Exploratory Thematic Analysis of Crowdsourced Photosensitivity Warnings

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ABSTRACT

Films often include sequences of flashing lights for visual effect that may inadvertently trigger seizures when viewed by individuals with photosensitive epilepsy (PSE). Warnings about photosensitive risk in films can help people with PSE make informed decisions about their personal safety, but little is known about how to design such warnings and what information to include. To better understand the design space for photosensitive risk warnings, we conducted a qualitative analysis of 265 crowdsourced warnings about flashing lights in films. We find that the crowdsourced warnings were tightly coupled to the scenic and temporal contexts of the films being described, unlike current practices for labeling media with potentially seizure-inducing sequences using general warnings that are not specific to the media at hand. As technological capabilities for detecting seizure-inducing sequences continue to improve, understanding how to effectively communicate this information to individuals with photosensitive epilepsy is critical for ensuring accessibility.

CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in accessibility**.

KEYWORDS

accessibility, photosensitive epilepsy, film, seizures

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1 INTRODUCTION

Upon release in 2018, the children's film *Incredibles 2* contained a climactic battle scene where the lead characters battle the main villain amidst brightly flashing computer screens and lights [18]. The battle sequence exceeded accessibility standards for flashing lights (e.g., [7]) and posed a threat to viewers who have photosensitive epilepsy (PSE). Photosensitive epilepsy is a neurological condition characterized by recurrent seizures triggered by exposure to certain light stimuli and is estimated to affect approximately 3% of the 65 million people worldwide with epilepsy [10]. The film was released with this scene of intense flashing lights intact despite the known threats to viewers with PSE. After moderate public outcry about adverse responses to the film on Twitter, individual theaters began posting signs warning potential viewers about the seizure-inducing flashes present in *Incredibles 2*.

The controversy of flashing lights in *Incredibles 2* illustrates the challenges of safely creating and distributing films with potentially dangerous light stimuli. Films often incorporate flashing lights for visual effect and storytelling purposes, but finding ways to communicate the potential for photosensitive risk in such films remains challenging. Films are not currently required to include accessibility warnings for photosensitive viewers. Some films are given warnings about photosensitive risk after an adverse response to flashing lights is reported (e.g., *Star Wars: The Rise of Skywalker* [2], *Incredibles 2* [20]), while others may never receive formal warnings from despite crowdsourced firsthand accounts of seizures or other adverse responses (e.g., *Everything Everywhere All At Once* [14]).

When warnings about flashing lights are distributed alongside films, the warnings are often interchangeable and devoid of information specific to a given film (Figure 1), making it difficult for viewers to make informed decisions about their personal risk in watching a film. Because official warnings generally do not include specific information about when flashing lights will appear in the film, a user might choose not to watch a film that would in reality be safe for them. For example, someone with sensitivity to red flicker might not be triggered by certain flashing lights [4], while someone on medication might be affected only if the flashing lights occupy the entire screen and flicker very rapidly [11]. Flashing lights may only occupy a small percentage of the total film and be relatively easy to avoid watching, yet individuals with PSE may choose to skip such a film entirely to avoid exposure to seizure-inducing sequences if this information is not conveyed in a warning.

