

Article

# A Snapshot of Bystander Attitudes about Mobile Live-Streaming Video in Public Settings

Cori Faklaris <sup>1,\*</sup>, Francesco Cafaro <sup>2,\*</sup>, Asa Blevins <sup>2</sup>, Matthew A. O'Haver <sup>2</sup> and Neha Singhal <sup>2</sup>

<sup>1</sup> Human-Computer Interaction Institute, School of Computer Science, Carnegie Mellon University, Pittsburgh, PA 15213, USA

<sup>2</sup> Department of Human-Centered Computing, School of Informatics and Computing, Indiana University-Purdue University Indianapolis, IN 46202, USA; asablevins@gmail.com (A.B.); maohaver@iupui.edu (M.A.O.); neha.letterdrop@gmail.com (N.S.)

\* Correspondence: cfaklari@cs.cmu.edu (C.F.); fcafar@iu.edu (F.C.)

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**Abstract:** With the advent of mobile apps such as Periscope, Facebook Live, and now TikTok, live-streaming video has become a commonplace form of social computing. It has not been clear, however, to what extent the current ubiquity of smartphones is impacting this technology's acceptance in everyday social situations, and how mobile contexts or affordances will affect and be affected by shifts in social norms and policy debates regarding privacy, surveillance, and intellectual property. This ethnographic-style research provides a snapshot of attitudes about the technology among a sample of US participants in two public contexts, both held outdoors in August 2016: A sports tailgating event and a meeting event. Interviews with  $n = 20$  bystanders revealed that many are not fully aware of when their image or speech is being live-streamed in a casual context, and some want stronger notifications of and ability to consent to such broadcasting. We offer design recommendations to help bridge this socio-technical gap.

**Keywords:** live streaming; Periscope; Facebook Live; TikTok; mobile video; privacy; surveillance; ubiquitous computing; human-computer interaction; intellectual property

## 1. Introduction

Live-streaming video is resurgent in social computing. While the ability to deliver video content in real time via the Internet has existed for many years now, the introduction in 2015 of the mobile live-streaming apps Meerkat and Periscope [1], spread rapidly thanks to their integration with the Twitter social networking service and improvements in streaming video technology [2], has sparked renewed growth and user enthusiasm for the medium [3,4]. Facebook so far is the largest company to jump into mobile live-streaming video [5].

Platforms for live-streaming have existed for years, with companies such as Twitch and Ustream broadcasting to a predominantly desktop-based online audience. Researchers in human-computer interaction (HCI) have also explored privacy perspectives among bystanders to augmented-reality glasses [6] and feeds from stationary always-on cameras used by telecommuters [7], as well as explored people's motivations for streaming [8].

Although this plethora of live streaming platforms may appeal to different user groups (e.g., younger vs. older adults), what is novel and provocative to privacy norms is the mobility, personal immediacy, and spontaneity afforded by the internet-connected smartphone and the normalization of their use to document the owner's life in almost any context thanks to the popularity of Instagram, Snapchat, TikTok, and the other social networking services in this space. A few prior

studies had explored attitudes about the use of mobile live-stream video apps, but they were limited to early adopters [9] and young college students [10].

In this paper, we present results from an ethnographic study that provides a snapshot of attitudes toward this technology among diverse residents of the Midwestern United States during August 2016, a period when the broadcasting and viewing of mobile live-streaming video was becoming commonplace. We first give an overview of related work in human–computer interaction, informatics, and related fields. Then, we report data from  $n = 20$  interviews with bystanders among a sample of “Middle America” participants at two types of outdoor group events: Tailgating before a sports game, and an invited group meeting held on a rooftop deck. We discuss key findings and offer design ideas to address themes that emerged from this observation and interview data.

### 1.1. Related Work

Privacy considerations with video streaming are not new: They have been previously explored in the context of wearable cameras, telecommute, and prerecorded video sharing. Mobile and wearable devices have sparked debates involving individuals’ right to privacy, to publicity, and (in the European Union) to be forgotten [11], as well as their owners’ legal rights to film others in various settings, who may view these videos, and what is captured by the video. Understanding the privacy implications of video-streaming technologies is, however, still a challenge [12].

#### 1.1.1. Wearable Cameras

Denning et al. [6] have conducted ethnographic-style research into the privacy perspectives of individuals who were bystanders in the vicinity of augmented reality (AR) devices modeled on Google Glass. During 12 field sessions in local cafes, they observed and interviewed 31 such persons regarding a mock AR device that was worn publicly by the researchers. Participants noted that what was being recorded made a difference in their perceptions, which echoes the discussion in Bohn et al. [13] of the actor and the context as two components of perceived boundary violations in ubiquitous computing. Participants were interested in being asked for permission to record and the ability to block transmission. Denning et al. used the results to sketch potential design axes for privacy-mediating technologies, such as push/pull, opt-in/opt-out, place-based versus proximity- or identity-based, and user versus bystander or third party. This is congruent with Erickson and Kellogg’s work in identifying the factors of awareness, visibility, and accountability in designing for social translucence [14].

These recommendations, however, are specific for wearable cameras, and difficult to generalize to mobile live-streaming. Furthermore, they generally assume that everybody is aware of what wearable cameras are, how they look like, and when they are in-use.

#### 1.1.2. Cameras and Telecommuting

The difficulty of the design work in balancing privacy with such awareness was shown by Neustaedter et al. in 2006 [7]. In a laboratory experiment, they recorded the attitudes of 20 participants who were shown blur-masked images such as of nude co-workers that might accidentally be transmitted by always-on video feeds of telecommuters working in home environments. The blur-filtering technology was not enough to answer some participants’ concerns about “high-risk” privacy violations in a home-to-office video system. The authors suggested additional elements be incorporated for privacy regulation and feedback, such as gesture-activated blocking in proximity to the camera, audio feedback such as the sound of a camera clicking or rotating, and visual feedback such as light-emitting diode (LED) lights, which are commonly used in small electronics.

