The Effect of Sound on the User Experience of Playing a Video Game

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Abstract

This project examined the effect of audio in a text-based video game on user engagement, enjoyment, and frustration. One hundred and eleven participants played the game for five minutes. One-third of the participants played the game with the audio effects and seeing the text on the screen. Another third of the participants played the game by only listening to the audio, and the remaining third only saw the text. After playing the game, we assessed participants' engagement, enjoyment and frustration. We also analyzed the log files of each player. In general, the inclusion of audio did not significantly influence engagement, enjoyment or frustration. However, the participants' opinions of the story and opinions of the audio were affected by the inclusion of audio and text. The inclusion of audio also influenced how quickly participants progressed through the game. This study helps to reveal the role audio plays in the experience of playing a video game and reveals potential areas for future research.

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The Effect of Sound on the User Experience of Playing a Video Game

Over the past few years, video games have dramatically increased in popularity. The Entertainment Software Association's annual report (2012) estimates that the average household has at least one game-dedicated PC, console, or smartphone. The average age of a video game player is currently 30 years old, and the average amount of time playing videogames is 12 years. There is approximately an equal number of men and women playing video games (53% male, 47% female). In 2011, it is estimated that $24.75 billion dollars was spent on video games.

However, the number of video games that are available for the visually-impaired are quite limited. Visually-impaired game players often have to figure out how to play games intended for seeing audiences. For instance, in 2010, a news station in Camden, South Carolina reported that the one blind man was able to complete The Legend of Zelda: Ocarina of Time, a 3D action adventure game in which the player explores dungeons and solves puzzles (Kearns, 2010). However, he was only able to accomplish this with the help of other gamer players. The other players created a script for him to follow so he could navigate the game via the script and other audio cues in the game.

Due to the fact that the games available to the visually-impaired are limited, some work has been done to determine how games for the visually-impaired should be designed. Russo, Vandal, and Sacks (2012) conducted interviews with visually-impaired students in which the students were asked what they wanted in games designed to be accessible to the visually-impaired. Russo, Vandal, and Sacks found that the visually impaired students wanted more, high quality accessible games and that they did not want the games to use a screen reader. The present work looks to apply what was learned from these interviews into making a game that is engaging, enjoyable, and accessible to the visually-impaired.

The Role of Audio in Video Games

To properly apply these lessons into game development, we must also understand the effect that audio in a game has on the user experience, which is defined here as the momentary, evaluative feelings that the player has with the game (Hassenzahl, 2008). However, the findings of the limited research on the effects of audio on user experience is somewhat mixed. Some research suggests visual effects trump audio. Wood, Griffiths, Chappell, & Davies (2004) asked participants for their subjective opinions on what they believed contributed to their enjoyment of a video game. They found that the majority of participants (65%) believed that sound effects significantly contributed to their enjoyment of the game, though many fewer participants deemed narration or background music as important to their enjoyment (28.7% and 35.5% of participants respectively). However, participants in this study also believed that realistic graphics played an important role in their enjoyment of a video game (80.7%). However, other research suggests that audio effects are more important than visual effects. Skalski & Whitbred, (2010) also ran a study examining the effects of audio and visuals on player engagement and enjoyment. The difference with their study was that they were studying the topic with objective data, rather than surveying participants' subjective attitudes. In the experiment, participants played a game with high or low sound quality and high or low image quality. They found that, contrary to the findings of Wood et al. (2004), sound quality had a stronger influence on player engagement and enjoyment than image quality did. Thus, one aim of the present study is to better understand the role of audio in entertainment-based games.

User Engagement and Frustration

While academic research on video games for entertainment and video game audio is still relatively new, much applicable research comes from the field of educational psychology, as

researchers in educational psychology have examined educational video games and their effects on learning outcomes.

Of particular interest from this field of work is the construct of flow (Chikszentmihalyi, 1991), which is often discussed by both educational psychologists and academics studying video games in wide variety of disciplines. Flow is a state of mind in which people are engaged in an activity and doing that activity for its own sake. Much of the research on flow has focused on examining elicit the flow state, especially in educational contexts. An important aspect of eliciting flow is the balance between the challenge of the problem and the skill of the person. If challenges and skills are matched, a flow state is likely. However, if the challenge increases too quickly, then frustration is likely. If challenge increases too slowly, boredom is seen. For example, if a 1st grade student is given a series of addition problems, there is a good chance that they will experience flow, as their skill and the challenge of the task is matched. If the same student is given calculus problem, the student is likely to feel frustrated. Likewise, if a college aged student is given the addition problems, they are likely to feel bored, as there is a mismatch between skill and challenge. We can expect to see similar patterns in video games, due to players of a variety of skill levels and games with different difficulties. For this reason, researchers typically examine user emotion along with flow.

Research on user emotion and behavior within the context of educational games and software has revealed several patterns of emotions and behavior within those learning environments. It has been shown that engaged concentration and confusion are very common affective states for students using learning environments (Baker et al., 2010), both of which are beneficial for learning, as they allow the student to remain focused on the material and to recognize and modify misconceptions they have about the topic area (Graesser, D'Mello,

Chipman, King, & McDaniel, 2007). Boredom is a less common affective state than engaged concentration and confusion. Unlike engaged concentration and confusion, it has a negative effect on learning outcomes. It tends to be persistent, meaning that if a student becomes bored, they are very likely to remain bored. Furthermore, boredom also tends to be associated with problem behaviors, such as cheating (Baker et al., 2011). However, further research has indicated that boredom can be counteracted with short periods of off-task behavior, which has been shown to relieve boredom and lessen the probability of future boredom (Baker et al., 2011). For example, a student using educational software may become bored. If they continue working, they may have negative learning outcomes. However, if they decide to go off-task, such as taking a break or talking to a friend, they can return to the software and be engaged again. Finally, the affective state of frustration less persistent and less associated with negative learning outcomes than boredom, as frustration may be a natural part of the learning process (Baker et al., 2010). However, the exact effects of frustration on learning outcomes are still under investigation (San Pedro, Baker, Gowda, & Heffernan, in press). Furthermore, it is unclear how frustration may influence user experiences when playing video games for entertainment. Thus, in the current research we are interested in assessing user engagement, enjoyment, and frustration.

Research Aims and Hypotheses

The goal of the present study is two-fold, as it seeks to both contribute to a theoretical understanding as well as have a practical application. First, we are looking to further clarify the effect of audio, including sound effects, music and voice acting, on the user experience when playing a video game. Second, we want to apply the results of the study to inform the design of a video game in development. To accomplish both of these goals, we are applying methodologies

from psychological research, especially those from educational psychology, to conduct research on the entertainment-based video game being developed. Specifically, this study examines the effects of audio on engagement, enjoyment, and frustration. In addition, we will investigate user behavior in the game. By exploring each of these factors, this experiment will enhance our understanding of the importance of audio in video games and it will provide information on the user experience to enable changes and improvements in the game itself. One specific element of the game's design that is being examined is the fact that the game is designed to be accessible to the visually-impaired. This means that the game must be playable without the need for the player to look at the screen. The present study not only looks to ensure that this is possible, but that it is also enjoyable, engaging, and not frustrating.

Due to the fact that much of the past research comes from educational games and software or more traditional video games that are not concerned with being accessible for the visually-impaired, there is some question about how much the results of previous work in the area will apply to the present study. Despite this, we believe that results found in prior research will still largely be supported within this study, as a game made for entertainment that is accessible to the visual-impaired still shares many similarities with both more traditional games and educational games. We believe that the addition of audio to a game, as opposed to having a game with no audio, will add to the players' enjoyment and engagement of it. We also believe that visible text and audio will work together to create the most engaging and enjoyable experience. Therefore, the game with audio and text will be more engaging and enjoyable than a game with only audio or text. Additionally, we expect that the only audio condition will be more engaging and enjoyable than the only text condition, as audio has been shown to be an important factor in the enjoyment of a video game (Skalski & Whitbred, 2010).

Method

Participants

One hundred and eleven undergraduate students (55 male, 56 female) participated in this study. All participants were drawn from a participant pool at a university in the northeastern United States. Participants had varying levels of past experience with video games, ranging from rarely or never playing video games to playing more than 20 hours of video games per week. On average, participants reported playing 5.4 hours of video games a week. Participants reported playing a wide variety of video games in all genres and across many different gaming platforms, including smartphones, tablets, personal computers, and gaming consoles. The most popular genres of games, as reported by participants, were Adventure (played by 66.7% of participants), Strategy (played by 59.5% of participants), and Puzzle (played by 50.5% of participants). Those who were taking a social science course at the time of the study were given course credit for their participation. Each session of the experiment was run with up to three participants, who played the game at separate computers.

Materials

Text-based video game. The experiment used a video game that had text as its only visual element (See Appendix A). This was different from many other video games, which contain fully drawn, modeled, and animated characters and environments for the player to view. In this game, the player was shown a passage of text that either a) explained part of the plot of the game, b) described the environment that the player was in, or c) showed dialogue between characters in the game. Below the text, the player saw several actions to choose from. These choices allowed the player to interact with the game by allowing them to select what the player character would say in conversation, to select what actions the player character would take, and

to influence the directions that the plot would take. Once the player made a choice, the game responded by printing a new passage of text that corresponded with the choice that was made.

The text-based video game used in this study was titled "Grail to the Thief." In the game, the player controlled Hank Krang, a thief from the future who used a sentient robotic wristwatch time machine, named TEDI, to travel throughout time stealing priceless artifacts from history. Hank travelled back in time to Camelot in an attempt to steal the Holy Grail from King Arthur. However, King Arthur would not let anyone near the Grail unless they proved that they were worthy of seeing it. The player guided Hank through the challenges that King Arthur set out for him, which included saving a child from danger, slaying a ferocious monster, and rescuing a princess. However, there were no problems in Camelot, so the player needed to be creative in both creating and solving problems for themselves so that Hank could get close enough to the Holy Grail to steal it.

While this type of text-based video game is not uncommon, this game was novel because it included audio elements, such as sound effects, voice acting, and musical compositions. Audio elements are not common in these types of text-based games because the game engine used to create this game and many other games of this type, Twine, does not support audio by itself (Klimas, 2008). An audio engine that plugs into Twine was built during the course of the game's development to add this functionality.

User Engagement. The participants' subjective experiences were measured via a paper survey that was distributed after the play session of the game ended. The survey measured the participant's engagement, enjoyment, and frustration while playing the game, as well the participant's opinions about the effectiveness of the story and the effectiveness of the audio of the game. To measure engagement, we created four questions that were adapted from the 19-

item Game Engagement Questionnaire (Brockmyer, Fox, McBroom, Burkhard, & Pidruzny, 2009). For example, one item was: "My mind wandered to topics unrelated to the game while I was playing it". All questions were measured on a 7-point Likert-Type Scale (1 = Strongly Disagree; 7 = Strongly Agree). See Appendix B for the other items. We ran a principle components factor analysis with varimax rotation to check if the four questions that measured engagement could be averaged together to create one score for engagement overall. The analysis indicated that each of the questions could be loaded together (Eigenvalue = 2.44; Factor Loading Range = .63 – .91; Cronbach α = .77).

User Enjoyment. To measure enjoyment, we created two questions: "I would continue playing this game if I had the opportunity to" and "I had a lot of fun playing the game." Both of these questions were measured on a 7-point Likert-Type Scale (1 = Strongly Disagree; 7 = Strongly Agree). See Appendix B to view the questions in the survey. We also ran a principle components factor analysis with varimax rotation on these two questions, which confirmed that they could be loaded together (Eigenvalue = 1.78; Factor Loading Range = .94 – .94; Cronbach α = .87).

