Brains in Sync:
Team coordination & interpersonal prefrontal neural synchrony during cooperative e-gaming

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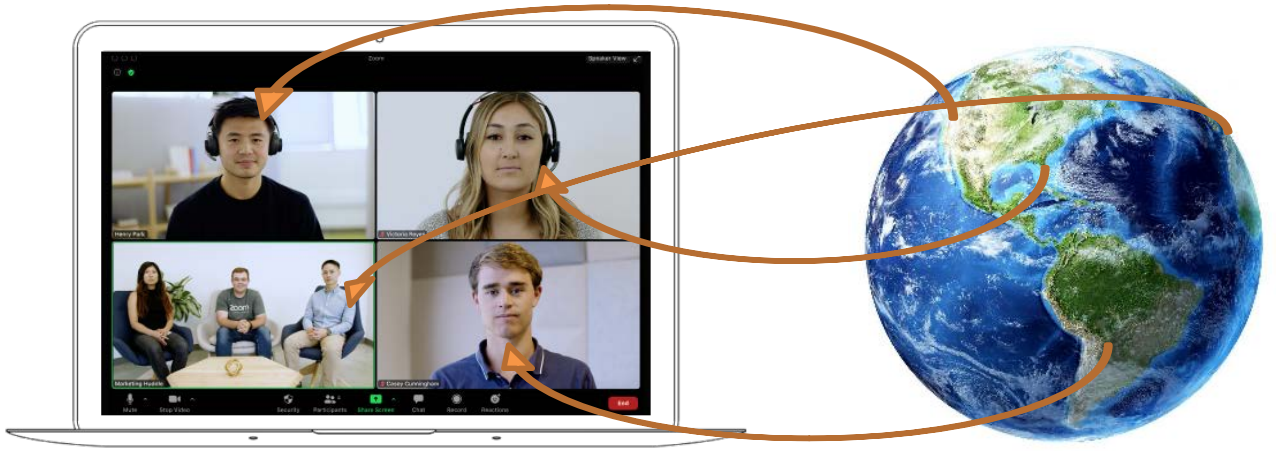
Teamwork/Future of Work



What makes a good team?

Team E-sports as Model Teamwork

- Mimics common team structures
  - Role specialization
  - Collective intelligence & cognition
- By providing a common goal
  - Highly motivating
  - Shared objectives
  - Helps develop strong interpersonal connections
- Can be done both remotely and in person

Objective

The Future of Work requires **more** online/remote collaboration

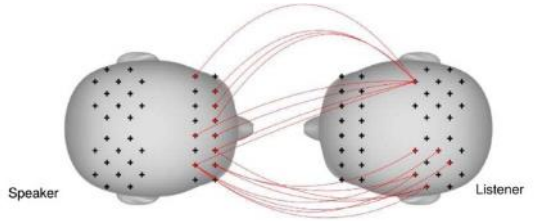
- Cooperative gaming is a good proxy for Collaborative work

