Health Technology in the Fire Services

Health Technology and Quantifying Health Panel

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Futures Forum
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Engaging the Fire Service in Research

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- Partnership created in 2005 (TFS) and 2015 (Durham Region)
- Ongoing research collaborations to improve on-the-job safety
- Develop gaming technologies for assessment and training

FIRE SERVICES TORONTO

OSHAWA FIRE SERVICES

What We Know

- Previous collaboration with Toronto Fire on studies of Air Management
- 1/3 of firefighter injuries are due to contact or exposure to fire with many being preventable by better decision making
- Another 1/3 are preventable by improving movement patterns
- ACE facility provides a fantastic simulation environment

How can we improve training
and reduce the risk of injury?

Serious Games for Training

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- **Serious games** are video games used for training
- Serious games have been used for cognitive function training under stressful conditions in:
  - Surgeons (Gallagher et al., 2005)
  - Military (Cox et al., 2010)
- Motor learning principles suggest that training can result in implicit learning by developing skills that are more stable under psychological stress (Mullen, 2007)

Current Research Goals

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To develop two modules of an interactive serious game to:

1. use posture-tracking technology to provide an effective educational and reinforcement tool for fire fighters to learn correct movement patterns and lifting techniques for specific tasks as test
2. train complex decision making skills required by firefighters in environments that are both physiologically and psychologically stressful.

Background

- Specifically, the games would provide a means of measuring and training in a physiologically challenging environment.

Current Research 1: Considering Ergonomics

- **Partnership with TFS, Durham Region Fire Services, and PSHSA**
- In the US, 66% of firefighters experience occupational injuries (Hong et al., 2012)
  - 54% of these injuries are to the back
- Obviously, many firefighting activities are unavoidable and safe lifting considerations are not a top priority
- Initially, our goal was to better understand tasks and activities performed in the fire hall

Lets make fire hall (and truck) tasks safer, so backs are stronger and ready for other activities!

Fire Hall Observations: Tasks in the Fire Hall

On the Fire ground →

Using Microsoft Kinect for Human Factors Research

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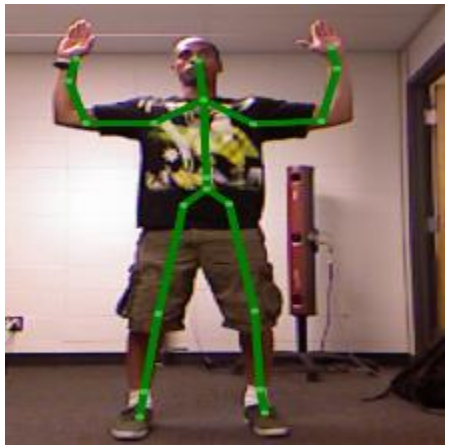
- Microsoft Kinect™ has the ability to provide real-time anatomical position data in three dimensions (3D)
  - Assessment
  - Training



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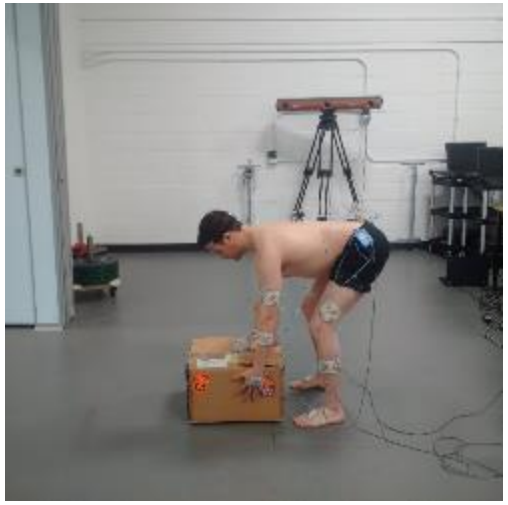

