CHEESY MATH

University of Geneva

Faculty of Science & CUI

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About Cheesy Math

01

01 Cheesy Math I

Objective

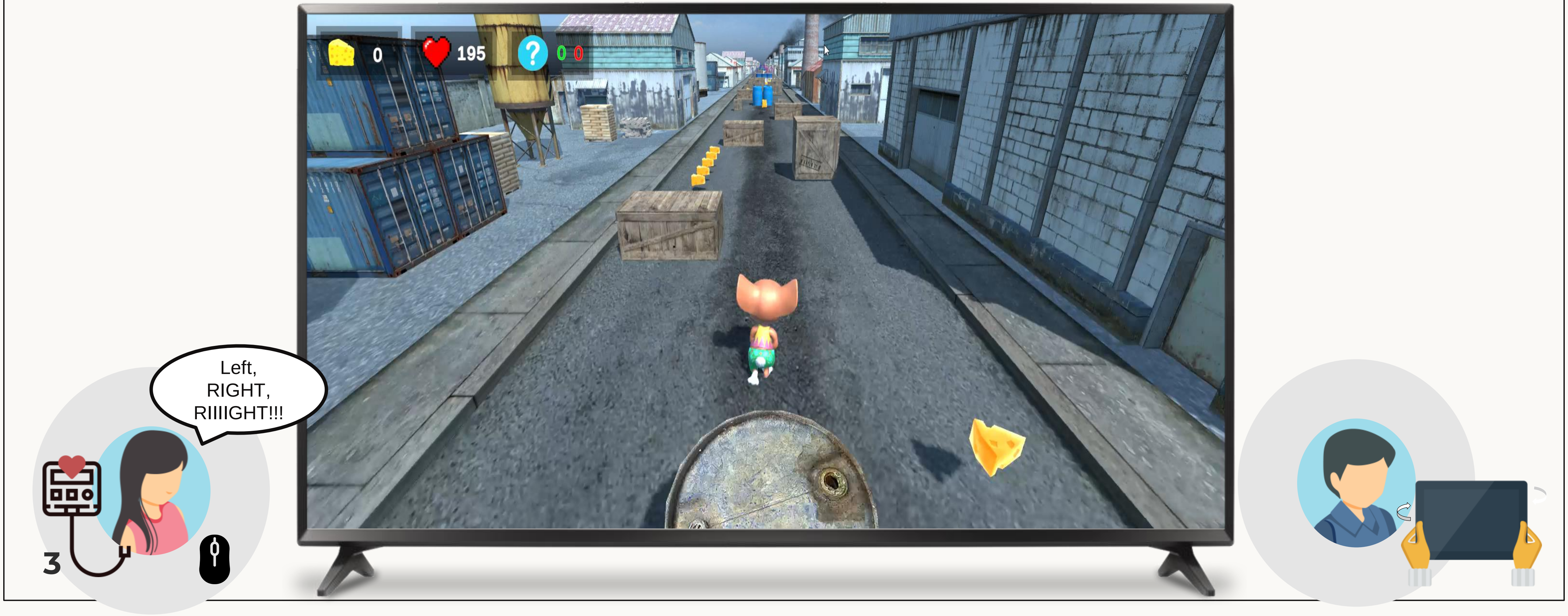
- The project aims to assess how the quality of human performance in solving easy math problems differs when individuals focus solely on math puzzles versus when playing a video game.

Game

- For this purpose, we've created a runner game with two-player control. In the game, they collect cheese and solve math puzzles.

01 Cheesy Math II

Game Play

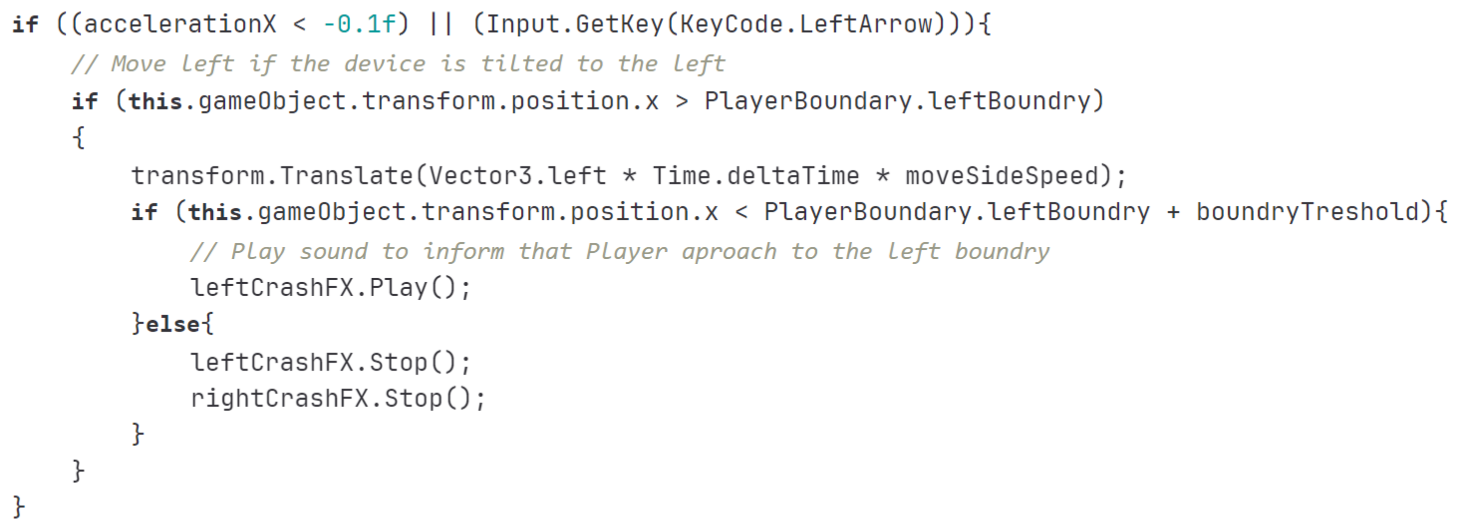


01 Cheesy Math III

Updates I

Professor Chanel

- When Mousy approaches the right and left boundaries too closely, players hear different alarms. It helps the second player better control the character.



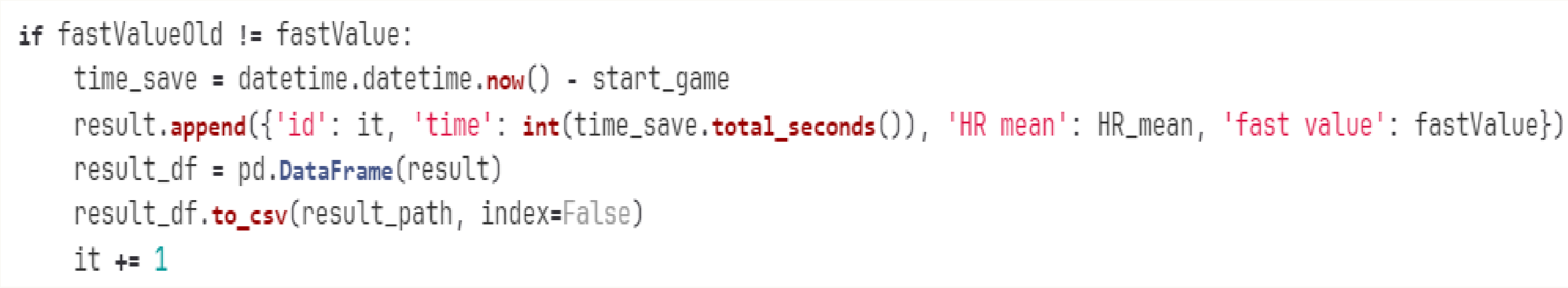
```
if ((accelerationX < -0.1f) || (Input.GetKey(KeyCode.LeftArrow))){
    // Move left if the device is tilted to the left
    if (this.gameObject.transform.position.x > PlayerBoundary.leftBoundry)
    {
        transform.Translate(Vector3.left * Time.deltaTime * moveSideSpeed);
        if (this.gameObject.transform.position.x < PlayerBoundary.leftBoundry + boundryTreshold){
            // Play sound to inform that Player aproach to the left boundry
            leftCrashFX.Play();
        }else{
            leftCrashFX.Stop();
            rightCrashFX.Stop();
        }
    }
}
```