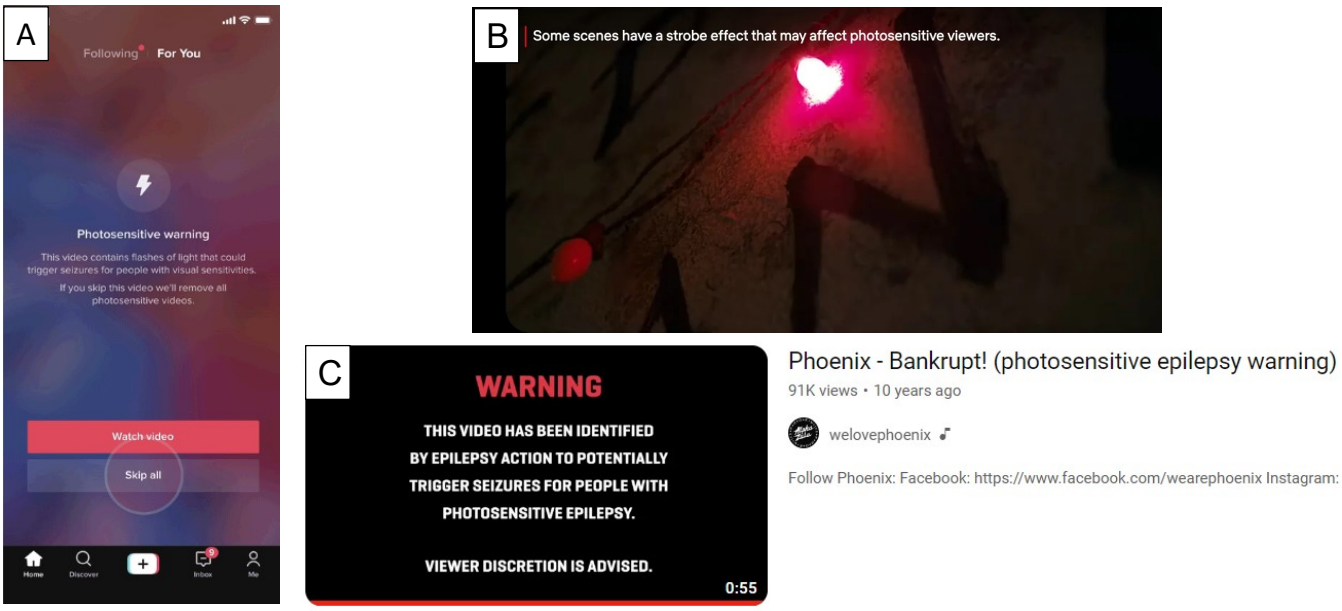

Figure 1: Three examples of non-crowdsourced photosensitivity warnings in online media: (A) TikTok's photosensitivity filter [13], (B) a warning attached to a video being shown on Netflix [19], and (C) a photosensitivity warning attached to a music video on YouTube [21]. Unlike the crowdsourced warnings shown in Figure 2, these warnings are vague and do not convey detailed information about what viewers can expect about upcoming seizure-inducing flashing lights.

While official warnings about flashing lights in films are often uniform and non-specific, online communities have formed to produce unofficial crowdsourced warnings with more detailed descriptions of potentially hazardous light stimuli. In particular, an online forum titled DoesTheDogDie[1] (DTDD) allows registered users to vote on whether media contains a long list of triggers, including flashing lights, using a simple "Yes" or "No" system (Figure 2). Users can also write comments to warn users about flashing lights in the film in greater detail. As of December 2022, 5254 films have been flagged as containing flashing lights by at least one user on the forum and 1688 films have received written warnings about flashing lights from at least one user. While it is impossible to know the background of every author of crowdsourced warnings about flashing lights, or their degree of familiarity with the specific light stimuli known to cause seizures, several comments explicitly reference the authors' personal familiarity with photosensitive epilepsy (e.g., "There is fast strobe effect during the projector scene. With photosensitive epilepsy I had to look away" [2], "My eyes physically hurt now and I'm overstimulated. I would NOT recommend this to folks with epilepsy or sensory sensitivity." [3]).

Crowdsourced warnings about flashing lights can provide valuable knowledge about what types of information are valued by individuals with PSE when communicating photosensitive risk about films; however, these data sources are understudied from human-computer interaction (HCI) and accessibility perspectives. Guidance on how to design warnings about hazardous flashing lights for videos and films are lacking and represent an open research question. In this paper, we contribute an exploratory qualitative analysis of crowdsourced warnings for photosensitive epilepsy based on a sample of 265 warnings posted on the DTDD website. Our analysis identifies common themes in crowdsourced warnings about seizure-inducing content. This work enables future investigations into the practice of warnings for photosensitive accessibility, such as evaluation of the effectiveness of different types of warnings and incorporation of more relevant and actionable information about dangerous content into the design of future assistive technologies for individuals with photosensitive epilepsy.