User Frustration. In addition, we also wanted to measure how frustrated participants felt while playing the game. Research has suggested that good video games satisfy needs related to psychological well-being, especially the need to have feelings of competency and autonomy (Tamborini et al., 2010; Pryzbylski, Rigby, & Ryan, 2010). If the player does not feel like they are in control or that they can complete the challenges in the game, they will disengage with the game and feel frustrated. As a result of this, having challenging, but still solvable, problems in a game is positively correlated with engagement (Rowe et al., 2011). Likewise, taking control

away, or otherwise undermining a player's competence, can frustrate them (Pryzbylski, Rigby, & Ryan, 2010). Thus, we created 3 questions that measured frustration, feelings of competency, and feelings of autonomy. For instance, items included: "The puzzles and challenges in the game were too difficult" and "The choices I made in the game affected the story in the way that I wanted it to." All questions were measured on a 7-point Likert-Type Scale (1 = Strongly Disagree; 7 = Strongly Agree). See Appendix B for each of the individual questions. When we ran a principles components factor analysis with varimax rotation on the three questions that measured frustration, the analysis indicated that the questions did not load together (Eigenvalue = 1.30; Factor Loading Range = .59 – .72; Cronbach α = .34). Therefore, the responses on each of the questions that measured frustration were not averaged together to create one score for frustration overall. Instead, frustration was examined by analyzing each of questions individually.

Effectiveness of Story and Audio. We also created items to measure the effectiveness of the game's story and of the game's audio (see Appendix B for the complete survey). Both the effectiveness of the story and the effectiveness of the audio were measured using three questions each. The effectiveness of the story was measured using items such as "I found the story in this game engaging" and "I found the story in this game humorous," while the effectiveness of the audio was measured using items such as "The sounds in the game were realistic" and "The audio of the game added a great deal to my enjoyment when playing the game." All of the questions in both categories were measured on a 7-point Likert-Type Scale (1 =Strongly Disagree; 7 = Strongly Agree). View Appendix B for all of the individual items. We ran principle components factor analyses with varimax rotation on the three questions that measured the effectiveness of the story and on the three questions that measured the effectiveness of the audio. Both factor

analyses indicated that the items loaded together: effectiveness of the story (Eigenvalue = 2.26; Factor Loading Range = .84 – .90; Cronbach α = .83) and effectiveness of the audio (Eigenvalue = 2.16; Factor Loading Range = .81 – .91; Cronbach α = .80).

Game transcript. In addition to self-report measures, we also collected behavioral data by looking at each participant's user log from their play session, which showed the choices that they made in the game. This type of measure is based off of Stealth Assessment (Shute, 2011). Stealth Assessment is a method of measuring and assessing student behavior and competencies within computer learning environment. It involves building tools within the computer environment to collect data and to make judgments about the progress of the user within those environments. The benefit of Stealth Assessment is that it limits the anxiety of the user (as they do not know that they are being assessed), it collects unbiased data from the user, and it can be used to personalize the content of the game or software to needs of each individual user. For example, the assessment tools might collect data about the accuracy of a student's responses for a series of mathematics problems. If the tools notice a pattern of incorrect answers, the assessment tools would assume the student is lacking knowledge of the subject. This real-time assessment analysis can then be used to allow the software, or game, to adapt to the user in real time, potentially by giving the student easier problems or tutorials that reinforces the base concepts and fill in knowledge gaps.

The present study employed the concept of Stealth Assessment in its most basic form. All that was recorded was the transcript of the user's play session, which contained information about what choices the user made, how many passages of text the user read, and at what time they made their choices. The assessment tools were not built into the game itself. Therefore, it could not be used to tailor content to the user as they played the game. Instead, it was being used

solely as means of data collection to understand how the participants played the game.

Specifically, while playing the game, the computer recorded the user's choices and at what time they made them. The user's progression through the game was monitored by recording the name of the passage a user had just transitioned to and by time stamping when the user began this passage. These game transcripts identified common responses, patterns, reactions, and behaviors. More specifically, the transcripts allowed us to see how many passages the user progressed through during their time with the game and if specific choices were made (such as choosing to be rude, polite, or somewhere in between in a conversation).

Headphones. Each participant was given headphones to put on while playing the game. This allowed participants to hear the game's audio elements (if they were in one of the audio conditions) and blocked out the sounds made by other participants in the experiment.

Procedure

Before participants arrived in the laboratory for the experiment, they were randomly assigned to one of three conditions. If more than one participant attended a session, then everyone was assigned to same condition as to avoid the possibility of the participants noticing any differences between themselves and the other participants. The three conditions were:

- **Text/No Audio Condition:** Participants played the game with the text visible on the screen, but there were no audio elements, such as sound effects, music, or voice acting.
- **No Text/Audio Condition :** Participants played the game with all of the audio elements, including sound effects, music, and voice acting. However, the text on the screen was not visible to the player, as the computer screen was covered with a black cloth for this condition.

- **Text/Audio Condition:** Participants played the game with all of the audio elements, including sound effects, music, and voice acting, and the text visible on the screen.

It is important to note that conducting a complete 2 x 2 between-participants design would have been impossible for this experiment because you cannot have participants play a video game when they cannot hear the associated audio and also not see the screen.

After randomly assigning participants to conditions, the experimenter set up the computers for the condition, loaded the game onto the machine, maximized the browser so nothing else was visible on the screen, and plugged the headphones in. For the Text/No Audio condition, the audio was muted on the computer. For the No Text/Audio condition, the screen was covered with a cloth.

When the participant(s) arrived, they gave informed consent. After giving consent, participants sat at one of the computers. Regardless of the condition, all of the participants learned they would play the game for five minutes. They then put the headphones on prior to playing. Participants in the No Text/Audio condition learned that they could begin the game by pressing the 'Spacebar' and that they would make choices by pressing certain number keys on the keyboard. After the five minutes elapsed, the experimenter informed the participants to stop playing the game. Participants then completed the user experience survey that assessed engagement, enjoyment, frustration, opinion of the story, and opinion of the audio. After completing the survey, participants were debriefed and dismissed. After the participants left, the experimenter catalogued the game transcript of each participant for later analysis.

Results

Correlations

Correlations were run between the overall scores of the metrics of interest in the study: Engagement, Enjoyment, Opinion of the Story, Opinion of the Audio. Frustration was excluded as the factor analysis indicated that the individual measures of frustration did not load together reliably into a single score. The correlations showed that each all of these items were highly, and significantly, correlated with each other (See Table 1). This indicates that these measures are very likely to occur together.

There was a strong positive correlation between engagement and enjoyment, $r = .71$, $p < .01$. In other words, the more engaged participants were with the game, the more they enjoyed it. There was also a strong positive correlation between engagement and opinion of the story, $r = .72$, $p < .01$. This indicates that the more engaged participants were with the game, the higher opinion they had of the story. Engagement also had a strong, positive correlation with opinion of the audio, $r = .63$, $p < .01$, which means that the more engaged participants were with the game, the higher opinion they had of the audio.

Likewise, there was a strong positive correlation between enjoyment and opinion of the story, $r = .73$, $p < .01$. This means that the more the participants enjoyed the game, the higher opinion they had of the story. There was also a strong positive correlation between enjoyment and opinion of the audio, $r = .66$, $p < .01$, which indicates that the more the participants enjoyed the game, the high the opinion they had of the audio. Finally, there was a strong positive correlation between opinion of the story and opinion of the audio, $r = .68$, $p < .01$, meaning that participants who had a higher opinion of the story also had a higher opinion of the audio.

Differences Based on Experimental Conditions

Enjoyment. To examine the effects of game playing modes on enjoyment of the game (Text/No Audio, Text/Audio, No Text/Audio), we ran a one-way Analysis of Variance (ANOVA). The ANOVA for the overall score of enjoyment did not indicate there were any differences between the three conditions on the enjoyment, $F(2, 108) = 1.08$, $p = .34$ (See Figure 1). This indicates that participants who played the game with text only (M = 4.55, SD = 1.11), text and audio (M = 4.36, SD = 1.40), and audio only (M = 4.81, SD = 1.48) reported equal levels of enjoyment. We also ran one-way ANOVAs on each of the individual questions that measured enjoyment. However, they also did not show any significant differences between the conditions (See Table 2).

Engagement. We also examined the effects of the game playing mode on engagement with a one-way ANOVA. There was no significant effect of game playing mode on engagement, $F(2, 108) = .23$, $p = .80$ (See Figure 2). This indicates that the participants in the three conditions, the text only (M = 4.94, SD = .85), text and audio (M = 4.88, SD = 1.24), and audio only (M = 5.05, SD = 1.18), reported equal levels of engagement while playing the game. Again, we also ran one-way ANOVAs on each of the four individual questions that measured engagement. However, they also did not show any significant differences between the conditions (See Table 3).

Frustration. Due to the fact that the individual measures of frustration on the survey did not load together reliably, we instead conducted three one-way ANOVAs, one for each of the three individual measures of frustration. We first examined the effect of game playing on the reported feelings of frustrated while playing the game. There was not significant effect of game

playing mode on frustration, $F(2, 108) = .14$, $p = .87$ (See Figure 3). Participants who played the game with text only (M = 2.27, SD = 1.44), with text and audio (M = 2.33, SD = 1.28), and with audio only (M = 2.18, SD = 1.17) reported equal levels of frustration. Second, we examined the effect of game playing mode on participants feeling that their choices affected the game in the way they wanted them to. There were no significant difference between the conditions on this measure either, $F(2, 108) = 1.23$, $p = .30$ (See Figure 4), with text only (M = 4.09, SD = 1.26), text and audio (M = 4.15, SD = 1.31), and audio only (M = 4.54, SD = 1.43) conditions reporting similar levels of having their choices affect the game in the way they wanted them to. Finally, we examined the effect of game playing mode on participants believing that puzzles and challenges in the game were too difficult. There was also no significant effect of game playing mode on believing that the games puzzles and challenges were too difficult, $F(2, 108) = 1.66$, $p = .20$ (See Figure 5). Participants with the text only (M = 2.12, SD = 1.22), text and audio (M = 1.69, SD = 1.28), and audio only (M = 2.15, SD = 1.20) all reported equal levels finding the puzzles and challenges in the game too difficult.

Opinion of the Story. The effects of the game playing mode on the participants' opinions of the story in the game were also examined with a one-way ANOVA. There was no significant effect of game playing on the opinion of the story, $F(2, 108) = 1.06$, $p = .35$ (See Figure 6). Overall, participants in the three conditions, text only (M = 4.99, SD = .96), text and audio (M = 4.72, SD = 1.26), and audio only (M = 5.09, SD = 1.19), rated the story of the game equally. Likewise, two of the three individual measures of the participants' opinions of the audio also did not show significant differences. However, the third measure, "The storyline of the game flowed naturally, was easy to follow, and was engaging," did show significant differences between the conditions, $F(2, 108) = 3.46$, $p = .04$ (See Figure 7). Post hoc comparisons using the

LSD test indicated that participants in the text and audio condition (M = 4.72, SD = 1.40) believed that the storyline flowed worse, was less easy to follow, and was less engaging than participants in the audio only condition (M = 5.46, SD = 1.27), t (108) = 2.46, p = .02. The text only condition (M = 5.09, SD = 1.01) was not significantly different from either of the other two conditions.

Opinion of the Audio. We also examined the effect of the game playing mode on the participants' opinion of the audio in the game by running a one-way ANOVA. There was not a significant effect of game playing modes in opinions of the audio in the game overall, F(1, 76) = 2.78, p = .10 (See Figure 8). Participants who had both the text and audio (M = 5.11, SD = 1.18) and participants who had the audio only (M = 5.56, SD = 1.18) had equal opinions of the audio in the game. Likewise, two of the three individual measures of the participants' opinions of the audio also did not show significant differences. However, one of the items measuring the opinion of the audio, "The sounds matched the scenarios in the game," did show significant differences between the conditions, F(1, 76) = 6.36, p = .01 (See Figure 9). The participants who played the game with the audio only (M = 5.87, SD = 1.17) believed that the audio matched the scenarios in the game more than participants who played the game with both the text and the audio (M = 5.10, SD = 1.50) did.

