

# **Counter PacMan**

-Sai Krishna Prasad. K

## **Abstract**

This game user research paper will measure how players in a single maze-action game, CounterPacMan, experience different Player Experience Inventory (PXI) [7] constructs when choosing the antagonist character over the protagonist character. CounterPacMan is designed to make players experience the perspective of an antagonist (Ghost [2]). We will inquire how players experience our game qualitatively and quantitatively through the lens of the PXI, which is based on ten constructs (meaning, mastery, [9]). For the qualitative analysis, we follow the think-aloud protocol to enquire whether playing the game as protagonist or antagonist is more suitable for them. Furthermore, use the mini Player Experience Inventory (mPXI) post-survey [5] to measure the player experience on the multiple dimensions (which include meaning, mastery, autonomy, immersion, and six other constructs) along with a Likert scale to evaluate this survey using a linear scale ranging from '1' - Strongly Agree to '5' - Strongly Disagree. We change the CounterPacMan game design based on the independent t-test performed on the mean of the obtained survey data to determine whether or not there is any significant difference between ten PXI constructs when players play the same game with a different perspective.

## **Introduction**

The documentation conveys the design and research process to check for player experience while playing the antagonist character [6] in a PacMan-like game created using Unity Engine (13).

This paper aims to check for the player's experience from a non-player character's (NPC's) perspective with the help of Counter PacMan. We will inquire how players experience Counter PacMan through the lens of PXI constructs based on the following ten constructs: meaning, mastery, immersion, autonomy, curiosity,

ease-of-control, challenge, progress feedback, audiovisual appeal, goals, and rules. In Counter PacMan, we provide the players with two levels to play the game, traditionally as a PacMan (protagonist) or as a Ghost (antagonist).

With the help of the Counter PacMan game, we provide players with the choice to play the PacMan game from two different perspectives as follows:

Choice 1: Play the game as PacMan (Protagonist)

Choice 2: Play the game as one of the Ghosts (4) (Antagonist)

From the above two choices, we check if player experiences better:

**Meaning** in Character choice 1 or Character choice 2.

**Mastery** in Character choice 1 or Character choice 2.

**Immersion** in Character choice 1 or Character choice 2.

**Autonomy** in Character choice 1 or Character choice 2.

**Curiosity** in Character choice 1 or Character choice 2.

**Ease-of-control** in Character choice 1 or Character choice 2.

**Challenge** in Character choice 1 or Character choice 2.

**Progress Feedback** in Character choice 1 or Character choice 2.

**Audiovisual appeal** in Character choice 1 or Character choice 2.

**Rules and objectives** in Character choice 1 or Character choice 2.

In the initial prototype of Counter PacMan, players could choose to be either one of the ghosts and switch between the four different ghosts when choosing to play as an antagonist. We found that most of the play testers would stake out near one of the four corners on the grid and trap the PacMan while the other ghosts (run by artificial intelligence) chase behind him during the playtesting. So, we had to redesign one of the core game design concepts by removing the remaining three ghosts being run by Artificial Intelligence (AI) when players play as the fourth ghost character.

Furthermore, after implementation of the second version of playtesting, we received the following redesign ideas:

1. Better UI in both levels, which shows the number of lives left and the score obtained [**Progress Feedback**].
2. Add the background audio available in the PacMan game [**Audiovisual appeal**].

3. Redesign ghost level or add a new multiplayer level with two sets of controls, one for the Pacman character and the other for the ghost character [**Meaning, Mastery, Curiosity**].
4. Better description of the goals and rules for different game levels [**Rules and objectives**].

To inquire how players experience Counter PacMan through the lens of PXI, they are provided with the mini-Player Experience Inventory (mPXI) post-survey (5). We use a Likert scale to evaluate this survey using a linear scale ranging from '1' - Strongly Agree to '7' - Strongly Disagree. We gather the survey data from players for both the game levels where they play as protagonist and antagonist. Moreover, set the players' responses for the protagonist level as a control group to establish baseline data regarding the ten different constructs, while the experimental group will be players playing the game as an antagonist character. We perform a two-sided independent t-test for the Likert scale data obtained on both game levels to determine any significant difference between the PXI constructs when players choose to play as an antagonist or as a protagonist.