2 RELATED WORK

2.1 Photosensitive accessibility

Recent research on accessibility for people with photosensitive epilepsy has focused on accurate and efficient detection of seizure-inducing content in videos [1, 3], GIFs [16], and interactive data visualizations [15]. Conversely, this work focuses on the question of how to communicate information about photosensitive risk to the viewer after a risk detection system has already identified the potential hazard. Prior qualitative research has shown that warnings attached to seizure-inducing content are considered useful and valuable for individuals with PSE when navigating online spaces [16]. Photosensitivity warnings are commonplace on user-generated content sites such as YouTube (Figure 1C). Online platforms have begun rolling out protective measures to warn users with photosensitivity about potentially harmful content. For example, TikTok released a photosensitivity filter in 2020 that automatically removes content with flashing lights from a user's feed [13] (Figure 1A) and

[1]DoesTheDogDie.com
[2]https://www.doesthedogdie.com/topics/167/media/16361/comments
[3]https://www.doesthedogdie.com/topics/167/media/18504/comments

Netflix gives provides warnings when users start watching a video that contains hazardous flashing lights (Figure 1B). Given recent technological innovations in detecting seizure-inducing content and growing interest in warning photosensitive individuals about hazardous content, understanding how to effectively communicate photosensitive risk is crucial. In this paper, we present an exploratory examination of the potential design considerations associated with constructing such statements about photosensitive accessibility.

2.2 Content warnings

The design and implementation of crowdsourced or automated content warnings have been examined in recent HCI literature and is relevant to the present work on warnings specifically for photosensitive epilepsy. Stratta et al. investigated the feasibility of delivering automated content warnings inferred from sentiment and keyword analysis using a web browser extension [17]. Charles et al. contributed a systematic review and typology of content warnings and trigger warnings across multiple sectors, including health, social media, education, and entertainment [9]. Their taxonomy includes a category for warnings about flashing lights, but the systematic review does not provide any in-depth analysis beyond identifying its existence as a distinct subcategory of content warnings. In this paper, we provide a deeper analysis specifically on content warnings for flashing lights attached to films.

3 METHODS

We used the DogTheDogDie website API to extract a list of all 5,254 films with at least one vote indicating that the film contained flashing lights. Because the purpose of this analysis was to examine written crowdsourced warnings, we narrowed our scope to films that had at least one written comment in addition to at least one upvote for the "flashing lights" warning category (Figure 2). This produced a list of 1,997 written comments drawn from 1,688 different films. We chose to run a more in-depth thematic analysis of a smaller subset of the written comments. To ensure that we were looking at comments for films that genuinely contained flashing lights, we restricted the subset to only films that had at least 20 community upvotes for the "flashing lights" warning category, indicating a general consensus among forum users. This led to a final dataset of 265 warnings from 129 different movies.

The first author performed thematic analysis using an inductive coding process based on the six phases identified by Braun and Clarke [5]. We used inductive coding to focus on generating theory based on the knowledge contained in the crowdsourced warnings, rather than attempting to apply existing models to explain the data in deductive fashion. The familiarization phase involved first browsing the DTDD website to gain exposure to common practices in writing crowdsourced warnings and eventually examining the full dataset of 1,997 written comments about flashing lights. During this phase we noticed a handful of spam comments and mislabelled warnings that did not appear to be discussing flashing lights (e.g., a warning about a suicide mention in the film *Dating Amber* miscategorized as a flashing lights warning: "Before the events of the movie but the characters visit the tree where it happened which may be triggering." [4]). We restricted our analysis to films that had at least 20 "Yes" upvotes for the flashing lights category of warnings to avoid accidentally including miscategorized warnings in our thematic analysis.

