

Zombie Fit!: User Study Two Report

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INTRODUCTION / SYSTEM DESCRIPTION

In this report, we will discuss user study two, which is the user study that was conducted to assess the first implemented functional prototype. More specifically, the report will summarize the tasks that the participants performed, documentation of the functional prototype, questions formulated and preparations made prior to evaluation, methods used for evaluation, and lessons learned from our participants. The implemented functional prototype was designed with *Zombie Fit!* in mind, which is a proposed system that would merge virtual reality, video games, and exercise. It is important to note that a total of six participants used our functional prototype and that feedback was recorded for each participant. The report will conclude with a discussion of any modifications, tweaks, and/or redesigns that are needed in order to make our system more compelling.

TASKS THAT PARTICIPANTS WILL PERFORM

Our functional prototype offers three pertinent user tasks that must be performed by participants in order for them to accomplish specific system goals. Furthermore, these three tasks will be used to assess the effectiveness of our system's design. We note that each task will be evaluated both individually and integrated to see if the current system configuration maximizes the experience of our game. The tasks include the following: grabbing a virtual chair, running in place, and hitting a virtual zombie with a virtual chair. It is important to mention that there exist other user tasks that can be performed by participants, such as grabbing a virtual box. However, data will not be collected on such tasks since they are irrelevant to our system's overall goal of increasing exercise motivation using a video game with a well-mapped storyline. The following table summarizes essential use cases that are needed to support the accomplishment of user intentions:

| User Goal: Complete an Effective Workout Routine | | |
|--|--|---|
| <u>User Intention</u> | <u>System Responsibility</u> | <u>System Goal</u> |
| Touch stretch to warmup for workout | Prompt the user to pick up a virtual chair from the floor | Allow players to grab virtual objects and use them as weapons |
| Run to burn calories | Prompt the user to run in place for a certain number of time | Simulate escaping from a zombie herd |
| Air box to exercise | Prompt the user to hit virtual zombies with a virtual chair | Defeat zombies in order to survive |

Table 1. Essential use cases used to develop the details of accomplishing the three user tasks.

DOCUMENTATION OF FUNCTIONAL PROTOTYPE

For this user study, participants will use a functional prototype that was implemented with an Oculus Quest, which is a virtual reality (VR) headset with two controllers, and the game engine Unity.



Figure 1. Picture of an Oculus Quest and its two controllers. This technology was used to implement the functional prototype.

The Oculus Quest was programmed to allow participants to do the following three tasks: run in the virtual environment, grab a virtual chair, and hit a virtual zombie with a virtual object. More detailed information about these three tasks and how they were implemented, as well as how they relate to the system's overall goal of exercising, can be found in the next three sections.

We note that the three tasks are related directly to the essential use cases outlined in Table 1. Furthermore, each task was designed to be independent from one another. That is, a participant will not be required to do two or more tasks at the same time. The rationale behind this decision was due to the results of the first user study where it was discovered that participants got confused and annoyed whenever two or more exercise tasks were assigned to them at the same time. This decision also adheres to the American College of Sports Medicine's (ACSM) exercise guidelines which state that an exercise routine should be composed of smaller, more modular exercise tasks [1]. The task of grabbing a virtual chair will fulfill the "warmup" stage in the ACSM configuration. For the "stimulus" stage, the participant will have to run in place towards a zombie. Lastly, the "cooldown" stage will consist of the participant hitting a zombie multiple times with a virtual chair.

While a participant is using our functional prototype, he or she will hold both controllers and will have on the VR headset. It is important to point out that the participant will see a first-person point of view of the virtual game character through the VR headset.

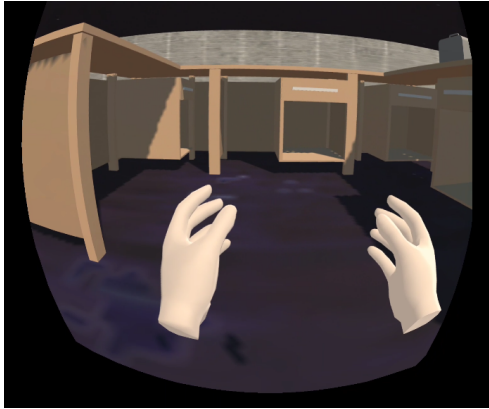


Figure 2. Screenshot of what the participant will see through the VR headset. The final system will be designed to be a first-person video game.