## Related Works

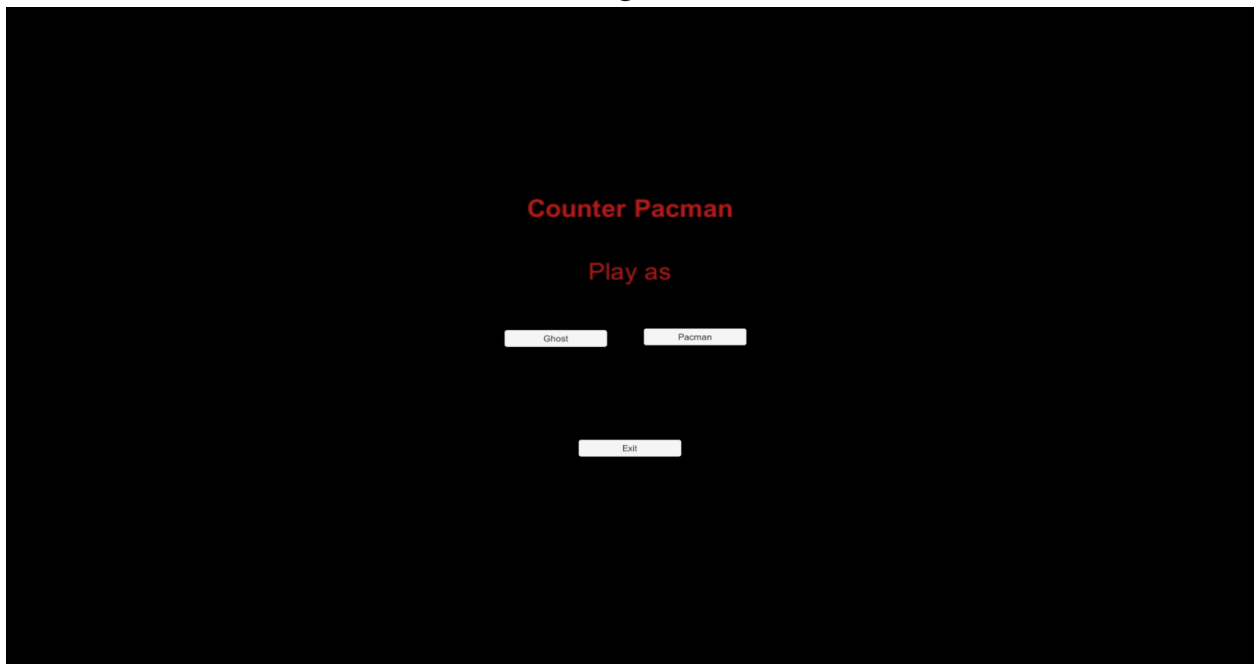
- **PacMan (1)** - The Counter PacMan was inspired by this single-player maze action arcade game. We use similar visual concepts for the design of Counter PacMan.
- **Last of us 2 antagonists** - Naughty Dogs decided to make players experience the game from the antagonist (Abby) perspective after playing as the protagonist (Ellie) for ten hours as the Abby kills a beloved character to Ellie and asking players to experience the viewpoint of an antagonist made this very controversial.
- **Kingdom Hearts (12) and Jaws Unleashed(11)** are two games that depict the players playing the roles of antagonists. In Jaws 2 players can upgrade their shark character by the amount of destruction obtained from previous levels.

# Methodology

## Game Design Methodology

Counter PacMan is a maze action game inspired by PacMan [1], designed and developed to provide players with a mirror perspective of playing the role of an antagonist with a change in rules and goals. The players play as ghosts or the PacMan based on their choice from the game menu to start a level (Fig 1). Both the game levels have a symmetrical structure and a fixed pre-rendered background. The ghost's home will be at the middle of the stage, and the ghost [2] starts coming out from home at the start of every level. We use immersive mechanics like killing and escaping from ghosts to collect players to experience an adrenaline rush. The game audio is minimal, making it more satisfying to hear when it is present. Most of the sound will be from the background music being played in a loop when the level begins.

Fig 1.

