Accessible Gaming Through Better Captions: A Study on Captions Preferences and Inclusivity of Deaf and Hard-of-Hearing Players

Wajdi Aljedaani
wajdi.aljedaani@unt.edu
University of North Texas

Marcelo M. Eler
marceloeler@usp.br
University of São Paulo

Lorene E Keeland
lorenekeeland@my.unt.edu
University of North Texas

Hamed Jalali
hamedjalali@my.unt.edu
University of North Texas

Khaled Al-Raddah
k.alraddah@seu.edu.sa
Saudi Electronic University

Mohamed Wiem Mkaouer
mmkaouer@umich.edu
University of Michigan-Flint

ABSTRACT

The increasing popularity of video games has fostered the accessibility demands for a wider range of players, including people who are deaf or hard of hearing (d/Deaf). Recent studies manifested that caption practices in video games are essential for providing an inclusive gaming experience for d/Deaf players. However, there is a lack of consistent caption practices in video games, which can make it difficult for d/Deaf players to understand the audio-visual content. This study highlights the importance of standardized captions in video games for deaf and hard-of-hearing individuals. To do this, we conducted a survey-based study with 73 deaf and hard-of-hearing individuals to collect participants' preferences and feedback on caption practices and the need for consistency. The open-ended comments from participants revealed interesting feedback regarding caption styles and valuable feedback on a variety of caption appearances. We also provide comprehensive captioning best practices for video game developers based on user preferences. This work contributes to the literature by providing an opportunity for researchers and the gaming industry to improve the accessibility and usability of gaming captions for players with hearing impairments.

CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in accessibility**; **Empirical studies in interaction design**; **HCI design and evaluation methods**.

KEYWORDS

Captions, Accessibility, Deaf/deaf and Hard-of-Hearing, Video games

ACM Reference Format:
Wajdi Aljedaani, Marcelo M. Eler, Lorene E Keeland, Hamed Jalali, Khaled Al-Raddah, and Mohamed Wiem Mkaouer. 2024. Accessible Gaming Through Better Captions: A Study on Captions Preferences and Inclusivity of Deaf and Hard-of-Hearing Players. In *The 21st International Web for All Conference (W4A '24), May 13–14, 2024, Singapore, Singapore.* ACM, New York, NY, USA, 12 pages. https://doi.org/10.1145/3677846.3677858

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W4A '24, May 13–14, 2024, Singapore, Singapore
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ACM ISBN 979-8-4007-1030-8/24/05
https://doi.org/10.1145/3677846.3677858

1 INTRODUCTION

Video games have attained a prominent position in contemporary entertainment, receiving widespread recognition on a global level since the inception of its industry in the 1970s [39]. The use of video games for purposes beyond entertainment is also on the rise [20, 63]. For instance, educational institutions are increasingly exploring the cognitive benefits of video games in educational settings [21, 27, 28, 40, 51]. Although video games are popular among many user profiles, people with diverse abilities are often excluded from the inclusive experience due to accessibility barriers [23, 35, 57, 60].

The worldwide number of active game players is projected to increase from 3.09 billion in 2023 to 3.32 billion in 2024, a growth of 23 million [37, 55], among which many have some impairment. For instance, Games [30] reported that more than 20% of game players have some impairment, and Baltzar et al. [12] reported that one-third of video game players face accessibility issues due to some form of disability. In addition, Beeston et al. [14] surveyed 154 participants with some degree of impairment and found out that a significant proportion (62%) identified themselves as gamers; for many of them (56%), video games are their main hobby.

In particular, people who are deaf or hard of hearing (d/Deaf) make up between 15% and 20% of the population in America [32, 59], ranking as the sixth most prevalent chronic medical condition [44]. Furthermore, the World Health Organization (WHO) has projected that the d/Deaf community will account for 25% of the global population by 2050 [48]. This projection highlights the importance of accessibility in video games for the d/Deaf community, especially when it comes to captioning features.

Under this consideration, this study explores captioning standards in video games for the d/Deaf community. More specifically, we aim to understand users' preferences for different caption designs and to identify best captioning practices in video games, thus contributing to improving accessibility for players with hearing impairments. We conducted a survey to gather feedback from a large number of participants (including d/Deaf and non-hearing impairment community) about their needs and preferences for better caption style, format, and timing in video games. We also asked participants about their experiences with captions in video games and how captions could be improved. The survey results provide feedback for existing caption designs to improve their accessibility

and user-friendliness in video games. The survey is guided by the following research questions (RQs):

RQ1: What type of video gaming captioning style should we use? (e.g., Drop Shadow, Stroke, Black Box, Semi-Transparent Box, or no preference.

RQ2: Which font do you prefer when viewing gaming captions? (e.g., font size: Small - 16pt, Medium - 20p, Large - 24pt, Extra Large - 28p, font type: Serif, Sans Serif, Handscript Print, Handscript Cursive, font weight: Normal, Italicized, Bold, font color: White, Yellow, Blue, Black, Character Identification: Names & Colors, Names, Colors, Hyphens & Names, Hyphens.).

RQ3: How many lines of captioning should be shown on the screen when playing video games? (e.g., 1, 2, no preference, or others).

RQ4: Do d/Deaf players believe that standardized guidelines for Captioning are a necessity?

The remainder of the paper is structured as follows. Section 2 discusses related work on captioning video games. Section 3 presents our study design, while Section 4 shows and discusses the results. Section 5 outlines the best captioning practices inferred from the results of this investigation. Section 6 presents some concluding remarks and future directions.

2 RELATED WORK

This section discusses the related work concerning caption practices and their standardization.