Game Transcript Analysis. The effects of the game playing mode was on the number of passages the participant progressed through in the game were also examined by running a one-way ANOVA. The analysis indicated that there was a significant effect of the game playing modes on the number passages progressed through in the game, F(2, 108) = 25.84, p < .01 (See Figure 10). Post hoc comparisons using the LSD test indicated that participants who had text

only in the game progressed through the highest amount of passages in the game (M = 24.42, SD = 9.99) and participants who had audio only in the game progressed through the least amount of passages in the game (M = 12.28, SD = 1.34), $t(108) = 7.53$, $p < .01$. Participants who had both the text and the audio (M = 18.59, SD = 7.75) progressed through more passages than those with audio only, $t(108) = 5.01$, $p < .01$, but fewer than those with text only, $t(108) = 2.79$, $p < .01$.

Exploratory Analyses

We also did a series of exploratory analyses.

Gender. First, we examined if there were differences in gender on any of the metrics. While we did not expect that there would be any gender difference, we decided to examine this to confirm our expectations. For the most we found that there were no significant differences on the survey measures or in the number of passages the progressed through based on gender. However, there was one individual survey measure that showed differences between genders. This was in how humorous participants found the game. Male participants tended to find the game more humorous than female participants, $F(1, 109) = 4.14$, $p = .04$ (See Figure 11). Male (M = 5.13, SD = 1.26), Female (M = 4.59, SD = 1.51). It is unclear what is causing this difference.

Previous Game Playing Experience. Additionally, we looked for differences caused by the amount of game playing experience that a participant had. We operationalized game playing experience in two ways. One method used was having participants self-report how often that they play video games on a 7-point Likert-type scale. The other method had the participants simply report how many hours per week they played video games on average. For each of these methods, the median was calculated. Any participant who was below the median was coded as

having a low game playing frequency. Any participant above the median was coded as having a high game playing frequency. If a participant's score was the median, then their responses were not included in these analyses. Both methods produced similar results, so we are only reporting the analyses for participants' self-report of game-playing frequency on the Likert-type scale.

In our data set, 49 participants were coded as having a low game playing frequency, 51 participants were coded as having a high game playing frequency, and 11 participants' scores were equal to the median. From these participants, we found that there were significant differences in how enjoyable participants found the game. Participants who played video games more often (M = 4.83, SD = 1.15) tended to enjoy the game more than participants who played video games less often (M = 4.19, SD = 1.51), $F(1, 98) = 5.71$, $p = .02$ (See Figure 12). Interestingly, only one of the measures of enjoyment had significant difference between the two by itself ("I would continue playing this game if I had the opportunity to), with participants who played games more often (M = 5.22, SD = 1.25) reporting wanting to continue playing more than participants who did not play games often (M = 4.33, SD = 1.68), $F(1, 98) = 9.073$, $p < .01$. Additionally, while the overall engagement score was not significantly different low and high game playing frequency, the individual measure of "I was immersed in this game while I was playing it" did show a significant difference. High frequency game players were more likely to report being immersed in the game experience than low frequency game players (M = 4.35, SD = 1.54), $F(1, 98) = 5.35$, $p = .02$.

General Discussion

Contrary to our predictions and past research (Skalski & Whitbred, 2010), the results of the current experiment show that there were no differences in user engagement, enjoyment, or frustration when playing the game with: a) audio and text, b) only audio, or c) only text. There could be several reasons for this. It could be that audio and visual elements are not important in finding a game engaging and enjoyable. It could also be that the effects of audio and visuals are more complex than previously thought. For example, perhaps people find reading text and listening to the audio equally enjoyable, but they enjoy them for different reasons. The lack of differences in this aspect of the study is worth further investigation.

While there were no differences in terms of engagement, enjoyment and frustration, there were a few significant findings that suggest that players experienced the game differently when it was presented with only audio, only text, and both audio and text. First, the flow of the storyline was affected by the way in which the game was played. Participants who had both the text and audio together believed that the game's storyline flowed worse than in the audio only condition. While it is unclear what was specifically causing this difference, it could be that having two information sources (audio and text) at the same time was distracting to players. Previous research has indicated that audio and visual elements that contain redundant information may increase a person's cognitive load, which interferes with comprehension (Kalyuga, Chandler, & Sweller, 1999). Thus, future research should investigate the effects that both audio and text have on user attention.

Second, we found that participants who only heard audio believed that the audio matched the scenarios in the game more than participants who both heard audio and read text. This may have been occurring because participants who had the text to read likely had clearer expectations

of the audio that should have been playing, as the text alluded to the audio that would play. Therefore, when the audio played, it may not have matched the participants' expectations for the audio, which would have created a disconnect.. Participants who did not have this text to go along the audio would likely not have had as clear an expectation of the audio. However, this also needs to be examined further.

Finally, we also found that the way the game was played influenced how far the participants' progressed in the game within the allotted time. Participants who only read text progressed through the most passages, while participants who only listened to audio progressed through the fewest passages. This was expected, as participants who just listened to the audio had to wait for the entire audio file to play before being able to make a choice, whereas participants who just read text progressed through the game as fast as they could read. Participants who both read text and listened to audio progressed through more passages than those who only listened to audio, but fewer passages than those who only read text. This indicates that participants who heard audio and read text did not listen to all of the audio available. However, they were still slowed down by the audio. It is possible that the audio was distracting to the participants, which may have forced them to slow down while reading in order to comprehend the text. Additional work should look to clarify this.

Limitations and Future Research

There were several factors in this study that may limit it generalizability. First, the text-based adventure game used in this study was a very specific type of game. Its only visual element was the text on the screen. Most video games contain more involved visual elements, such as character models and animations. It is unclear how using a different game for this study would have affected the results. It is possible that players respond to text as a visual element

differently than to more artistic visual elements. Therefore, future research should examine the effect of audio when the game contains graphical, visual elements, such as animations, character models, and background art, as compared to games that contain text only or no visuals at all.

Likewise, the genre of the game may also be an important factor to consider in future research endeavors. For instance, in different genres, players may have more control over their character in the game. In the current game, players engaged in very simple interactions that consisted of making decisions based on a multiple choice format. Yet, in other types of games, such as an action game, players would be able to fully control the player character in an environment, deciding exactly where the player character will go and what they will do in that situation. These differences may influence the effect that audio has on the user experience. Future research should also replicate this study with games in different genres, as it is possible that the actions being done in the game interact with the audio in different ways.

Another avenue for future research is to test the game with visually-impaired participants. The results of this study indicate that the game was playable without the text. Additionally, the results also indicate that the game was equally enjoyable and engaging for participants who could not view the screen as for participants who could view the screen. However, the study does not indicate how a visually-impaired individual might interact with the game. This experiment emulated the situation in which a visually-impaired individual might experience the game (with audio only). However, the visually-impaired may process information differently, as compared to seeing individuals. Therefore, it is possible that visually-impaired participants would not find the game enjoyable and engaging. The current study did not use a visually-impaired population because our first goal was to confirm that the game was playable without needing to look at the screen. In addition, we wanted to have the opportunity to work out any

unintentional bugs and wanted to make sure an enjoyable and engaging game was created prior to testing the game with a visually-impaired population.

We would also like to further employ the concept of Stealth Assessment (Shute, 2011) into the game. In the game's current state, we collected data without the participants' knowing about it. However, this is only one of the advantages of the Stealth Assessment. It can also be used to make inferences about the player and personalize the content of the game. However, to do this, we will first need to build assessment and data collection tools into the game. With further developed tools, we can gather a more robust data set that can calculate more specific pieces of data, such as what choices are being made (i.e. the first choice, second choice, third choice), how much time is spent on each page, and even what mouse movements are made on each page. We would then be able to use this data to look make inferences about the player, and then use these inferences to personalize content in the game.

For example, in the game used in this study, Stealth Assessment might manifest itself in a few ways. We might use it to intervene if players are being careless while playing the game, which could be evidenced by the player moving through the game too quickly. These interventions could take the form of messages telling the player to slow down in order to comprehend and enjoy the game more. We also would like to use Stealth Assessment to personalize the content of the game to each individual player. The inferences the computer makes about the player could indicate what they enjoy and their affective state. These inferences could then be used to make changes to the games, such as changing elements of the plot or adjusting the pace of the game.

Conclusion

In this study, we examined the effect of audio and visuals on the user experience of playing a video game. Through this research, we have learned more about how to create video games that maximizes player engagement and enjoyment and also minimizes frustration. We also began to investigate ways to design video games that could be accessible to the visually-impaired. With this knowledge, further research can be conducted on the audio and user experience of video games. Additionally, game developers can use this information to create games that have better user experiences and can be more accessible to the visual impaired.

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Tables

Table 1

Correlations between the scores of the various aspects of user experience

	Engagement	**Enjoyment**	**Opinion of the Story**	**Opinion of the Audio**
Engagement	1			
Enjoyment	.71 ($p < .01$)	1		
Opinion of the Story	.72 ($p < .01$)	.73 ($p < .01$)	1	
Opinion of the Audio	.63 ($p < .01$)	.66 ($p < .01$)	.68 ($p < .01$)	1

Table 2

The results of the ANOVAs for the individual questions measuring enjoyment.

	Text / No Audio	**Text / Audio**	**No Text / Audio**	**F**	***P***
Continue Playing the Game	4.79 (SD = 1.27)	4.69 (SD = 1.59)	5.00 (SD = 1.62)	.42	.66
Had Fun Playing the Game	4.30 (SD = 1.16)	4.03 (SD = 1.39)	4.62 (SD = 1.46)	1.86	.16

Table 3

The results of the ANOVAs for the individual questions measuring engagement.

	Text / No Audio	**Text / Audio**	**No Text / Audio**	**F**	***P***
Engaged While Playing the Game	5.00 (SD = 1.09)	4.92 (SD = 1.53)	5.13 (SD = 1.45)	.22	.81
Immersed While Playing the Game	4.64 (SD = 1.27)	4.67 (SD = 1.56)	4.92 (SD = 1.37)	.47	.63
Mind Wandered to Unrelated Topics While Playing	3.00 (SD = 1.73)	2.72 (SD = 1.52)	3.15 (SD = 1.83)	.66	.52
Events and Challenges Flowed Together	5.12 (SD = .96)	4.67 (SD = 1.31)	5.31 (SD = 1.40)	2.70	.07

Table 4

The results of the ANOVAs for the individual questions measuring frustration.

	Text / No Audio	**Text / Audio**	**No Text / Audio**	**F**	***p***
Frustrated While Playing the Game	2.27 (SD = 1.44)	2.33 (SD = 1.28)	2.18 (SD = 1.17)	.14	.87
Choices Affected the Game in the Way I Wanted Them To	4.09 (SD = 1.26)	4.15 (SD = 1.31)	4.54 (SD = 1.43)	1.23	.30
Puzzles and Challenges Too Difficult	2.12 (SD = 1.22)	1.69 (SD = 1.28)	2.15 (SD = 1.20)	1.66	.20

Table 5

The results of the ANOVAs for the individual questions measuring opinion of the story.

	Text / No Audio	**Text / Audio**	**No Text / Audio**	**F**	***P***
Story in the Game was Engaging	4.88 (SD = 1.05)	4.64 (SD = 1.41)	5.00 (SD = 1.40)	.76	.47
Story in the Game was Humorous	5.00 (SD = 1.37)	4.79 (SD = 1.45)	4.79 (SD = 1.44)	.24	.79
Story in the Game Flowed Naturally	5.09 (SD = 1.01)	4.72 (SD = 1.40)	5.46 (SD = 1.27)	3.46	.04

Table 6

The results of the ANOVAs for the individual questions measuring opinion of the audio.

