

Virtual-Gym: A Personalised Exercise Platform for Seniors

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Age-related Changes and Challenges

- **Cognitive function:**



Healthy older adults might forget familiar names or words, or they may find it more difficult to multitask.

Some older adults may be affected by dementias.

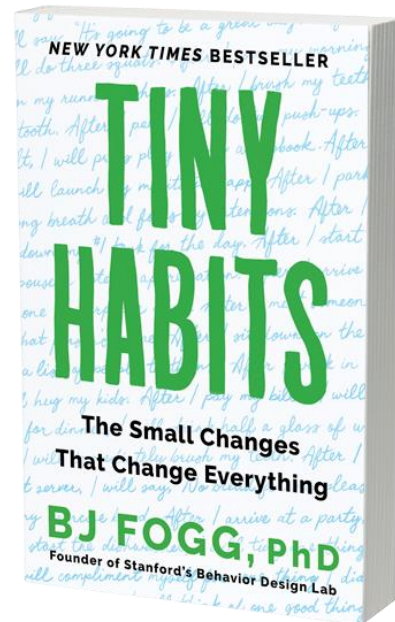
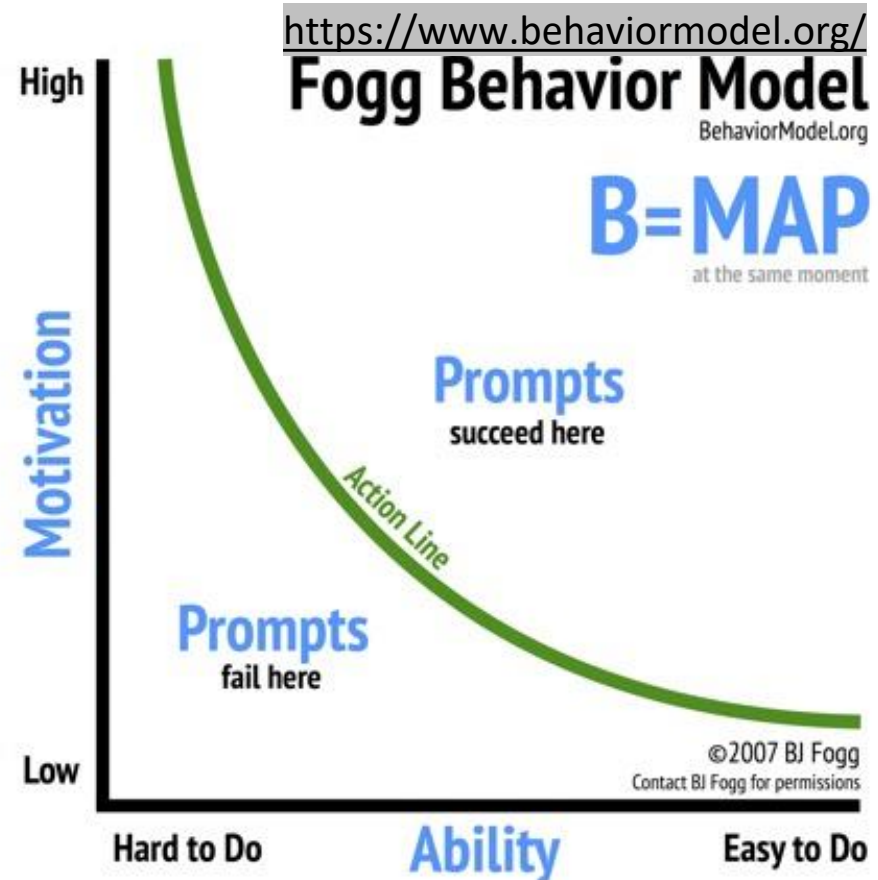
- **Physical mobility:**



Muscles lose strength, endurance and flexibility, impacting coordination, stability and balance.

Serious Games
can support
sustainable and safe
mental and physical activity,
that can promote cognitive
and physical health

Gamification: Using Game Mechanics to Motivate Behavior





VIRTUAL GYM

Games for Effective Cognitive and Physical Training



VIBRANT
MINDS

Vibrant Minds is platform offering fun serious games to seniors looking for cognitive exercise.

The platform supports APIs for developers to add new games to it, and for researchers to conduct [studies](#) using these games.

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Whack-A-Mole

[Try It](#) [Watch Demo](#)

Whack-a-Mole is an app that can be downloaded and played on an android device.
The objective of the game is to force the individual moles back into their holes by hitting them by tapping them.
But you have to be careful not to hit the bunnies!

Vibrant Minds for Cognitive Training

Effective cognitive assessment and training can be implemented in fun tablet-based games, such as whack-a-mole, word-search, card matching, bejewelled, and mahjong.



<http://vibrant-minds.org>

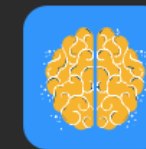
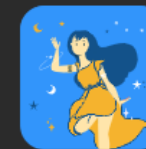
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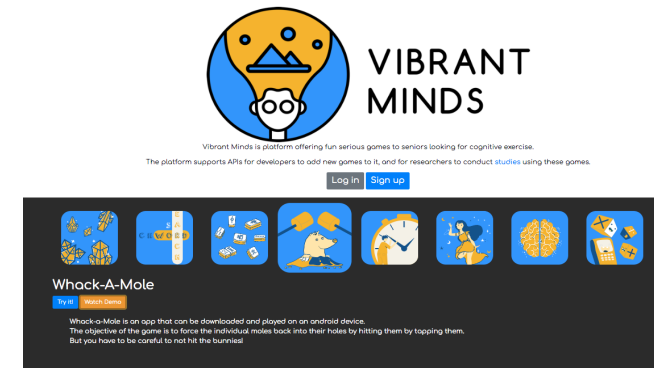
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The Vibrant Minds Methodology

- The games have to be “real” and fun
 - No logic puzzles
 - No computer-based assessment instruments
 - The users should already know them
- Progression through difficulty levels is controlled with advice from health professionals
 - Model-driven software engineering: levels are automatically generated
- **The Platform** supports study workflows for participant cohorts, recording performance logs, and analyses.



