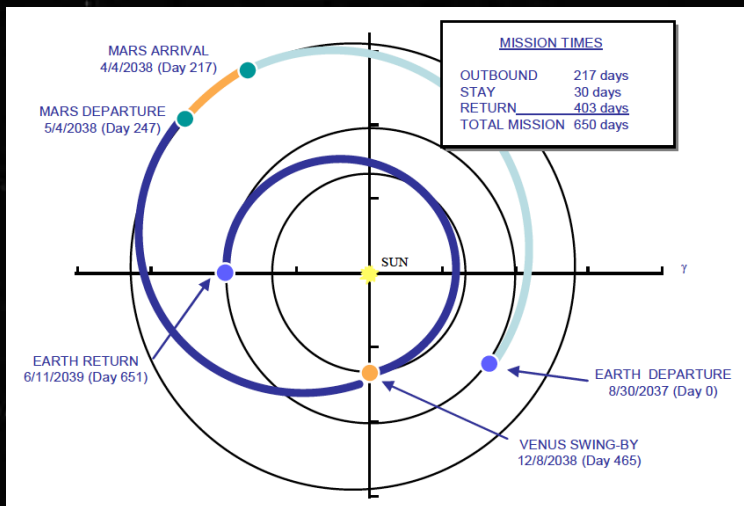
Spaceflight training for Apollo era and Space Shuttle missions was designed to train crew on specific tasks for their short duration missions. The training mottos included “practice, practice, practice” and “hammering it in.”

However, training for longer duration ISS missions has been more challenging. There is clear documentation that tasks and skills trained pre-flight are not all retained throughout the mission, and this lack of training retention is augmented with real-time ground support.

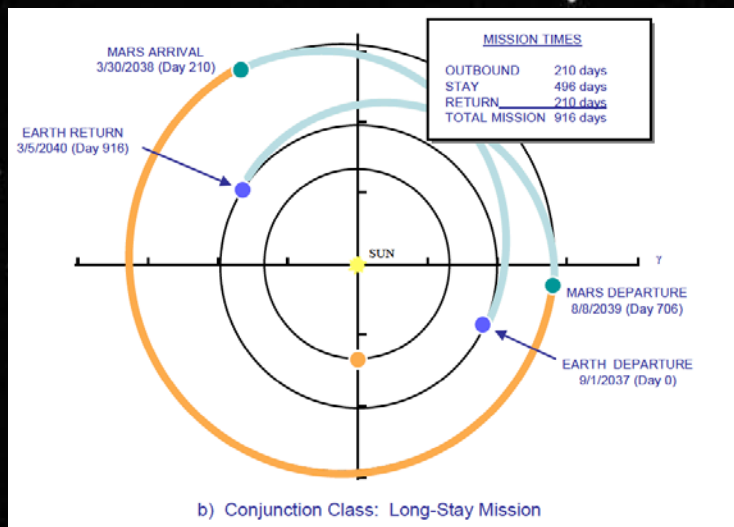
NASA does not currently have a training design that supports semi-autonomous to autonomous mission operations.

Mission to Mars

The current design of a manned Mars mission calls for a 32-month long mission and asynchronous communication involving long delays.



Short-Stay Mission



b) Conjunction Class: Long-Stay Mission

Long-Stay Mission

Training for Mars

The long duration of the mission and the inability to maintain real-time communication with Earth for mission support require skill-based training that ensures long-term retention and the ability to transfer the acquired skills to tasks and situations that were not previously trained.

Training Retention and Transfer Research Study

To design such training, we have been studying the long term retention and transfer of trained skills using two tasks:

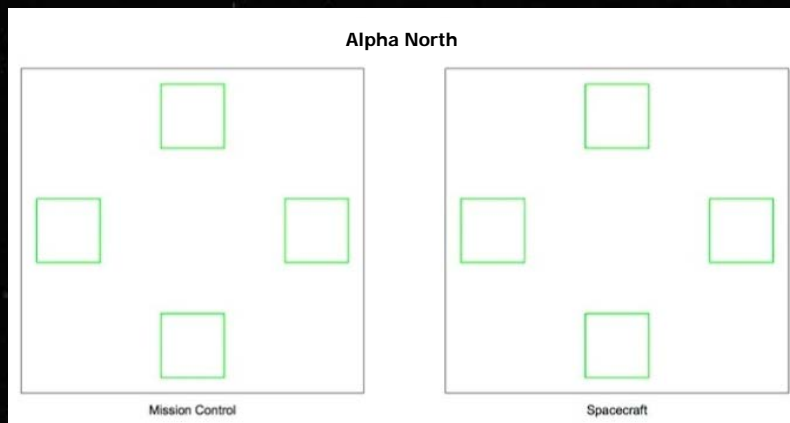
- **A memory task**
- **A data entry task**