	Text / No Audio	**Text / Audio**	**No Text / Audio**	**F**	***P***
Audio Matched the Game Scenarios	NA	5.10 (SD = 1.50)	5.87 (SD = 1.17)	6.36	.01
Audio in the Game were Realistic	NA	5.21 (SD = 1.28)	5.56 (SD = 1.23)	1.59	.21
Audio Add a Great Deal to my Enjoyment	NA	5.00 (SD = 1.64)	5.23 (SD = 1.51)	.41	.52

Figures

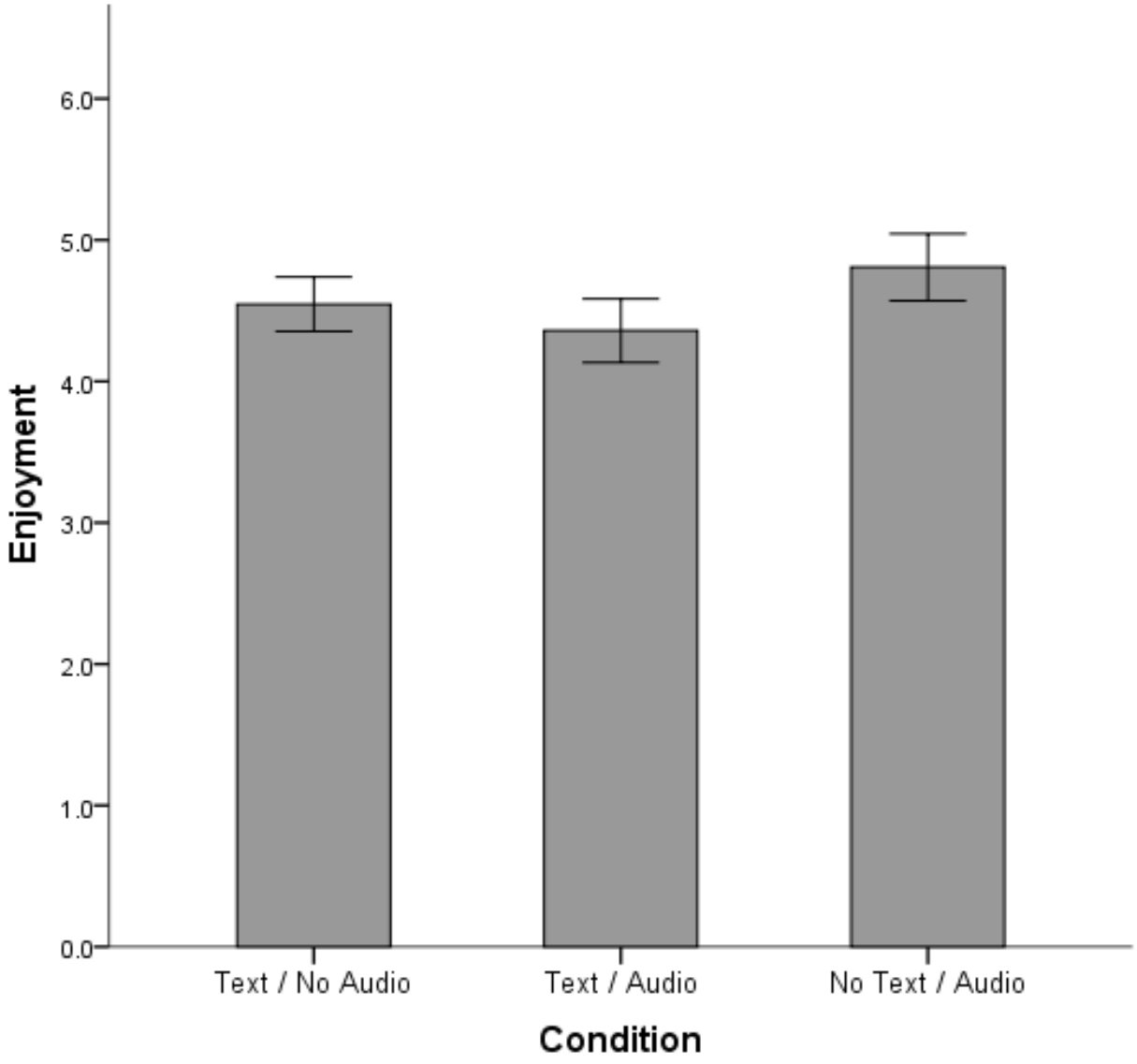

Figure 1. The differences in reported enjoyment by game playing mode.

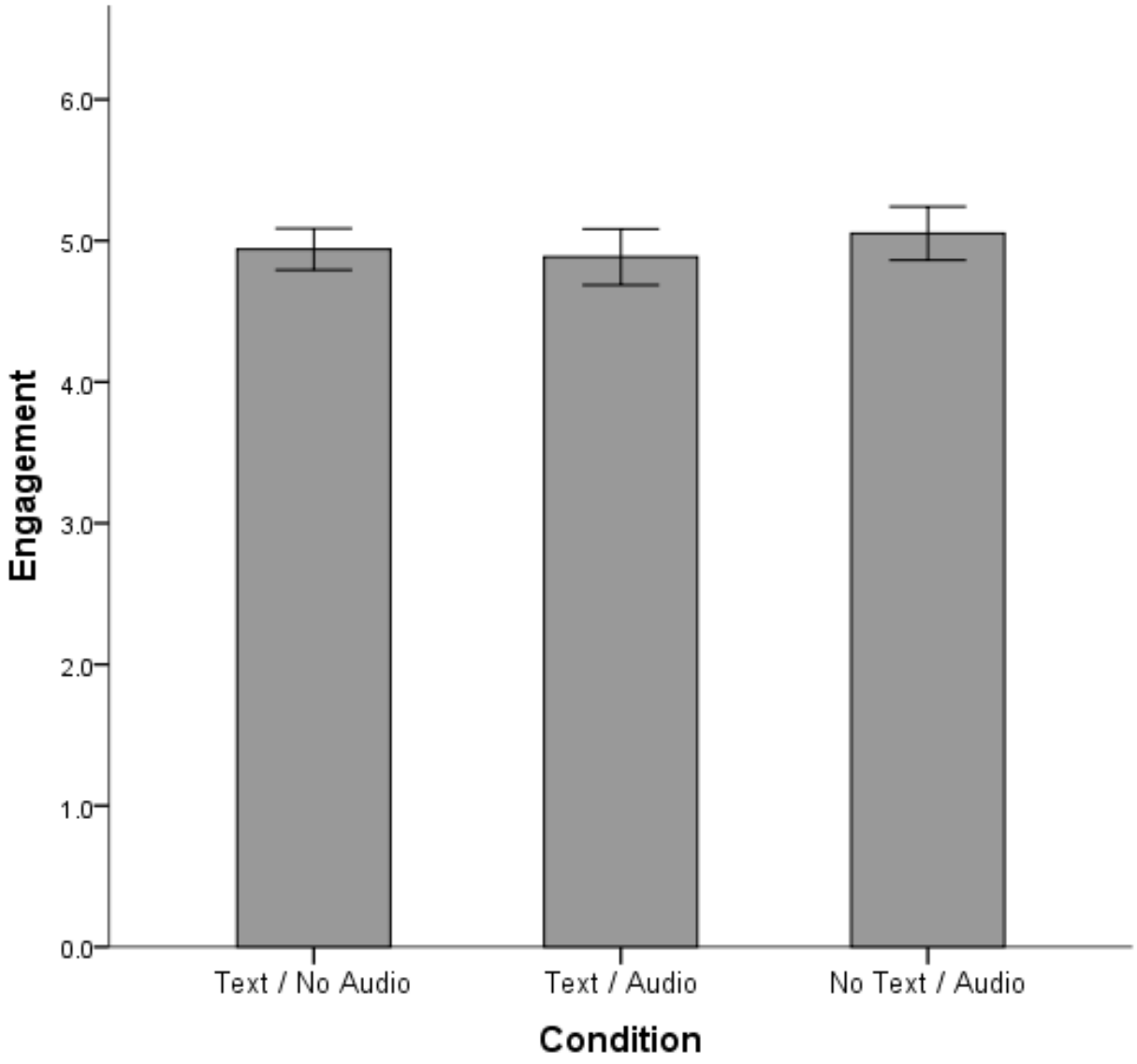

Figure 2. The differences in reported engagement by game playing mode.

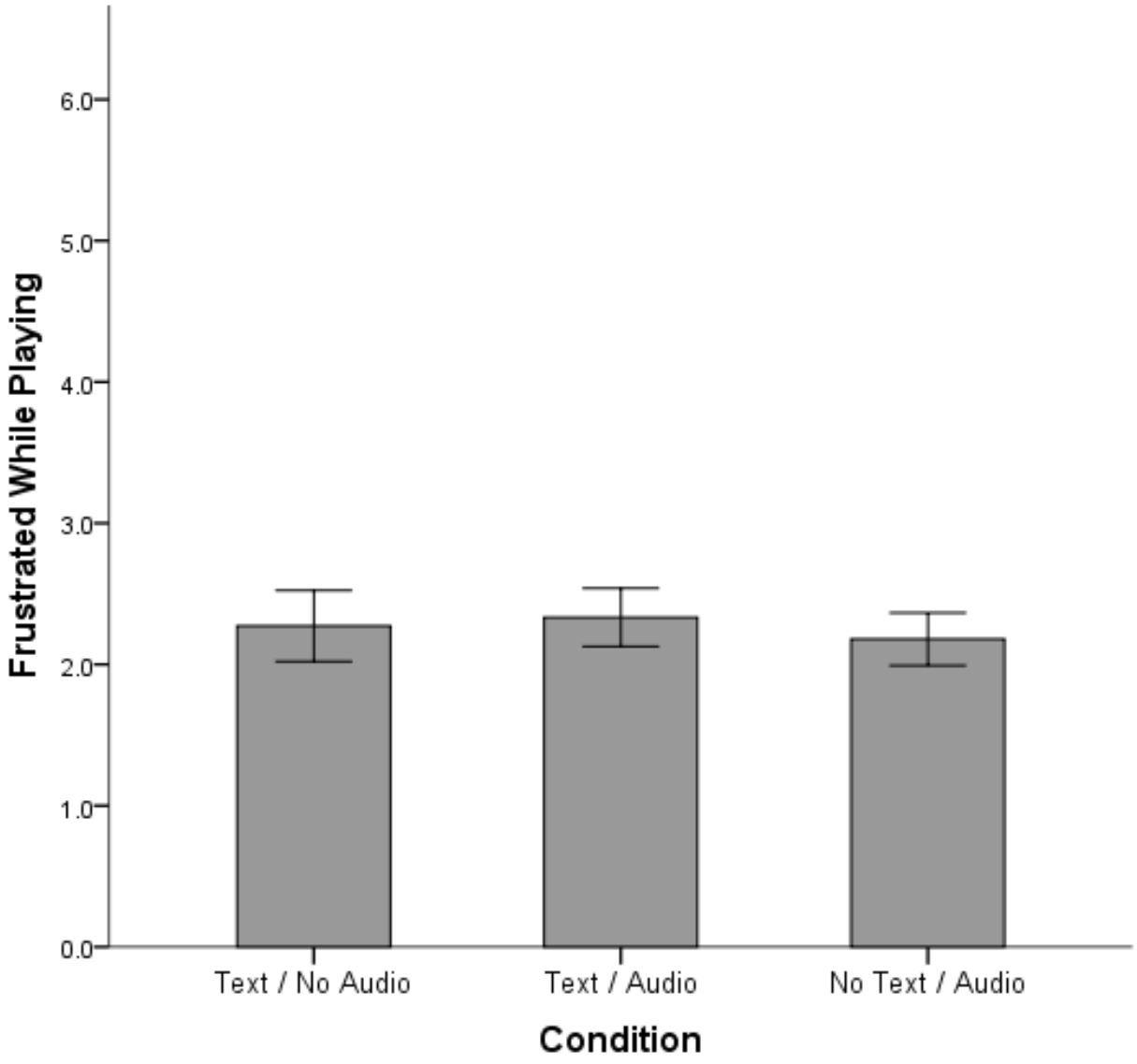

Figure 3. The differences in reported frustration by game playing mode.