01 Cheesy Math IV

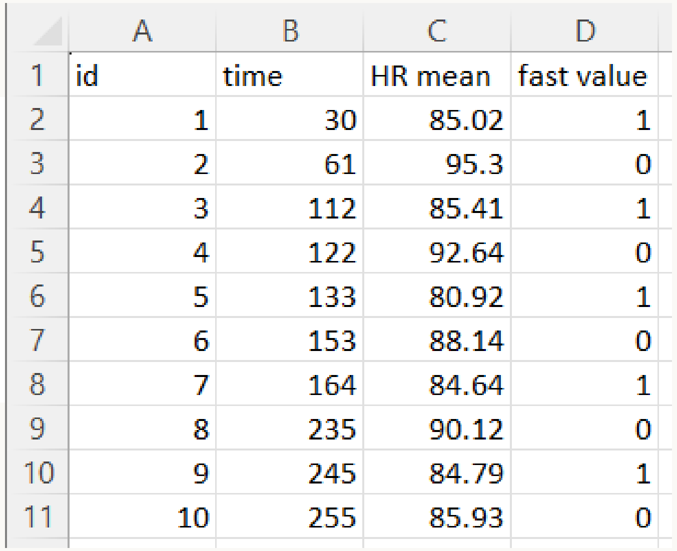
Updates II

Professor Moccozet

- ➢ Count the number of speed changes during the game for each participant.



```
if fastValueOld != fastValue:
    time_save = datetime.datetime.now() - start_game
    result.append({'id': it, 'time': int(time_save.total_seconds()), 'HR mean': HR_mean, 'fast value': fastValue})
    result_df = pd.DataFrame(result)
    result_df.to_csv(result_path, index=False)
    it += 1
```



	A	B	C	D
1	id	time	HR mean	fast value
2	1	30	85.02	1
3	2	61	95.3	0
4	3	112	85.41	1
5	4	122	92.64	0
6	5	133	80.92	1
7	6	153	88.14	0
8	7	164	84.64	1
9	8	235	90.12	0
10	9	245	84.79	1
11	10	255	85.93	0

Research Question

02

02 Research Question I

How does playing video games affect human performance in solving easy math problems?

- Before the game, one player answers 10 math questions in 1 minute (Six seconds per question).

- During the game, they respond to similar questions.

- Measure the differences in their math-solving performance.

02 Research Question II

What about the noisy data?

- A supervisor notes player one's answers while they guide player two.
- It helps to reveal interaction errors.

02 Research Question II

Hypothesis

- An underlying assumption in our research is that the player's math-solving performance during the game would likely be less accurate compared to when they were not playing.

- This hypothesis is rooted in the notion that the act of gaming introduces multitasking and distractions that could affect performance.

Emotional Model

03

04 Emotional Model I

Flow

- Change the speed of the character based on the changes in heart rate.
- In different levels of difficulty, the HR will change, with higher HR as the difficulty increases. *

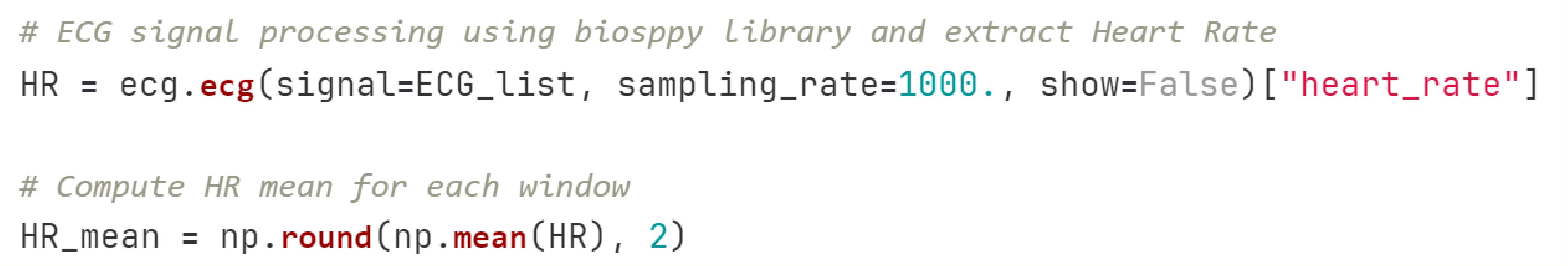
* Tian Y, Bian Y, Han P, Wang P,Gao F and Chen Y (2017) Physiological Signal Analysis for Evaluating Flow during Playing of Computer Games of Varying Difficulty. Front. Psychol. 8:1121. doi: 10.3389/fpsyg.2017.01121

04 Emotional Model II

Flow

- ➢ Before the game, we set a baseline heart rate (HR) for player one by calculating the mean.

- ➢ During the game, we dynamically adjust the character's speed based on their heart rate mean fluctuations.



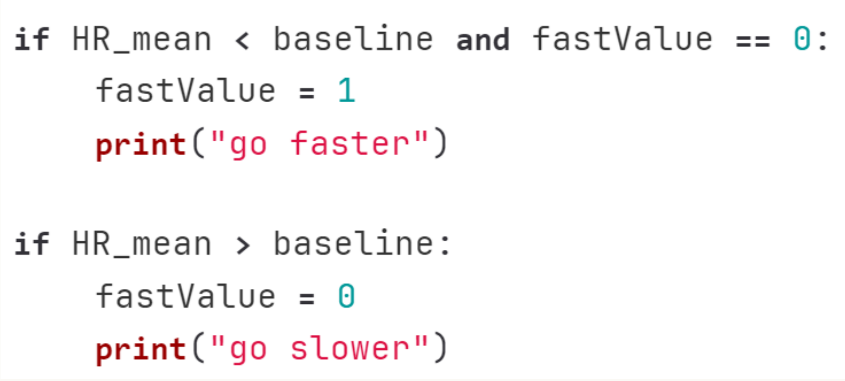
```
# ECG signal processing using biosppy library and extract Heart Rate
HR = ecg.ecg(signal=ECG_list, sampling_rate=1000., show=False)["heart_rate"]

# Compute HR mean for each window
HR_mean = np.round(np.mean(HR), 2)
```

04 Emotional Model III

For each window size of 10 seconds:

- If the player's Mean of HR dropped below the baseline, indicating a decrease in arousal or engagement
  - **Increase the character's speed**

- If the HR exceeded the baseline, indicating heightened arousal
  - **Decrease the character's speed**



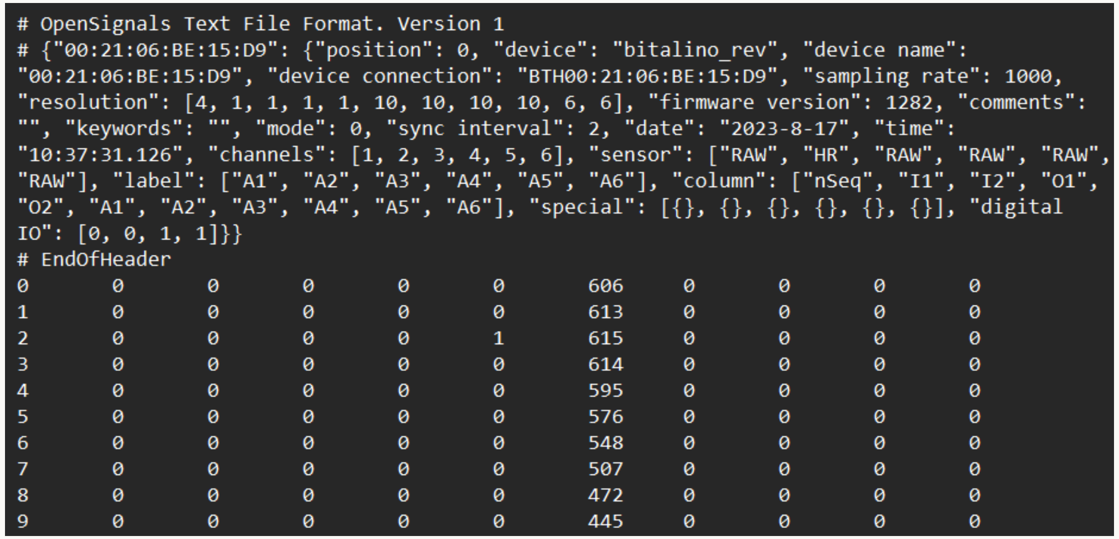
```
if HR_mean < baseline and fastValue == 0:
    fastValue = 1
    print("go faster")

if HR_mean > baseline:
    fastValue = 0
    print("go slower")
```

04 Problem Fixed

HR label

ECG label

OpenSignals Saved Data



```
# OpenSignals Text File Format. Version 1
# {"00:21:06:BE:15:D9": {"position": 0, "device": "bitalino_rev", "device name":
"00:21:06:BE:15:D9", "device connection": "BTH00:21:06:BE:15:D9", "sampling rate": 1000,
"resolution": [4, 1, 1, 1, 1, 10, 10, 10, 10, 6, 6], "firmware version": 1282, "comments":
"", "keywords": "", "mode": 0, "sync interval": 2, "date": "2023-8-17", "time":
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"O2", "A1", "A2", "A3", "A4", "A5", "A6"], "special": [{}, {}, {}, {}, {}, {}], "digital
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# EndOfHeader
0       0       0       0       0       0       606     0       0       0       0
1       0       0       0       0       0       613     0       0       0       0
2       0       0       0       0       1       615     0       0       0       0
3       0       0       0       0       0       614     0       0       0       0
4       0       0       0       0       0       595     0       0       0       0
5       0       0       0       0       0       576     0       0       0       0
6       0       0       0       0       0       548     0       0       0       0
7       0       0       0       0       0       507     0       0       0       0
8       0       0       0       0       0       472     0       0       0       0
9       0       0       0       0       0       445     0       0       0       0
```

