Anonymity vs. Familiarity: Self-Disclosure and Privacy in Social Virtual Reality

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ABSTRACT

Understanding how and why users reveal information about their self in online social spaces and what they perceive as privacy online is a central research agenda in HCI. Drawing on 30 in-depth interviews, in this paper we focus on what type of information users disclose, to whom they reveal information, and concerns they had regarding self-disclosure in social Virtual Reality (VR) - where multiple users can interact with one another through VR head-mounted displays in 3D virtual spaces. Our findings show that overall, users felt comfortable to disclose their emotions, personal experience, and personal information in social VR. However, they also acknowledged that disclosing personal information in social VR was an inevitable trade-off: giving up bio-metric information in order to better use the system. We contribute to existing literature on self-disclosure and privacy online by focusing on social VR as an emerging novel online social space. We also explicate implications for designing and developing future social VR applications.

CCS CONCEPTS

• **Human-centered computing** → *Empirical studies in collaborative and social computing*.

KEYWORDS

self-disclosure, social virtual reality, digital privacy, online social interaction

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1 INTRODUCTION

Social virtual reality (VR) is a growing social ecosystem where multiple users can interact with one another through VR head-mounted displays in 3D virtual spaces [38, 39]. In the past five years, commercial social VR applications such as Facebook Spaces (discontinued in 2019), AltspaceVR, VR Chat and Rec Room have emerged as an important research agenda for VR and HCI communities. However, social VR research is still in its infancy as existing literature mainly focuses on design considerations [38, 39], avatar perceptions [17, 18], and interaction dynamics [9, 33–36]. This demonstrates that these immersive social ecosystems have emerged beyond purely gaming and entertainment to instead cultivate more intimate family experiences [35] and self explorations via embodied avatars [18]. Yet, they also raise a wide range of new challenges and questions regarding negative social experiences and interactions, such as harassment [9] and privacy concerns in these growing immersive spaces.

In this paper, we especially focus on the sharing of information and privacy in social VR for two reasons. First, though most social VR platforms (e.g., AltspaceVR, RecRoom, VRchat) are free to play and are open worlds, they do not clearly inform users on privacy in social VR, for example, regarding what information is public versus what information is private on these platforms. This lack of education and transparency often creates tensions for privacy centric users, and places their personal information at risk. Second, little to no work has investigated privacy and self disclosure in social VR. The majority of prior scholarship on privacy in VR has focused largely on eye tracking [47] and assessing the privacy knowledge of developers and consumers [2], but not specifically relating to social VR.

Therefore, we are motivated to explore: (1) what the common ways social VR users disclose information; (2) what type of information users often share in social VR; and (3) users' concerns regarding disclosing information in social VR. Answers to these questions are not only important to better understand the complicated social dynamics that are afforded in social VR but also can inform the future design of social VR environments and experiences. We thus offer two main contributions to research on VR and HCI. First, we contribute to the existing literature on privacy and self-disclosure in online settings by exploring social VR, a novel and emerging online social space. With little to no scholarship on privacy in social VR, to the best of our knowledge, our work is one of the first that offers empirical evidence to explore user privacy in social VR. Second, our focus on self-disclosure and privacy sheds

light on end-user communication and interaction dynamics that can be used to inform the future design of social VR platforms. We especially highlight four potential design implications - *educating the User, platform embedded voice modulators, platform generated non-identifiable avatars, and adapting social media privacy sharing settings* - for better supporting user privacy and safe self-disclosure in social VR.