Neustaeder et al. noted the limitation of their privacy findings in the simplified and artificial context of their laboratory experiment, versus the more complex contexts in which such concerns are situated in the real world. The home media space also is a context that is a private enclosure and which those present in the home make a choice to enter despite knowledge of the presence and the risks of the always-on video feed.

### 1.1.3. Mobile Live Video Recording and Sharing

In 2010, Juhlin et al. [3] explored the possibilities for mobile-broadcast live video shared on the social web—as distinct from mobile video calling, website-based streaming, and desktop-original platforms such as YouTube. In a qualitative analysis of  $n = 178$  video clips posted to four websites, they sorted the clips into the following topics by number of occurrences: Test broadcasts, screens, groups and crowds, tours, social events, kids and pets, demonstrations, presentations, performances, video logs, landscapes and sudden events (as well as a “not viewable” category of video misfires). The authors focused on shortcomings in the novice videographers’ techniques and in the lack of camera interface cues such as a countdown timer from the time the record button is pressed to the broadcast of the first image frame, suggesting that these would need to be addressed in order to fulfill the medium’s promise for empowering citizens and democratizing video broadcasting. However, their work did not address whether the seeming shortcomings were a motivating or limiting factor in their broadcast and consumption, nor did it address any legal or ethical issues such as invasion of privacy with domestic videos or intellectual property concerns with the broadcast of artistic performances or tours.

The following year, Dougherty [15] offered an analysis of  $n = 1000$  randomly selected mobile videos posted over five months on Qik.com and interviews with  $n = 7$  producers of these videos. She noted “spontaneity” and “immediacy” as motivating factors for mobile live video sharing. Those interviewed for her study also cited a motivation of building an audience for more civically minded videos such as of school board meetings through their sharing of personal or otherwise unsophisticated video clips. Her interviewees reported being mindful of privacy issues with public filming and of general ethical issues in video production. Somewhat contradictorily, her content analysis revealed many videos shot by men were of women in domestic spaces or of coworkers of either gender and that some of these subjects may not have been fully or even partially aware of being captured on video for an audience. Dougherty did not explore the familiarity or attitudes of bystanders to such video broadcasting.

Tang et al. [8] appear to be the first researchers in human-computer interaction (HCI) to investigate the use of the current generation of dedicated apps for mobile live-streaming video. In their interviews with  $n = 20$  early adopters of Meerkat and Periscope and crowdsourced analysis of  $n = 767$  live streams on these apps during April–May 2015, they found that a significant amount of use can be characterized as either personal blogging or branding. Coders on Amazon Mechanical Turk identified many videos as featuring expository content (chatting), as well as experiential content (broadcasts of notable objects, places, or events). Users said they relished the immediacy of the connection with their audiences, who often interact via emoji and text comments with the live streamer during the broadcast. While many users said they found the apps to be easy to learn and use, they described investing considerable time and thought into deciding what to broadcast, how to present themselves on camera and in the app, how to cultivate followers and how best to interact with those watching and deal with inappropriate comments—community work that is common among all forms of social networking sites (SNSs). This study, however, did not involve bystanders to mobile live-streaming video. The authors also noted the need for continuing research as the apps matured and evolved in the marketplace.

In 2016, Singhal et al. [10] presented findings from an *in situ* field study of the reactions of bystanders in an indoor university building to two types of devices for capturing video: A smartphone and Google Glass. Their interviews with  $n = 9$  of these bystanders revealed that many expressed fewer concerns with streaming video than with recorded video because of its perceived ephemeral quality; participants thought that streamed video was not likely to be saved to a disk and that their activities, even if embarrassing in nature, would be visible online for a few seconds only. They were also more likely to accept video capture from a smartphone in a public place and if the camera was constantly moving rather than fixating on them. Additionally, three of the four female participants said they would be uneasy if a male was using the camera. All participants said they wanted to be asked for permission before video was recorded of them. However, the generalizability of Singhal’s study was limited by a small sample of relatively homogeneous population (all were students, and all were 25 or under), as well as the field studies’ location in the relative artificiality of an indoor campus

environment. The researchers also chose to hold the smartphone in a horizontal orientation for their study, which became an anachronistic behavior once Snapchat popularized vertical video capture on smartphones in casual contexts.

#### 1.1.4. Overview of Recent US Mobile-Video Environment

At least 75% of the surveyed US population is watching online video, often while using their mobile devices, and at least 40% of mobile users report either uploading or sharing content or using their devices for video calling [9,16]. User-generated short clips shared via apps such as Instagram, Snapchat, and TikTok let their users share their experiences and performances immediately with their friends or followers [17]. The use of mobile-first social networking apps and the limitation of short clips can help in attracting viewers and minimizing the costs of creating such content. While desktop-native gaming sites such as Twitch that offer live-streaming have reported more than 2 million broadcasts every month, many users have reported difficulties in attracting a meaningful audience for their channels that will make their efforts seem worthwhile [18].

In most uses of mobile recording or streaming in US public spaces, video recording or live-streaming is legally permissible because there is no reasonable expectation of privacy. One exception to this is voyeurism, defined as “the act of filming or disseminating images of a person’s private areas under circumstances in which the person had a reasonable expectation of privacy regardless of whether the person is in a private or public area” [19]. In semi-private or even private areas, however, some recording or streaming devices may be welcomed if and when its subjects become explicitly aware of them depending on whether they seem to benefit from their existence. Examples include those that allow video conferencing or are part of security systems for home or business [20,21].