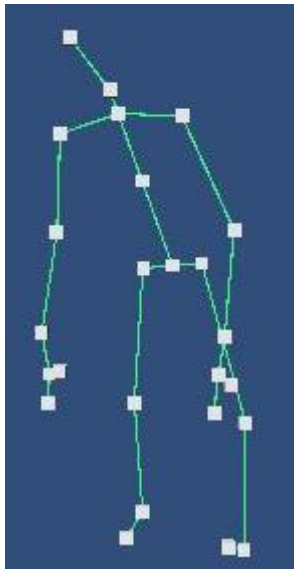

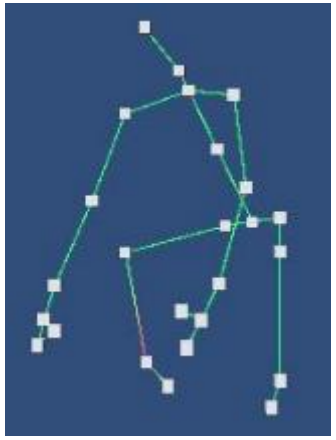

Current Research 2: Decision Making

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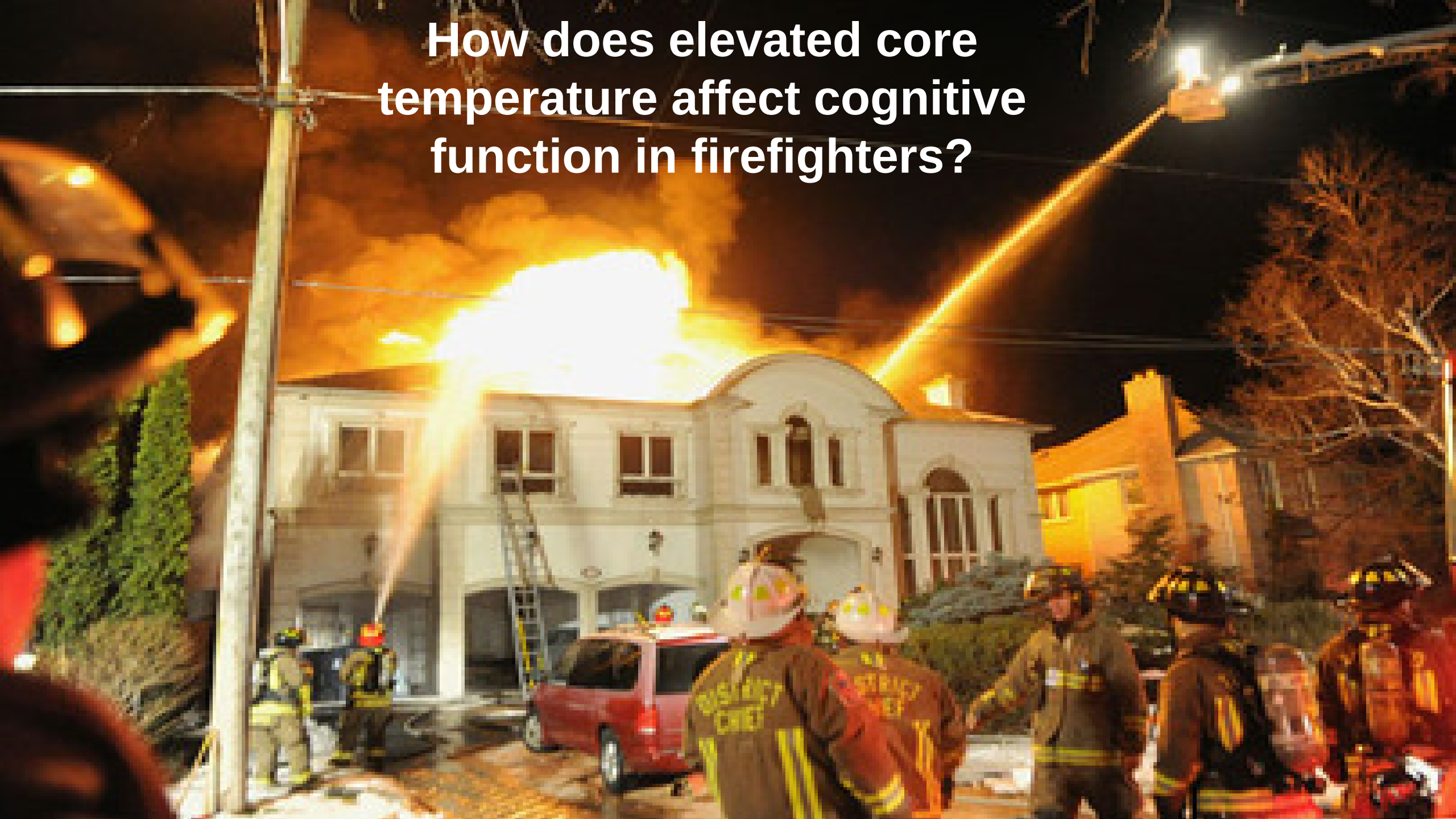
- **Under potentially life threatening conditions, firefighters are required to:**
  - Maintain attention
  - Retain important details (e.g. points of egress)
  - Cognitive components related to decision making (e.g. recognizing smoke patterns)
  - Air Management



How does elevated core temperature affect cognitive function in firefighters?