Several studies were conducted on deaf or hard of hearing (d/Deaf) in various aspects such as learning management system (E-learning) [2–5], mobile app [6, 8], and user reviews [7, 9, 10, 29]. Video game player satisfaction is highly influenced by the inclusion of captions in video games [24]. However, the captioning practices in the gaming industry are still in the early stages of development, and there are no universally accepted standards for captions in games [36, 49]. Griffiths [34] proposed sixteen professional guidelines for captioning in video games, but they were too vague. For example, the guideline on font size simply stated that the font should be "large" but did not specify an exact size. This lack of specificity makes it difficult for developers to follow the guidelines and create captions that are effective and unobtrusive [45].

Mangiron [46] argues that game developers often overlap the Captioning standards used for TV programs, DVDs, and cinema movies. However, Sajna [52] points out significant differences between games and other multimedia content, such as their interactive and multi-semiotic nature [22]. Furthermore, clear and consistent character identification in captions is crucial for comprehension in games with multiple characters engaged in conversations [11]. Games may not offer the same level of assistance as TV shows or movies that often utilize camera angles to provide visual cues.

Therefore, to enable players to accurately follow dialogues and prevent confusion, it is vital to implement effective character identification [22]. A survey study [54] found that participants were bothered by different aspects of captions, such as font, size, length, background, and timing. Another concern is the very limited access to sound cues in video games for the d/Deaf community, which can be a barrier to their enjoyment of the medium [25]. In summary, the literature search revealed a lack of systematic and structured guidelines to achieve true accessibility in video games [33]. This suggests a pressing need for standardization in captioning practices in the gaming industry. Accordingly, the survey we proposed is conducted to analyze the guidelines for captioning practices in video games for players, especially the d/Deaf gaming community.

3 MATERIALS AND METHODS

In this section, we provide an overview of the methodology followed in our study, information about the participants, the data collection process, and the data analysis.

3.1 Study Approach

This study aims to understand users' preferences for different caption designs in video games and to devise standard guidelines for inclusive captioning in video games. Therefore, we designed a survey [41] intended to discover more about the perspectives of d/Deaf players who play video games. This survey integrates qualitative as well as quantitative approaches. The qualitative approach combines descriptive and exploratory aspects. The descriptive aspect provides insights into the usability of captions in video games by d/Deaf players, while the exploratory qualitative aspect aims to determine standard guidelines for captioning in video games through user experiences. The direction provided by Kitchenham and Pfleeger [42] guided the survey approach in this study.

3.2 Survey Design

We designed a survey to discover insights on the usability of captions in video games. The survey covers the following aspects: (i) participants' experience with captions in video games, (ii) participants' preferences for caption style and format, (iii) the need for standardized captions in video games, and (iv) standard guidelines for captioning in video games for enhanced accessibility.

The survey (41 multiple choice and 7 open-ended questions) was designed using Google Forms[1]. To ensure that participants could provide informed responses, the survey used a series of images to illustrate the different caption characteristics [1]. The survey was organized into nine sections: *Section I* user consent, *Section II* survey training, *Section III* demographic questions, *Section IV* questions about gaming experience, *Section V*, questions about gaming experience with captions. *Section VI* caption appearance. *Section VII* questions about caption content. *Section VIII* participants' color preferences for captioning practices.

The survey questions were designed based on the findings of the literature review. Griffiths [34] proposed sixteen guidelines for captioning in video games, but these guidelines were based on the captioning practices for TV, movies, and DVDs and did not take into account the unique challenges of captioning in video games. Mangiron [45] identified several issues with the current captioning practices in video games, such as the use of inadequate font colors, sizes, lengths, and timing. Sciberras [54] also found that current video game captioning lacks standard font color, size, and length. Table 1 shows in detail the characteristics we integrated into our survey questions for further analysis.

The survey questions were also initially based on the gaming and captioning experience of the respondents. Subsequent questions

[1] https://www.google.com/forms/about/

Table 1: Characteristics evaluated in the study.

Characteristic	Description	RQ
Text Contrast	Different types of contrast between text and background were evaluated. Techniques included Drop Shadow, Stroke, Semi-Transparent Box, No Text Contrast, and Black Box.	RQ1
Font Weight	Text weight was assessed using Normal, Bold, and Italicized font weights.	RQ2
Font Style	Different font types, including Serif, Sans Serif, Hand script Print, and Hand script Cursive, were assessed.	RQ2
Font Size	Different font sizes (Small-16pt, Medium-20pt, Large-24pt, and Extra-Large-28pt) were compared for their effects on caption readability.	RQ2
Caption Colors	Influence of White, Black, Yellow, and Blue caption colors on readability were assessed.	RQ2
Character Identification	Several methods for character identification were utilized, including Colors, Names, Names and Colors, Hyphens, and Hyphens and Names.	RQ2
Color Combination	Impact of contrasting caption colors, specifically pairs of White and White (No contrast), Blue and White, Yellow and White Blue, and Yellow, were also studied concerning character identification.	RQ2
Line Length	Line length were evaluated using single-line and double-line captions.	RQ3

were asked about respondents' preferences for captioning, such as font weight, size, style, background, and length. We presented these preferences in the form of images to make them easier for respondents to understand and to facilitate data analysis[2] [1]. Participants were allowed to make multiple selections. We further outline the motivation behind each caption characteristic in Table 2.

We designed the most suitable options for the captions by referring to the predominant choices mentioned in the literature. For example, the literature [45] suggests that white is the most common caption color, with yellow being used less frequently. Therefore, we mainly used white captions for other characteristics but presented different colors when asking about the preference for the caption color. Similarly, the font sizes were set to 16, 20, 24, and 28 points based on the guidelines provided by BBC [13]. Small font sizes were not considered, as Deryagin [25] found that they are ineffective and can cause eye strain. We selected the font sizes that were preferred rather than simply eliminating those that were considered unsatisfactory. When choosing colors, we selected those that have been shown to be effective in previous captioning scenarios [43]. When considering the length of the caption, we did not exceed two lines since it is not recommended in the literature [13, 53, 62, 64].