Miguel Cruz, A.; Rios Rincon, A.; Daum, C.; Quiroga Torres, D.A.; Jesus, Ruby De; Liu, L.; Stroulia, Eleni (2021 Mar). Predicting engagement in older adults with and without dementia while playing mobile games. *IEEE Instrumentation & Measurement Magazine*

Bruce Wallace, Frank Knoefel, Rafik A. Goubran, Philippe Masson, Amanda Baker, Brianna Allard, Victor Guana, Eleni Stroulia: Detecting Cognitive Ability Changes in Patients With Moderate Dementia Using a Modified "Whack-a-Mole" Game. *IEEE Trans. Instrumentation and Measurement* 67(7): 1521-1534 (2018)

Tiffany Tong, Victor Guana, Andrea Jovanovic, Fiona Tran, Golnaz Mozafari, Mark Chignell, Eleni Stroulia: Rapid Deployment and Evaluation of Mobile Serious Games: A Cognitive Assessment Case Study. *Procedia Computer Science*. 69. 96-103 (2015)

Time Left: 25

Level 1 Score: 0

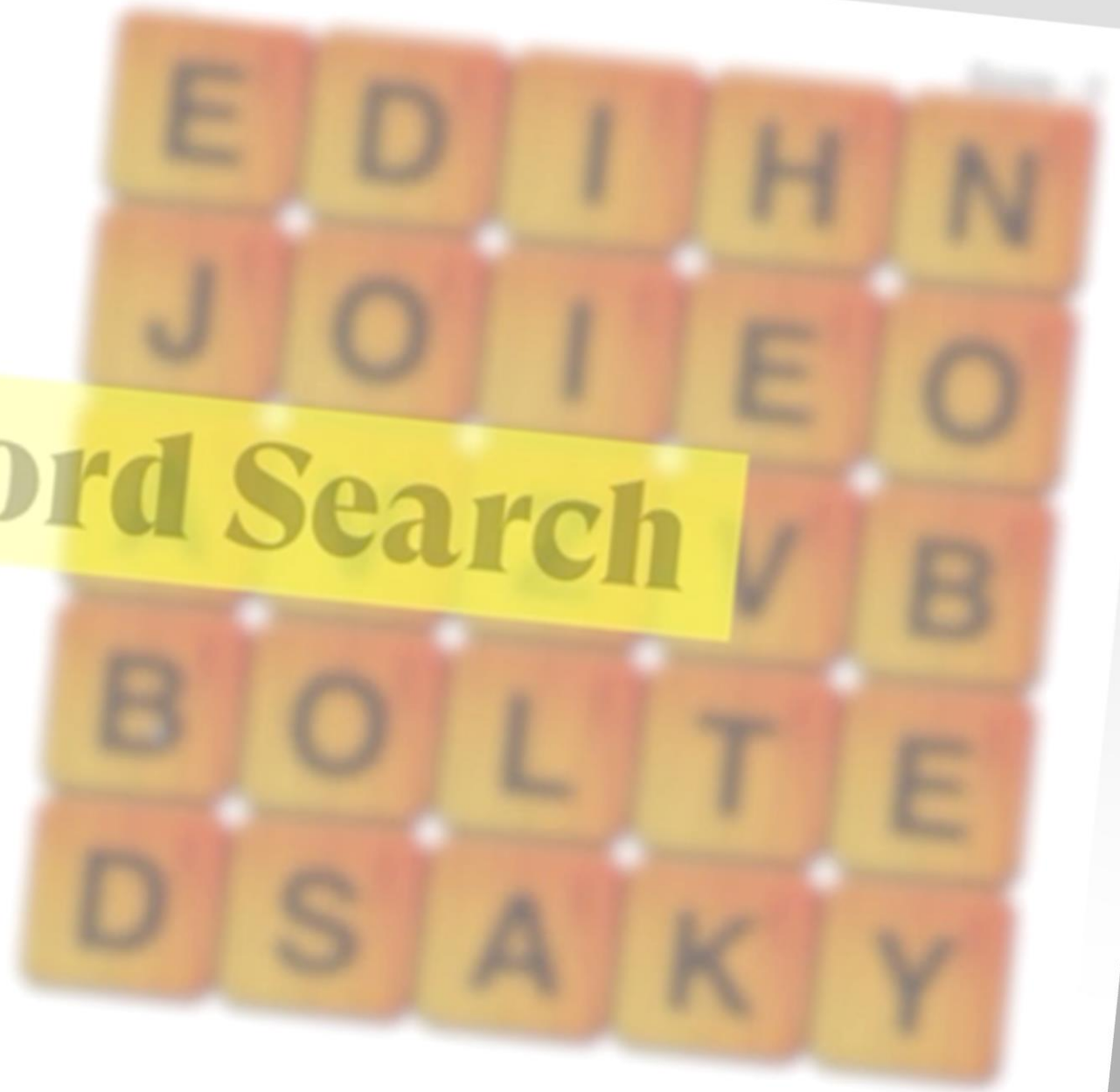


Time Left: 25



Practice

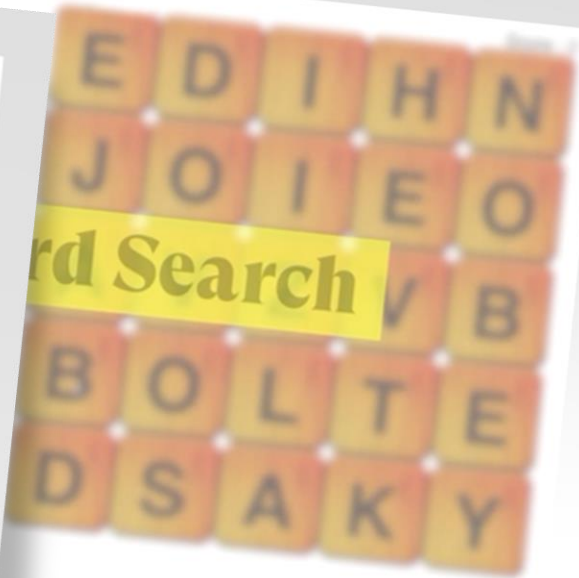
Word Search



Time Left: 25



ejeweled

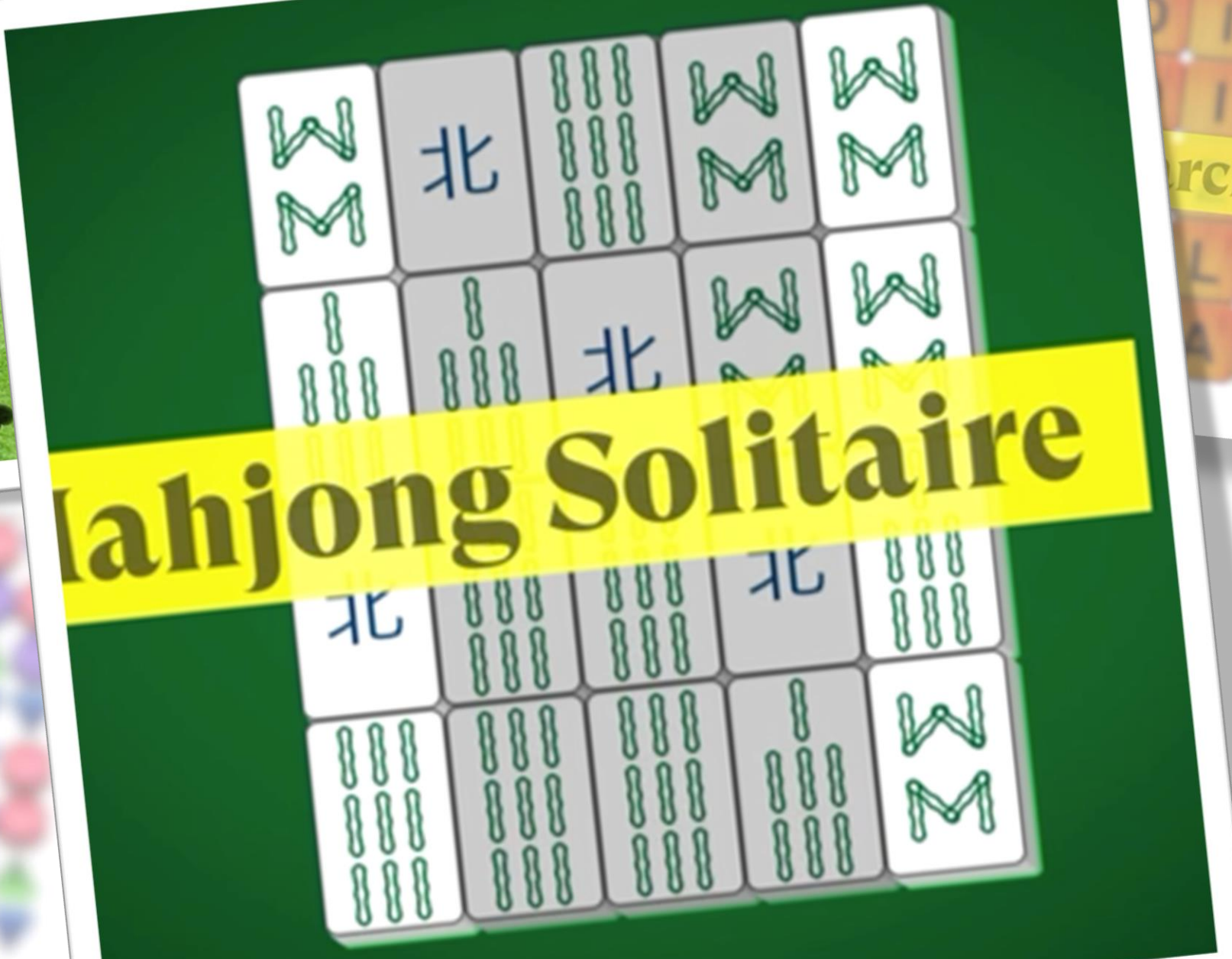


Time Left: 25