CANTAB
Cognitive Function Tests

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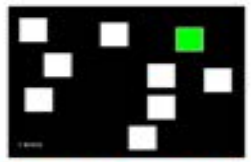
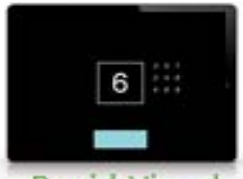


Spatial Span (SSP)

Working memory capacity

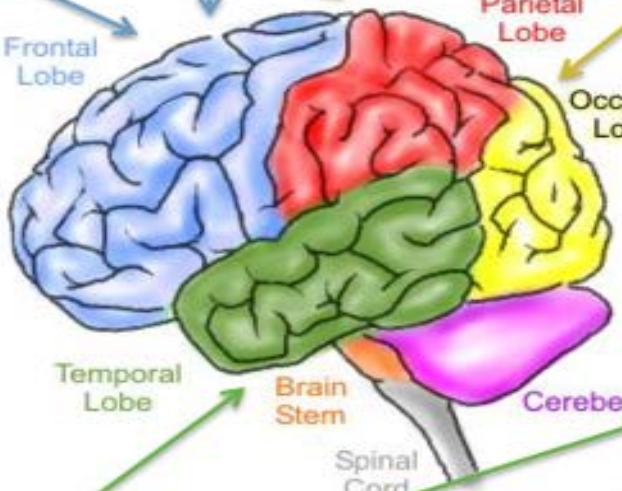
Reaction Time Task (RTI)

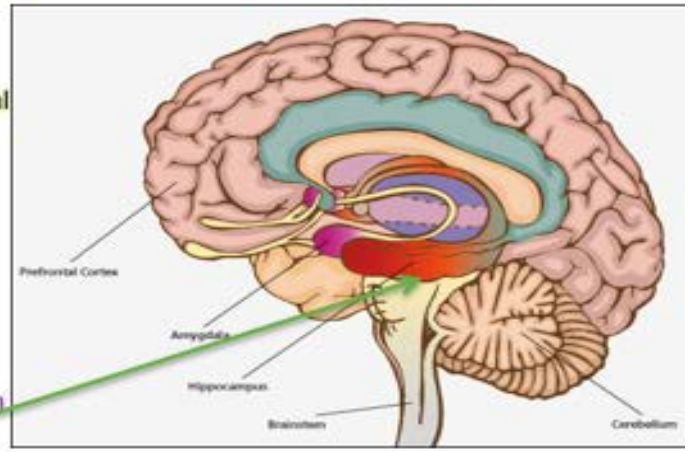


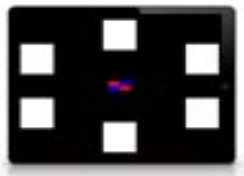
Rapid Visual Information Processing (RVP)

Sustained attention

Spatial Working Memory (SWM)







Paired Associates Learning (PAL)

Visual episodic memory and new learning

How Can We Measure Physiological Demands?

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Human Physiological Monitoring Equipment

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Heat Stress and Cognitive Function

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- ***Conducted in UOIT's ACE Climate Chamber***
- 19 firefighters from TFS
- Exercise-induced heat Stress on treadmill:
  - Moderate Intensity: 4.5 km/h at 2.5% grade
  - Conditions:
    1. 30°C, 50% relative humidity
    2. 35 ° C, 50% relative humidity

What Did We Find?