[2]https://wajdialjedaani.com/W4ALL_Captioning/

3.3 Data Collection, Participants, and Analysis

Participants in our experiment were selected using convenience sampling techniques from within a community of Deaf and Hard-of-Hearing people who belong to networks connected to the authors of this study. In total, (73) Deaf and Hard-of-Hearing participants took the online-based survey over a period of four months. Their responses were received and organized for further analysis. In this survey, we collected quantitative and qualitative data from participants. The qualitative data were analyzed by two researchers using agreeable themes, whereas the quantitative data were analyzed using statistical techniques.

4 STUDY RESULTS

In our study, participants were asked about their preferences regarding a range of captioning styles, including text contrast, font weight, font type, font size, caption length, character identification, and caption color. These options were further broken down into detailed characteristics for a more granular analysis. To gain a deeper understanding of participants' preferences, they were asked to rate each option based on the following criteria:

Option 1 *Can read the text perfectly with ease:* This option indicates that the participant found the text to be easy to read and understand.

Option 2 *Cannot read the text:* This option indicates that the participant found the text difficult or impossible to read.

Option 3 *The text is difficult to read but doable:* This option indicates that the participant found the text difficult to read, but they were able to understand it with some effort.

This section is divided as follows: Section 4.1 Users' Preference of Captioning Style, Section 4.2 Users' Suggested Font Type, Size, and Weight, Section 4.3 Preferred Number of Captioning Lines, and Section 4.4 Importance of Standardizing Guidelines for Captioning.

4.1 RQ1: Preference of Captioning Style

In our study, participants were presented with various text contrast options, namely *Black Box*, *Semi-Transparent Box*, *Drop Shadow*, *Stroke*, and *No Text Contrast*, visual representations of which were depicted in Figure 1. They were also encouraged to share feedback on their selections. The overall popular choices for text contrast emerged as Semi-Transparent Box and Black Box, with a preference shown by 31.4% and 31% participants, respectively. The Drop Shadow option was favored by 25.2% of the participants, followed by Stroke (10.2%) and No Text Contrast, which was preferred by a minority of 2.07% participants as shown in Figure 2 (A).

The breakdown of these results is summarized in Table 3. This detailed feedback revealed that the majority of participants found the captions with Black Box and Semi-Transparent Box easily readable. However, the No-Text Contrast option presented readability issues, with a significant portion of participants finding the text difficult to read. The survey results revealed that participants had similar preferences for all captioning characteristics. *Semi-Transparent Box* was the most popular choice, as it was easy to read and did not distract. *Black Box* was also popular, but some participants found it distracting and bulky:

Table 2: Motivation behind the survey questions related to each caption characteristic.

Characteristic	Motivation	Reference
Text Contrast	The lack of text contrast is a major problem in video game captions, making them unreadable for many players. This question outlines the widespread readability issues caused by a lack of text contrast and highlights various ways to improve text contrast and user reception.	[19, 58, 63]
Font Weight	Font weight is an important consideration for video game Captioning, as it can be used to give specific text emphasis or to convey the game's theme. By gauging users' perceptions and preferences for font weight, developers can create readable and visually appealing captions.	[19, 45, 50, 63]
Font Style	In-game development, aesthetics often precede practicality during the selection process of caption fonts, which may compromise readability for a fraction of players. By gaining insights into players' preferred font types and their consequential impact on legibility, developers have the potential to design captions that harmoniously blend visual allure with readability.	[19, 38, 47, 61, 63]
Font Size	Ensuring an optimal font size remains sufficiently legible without monopolizing screen real estate is vital for an encompassing user experience. A variance in user preferences exists, with some favoring more prominent typography, while others lean towards more diminutive fonts. By asking users their preferences, developers can curate captions that universally enhance readability and satisfaction.	[19, 61, 63]
Caption Colors	Using colors in captions can be helpful for readability, but it is important to choose the right colors. The goal is to make captions easy to read and understand without being visually overwhelming. This analysis will assist developers in creating captions that are both readable and visually appealing.	[16, 17, 63]
Character Identification	Character identification is essential for Captioning video games, especially for d/Deaf players. It can be achieved through a variety of methods, such as colors, names, or hyphens. The best method will vary depending on the game and the user's preferences.	[18, 46]

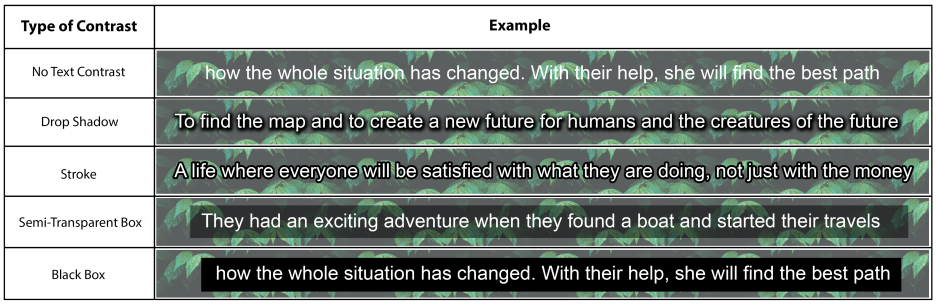


Figure 1: Illustrations of text contrast for each offered choice.