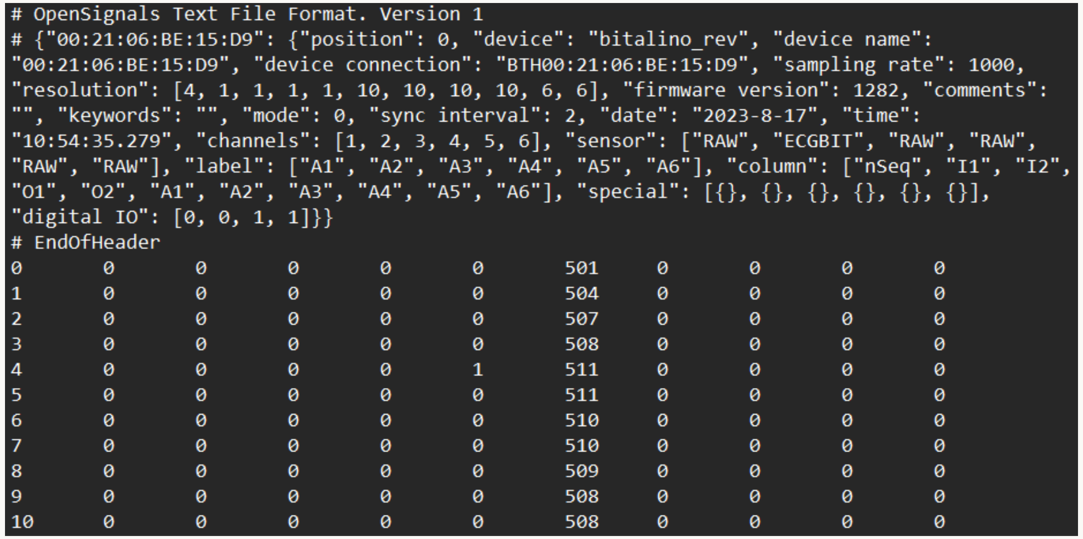

```
# OpenSignals Text File Format. Version 1
# {"00:21:06:BE:15:D9": {"position": 0, "device": "bitalino_rev", "device name":
"00:21:06:BE:15:D9", "device connection": "BTH00:21:06:BE:15:D9", "sampling rate": 1000,
"resolution": [4, 1, 1, 1, 1, 10, 10, 10, 10, 6, 6], "firmware version": 1282, "comments":
"", "keywords": "", "mode": 0, "sync interval": 2, "date": "2023-8-17", "time":
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"RAW", "RAW"], "label": ["A1", "A2", "A3", "A4", "A5", "A6"], "column": ["nSeq", "I1", "I2",
"O1", "O2", "A1", "A2", "A3", "A4", "A5", "A6"], "special": [{}, {}, {}, {}, {}, {}],
"digital IO": [0, 0, 1, 1]}}
# EndOfHeader
0       0       0       0       0       0       501     0       0       0       0
1       0       0       0       0       0       504     0       0       0       0
2       0       0       0       0       0       507     0       0       0       0
3       0       0       0       0       0       508     0       0       0       0
4       0       0       0       0       1       511     0       0       0       0
5       0       0       0       0       0       511     0       0       0       0
6       0       0       0       0       0       510     0       0       0       0
7       0       0       0       0       0       510     0       0       0       0
8       0       0       0       0       0       509     0       0       0       0
9       0       0       0       0       0       508     0       0       0       0
10      0       0       0       0       0       508     0       0       0       0
```
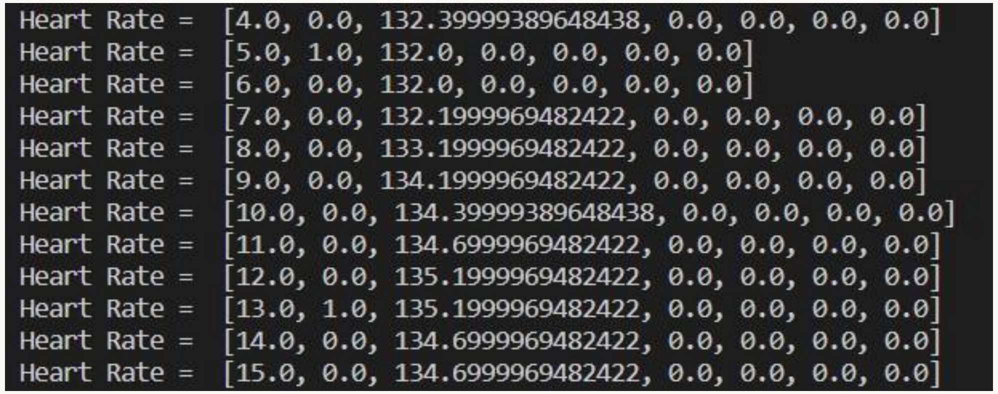
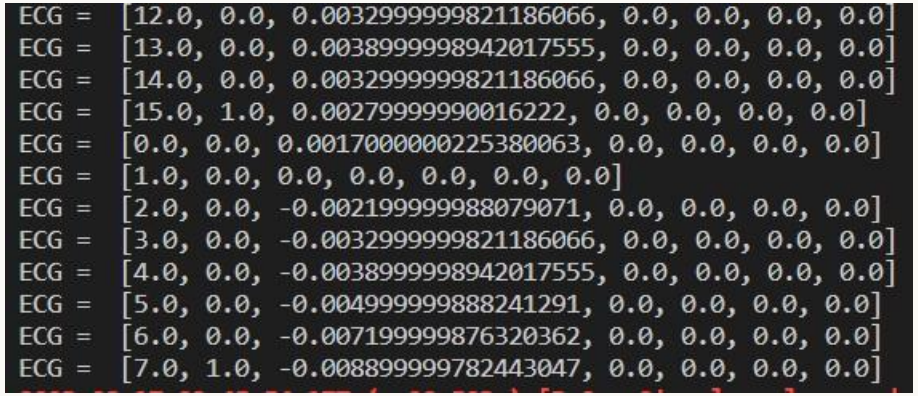

Transferred Data

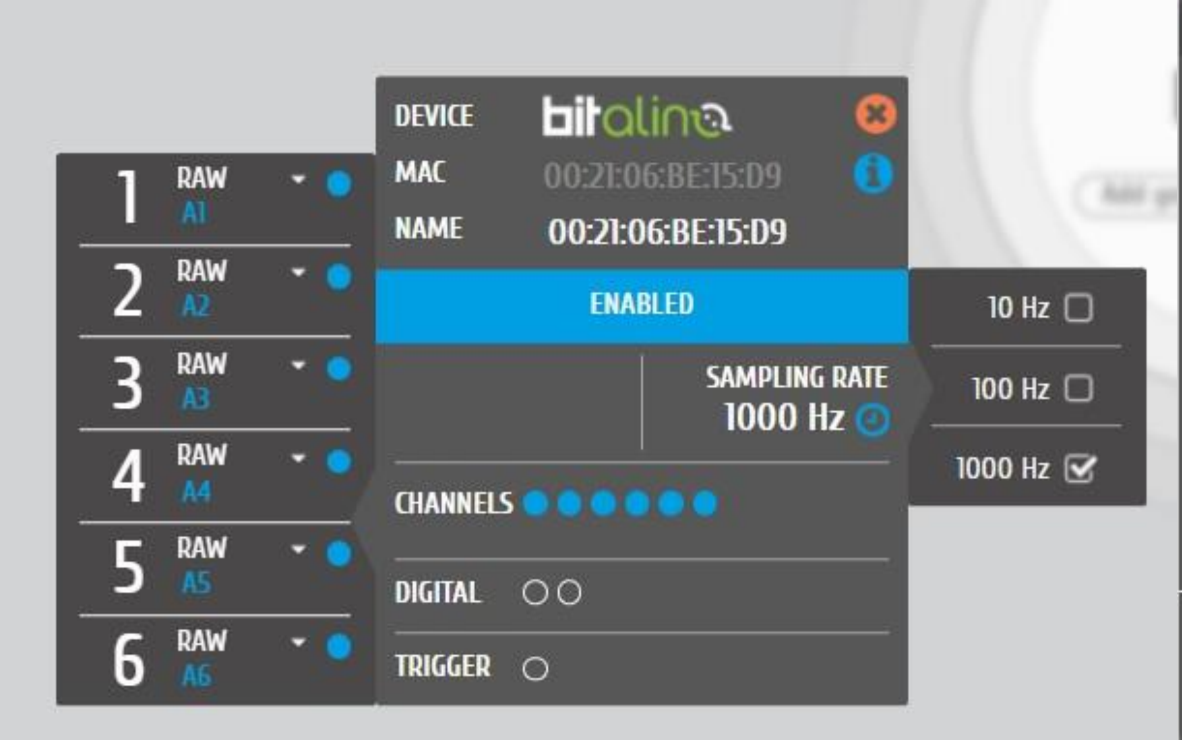


```
Heart Rate =  [4.0, 0.0, 132.39999389648438, 0.0, 0.0, 0.0, 0.0]
Heart Rate =  [5.0, 1.0, 132.0, 0.0, 0.0, 0.0, 0.0]
Heart Rate =  [6.0, 0.0, 132.0, 0.0, 0.0, 0.0, 0.0]
Heart Rate =  [7.0, 0.0, 132.1999969482422, 0.0, 0.0, 0.0, 0.0]
Heart Rate =  [8.0, 0.0, 133.1999969482422, 0.0, 0.0, 0.0, 0.0]
Heart Rate =  [9.0, 0.0, 134.1999969482422, 0.0, 0.0, 0.0, 0.0]
Heart Rate =  [10.0, 0.0, 134.39999389648438, 0.0, 0.0, 0.0, 0.0]
Heart Rate =  [11.0, 0.0, 134.6999969482422, 0.0, 0.0, 0.0, 0.0]
Heart Rate =  [12.0, 0.0, 135.1999969482422, 0.0, 0.0, 0.0, 0.0]
Heart Rate =  [13.0, 1.0, 135.1999969482422, 0.0, 0.0, 0.0, 0.0]
Heart Rate =  [14.0, 0.0, 134.6999969482422, 0.0, 0.0, 0.0, 0.0]
Heart Rate =  [15.0, 0.0, 134.6999969482422, 0.0, 0.0, 0.0, 0.0]
```



```
ECG =  [12.0, 0.0, 0.0032999999821186066, 0.0, 0.0, 0.0, 0.0]
ECG =  [13.0, 0.0, 0.0038999998942017555, 0.0, 0.0, 0.0, 0.0]
ECG =  [14.0, 0.0, 0.0032999999821186066, 0.0, 0.0, 0.0, 0.0]
ECG =  [15.0, 1.0, 0.00279999990016222, 0.0, 0.0, 0.0, 0.0]
ECG =  [0.0, 0.0, 0.0017000000225380063, 0.0, 0.0, 0.0, 0.0]
ECG =  [1.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
ECG =  [2.0, 0.0, -0.002199999988079071, 0.0, 0.0, 0.0, 0.0]
ECG =  [3.0, 0.0, -0.0032999999821186066, 0.0, 0.0, 0.0, 0.0]
ECG =  [4.0, 0.0, -0.0038999998942017555, 0.0, 0.0, 0.0, 0.0]
ECG =  [5.0, 0.0, -0.004999999888241291, 0.0, 0.0, 0.0, 0.0]
ECG =  [6.0, 0.0, -0.007199999876320362, 0.0, 0.0, 0.0, 0.0]
ECG =  [7.0, 1.0, -0.008899999782443047, 0.0, 0.0, 0.0, 0.0]
```