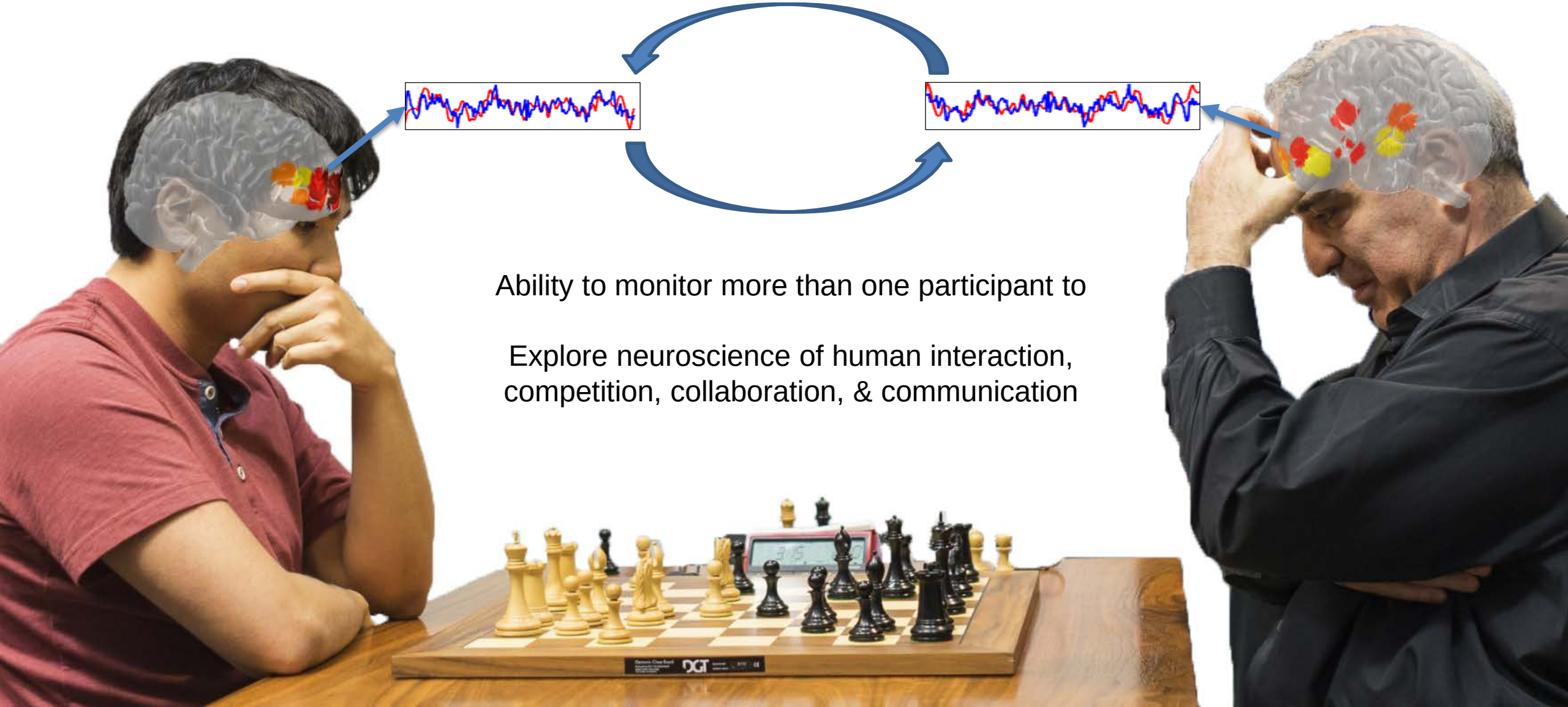
How do players cooperate with each other?

- *Does physical proximity affect cooperation?*
- *Does a player's experience affect cooperation?*

Improve team cooperation through use of neurotechnology

Hyperscanning





Ability to monitor more than one participant to

Explore neuroscience of human interaction, competition, collaboration, & communication