> ***Response:*** *"Easy to see the words and the semi-transparent box isn't so distracting "* ***P12***

> ***Response:*** *"Since the color of the captions may match with the colors in the background, having a box ensures that the text is readable. "* ***P33***

> ***Response:*** *"Black box is nice but can be too bulky at times thus blocking possible aspects on screen."* ***P58***

Some participants also preferred *Drop Shadow*, however, the drop shadow is a lighter color than the text, so it can blend in with the background, posing difficulty for the players to read captions. All text contrast options were criticized for breaking immersion to some degree, but the high preference for *Semi-Transparent Box* and *Black Box* for text contrast suggests that players prefer captions that are easy to read and do not blend in too much with the background. Our findings confirm the suggestions in the literature that using more contrast, such as a *Semi-Transparent Box* or *Black Box*, can improve legibility [64]. Moreover, it is evident from Figure 2 (A) that participants also highly preferred *Semi-Transparent Box* and *Black Box*:

> ***Response:*** *"I prefer boxes because they create enough contrast to read captions on any background."* ***P7***

Although the majority of participants preferred the *Black Box*, their feedback suggested otherwise. Some participants found the *Semi-Transparent Box* option more convenient because it did not block any background scenes:

> ***Response:*** *"the contrast is helpful and with the semi-transparent i can read the words better without worrying that i might be missing something"* ***P67***

4.2 RQ2: Suggested Font Type, Size, Weight, Color, & Character Identification

We investigated participants' choices of different captioning font types, sizes, weights, colors, and character identification when playing video games. We summarized our findings as follows.

4.2.1 Font Weight. Three different font weights, namely *Normal*, *Bold*, and *Italicized*, were presented to the participants to assess their preferences. The survey findings revealed that the majority of participants (61.64%) found *Bold* caption text to be easily readable while playing video games. In contrast, the percentage of participants

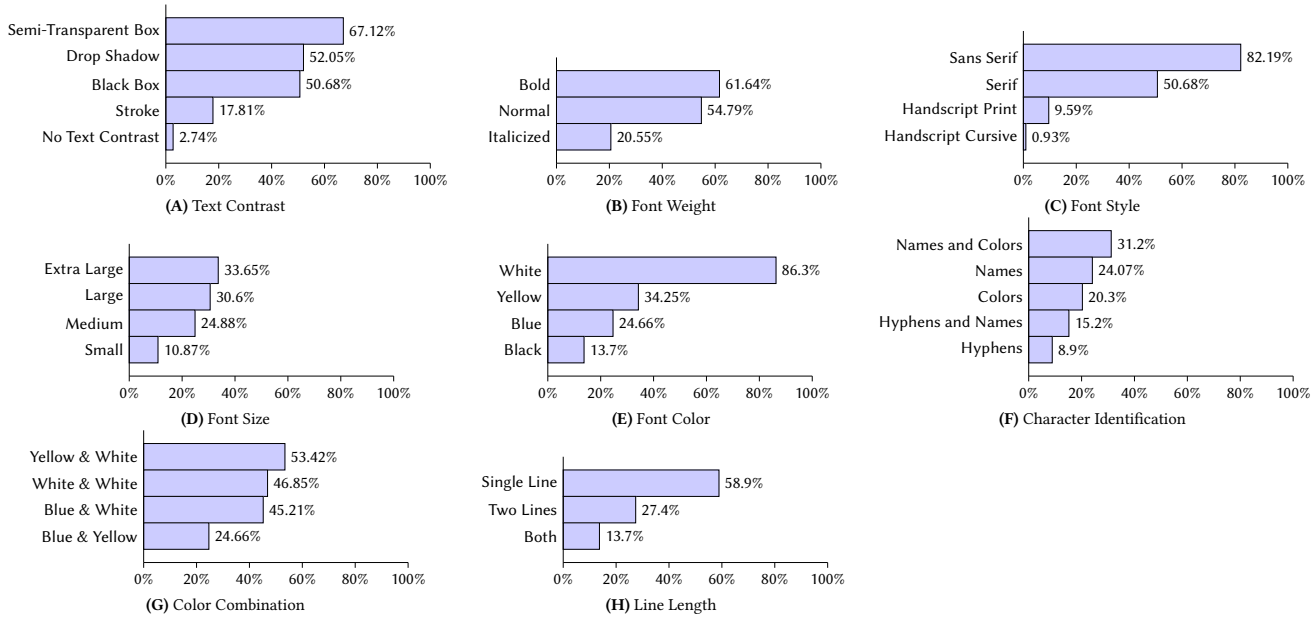


Figure 2: Present the participants' responses to preferences for each category.

Type	Example
Normal	But there is a new hope! A new technology has been discovered by a young scientist
Bold	**But the Martians want to attack the earth before the earth can develop the technology**
Italicized	*But there are lots of obstacles left to be overcome before he can get his discovery*

Figure 3: Illustration of font weight for each offered choice.

who favored *Normal* caption text was 54.79%, while the remaining participants preferred *Italicized* text as shown in Figure 2 (B). Our analysis revealed some similarities in participants' preferences, as shown in Table 3.

Overall, feedback from the participants revealed that font weight should be used in moderation, either for utility or for storytelling purposes. Most participants preferred *Bold* text because it is easier to read. *Italicized* text can make reading difficult because it narrows the letters. *Normal* text, on the other hand, blends in with the background, making it more challenging for players to read. Figure 2 shows the preferences of participants for font weight. The preferences are somewhat similar, with the majority of participants preferring *Bold* font weight:

> ***Response:*** *"Bold is better because it makes the text slightly bigger. I was able to read all of the text but bold is better."* ***P19***
>
> ***Response:*** *"Bold draws attention to the captions so that they are not easily overlooked."* ***P71***

Additionally, font weight can be used to emphasize different types of dialogue. Some participants suggested using font weight to identify character names or narrative dialogue, while others suggested using it to convey the tone of the dialogue, such as whether it is a whisper or a yell:

> ***Response:*** *"Usually I think of italicized font as indicating a different character is speaking or something."* ***P28***
>
> ***Response:*** *"Bold and italicized both imply emphasis in different ways."* ***P10***
>
> ***Response:*** *"Normal should be the regular text for all captions, and bolded or italicized formats should be used for character names or narrative dialogue rather than dialogue spoken by a character."* ***P36***

Participants also noted that using font weight for the entire caption can make it difficult to read. It is evident from the survey results that font weight can be a useful tool for captions, but it is important to use it in moderation and to consider the context of the dialogue.