Bejeweled

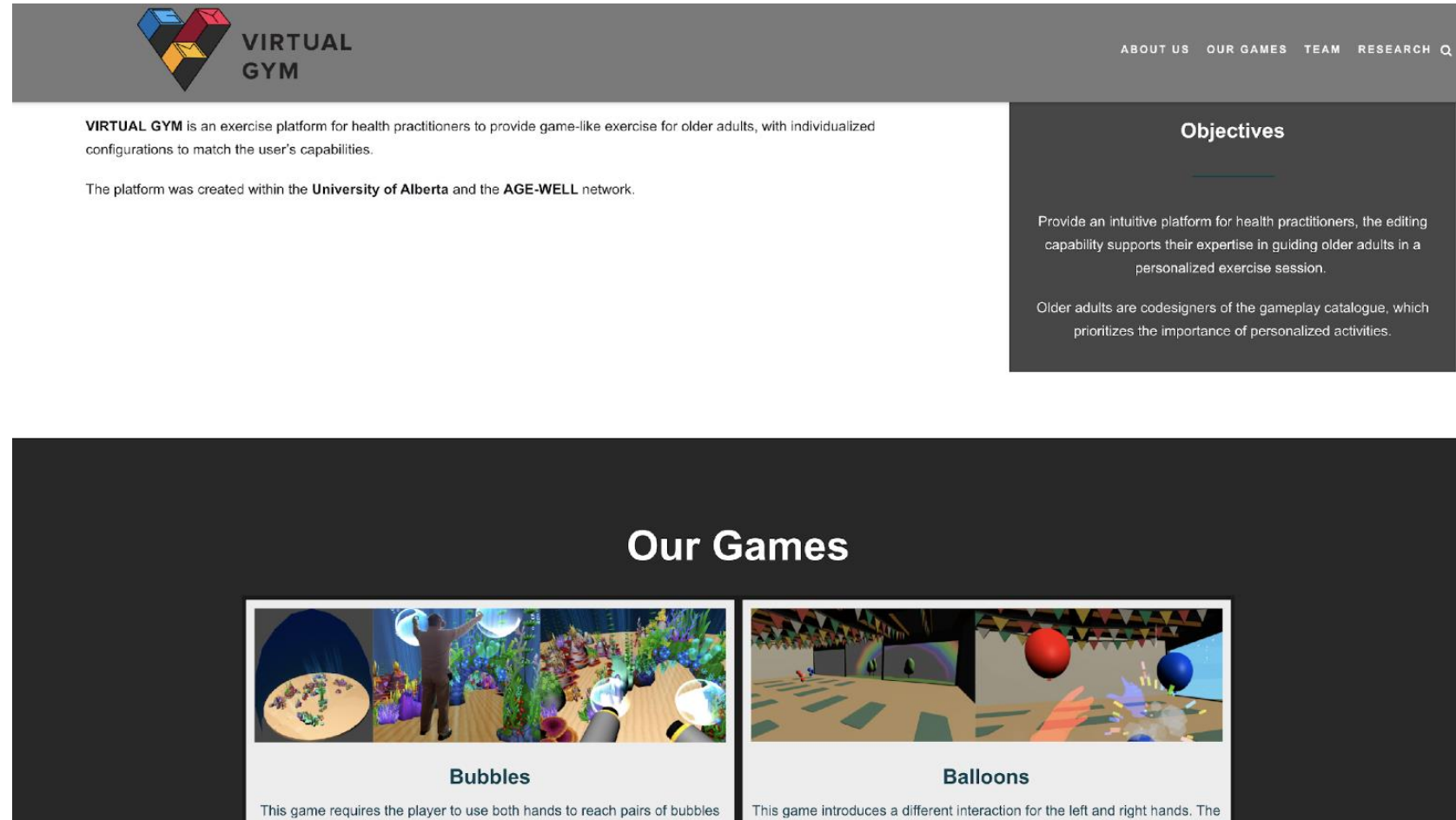
Mahjong Solitaire



Virtual Gym Exergames

The Virtual Gym guides older adults through personalized exercise postures, specified by their therapists.

It can be deployed on an external display with a Kinect, or in a Virtual Reality mode, with Oculus.



VIRTUAL GYM

ABOUT US OUR GAMES TEAM RESEARCH Q

VIRTUAL GYM is an exercise platform for health practitioners to provide game-like exercise for older adults, with individualized configurations to match the user's capabilities.


The platform was created within the **University of Alberta** and the **AGE-WELL** network.

Objectives

Provide an intuitive platform for health practitioners, the editing capability supports their expertise in guiding older adults in a personalized exercise session.


Older adults are codesigners of the gameplay catalogue, which prioritizes the importance of personalized activities.

Our Games



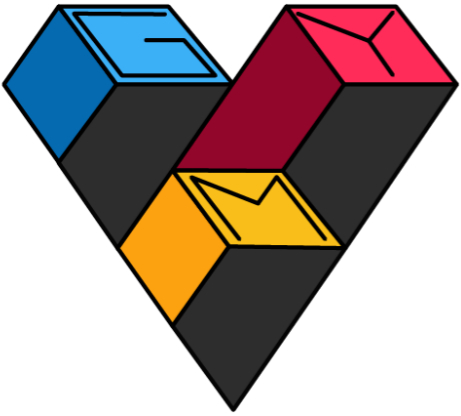
Bubbles

This game requires the player to use both hands to reach pairs of bubbles