The first author then manually identified and applied codes to the 265 warnings included in the final sample. Warnings and codes were reviewed and compared in an iterative fashion to develop themes, which are reported in detail in Section 4. Warnings may contain multiple codes and codes may contribute to multiple themes. Therefore, individual warnings in the dataset may contain multiple themes. We did not attempt to establish inter-rater reliability (IRR) as it is inconsistent with the methods and goals of thematic coding as described by Braun and Clarke [6]. All warnings and associated codes can be viewed in our Supplementary Material or online at https://osf.io/582jp/.

4 RESULTS

Our results are organized around two themes generated during the thematic analysis process (Table 1). First we discuss methods used to help the reader locate scenes with flashing lights within a film (Section 4.1), followed by descriptive details about flashing lights mentioned by warning authors (Section 4.2).

4.1 Locating flashing lights

A stated goal of the DTDD website is to give "emotional spoilers" by warning readers about potentially distressing or triggering imagery in content they are considering watching. In the case of flashing lights, the DTDD website serves the additional purpose of avoiding physically debilitating seizures or other symptoms. It follows that a key function of the photosensitive warnings posted on the side is to provide estimates of where in a given film a photosensitive viewer might expect to encounter flashing lights. Locating flashing lights for readers was the most commonly identified theme in our thematic analysis, appearing in 181 out of 265 warnings (68.3%).

We observed two main techniques used to locate scenes with flashing lights for readers in our sample of crowdsourced warnings: scene descriptions and time descriptions.

Warnings with **scene descriptions** identified potentially hazardous segments of the film by naming or describing recognizable elements that would be familiar to someone watching or contemplating watching the film. For example, several warnings mention a character doing a particular action during a scene with hazardous flashing lights (e.g., "There's also one scene where Robotnik is dancing in his lab the camera is spinning and the lights are flashing." -W142). Scene descriptions appeared in more than half of the dataset (140 warnings, 52.6%). Scene descriptions help to situate warnings in the context of the film being described, but they leave room for misinterpretation and confusion, particularly if the film elements being used to situate the warning appear multiple times in a film (e.g., a warning for *A Star Is Born* framed in terms of setting, despite the fact that many scenes in the film take place in a concert setting: "Some of the concert scenes are a bit flashy" -W163).

Locating scenes with flashing lights using **time descriptions** (e.g., timestamps or estimated timestamps) would appear to be less vulnerable to misinterpretation than scene descriptions because