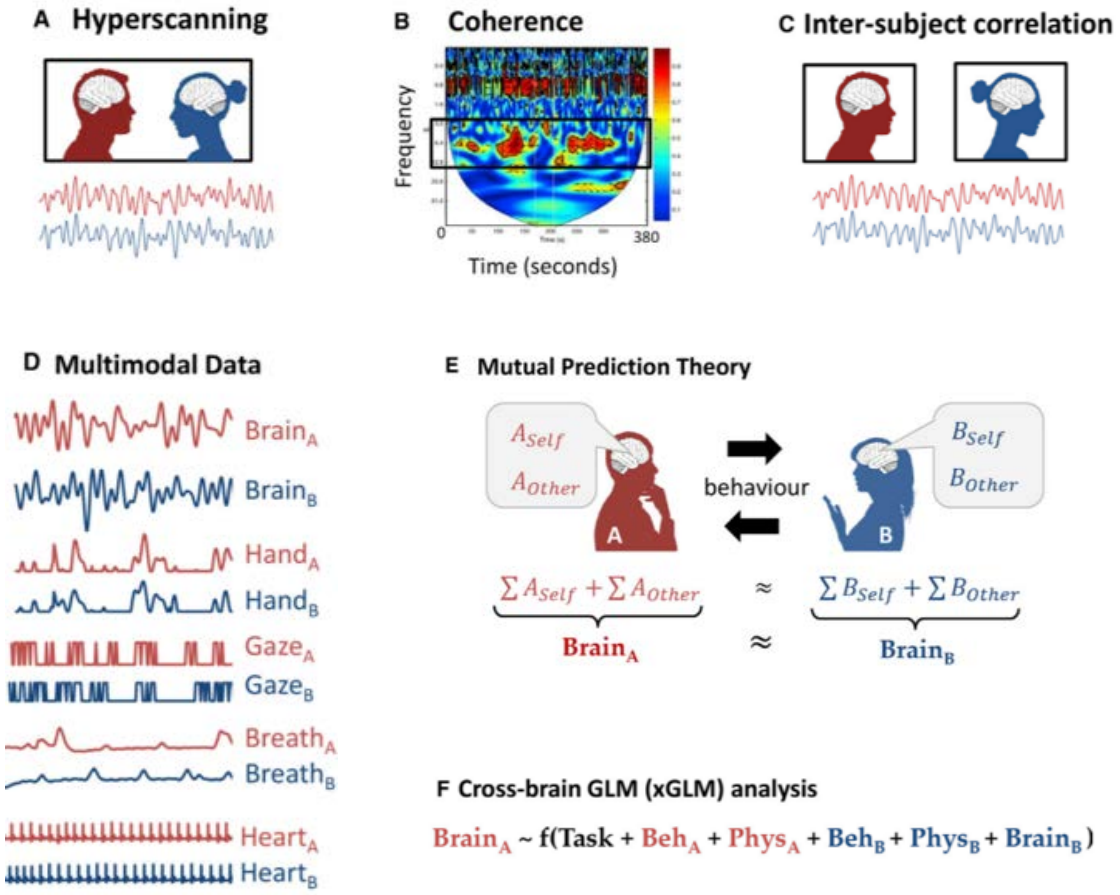
Hyperscanning:

Social Neuroimaging & Interpersonal Neural Synchrony

Means of quantifying the temporal/informational relationship between neural signals

Relates:

- Leaders to followers
- Speakers to listeners
- Coordination & Cooperation during mutual problem solving



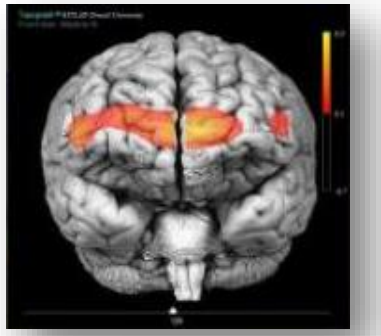
Hamilton, 2021

A. F. d. C. Hamilton, "Hyperscanning: Beyond the Hype," *Neuron*, vol. 109, no. 3, pp. 404–407, 2021, doi: 10.1016/j.neuron.2020.11.008.

Study Design

MULTI-MODAL APPROACH

- ✓ Behavioral Performance
  - Cognitive Tasks & In-Game Behavior
- ✓ Neural Synchrony and Mental Workload
  - Prefrontal Cortex Activity
- ✓ Physiological Measures of Affect
  - Emotional Arousal & Valence
- ✓ Self-Reported Evaluation
  - Perception of Teammate & Collaboration