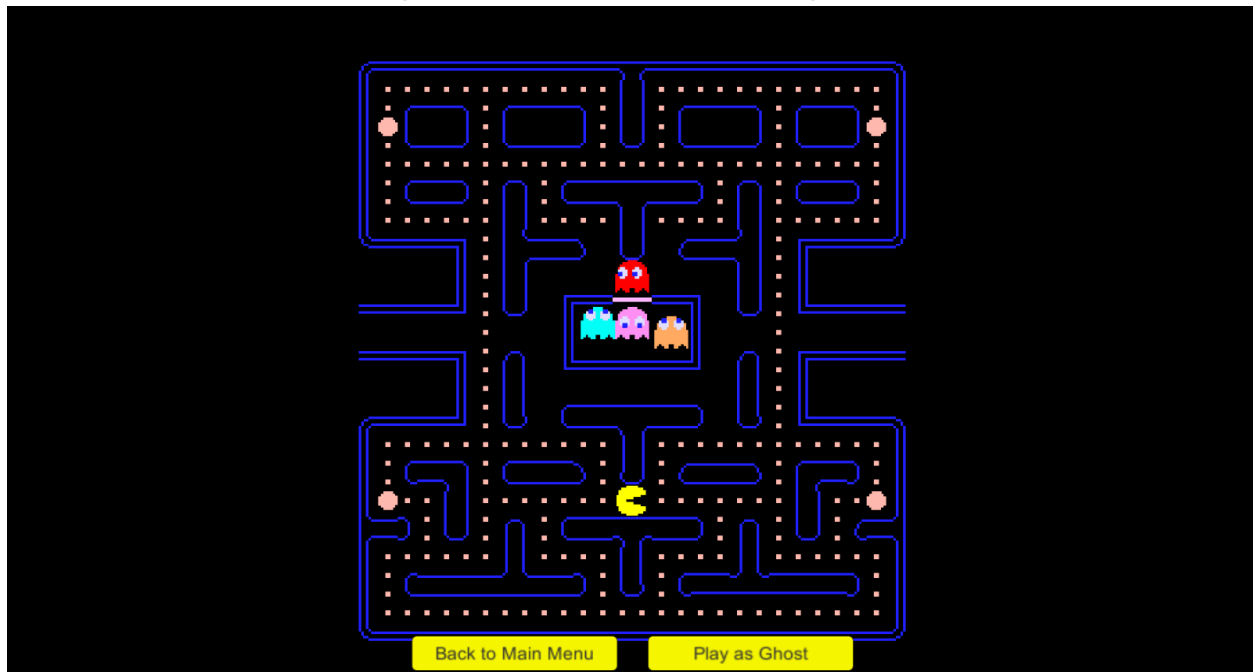


Both the rules and objectives of the game will vary depending on the player's choice of character. The following instructions and guidance are provided to players through UI and visual feedback.

Choice 1: Players rules & objectives as the PacMan character:

- Objectives
  - Collect all the yellow dots on the screen.
  - Consume ghosts to increase the score when boosted.
  - Obtain the perfect score.
  - There will be a different time system to increase the challenge for the player.
- Rules
  - Complete the game level in three lives.
  - Avoid ghosts trying to eat him.
  - Consume any of the four large yellow pills scattered through the stage, giving the lead character (Pac-Man) a boost/ability to eat ghosts for a limited amount of time.

Fig 2 (Counter PacMan Protagonist level)