Memory Task

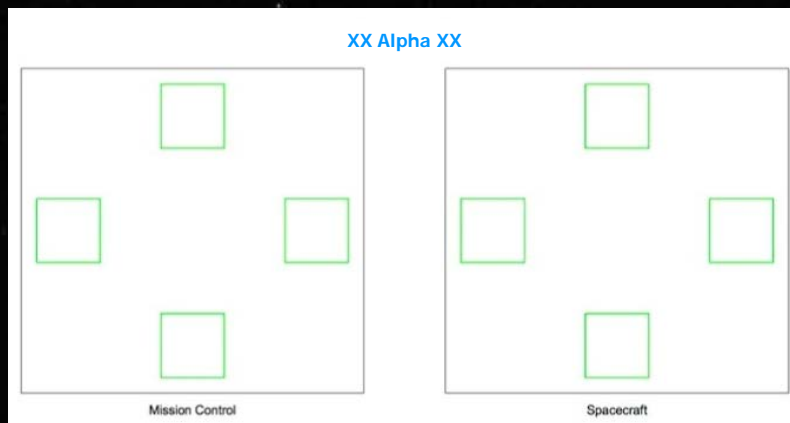
In a continuous memory-updating paradigm, subjects studied name-location associations and were tested later for the location most recently associated with a given name.

Subjects study the name-location association and mark the corresponding location on the map.

The black font indicates that a default response will be required later when recalling the location of Alpha:



The default response for Alpha is marked in the same location, on the right side of the map:

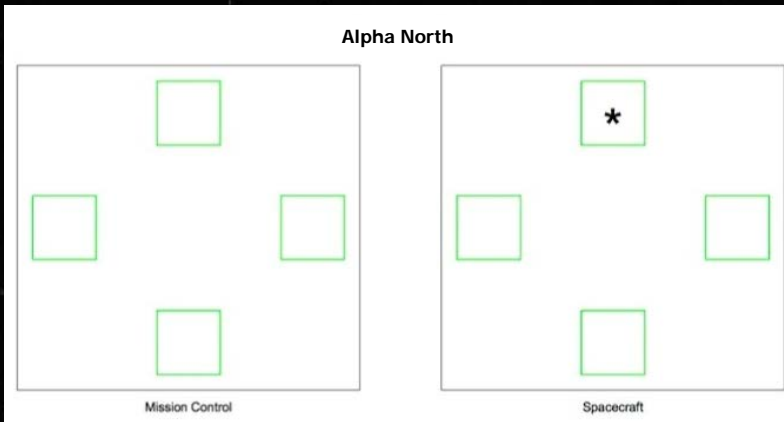


Default Response

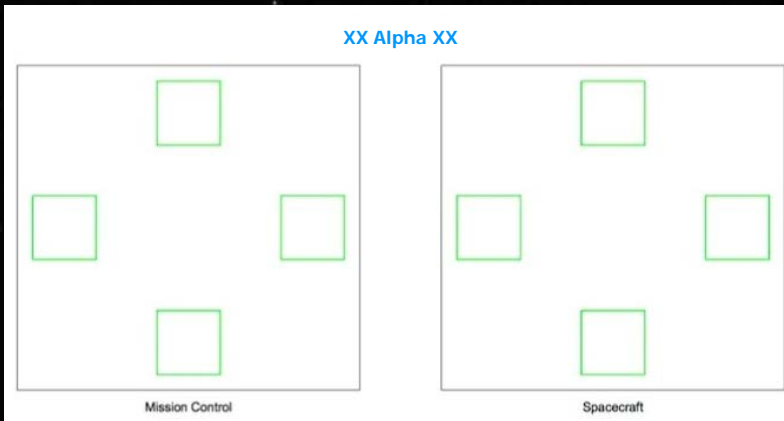
- For the default response, subjects mark the same location, on the right side of the map.