Video voyeurism is also increasingly becoming accepted as legal, although controversial, entertainment, as well as big business. Websites that have emerged in the past 10 years such as Chatroulette and YouNow allow users of internet-connected cameras to live-stream video to random strangers around the globe of even mundane activities such as eating and sleeping. Adult video sites such as YouPorn and PornHub will likely continue as the largest internet category of entertainment and business [22]. Two other categories of multimillion-dollar entertainment businesses for live video streaming are gaming and sports [23].

#### 1.2. Problem Space

As the above review notes, the popularity and pervasiveness of mobile video has brought with them numerous legal and ethical concerns for their use. The prior literature, however, either focused on the design of technology itself or, when the focus was on users and passersby, seemed to abstract from the complexity of everyday mobile live-streaming scenarios. We believe that an investigation on attitudes and behaviors of the people who are interacting with mobile live-streaming application need to: (1) Assess people’s familiarity with mobile live-streaming technologies and with the legal implications of their use; and (2) consider social space (public, or semi-public), device, app, user(s), and bystanders, as a unit of analysis.

Our study thus sought to answer the following research questions:

**RQ1.** *What familiarity and legal or ethical attitudes do likely users and subjects/bystanders report regarding mobile live-video technologies and other apps or platforms?*

**RQ2.** *How do bystanders react “in the wild” to the presence of mobile live-streaming video in public and semi-public settings?*

## 2. Materials and Methods

For our research into the above questions, we planned and executed two qualitative field studies in August 2016 to gauge how awareness of and attitudes about mobile live-streaming video varied among bystanders to simulated broadcasts “in the wild.” The Institutional Research Board at Indiana University reviewed and approved our study design and research protocols prior to the commencement

of this work, consistent with the U.S. Department of Health and Human Services' "Common Rule" for protection of human subjects in research (US 45 CFR 46).

### 2.1. Participants

All participants for the field studies were encountered or recruited in August 2016 in a US Midwestern metropolitan area of more than 2 million, and was diverse as to age, race, and education. Our participants were people who are current US residents and age 18 or older (although video apps are popular with children and teens, we believe that issues with mobile streaming and informed consent from minors may require an ad hoc study).

In contrast with Tang et al. [8], our study largely is not comprised of expert users or "early adopters" of the technology being studied—we did not want to assume that both users and passersby are always completely aware of mobile live-streaming applications. Only 4 in 20 (20.0%) of those we interviewed told us they had ever live-streamed video. However, our participants were not strangers to computing devices in general, as almost every interviewee reported at more than 40 h a week of such use overall, whether desktop, laptop, tablet, smartphone, or wearable device. The exact demographic breakdown of these participants is as follows:

- **Gender:** Male  $n = 13$ , female  $n = 7$ .
- **Age:** 18–29  $n = 8$ , age 30–39  $n = 6$ , age 40–49  $n = 4$ , age 50–59  $n = 2$ .
- **Education:** Graduate degree  $n = 11$ , bachelor's degree  $n = 4$ , some college, technical degree, or associate's degree  $n = 5$ .
- **Ethnicity:** Caucasian/European heritage  $n = 14$ , Asian  $n = 3$ , African  $n = 2$ , Latino  $n = 1$ .

### 2.2. Procedure

We observed how bystanders reacted "in the wild" to the presence of mobile live-streaming video in two contexts: An outdoor gathering space that is open to the public with no access controls (Public Context 1—"Sports Event"); and an outdoor gathering space with controlled public access (Public Context 2—"Meeting Event"). Of these, we recorded a total of  $n = 20$  interviews.

#### 2.2.1. Public Context 1—"Sports Event"

In our first study, we conducted field observations and interviews of tailgating fans gathered in a public outdoor space before the start of home games for a local professional soccer team in August 2016. These observations and interviews took place in the open-air surface parking lot and along the tree-lined sidewalks outside the "will-call" box office of the stadium. We posted notices and study information sheets on posts and trees around the perimeter of the area at least two hours before game time to let passers-by and entrants to the space know that they were being video-recorded as part of a research study, though without specifying what that study was. Other parking areas and sidewalks nearby were available for any tailgating fans or other passers-by that did not wish to enter the space and be subject to our video recording.

We chose to simulate the act of streaming live video from a mobile phone, rather than actually broadcast live, in order to protect against the type of privacy violations that are a subject of our study. Accordingly, a team member started walking around with a mobile phone, pantomiming the act of recording live-streaming video by holding her phone up in a vertical orientation and narrating the scene as if she were broadcasting to an unseen audience. Meanwhile, a second team member stood a distance away with a portable video camera to record bystanders' reactions to the simulated mobile video. From analyzing the video footage, we estimate that about 90 bystanders were recorded in proximity to these pantomimes.

After several minutes of this pantomime around the space, two other team members approached and invited 10 of these bystanders to participate in semi-structured interviews about the "live-streaming," using the following questions adapted from Denning et al. [6]:

- Did you notice the person who was broadcasting live video from their phone? What about them did you notice?
- Have you heard about mobile live-streaming video apps similar to theirs? What have you heard?
- Why do you think someone would want to stream live video from their phones?
- How do you feel about being around someone who is streaming live video? Why?
- Would you want someone to ask your permission before streaming a live video from your location?
- Would you be willing to take an action to block someone from being able to stream a video of you?

During these interviews, our video camera operator recorded the conversations, while the interviewers recorded audio of the participants and took written notes on their demographics and the answers to the above questions. Interviews were later transcribed. A total of tailgate  $n_1=10$  bystanders were interviewed for an average of 7 min each on the two occasions of these in situ studies. Each interviewee was given a \$5 gift card as compensation for their time.