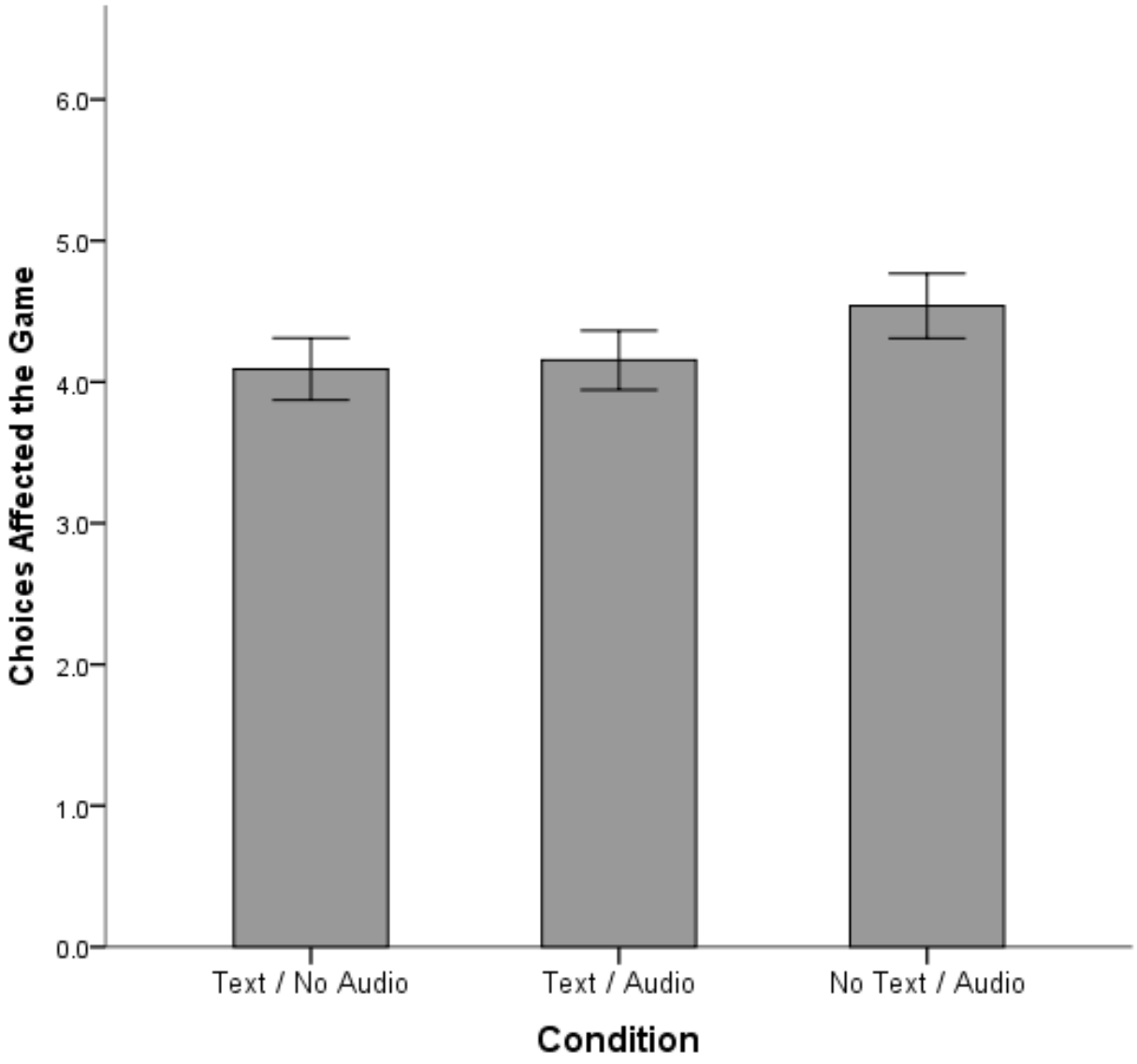

Figure 4. The differences in the reported perception that the player action affected the game by game playing mode.

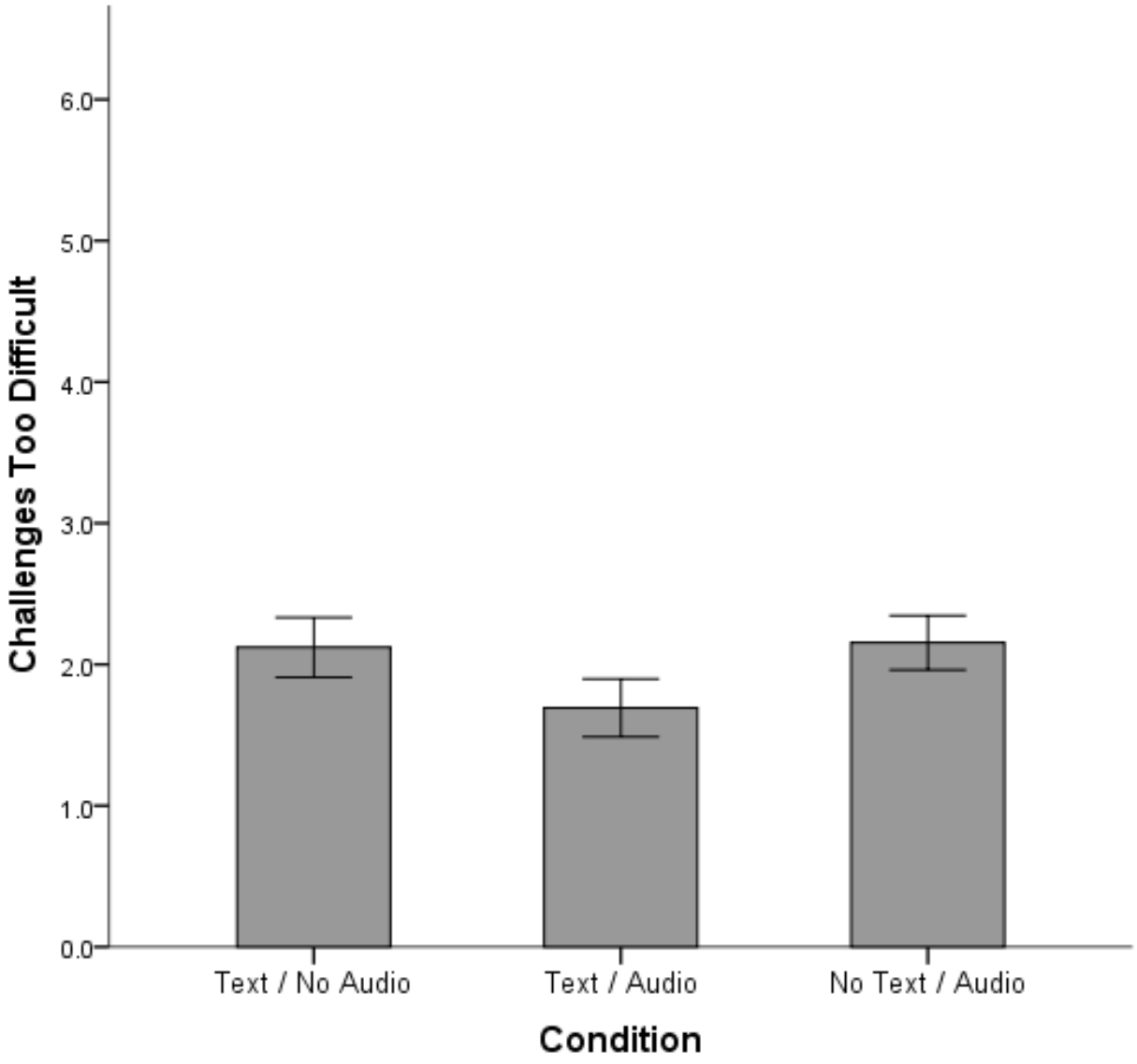

Figure 5. The differences in the reported difficulty of the puzzles and challenges by game playing mode.

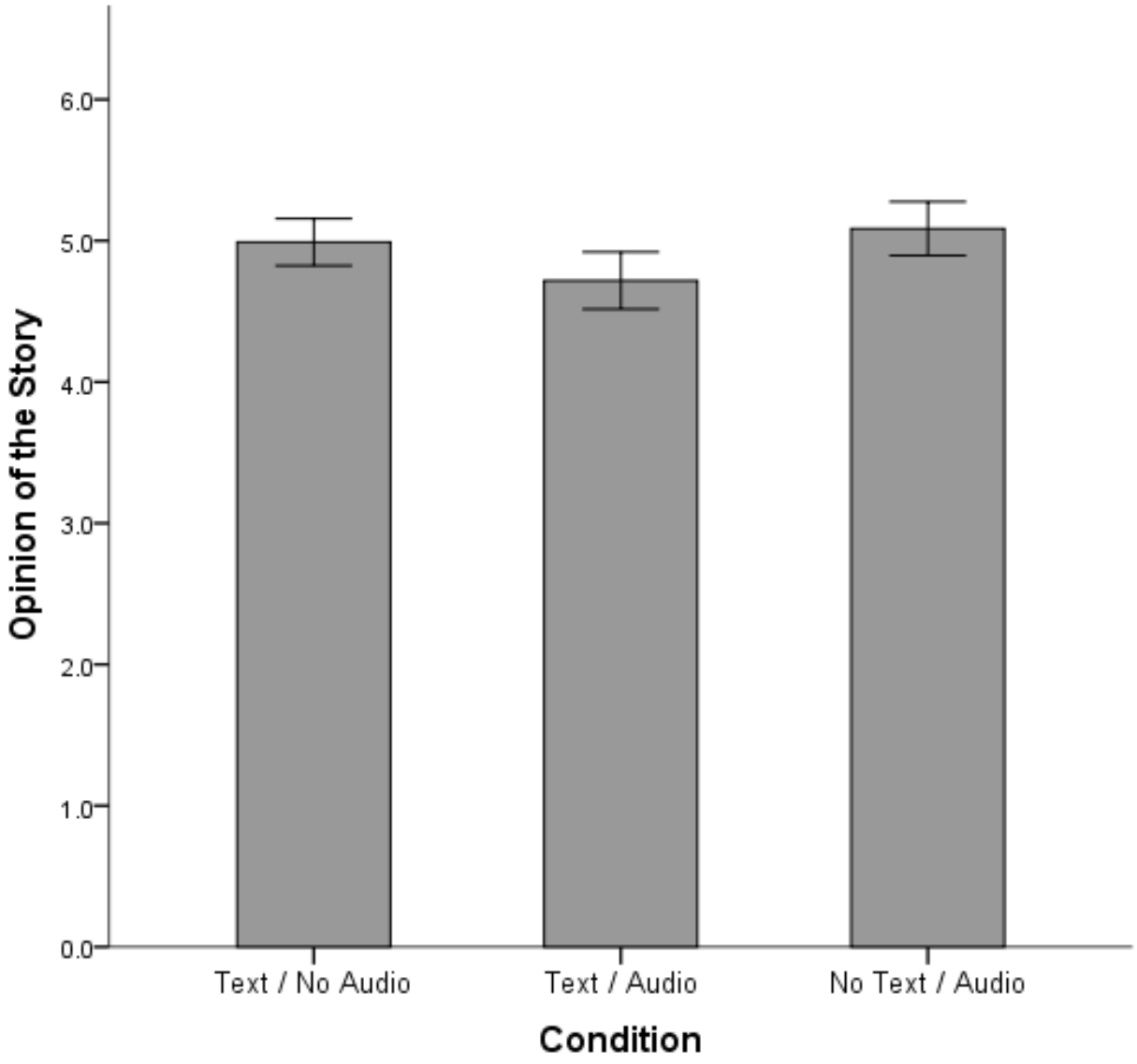

Figure 6. The differences in reported opinion of the story by game playing mode.