A single team member from our group will then instruct the participant on what to do. Because of this, our functional prototype also incorporates the “Wizard of Oz” method since some of the functionality and storytelling will be simulated through instructions and commands. The following table summarizes the instructions and commands that will be told to each participant during the evaluation of our functional prototype:

| <i>Instruction / Command</i> | <i>Reasoning</i> |
|--|---|
| “To walk or run in the virtual environment, you must use the left controller’s joystick. However, you must also walk or run in place. Moving around in the virtual environment only using the joystick, and without moving in place, constitutes as cheating.” | The functional prototype allows participants to walk or run in the virtual environment using the left controller’s joystick, which defeats the purpose of our system’s goal of providing a means of exercising. Instructing users to run or walk in place simulates a functionality that does not exist (i.e. using the controllers’ sensors instead of the single joystick to move the game character around the virtual environment). |
| “There is a zombie apocalypse! You need to find a weapon! Grab the chair next to you using the right controller’s side trigger.” | There should be some sort of context as to what is going on in the game and why the participant needs to grab the chair. |
| “Run towards the zombie next to you. Remember, you must run in place while using the joystick.” | We should remind participants constantly that they must walk or run in place in order to move in the virtual environment. |

| | |
|--|--|
| “Hit the zombie as hard as you can a couple of times.” | Participants should know that they can defeat a virtual zombie by hitting it with the virtual chair. |
|--|--|

Table 2. List of instructions and commands that were given to participants before and during the evaluation in order to simulate storytelling and some functionality.

It is worth mentioning that the virtual environment was designed as realistic as possible in order to create an immersive experience. More specifically, virtual game components, such as rooms and hallways, were chosen in such a way that they would mimic New Mexico State University’s (NMSU) Science Hall building. Zombies were also designed to have a realistic appearance and were programmed to walk randomly. In addition, eerie music and zombie sounds were added to the functional prototype in order to enhance user experience. Ultimately, we wanted our functional prototype to be as immersive as possible since our final system must be compelling enough to motivate users to exercise. Screenshots that demonstrate how we designed the virtual environment can be found in Figures 3 and 4.

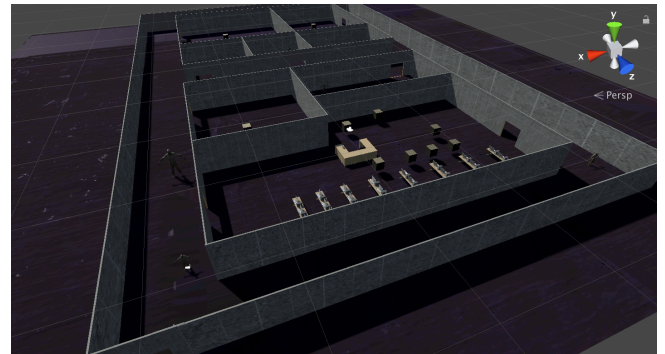


Figure 3. Aerial view of the virtual environment that was designed by our group. We note that we used Unity as the game engine platform.

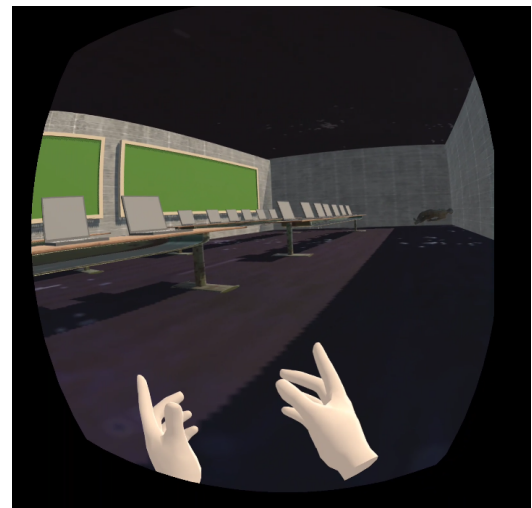


Figure 4. One of the multiple rooms that was designed to have a realistic appearance.