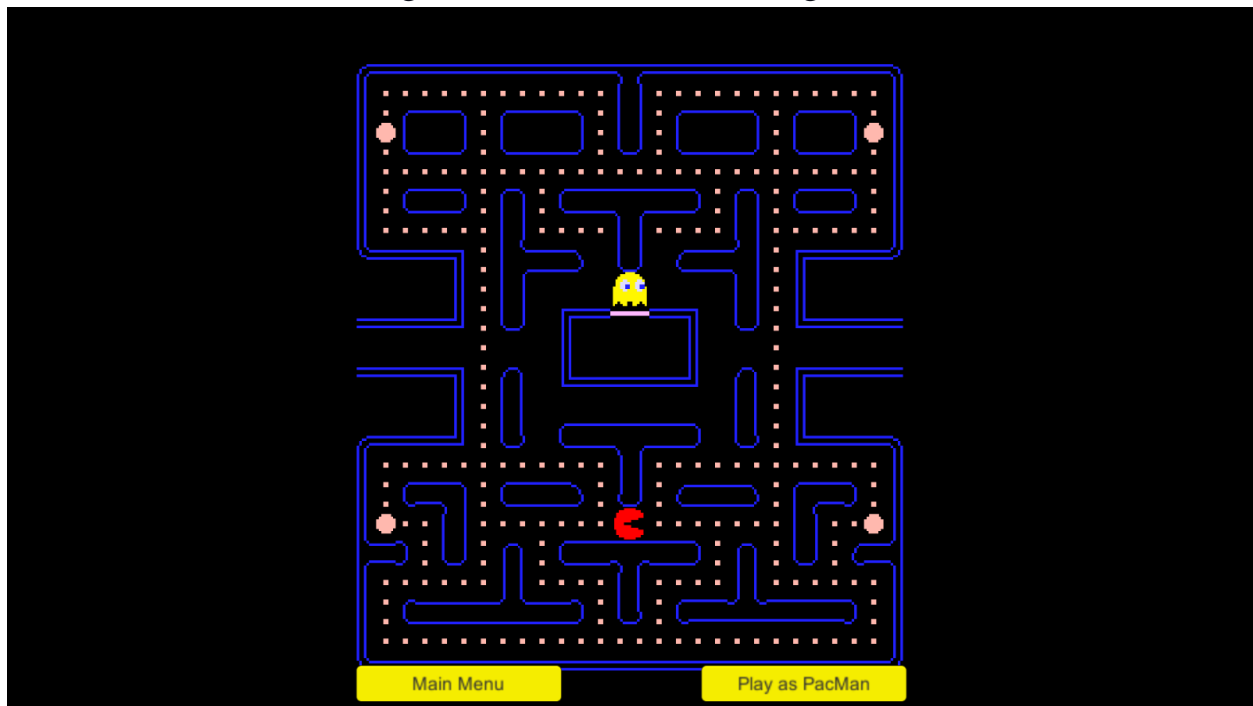
(Playing the game as PacMan)

Choice 2: Players rules & objectives as ghost characters:

- Objectives
  - Catch up to the PacMan character and stop them from collecting all the points on the game level leading to game completion.
  - End the game by taking away all the lives of the PacMan character.
- Rules
  - Use multiple lives to complete the objectives listed above.
  - Avoid PacMan when they consume the power pill. ( The power pill makes the ghost invisible, but the player can still control its movement).

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Fig 3 (Counter PacMan Antagonist level)



(Playing the game as Ghost)

## Research Methodology

### Qualitative data

For the preliminary user test and analysis for PXI constructs in Counter Pacman, we used the think-aloud method to collect data from the first set of playtesters containing five players (4 male, one female of 24 - 27 years of age). We failed to get any information from the first two playtesters as they were unaware of the think-aloud protocol and did not provide any valuable data for this research. The remaining three playtesters provided us with data as expected without much bias. Due to the suggestions provided by the faculty in charge, we changed the qualitative analysis method from think-aloud protocol to the inscriptive notetaking method for the second set of playtesters, and for this session, we had six playtesters/participants (five female and one male ranging from 24 - 29 years of age).

### Quantitative data

To inquire how players experience Counter PacMan through the lens of PXI, they are provided with the mini-Player Experience Inventory (mPXI) post-survey [5] after playing the CounterPacMan game as both the protagonist and antagonist. We use the mPXI questionnaire to measure the player experience on the multiple dimensions provided by this questionnaire. And use a Likert scale [8] to evaluate this survey using a linear scale ranging from '1' - Strongly Agree to '5' - Strongly Disagree. We gather the survey data from players for both the game levels where they play as protagonist and antagonist. And will set the players' responses for protagonist level as a control group to establish baseline data regarding the ten different constructs, while the experimental group will be players playing the game as an antagonist character. As a result, we analyze the following ten constructs of player experience inventory in our game:

*Meaning* [PC]: Playing the game was meaningful to me.

*Mastery* [PC]: I felt a sense of mastery playing this game.