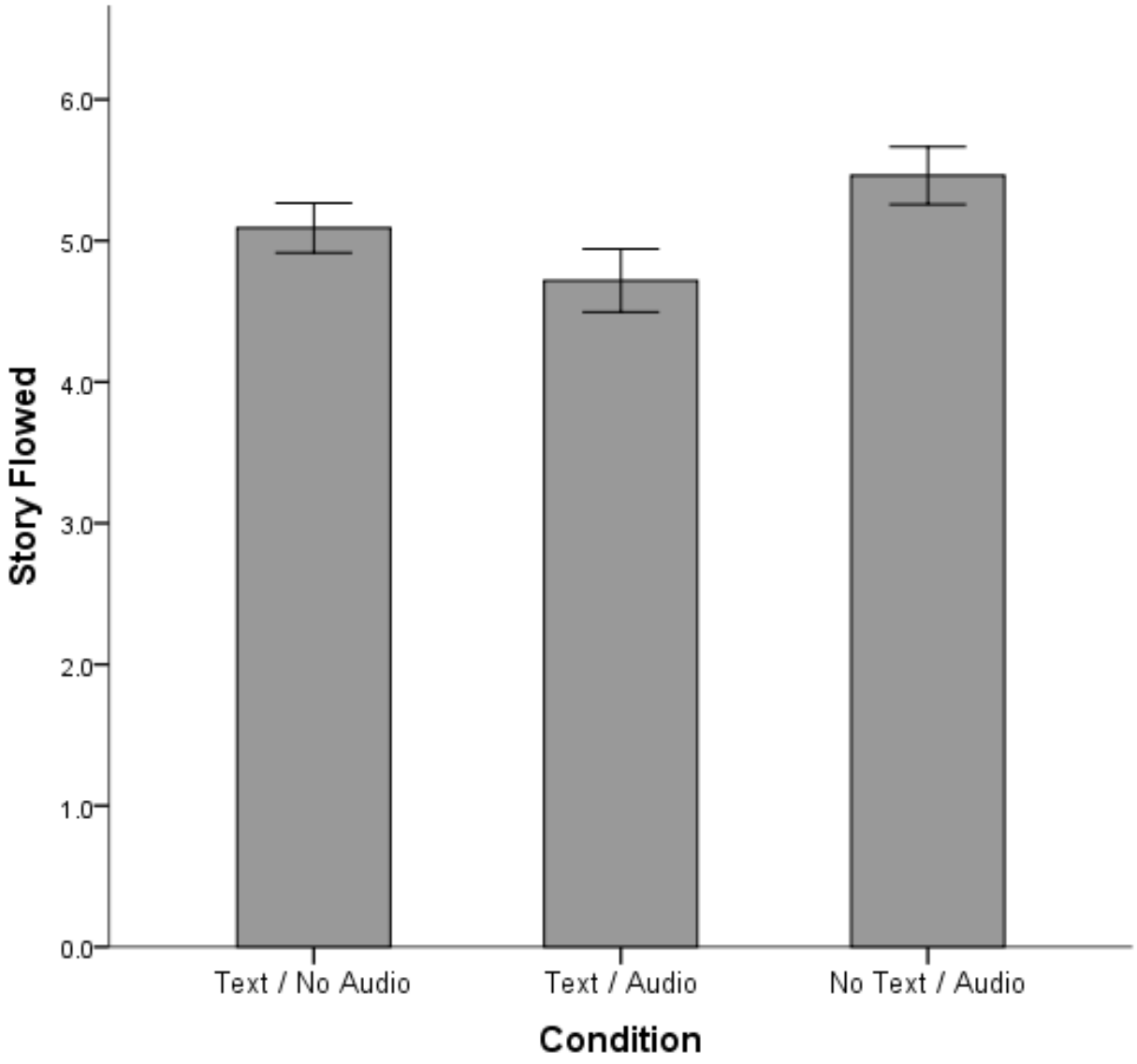

Figure 7. The differences in reporting how the story flowed by game playing mode.

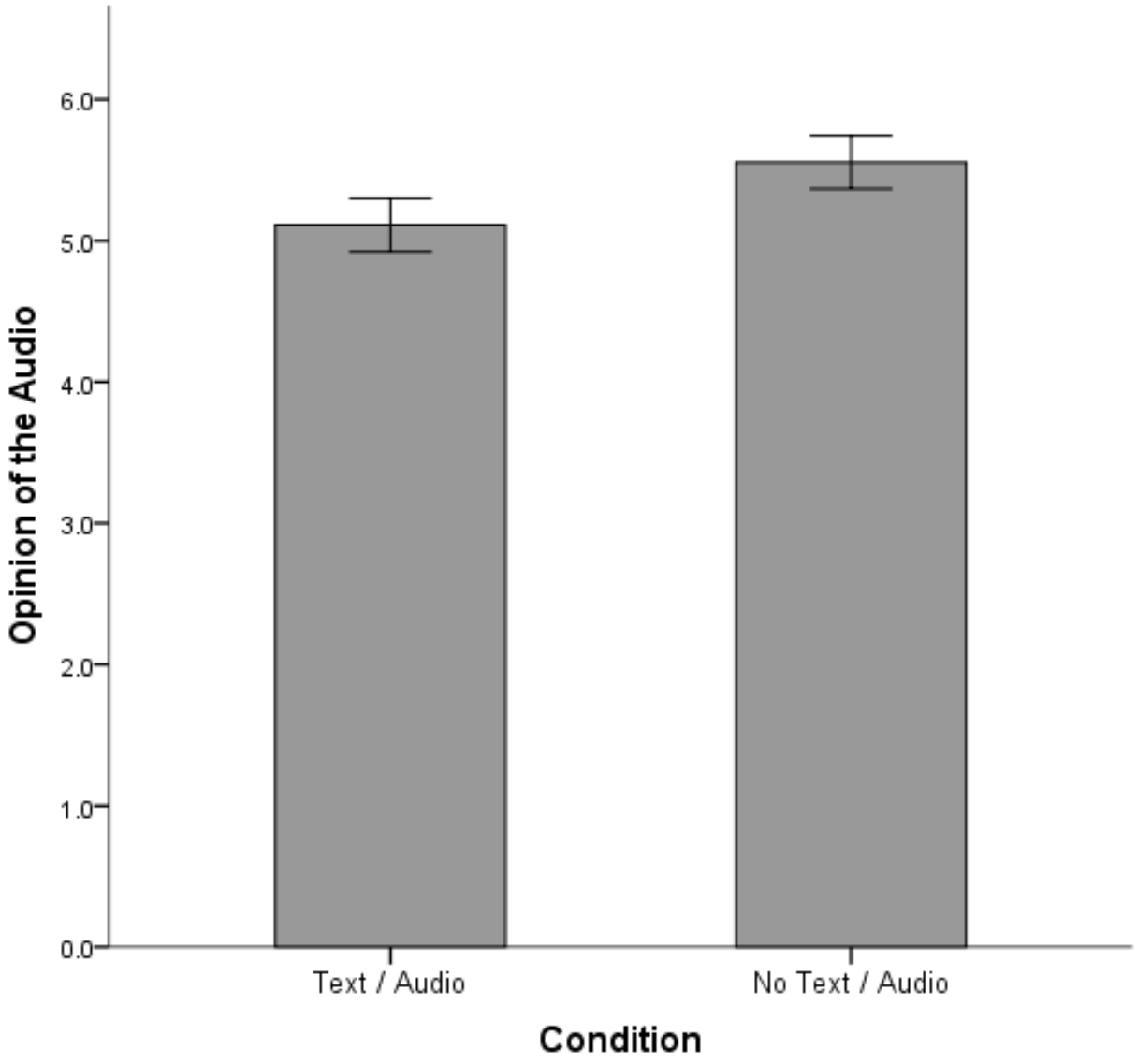

Figure 8. The differences in reported opinion of the audio by game playing mode.

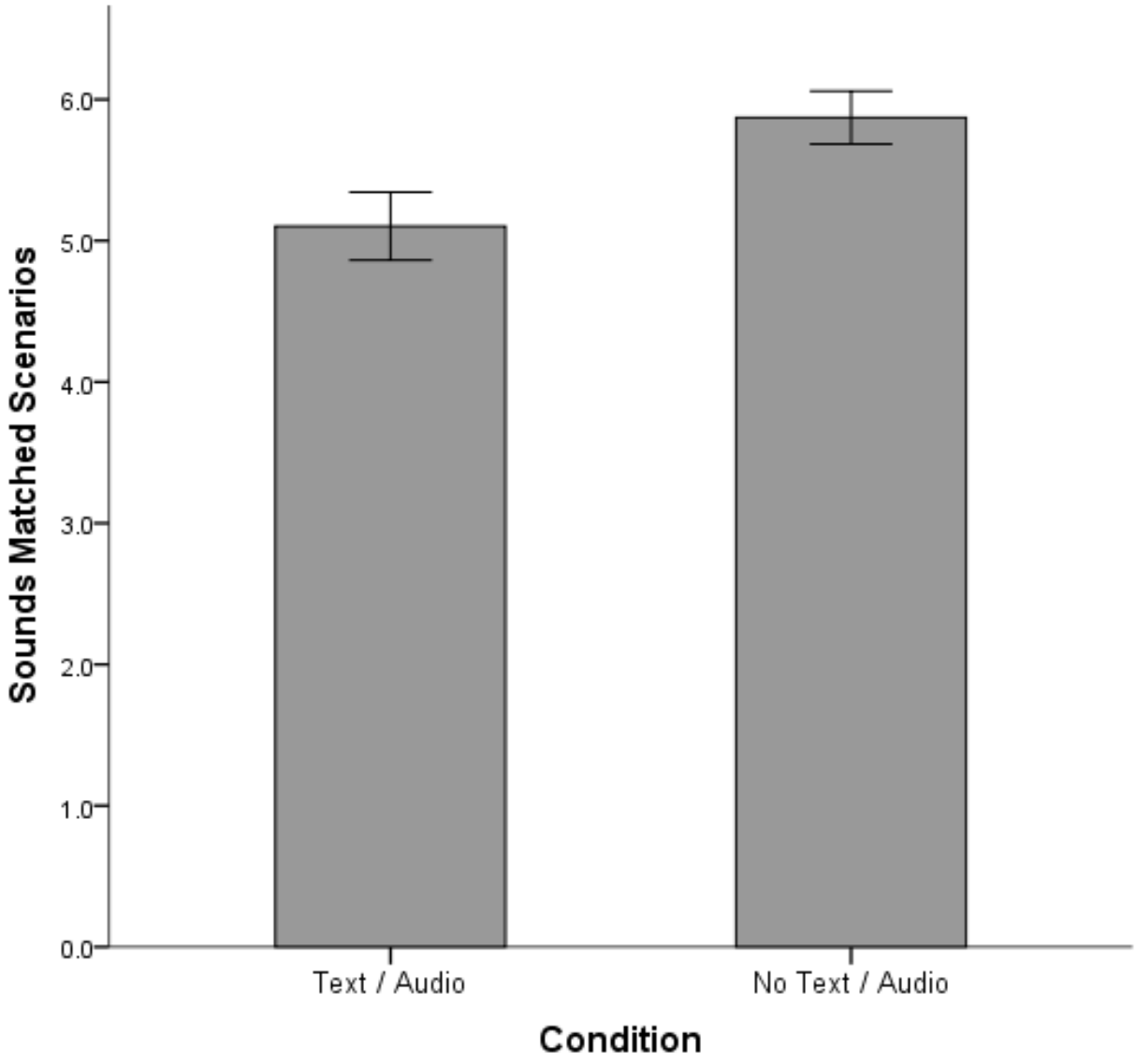

Figure 9. The differences in the report of how well the audio matched the game scenarios by game playing mode.