Subjects study the name-location association and mark the corresponding location on the map.

The black font indicates that a default response will be required later when recalling the location of Alpha:



The default response for Alpha is marked in the same location, on the right side of the map:

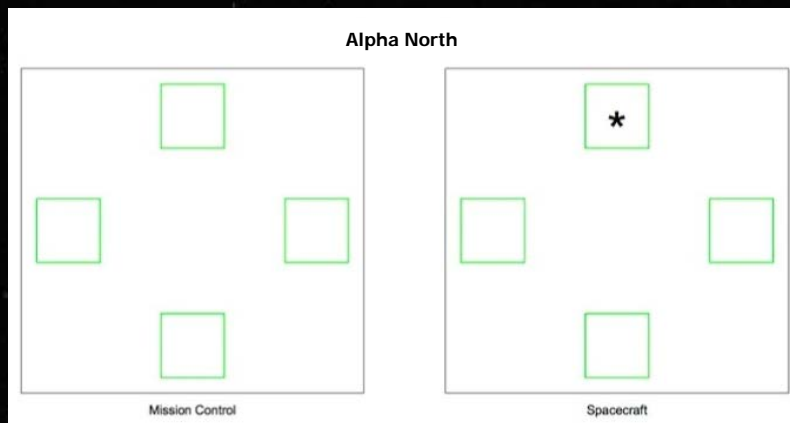


Default Response

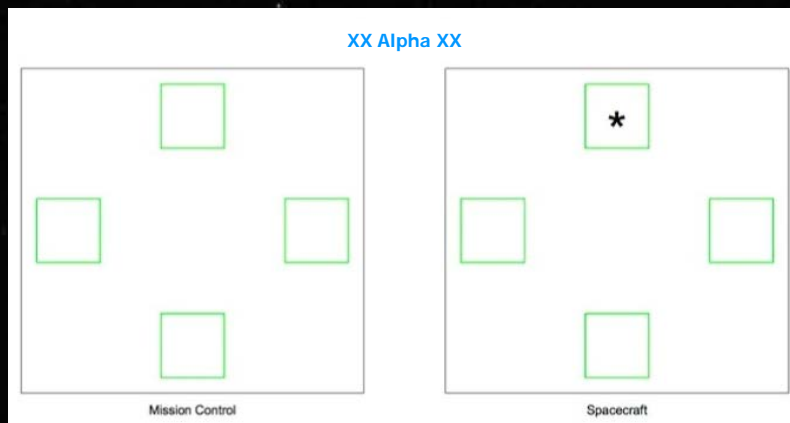
- For the default response, subjects mark the same location, on the right side of the map.

Subjects study the name-location association and mark the corresponding location on the map.

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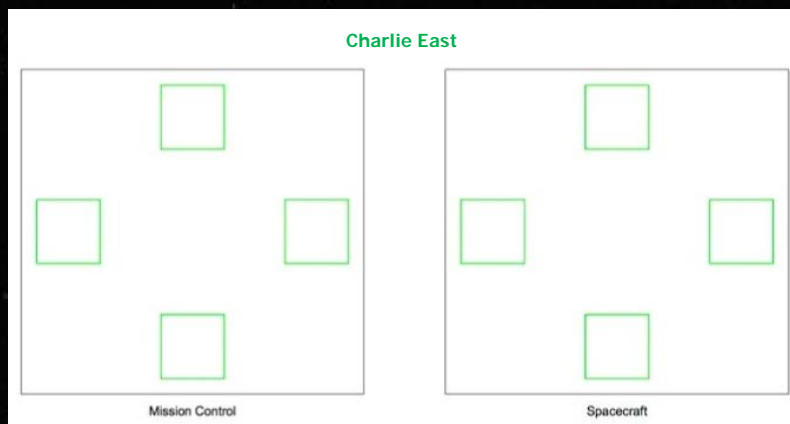