Balloons

This game introduces a different interaction for the left and right hands. The



VIRTUAL GYM

Methodology

- Healthy minds live in healthy bodies
- The exergame should be
 - Aware of the individual body (size, shape and ability)
 - Easy to learn
 - Challenging
 - Fun
- The purpose is to exercise the body and challenge the mind



VIRTUAL GYM

The Kinect-based Toolkit

THE EXERCISE EDITOR

An exercise expert

- records an exercise demonstration
- edits it to identify key postures
- composes these postures in an exercise script that
 - starts with the user at the T-posture,
 - specifies how long the user has to hold the posture, and
 - what posture to transition to

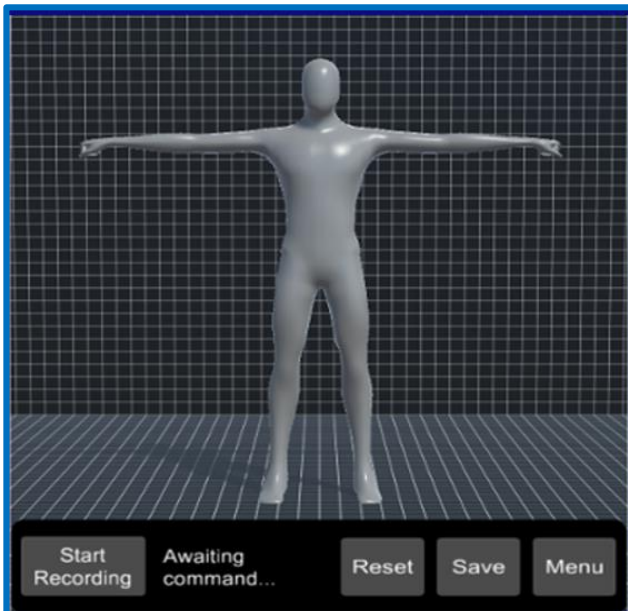
THE KINECT-BASED GAME

- Users, during game-play, mimic the postures and movements of a coach avatar.
- The avatar (driven by the script) demonstrates the exercise, configured to the user's constraints.
- The system compares the user's posture against that of the avatar and provides feedback.