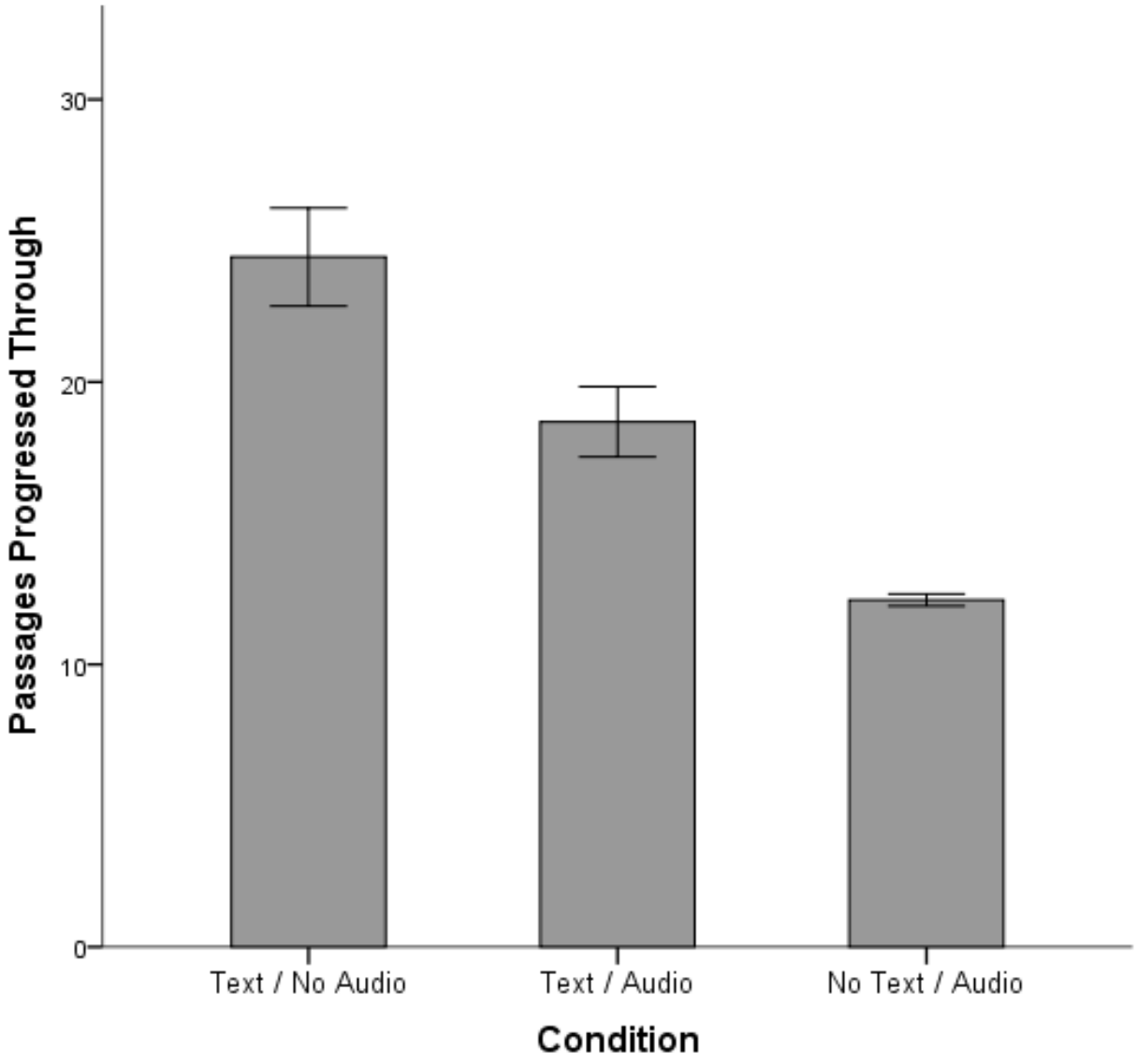

Figure 10. The differences in the number of passages progressed through by game playing mode.

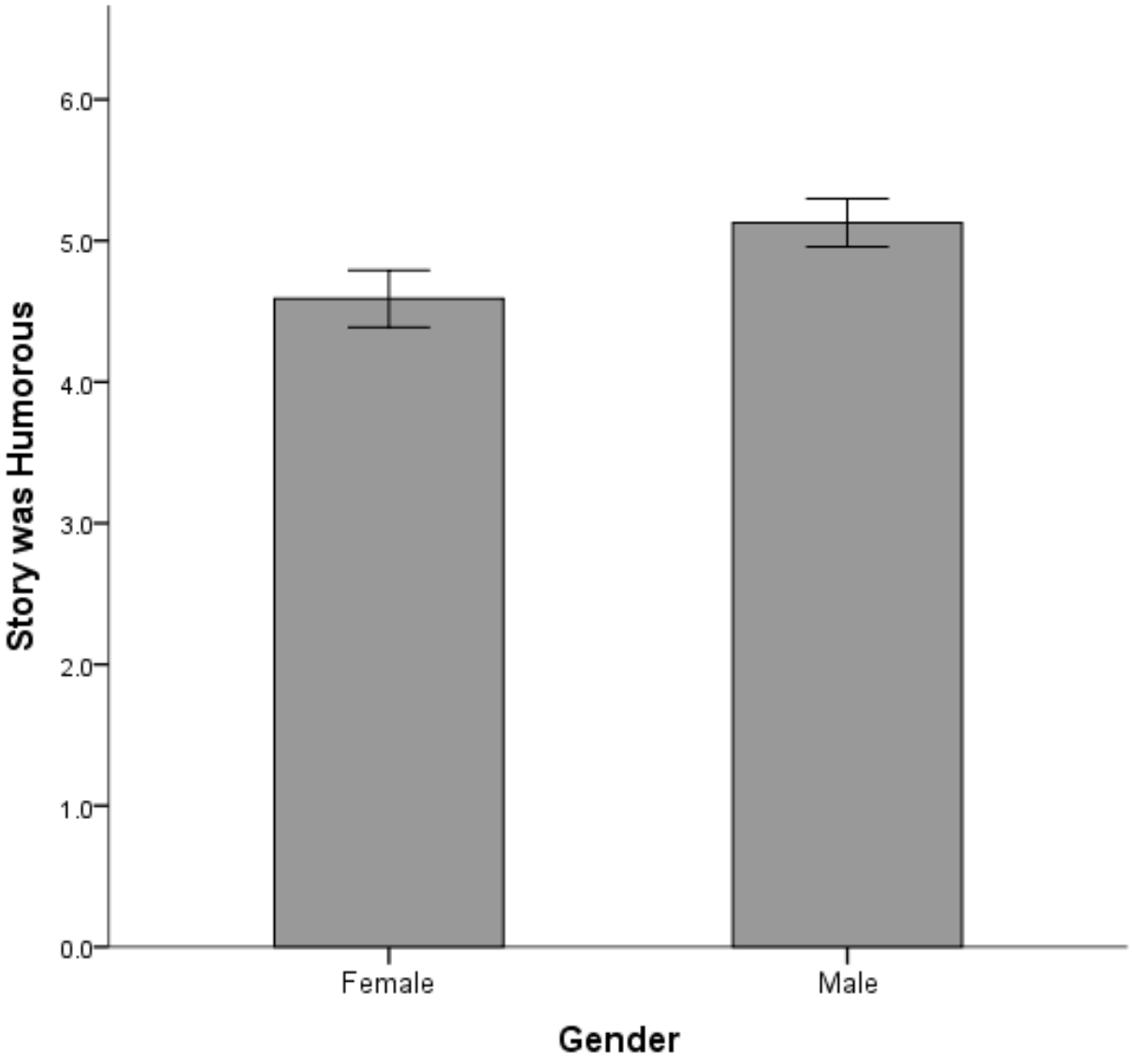

Figure 11. The differences in finding the game humorous by gender.

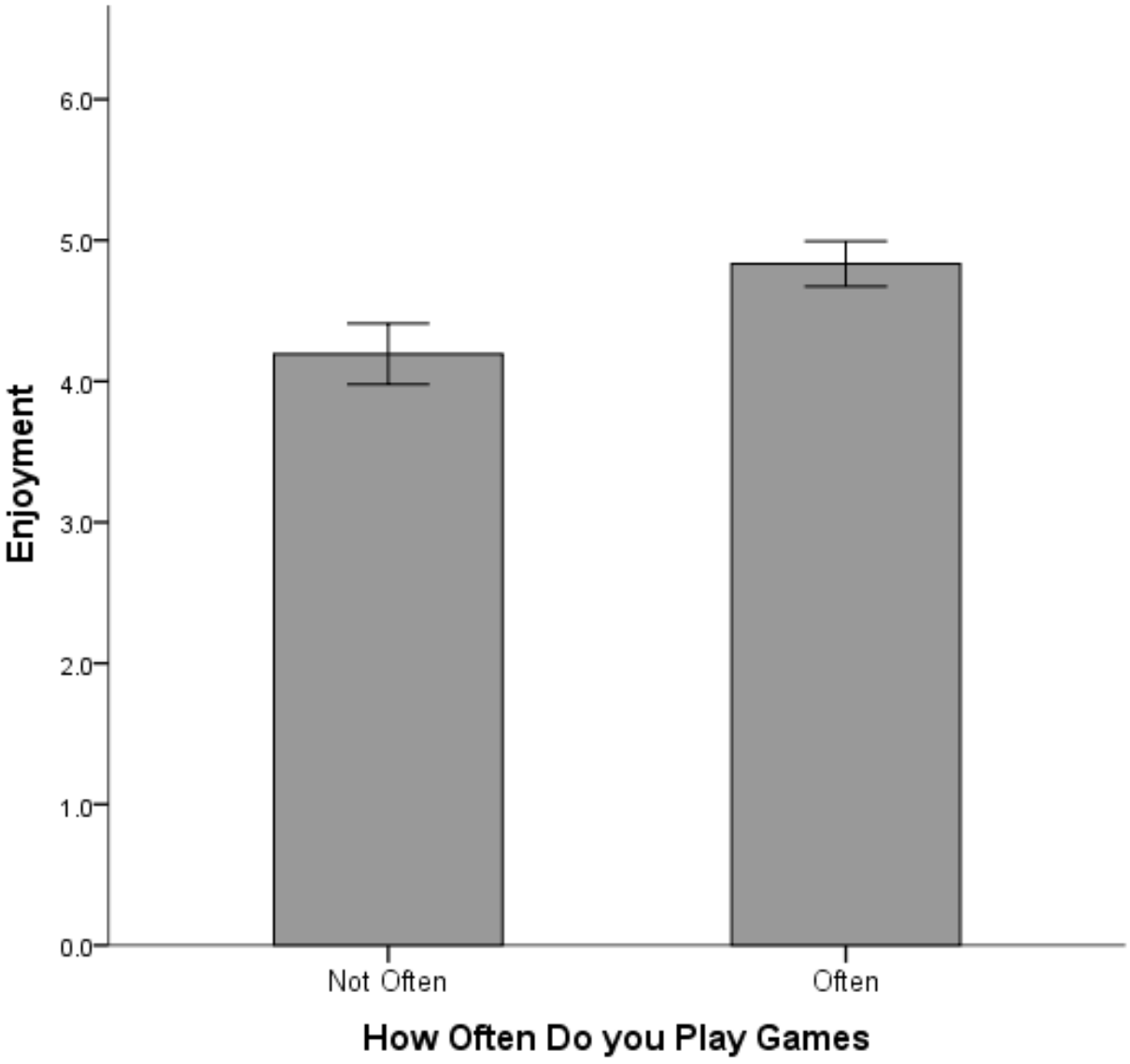

Figure 12. The differences in finding the game enjoyable by game playing frequency.