Default Response

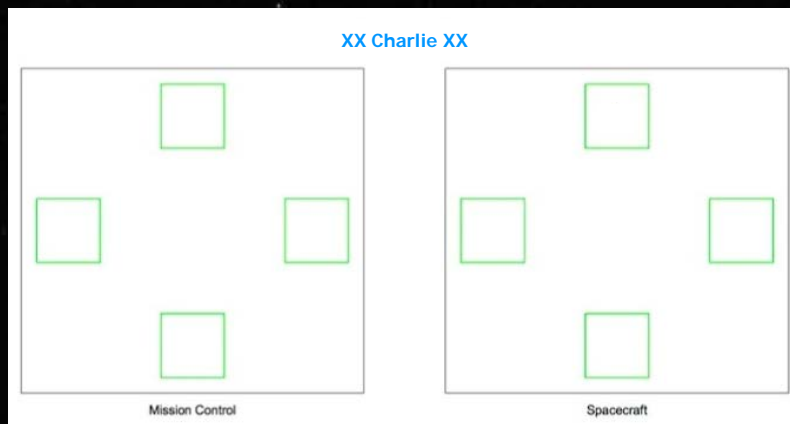
- For the default response, subjects mark the same location, on the right side of the map.

Subjects study the name-location association and mark the corresponding location on the map.

The green font indicates that a distinctive response will be required later when recalling the location of Charlie:



The distinctive response for Charlie is marked on the map on the other side of the display:

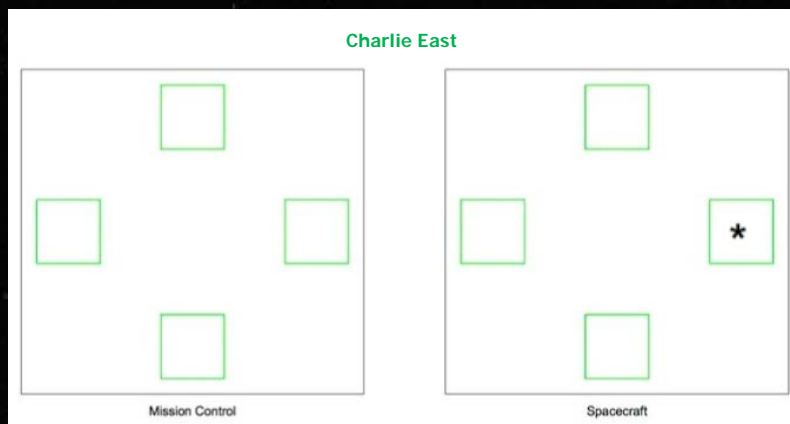


Distinctive Response

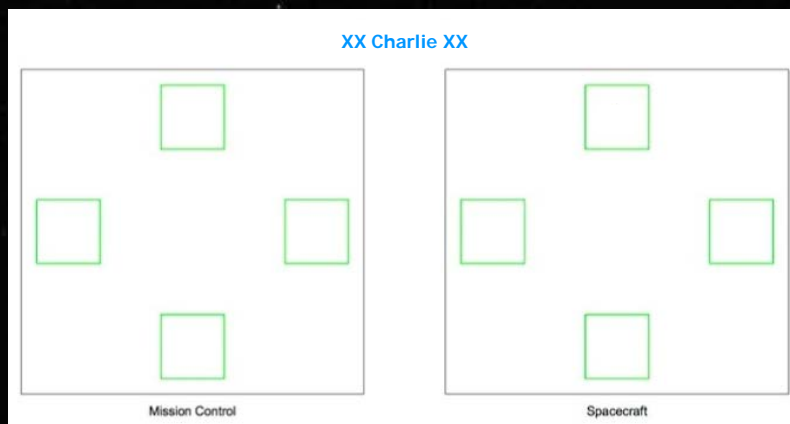
- For the distinctive response, subjects mark the location on the map on the other side of the display.

Subjects study the name-location association and mark the corresponding location on the map.

The green font indicates that a distinctive response will be required later when recalling the location of Charlie:



The distinctive response for Charlie is marked on the map on the other side of the display:

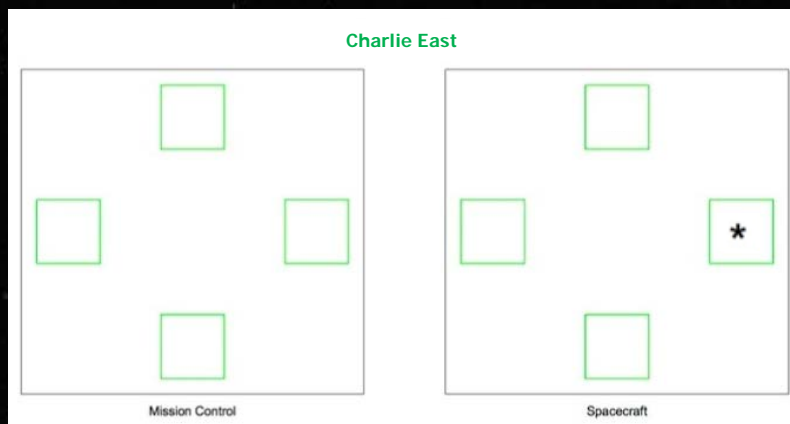


Distinctive Response

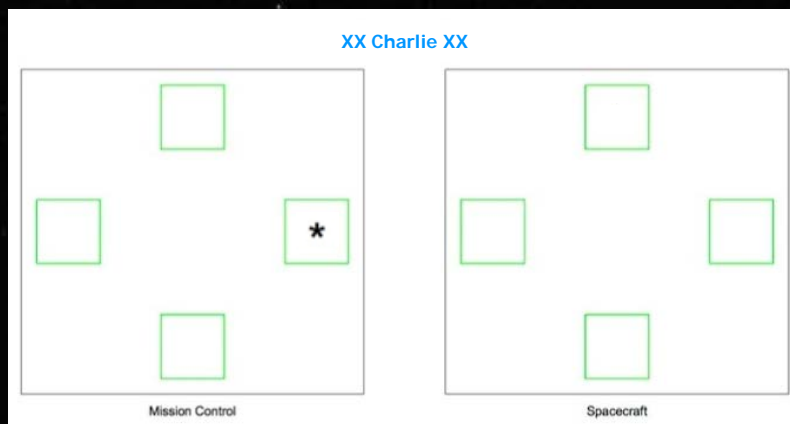
- For the distinctive response, subjects mark the location on the map on the other side of the display.

Subjects study the name-location association and mark the corresponding location on the map.

The green font indicates that a distinctive response will be required later when recalling the location of Charlie:



The distinctive response for Charlie is marked on the map on the other side of the display:



Distinctive Response

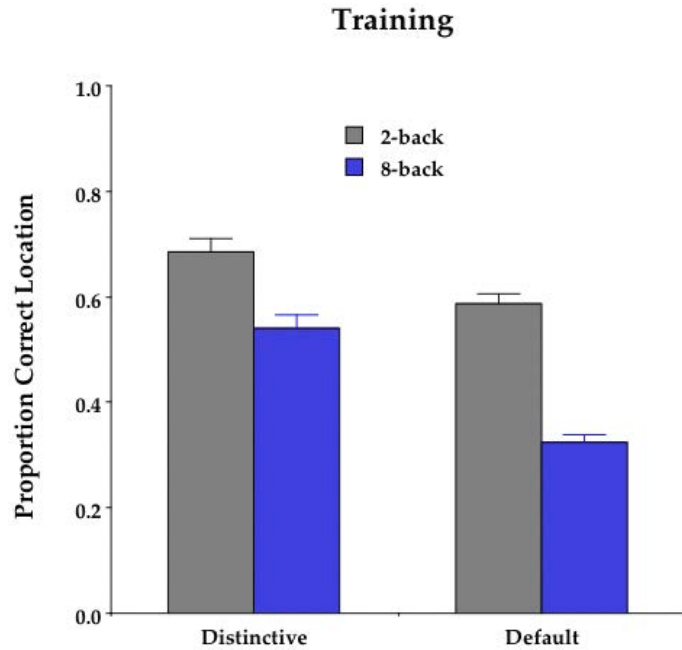
- For the distinctive response, subjects mark the location on the map on the other side of the display.

Memory Task Results

Participants completed the task at test 6 or 8 months after training under conditions where working memory was or was not occupied with a secondary counting backwards task.

