Sound in Video Games: How does sound impact the identification of elements and immersion in Dark Echo?

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ABSTRACT

Creating convincing in-game environments is essential for delivering immersive gaming experiences. Sound provides critical information about the game world, enhancing environmental awareness and aiding object identification while deepening immersion. Using the game *Dark Echo* as our test case, we examined how sound affects gameplay immersion and overall player experience. Participants were divided into two groups—one playing with sound and one without. Data collected through interviews and questionnaires allowed us to assess immersion levels using statistical analysis. Our findings confirm that sound plays a critical role in creating gameplay immersion and helps players identify in-game objects and understand context.

Keywords:
Sound Design, Audio Immersion, Informative Sound, Video Game Design, Identification of Gameplay Components

1. INTRODUCTION

Videogames are composed with many elements in its design including the sound design and audio cues. The sound component helps the player to create an immersive environment, as Haehn mentions in their paper, there is a significant effect of ambient sounds on immersion [3], it can be used as a mechanic to notify the players or distinct elements inside the game's world just as Ng state in their research, the video game can employ auditory sensory cues to design the feedback so that it assists the player to perform essential tasks [4], and sound design can enable player accessibility and inclusion [5] as Guillen and Jylhä wrote in their co-written paper. Research on this topic is important to understand how sound can be used and how different applications can have an impact through the industry to enhance the experience, influence the design and make an engagement solution.

This study investigates the impact of sound design on the gaming experience, focusing on two key aspects:

RQ1: How does sound help players identify environmental objects in *Dark Echo*?

RQ2: How does sound enhance the gaming experience in *Dark Echo?*

We use the video game *Dark Echo* in a controlled experiment, intending to investigate the effects of sound in terms of gameplay in a game where visual designs are abstract and simple. Participants interacted with the game in two conditions: with and without a sound design.

First, we are going to explain what the game Dark Echo is about and why we choose this game for this experiment. For the experiment, we are going to have two groups play *Dark Echo* and the distribution of these groups was between subjects. The control group would play with the sound enabled and the experimental group would have it disabled. With these settings, we are going to validate if the participants could identify what the sound comes from. After they finish every level, we will ask the participants an interview about their experience and what each sound of the level was, to validate if they can identify it and how immersed they felt they were.

We were able to detect that visual cues without sounds are not enough to identify distincts elements through the game and the game experiences does vary if the player is playing with sound or not.

2. BACKGROUND

2.1 *Dark Echo*

The game we choose to make the experiment is Dark Echo, this is the game developed by the two members team Rac7. *Dark Echo* released in 2015, but originally it was a project of game jam Ludum Dare 48 hours and the theme is “You Must Escape”. During the game the player will be set in a totally dark area, the player could use the visualized sound to explore the environment and find the way out, at the same time there are many dangerous things hiding in the darkness whether the traps or the chase from the monster.

2.2 Why *Dark Echo*

The control of *Dark Echo* is very simple, and it has only four categories: Walking, Running, Clap and Throw, which are able to fulfill the needs of the player when they are facing different situations. Walking allows the player to move slowly without making a lot of noise; running allows the player to move quickly but make noise and the monsters will notices; clap allows the player to make a really large noise and to see a wider area of the current environment; throw allows the player to throw some objects and create some noise at the far distance. Because of these simple controls, the learning curve of this game is very low. We were able to invite people from different gaming backgrounds to attend our experiments. At the same time it will also reduce the learning time of participants to get familiar with the game which means the participants could get involved quickly. The minimalist design of the game was very helpful in our experimental study. Because of it, simplified control and visual design allowed us to manipulate the variables easier

and explore the relationship between sound and immersion in such a direct way.

3. RELATED WORKS

Game Experience Questionnaire

We adapted our survey based on the *Game Experience Questionnaire* (GEQ) developed by IJsselsteijn et al. [1]. This is a validated instrument that can be used to measure the players' gaming experience in different aspects of games. It covers immersion, fluency, tension and enjoyment, which are considered in the paper as one of the key references used to understand player satisfaction and emotional engagement. By using the GEQ researchers could quantify the usability and immersion and calculate the factors that will have important influence. The Core Module is GEQ which covers immersion.

We picked the questionnaire's Core Module for our study. By using this tool we were more easily to get the quantifiable subjective data of feelings from the players and find out the relationship between the sound and immersion. (See Appendix for survey questions used for our experiment.)

Game Audio and Immersion

Scholars studying gameplay immersion agree that audio enhances this experience. Immersion can be divided into three base categories: sensory, challenge-based, and imaginative [2]. All these work in collaboration to create a sense of immersion where players feel like they are being taken to a different space, feeling highly invested in the current task and narratives.