Appendix A

Game Images

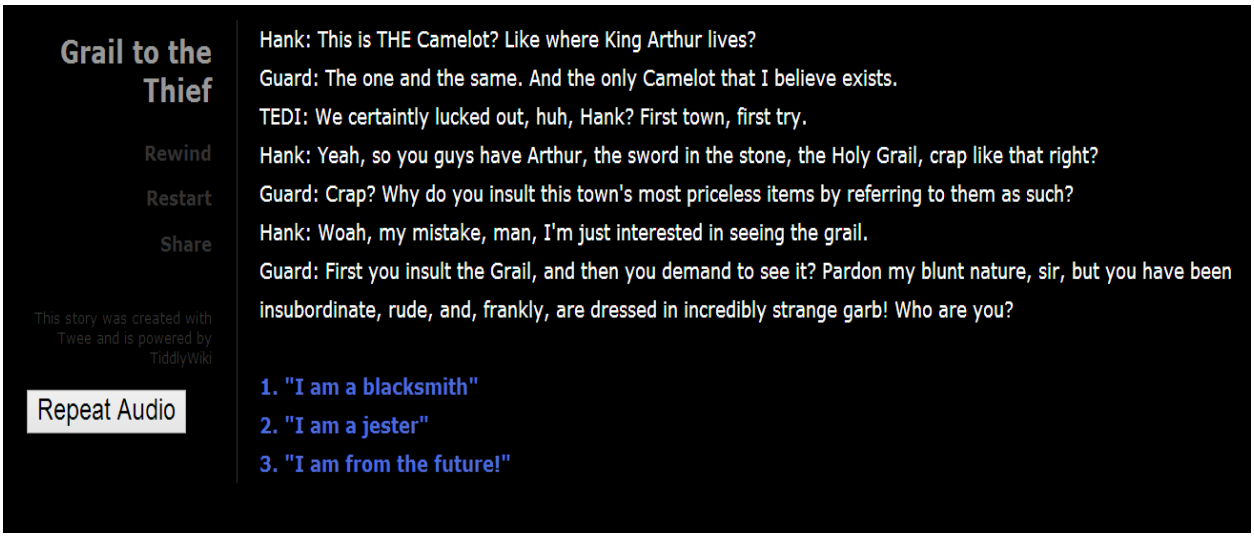

Image 1. A screenshot of the game as the player would view it

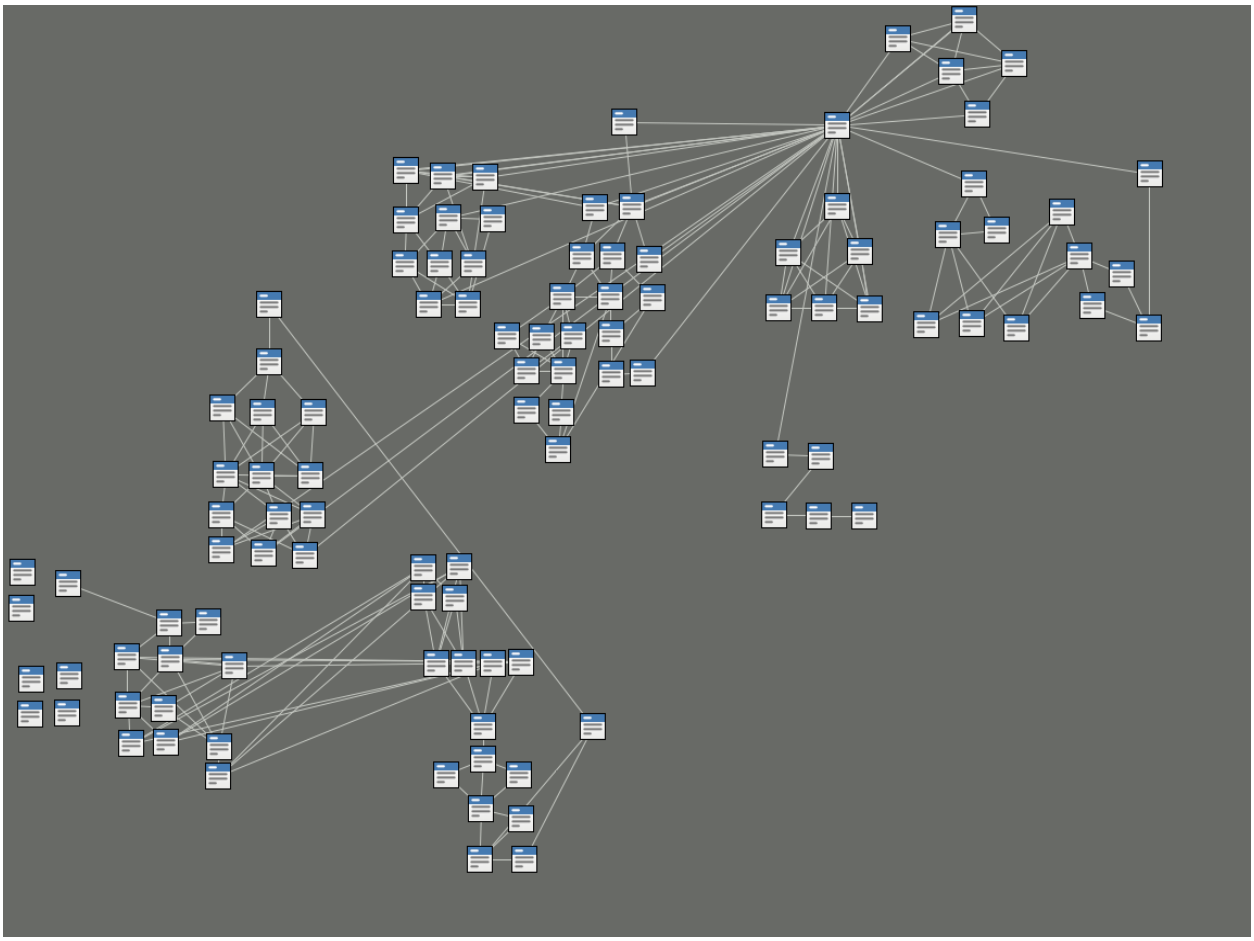

Image 2. The structure of the game in a web format. Each box is a passage and each line represents a choice made.

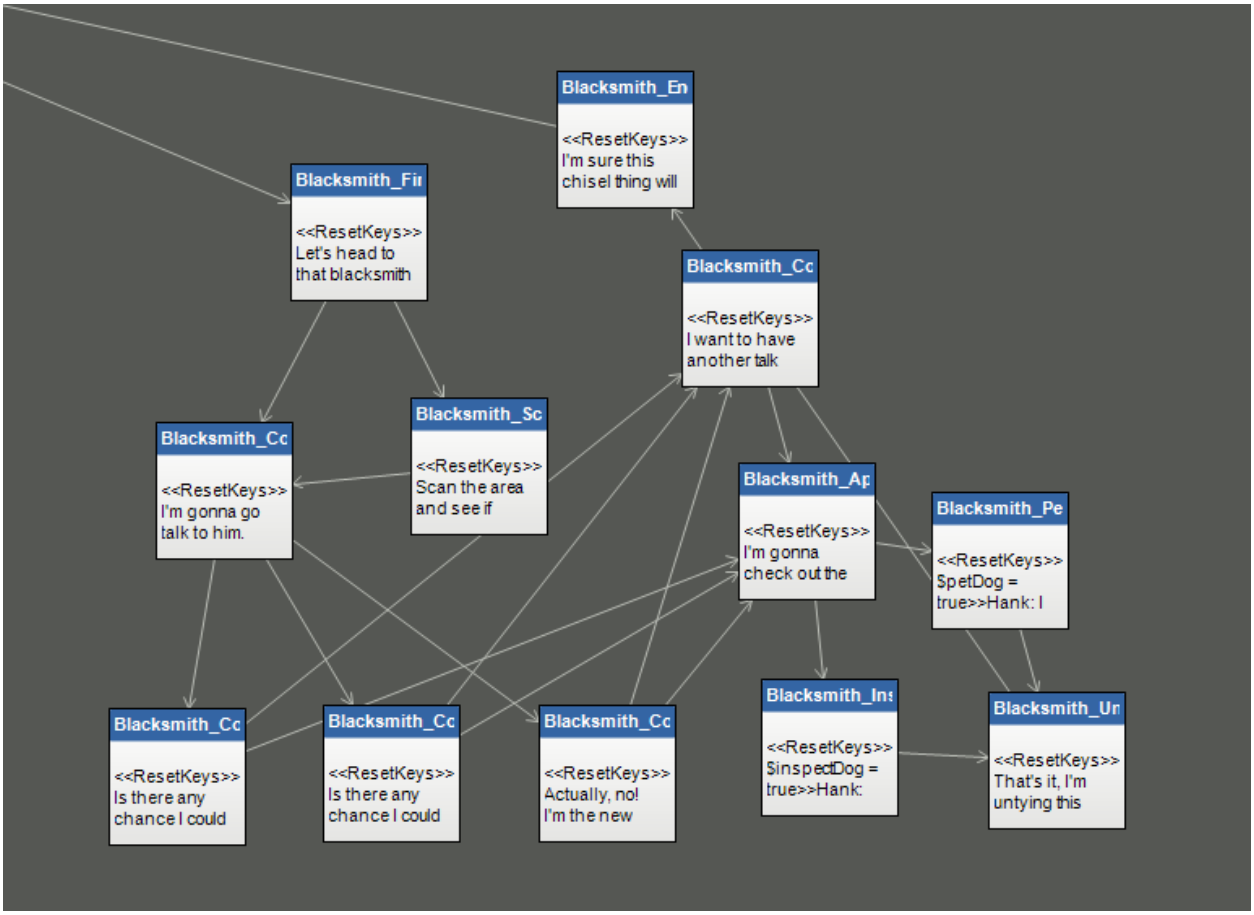

Image 3. A zoomed in section of the game that shows a puzzle in the game in detail

Appendix B

Post-Play Survey

1. I would continue playing this game if I had the opportunity to.

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

2. I had a lot of fun playing this game.

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

3. I was engaged while I was playing this game.

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

4. I was immersed in this game while I was playing it.

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

5. I felt frustrated while I was playing this game.

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

6. My mind wandered to topics unrelated to the game while I was playing it.

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

7. I found the story in this game engaging.

1 2 3 4 5 6 7

Strongly Disagree Strongly Agree

8. I found the story in this game humorous.

1 2 3 4 5 6 7

Strongly Disagree Strongly Agree

9. The choices I made in the game affected the story in the way that I wanted it to.

1 2 3 4 5 6 7

Strongly Disagree Strongly Agree

10. The events and challenges in the game flowed naturally together.

1 2 3 4 5 6 7

Strongly Disagree Strongly Agree

11. The puzzles and challenges in the game were too difficult.

1 2 3 4 5 6 7

Strongly Disagree Strongly Agree

12. The storyline of the game flowed naturally, was easy to follow, and was engaging.

1 2 3 4 5 6 7

Strongly Disagree Strongly Agree

13. Only answer if you heard sound while playing the game: The sounds matched the scenarios in the game.

1 2 3 4 5 6 7

Strongly Disagree Strongly Agree

14. Only answer if you heard sound while playing the game: The sounds in the game were realistic.

1 2 3 4 5 6 7

Strongly Disagree Strongly Agree

15. Only answer if you heard sound while playing the game: The audio of the game added a great deal to my enjoyment when playing the game.

1 2 3 4 5 6 7

Strongly Disagree Strongly Agree

16. How often do you play video games?

1 2 3 4 5 6 7

Never Very Often

16. Approximately how many hours per week do you play video games? _____

17. If you were to play a video game, what genres of video games would you play? (Circle all that apply and rank in order of preference)

-Action -Adventure -Facebook/Online -Fighting

-Mobile/Phone -Music -Multiplayer -Puzzle

-Racing -Role-playing -Simulation -Strategy

-Shooter -Sports -Massively Multiplayer Online

-Other: _____

18. What is your gender?

Male Female

19. What is your class year?

Freshmen Sophomore Junior Senior Graduate

20. Do you have any other comments about this game