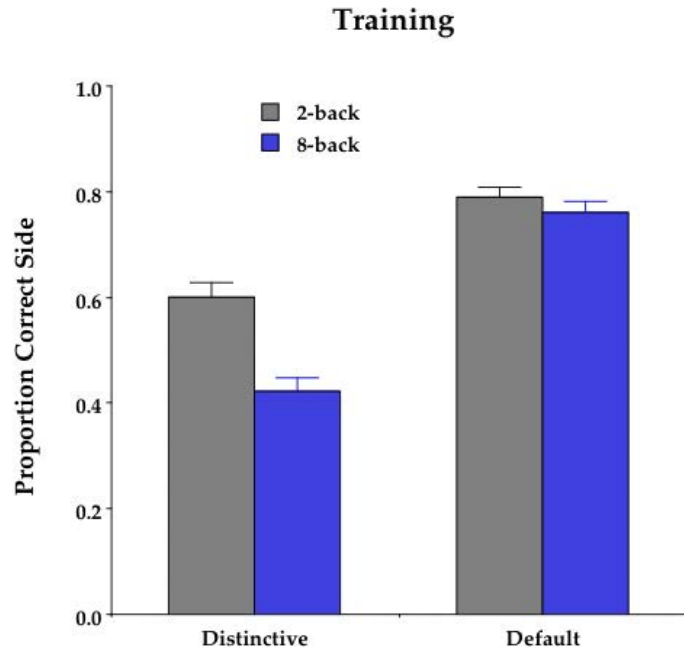
Memory for the location associated with a given name was better overall with short than with long retention intervals and was better when distinctive (rather than default) responses were to be made, especially at the long retention interval, even when counting backwards was required.

Results: Training



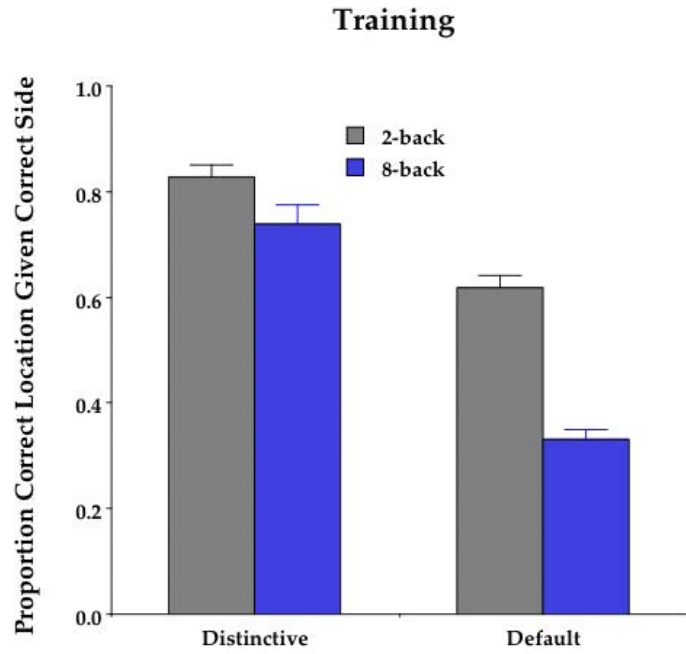
- Proportion correct **location** as a function of trial type and retention interval during training.

Results: Training



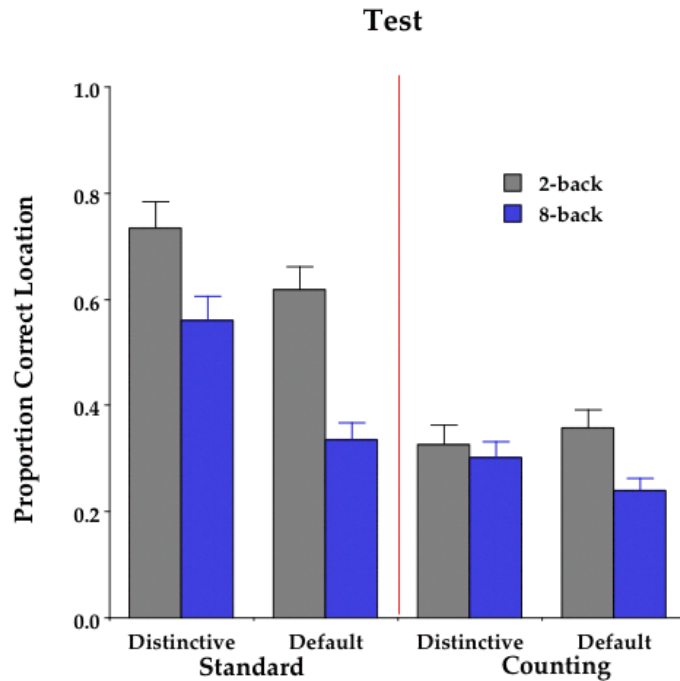
- Proportion correct **side** as a function of trial type and retention interval during training.