04 Problem Fixed



DEVICE bitalino

MAC 00:21:06:BE:15:D9

NAME 00:21:06:BE:15:D9

ENABLED

SAMPLING RATE 1000 Hz

CHANNELS ● ● ● ● ● ●

DIGITAL ○ ○

TRIGGER ○

1 RAW A1 ●

2 RAW A2 ●

3 RAW A3 ●

4 RAW A4 ●

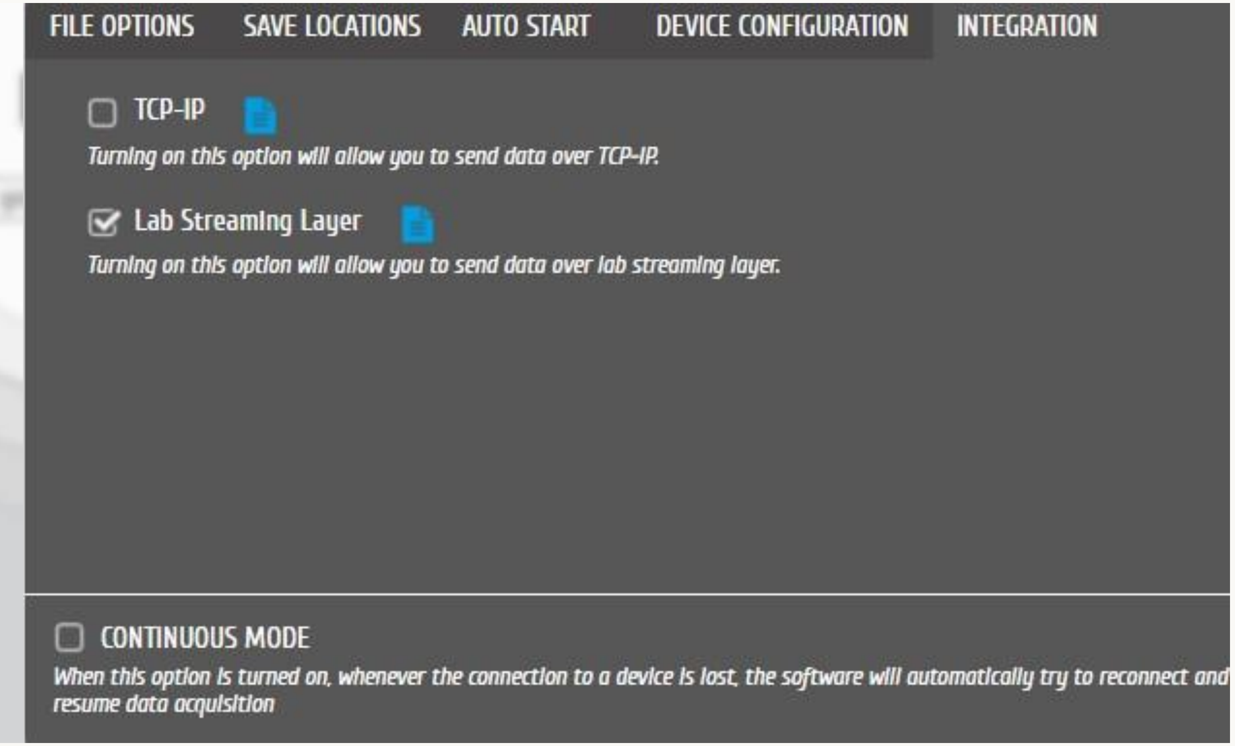
5 RAW A5 ●

6 RAW A6 ●

10 Hz □

100 Hz □

1000 Hz ☑



FILE OPTIONS | SAVE LOCATIONS | AUTO START | DEVICE CONFIGURATION | INTEGRATION

□ TCP-IP

Turning on this option will allow you to send data over TCP-IP.

☑ Lab Streaming Layer

Turning on this option will allow you to send data over lab streaming layer.

□ CONTINUOUS MODE

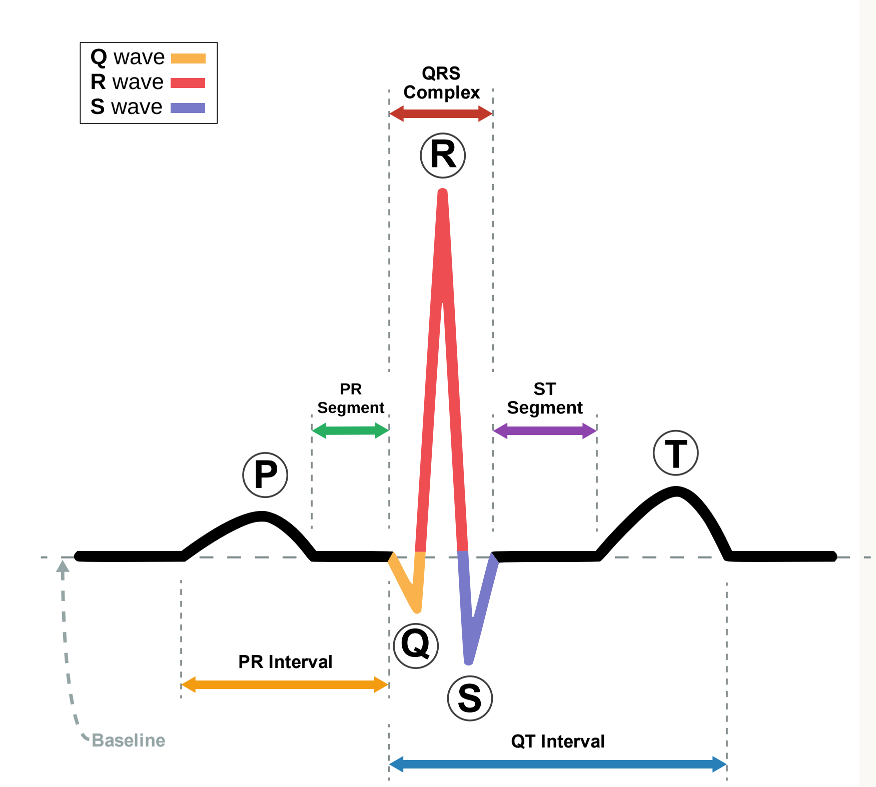
When this option is turned on, whenever the connection to a device is lost, the software will automatically try to reconnect and resume data acquisition