Study Design

CONTRASTS

Gaming Population

Player Skill Level

Novice

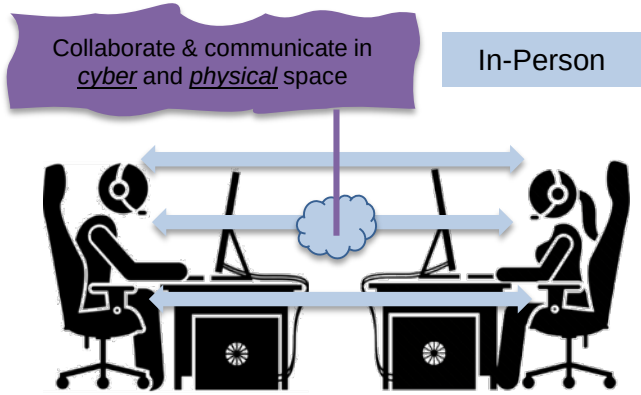
Advanced/Expert

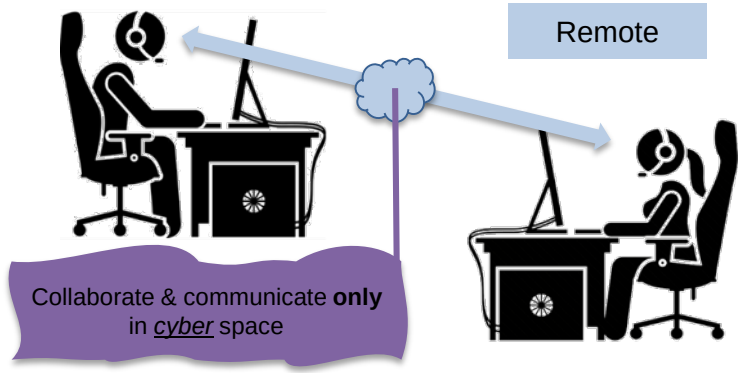
Player Background

Civilian

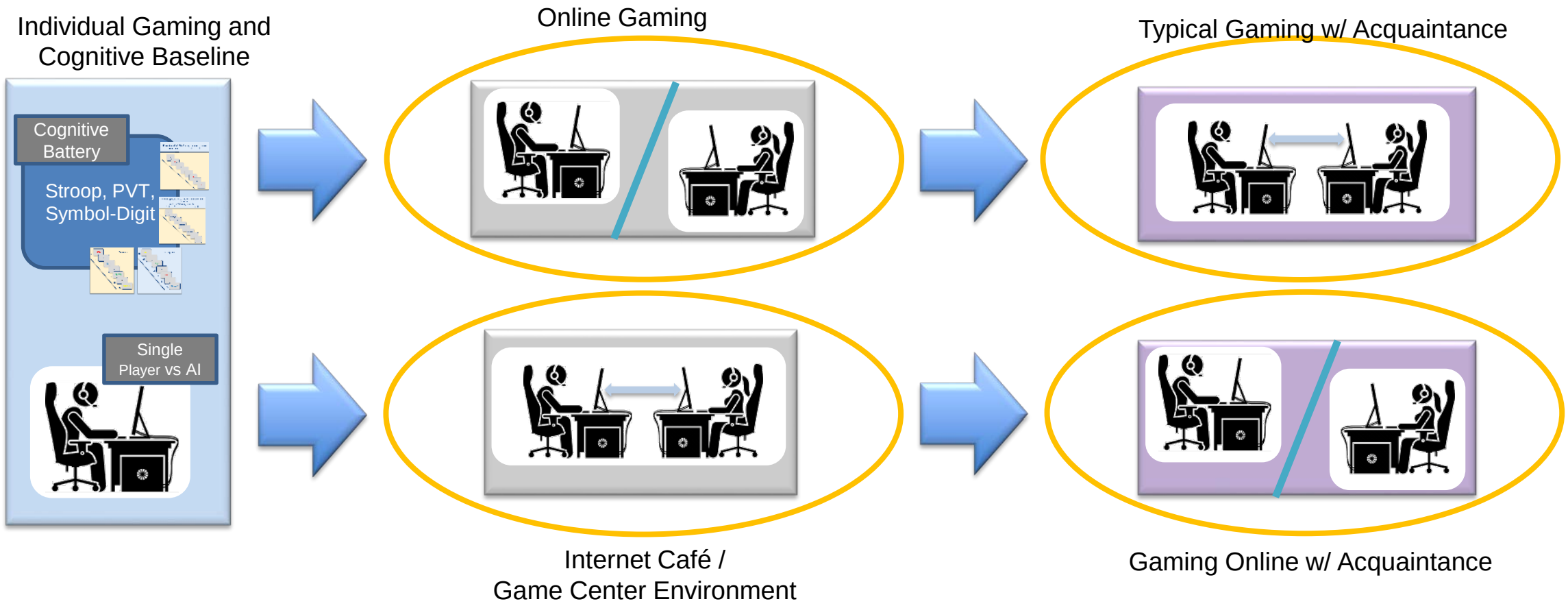
Veteran

Gameplay & Cooperation Space





Study Design

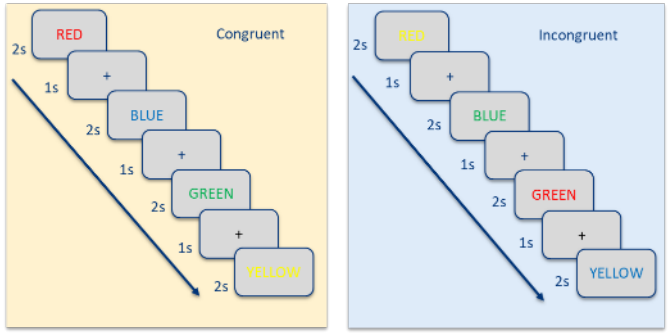


Study Design

COGNITIVE TASKS