*Immersion* [PC]: I was no longer aware of my surroundings while I was playing.  
*Curiosity* [PC]: I wanted to find out how the game progressed.  
*Ease of Control* [FC]: I thought the game was easy to control.  
*Challenge* [FC]: The challenges in the game were at the right level of difficulty for me.  
*Progress Feedback* [FC]: The game gave clear feedback on my progress towards the goals.  
*Audiovisual Appeal* [FC]: I enjoyed the way the game was styled.  
*Goals and rules* [FC]: I grasped the overall goal of the game.  
Where [FC] - Functional Consequences and [PC] - Psychosocial Consequences.

In our final analysis, we check if players who choose to play the game as an antagonist character have any change experience relating to different PXI constructs.

An independent t-test is used to analyze the data obtained to determine if there is any significant difference between the means of the ten different PXI constructs.

## **Results**

### **Qualitative data**

We collected the data for qualitative analysis in two separate sessions using different methods in each session as follows:

Session 1: In this qualitative method session, we used the think-aloud protocol on participants.

The video and transcript data for the above participants can be accessed using the following link [[PXI Qualitative data](#)].

Session 2: The qualitative data of seven playtesters was obtained through the inscriptive note-taking method. From the data obtained from the first five participants we started taking notes on some key constructs where some patterns



were starting to form and asked questions to participants if they forget to provide feedback on the following three constructs or both the game levels as follows:

#### Questions in Ghost Level

- 1) Are you aware of your surroundings? (Immersion)
- 2) Is it challenging to play as a ghost? (Challenge)
- 3) Are you able to control the ghost movement when in an invisible state?  
(Control)

#### Questions in PacMan Level

- 1) Are you aware of your surroundings? (Immersion)
- 2) Is it challenging to play as a PacMan? (Challenge)
- 3) Are you able to control the PacMan movement as expected? (Control)

Questions asked after playing both levels:

#### Final Questions

- 1) Which level are you going to play for the third round? (Meaning)
- 2) Which level did you feel the most under control? (Mastery)
- 3) What do you think about the progress feedback and audio-visual appeal?  
(Progress feedback and Audio-Visual Feedback)
- 4) Do you need UI feedback for Goals and rules? (Goals and Rules)

The participants responded with the following comments for the above questions.

The image and transcript data for the above participants can be accessed using the following link [[PXI qual Session2](#)].

The changes suggested to the game CounterPacMan by participants after their qualitative analysis are as follows:

- Better UI in both levels, which shows the number of lives left and the score obtained.

- Change the concept of the grid for ghost level.
- Add the background audio available in the PacMan game.
- Level with two PacMan's.
- Redesign ghost level or add a new multiplayer level with two sets of controls, one for the Pacman character and the other for the ghost character.
- Better description of the goals and rules for different game levels.

Due to the time limitation for this paper submission, we fell short on time to “Change the concept of the grid for ghost level, Level with two PacMan's” and will consider these to be Counter PacMan's future design implementations.

## **Quantitative data**

We use the google form to collect data for our quantitative analysis. The mPXI post-survey shared with the playtesters is transmitted using the following link: [CounterPacMan Post-Survey](#). Furthermore, we structure the data as follows to calculate their mean and perform a t-test on different PXI constructs:

[Counter PacMan Post survey \(Responses\)](#).

We obtain data for the two contrasting game levels (protagonist level and antagonist level) and collect participants' responses on the ten different PXI constructs to check if players when choosing the antagonist character over the protagonist character, have better experience in any specific way PXI construct. We perform an independent t-test for the Likert scale with a two-tailed hypothesis on our data. The null hypothesis is that the player's experience does not change as an antagonist and protagonist character. Moreover, the alternative view is that the player's experience does change when they play the game as an antagonist character and not as a protagonist character. Furthermore, we set the significance level to 0.05. We conclude that the alternative hypothesis is true if the  $p\text{-value} < 0.05$ , which means there is a statistically significant difference in the means of both constructs. Otherwise, the null hypothesis remains true. (The p-value is how likely the difference between antagonist and protagonist gameplay could have happened by accident.)

The data obtained through the Likert scale has been rearranged in excel for ease of interpretation in RStudio.