It is important to note that immersion is not absolute and it may change for the player over time. We took this into consideration while collecting and analyzing our data since we may see inconsistency in the responses given by different players or even by the same player.

The Impact of Ambient and Character Sounds

In *Dark Echo,* the ambient sound of an empty, echoing cave or spacious environment is constantly present. When the player takes actions such as walking, running, and throwing objects, different sounds are played accordingly. When the player walks into different spaces such as water or on the wooden floor, the sound effects also change. In addition, when the player character dies by interacting with a red object, a terrifying scream is played to remind the player of its danger. All these components help shape the environment and create a strong sense of immersion for the player by giving them timely feedback and environmental context.

In addition, sound can further create a sense of flow for players as they navigate through the game space. Luise Haehn et al. [3] investigate the influence of ambient and character sounds on player engagement and immersion. Their results show that sound does really influence the players' experience and flow while playing video games.

Influence of Sound Design

When we talk about how the sound works in games, we need to know that sound encompasses both ambient, effect, and character sounds. Different sounds can contribute to the

different aspects of immersion which we mentioned in the previous section: the ambient sounds contributing to sensory, effect sounds contributing to challenge-based, and character sounds contributing to imaginative enhancement. Haehn, Luise [4] in 2023 showed that character voices enhanced character recognition, while ambient sounds did really increase immersion, but to a certain extent ambient sounds may have weakened the function of character voices.

Getting back to *Dark Echo*, the developer has put less character sounds in the game, instead the majority of the game sound is ambient, which build an atmosphere that easier for the player bring themself into the game.

Informative Sound Design

Sound is a medium that could contain information just like words and images, and it also plays an important role in game design. In *Dark Echo*, sound provides the player with key information about the environment, allowing the player to imagine scenes in their mind by combining sound with game visuals. For example in *Dark Echo*, swarms of flies in the air, the hissing of monsters chasing players, etc. Patrick Ng and Keith Nesbitt [5] argue that sound can be used as a complementary tool to visual feedback, which can materialize or enrich the objects in games, and improve the player experience and game performance.

To recognize objects in *Dark Echo* is also one of the most important parts we use to measure player immersion.

4. METHODS

4.1 Overview

In this study, we aimed to examine how the presence or absence of sound affects players' ability to identify in-game elements and their overall sense of immersion. To achieve this, participants were divided into two groups: one playing the game *Dark Echo* with sound enabled, and the other playing under silent conditions. The primary independent variable in this experiment was the presence of sound, whereas the main dependent variables included players' accuracy in identifying in-game objects and their self-reported levels of immersion, concentration, boredom, and confusion, as collected through subsequent surveys. Detailed procedures, including participant recruitment, apparatus setup, and data collection methods, are outlined in the following sections.

4.2 Participants

Random volunteers are recruited in the common space of a community lounge. Their ages range between 20 to 34 years old. A total of 8 subjects partook in this experiment.

4.3 Apparatus

One touchscreen iPad is used for both gameplay and survey creation. Participants all did the experiment in the same enclosed, quiet room, reducing environmental variations.

Figure 1: The Experiment Environment and Setting

4.4 Procedures

Participants are invited to conduct an experiment about video games. They are first given a brief introduction to *Dark Echo* and informed that they will do short interviews and surveys in this research. Minimal information about the game's context is mentioned during this beginning phase to ensure no bias is introduced to the audience.

Participants then answer some basic background questions about their age, gender, and whether they play video games on any platform (phone, PC, console, arcade, etc). All this information is collected and combined with each participant's survey data.

Participants then proceed to play the game for 10-15 minutes. After they finish each level, while the memory is still fresh, we ask participants to look at images of objects that appeared in the most recent level and identify them based on their gameplay knowledge. Answers are recorded for future analysis.

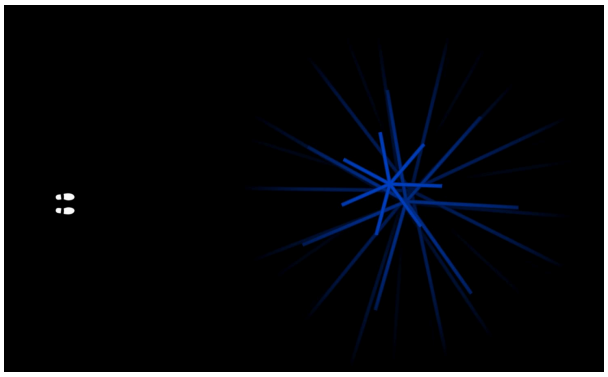


Figure X: Level VX of *Dark Echo*

Finally, participants finish playing the selected levels and fill out a survey featuring their user experiences.