Results: Training



- Proportion correct **location** given correct **side** as a function of trial type and retention interval during training.

Results: Test



- Proportion correct **location** as a function of test session, trial type, and retention interval at test.

Memory Task Conclusions

This research replicated the finding that distinctive responding protects against forgetting associations.

However, researchers found no evidence that the protective function is due to holding the associations from the distinctive trials in working memory.

Understanding the cause of the protective function for distinctive responding is, thus, a challenge for future theorizing and research

Data Entry Task

In an data entry task, subjects trained in a standard data entry task and were tested later on the standard test followed by variants of the standard task.

Standard Task



Left-Hand Task (Motoric Change)



Code Task (Perceptual Change)



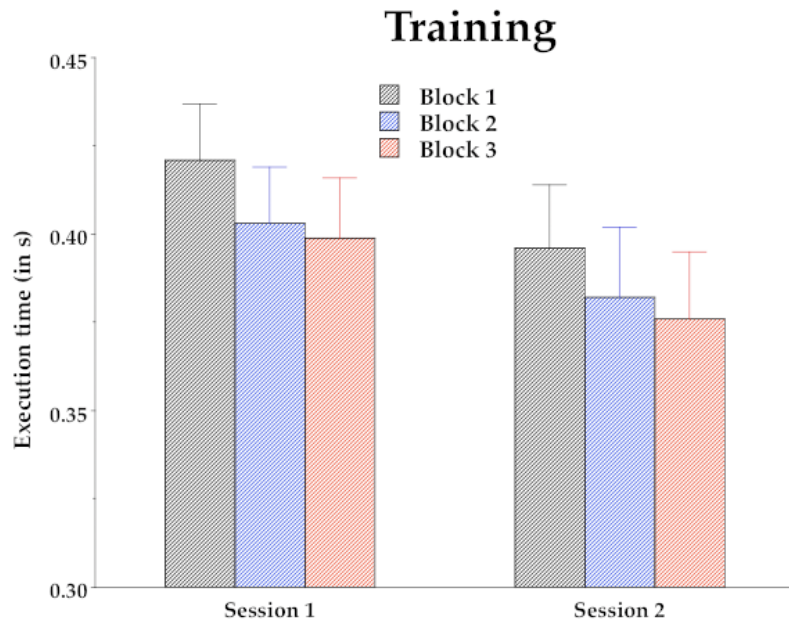
Standard Task and Variants

- Standard Task
 - Involved subjects typing numbers using their right (or dominant) hand.
- Left-Hand Task
 - At an initial test (6 months after training), subjects completed the standard task, followed by a left-hand variant (typing with their left hands) that involved the same perceptual, but different motoric, processes as the standard task.
- Code Task
 - At a second test (8 months after training), subjects completed the standard task, followed by a code variant (translating letters into digits, then typing the digits with their right hands) that involved different perceptual, but the same motoric, processes as the standard task.

Data Entry Task Results

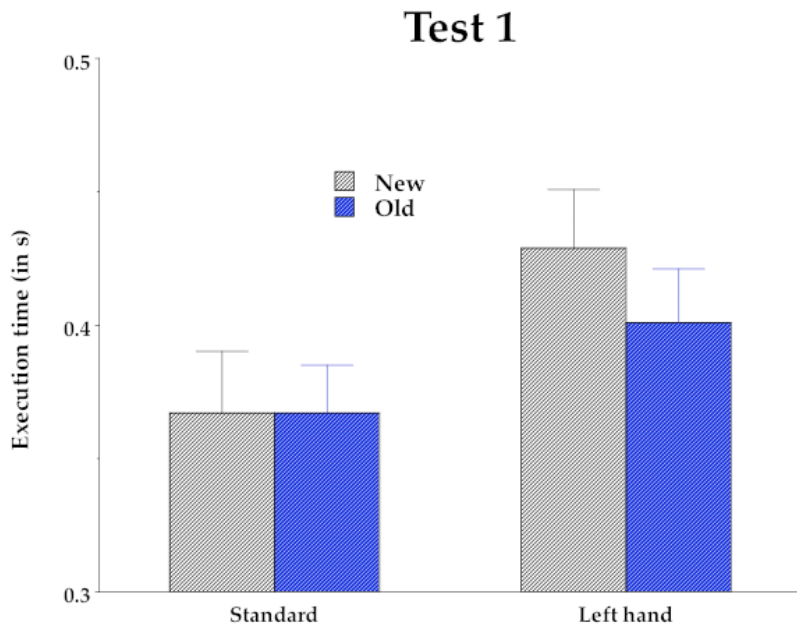
At test, for each of the three tasks, half the trials were trained numbers (old) and half were new. Repetition priming (faster response times to old than new numbers) was found for each task. Repetition priming for the standard task reflects retention of trained numbers; for the left-hand variant reflects transfer of perceptual processes; and for the code variant reflects transfer of motoric processes. There was thus evidence for both specificity and generalizability of training data entry perceptual and motoric processes over very long retention intervals.