4.2.2 Font Style. Figure 4 shows the font type choices offered to participants. Survey results showed that the majority of the participants preferred *Sans Serif* font over *Serif* *Handscript Print* and *Handscript Cursive* fonts as showcased in Figure 2 (C). The survey also found that Handscript Cursive was the least readable font style for captioning in video games. Table 3 shows the participant's responses to each option. While the majority of respondents preferred *Sans Serif* font style, there was a proportion of respondents (4.11%) who could not read the captions in this font style.

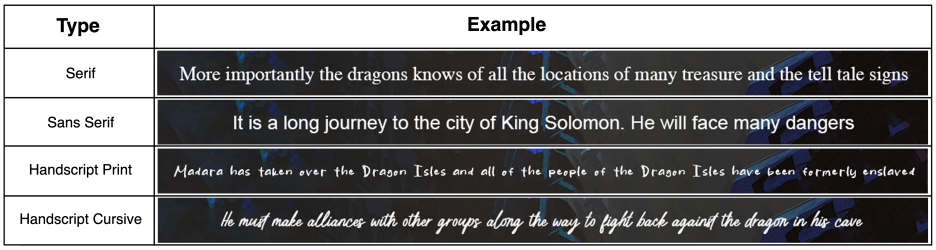


Figure 4: Illustration of font type for each offered choice.

Table 3: Survey results of the captioning characteristics.

Category	**Text Contrast**		
	Option 1	**Option 2**	**Option 3**
No Text Contrast	3 (4.11%)	22 (30.14%)	48 (65.75%)
Stroke	22 (30.14%)	6 (8.22%)	45 (61.64%)
Drop Shadow	44 (60.27%)	3 (4.11%)	26 (35.62%)
Semi-Transparent Box	60 (82.19%)	3 (4.11%)	10 (13.70%)
Black Box	67 (91.78%)	4 (5.48%)	2 (2.74%)
Category	**Font Weight**		
	Option 1	**Option 2**	**Option 3**
Normal	58 (79.45%)	4 (5.48%)	11 (15.07%)
Bold	61 (83.56%)	3 (4.11%)	9 (12.33%)
Italicized	44 (60.27%)	5 (6.85%)	24 (32.88%)
Category	**Font Style**		
	Option 1	**Option 2**	**Option 3**
Serif	37 (50.68%)	6 (8.22%)	30 (41.10%)
Sans Serif	60 (82.19%)	3 (4.11%)	10 (13.70%)
Handscript Print	2 (2.78%)	32 (44.44%)	38 (52.78%)
Handscript Cursive	5 (7.04%)	47 (66.20%)	19 (26.76%)
Category	**Font Size**		
	Option 1	**Option 2**	**Option 3**
Small (16pt)	11 (15.28%)	15 (20.83%)	46 (63.89%)
Medium (20pt)	43 (59.72%)	6 (8.33%)	23 (31.94%)
Large (24pt)	60 (83.33%)	2 (2.78%)	10 (13.89%)
Extra Large (28pt)	66 (91.67%)	2 (2.78%)	4 (5.56%)
Category	**Caption Color**		
	Option 1	**Option 2**	**Option 3**
White	61 (83.56%)	3 (4.11%)	9 (12.33%)
Black	5 (6.85%)	21 (28.77%)	47 (64.38%)
Yellow	33 (45.83%)	12 (16.67%)	27 (37.50%)
Blue	38 (52.78%)	9 (12.50%)	25 (34.72%)

Note: Option 1: I can read them perfectly with ease. Option 2: I can not read them. Option 3: They are difficult to read but do-able.

Analysis of survey results revealed that *Handscript* fonts, including *Hnadscript Print* and *Handscript Cursive* are not ideal for captions, as they can be difficult to read and understand. Participants believed that captions should be bold, which is not possible with *Handscript* fonts. Moreover, *Handscript* fonts would add more difficulty for people who rely on captions. Figure 2 (C) shows that participants least preferred *Handscript* fonts. This is evident from the fact that the *Handscript* font has the lowest percentage of participants who preferred it. They believed that they were too difficult to read and understand and could be a failure to accessibility:

> ***Response:*** *"I like how originality is used with the handwritten fonts, but it just doesn't work for me, and it especially may not work for people who genuinely need to have the captions or rely on them."* ***P5***
>
> ***Response:*** *"Never do hand script, ever. It takes mental energy to understand what the text is saying, which in my opinion, is a failure to the accessibility and readability of captions."* ***P44***

However, some participants thought that *Handscript* fonts could be used in small amounts of text to add visual interest. On the other hand, *Serif* and *Sans Serif* fonts were generally considered more readable, as they have a simple and clear design. Participants considered *Sans Serif* fonts to be easily readable because they lack visual noise and busy shapes:

> ***Response:*** *"I always prefer to read sans serif fonts whenever possible."* ***P2***
>
> ***Response:*** *"It was easily the most readable and natural."* ***P14***

The participant's preference for *Sans Serif* fonts suggests that they require captions that are easy to read and do not require additional mental effort. Furthermore, the ubiquity of *Sans Serif* fonts across multiple platforms makes them familiar and easy to read for players [15]. Moreover, the lack of serifs (the small strokes at the ends of letters) reduces visual clutter and makes the text easier to focus on.

4.2.3 Font Size. Figure 5 shows font size choices offered to participants, and Figure 2 (D) presents the participants' preferences for suitable font sizes for captions. A major portion (91.67%) of the participants preferred *Extra Large* font size, with (83.33% participants opting for *Large* font size (see Table 3). A total of 60 (83.33%) participants said they could read Large font perfectly with ease. Small font size was the least preferred font size, with 46 (63.89%) of participants saying that they found it difficult to read but still manageable.

The survey results also suggest that the font size of the captions should be large enough for most people to read them easily. *Extra Large* font size is the preferred font size for most people, but *Large* font size is also a good option. *Small* font size should be avoided, as most people find it difficult to read.