[4] https://www.doesthedogdie.com/topics/167/media/737004/comments

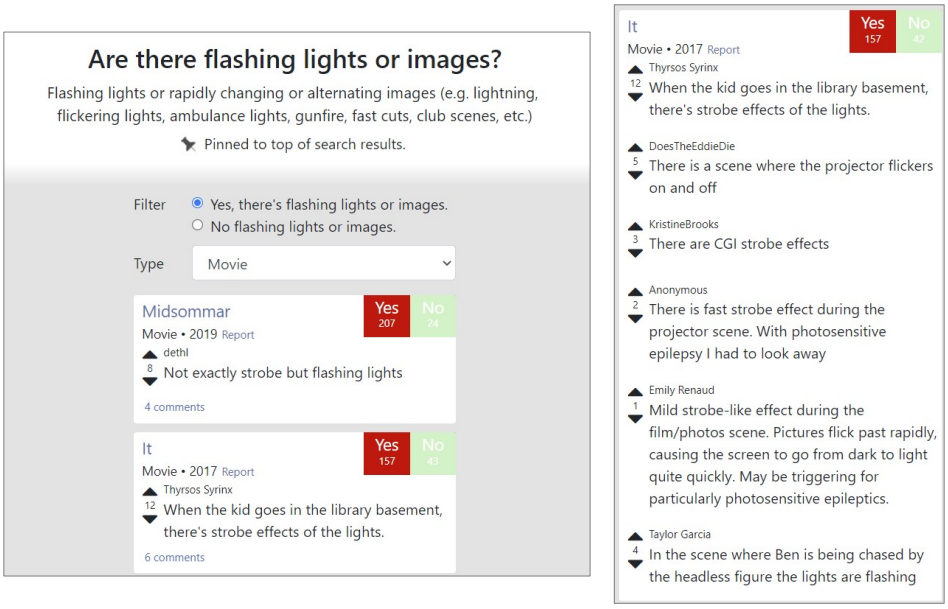

Figure 2: The main interface for the DoesTheDogDie website allows registered users to vote on whether a piece of media contains flashing lights, in addition to other kinds of triggering content. Users can also add comments to provide additional information about the triggering content.

Theme	Codes	Example quote
Locating flashing lights	Time description	"Yes *the last half an hour* of the film has on and off intense strobe effects" (W16, emphasis added)
	Scene description	"*In the night club* and moments in Ellie's bedroom there are flashing lights." (W122)
	Preceding scene descriptions	"There is a very strong strobe effect for a solid minute or so during the channeling scene *after a man writes frantically in his notebook*." -W133
Describing flashes	Duration	"Happens after the camera zooms in on the main character's pupil *lasts about 5 to 10 seconds*" -W60
	Frequency	"One scene has a *very slow strobe effect* it's when the hallway becomes filled up with smoke." -W97
	Color	"During the countdown sequence there is the classic *white/blue strobe*." -W53
	Size	"Yes a lot of rapid flashing colours and images throughout that *sometimes take up the whole screen*" -W234

Table 1: Two themes were generated during the thematic analysis process described in Section 3. Themes are shown alongside codes used to develop each theme. Segments of each warnings that are directly related to the exemplified code have been italicized for emphasis.

estimates can have greater precision. However, we observed relatively few instances of authors providing temporal information to help readers locate scenes with flashing lights (79 warnings, 29.8%). Only 11 out of 265 warnings (4.1%) provided explicit and precise timestamps demarcating instances of flashing lights in films ("Times are HH:MM(:SS) and approximate but close. If prone to seizures view in well lit conditions. 00:30 - CRT video monitors in a darkened room not in sync with camera filming. Some strobing effects. 00:50 - Lights flickering higher than 3 hz with strong contrast changes. 00:52 - Fireworks. 00:54 - Extended flashlight strobing effects. 01:04 - Flickering lights/reflections with strong contrast. starting at 01:09:30 - Significant strobing/flashing with strong contrast changes." -W28).

The remaining 68 warnings included time descriptions that ranged in terms of detail from vague descriptions in relation to the arc of the film (60 warnings, 36.3%; e.g., "There are a lot of camera flashes during 'Honky Cat' scene around the middle of the

movie." -W111) to quantitative but imprecise estimates of timestamps (8 warnings, 3.0%; e.g., "the final 30-40 minutes of this film is riddled with strobing images so be careful. " -W126)

We also observed that authors of crowdsourced warnings used descriptions of the scenes immediately preceding scenes with flashing lights as "signposts" to help viewers anticipate hazardous sequences. This code was generated from 14 warnings. Several warnings appeared to be carefully constructed to minimize spoilers for readers through the use of spoilers tags (e.g., "(SPOILERS) When Deena starts chasing Goode through the door in the mall an emergency alarm goes off with loud beeping and bright flashing lights." -W140) or by not naming characters connected to plot points (e.g., "When the kid goes in the library basement, there's strobe effects of the lights." -W8). At least one warning used the preceding scenes description technique to communicate a pattern that could help viewers anticipate seizure-inducing sequences in the film: "Anytime there is TV static there are usually strobe shots of the characters following" (W130).