The Exercise Editor

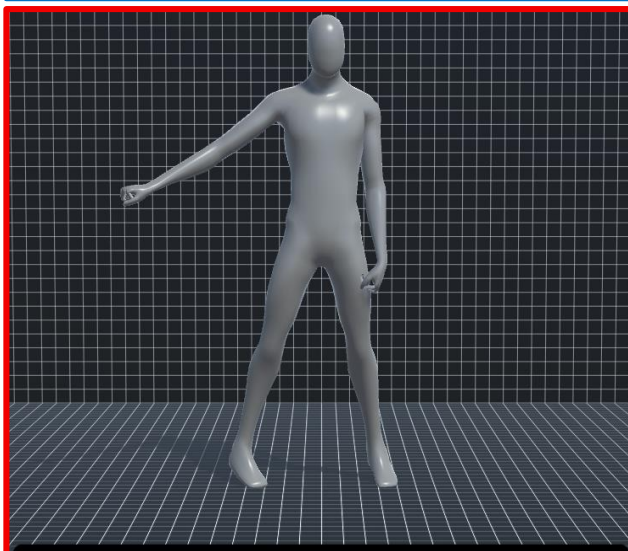
1

First, exercises are demonstrated by an expert and recorded in front of the Kinect™.



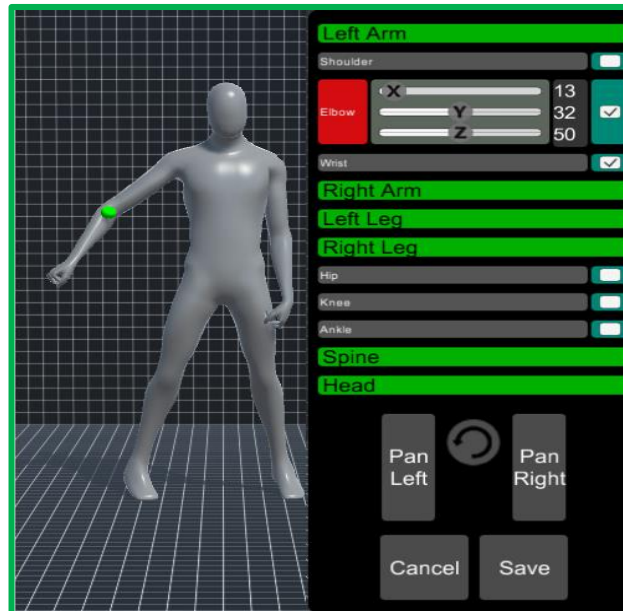
2

Once a recording is made, it can be replayed, paused, and edited.



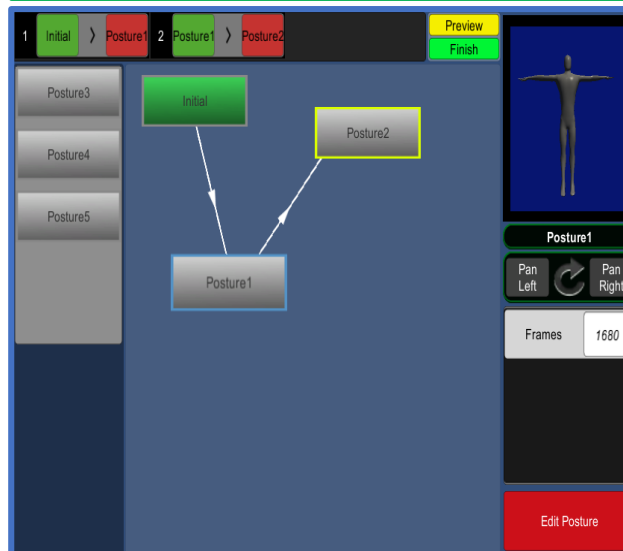
3

Once paused, a therapist can edit the posture (i.e., the angles between the joints); edited postures are the key postures of the exercise.