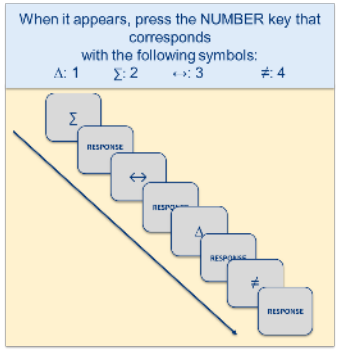
1. Stroop Task (3min)

- Attention
- Reaction time
- Speed of processing



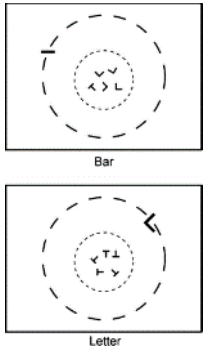
2. SDST (Symbol Digit Substitution Task) (3min)

- Working memory
- Attention
- Reaction time
- Speed of processing



3. Dual Search Task (6min)

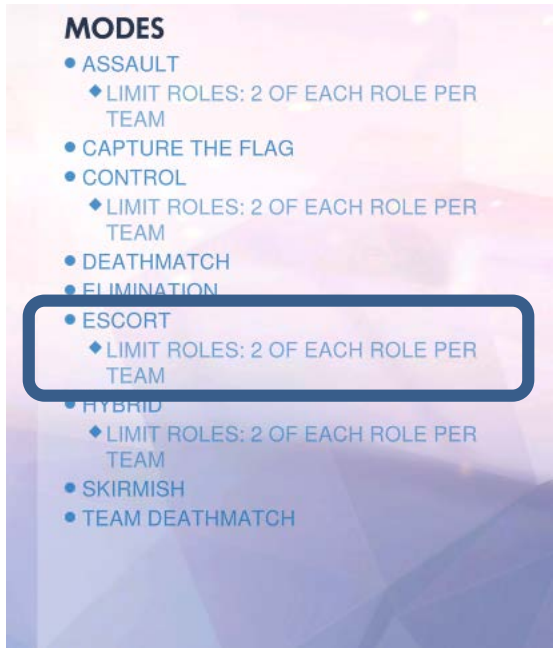
- Perceptual processing
- Task-switching