2 RELATED WORK

2.1 Self-Disclosure Online and Offline

Broadly defined, self-disclosure refers to intentionally revealing unknown information about themselves to others and making such information shared knowledge [13, 23, 27]. A large body of social scientific research has highlighted several positive and negative effects of self-disclosure. For example, prior studies have shown that one of the most important benefits of self-disclosure is to establish alliance with others [21, 26, 42, 45, 46]. As a social strategy [41], self-disclosure is also an essential component of forming and maintaining social relationships, such as friends, neighbors, and colleagues [3, 48] by facilitating friendliness, close bonds, and enjoyment between people [11, 46]. In this sense, people who self-disclose reveal information to achieve self-expression, self-clarification, social validation, relationship development, and social control [12]. Specifically, information that people often disclose include tastes, interests, hobbies, and works; and information that people seldom disclose consist of money, personality, and physical attributes [25].

More recently, constantly evolving social technologies such as social media, online gaming, and virtual worlds offer new and more complicated ways through which people disclose personal information online. The amount of information users disclose online is more than face-to-face communication [23, 53]. For example, even though individuals are not forced to join online social networking sites (SNS) and share their personal information, they often choose to do so. For them, they are motivated to disclose information on SNS because it is an easy way to maintain and develop social relationships and cultivate platform enjoyment [30]. They also share a wide range of personal information and experiences on SNSs [52], including travel [28], food [29], and mundane experiences [6]. Even those who have privacy concerns choose to share their full name, or even cell phone number [14].

This behavior is especially in contrast to offline social interactions, where the anonymity of online social spaces seem to make users feel more comfortable when disclosing information [4, 22, 51]. Users often share both positive and negative emotions through social networks [31, 43, 54]. In addition, how people trust a particular online social space seems to affect how much they would be willing to disclose [16, 19]. For example, one reason for disclosing information despite having privacy concerns is trust in social networks [32]. This difference between user's privacy intention and behavior is called privacy paradox [5], where high trust can lead to low privacy and low trust can lead to high privacy [24].

In summary, existing HCI studies have highlighted the importance of better understanding the interplay between privacy, online self-disclosure, and technological affordance of the ever-changing online social spaces. Exploring how people understand, conduct, and experience self-disclosure in different online social settings is essential to create safer and more supportive social technologies to better protect people's privacy online. Therefore, we now introduce social VR, a novel and increasingly popular sociotechnical system that both innovates how people meet, connect, and interact and leads to new challenges and opportunities for privacy protection and potentially new ways of self-disclosure online.

2.2 Social Virtual Reality

Virtual Reality (VR) refers to the use of computer modeling and simulation to enable users to interact with an artificial three-dimensional visual or other sensory environment [8, 10, 44]. Prior studies on privacy and ethics in VR have focused on how privacy is defined [40] and how users perceived privacy risks [1, 2]. They have shown that VR users were unsure what type of information was collected by the platforms and had various perceptions of privacy risks [1]; yet they in general considered VR a safe environment [2].

Over the past five years, social VR has emerged as the next generation of VR, becoming increasingly popular digital social spaces where people meet, interact, and socialize in new and more immersive ways. It refers to 3D virtual spaces where multiple users can interact with one another through VR head-mounted displays [38, 39] and can be traced back to the concept of collaborative virtual environments (CVEs)[7]. Social VR users can conduct and enjoy real-life social activities such as walking in public space, playing a game, watching a movie, participating in a concert and having a party in a highly realistic simulated 3D virtual environment through full-body tracking (i.e., one's physical body actions would correspond to his/her avatar body actions). Examples of popular social VR platforms include AltspaceVR, VR Chat, Rec Room, Facebook Spaces (discontinued in 2019), High Fidelity VR, and so forth. They tend to afford diverse activities and a broad range of social atmospheres.

However, they also introduce new challenges for self-disclosure and protecting people's privacy online. For example, social VR affords the intentional or unintentional sharing of tremendous personal information including facial features (e.g., through avatar creation), behavioral patterns, and voices. The amount of information that users can share in a social VR system is much more than what they can through other sociotechnical systems such as SNSs or online games. This leads to higher risks for their privacy when engaging in social interactions and building interpersonal connections. Such systems also simulate more intimate physical contacts (e.g., hugs, holding hands, and dancing), which may lead to new questions of self-disclosure when interacting with others (e.g., new forms of harassment).