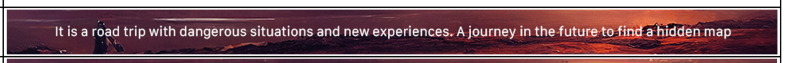
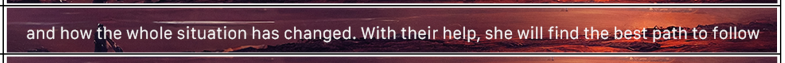
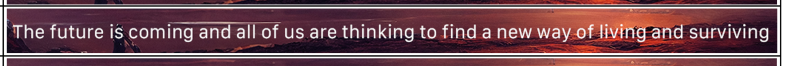
Type	Example
Small (16pt)	
Medium (20pt)	
Large (24pt)	
Extra Large (28pt)	

Figure 5: Illustration of font size for each offered choice.

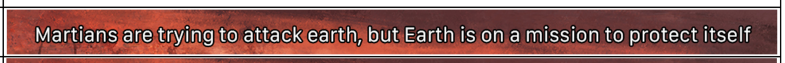
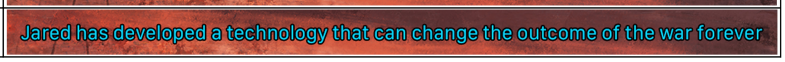
Type	Example
White	
Black	
Yellow	
Blue	

Figure 6: Illustration of font color for each offered choice.

4.2.4 Font Color. Figure 6 shows the font color choices offered to participants. Majority of the overall participants preferred *White* color for captions with *Black* caption color to be the least preferred option (see Figure 2 (E)). A total of 73 participants, of which 63 preferred captions in *White* color to be easily readable. *Yellow*-colored captions were the second most preferred choice of captions, with 34.25% of participants finding them easily readable.

Participants' preferences for caption color are consistent with the findings of other studies [31, 45, 56], which have stated that *White* text is generally easier to read than colored text. However, some participants found *White* captions difficult to read in scenes with high brightness levels:

> ***Response:*** *"White could possibly be a poor choice though in bright scenes or scenes with a lot of white where the captions would be."* ***P26***

This suggests that the background color can also affect the readability of the captions. Some participants also preferred colored captions, as they felt more eye-catching.

> ***Response:*** *"Showing captions with a different color to the scheme/background catches the reader's eye more efficiently."* ***P66***

However, other participants found that colored captions could be difficult to read, especially if the colors did not contrast enough with the background:

> ***Response:*** *"The yellow doesn't contrast enough, and the blue contrasts way too much. It just ends up sticking out and looking gross."* ***P18***

The survey results and participants' feedback showed that *White* is generally the preferred color for captions in video games. This is because *White* text has the most contrast with most backgrounds, making it the easiest to read [64]. Additionally, *White* text is not as distracting as colored text, which can be helpful in games where the player must focus on the action [56].

4.2.5 Character Identification. Figure 7 shows the character identification choices offered to participants. Survey results shown in Figure 2 (F) illustrate that *Names and Colors* was the most preferred character identification style, with 31.2% of participants choosing it. *Names* was the second most preferred style (24.07%), followed by *Colors* (20.3%). The styles featuring *Hyphens* were less popular since *Hyphens and Names* received 15.2% of participants' votes and *Hyphens* received 8.9% of participants' votes, which is comparatively much less.

Although the literature suggests that *Color* is the favored technique for character identification [64], the participants had mixed feedback on the use of only *Colors* for character identification. Some participants found them to be an easy and simple way to identify who was speaking, while others found them distracting or difficult to read. Using colors for character identification can introduce ambiguity and make it difficult to remember which character is speaking:

> ***Response:*** *"Colors are too distracting and requires some memorization."* ***P38***

> ***Response:*** *"I prefer reading the names of characters so I know exactly who is speaking. I also prefer a consistent font color. If the colors/hyphens only are used, and I am unsure of what voice corresponds to each character it can be hard to figure out which one is speaking at what time."* ***P14***

In contrast, d/Deaf players may find it difficult to know which character is speaking without additional cues, such as *Names*. The survey results showed that the participants preferred both *Names and Colors* for character identification. This allows players to quickly

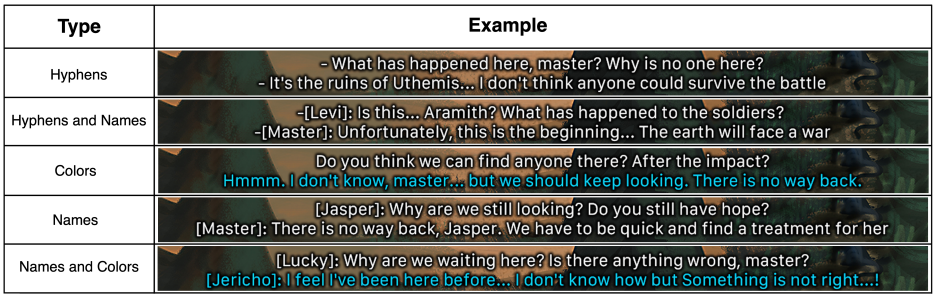


Figure 7: Illustration of character identification for each offered choice.

identify the speaker by the color of the text and then learn the characters' names over time [26]:

> ***Response:*** *"If there are two characters in the same scene talking, giving them captions with no elaborate way of showing or telling the reader that two different characters are speaking makes it hard for them to understand especially if the reader it's hard of hearing."* ***P35***

> ***Response:*** *"You get to see the name of who is talking, plus the color helps to differentiate them quickly."* ***P47***

4.2.6 Color Combination. We also asked participants which color combination they found most suitable for character identification. The results showed that *Yellow & White* was the most popular choice, with 53.42% of participants selecting it as the most appropriate color combination with no contrast. This is likely due to the fact that d/Deaf people rely more on visual cues to identify characters in video games. *White & White* and *Blue & White* were the second and third most popular color combinations, with 46.85% and 46.85% of participants choosing them, respectively. Such a combination (e.g., *White & White*) can be difficult to see for people with hearing loss, as it does not contrast much with the background. The *Yellow & Blue* combination was the least popular, with only 24.66% of participants voting for it (Figure 2 (G)). Therefore, we will focus on contrasting combinations, including *Blue & White*, *Yellow & White*, and *Yellow & Blue* for our analysis.