RUNNING IN PLACE TASK DESCRIPTION

As previously mentioned, participants will be allowed to run in the virtual environment using the left controller's joystick. Ideally, the functional prototype would, instead, measure the participants' hand movements while they run in place and would use such measurements to move the virtual game character forward. However, such functionality does not exist in this functional prototype version. Such functionality is critical since our final system must prompt users to do physically challenging movements that promote exercise. In order to compensate for this shortcoming, we will instruct participants to run in place while they use the joystick to move in the virtual environment. This will, ultimately, simulate a functionality that does not currently exist.

GRABBING A VIRTUAL CHAIR TASK DESCRIPTION

Participants will be instructed to grab a virtual chair from the floor in order to use it as a weapon. It is critical to note that the virtual chair was purposely designed to be small and close to the floor. Because of this, the functional prototype will require participants to bend down to grab the virtual chair, thus simulating stretching in the real world. Grabbing a chair from the floor will help promote exercise since it forces participants to do upper-body movements. The reason why this is possible is because the Oculus Quest has multiple sensors that allow it to measure the height of a participant. This means that participants must get physically lower to the ground in order to interact with objects that are on the floor.

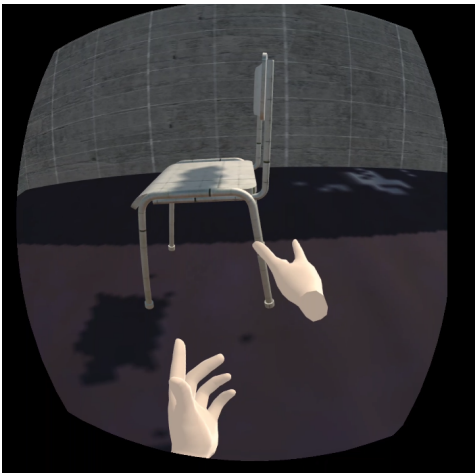


Figure 5. Image of what a participant will see when trying to grab a virtual chair from the floor. We note that the participant will need to stretch in order to grab the virtual chair.

HITTING VIRTUAL ZOMBIES TASK DESCRIPTION

When participants grab a virtual chair, they will be instructed to hit a virtual zombie as hard as they can. Such functionality is possible since all zombies and chairs were programmed with colliders. We note that such assigned task will simulate air boxing in the real world since

participants will be, in essence, moving the controllers as if they are “punching” something. Simulating air boxing helps promote exercise since this routine is used in many cardio workouts.

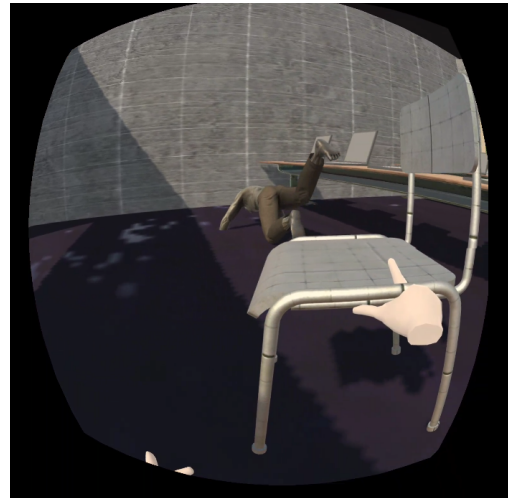


Figure 6. Image of what a participant will see when hitting a virtual zombie with a virtual chair.

QUESTIONS FORMULATED PRIOR TO EVALUATION

The following list of questions was formulated prior to our evaluation:

1. What goes right when performing the tasks?
2. What goes wrong when performing the tasks?
3. What elements of the design are fun in nature?
4. Is the design error-prone?
5. Is the design physically challenging?
6. Is the design realistic and immersive?
7. Is the design practical and does it map well with the real world?
8. Does the design cause any discomfort (e.g. dizziness, disorientation, etc.)?
9. Are any of the assigned tasks awkward or out of place?