### 2.2.2. Public Context 2—"Meeting Event"

In our second field study, also in August 2016, we recruited  $n_2 = 10$  participants to convene with four co-investigators and a confederate at the rooftop deck area of a local condominium building. Access to this building is restricted to residents and their guests, though people inside the building are free to enter the deck area at any time and to schedule it for group events such as meetings and parties. Our team secured the permission of the management for this use.

On the day of our study, a team member posted a notice and study information sheet outside the door to the deck area to alert anyone entering that they would be subject to video-recording as part of a research study, though (as with the "Sports Event" Public Context 1) without giving study specifics. Likewise, our recruits were informed that they would be recorded during a focus group and interviewed about the social implications of technology, but were not provided with the specific apps or research questions under investigation.

One co-investigator was stationed in the corner with a video camera to record the interactions among participants. Each invited participant was greeted by three other co-investigators and provided with seating and refreshments (valued at an estimated \$5 per participant). Our confederate also was greeted and introduced as an 11th participant in the proceedings.

Once the group was assembled, we introduced a misdirection by setting up a portable white board, asking participants to pull out their smartphones and then leading them in a discussion of why they favored certain mobile apps for keeping connected with others.

While this activity was being conducted, our confederate, who had been sitting with the participants and took out her smartphone along with them, began simulating the act of live-streaming video using her phone, first from a seated position and then while walking around the perimeter of the study space. As with the previous field studies, the confederate held her phone in a vertical position and narrated the scene to an unseen audience.

Once the confederate had made two circuits, we stopped, introduced her fully, and informed the gathering of the exact purpose of the study. The co-investigators then interviewed the participants individually, using the questions adapted from Denning et al. [6] in the "Sports Event" study. The interviewers recorded audio of the participants and took written notes on their demographics and the answers to the above questions. Interviews were later transcribed.

### 2.2.3. Data Analysis

After each field session, three researchers conferred to debrief each other and to write down impressions while they were fresh in mind. Members of the study team then reviewed the video recordings of each field session that documented reactions to the pantomimed live-streaming, the code sheets with written demographic information about each interviewee, the audio recordings of these interviews, and the supplemental written notes from the field studies.

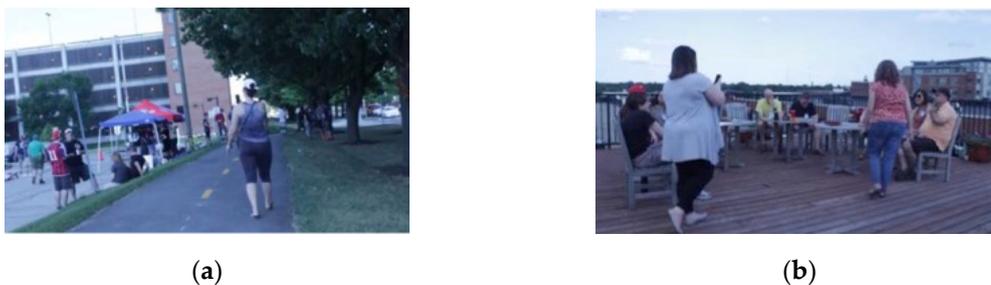
To quantify the bystander observations, one researcher watched the video recordings of the field sessions to count how many people were in the vicinity of the pantomimed smartphone streaming and to count how many of those nearby reacted in a visible physical fashion to the pantomiming confederate, either with glances or by turning their heads or bodies toward the action or overheard conversation.

To identify commonalities and notable comments among the interviews, the audio recordings were transcribed and read through, and the research group discussed and agreed to the emergent themes.

### 3. Results

#### 3.1. Bystander Awareness of Mobile Live-Streaming Nearby

The analysis of video recorded in Public Context 1—“Sports Event” (Figure 1a) shows that only 15 of the 90 bystanders visibly reacted to the simulated mobile live-streaming in their vicinity, as indicated through glances, turning their heads or bodies toward the actions, and overheard conversations of the research confederates who were pantomiming the smartphone actions. In Public Context 2—“Meeting Event” (Figure 1b), all 10 participants visibly reacted to the presence of simulated mobile live-streaming with a glance, head, or body turn to the pantomime. We theorize that this difference stems from the tighter space and more intimate feel of the smaller social gathering in the “Meeting Event” context versus the raucous party atmosphere in the “Sports Event” context.



**Figure 1.** In each field study, a research confederate simulated the act of recording live-streaming video by holding her phone up in a vertical orientation and narrating the scene as if she were broadcasting to an unseen audience. Meanwhile, a second team member stood a distance away with a portable video camera to record bystanders’ reactions to the pantomimed live-stream. (a) A screenshot from video of Public Context 1—“Sports Event”, in which only 15 of the 90 bystanders visibly reacted to the simulated mobile live-streaming in their vicinity, as indicated through glances, turning their heads or bodies toward the actions and overheard narration; (b) a screenshot from video of Public Context 2—“Meeting Event”, in which all 10 bystanders were seen visibly reacting to the pantomimed live-stream from confederate’s upheld smartphone.

Interviews with selected bystanders in both public contexts confirmed that not many suspected the confederates were live-streaming using an app such as Periscope or Facebook Live. A slight majority ( $n_1 = 6$  of 10 in the “Sports Event” context,  $n_2 = 6$  of 10 in the “Meeting Event” context) thought the confederates were recording video, taking audio notes, or using FaceTime or Skype. Some assumed the confederates were playing the mobile game Pokémon Go, which had just been released. Sample comments from interviews:

[P2] “We were trying to figure out whether she was recording video or searching for Pokémon.”

[P4] “At one point, I thought she was talking to somebody.”