Once this process is completed, information about the actual intent of the experiment is shared with each participant and they are thanked for their contributions.

4.5 Data Collection and Analysis

Data is collected through both in-person short interviews for quick answers and digital surveys. Raw survey data is composed of 13 questions that inquire about the user experience adapted from *The Game Experience Questionnaire*.[1] The complete survey questions can be found in the Appendix.

Participants answer questions that reflect their overall gaming experience. They are asked to rank their opinion from 1 to 5 where 1 is "not at all" and 5 is "extremely."

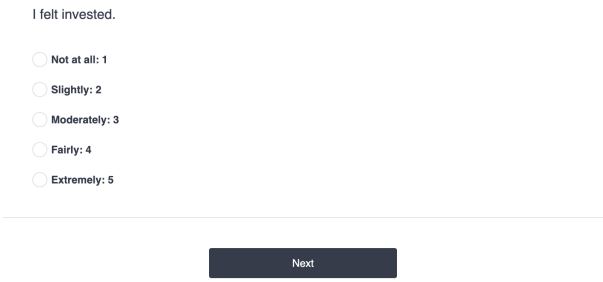


Figure X: A Screenshot of the Survey

During this experiment, participants are asked to identify unique objects in the selected levels they played in the game through simple verbal descriptions. Their answers are then manually verified by the researchers to determine whether they have correctly identified the objects. For instance, someone who answers "doors" or "exit" will be marked as correct based on the game's intended design whereas an answer like "bushes" will be considered incorrect.

5. RESULTS

5.1 Demographics Overview

The table below shows the breakdown of the participants' backgrounds and demographics.

Age Average	Gender	Gamer
23.13	50% Male and 50% Female	50% Gamer and 50% non-Gamer

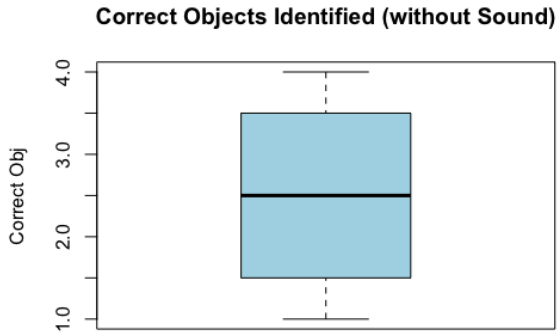
In our statistical analysis, we did not find a significant correlation between gender and player experience. Survey results given by gamers versus non-gamers did not vary much either across this category.

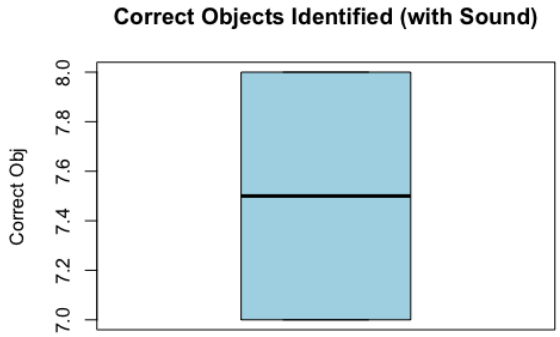
5.2 Objects Correctly Identified

There is a significant difference between the groups of participants when it comes to correctly identifying the in-game objects and environmental elements. We selected eight unique in-game objects for the participants to identify including:

1. Door
2. Trap
3. Monster
4. Water
5. Collapsing walls
6. Another person running by
7. Bugs
8. Switch that opens pathways

The answers participants gave may not be the exact wording as the ones given, but correct answers tend to be similar and are cohesive with the gaming context whereas random guesses vary significantly across participants.





For the group that played *with sound*, the mean for "correctly identified objects" is 7.5 whereas the mean for the group without sound is 2.5. The median is the exact same for both groups, with sound is 7.5 and without sound is 2.5.

We used t-test with Bonferroni correction to check for statistical significance between the two experiment groups: with and without sound during gameplay.

H_0: There is no statistical difference between the sound and without groups.
H_a: There is a statistical difference between the sound and without groups.