04 Emotional Model IV

Biosppy

```
# ECG signal processing using biosppy library and extract Heart Rate
HR = ecg.ecg(signal=ECG_list, sampling_rate=1000., show=False)["heart_rate"]

# Compute HR mean for each window
HR_mean = np.round(np.mean(HR), 2)
```

1. **R-Peak Detection**
   - Pan-Tompkins QRS detection algorithm
2. **Calculate RR Intervals**
   - Time intervals between 2 successive R-Peaks
3. **Calculate Heart Rate**
   - Heart Rate (BPM) = $\dfrac{60 \times 1000}{\text{Average RR Interval (ms)}}$



*https://commons.wikimedia.org/wiki/File:SinusRhythmLabels.svg

Modalities

Inputs & Outputs

04

04 Modalities I

Inputs

1. **Movement (Smartphone accelerometer)**
   - Move Mousy left and right

2. **Touch (Laptop touchpad)**
   - Jump

3. **Heart Rate (Bitalino + OpenSignal)**
   - Mousy’s speed Adjustment

04 Modalities II

Outputs

1. **Sound (Speaker)**
   - Correct and Wrong answer
   - Running close to the boundaries
   - Crashes

2. **Display (Monitor)**
   - The number of collected cheeses
   - Correctness of answers

3. **Vibration in Mobile version (Smartphone Sensor)**
   - In case of crashes into obstacles

Tools & Applications

05

05 Tools & Apps I

Unity3D(v2021.3.9f1)

- It's a powerful cross-platform game engine for creating video games, VR, and AR apps. Equipped with many tools, a user-friendly interface, and a strong C# scripting API.

Visual Studio Code

- A streamlined code editor with support for development operations like debugging, task running, and version control. (C# and Python)

05 Tools & Apps II

Bitalino and OpenSignal

- Bitalino is a device used for heart rate acquisition. Open Signal is its corresponding app designed to collect and transfer data to other applications.

Unity Remote

- Unity Remote is a downloadable app that sends live inputs from Android and iOS devices to Unity projects.

05 Tools & Apps III

Unity Asset Store & Mixamo

- Unity Asset Store is a Unity Technologies online marketplace for developers to discover digital assets like 3D models, 2D textures, animations, audio, and more for their game projects.

Adobe Photoshop & Premier Pro

- Apps for editing photos, videos, and sound used to create game logos and loop music.

User Test

06

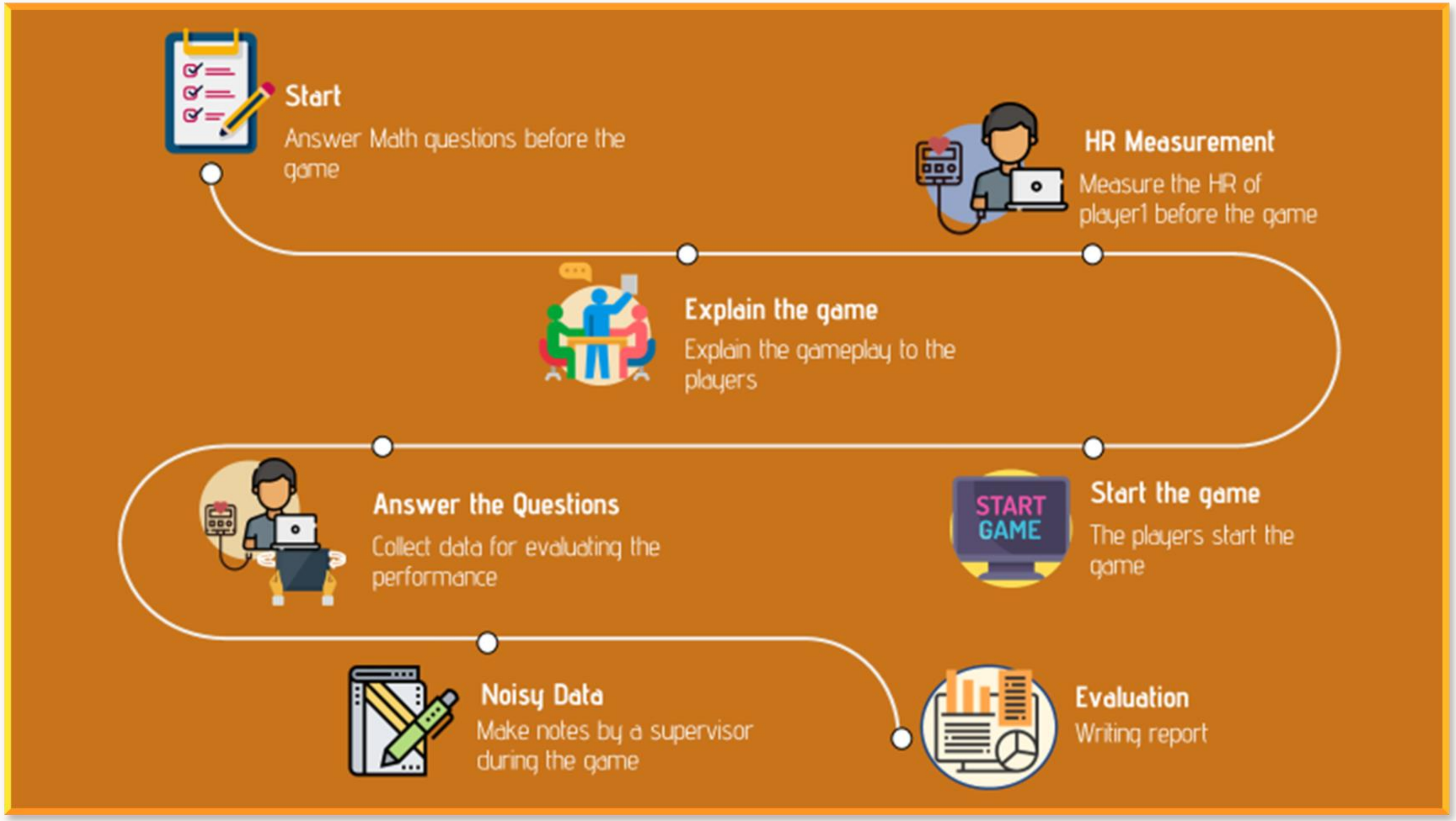
06 User Test I

Participants

- 3 men and 3 women as player 1
- 6 adults with gaming experience

06 User Test II

User Test Process Diagram



Start
Answer Math questions before the game

HR Measurement
Measure the HR of player1 before the game

Explain the game
Explain the gameplay to the players

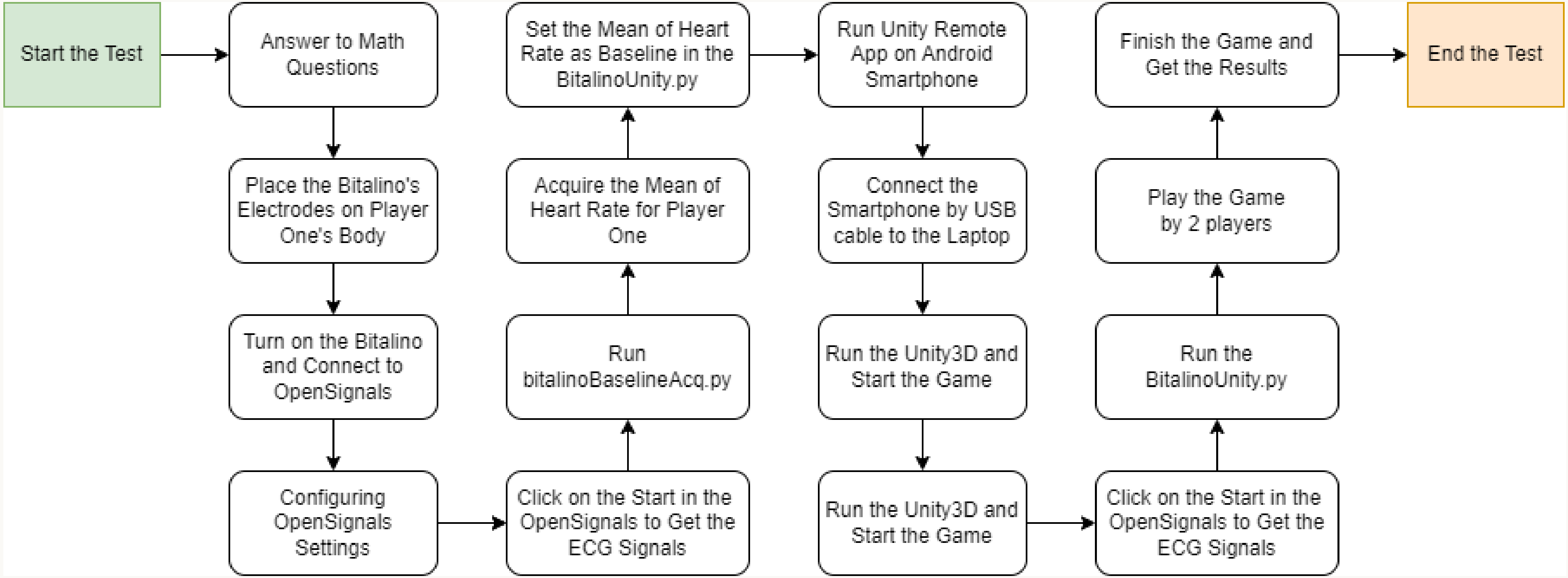
Start the game
The players start the game