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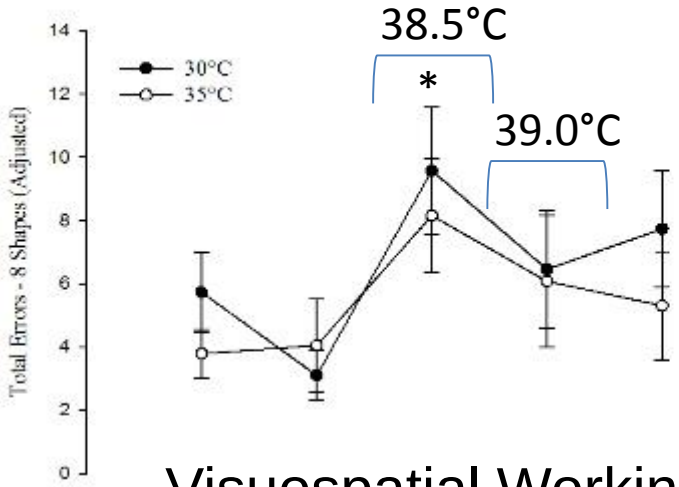
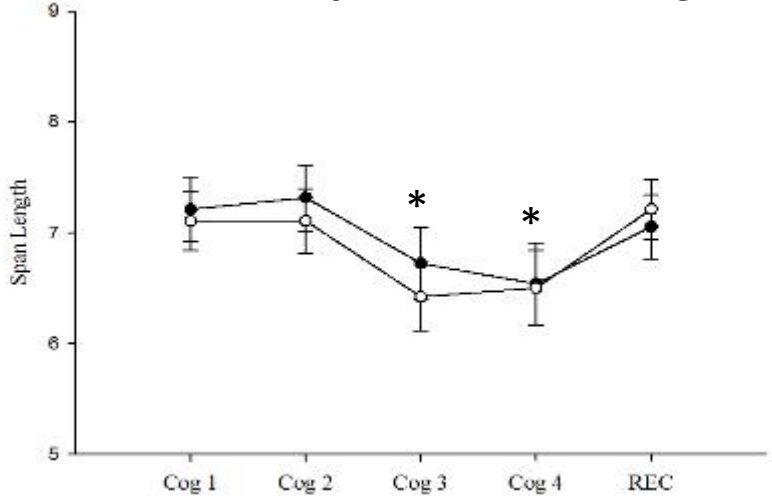
Visual Episodic Memory



total errors

Visuospatial Working Memory



spatial span length

Development of Serious Game

In collaboration with TFS:

- **Firefighter Task Level Serious Game (FFTL)**
  - Development of a two-storey fire scenario (SME)
  - Story board created for game developers
  - Weekly meetings during development
  - 2 focus groups for SME feedback

FFTL Serious Game

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Results: Percent Change in Tasks Completed

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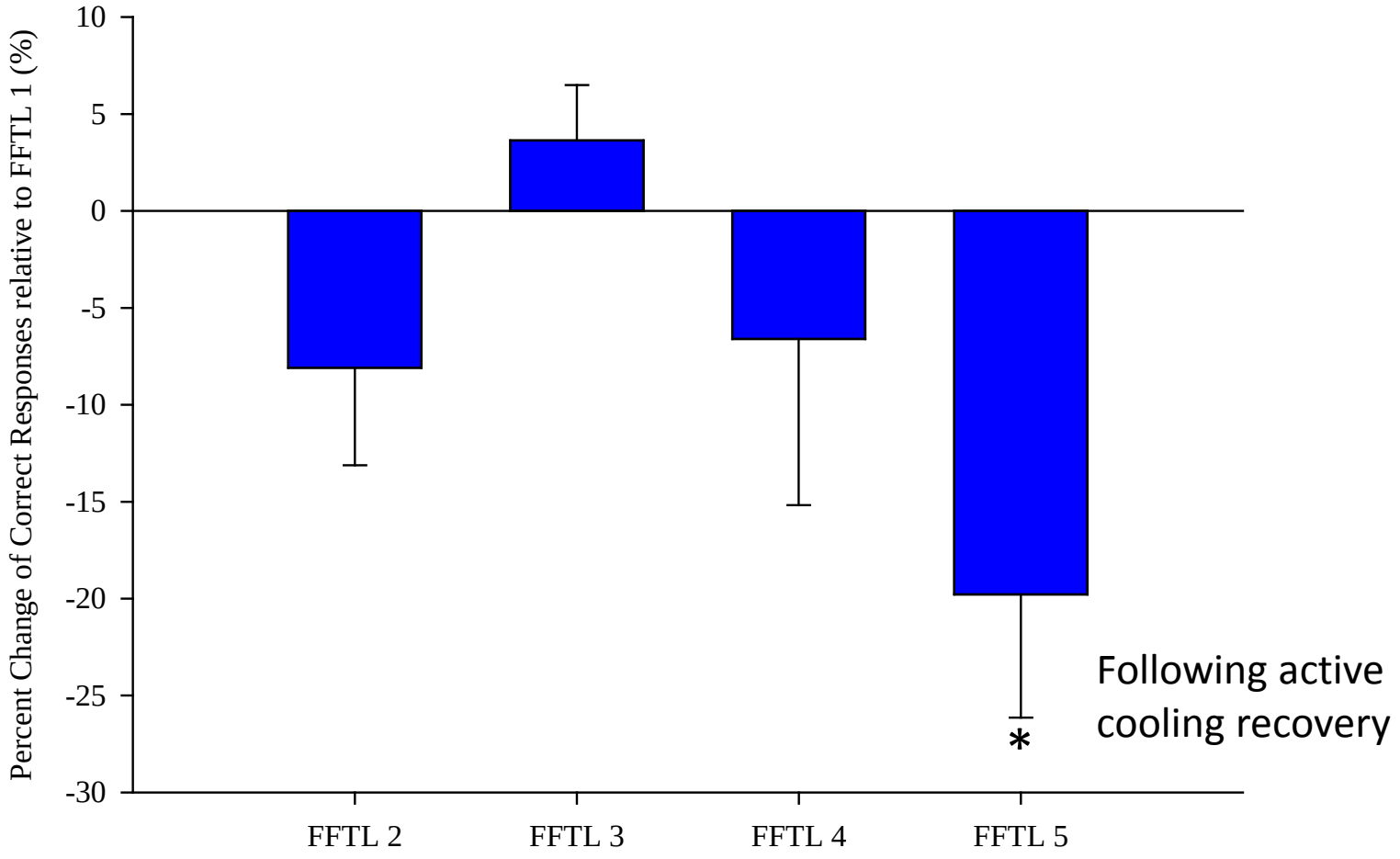