[P20] “Didn’t realize what she was doing. Just thought she was videotaping for later. You can’t tell the difference, right?”

### 3.2. Bystander Familiarity with Mobile Live-Streaming Apps in General

About half ( $n = 11$ , 55%) of the 20 total interviewees said that they had heard of mobile live-streaming video apps, and many of these said they had watched at least one video stream on Facebook and seen multiple notifications for them. A general degree of indirect familiarity with such applications transpires from comments that participants made regarding the streaming of public sport events and police actions. For example, interviewees described experiential live streams, such as those being broadcast from a novel or newsworthy event such as the 2016 Rio Summer Olympics, as a positive use of the apps or even a social good.

[P16] *“If there’s news going on right as the person is live-streaming, it’s very helpful to see what’s going on in the moment.”*

This sentiment held even for shocking or violent news events such as the death of Philando Castile, a motorist whose shooting during a 2016 traffic stop was live-streamed by his girlfriend and watched by millions, which was mentioned specifically by three interviewees.

[P12] *“We need more cops to live-stream. We need more live streaming of the scary things going on.”*

[P9] *“I think [it’s good] to get the true content or ideas of things that are really happening live, so there’s no way you can deny it. For the simple fact is, it is live.”*

Far fewer ( $n = 3$  of 20, 15%) reported being directly familiar with the apps or having used one of the apps to themselves live-stream video. Participant 7 said that “too much data” would be used on his phone if he tried it.

### 3.3. Bystander Attitudes About the Use of Mobile Live-Streaming Apps Nearby

Surprisingly, most of the 20 total interviewees expressed a general level of comfort with the fact that live-streaming was occurring nearby, though some ( $n = 8$ ) expressed discomfort with aspects of the confederate’s live-streaming pantomime that seemed obtrusive or annoying, such as narration or standing in close proximity to one or two people. There was no difference in attitudes between those interviewed in the “Sports Event” context (Figure 1a) and the “Meeting Event” context (Figure 1b).

[P14] *“Live streaming for social gatherings [is appropriate], but not when I am walking around [the local entertainment district] by myself.”*

[P11] *“If they just want to film it, that wouldn’t bother me, but if they’re narrating while other people are talking, it’s [distracting].”*

Others ( $n = 5$ ) noted that the act of live streaming is no longer novel and, thus, is easier to ignore.

[P16] *“I am around it enough now so that it is fairly commonplace. So I am like, whatever.”*

[P12] *“I’m desensitized to it. My friends are always on Snapchat. . . . We’re videotaped all the time now.”*

### 3.4. Bystander Attitudes About Social Appropriateness and Legality of Mobile Live-Streaming

In Public Context 1—“Sports Event”, all 10 interviewees generally supported live-streaming as an appropriate and legal activity.

[P2] *“Personally I don’t really care, I know some people freak out but if you’re in a public spot, there’s no way to stop them.”*

[P6] *“Everybody has a right to privacy, but when you’re in a public place, you’re in a public place. C’mon.”*

In Public Context 2—“Meeting Event”, most interviewees (8 of 10) were not concerned about their video being recorded and live-streamed. One wondered aloud whether using a mobile phone is a desirable behavior in a professional setting.

*[P18] “I wouldn’t feel uncomfortable because I don’t think it’s that different from taking pictures. It might make me less willing to interact with that person because his or her attention is somewhere else.”*

Even those who had reservations about being on camera ( $n = 3$ ) still saw live-streaming as on par with traditional recording devices in terms of its appropriateness to use in the space, with one explicitly saying they expected the same social norms to apply to streaming video as with images of themselves being posted on social media by friends.

*[P11] “I tell friends I don’t want to be in pictures. I’d also want to know ahead of time if they’re live-streaming.”*

One person was concerned about limited portions of her image or voice being streamed without permission in a way that would manipulate or misrepresent her original ideas, and thus harm her public image or social relationships or both.

*[P17] “The face thing doesn’t bother me so much as if I were talking and that gets posted. I’m very direct and I have opinions. . . . Maybe I intended to make that comment in a social setting for 10–15 people, but all of a sudden it’s taken out of context.”*

### 3.5. Bystander Attitudes about Notification of and Permission for Mobile Live-Streaming

Nearly all 20 interviewees indicated that, either verbally or through some sort of technology, they would like to receive stronger notifications of nearby live streaming and the ability to consent to, and/or to opt out of, taking part in the broadcast.

*[P20] “Kind of like with Google Glass . . . people’s concern was, if I’m talking to you and you’re videotaping this, I’d like to know that because it could affect what I would say and how I would say it. There are different zones [of behavior].”*

One participant described how it should be “common manners” to ask for permission to people near the camera.

*[P15] “If I were just in the background, I probably won’t care. But if I’m the focus of the live stream, I’d like to know what’s going on. I would want them to get my permission to do that. . . . It’s common manners.”*

When pressed for specifics, however, few of the 20 interviewees ( $n = 5$ , 25%) said that they were likely to take actions that require effort, such as signing up for a “Do Not Record” registry or other initiatives, to block or restrict live-streaming of their persons by app users nearby. Instead, they favored interface design tools or context-aware notifications in the moment of broadcasting.

*[P20] “I might, if you can turn it on and off.”*

*[P5] “It would be helpful . . . if you have an option to get out of that stream or to participate.”*

## 4. Discussion

In this section, we restate the identified commonalities and notable comments from Results as emergent themes. Then, we suggest design interventions that stem from these themes.