Further analysis of the results revealed that although *White & White* (no contrast) was the most selected color combination for character identification, d/Deaf participants highly preferred color combinations with contrasts such as *Blue & White* with *Yellow & White*. The participants preferred the presence of white in the color combination as long as the other color did not blend in with the background. This is because white is a very bright color that contrasts highly with most other colors. This makes it easy for players to read the captions, even on busy or dark backgrounds. However, using only white for the color combination was disregarded, as participants also preferred colors for character identification:

> ***Response:*** *"One color paired with white works fine, as long as it doesn't blend into the background."* ***P11***

On the contrary, *Yellow & Blue* combination is the least popular. This may be because it is difficult to read or because the colors do not contrast well. There were also concerns that the colors could blend into the background or be too contrasting, which could break immersion:

> ***Response:*** *"No contrast is just as bad as too much contrast (blue and yellow)."* ***P9***

> ***Response:*** *"Blue and yellow contrast too much with each other and too little with the background."* ***P12***

A high preference for the combination of yellow or blue with white suggests that the requirement for white to highlight or emphasize the other colors may be more universal. Participants preferred simple color combinations. This is because complex color combinations can be distracting and make it difficult to read the captions. This suggests that the combination should be easy to read and understand and provide a good contrast between the text and the background:

> ***Response:*** *"Keeping white kept it from being overwhelming."* ***P1***

4.3 RQ3: Preferred Number of Captioning Lines

Furthermore, we also investigated the number of lines for displaying captions on the screen when playing video games. Participants were asked to choose their preferred length of captions. They could choose either single-line, two-line, or both. The results showed that the majority of participants (58.9%) preferred single-line captions. Only 27.4% of the participants opted for two-line captions. The remaining participants opted for both options, as demonstrated in Figure 2 (H). Therefore, the majority of participants preferred single-line captions.

We also found that the number of caption lines can affect the amount of text a user perceives, even if the number of characters is the same. When analyzing the participants' feedback, there were multiple points of contention based on reading speed, eye movement, and distraction from the game content based on caption length. Many participants arguing for their preferred line length stated that they believed that the same feature was true for their preferred type. For example, one participant who preferred *Single-Line* captions said:

> ***Response:*** *"It is easier for me to quickly skim the contents of the captions when everything is on one line."* ***P22***

Another participant argued that a single line isn't enough and preferred *Two-Line* captions said:

> ***Response:*** *"I personally prefer two-line captions as they require less eye movement across the screen, speeding up reading comprehension."* ***P49***

Both statements suggest that the participants believe that their preferred line length makes it easier to read the captions. An additional argument from both sides was that their preferred line length was less distracting from the game content. One participant who preferred *Single-Line* captions said:

> ***Response:*** *"I find that two lines of captions can be more distracting, as I have to look back and forth between the two lines."* ***P55***

Another participant who preferred *Two-Line* captions said:

> ***Response:*** *"I find that single-line captions can be more distracting, as I have to scroll my eyes further to read the entire line."* ***P4***

While many participants preferred *Single-Line* and some preferred *Two-Line* captions, a significant portion of the respondents also stated that both had their merits. Some participants said that it depended on the flow of the scene, while others said it depended on the length of the sentences or the speed of the dialogue. However, the survey results showed a clear preference for *Single-Line* captions.

Finally, participants were asked about their preferences for character identification in captions. Participants generally did not prefer the use of *Hyphens* since they required too many context clues for d/Deaf players:

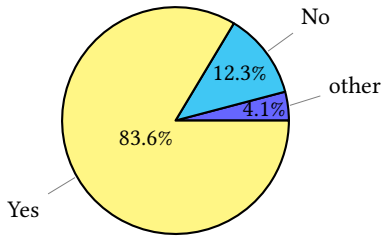
> ***Response:*** *"Hyphens require a lot more context clues if the player is hard of hearing. Even if not hard of hearing, deciphering voices can be difficult if the characters sound the same."* ***P64***

4.4 RQ4: Standardizing Guidelines for Captioning

Captioning is an intricate process that requires the consideration of several aspects, including font size, color, and type, along with the length and timing of captions. There is no standard approach to captioning, and what works well for a particular game may not serve well for another. To ensure that captions are comprehensible, readable, and available to all players, standards in Captioning are needed. It can help ensure that captions are consistent across games, which is useful for people who play several games. To create and implement captioning standards that satisfy gamers' expectations, this **RQ4** investigates the need for captioning standards.

Figure 8 presents the results of the survey question "Should there be standards in the way captions are presented in video games?". The majority of the participants $n = 61$ (83.6%) were in agreement with the existence of captioning standards in video games. On the other hand, $n = 9$ (12.3%) participants responded with "No", showing disagreement, and the remaining participants $n = 3$ (4.1%) responded with "Other".

Moreover, Figure 8 showcases that a majority of participants believe that there should be standards in place to ensure that captions are clear, readable, and accessible to all players. The results also highlight the difference in positive responses between d/Deaf participants. For example, consisting of d/Deaf respondents, were more likely to support captioning standard practices in video games. Not surprisingly, the fact that participants were more likely to support captioning standards suggests that d/Deaf players may be more directly impacted by the lack of standardization in this area.



(Q) Should there be standards for subtitles in video games?

Figure 8: Participants' responses to standardized subtitling guidelines in video games.