These formulated questions were used to aid us on finding any emerging design problems in our functional prototype.

PREPARATIONS MADE PRIOR TO EVALUATION

Several preparations were made prior to meeting with our participants. The first preparation we made was to create

an open-ended, unstructured interview script containing the following list of questions:

Pre-Evaluation Interview Questions

1. What is your gender?
2. What is your age?
3. Are you a frequent video game player?
4. On a scale of 1 to 5, with 5 being favorable and 1 being unfavorable, how do you feel about exercise?

Post-Evaluation Interview Questions

5. Did you experience any discomfort during or after gameplay, such as nausea, dizziness or disorientation?
6. Were any of the tasks (grabbing a virtual chair, running in place, or hitting a zombie) difficult to accomplish? Why?
7. Did the game establish an immersive experience? Why?
8. Did you feel like you were exercising? Why?
9. Would you use a system like this to exercise? Why?
10. Any other suggestions or comments?

It is critical to note that questions one through four were asked to participants before the evaluation began, while questions five through ten were asked shortly after they finished playing the VR game.

The second preparation we made was to familiarize ourselves with the questions formulated in the previous section in order to look for specifics while each participant evaluated our functional prototype. That is, our group also conducted an observational study while participants played our VR game. Notes were taken by a specific group member for each participant and for each of the nine formulated questions.

The last preparation we made was to make sure that we recruited a diverse group of participants. In our case, we recruited the following six participants:

| <u>Participant Number</u> | <u>Gender / Age</u> | <u>Frequent Video Game Player?</u> | <u>Favorability Towards Exercise (1 – 5)</u> |
|---------------------------|---------------------|------------------------------------|--|
| 1 | Female / 20 | Yes | 1; Extremely unfavorable |
| 2 | Male / 30 | Sometimes | 3; Neutral |
| 3 | Male / 26 | Yes | 2; Somewhat unfavorable |
| 4 | Female / 28 | No | 4; Favorable |
| 5 | Male / 22 | Yes | 4; Favorable |
| 6 | Male / 24 | No | 3; Neutral |

Table 3. General description of the six participants used in this user study. This data was collected using the previously mentioned pre-evaluation interview questions.

As the previous table demonstrates, we seem to have recruited a wide range of participants ranging in age, sex, and life experiences.

METHODS USED FOR EVALUATION

Several methods were implemented and used during our evaluation. For example, we evaluated only one participant at a time. Furthermore, the ordering of which participant was chosen to evaluate our functional prototype was done at random in order to reduce lurking variables within our data. We note that participants evaluated our functional prototype in different settings, such as in a classroom or computer lab. However, we assume that changing the setting from evaluation to evaluation will not introduce any lurking variables in our data since the physical world cannot be seen while wearing the VR headset.

As previously mentioned, each participant was asked four pre-evaluation interview questions before they used and assessed our functional prototype (see previous section for more detailed information on these questions). These questions allowed us to gather some generic demographic information, how frequent each participant plays video games, and the favorability each participant has towards exercise in general. This information is valuable for our user study since we want to see if frequent video game players see our functional prototype as an actual and practical video game, and whether or not our system is intriguing enough to motivate individuals to exercise.

Each participant was instructed to use our functional prototype after answering the four pre-evaluation interview questions. It is critical to mention that, during

the evaluation process, one team member instructed the participant on what to do by using the instructions and commands outlined in Table 2. Meanwhile, a separate team member observed and documented any positive or negative reactions to our design by answering all nine formulated questions for each participant. In other words, one team member “drove” the evaluation while another one observed and documented.