[Link to view rearranged PXI data.](#)

T-test results between PXI construct data from protagonist and antagonist game levels are as follows:

- 1) **Meaning** - There is no significant difference in the meaning construct from available data.

```
> summary(Meaning_Protagonist)
  Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 1.000  1.000  2.000  1.545  2.000  2.000
> boxplot(Meaning_Protagonist, Meaning_Antagonist)
> t.test(Meaning_Protagonist-Meaning_Antagonist, mu=0, alt="two.sided", conf=0.95, var.eq=F, paired=F)

welch Two sample t-test

data: Meaning_Protagonist by Meaning_Antagonist
t = -0.82514, df = 8.4233, p-value = 0.432
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -1.0054497  0.4721163
sample estimates:
mean in group 1 mean in group 2
 1.400000      1.666667
```

- 2) **Mastery** - There is no significant difference in the mastery construct from available data.

```
> t.test(Mastery_Protagonist, Mastery_Antagonist, mu=0, alt="two.sided", conf=0.95, var.eq=F, paired=F)

welch Two Sample t-test

data: Mastery_Protagonist and Mastery_Antagonist
t = 1.9781, df = 16.277, p-value = 0.06509
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.03828289  1.12919198
sample estimates:
mean of x mean of y
 2.272727  1.727273
```

- 3) **Immersion** - There is a significant difference in the immersion construct from available data.

```

> boxplot(Immersion_Protagonist, Immersion_Antagonist)
> t.test(Immersion_Protagonist, Immersion_Antagonist, mu = 0, alt="two.sided", conf=0.95, var.eq=F, paired=F)

welch Two Sample t-test

data: Immersion_Protagonist and Immersion_Antagonist
t = -2.8492, df = 17.583, p-value = 0.01083
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -2.6869696 -0.4039395
sample estimates:
mean of x mean of y
 2.727273  4.272727

```

- 4) **Autonomy** - There is a significant difference in the autonomy construct from available data.

```

> boxplot(Autonomy_Protagonist, Autonomy_Antagonist)
> t.test(Autonomy_Protagonist, Autonomy_Antagonist, mu = 0, alt="two.sided", conf=0.95, var.eq=F, paired=F)

welch Two Sample t-test

data: Autonomy_Protagonist and Autonomy_Antagonist
t = -2.3009, df = 16.374, p-value = 0.03485
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -1.0470722 -0.0438369
sample estimates:
mean of x mean of y
 1.636364  2.181818

```

- 5) **Curiosity** - There is no significant difference in the curiosity construct from available data.

```

> boxplot(Curiosity_Protagonist, Curiosity_Antagonist)
> t.test(Curiosity_Protagonist, Curiosity_Antagonist, mu = 0, alt="two.sided", conf=0.95, var.eq=F, paired=F)

welch Two Sample t-test

data: Curiosity_Protagonist and Curiosity_Antagonist
t = 1.9174, df = 19.396, p-value = 0.07003
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.04094611  0.95003702
sample estimates:
mean of x mean of y
 1.818182  1.363636

```

- 6) **Controls** - There is a significant difference in the controls construct from available data.

```

> boxplot(Controls_Protagonist,Controls_Antagonist)
> t.test(Controls_Protagonist, Controls_Antagonist, mu = 0, alt="two.sided", conf=0.95, var.eq=F, paired=F)

welch Two Sample t-test

data: Controls_Protagonist and Controls_Antagonist
t = -2.3078, df = 19.665, p-value = 0.03202
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -1.21217711 -0.06055016
sample estimates:
mean of x mean of y
 1.818182  2.454545

```

- 7) **Challenge** - There is a significant difference in the challenge construct from available data.

```

> boxplot(Challenge_Protagonist,Challenge_Antagonist)
> t.test(Challenge_Protagonist, Challenge_Antagonist, mu = 0, alt="two.sided", conf=0.95, var.eq=F, paired=F)

welch Two Sample t-test

data: Challenge_Protagonist and Challenge_Antagonist
t = 3.4785, df = 20, p-value = 0.00237
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.4003277 1.5996723
sample estimates:
mean of x mean of y
 2.363636  1.363636