4.2 Describing flashing lights

The second theme generated through our thematic analysis focused on the specific details that authors chose to include in their warnings when describing the appearance and characteristics of individual flashing sequences. Unlike the first theme (Section 4.1), this theme centers around efforts to describe the characteristics of the flashes themselves rather than helping viewers locate scenes in which the flashes occur. This theme was generated during the open coding phase when the first author noticed recurring mentions of color and frequency in warnings. Color and frequency of a flash are two characteristics known to determine the potential for a flash to be considered seizure-inducing, based on the findings of EEG-based experiments with flashing visual stimuli [12]. The other two characteristics of a flash identified by Fisher et al. as determinants for seizure risk are the duration of a flashing segment and the size of flashes (i.e., the number of pixels occupied by the flashing stimuli). We decided to create codes for all four known determinants of seizure risk, using a top-down analytical approach based on our familiarity with known triggers of photosensitive epilepsy. These codes together were eventually used to develop the theme for describing flashing lights.

We found that authors most often mentioned the **duration** of a flashing sequence (50 warnings, 18%) when writing warnings. The other three flash characteristics were less frequently described in warnings included the color (37 warnings, 14.0%), frequency (24 warnings, 9.1%), and size (8 warnings, 3.0%) of the flash. In the same way that we observed a range of precision in locating scenes with flashes (Section 4.1), we observed variations in the level of precision used by authors when describing flashes. Descriptions of duration, for instance, ranged from vague estimates (e.g., "There is an extended sequence of two characters dancing at a nightclub under bright strobe lights."-W116) to precise measurements (e.g., "In part 2 beginning at 45:05 SEVERE strobing lights take over. It stops at 46:43." -W264).

Color was mentioned in 37 warnings (14.0%). Most warnings (23, 62%) explicitly stated the color or colors shown during flashes (e.g., "More flashing lights (red and white) at 36 minutes 30 seconds." -W57, "In the opening credits after the moose gag the credits' background is a flashing red/orange and can be quite headache inducing." -W213). Other warnings emphasized the brightness or contrast of the colors involved in the flashes without specifying the hue of the colors involved (e.g., "the evil is associated with bright colourful lights which are shown flashing rapidly in several scenes throughout the film." -W154).

The **frequency** of flashes was mentioned in 24 warnings (9.1%) and often was conveyed through qualitative descriptions rather than with quantitative estimates. Only one warning explicitly stated that lights were flickering a rate greater than the widely-accepted 3 Hz threshold [12] ("00:50 - Lights flickering higher than 3 hz with strong contrast changes." -W28). The rest of the warnings that mentioned the frequency of flashes used non-numerical language to convey this information to readers (e.g., "The light in a store continuously flashes on and off pretty quickly." -W167). It is interesting to note that some warnings use flash frequency details to explain why a film with flashing lights did not trigger an adverse response: "There is a camera with a powerful flash at the very end and partway through the first half. It did not trigger my photosensitivity as the flashes are spaced out." -W24). Flash **size** was only mentioned in a handful of warnings (8 warnings, 3%) and was always reported in qualitative, non-numerical forms (e.g., "In one scene it's like the whole screen is off for a second on for a second off for a second and so on" -W149, "There is a pretty big flashy explosion that also makes fireworks happen." -W67).

The second theme generated through our thematic analysis demonstrates that crowdsourced warnings often describe flashing lights in terms of characteristics that are known to contribute to seizure-inducing potential [12]. This is a notable difference from the vague language often found in non-crowdsourced warnings (e.g., Figure 1). We discuss the implications of our results for future work in photosensitive accessibility in Section 5.

5 DISCUSSION

The results of our thematic analysis of crowdsourced photosensitivity warnings have implications for future avenues of HCI research into photosensitive accessibility. In particular, we identify two primary categories of future research in response to the themes generated by our exploratory analysis: i) connecting automated warnings to the context of the media being analyzed and ii) balancing levels of precision to construct detailed yet comprehensible photosensitivity warnings.