While self-disclosure and privacy concerns may play an important role in social VR users' experiences, little to no prior work has explored these phenomena and their implications for designing safer and more supportive social VR system in the future. Therefore, in this paper we focus on two research questions: *RQ1: How do users disclose information in social VR, and what type of information do they often disclose?*; and *RQ2: What are users' concerns regarding revealing information in social VR?*

3 METHODOLOGY

3.1 Data Collection

3.1.1 Recruitment. This study was part of a broader research project on social experiences in social VR. To recruit participants, we posted a recruitment message on nine popular online forums for social VR users (e.g., Reddit-Recroom, Reddit-Altspace VR, and Reddit-VRChat). We also directly recruited participants by entering popular social VR spaces (e.g., AltSpace and VRchat). All participants who responded to our requests and agreed to participate were interviewed.

3.1.2 Interviews. As a result, 30 semi-structured in-depth interviews were conducted. Interviews were conducted via text or audio chat through Discord, Skype, or Google Hangouts based on participants' preferences from October 2019 to November 2019. The average length of interviews was 60 min and participants were given a $20 gift card after they completed the interviews. The main interview questions were related to their social interactions and relationship building in social VR, important activities and social experiences they conduct in social VR, and perceptions and understandings of social VR affordance. Example questions that were relevant to this study included *"Have you ever disclosed personal information/feels/emotions in social VR?", "Have you ever disclosed your gender, race, and/or sexuality to a stranger in social VR?, "Do you have any privacy/security concerns when you share your personal information in social VR or met with online strangers in real life?".*

3.1.3 Participants. Among the 30 participants, 21 are cis male, five are cis female, and four are trans woman. Of the 29 participants who shared their ethnicity, 21 are White, two are African American, four are Asian, and two are Latino. Participants aged from 18 to 65 (average age: 32.2) and with diverse experiences of social VR ranging from 5 months to 36 months (average: 18.7 months). Two participants (P26 and P27) self identified as disabled users. Participants had also experienced a variety of popular social VR platforms including *Rec Room, VR Chat, AltspaceVR, High Fidelity, Facebook Spaces, Vtime, Engagae VR, Mozilla Hubs, Sonoroom, Pokerstar, Oculus Rooms, Sansar, Anyland,* and so forth.

3.2 Data Analysis

We used an empirical, in-depth qualitative analysis [50] of the collected data to explore what users share in social VR and what privacy concern they have when they do self-disclosure. We sought first-person, subjective, narrative accounts of their experiences in the interviews and identified recurring themes. Our analytical procedures focused on eventually yielding concepts and themes (recurrent topics or meanings that represent a phenomena) rather than agreement – because even if coders agreed on codes, they may interpret the meaning of those codes differently [37]. Therefore, we did not seek inter-rater reliability in our analysis but endeavored to identify recurring themes of interest, detect relationships among them, and organize them into clusters of more complex and broader themes.

Our analytical procedures were: 1) two of the authors closely read through the collected data to acquire a sense of the whole picture as what users disclosed in social VR and what concern they had when sharing information in social VR. They then collectively identified thematic topics and common features in the data (e.g., share, practices, concern, disclose, privacy challenges) for further analysis; 2) two of the authors carefully examined and reviewed the thematic topics and developed sub-themes; 3) all authors collaborated in an iterative coding process to discuss, combine, and refine themes and features to generate a rich description synthesizing diverse perceptions and approaches towards self-disclosure in social VR.

4 FINDINGS

Using quotes from participants' own accounts, in this section we present our findings as two parts. First, we investigate how users of different social VR platforms disclosed information and what types of information they chose to disclose (RQ1). Second, we discuss users' concerns regarding risks and barriers for revealing information in social VR (RQ2).