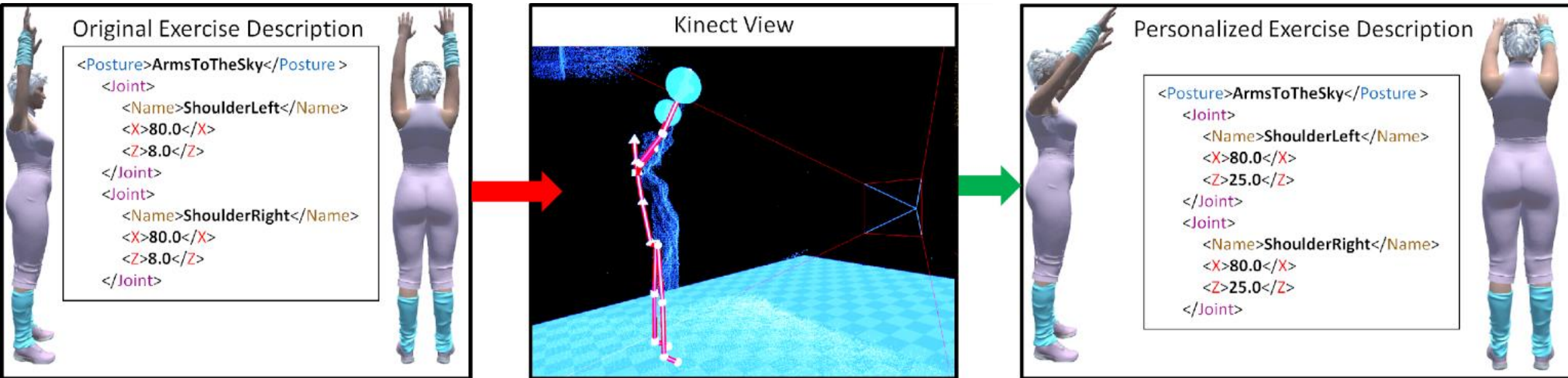


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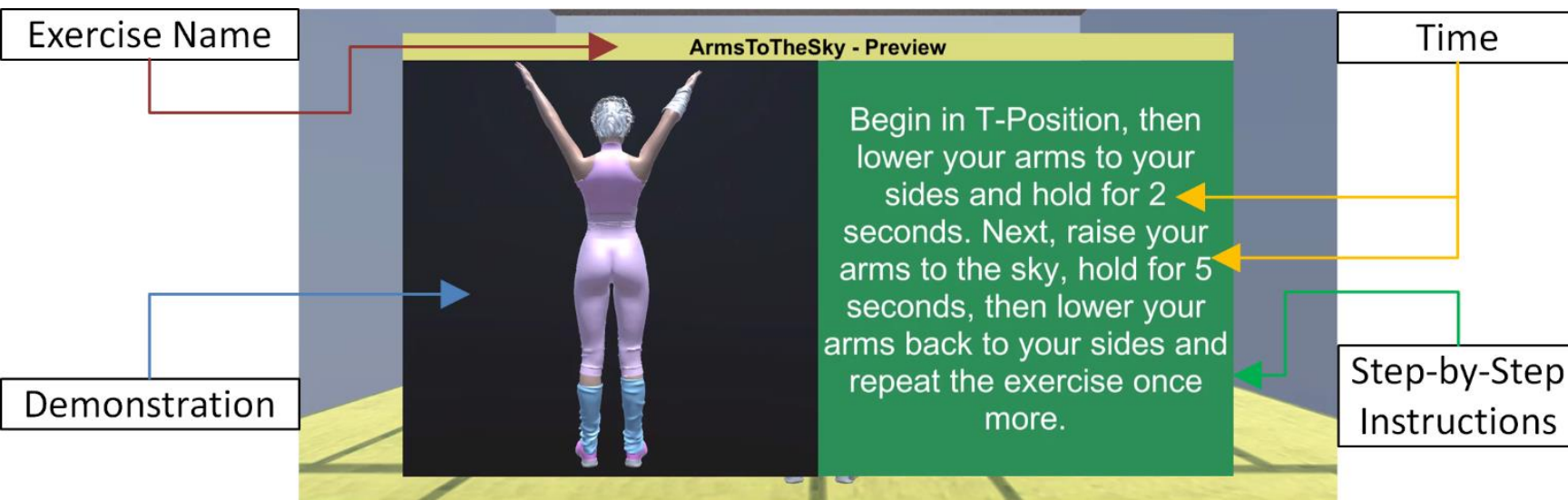
Once *Key-Postures* are created, the animations between them are specified.



Adapting to Individual Ability



The Importance of the User Interface



VIRTUAL GYM



Aging Gracefully across Environments using Technology
to Support Wellness, Engagement, and Long Life

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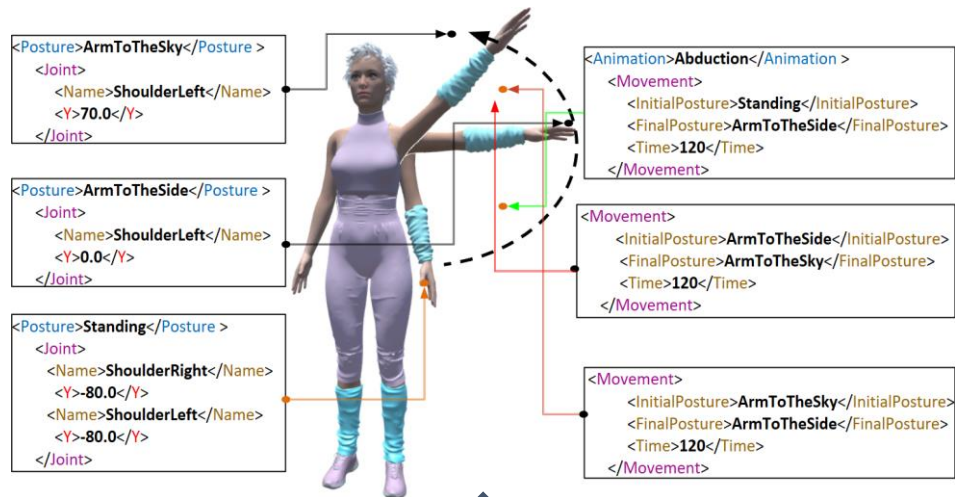
VIRTUAL GYM

Moving to Immersive VR

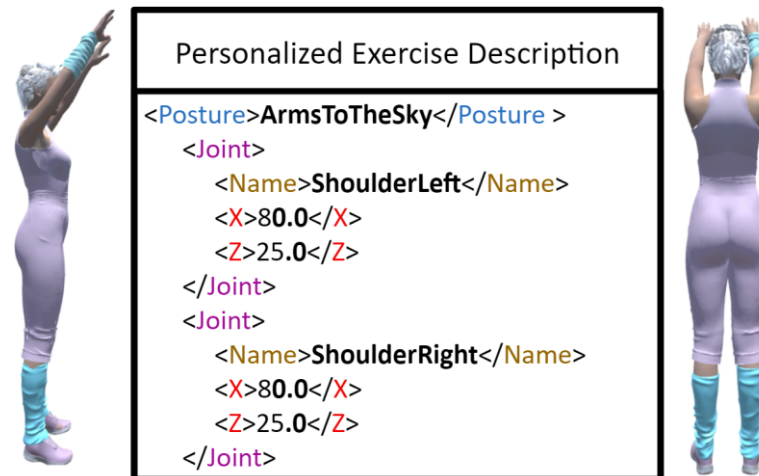
- Simpler metaphor
 - First-person Interaction, no need for projection to 2D
 - More fun, more engaging environment
- Full-body exercises
 - Personalized Postures
 - Arms, Shoulders, Legs, Hips, Knees,
- Surrounding sound

The Virtual-Gym^{VR} Process

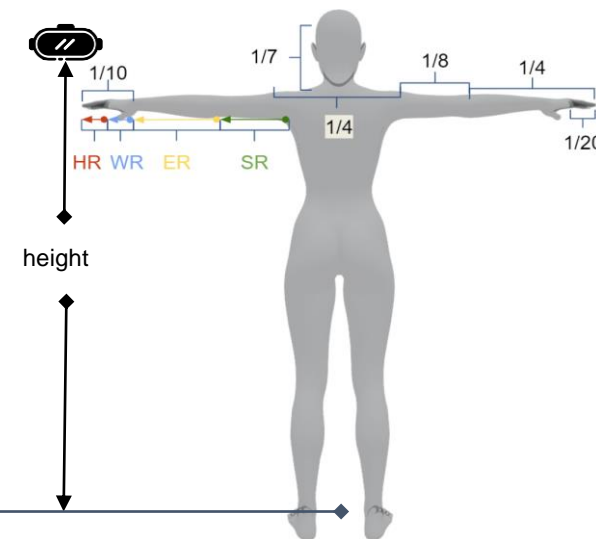
Posture-based Innovative Language



User physical Abilities



Golden Ratio and Biometrics



Bubbles

- Player [PlayerBubbles]
- Target [Bubble]
- Environment [Undersea]
- Music [DB-04,164.0]
- Speed [Multiplier]
- Sequence [Time, Posture]
- Data [Head, ... , LeftHand]