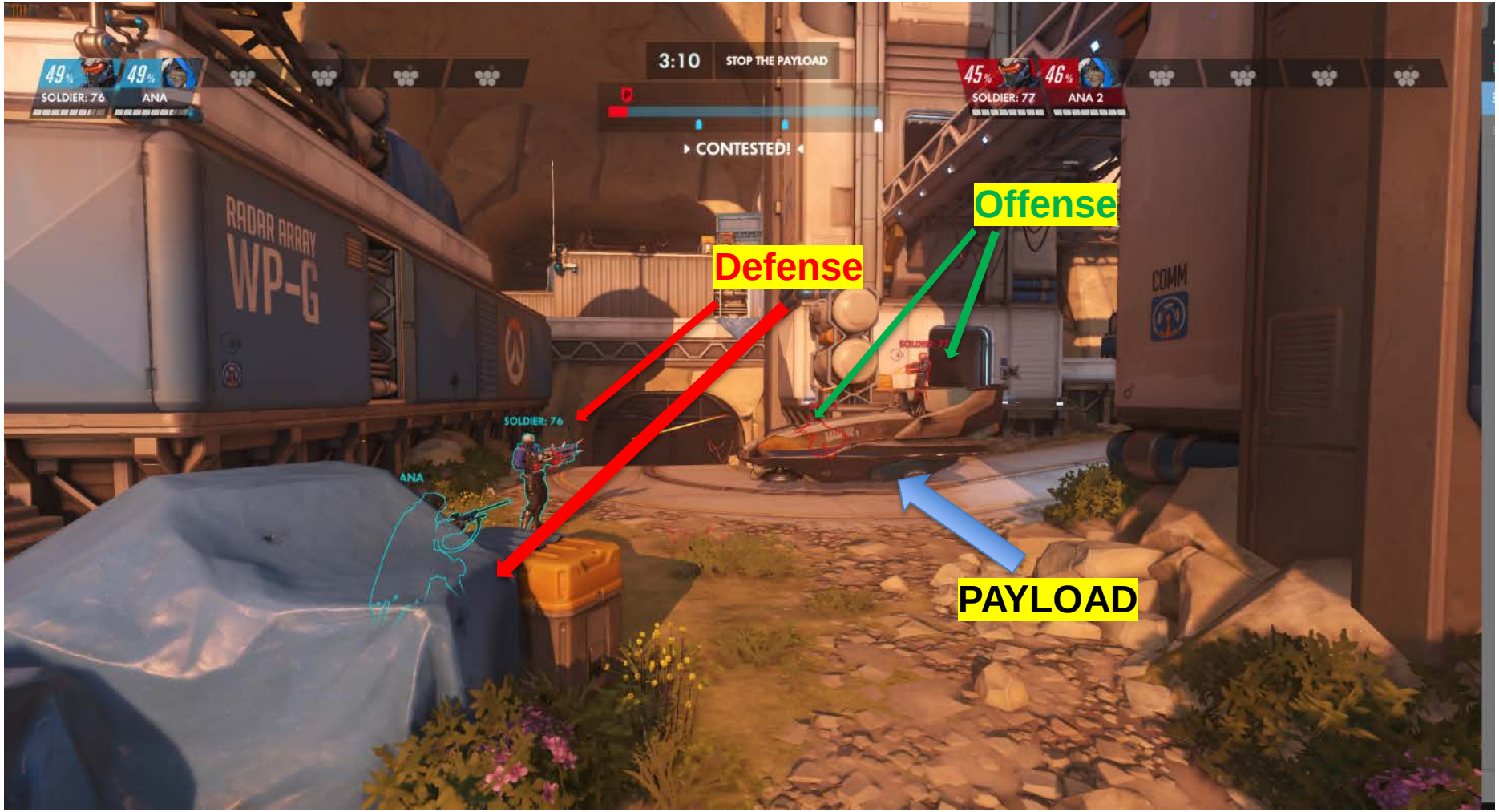


Total is approx. 10min

Study Design

GAME TASK



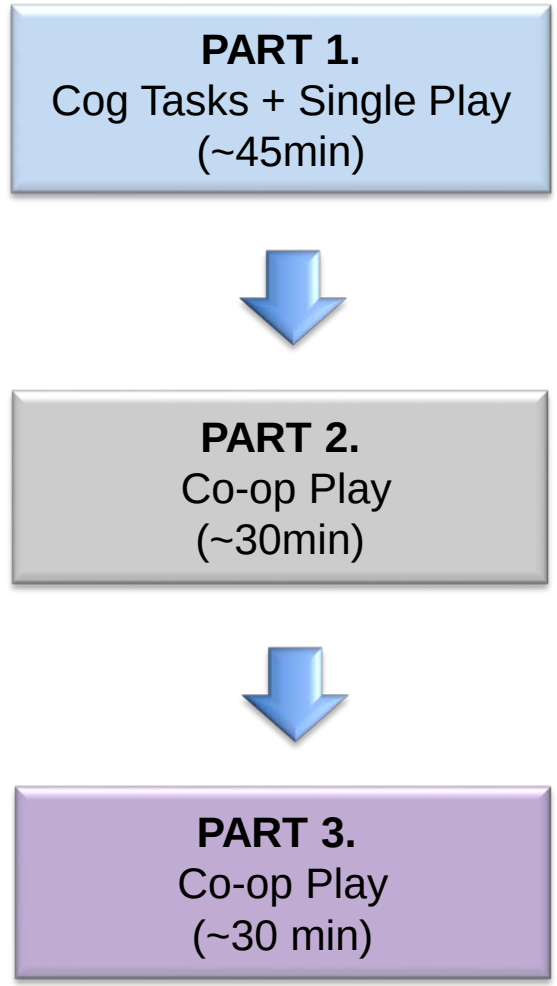


Study Design
TIMELINE

1. Single Play + Cognitive Tasks
   - Consent (triage forms to be done online)
   - Background forms (gaming preference, personality and other info)
   - Go to workstations (separate rooms)
   - Attach sensors (fNIRS + EDA)
   - Cognitive task battery (10-15min)
   - Single-player gameplay (20-25min)
   - Break

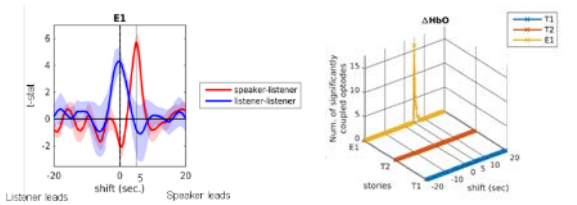
2. Co-op Play Condition 1 - Same room or different rooms
   - Introductions / Icebreaker
   - Mission Briefing
   - Attach sensors (fNIRS + EDA)
   - Multi-player gameplay
   - Break

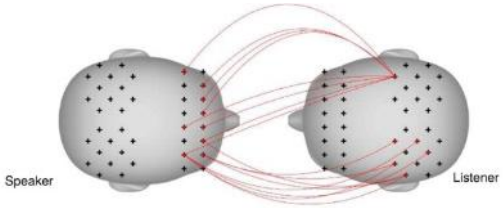
