ICA-7

Increasing Cognitive Ability/Reserve Using Software – Pilot Study (ICARUS-Pilot)

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Technology Taxonomy Area (TX): 6.2.3 Informatics and Decision Support Systems, 6.3.2 Prevention and Countermeasures, 6.3.3 Behavioral Health and Performance, 6.3.7 System Transformative Health and Performance Concepts, 6.6.1 Human Factors Engineering, 6.6.2 Training, 6.6.4 Operations Effectiveness

TRL: Start 2 / Current 3

FY22 ICA PROJECT OVERVIEW

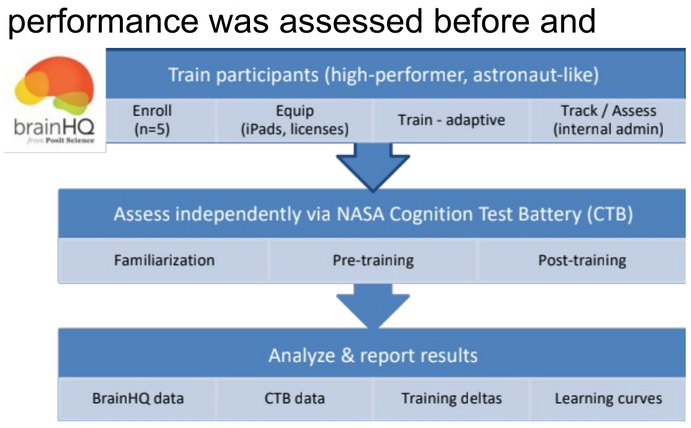
The ICARUS-Pilot study sought to quantify and assess the potential benefit of using commercial-off-the-shelf (COTS) cognitive training software to improve cognitive performance in an astronaut-like terrestrial population.

INNOVATION

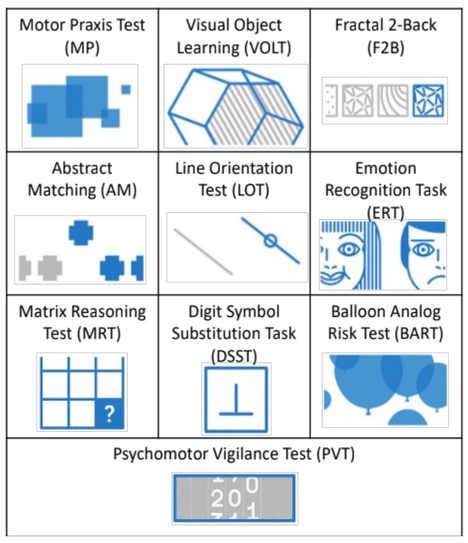
The brain adapts and changes throughout a person's lifetime, creating new pathways in response to challenges (such as injury or disease) or training. Software training has shown cognitive performance improvement in healthy military and law-enforcement populations as well as terrestrial disease and aging populations, with performance data showing generalization outside the training program. Little cognitive training data is available specifically related to an astronaut-like population for tasks specifically relevant to crew autonomous operations. This study is the first step to provide that.

METHODS

Five volunteer research participants were recruited from the JSC employee population to mimic certain characteristics of the NASA astronaut population (age, education/discipline). Participant cognitive performance was assessed before and after executing 18 remote cognitive training sessions nominally three times per week using an adaptive app-based COTS software package (BrainHQ). Pre- and post-training cognitive performance was measured using internal BrainHQ assessments as well as Cognition Test Battery (CTB), an independent suite of software tests developed specifically for NASA and used currently in research studies on astronauts. Participants provided feedback on their study experience formally via semi-structured interview at the end of testing and informally throughout the study if they encountered issues.



ICARUS-Pilot operational study flow



CTB tests used for assessment

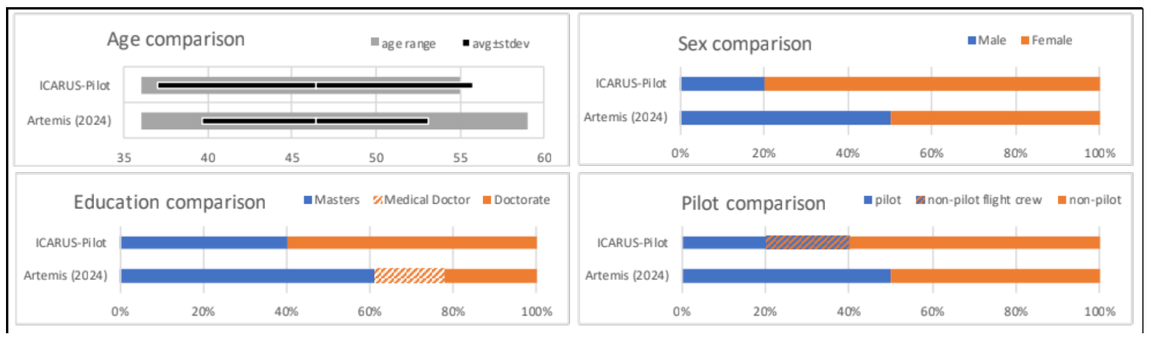
Double Decision	Target Tracker	Mind's Eye
• Targets visual processing speed and useful field of view • Focuses your attention on a task in the middle of the screen while also noticing where a target appears in the periphery of the screen	• Targets visual attention • Requires you to track several items moving around your screen at the same time, then click on the desired targets	• Targets sensory discrimination • Requires you to focus on one particular aspect of the visual field while ignoring similar visual distractors all around you
Card Shark	**Mind Bender**	**Mental Map**
• Targets the ability to retain, compare, and work with visual information • Focuses your attention on target characteristics and requires you to remember what was shown earlier in the sequence	• Targets executive control and cognitive flexibility • Requires you to react quickly and accurately to choose between two items based on a specified rule	• Targets spatial memory and mental manipulation • Requires you to remember relative locations of important objects on a grid, then reconstruct the grid from memory after it has been rotated, flipped, or translated