4.1 Self-disclosure in Social VR

In our study, participants showed three patterns when disclosing information in social VR: 1) they often used familiarity or anonymity to decide to whom they chose to share information; 2) they tended to feel comfortable to share emotions and life experiences with others; and 3) sharing certain personal information such as gender, age, and location was complicated.

4.1.1 Familiarity vs. Anonymity. For our participants, it was important to decide whether they would disclose themselves based on whom they would reveal information to. For some, they only disclosed themselves with someone whom they were familiar with. For some others, they only revealed information if they were anonymous. For example, P29 (Cis Female, 21) pointed out that she only shared information with users who she knew.

> *"If I know that person for like a long time and we are friends, not a suspicious friend. I would listen to them and they would listen to me. But doing something like that with just a stranger to tell them like my personal information or anything. No, I don't do that."*

According to P29, after building a relationship with someone, it was easier to share personal information with them. She also mentioned the importance of reciprocity when sharing information with someone and how it helped build trust when sharing. P5 (Cis Male, 29) also reported that he revealed information only with people whom he knew:

> *"Yes, but only because they were someone I talked to for a long period of time. I wouldn't tend to be more private in general but some of the Echo arena players who I've known for a long time now with them, I've been fine to disclose some information."*

To P5, while he defined himself as a person who did not have privacy concerns, he was still hesitant to reveal his information with users whom he knew for a relatively short period of time. This demonstrates building rapport is important to users before sharing information. However, P23's (Trans Woman, 21) opinion

about the level of familiarity with a person with whom she shared information contradicted P29 and P5:

> *"Many times, the fact that it's anonymous on the internet makes it way easier."*

P23's quote highlights the anonymity afforded by social VR platforms. P23 appreciated this facet of social VR because other users could not identify who she was, which made it easier for her to talk to them. In this sense, anonymity encouraged her to disclose information. P10 (Cis Male, 20) shared a similar story:

> *"It's actually been easier for me to share it in social VR than I think in real life.I think part of it is like at least the initial anonymity."*

P10 stated that anonymity in social VR gave him an opportunity to share information with other users. For him, such self-disclosure was "easier" compared to the offline world because he was not bounded by his offline identity.

However, P17 (Trans Woman, 26) also stated that she revealed information about herself with strangers, but her perspective was different:

> *"I feel so comfortable in VR, That I don't mind who I'm telling anything to. It's weird. I don't really feel like I need to withhold information from even strangers because strangers are frequently people that maybe you could be really good friends with. And the best way to kind of be friends with people to be honest with them, right? So, if you're just kind of honest with everyone, you're more likely to find people who you like to connect with."*

P17's experience is different from previous perspectives on familiarity and anonymity. She would rather share information openly regardless of the advantages of anonymity or the secure feelings of familiarity of other users. Her perspective was that every stranger could be a potential friend, so she preferred to disclose her information even with strangers. Her approach also demonstrates an act of goodwill and reciprocity where she extends trust and honesty, in hopes of connecting with individuals that value those same attributes. Another participant, P8 (Cis Female, 28) echoed this view and revealed that establishing meaningful connections with others required more self-disclosure:

> *"I always tell people where I'm from, how old I am. I usually tell people I'm a mother. I think I am pretty open. I don't really have a problem. I think it helps me make connections with people, somewhat. I get to find people in a somewhat similar situation to me."*

According to P8 and P17, sharing information allowed them to find users that had similar interests. The more information they shared, the higher chances were that they may find something in common with other people. In this sense, disclosing information such as age, gender, and cultural information helped social VR users make connections with others.

In conclusion, our participants showed three different perspectives about disclosing information. First, some felt that it was beneficial to reveal information with people they already knew. Second, some emphasized using anonymity to freely share information. Third, an alternative perspective was to be open with sharing information with any strangers regardless of familiarity or anonymity.