#### 4.1. Emergent Themes from Observations and Interviews

##### 4.1.1. Familiarity vs. Awareness

Although most of our participants (55%) were indirectly or directly familiar with mobile live-streaming apps, a much smaller number of them (less than 25%) actively noticed the simulated use of such technologies through our study. In particular, people's familiarity with a variety of mobile applications (that are not related with live-video streaming) seems to completely normalize the confederate's usage pattern (holding a phone up while narrating a scene)—thus, reducing their awareness of being recorded and their video being (supposedly) broadcasted live.

##### 4.1.2. Social Norms, Proximity to the Streaming Device, and Permission

One overwhelming, if intuitive, key theme from our work is that bystander interactions with mobile live-streaming video pose challenges that are more social than technical in nature.

For example, P15 describes his request to ask for consent to those who are in close proximity and likely to be featured in the foreground as "common manner." The same interviewee commented regarding appropriate contexts for live-streaming that certain situations such as "a funeral, an [Alcoholics Anonymous] meeting are both places where live streaming is probably not appropriate and where you don't want to be live-streamed." A nontechnological solution would be a public awareness campaign to promote the desirability of app users asking for permission and otherwise being sensitive to others in public situations before broadcasting their actions.

We believe, however, that such social norms may be also supported and/or enforced through the design of mobile applications. For example, P15 suggested a smartphone setting that toggled "I don't want to be live-streamed" and "I don't care" to broadcast your preferences to those around you. Furthermore, the idea of spatial boundaries (people in the background vs. in the foreground) echoes the "zones of interaction" described by Hall in [24] and the application of proxemics to ambient displays (e.g., [25]) and personal interactive devices [26]. Future work should investigate which spatial boundaries are most relevant for mobile live- video streaming, and the best strategies to enforce them.

##### 4.1.3. Impact of the Social Space: The Presence of Others as a Normalizing Factor

Interviewees repeatedly drew parallels among their thresholds for boundary violations [13] between group shots and public contexts versus tight shots and private contexts. Being streamed as one in a large crowd, usually in a public space and where you are less likely to be identifiable, was seen as much less concerning than being streamed as the sole or among only a couple people in a more intimate or private setting, where disclosure of your presence is almost assured and may be unwanted.

##### 4.1.4. (Un)Consciousness of the Legal Implications of Mobile Live-Video Streaming and of Copyright Laws

Possible legal consequences to live-streaming were also mentioned by a few interviewees ( $n = 2$ ). Participant 13 said she thought broadcasting from a street protest might be "a little dangerous" and that some "wouldn't want other people to know" it was their action, taking it down after the fact. In some sense, these comments express disconnect between what is perceived as legal (video-streaming in public spaces) and what is, instead, desirable.

Another area of concern revolves around live events and intellectual property rights for the performances or even for the rights of publicity for the attendees. The question of what is fair use for broadcasting from events, or even for using the likeness of people who can be identified through facial recognition, was mentioned by some interviewees. Participants, however, generally had a positive attitude towards mobile streaming of public events (e.g., P16 described it as a positive use of the apps or even a social good).

Our findings are in line with existing literature that depicts a problematic picture on the disconnect between the use of mobile streaming platform and the potential legal implications of such uses. For example, Zimmer et al. [27] also reports copyright and privacy violations on Periscope, Ustream,

and YouNow. Similarly, Honka et al. [28] highlights that 57.7% of the observed streamers committed some types of potentially illegal acts while streaming video on YouNow, ranging from copyright infringement, to insulting and violating data privacy laws.

In addition to clarification in case law and in legislation about the proper use of live streaming at public events involving artistic performances or sports matches, a need exists for more education of the general public about what types of use of new technologies will be allowed under “fair use” exceptions to copyright law.

#### 4.2. Design Recommendations Stemming from Emergent Themes

Although the majority of participants had a generally positive attitude towards mobile live-streaming technologies, some expressed reservations that we believe should be addressed when designing for such technologies. Specifically: Mobile devices should inform those in visual proximity to the devices that they are being recorded (to increase awareness), help all bystanders control the ability of mobile app users to record and broadcast video of them (to allow them to provide permission), and to allow disable mobile streaming remotely when needed (to enforce copyright at public events).

##### 4.2.1. Awareness: Colored Lights to Indicate Front or Back Live Video Capture

Most participants ( $n = 18$ ) said they could not tell that our confederates were live streaming vs. recording notes, snapping photos, or playing games. We propose a color LED light next to the camera lens in mobile devices, akin to the red LED light of analog videos cameras that would turn on when the camera was in use, to alert a user or bystander to its activation by lighting up and perhaps blinking while video is being recorded or streamed live over the Internet (Figure 2).



**Figure 2.** Proposed back light on mobile phones to notify bystanders of recording or live-streaming.

This solution would help people to set personal boundaries regarding others’ live-streaming, consistent with the concepts of what constitutes violations of these transitory borders as described by Bohn et al. [13] and with design of privacy-mediating technologies that are proximity-based, as originated in Denning et al. [6]. It would supplement verbal notifications of live-streaming and ease concerns about surreptitious surveillance or streaming at live events.

##### 4.2.2. Permission: “Do Not Record” List and/or Toggle Button

Participants said that unexpected live streaming by others discomfits them when they are in the foreground or otherwise in close proximity. To provide a low-user-effort method of combating this issue, we suggest a “Do Not Record” database to which individuals can register an image of their face. Mobile streaming apps would be required to check faces in the camera’s field of view against the database. If the facial recognition system found a match, the app would blur out the registered user’s face. Alternatively, mobile streaming apps might be forced to communicate with nearby devices to check if anybody within the camera field of view has activated a “I don’t want to be live-streamed” toggle button on her/his phone (Figure 3).



**Figure 3.** Passerby face is blurred thanks to nonrecording database or toggle setting.

Such a system would be consistent with Bohn et al.'s discussion of boundary management [13] and Goffman's concept of impression management [29], as well as the EU legal doctrine of the "right to be forgotten" [11].