BrainHQ exercises used for participant training/assessment

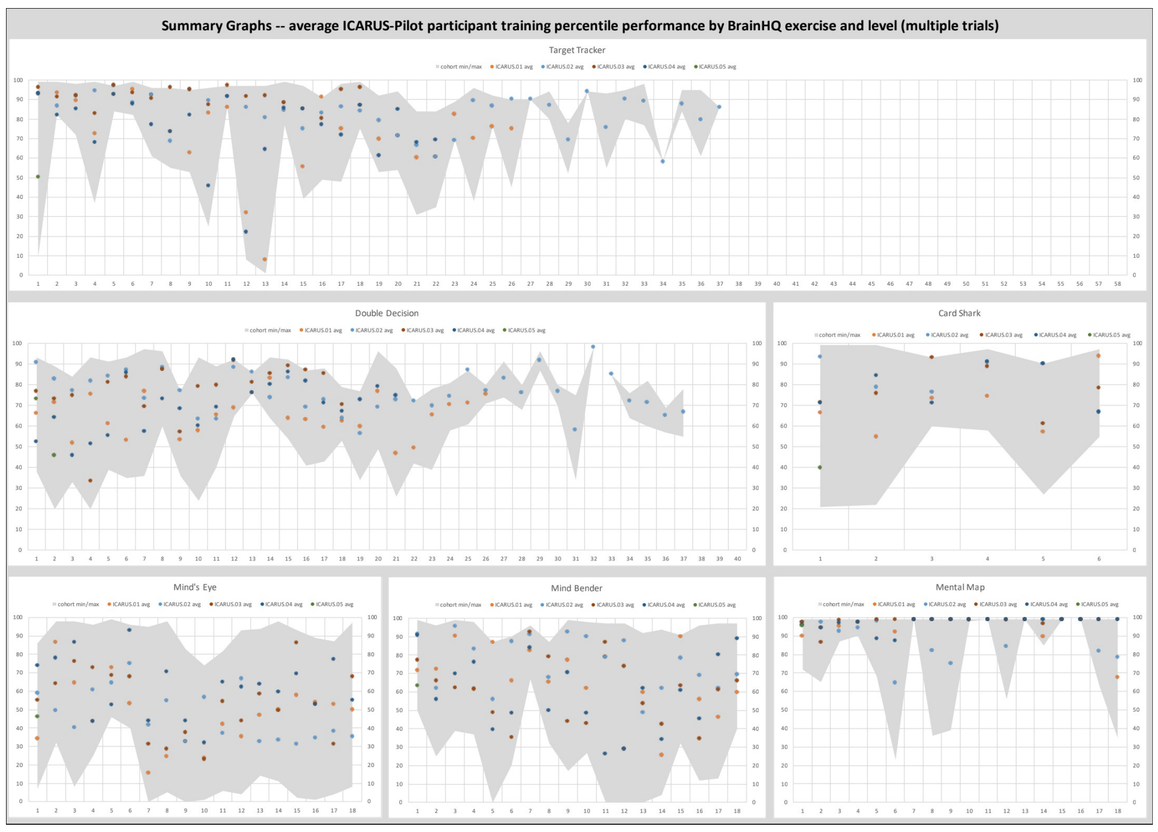
PARTNERSHIPS / COLLABORATIONS

This effort engaged NASA personnel from JSC and Ames as well as industry (Posit Science, the company that offers the COTS software BrainHQ).

RESULTS



Population comparison – ICARUS-Pilot participants (current) vs Artemis crew (2024)



Summary of BrainHQ training performance by exercise, level

subject ID	training duration (days)	training sessions completed	mean time between training (days)	total training time (min)	avg session training time (min)	total trials / levels completed	ending performance [delta] (%ile)
ICARUS.01	56	18	3.3	994.1	55.2	429 / 112	79 [+35]
ICARUS.02	34	18	2.0	1001.8	55.7	460 / 134	81 [+25]
ICARUS.03	42	18	2.5	771.4	42.9	293 / 96	87 [+23]
ICARUS.04	48	18	2.8	798.7	44.4	319 / 103	93 [+48]
ICARUS.05	1*	1*	NA*	61.0*	61.0*	28* / 7*	48 [+23]

**Training data recovery pending from app (used offline) – only training data from online website use is reflected*

ICARUS-Pilot participant BrainHQ training summary

BrainHQ internal assessment showed 71% average performance metric increase and 31 percentile overall ranking increase for the study cohort against performance for the entire BrainHQ subscribing population, which agreed with post-study survey self-reported performance assessment. CTB pre/post assessment (not corrected for learning effects) showed average 19% performance improvement in aggregate across its 10 performance measures over the training period for the study cohort.

DISCUSSION / FUTURE WORK

Preliminary analysis of results shows a trend for the effectiveness of the training approach within the bounds of the specific modules trained, and the results suggest the needed subject pool size for subsequent efforts to achieve statistically significant outcomes.

The study team will continue data analysis efforts and pursue publication of these pilot study results. The team will also seek future funding opportunities to continue the development of this concept, using the lessons learned in this pilot study.