In general, the participants who responded with "Other" and provided their personal feedback to the survey question had different opinions. For instance, one participant believes that captioning standards should be flexible and adaptable to the specific game and its style/aesthetic:

> ***Response:*** *"It really depends on the video game and it's style/aesthetic. Personally I do not believe there should be any standards on captions other than that they should represent what the character(s) actually say, mean, and do."* ***P39***

Some participants found the existing captioning practices in video games to be non-problematic. However, they recommended that captioning practices should be customizable to accommodate user preferences. We conclude this from the personal feedback provided by the participants:

> ***Response:*** *"If a standard is a person being able to set up the contrast and text size instead of having them set, then yes"* ***P8***

> ***Response:*** *"There should be a standardized display option that most games should have, but allow for game specific styles in addition that add to the experience."* ***P25***

The participants suggested that the font and style of captions in video games should be tailored to the specific game and its graphics. The captions should be clear, precise, and brief so that they are easy to read and understand, even if displayed in a small space:

> ***Response:*** *"Different games deserve different fonts based on the game graphics "* ***P48***

> ***Response:*** *"They should be clear, precise, and brief since they might not fit in the game interface "* ***P52***

The participants' feedback highlights the need for different caption standards in video games than in the film industry. Video games and films differ in how they tell stories to their audiences due to the level of immersion required. Video games require the active participation of users while viewing films is a more passive experience [45, 52]. Therefore, caption standards for video games should be designed to promote participation among a diverse user base.

The requirement for uniform captioning methods in video gaming cannot be overstated. This holds particular significance for the d/Deaf community, who may experience a greater impact due to the non-uniformity prevalence in the sector. Furthermore, the font, style, and other caption attributes should be adapted to each game to avoid disrupting the overall gaming experience. In addition, captions' clarity, precision, and succinctness are crucial factors. This ensures readability and comprehension, even when a small display area is given. Finally, the video game captions benchmark should diverge from cinema. The rationale behind this is that video gaming necessitates user engagement, contrasting the more passive nature of film absorption.

5 BEST CAPTIONING PRACTICES

Although the overall feedback from participants suggests that no single standard can meet all user preferences, the survey results provide valuable insights into the preferences of d/Deaf players regarding captioning practices in video games. This can help gaming developers use such information to create captions that are more accessible, less distracting, and easier to read. These trends observed in the preferences of d/Deaf players regarding captioning practices in video games suggest that developers need to adopt universal caption standards that are accessible to all players. Participants preferred captions that were:

- Conspicuous: The captions should not blend too much with the background.
- Legible: The captions should be easy to read and not visually noisy.
- Unobtrusive: The captions should not be too distracting from the gameplay.
- Simple: The captions should be simple and easy to understand.
- Space-efficient: The captions should not take up too much screen space.

We also inferred that the best-suited practices for character identification are:

- Using names: The characters' names should be used to identify them.
- Using color combinations that involve white: Colors that involve white, such as blue and white or yellow and white, can be used to identify different characters.

Based on these findings, we identify the highly preferred Captioning practices in Table 4.

In summary, the high preference for Semi-Transparent Box and Black Box for text contrast suggests that d/Deaf players prefer captions that are easy to read and do not blend in too much with the background. Participants also favored Bold font weight, which suggests that players want captions that are easy to see and distinguish from the surrounding text. In addition, participants also preferred the Sans Serif font style, which suggests that d/Deaf players prefer captions that are simple and easy to read. Moreover, participants liked the Extra Large font size, which suggests that d/Deaf players want captions that are large enough to be easily read, even in fast-paced or action-packed scenes.

In regard to using White caption color, this suggests that players prefer captions that are easy to see against a variety of backgrounds. Furthermore, the preference for Single-line captions suggests that d/Deaf players prefer captions that do not take up too much of the screen space. Also, participants preferred the Names and Colors character identification style, which suggests that d/deaf players want to be able to identify the characters who are speaking easily. Finally, the preference for Blue & White and Yellow & White color combinations suggests that d/Deaf players prefer color combinations that are easy to see and distinguish from each other.

Table 4: Best captioning practices inferred from results.

Characteristic	Best Practice	Rationale
Text Contrast	Semi-Transparent Box	Ensures high visibility of the captions without obscuring vital information on the screen, enhancing the gaming experience.
Font Weight	Bold	Draws attention to the dialogue, giving it a feeling of importance and immediacy, which can facilitate a more immersive gaming experience.
Font Type	Sans Serif	Facilitates easier and quicker reading compared to serif fonts, reducing the cognitive load on players.
Font Size	Extra Large	Aids in quick and easy reading, which is particularly vital during fast-paced or action-packed scenes.
Caption Colors	White	High contrast with most backgrounds ensure readability, catering to the dynamic backgrounds and rich color palettes in video games.
Line Length	Single-Line	Prevents the captions from occupying too much screen space, reducing distractions for players.
Character Identification	Name and Color	Allows players to effortlessly identify who is speaking, enhancing the narrative flow and player immersion.
Color Combination	Blue, White, and Yellow	Ensure high contrast and readability against a multitude of backgrounds, including those that are busy or dark.

6 CONCLUDING REMARKS

This study investigated the preferences and feedback of deaf and hard-of-hearing (d/Deaf) players regarding the use of captions in video games. We anticipate that our research will add to the body of knowledge on the importance of using standardized captions in video games for players with hearing impairments. The survey results indicate that most participants strongly favor the use and

standardization of captions in video games since they rely heavily on visual cues for understanding the game. Similar results were confirmed when we analyzed the participants' feedback. Some factors that made captioning techniques inaccessible and difficult for players to read and understand included distracting color combinations, unreadable font styles, and poor text contrast with the background.

Our findings provide valuable insights for game developers to improve the accessibility, readability, and usability of captions in video games. We recommend that developers use standardized captions that are simple to read and comprehend and avoid using inaccessible color combinations and text formats. They should also ensure that the captions are not distracting or obstructing background cues. We believe that our research is a significant contribution to the field of video game accessibility, and we hope that it will help to enhance the experience of d/Deaf players.

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