4.1.2 Comfortable to Share Emotion and Life Experiences. Our participants regarded that immersing themselves in a shared virtual environment made them comfortable sharing emotions and personal experiences. For them, social VR provided feelings of comfort and safety when disclosing information. For example, P12 (Cis Male, 49) shared that social VR for him was a convenient place to share his feelings:

> *"I'm pretty private when it comes to online stuff. Yeah, like, you know, you see my Discord Avatar that's going to be on the picture will meet you somewhere in the picture graph of the web. Yeah, like on Facebook. I don't use my real name and stuff like that. Yeah, so that in terms of specific personal information not really but in terms of like, oh I had a bad day, its nice to tell people things like that"*

P12's quote highlights that to him, privacy was an adamant concern. However, sharing his emotions did not seem to fit into his criteria for privacy. In fact, social VR seemed to provide feelings of safety and security for a privacy centric user to feel comfortable to share feelings about his life with other users.

Another user P22 (Cis Male, 32) added that he would disclose his emotions and sentiments just like in his offline life:

> *"I might say I'm having a shitty day today kind of thing, but nothing like, oh, my parents just died. I wouldn't disclose anything to somebody that I wouldn't disclose with a coworker, almost nothing."*

For P22, his approach towards interactions and self-disclosure in social VR was similar to his approach in his offline life where he made a direct comparison of users in social VR to his colleagues at work. He also alluded to feelings of safety in social VR, where social VR afforded a safe, comfortable space to let go of his emotions and where he felt safe to express his feelings but not necessarily the details with strangers. P7 (Cis Male, 18) shared similar feelings regarding the ease of expressing himself.

> *"Yeah, Friday night and Saturday nights. I drink a lot with people in social VR. So like, you know, like once people are at that point, you know I slip out of my mind, I think it's better for me to personally to tell these random people on the internet some random emotions that I feel or whatever. Some frustrating thing about my real life that I have rather than someone in real life."*

According to P7, social VR afforded tremendous anonymity, which allowed him to feel safe in sharing "frustrating" details about his offline life. It also allowed him to escape the social confines of the offline world where he did not feel comfortable sharing his emotions. Rather, he would prefer to share his emotions with a "random" person in social VR whom he had little to no social connection with. In a sense, social VR frees him from the offline world and allows him to freely emotionally express himself how he chooses.

In addition, P30 (Male, 43) highlighted that certain situations in social VR allowed people to naturally share emotion. For example, he mentioned watching a sad movie with friends in BigScreen.

> "If you are watching a sad movie like in the big screen. I can remember talking about the first time I saw a particular movie, it was a bit of a weepy and made you tear up. So I think, yeah, it's definitely something that you can talk about."

In this example, when he watched an emotional movie in BigScreen, because he felt close with his friends in the environment, it was easier for him to cry and share emotions. This highlights the many affordances of social VR for fostering an appropriate social atmosphere that allow users to feel connected with others and share their emotions.

4.1.3 Sharing Personal Details Was Complicated. Social VR users also tended to share sensitive private stories and personal details about themselves. However, such self-disclosure was more complicated. To some participants, they were willing to share private personal stories if such sharing could offer some help to other users. For instance, P24 (Cis Female, 27) talked about information she shared in the AltspaceVR:

> "I've talked about stuff having to do with substance use. I had a personal experience and I think it can be educational to others."

According to P24, she chose to share her experiences about illegal substances because she thought it would be helpful to educate and inform other users. For her, social VR seemed to provide an easier non-intrusive way of knowledge transfer, which involved a level of anonymity when disclosing such a sensitive experience. It may also facilitate an open non-judgemental means of disclosure.

Additionally, P9 (Cis Male, 24) explained how he could share some of his personal stories with others when he gave others tours in VRchat.

> "I do share sometimes personal stories as I said before the tour. - things just to give the Japanese area that I used to share like a personal experience that they had there at these kinds of places."