Figure 2: Data from the FFTL revealing the percent change of tasks completed.
*indicates different from FFTL 1 ($p \leq 0.05$)

Next Steps

- Create additional levels of serious game
- Varying levels of difficulty
- Refine scoring/measurement techniques
- Conduct training study

Future Research:
Mixed Reality/Immersive Simulation

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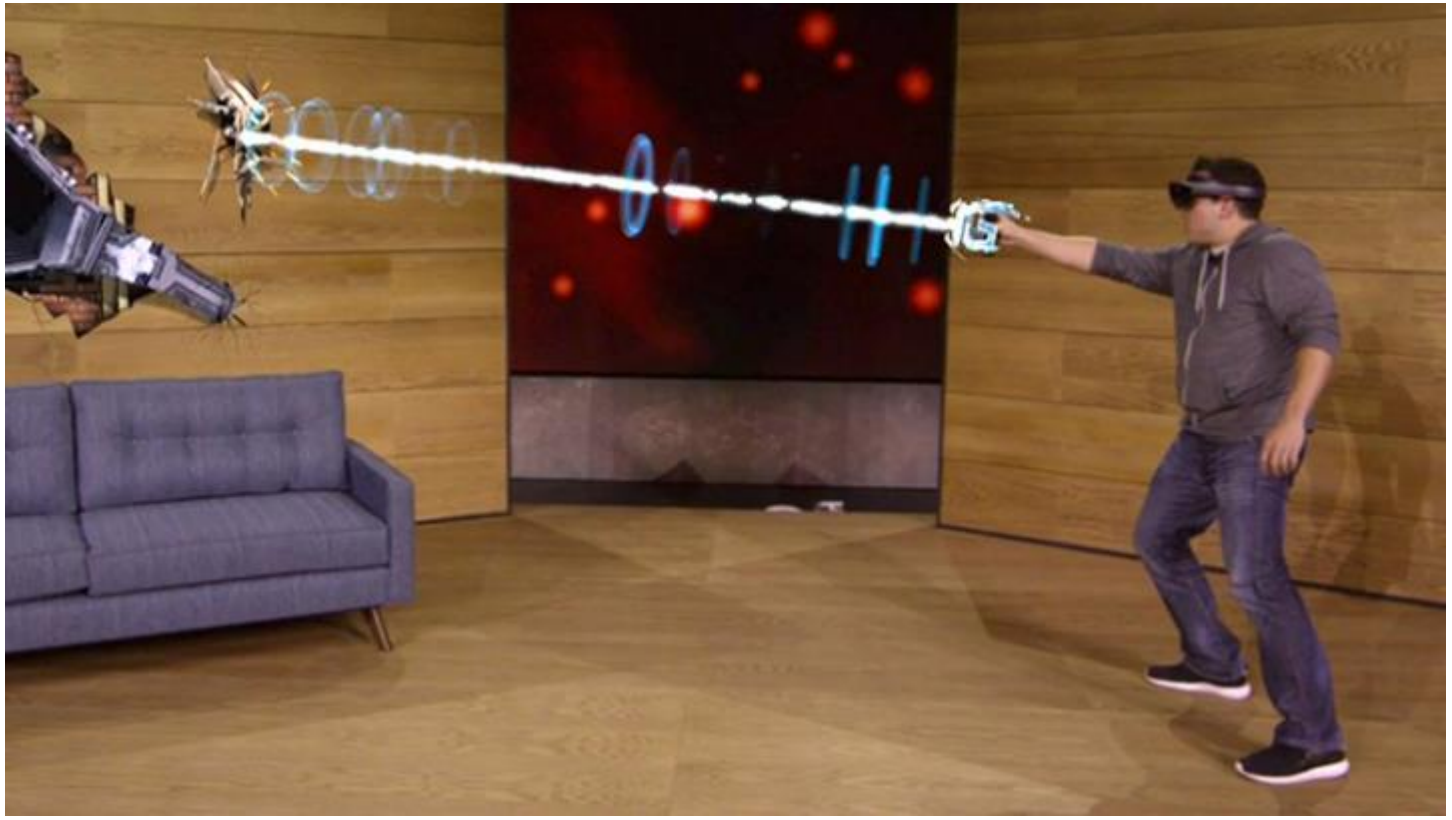