Answer the Questions
Collect data for evaluating the performance

Noisy Data
Make notes by a supervisor during the game

Evaluation
Writing report

06 User Test III


Start the Test

Answer to Math Questions

Place the Bitalino's Electrodes on Player One's Body

Turn on the Bitalino and Connect to OpenSignals

Configuring OpenSignals Settings

Click on the Start in the OpenSignals to Get the ECG Signals

Run bitalinoBaselineAcq.py

Acquire the Mean of Heart Rate for Player One

Set the Mean of Heart Rate as Baseline in the BitalinoUnity.py

Run Unity Remote App on Android Smartphone

Connect the Smartphone by USB cable to the Laptop

Run the Unity3D and Start the Game

Run the Unity3D and Start the Game

Click on the Start in the OpenSignals to Get the ECG Signals

Run the BitalinoUnity.py

Play the Game by 2 players

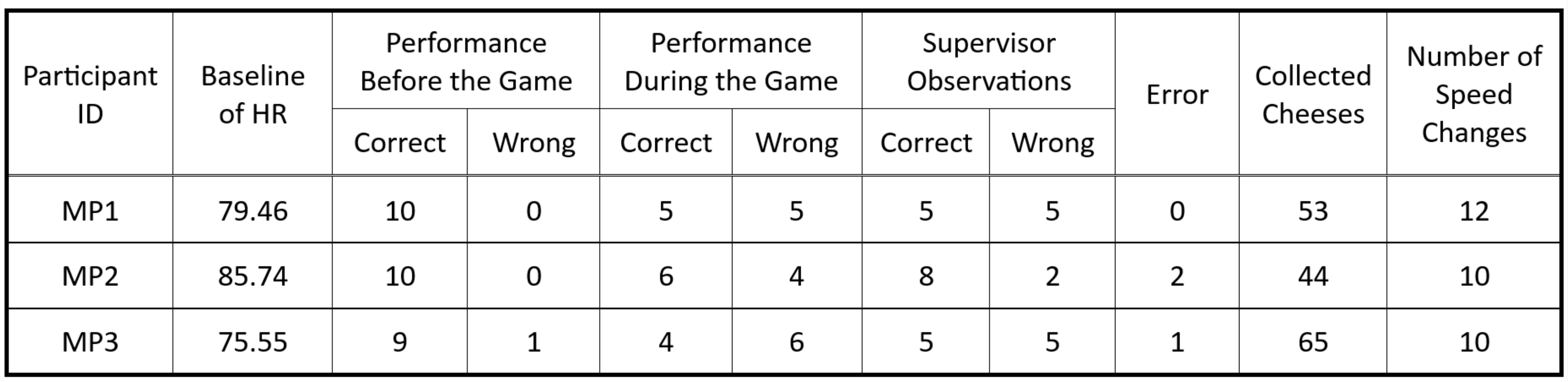
Finish the Game and Get the Results

End the Test

06 User Test IV

Results

Men’s Performance

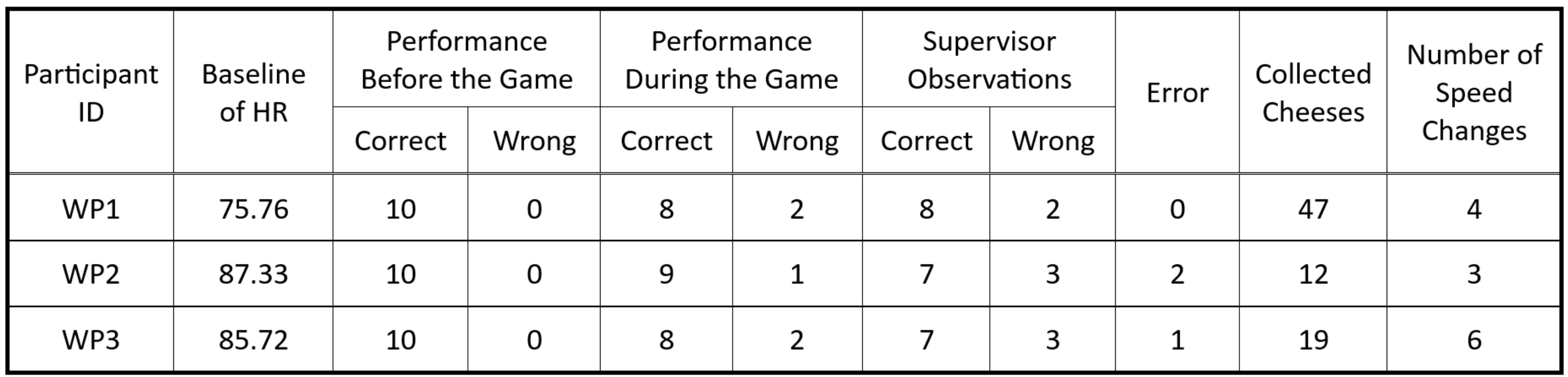


Participant ID	Baseline of HR	Performance Before the Game		Performance During the Game		Supervisor Observations		Error	Collected Cheeses	Number of Speed Changes
		Correct	Wrong	Correct	Wrong	Correct	Wrong			
MP1	79.46	10	0	5	5	5	5	0	53	12
MP2	85.74	10	0	6	4	8	2	2	44	10
MP3	75.55	9	1	4	6	5	5	1	65	10