Targets

- Sequence $[T_1, Target, x, y, z, \alpha, \beta, \theta]$
- ⋮
- Sequence $[T_{n-1}, Target, x, y, z, \alpha, \beta, \theta]$
- Sequence $[T_n, Target, x, y, z, \alpha, \beta, \theta]$

Prescription

- Player
- Targets
 - Size
- Environment
- Music
- Data
- Sequence (Targets)
 - Position
 - Orientation
 - Speed



Virtual Gym Bubbles

Bubbles

Player [PlayerBubbles]

Target [Bubble]

Environment [Name: Undersea]

Music [name, length]

Speed [Multiplier]

Sequence [Time, Posture]

Data [Names: Head, ... , LeftHand]

Configuration

- Speed
- Position
- Hand Choice

Challenge

- Coordination
- Concentration
- Endurance

Behaviour

- Bubble Limited Time
- Bubble Center
- Bubble Speed
- Bubble Magnetic Adjustment



Virtual Gym Balloons

Balloons

Player [PlayerBalloons]

Target [Color, Balloon]

Environment [Name: PartyRoom]

Music [Name, Length]

Speed [Multiplier]

Sequence [Time, Posture]

Data [Name: Head, ... , LeftHand]

Configuration

- Speed
- Position
- Colour
- Hand Choice

Challenge

- Reflexes
- Coordination
- Focus
- Concentration
- Endurance

Behaviour

- Balloon Limited Time
- Balloon Touch
- Balloon Push
- Balloon Pop
- Balloon and Hand Colour Change



Virtual Gym Climbing

Climbing

Player [PlayerClimbing]

Target [Position]

Environment [Mountain]

Music [Name, Length]

Speed [Multiplier]

Sequence [Rocks: Time, Position]

Data [Name: Head, ... , LeftHand]

Configuration

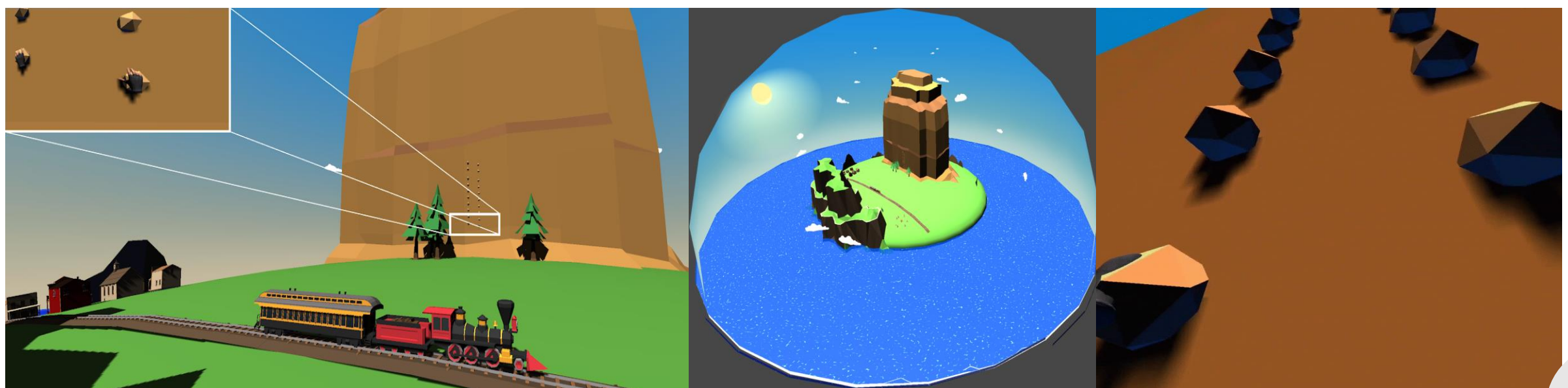
- Speed
- Position
- Hand Choice

Challenge

- Coordination
- Focus
- Concentration
- Endurance

Behaviour

- Rock's Limited Time
- Rock's Change Pull
- Rock's Push



Virtual Gym Archery

Archery

Player [PlayerArcher]

Target [Position, Rotation]

Environment [Castle]

Music [Name, Length]

Speed [Multiplier]

Sequence [Targets: Time, Position, Rotation]

Data [Name: Head, ... , LeftHand]

Configuration

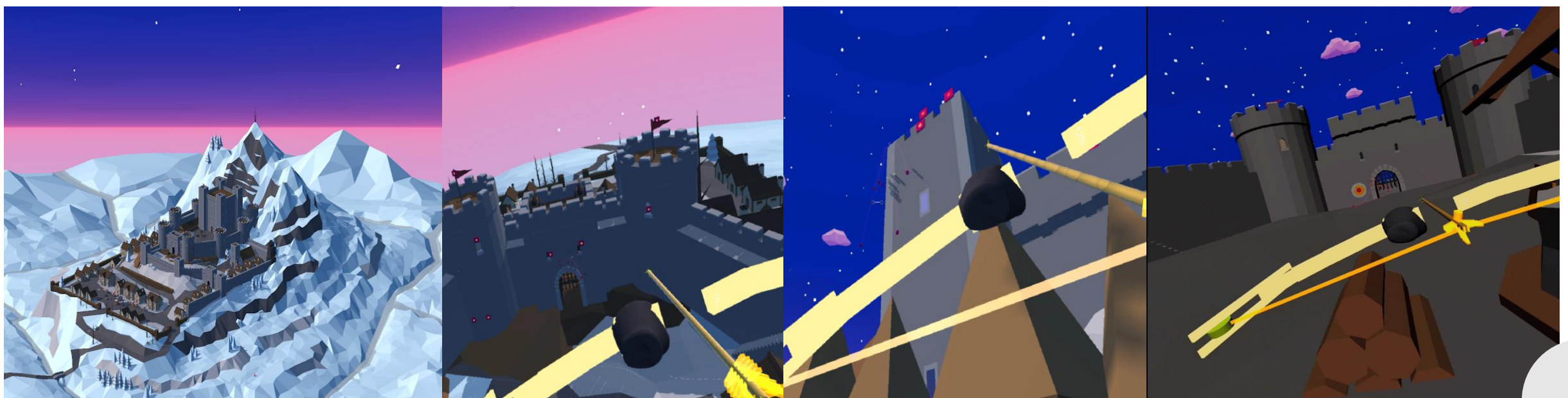
- Speed
- Distance
- Position
- Orientation