3. Co-op Play Condition 2 – Cross over condition - Same/different rooms
   - Introductions / Icebreaker
   - Mission Briefing
   - Attach sensors (fNIRS + EDA)
   - Multi-player gameplay



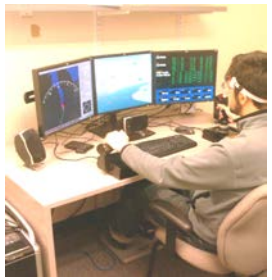
Data Collection and Next Steps

- Participant Recruitment (Target N=120)
- Ongoing Data collection
- Signal Processing and Analysis
  - Single-brain
    - Cognitive tasks + Gaming Task Performance
  - Multi-brain
    - Inter-play of brain activity and performance across team-members and outcomes

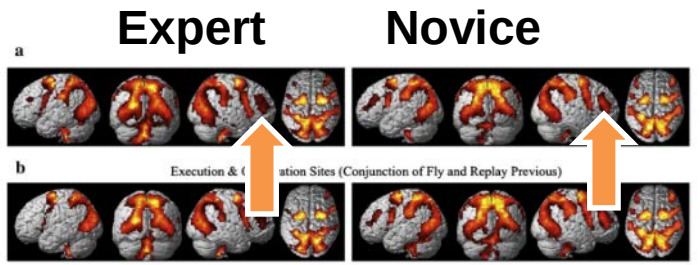




(Liu et al., 2017)
(Liu et al. 2018)



(Ayaz et al., 2012; 2013)



(Callan et al., 2013)

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Thank you!