06 User Test V

Results

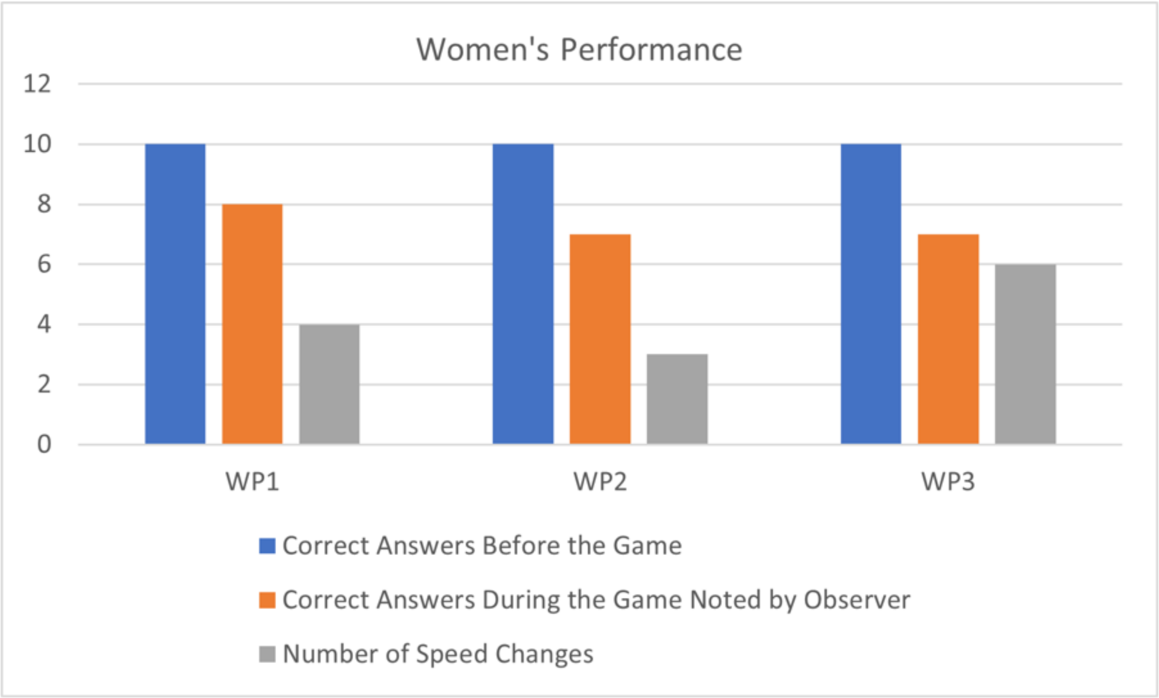
Women’s Performance

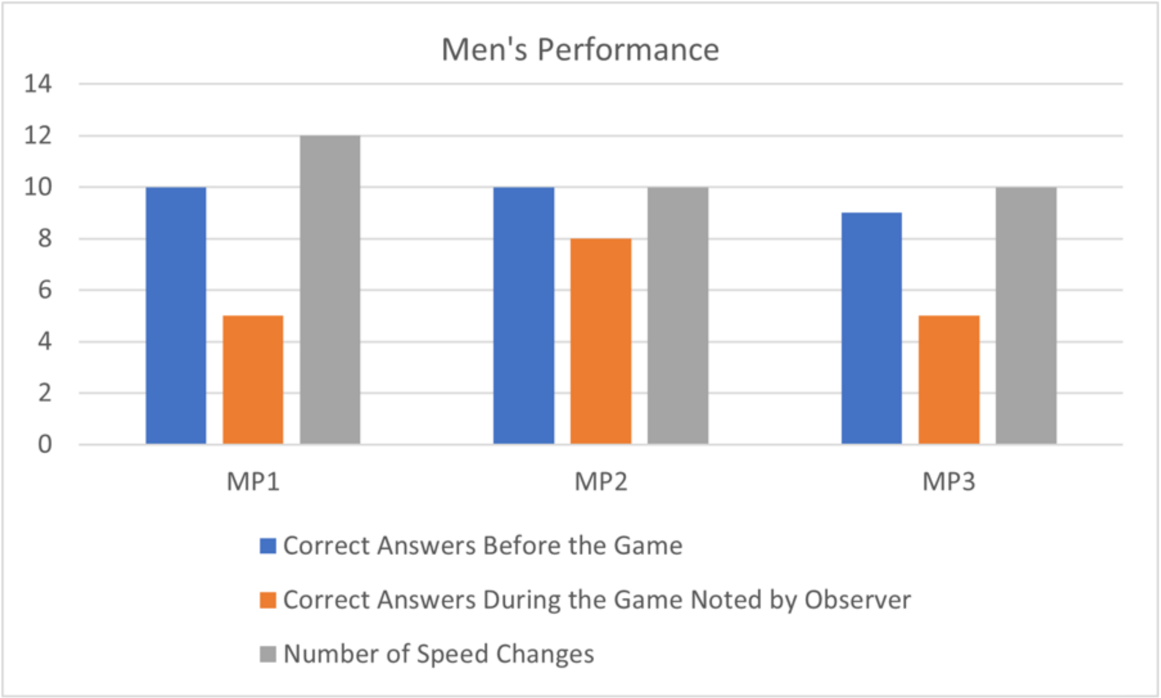


Participant ID	Baseline of HR	Performance Before the Game		Performance During the Game		Supervisor Observations		Error	Collected Cheeses	Number of Speed Changes
		Correct	Wrong	Correct	Wrong	Correct	Wrong			
WP1	75.76	10	0	8	2	8	2	0	47	4
WP2	87.33	10	0	9	1	7	3	2	12	3
WP3	85.72	10	0	8	2	7	3	1	19	6

06 User Test VI

Results

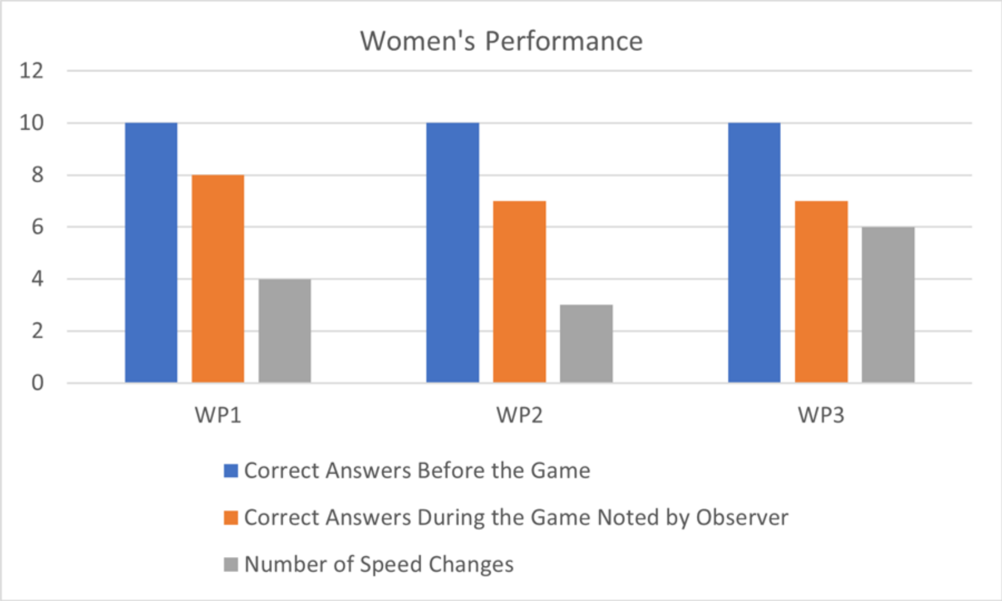


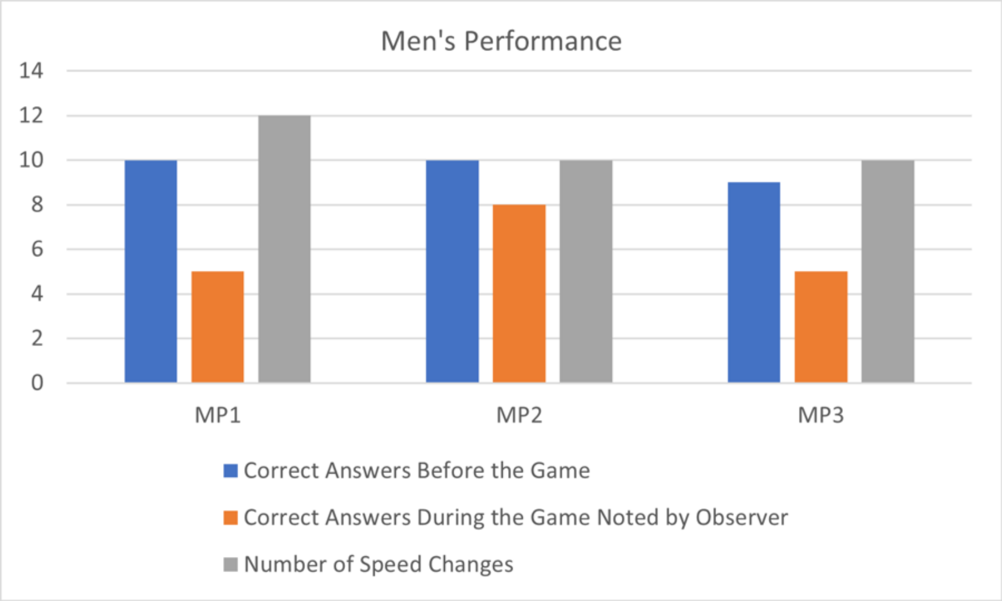


Observations I

Participants exhibited a considerable drop in in-game performance compared to their performance before starting the game.

- ➢ The effects of factors that cause distraction in the game for players
- ➢ The impact of multitasking during gameplay

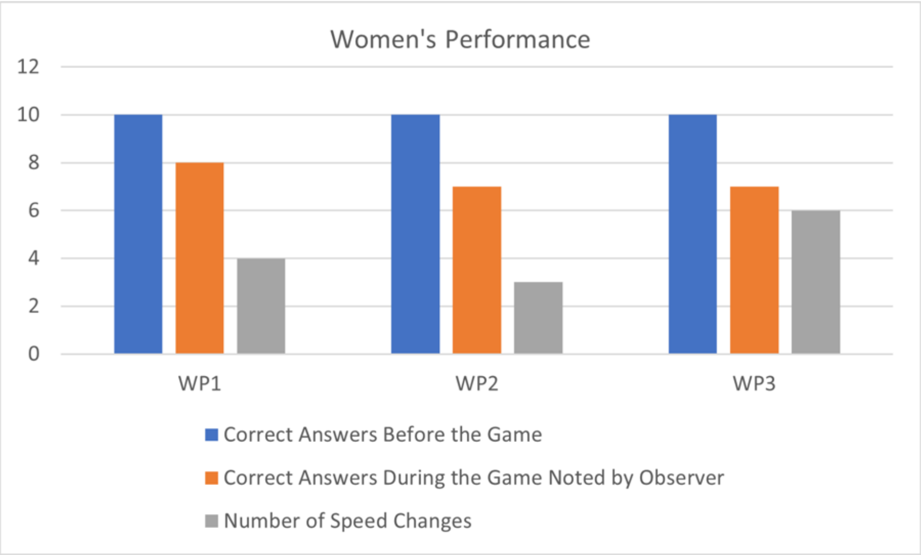


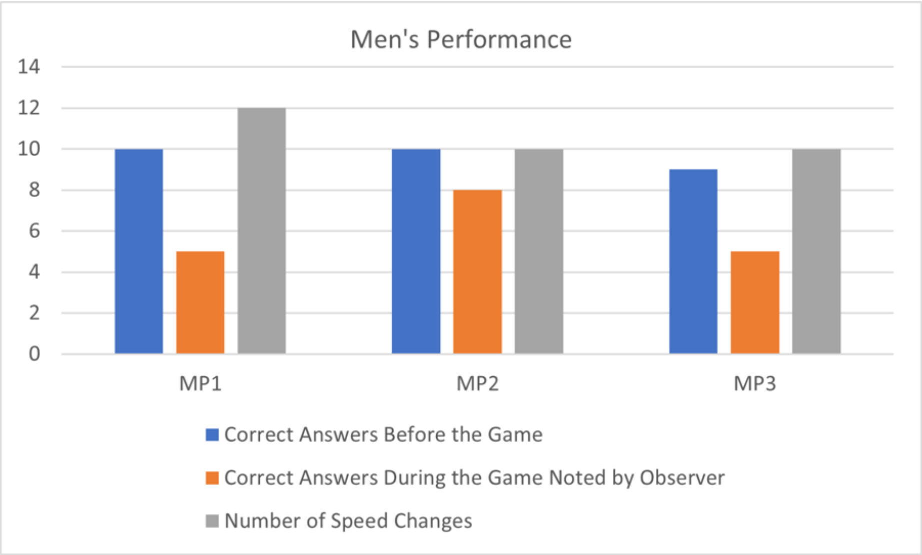


Observations II

The Heart Rate fluctuation was less among female participants compared to male participants.