Results: Training



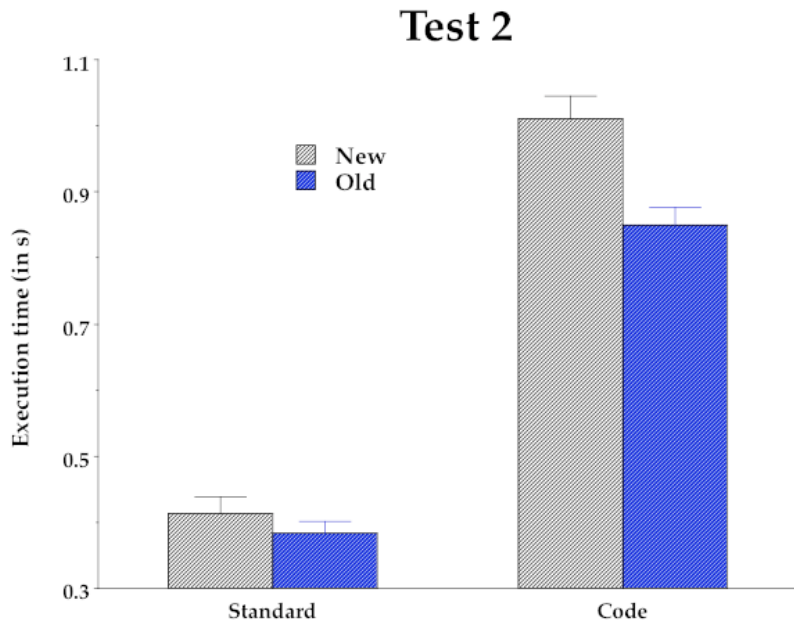
- There were significant main effects of both session and block of training.

Results: Training



- There were significant main effects of task and trial type and a significant interaction between task and trial type. In separate analyses of each task, there was significant repetition priming (**old** faster than **new**) for the **left-hand** task but not for the **standard** task.

Results: Results



- There were significant main effects of task and trial type and a significant interaction between task and trial type. In separate analyses of each task, there was significant repetition priming for both tasks, but repetition priming was larger for the **code** than for the **standard** task.

Data Entry Task

Conclusions

The observed repetition priming in the **standard** task at Test 2 (advantage for **old** relative to **new** stimuli) provides evidence both for specificity of training and for retention of the trained stimuli over the very long retention interval of 8 months.

The observed repetition priming on the **left-hand** and **code** tasks at Tests 1 and 2 (which was significantly larger than that for the standard task) provides evidence for generalizability of training from the **standard** task to other conditions. For the **left-hand** task there was transfer of perceptual processes despite changes in motoric processes, and for the code task there was transfer of motoric processes despite changes in perceptual processes.

Data Entry Task Conclusions

In previous work with other tasks and measures (Healy, Schneider, & Barshi, 2015), either specificity or generalizability was found, but not both. Nevertheless, there was evidence here for both specificity and generalizability of training for both perceptual and motoric processes of data entry even over very long delays.

Implications for Training for Mars

We are currently running two additional subject groups through these two tasks, the 2017 astronaut candidate class and a group of “crew-like” subjects.

The results of our research will inform the design of training for a future manned mission to Mars, including the need for and possible scheduling of onboard refresher and JIT training.