Based on our calculations, the fields that yield statistical significance are:

1. Bored
2. Concentrated
3. Confused
4. Distracted

	key	group1	group2	n1	n2	p	p.adj	p.adj.signif
	<chr>	<chr>	<chr>	<int>	<int>	<dbl>	<dbl>	<chr>
1	Aesthetics	0	1	4	4	0.129	1	ns
2	Bored	0	1	4	4	0.00114	0.0148	*
3	Concentrated	0	1	4	4	0.0428	0.556	ns
4	Confused	0	1	4	4	0.000161	0.00209	**
5	Distracted	0	1	4	4	0.0182	0.237	ns
6	Fun	0	1	4	4	0.2	1	ns
7	Immersed	0	1	4	4	0.0973	1	ns
8	Intense	0	1	4	4	0.0667	0.867	ns
9	Invested	0	1	4	4	0.19	1	ns
10	Irritated	0	1	4	4	0.182	1	ns
11	RichExp	0	1	4	4	0.121	1	ns
12	Skillful	0	1	4	4	0.178	1	ns
13	Tiresome	0	1	4	4	1	1	ns

Figure X: Raw t-Test Values

We fail to conclude that sound greatly impacts the other parts of the gaming experience.

6. DISCUSSION

Our findings highlight the pivotal role that sound plays in shaping the player's experience within *Dark Echo*. Overall, participants who played with sound more accurately identified in-game objects and reported feeling less confused, more focused, and less bored. Although we anticipated that sound might enhance immersion, statistical analysis did not reveal a significant effect on this aspect of gameplay. Similarly, sound did not appear to influence skill-based outcomes. These results suggest that while audio cues are valuable for guiding players and mitigating confusion, their impact on deeper experiential factors like immersion and skill acquisition may be more limited than initially hypothesized.

6.1 Sound Reduces Confusion and Provides Better Gameplay Guidance

Sound helps correctly identify objects

Players are less confused about game context and environment. They can navigate the space more easily and understand what they're doing and where they go.

6.2 Sound Improves Player Concentration and Reduces Boredom

In addition to enhancing object recognition, the presence of sound also improved participants' overall focus and reduced feelings of boredom. Players reported that the auditory feedback and ambient soundscapes drew their attention into the game world, helping them concentrate more fully on the tasks at hand. This heightened engagement manifested as a decrease in distractions—participants were less likely to think about external factors or feel restless during gameplay.

Without sound, participants often commented that they lost track of their objectives more frequently and found the experience less stimulating. The absence of audio cues led to moments of disengagement and decreased excitement. In contrast, when players were guided by sound, they remained more immersed in the game's unfolding narrative and challenges, contributing to a more enjoyable and sustained level of involvement throughout the play session.

6.3 Sound Does Not Significantly Impact Immersion

Contrary to our initial expectations, the presence of sound did not produce a statistically significant increase in immersion. Although participants who played with sound displayed improved object recognition and a reduction in confusion and boredom, these benefits did not

translate into heightened feelings of being "in the game." The quantitative measures of immersion—drawn from self-reported survey responses—showed no meaningful difference between the group that experienced full audio feedback and those who played in silence. This suggests that immersion, as a complex, multifaceted experience, may not be solely or directly influenced by auditory cues, but rather by a combination of factors including narrative depth, visual complexity, and personal player preferences.

6.4 Sound Does Not Affect Gaming Skills

While sound proved beneficial in guiding players and reducing confusion, it did not appear to influence their fundamental skill level or improve their performance at the game's core mechanics. The participants' ability to navigate challenges, solve puzzles, and avoid obstacles did not meaningfully differ between those playing with sound and those playing without it. This suggests that, although audio cues provide helpful context and may refine the player's decision-making process, they do not inherently enhance the underlying skill sets required for success in Dark Echo. Instead, gaming proficiency seems to remain relatively stable, regardless of the auditory environment.

7. LIMITATIONS AND FUTURE WORK

The sample size is clearly too small. Our sample size is 8 whereas it needs to be at least 20 for us to assume its normal distribution. So, in the future, the sample size needs to be further expanded. We did manage to gather all the data from individuals not affiliated with game design professionally so the backgrounds of participants are at least decently diverse.

Other factors other than sound might have affected our experiment's results. At least two of the participants admitted that they prefer games with more colorful visuals than simple puzzle games like *Dark Echo*. So, it appears that participants' previous gaming experiences and tastes could influence the survey results and they may be biased as to how immersed they are during gameplay regardless of the presence of sound.

We designed the gameplay to be 10-15 minutes for each participant. We speculate that this may be a bit too short since they have to learn the controls and experience the game while identifying objects at the same time. We would recommend increasing gameplay time for the participants to gain a better grasp of the game and experience it a bit longer for the immersion and fun to be fully processed.

8. APPENDIX

Survey questions:

1. I felt invested.
2. I felt immersed.
3. I felt skillful.
4. I thought it was fun.
5. I get distracted and think about other things while playing the game.
6. I found it tiresome.
7. I felt confused and wasn't sure what I was doing.
8. The game was aesthetically pleasing.
9. I forgot everything around me.
10. I felt bored.
11. I felt irritated.
12. It felt like a rich experience.

13. I felt the intensity and pressure.

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