- ➢ Female players’ physiological system undergoes fewer changes during gameplay.
- ➢ Higher character speed variability in male players may affect their performance in answering the math questions.



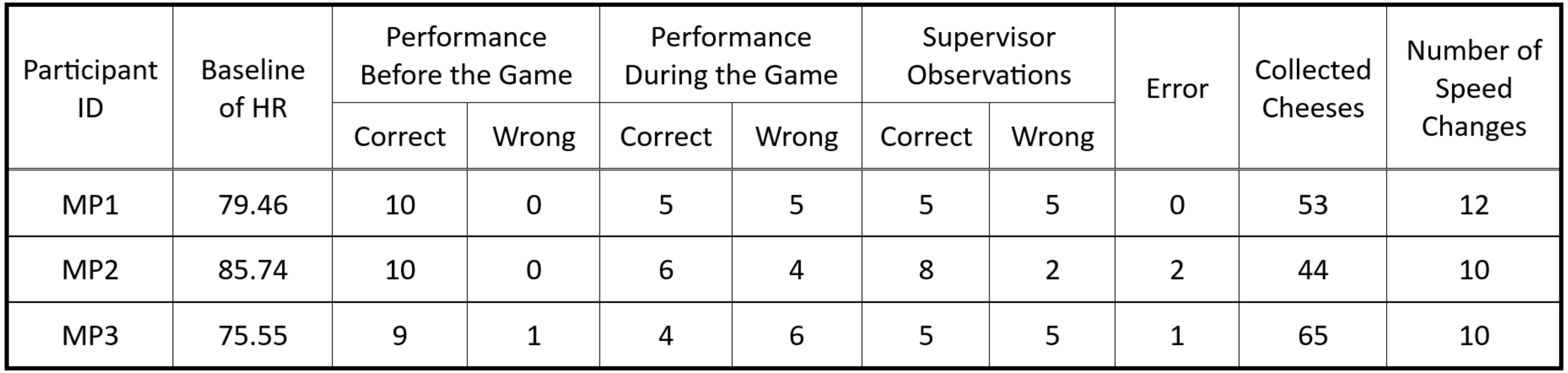


Observations III

The average heart rate (HR) obtained as the baseline before the game varies among the participants.

- Individuals have distinct physiological responses.

Men’s Performance



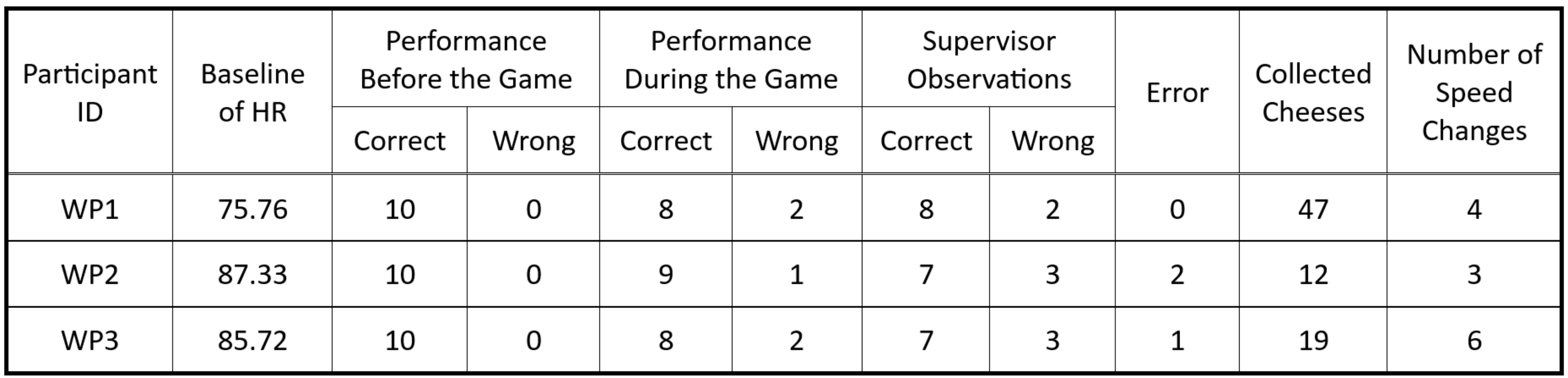
Participant ID	Baseline of HR	Performance Before the Game		Performance During the Game		Supervisor Observations		Error	Collected Cheeses	Number of Speed Changes
		Correct	Wrong	Correct	Wrong	Correct	Wrong			
MP1	79.46	10	0	5	5	5	5	0	53	12
MP2	85.74	10	0	6	4	8	2	2	44	10
MP3	75.55	9	1	4	6	5	5	1	65	10

Observations IV

The number of cheese items collected by female players was lower than that of male players.

- ➢ Female players prioritizing the solving of math questions more than collecting cheese items.

Women’s Performance



Participant ID	Baseline of HR	Performance Before the Game		Performance During the Game		Supervisor Observations		Error	Collected Cheeses	Number of Speed Changes
		Correct	Wrong	Correct	Wrong	Correct	Wrong			
WP1	75.76	10	0	8	2	8	2	0	47	4
WP2	87.33	10	0	9	1	7	3	2	12	3
WP3	85.72	10	0	8	2	7	3	1	19	6

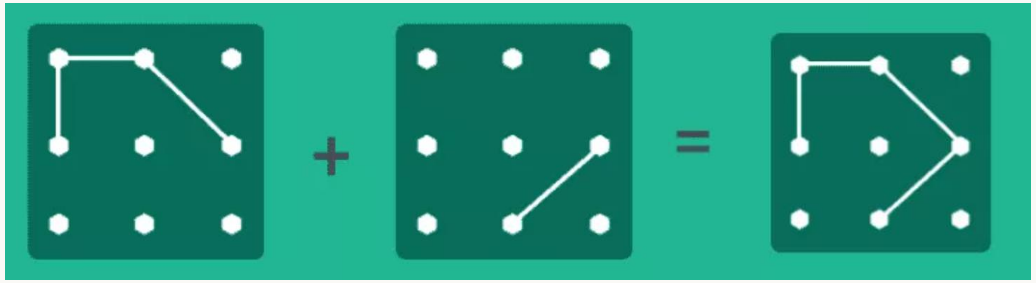
Future Work

07

07 Future Work

1. Expanding our participant pool to include a more diverse range of players.

2. Change the type of questions. For example:



3. Monitoring the heart rate of player two

*https://prepopedia.com/procter-and-gamble-assessment-practice/

References

08

08 References

1. Character and its animations:

- https://www.mixamo.com/
- https://www.youtube.com/watch?v=2-_V0ZuB2eA&t=354s

2. Environment:

- https://assetstore.unity.com/packages/3d/environments/industrial/rpg-fps-game-assets-for-pc-mobile-industrial-set-v2-0-86679
- https://assetstore.unity.com/packages/tools/utilities/tg-utility-131460
- https://assetstore.unity.com/packages/3d/props/food/free-casual-food-pack-mobile-vr-85884
- https://assetstore.unity.com/packages/3d/environments/roadways/road-props-for-games-diffuse-map-atlas-lp-238835
- https://assetstore.unity.com/packages/3d/vehicles/controllable-forklift-free-80275

3. Sound FX:

- https://assetstore.unity.com/packages/audio/sound-fx/8-bits-elements-16848

4. Music:

- https://assetstore.unity.com/packages/audio/music/rock/funky-blues-rock-jam-free-118085

5. Tools

- https://unity.com/
- https://code.visualstudio.com/
- https://www.pluxbiosignals.com/
- https://assetstore.unity.com/
- https://docs.unity3d.com/Manual/UnityRemote5.html
- https://www.adobe.com/

6. Articles

- Tian Y, Bian Y, Han P, Wang P,Gao F and Chen Y (2017) Physiological Signal Analysis for Evaluating Flow during Playing of Computer Games of Varying Difficulty. Front. Psychol. 8:1121. doi: 10.3389/fpsyg.2017.01121

THANK YOU

Does anyone have any questions?

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