Nevertheless, a facial recognition system itself would invoke a host of legal and ethical issues. The design of such a system should be carefully considered to balance the relative tradeoffs. For instance, making the system opt-in system would run the risk of not being able to adequately cover those individuals who have not had the motivation or the knowledge to be able to join in the system. An opt-out system, conversely, may subject some to data tracking and surveillance who would not consent if given the choice first to opt into the system due to concerns about retention and misuse of facial data.

#### 4.2.3. Copyright Laws: Remote Deactivation of Streaming and/or Camera

Similarly, a functionality to remotely de-activate streaming capabilities may be needed in order to comply with copyright regulations (e.g., during sport events). In the absence of any strong advocates for legal safeguards on permissive public live streaming, it is likely that corporations will set de-facto public policy through technology rollouts. Indeed, at the time of this research, Apple was already filing for a patent for an infrared system that could disable iPhone cameras at public events, though it is unclear if they plan to deploy the technology [30].

#### 4.3. Limitations and Recommendations

One limitation of the research is that we did not follow up with participants in the public setting. The authors recognize that the fully public dimension of the first setting made it difficult for the team to fully inform all subjects involved about the deceptive nature of the live-streaming pantomime. In future studies, a final debriefing of some kind (such as handing out leaflets or issuing a public announcement of the study's full methods) would be advisable.

Another limitation of this research is the time that has elapsed from when the research was conducted to this report. Apps such as Meerkat have disappeared, while others such as TikTok have emerged. Social norms and strategies for negotiating legal and privacy concerns around live-streaming have also evolved due to the spread of mobile-social recording-enabled devices and novel circumstances such as the 2020 Covid-19 pandemic. New research is needed to better determine the extent to which the ubiquity of and personal attachment to smartphones is impacting live-streaming video's acceptance in mainstream social situations. This changing environment for related media and policy considerations

also may be affecting attitudes among mobile users and bystanders regarding legal and ethical issues with mobile live-streaming video.

Finally, this report is limited by the relatively small sample size ( $n = 20$ ) and limited setting (US Midwest) of research. We are likely to follow up in the future with a larger research project on this topic.

## 5. Conclusions

In this paper, we presented the results of two field studies pertaining to the public's awareness of and familiarity with mobile live-streaming video apps. We found that, in a "Sports Event" public context, our interviewees were initially unaware that someone was live streaming in their vicinity, and that in this and the "Meeting Event" context, they misattributed a pantomimed live-stream to other types of mobile use with which they were familiar, such as Pokémon Go. Additionally, our data formed a snapshot of bystander attitudes in August 2016 toward mobile live-streaming video, with the popularization of streams and media coverage of news events having normalized its use, but also with tension remaining between the ease of use of these apps and the unsettled social and legal norms for their use in public contexts. Finally, we offered design recommendations for better supporting bystander awareness of and ability to consent to use of their likenesses in mobile live-streaming video, and note the technical possibilities of remote deactivation of live streaming and/or camera use.

We hope this report can help in realizing better technical affordances for bystander notice of, and choice to participate in, nearby mobile live-streaming video.

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## References

1. Williams, R. What is Twitter's New Periscope app? Available online: <http://www.telegraph.co.uk/technology/2015/12/01/what-is-twitters-new-periscope-app/> (accessed on 28 March 2015).
2. Harris, R. App Publishers Can Now Easily Add Mobile Live Video Streaming to iOS and Android Apps. Available online: <https://appdeveloperomagazine.com/3667/2016/2/24/App-Publishers-Can-Now-Easily-Add-Mobile-Live-Video-Streaming-to-iOS-and-Android-Apps> (accessed on 24 February 2016).
3. Juhlin, O.; Engström, A.; Reponen, E. Mobile broadcasting: The whats and hows of live video as a social medium. In Proceedings of the 12th International Conference on Human Computer Interaction with Mobile Devices and Services (MobileHCI '10), Lisbon, Portugal, 7–10 September 2010; ACM: New York, NY, USA, 2010; pp. 35–44. [CrossRef]
4. Morrison, K. Beyond Periscope and Meerkat: The State of Live-Streaming Video. AdWeek. Available online: <http://www.adweek.com/socialtimes/beyond-periscopeand-meerkat-the-state-of-live-streaming-video/620195> (accessed on 13 May 2015).
5. Lavrusik, V. Introducing Live Video and Collages. Facebook.com Newsroom. Available online: <https://newsroom.fb.com/news/2015/12/introducing-live-video-and-collages/> (accessed on 3 December 2015).
6. Denning, T.; Dehlawi, Z.; Kohno, T. In situ with bystanders of augmented reality glasses: Perspectives on recording and privacy-mediating technologies. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '14), Toronto, ON, Canada, 26 April–1 May 2014; ACM: New York, NY, USA, 2014; pp. 2377–2386. [CrossRef]