Each participant was asked six post-evaluation interview questions once they finished using our functional prototype (see previous section for more detailed information on these questions). It is worth mentioning that the post-evaluation exit interview for each participant was very unstructured and informal. In fact, we allowed other bystanders (e.g. participants’ friends, other classmates, etc.) to converse with our participants during the exit interview process. The reason why our exit interview was unstructured and why we allowed bystanders to get involved in the interview process is because we wanted to be as unobtrusive and unrestrictive as possible. That is, we wanted our participants to express themselves to the fullest and to provide an honest critique. Furthermore, by allowing other people to get involved, we created an open environment that all participants seemed to enjoy since new ideas were being discussed and interchanged.

Because of the methods used during our evaluation, our group managed to gather more qualitative data than quantitative. Nevertheless, our group was more interested in qualitative data since, as of now, we want our participants to suggest new innovative ideas that we have not yet thought about.

WHAT WE LEARNED FROM PARTICIPANTS / RESULTS FROM USER STUDY

In this section, we will summarize the results gathered from our user study and what we learned from our participants. As previously mentioned, our evaluation led to mostly qualitative data since this is what we are more interested in at the moment. The following table summarizes the observed data that was gathered while participants used our functional prototype:

| <u>Formulated Question</u> | <u>Observed Data</u> | <u>Lesson(s) Learned from Participants</u> |
|--|---|--|
| What goes right when performing the tasks? | All participants know how to run in place and air box. Furthermore, there is an effective mapping between the physical tasks and the virtual environment. For example, all participants felt like they were actually running in the virtual environment and that they | The virtual environment does not affect running in place and air boxing. |

| | | |
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| | were physically punching a zombie. | |
| What goes wrong when performing the tasks? | It was quite difficult for all participants to grab the virtual chair since it was hard for them to calculate how much stretching is needed to actually get close to the object. Furthermore, grabbing virtual objects using the Oculus Quest’s controllers was not really intuitive. | Instructing users to touch stretch in order to grab a virtual object may cause some disorientation since all users have different physical heights that map differently to the virtual environment. A small tutorial on how to grab a virtual object is also needed. |
| What elements of the design are fun in nature? | All participants were intrigued by the functional prototype. They all expressed enjoyment at how the zombies and virtual environment were designed. Three of the six participants still continued to use the functional prototype even after the evaluation was over. | The functional prototype is intriguing and interesting enough to motivate users to exercise. The functional prototype might also be considered as fun by future potential users. |
| Is the design error-prone? | All participants had a hard time grabbing a virtual chair, as well as hitting a zombie. | The colliders in each game object should be more accurate and precise. Allowing participants to grab virtual chairs from different angles might also make the design less error-prone. |
| Is the design physically challenging? | All participants appeared to get physically tired at times, especially when running in place. | Running in place for a long period of time is physically challenging for some individuals. Physically challenging movements does not, however, equate to exercising in most cases. |
| Is the design realistic and immersive? | All participants unanimously agreed that the functional prototype is realistic and immersive. In fact, all participants commented that they felt like they were physically “inside” the virtual world. | It is possible to create a realistic and immersive video game using VR technology. |
| Is the design practical and does it map well with the real world? | Five of the six participants commented that the design is practical and that all tasks map well to the physical world. One participant stated that the design is practical but that grabbing a virtual object does not map well with the physical world since a button needs to be pressed to successfully grab the object. All participants commented that the functional prototype should only be used in an open space in order to avoid hitting physical objects. | Some users might not like grabbing virtual objects using buttons. Furthermore, a warning must be given to users stating that the system must only be used in large and open areas. |

| | | |
|--|---|---|
| Does the design cause any discomfort (e.g. dizziness, disorientation, etc.)? | Three participants physically showed signs of discomfort. One participant commented that she felt disoriented while two stated that they felt a little nauseous while using the system. | A portion of all users will experience some physical discomfort while using the system. |
| Are any of the assigned tasks awkward or out of place? | None of the participants stated that a task felt awkward or out of place. | The three assigned tasks map well between the physical world and the virtual environment. |

Table 4. Summary of the observed data that was collected during the evaluation of our functional prototype.