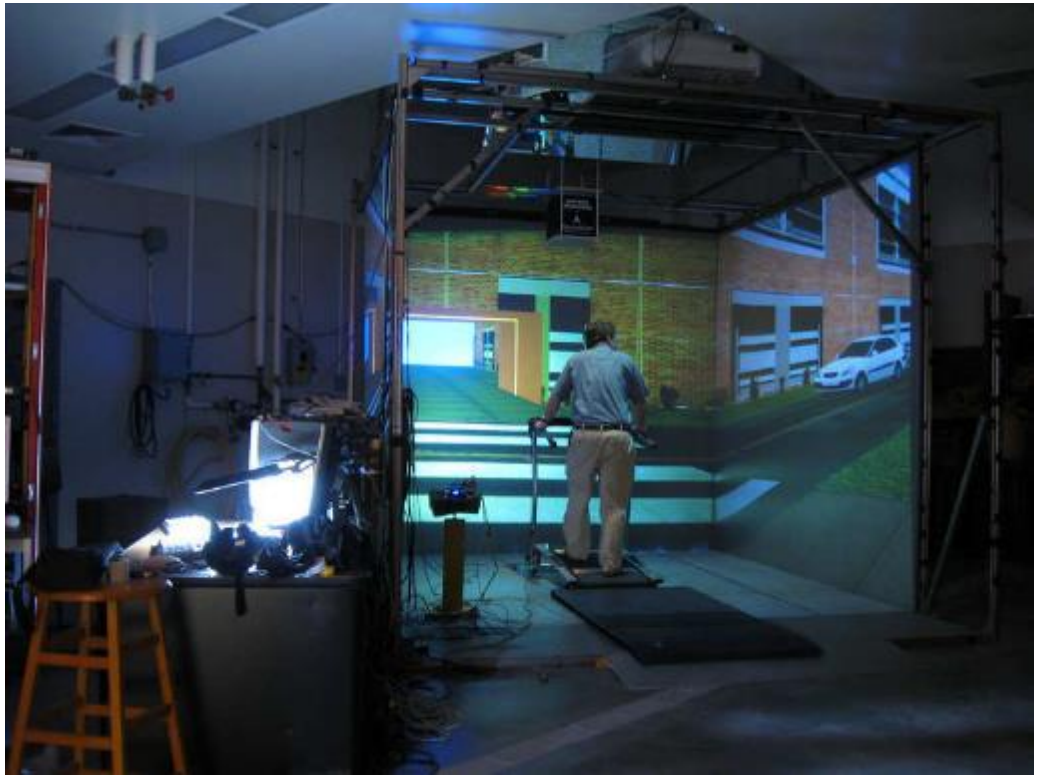

THANK YOU!