7. Neustaedter, C.; Greenberg, S.; Boyle, M. Blur filtration fails to preserve privacy for home- based video conferencing. *ACM Trans. Comput. Hum. Interact.* **2006**, *13*, 1–36. [CrossRef]
8. Tang, J.C.; Venolia, G.; Inkpen, K.M. Meerkat and periscope: I stream, you stream, apps stream for live streams. In Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems, San Jose, CA, USA, 7–12 May 2016; ACM: New York, NY, USA, 2016; pp. 4770–4780.
9. Statista Online Video & Entertainment | Statista. Available online: <https://www.statista.com/markets/424/topic/542/online-video-entertainment/> (accessed on 17 March 2020).
10. Singhal, S.; Neustaedter, C.; Schiphorst, T.; Tang, A.; Patra, A.; Pan, R. You are Being Watched: Bystanders' Perspective on the Use of Camera Devices in Public Spaces. In Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems (CHI EA '16), San Jose, CA, USA, 7–12 May 2016; ACM: New York, NY, USA, 2016; pp. 3197–3203. [CrossRef]
11. Right to Be Forgotten (EU). Lumen database, Berkman Center for Internet & Society at Harvard University. Available online: <https://lumendatabase.org/topics/34> (accessed on 17 February 2016).
12. Faklaris, C.; Cafaro, F.; Hook, S.A.; Blevins, A.; O'Haver, M.A.; Singhal, N. Legal and ethical implications of mobile live-streaming video apps. In Proceedings of the 18th International Conference on Human-Computer Interaction with Mobile Devices and Services Adjunct (Mobile HCI '16), Florence, Italy, 6–9 September 2016; ACM: New York, NY, USA, 2016; pp. 722–729. [CrossRef]
13. Bohn, J.; Coroamă, V.; Langheinrich, M.; Mattern, F.; Rohs, M. Social, economic, and ethical implications of ambient intelligence and ubiquitous computing. In *Ambient Intelligence*; Werner Weber, J.M., Rabaey, E.A., Eds.; Springer: Berlin/Heidelberg, Germany, 2005; pp. 5–29.
14. Erickson, T.; Kellogg, W.A. Social translucence: An approach to designing systems that support social processes. *ACM Trans. Comput. Hum. Interact. (TOCHI)* **2000**, *7*, 59–83. [CrossRef]
15. Dougherty, A. Live-streaming mobile video: Production as civic engagement. In Proceedings of the 13th 24. International Conference on Human Computer Interaction with Mobile Devices and Services (MobileHCI '11), Stockholm, Sweden, 30 August–2 September 2011; ACM: New York, NY, USA, 2011; pp. 425–434. [CrossRef]
16. Leading Mobile Internet Activities by Device 2017 | Statista. Available online: <https://www.statista.com/statistics/249761/most-popular-activities-carried-out-on-mobile-internet-devices/> (accessed on 17 March 2020).
17. Topic: User-Generated Content. Available online: <https://www.statista.com/topics/1716/user-generated-content/> (accessed on 17 March 2020).
18. Hernandez, P. The Twitch Streamers Who Spend Years Broadcasting to No One. *The Verge*, 16. Available online: <https://www.theverge.com/2018/7/16/17569520/twitch-streamers-zero-viewers-motivation-community> (accessed on 17 March 2020).
19. Barfield, W.; Caudel, T. *Fundamentals of Wearable Computers and Augmented Reality*; CRC Press: Boca Raton, FL, USA, 2015.
20. Danielson, P. Video surveillance for the rest of us: Proliferation, privacy, and ethics education. In Proceedings of the IEEE 2002 International Symposium on Technology and Society (ISTAS'02). Social Implications of Information and Communication Technology. Proceedings (Cat. No. 02CH37293), Raleigh, NC, USA, 6–8 June 2002; pp. 162–167.
21. Rainie, L.; Duggan, M. Privacy and Information Sharing. Pew Research Center, 16. Available online: <http://www.pewinternet.org/2016/01/14/privacy-andinformation-sharing/> (accessed on 14 January 2016).
22. Tyson, G.; Elkhatib, Y.; Sastry, N.; Uhlig, S. Demystifying porn 2.0: A look into a major adult video streaming website. In Proceedings of the 2013 ACM Conference on Internet Measurement (IMC '13), Barcelona, Spain, 23–25 October 2013; ACM: New York, NY, USA, 2013; pp. 417–426. [CrossRef]
23. Edelman, M. From Meerkat to Periscope: Does intellectual property law prohibit the live streaming of commercial sporting events. *Colum. J.L Arts* **2015**, *39*, 469. Available online: <http://ssrn.com/abstract=2661875> (accessed on 17 February 2016).
24. Hall, E.T. *The Hidden Dimension*; Doubleday: Garden City, NY, USA, 1966; pp. 113–125.
25. Ballendat, T.; Marquardt, N.; Greenberg, S. Proxemic interaction: Designing for a proximity and orientation-aware environment. In *ACM International Conference on Interactive Tabletops and Surfaces (ITS '10)*; ACM: New York, NY, USA, 2010; pp. 121–130. [CrossRef]
26. Vogel, D.; Balakrishnan, R. Interactive public ambient displays: Transitioning from implicit to explicit, public to personal, interaction with multiple users. In Proceedings of the 17th Annual ACM Symposium on User

- Interface Software and Technology (UIST '04), Santa Fe, NM, USA, 24–27 October 2004; ACM: New York, NY, USA, 2004; pp. 137–146. [[CrossRef](#)]
27. Zimmer, F.; Fietkiewicz, K.J.; Stock, W.G. Law infringements in social live streaming services. In *International Conference on Human Aspects of Information Security, Privacy, and Trust*; Springer: Berlin/Heidelberg, Germany, 2017; pp. 567–585.
  28. Honka, A.; Frommelius, N.; Mehlem, A.; Tolles, J.N.; Fietkiewicz, K.J. How safe is YouNow? An empirical study on possible law infringements in Germany and the United States. *J. MacroTrends Soc. Sci.* **2015**, *1*, 1–17.
  29. Goffman, E. *The Presentation of Self in Everyday Life*; Doubleday: Garden City, NY, USA, 1959; pp. 17–25.
  30. Blake, E. New Apple Patent Could Block iPhone Recording at Concerts. Mashable (30 June 2016). Available online: <http://mashable.com/2016/06/30/apple-concert-photos-patent/#oStgyVPJTPqz> (accessed on 20 September 2016).



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