Challenge

- Reflexes
- Coordination
- Focus
- Concentration

Behaviour

- Target Size
- Target Position
- Target Rotation



Virtual Gym Slice Saber

Slice Saber

Player [PlayerSliceSaber]

Target [Colormaker]

Environment [Island]

Music [Name, Length]

Speed [Multiplier]

Sequence [Targets: Time, Position, Orientation]

Data [Name: Head, ... , LeftHand]

Configuration

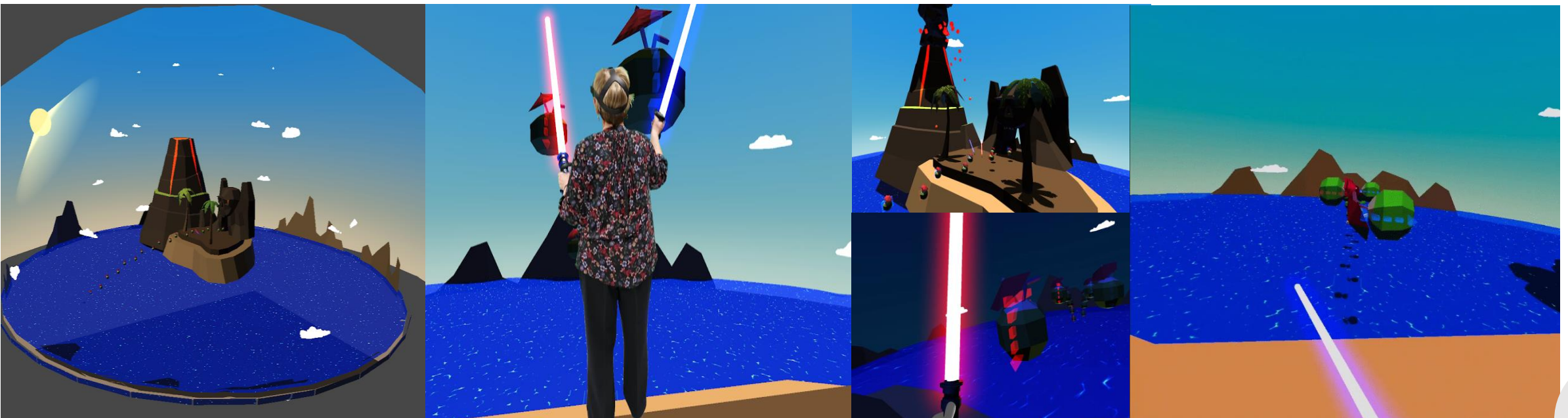
- Speed
- Color Position
- Orientation

Challenge

- Reflexes
- Coordination
- Focus
- Concentration

Behaviour

- Lightsaber Color
- Target Direction
- Target Rotation
- Target Colour



Virtual Gym Flying Rings

Flying Rings

Player [PlayerFlying]

Target [Size, Angle]

Environment [City]

Music [Name, Length]

Speed [Multiplier]

Sequence [Rings: Time, Position, Rotation]

Data [Name: Head, ... , LeftHand]

Configuration

- Speed
- Position
- Rotation
- Time Limit

Challenge

- Coordination
- Concentration
- Endurance

Behaviour

- Ring Limited Time
- Ring Size
- Ring Movement



Our Experience w ~40 seniors (60+, avg 72)

"I went on a trip to the beach today. Thanks to VR"

"The archery I like. Watch some of Kenya. Brought me back to our trip there years ago, Best trip ever."

"Loved the scenery after I arrived at the top! BTW, I think the moon's direction is the moon in Mexico LOL. The crescent of your moon is the other way around than here in Canada."

"I also love the new graphics! Great job!"

"The music really made a difference, and I think it was a good choice for this level. "

"I have never seen this sort of thing before. I find it fascinating. I am always amazed at what technology can do. You put a lightsaber that wasn't really there. It is a good brain exercise too, makes you pay attention, you have to be quick, react. "

"I was worried, I wouldn't know how to do it. But, I guess I do know how. I never [used] computer games, so it is all new for me."

"I wasn't sure I was doing it right. But it kept me thinking, keeps me busy."

"Very fun! At the beginning, it is a little difficult. Because I didn't know how to play."

"I enjoy it very much! Keep me on my toes. It was quite challenging."



VIRTUAL GYM

Virtual Reality Paradigm

ADVANTAGES

- First Person Interaction
- Immersive Environment
- Immediate Avatar Embodiment
- Surrounding Sound Effects
- Accurate Tracking
- High-Quality Data Collection

LIMITATIONS

- Blind from Obstacles in the Real World
- Not suitable for Everybody: Possible issues
 - Discomfort with the headset
 - Disorientation
 - Nausea
- Meticulous Hygiene Required
- Some Users May Need Graduated Lenses



VIRTUAL GYM

Reflections

- (Computer) Games have a meaningful role in personalized health (precision health)
 - Providing assessment proxies for cognitive, mental and physical state
 - Easier to collect data
 - More sensitive to change
 - Motivating health-promoting behaviors
 - Fun
 - Prompting
 - Adapting the level of difficulty to maintain engagement
- Key methodological points
 - Interdisciplinary team, with focus on design
 - Wealth of data-recording sensors



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