```

- 8) **Progress Feedback** - There is no significant difference in the progress feedback construct from available data.

```

> boxplot(ProgressFeedback_Protagonist, ProgressFeedback_Antagonist)
> t.test(ProgressFeedback_Protagonist~ProgressFeedback_Antagonist, mu = 0, alt="two.sided", conf=0.95, var.eq=F, paired=F)

welch Two Sample t-test

data: ProgressFeedback_Protagonist by ProgressFeedback_Antagonist
t = -2.1086, df = 5.0119, p-value = 0.08865
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -1.3467839 0.1324981
sample estimates:
mean in group 2 mean in group 3
 2.250000 2.857143

```

- 9) **Audio & Visual Feedback** - There is no significant difference in the audio-visual feedback construct from available data.

```

> boxplot(AudiovisualFeedBack_Protagonist, AudiovisualFeedBack_Antagonist)
> t.test(AudiovisualFeedBack_Protagonist~AudiovisualFeedBack_Antagonist, mu = 0, alt="two.sided", conf=0.95, var.eq=F, paired=F)

welch Two sample t-test

data: AudiovisualFeedBack_Protagonist by AudiovisualFeedBack_Antagonist
t = 1, df = 2, p-value = 0.4226
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -1.100884  1.767551
sample estimates:
mean in group 1 mean in group 2
 2.333333      2.000000

```

10) **Goals and Rules** - There is no significant difference in the goals constructed from available data.

```

> boxplot(GoalsRules_Protagonist, GoalsRules_Antagonist)
> t.test(GoalsRules_Protagonist~GoalsRules_Antagonist, mu = 0, alt="two.sided", conf=0.95, var.eq=F, paired=F)

welch Two sample t-test

data: GoalsRules_Protagonist by GoalsRules_Antagonist
t = -1.5215, df = 2.5874, p-value = 0.2394
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -1.7839997  0.7006664
sample estimates:
mean in group 2 mean in group 3
 2.125000      2.666667

```

To view, the Rscript used to perform t-test and graphical distribution of data using the boxplot please refer to the following link [[PXI Quant Data In detail](#)].

From the independent t-test performed on each of the ten PXI constructs, we can observe that there is no significant difference between the meaning, mastery, curiosity, goals, and rules, audio-visual feedback, and progress feedback for protagonist and antagonist game levels.

## Discussions and Conclusion

From the results above, we can observe that participants felt the need to enhance and make changes in the CounterPacMan game for them to get better experience in the following constructs while playing at an antagonist level:

- Progress Feedback
- Audiovisual appeal

- Meaning
- Mastery
- Curiosity
- Rules and objectives

Taking the above six constructs into consideration we implement the following changes to our game Counter PacMan:

- 1) Add in a two-player level where one player controls the PacMan and the other player controls the ghost. (Increase the scope for testing mastery construct) [**Meaning, Mastery, Curiosity**]
- 2) Add background music (BGM) to both the game levels to change the audio construct feedback received by most participants. [**Audiovisual appeal**]
- 3) Make a score and number of lives left UI for better visual construct. [**Progress Feedback**]
- 4) Add goals and rules for both levels on the main menu page below their respective buttons. [**Rules and objectives**]

The above changes made to the game Counter PacMan allow players to experience a better perspective of playing the traditional game like Pacman from an antagonist perspective (NPC, Ghost). Due to time limitations on the paper, we are not able to add in multiple levels for both protagonist and antagonist levels. We plan to work on the remaining suggestions to improve the player experience when choosing the antagonist level from the qualitative analysis for the future study of this paper.

## References

- 1) Pac-Man game wiki - ([1](#))
- 2) Pac-Man Ghosts - ([2](#))
- 3) Non-player characters - ([3](#))
- 4) Ranking of the top 10 Pac-Man ghosts - ([4](#))
- 5) mPXI mini-Player Experience Inventory - ([5](#))
- 6) Game AI - ([6](#))
- 7) Player experience inventory (PXI Bench | User Guide) - ([7](#))

- 8) Likert Scale - [\[8\]](#)
- 9) PXI Bench - [\[9\]](#)
- 10) Last Of US 2 - Antagonist [\(10\)](#)
- 11) Jaws Unleashed [\(11\)](#)
- 12) Kingdom Hearts [\(12\)](#)
- 13) Unity Engine [\(13\)](#)