Both qualitative and quantitative data was collected when participants were interviewed before and after the evaluation. The pre-evaluation interview results are summarized and outlined in Table 3. The data gathered from the post-evaluation exit interview is summarized in the following table:

| <u>Post-Evaluation Interview Question</u> | <u>Summary of Recorded Qualitative / Quantitative Data</u> | <u>Lesson(s) Learned from Participants</u> |
|---|---|---|
| Did you experience any discomfort during or after gameplay, such as nausea, dizziness or disorientation? | Three out of the six participants felt discomfort during gameplay. More specifically, one participant commented that she felt disoriented and had to physically remove the VR headset numerous times. She did say, however, that running in place helped her get less disoriented. The other two participants that experienced discomfort commented that they felt dizzy and a little nauseous during gameplay. | We can expect a large portion of users to experience some sort of discomfort. Purposely mapping more physical movements to the virtual world might help reduce some of these discomforts. |
| Were any of the tasks (grabbing a virtual chair, running in place, or hitting a zombie) difficult to accomplish? Why? | All participants stated that grabbing the virtual chair was somewhat difficult to accomplish. Five of the six participants cited that they had to be extra precise and accurate with the controller when trying to grab the virtual chair. One participant stated that the controllers have awkward buttons, but that she got used to | Colliders around the chairs must be modified and reprogrammed so that they are easier to grab with the controllers. A tutorial level might also make it easier for a user to learn how to grab a virtual chair. |

| | | |
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| | them quickly. Furthermore, she also stated that we need to be more specific since users might have the false impression that they need both hands to grab the virtual chair. | |
| Did the game establish an immersive experience? Why? | All participants unanimously agreed that the game did established an immersive experience. More specifically, all participants commented that the game was very well designed and that its realistic design choices made them feel like they were actually "inside" the virtual world. Furthermore, all participants that frequently play video games commented that the functional prototype was very immersive and enjoyable. | Designing the virtual environment in a realistic manner makes the gaming experience immersive. In addition, most users that are frequent video game players might agree that our system is, in fact, a video game (i.e. having validation from actual video game players is important). |
| Did you feel like you were exercising? Why? | Four of the six participants stated that they felt like they were exercising. More specifically, they mentioned that running in place made them feel physically tired. In contrast, the other two participants did not feel like they were exercising since they were, according to them, not moving enough. | Running in place for a long period of time is physically challenging for only some users. Because of this, the final system should have levels that vary in exercise difficulty. More specifically, levels that increase in difficulty should prompt the user to move for longer periods of time. |
| Would you use a system like this to exercise? Why? | Five of the six participants stated that they would use our system to exercise. Furthermore, all five participants stated that they would use such system since it is immersive and makes exercising fun. One of the participants would not use our system to exercise since he is not interested in exergames. It is important to mention that the two participants who had an unfavorable view of exercise would | Most users would use our system to exercise. However, users who are not interested in exergames in general would rather go to a gym or outside to workout. Nevertheless, we can safely assume that our system does change the opinions on those individuals who have an unfavorable view on exercise. |

| | | |
|------------------------------------|--|--|
| | consider using out system to exercise, which means that there was a change in opinion after they evaluated our functional prototype. | |
| Any other suggestions or comments? | All six participants suggested that we fix our zombies (i.e. our zombies sometimes fall over) and that we should make them chase after the game character. In addition, all six participants suggested to add the “running in place” functionality instead of allowing users to use the joystick to move around the virtual environment. Three participants suggested that we display instructions in order to make the objective of the game clearer. Five participants suggested to add more grabbable objects such as a laptop or desk. Lastly, two participants commented that it would be beneficial to have more “modular” objectives since, as of now, the functional prototype is a sandbox game, which means that there are minimal restrictions placed on the game player. | Our final system should have the “running in place” functionality, as well as clearer objectives. In addition, more grabbable objects should be introduced and virtual zombies should be programmed to chase after the game character. |

Table 5. Summary of participants’ responses to their post-evaluation interview questions.