5.1 Design implications for automated photosensitivity warnings

Photosensitivity risk detection systems such as the free Photosensitive Epilepsy Analysis Tool (PEAT)[5] or the proprietary Harding Flash and Pattern Analyzer (FPA)[6] communicate photosensitive accessibility in a binary manner, where content can either pass or fail (i.e., content is safe or risky to be viewed by someone with PSE, respectively). Non-crowdsourced photosensitivity warnings, such as the warnings shown in Figure 1, often use the same binary interpretation of photosensitive safety, labeling content as safe or

[5]https://trace.umd.edu/peat/
[6]https://www.hardingfpa.com/

dangerous without giving additional context about the specific way in which the content may be hazardous. In contrast, the majority of the crowdsourced warnings analyzed in this work were tightly coupled to the content they described by including time and scene descriptions about where flashes were observed, as well as specific information about the characteristics of flashes within the film. Our results imply that platform-driven warnings about photosensitive risk should consider creating more informative warnings that include details about flashing lights that people with PSE need to know to make an informed decision about whether to consume content.

When photosensitive risk detection systems such as PEAT do provide information about the location of flashing light sequences, they are reported in the form of timestamps. To borrow terminology from our thematic analysis (Section 4.1), such systems have prioritized using time descriptions over scene descriptions to communicate the location of hazardous light stimuli. Producing time descriptions in the form of timestamps is significantly easier from a computational perspective and allows for more precise, quantitative estimates. Our findings suggest that there could be a benefit to incorporating elements of scene description in addition to time descriptions into warnings to help viewers successfully identify and locate scenes that could be dangerous. In particular, we see value in incorporating descriptions of the scenes that precede hazardous sequences to give additional warnings to viewers.

5.2 Implications for communicating photosensitive risk

We observed significant variation in the degree of precision used to communicate information about flashes in crowdsourced warnings. This pattern was present in both themes generated during our thematic analysis. Some estimates for locating flashes (Section 4.1) and describing flashes (Section 4.2) were reported in precise quantitative estimates, while most warnings used more informal and imprecise language to summarize information. Automated methods for detecting photosensitive risk in media tend to produce precise and quantitative estimates of the flash characteristics that determine potential photosensitive risk, such as flash duration or frequency. Reporting precise estimates of these characteristics allows for more accurate judgements about photosensitive safety and aligns well with the precise thresholds established in accessibility standards, such as the WCAG 2.0 Success Criterion 2.3.1 [8]. However, our study indicates that always reporting flash characteristics in quantitative terms might not reflect the communication practices used by individuals with photosensitive epilepsy and could lead to confusion. In particular, we observed no instances of flash size being reported in precise quantitative terms (i.e., number of pixels flashing or percentage of screen occupied by a flash). Similarly, we observed only one instance of frequency reported in quantitative terms (i.e., number of flashes per second). Our findings would suggest that a viewer with photosensitivity who frequently relies on crowdsourced warnings such as those posted to the DTDD website might have more familiarity with less formal and less precise ways to communicate these risk factors. Future research should investigate the potential benefits of using non-numerical methods to summarize certain flash characteristics in photosensitive warnings.

6 CONCLUSION

In this paper we have presented the results of an exploratory thematic analysis of crowdsourced warnings about flashing lights in films published on the DoesTheDogDie website. We demonstrate through qualitative analysis that crowdsourced warnings are often tightly coupled to the context of the films being described and frequently reference film elements to help viewers with photosensitivity locate scenes with hazardous flashing lights. We additionally demonstrate that crowdsourced warnings explicitly mention characteristics of flashes that are known to determine their seizure-inducing potential, such as the frequency or the color of a flash. Non-crowdsourced photosensitive warnings (e.g., Figure 1) often label content as hazardous for viewers with PSE but do not provide additional information about why the content was flagged as potentially dangerous or where the flashing lights can be expected to appear within the content. This work motivates several areas for future work investigating ways that automated platform-driven photosensitivity warnings can be made more informative and therefore more valuable for individuals with PSE as they make informed decisions about what content to consume.

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