CHOSEN DESIGN / FINAL DESIGN

As indicated in our first user study, our first functional prototype was designed based on the ACSM low-fidelity model, which contained a warmup period, period of moderate physical activity, and cooldown period. In addition, we also took our participants’ comments into consideration while implementing our functional prototype. Moving forward, we will use the data and suggestions gathered in this user study to implement our final system. More specifically, we will aim to have a more abstract environment in order to alleviate user discomfort (such as nausea and dizziness) since we observed that one of our earlier functional designs did not cause these problems. This earlier design consisted of rooms that were simple and did not have any realistic

objects in them. A list of other future design modifications can be found in the next section.

We will continue to use the Oculus Quest virtual reality headset and Unity to implement our final functional system. We will also keep the tasks of running in place, grabbing a chair, and hitting a zombie with the chair. These tasks were found to be enjoyable by participants since all of them commented that they were not awkward or out of place. Ultimately, we will use most of our first functional prototype as a basis for our final system. Slight modifications will be made, however, and will reflect on what was learned in this user study.

FURTHER DESIGN MODIFICATIONS / REDESIGN ITERATIONS

Some modifications will be made to our functional prototype in order to make it more interactive, immersive, and compelling. Other modifications will also be made to help alleviate user queasiness. It is worth mentioning that all modifications will form the conceptual basis of changes that need to be made and will be used in all future design iterations of our system. As decided with our first user study, we will instruct users to run in place for a period of time instead of having the system count the required number of steps. If time permits, we will display a timer through the virtual reality environment to indicate how long a user should run in place for. Furthermore, we would ideally have a prompt implemented that instructs the user to run in place instead of our team telling them via the “Wizard of Oz” prototyping method. Providing prompts visually instead of verbally would make our system’s objectives clearer. If time permits, we would also like to implement the ability for the user to move forward in the virtual environment by running in place in the real world. Implementing such functionality would require users to physically move in order to move in the virtual environment (i.e. moving with the joystick would no longer be allowed).

In this user study, we got a lot of comments regarding the zombies not acting natural or realistic. To change this, we plan to assure that all zombies walk upright to increase the perception of realism. We also want to program the zombies to chase after the user in order to add an extra level of suspense that would complement the ominous music. We would also, ideally, add an opening and closing scene so that the system looks more like a game. If time permits, we also plan to display a health bar/hit counter on the virtual environment in order to provide feedback, which was a feature that was recommended by a few of our participants. Adding a health bar/hit count would also allow users to feel more engaged with the game since it would incite them to purposely avoid getting “bitten” by zombies.

Data outlined in Tables 4 and 5 support the notion that most participants had a hard time, at the beginning, learning how to use our functional prototype and that most of them also felt some sort of discomfort (e.g. dizziness, nausea, etc.) during and/or after gameplay. Because of this, tutorial levels should be implemented in our final system to allow the users to be able to learn how to use our system with more ease. That is, tutorials would allow the user to get familiar with the controllers and tasks via animations and prompts before facing the zombies in the gameplay. As mentioned earlier, the data in Tables 4 and 5 indicated that many of the users felt discomfort during and/or after using our system. In order to mitigate this discomfort, we will redesign the virtual environment with less realistic details. More specifically, the rooms in the virtual environment will be redesigned to contain less realistic objects that serve to add unneeded aesthetics (e.g. rows of laptops and computers, desks, etc.). We will leave in very few items on the walls in order to allow users to differentiate between different rooms. It is worth noting that while less of the decorative objects will remain in the rooms, more grabbable objects will be added since many participants suggested this modification. We plan to add a variety of objects that can be grabbed in different ways, such as a laptop or broom.

CONCLUSION

Our first functional prototype had both advantages and disadvantages. However, participants overwhelmingly agreed that it was not only well-designed, but also immersive, fun, and realistic. Therefore, we conclude that our first functional prototype will be used as a basis for our final system. User study two also provided helpful data and suggestions that will be used while moving forward with our design iterations. Such data and suggestions will not only make our final system more interactive, but also more compelling.

REFERENCES

[1] Sinclair, J., Hingston, P., & Masek, M. (2007, December). Considerations for the design of exergames. In *Proceedings of the 5th international conference on Computer graphics and interactive techniques in Australia and Southeast Asia* (pp. 289-295). ACM.