For P5, social VR compelled him to provide a contextual experience of what it is like being in Japan. He enjoyed sharing his personal anecdotes because social VR allowed for more in-depth sharing of personal anecdotes compared to traditional mediums - in this example, he could describe exactly what he was doing in the spot where he was.

Other participants mentioned sharing personal details such as their location, age, and gender. For example, P17 (Trans Woman, 27) and P22 (Cis Male, 32) did not have any objections to sharing such private personal information:

> "I feel totally safe. I think it's really up to how much information you're willing to give. I let people know that I live in the St. Paul Minneapolis Twin Cities area and Minnesota even to complete strangers and say like, it's like cold today. I never tell anyone about my address. But I don't feel concerned with information to that level I feel pretty okay with."

> "I'd tell people where I live, generally, not my address, you know, in Canada and Calgary kind of thing."

For P17 and P22, voluntarily sharing private information such as location was not seen as a concern but rather a way to provide relevant information for strangers to know about them and their backgrounds.

However, some people also mentioned that regardless of one's willingness to disclose personal information, they were forced to disclose some part of personal information in order to use the social VR platforms. For example, P11(Cis Male, 21) noted that his gender was identifiable in social VR:

> "I have disclosed my gender, and I think it's relatively obvious because people can tell that I'm a male from my voice even if I didn't tell them my gender."

In this example, we see that some features are inherently identifiable in social VR, such as the visual representation of the avatar or voice chat, which can reveal the user's gender regardless of one's willingness to self-disclose or not. As P11 emphasized, whether one chose to disclose or conceal one's identity other users could identify gender based on voice. Even unisex avatars can be exposed by their voices. For instance, P24 (Cis Female, 27) said that though she did not disclose her gender, it could be easily identified:

> "it's pretty clear my gender because I use a female Avatar and I'll often talk so they can hear my voice is feminine. I haven't really disclosed that before."

According to P24, gender identification was a relatively common phenomenon in social VR. P24, asserted that via her voice and her avatar appearance, it is easy to identify what her gender was. In particular, for some other users, the use of voice chat in social VR forced them to self-disclose. P23 (Trans Women, 21) added that she had to self-disclose to corrected users, who misinterpreted her gender:

> "Yeah, sometimes I have to say I'm trans to correct people. Voice masculinity training is hard."

P10 (Cis Male, 20) also emphasized that unintentionally disclosed voices could reveal more information about people:

> "when they allow voice chat, right, instead of just having text chat essentially reveals more about people's identity. There have been other people who I would assume potentially have autism or some other condition in which people would then kind of like, look more negatively upon them. Okay, because they could hear the voice."

P10 explained that the combination of having an avatar and perceiving one's voice can reveal much more than gender - it can reveal information on one's "ability." Such disclosure can impact one's social interactions based on how others view someone's ability.

In particular, some participants were motivated to create avatars that were as similar to their physical self as possible. In this way, they not only took advantage of the advanced customized avatar features provided by the social VR platforms but also enjoyed more engaging social VR experiences - by controlling a full body tracked

avatar that looks like them. For example, P10 (Cis Male, 20) mentioned his avatar in social VR resembled his physical appearance in offline life:

> "my avatar is fairly similar to what I look like
> in real life. So I've actually pretty much modeled
> it as close as possible in terms of the whatever
> default options they give us."

P21 (Cis Female, 46) also stated that she tried to make avatar similar to herself:

> "I try to customize the avatar in the way I look.
> It got short hair, medium to tall height, and was
> quite muscular."

For these participants, they felt that it was very important to represent themselves in social VR with specific details about their offline appearance. However, while they enjoyed a closer connection to their avatar and a more engaging social VR experience by doing so, they also intentionally or unintentionally disclose important information about their offline identity to other users (e.g., physical appearance). Such disclosure not only made them more identifiable but also may lead to potential privacy risks.

4.2 Concerns about Self-disclosure in Social VR

Our participants collectively highlighted two themes of concerns regarding self-disclosure in social VR. Some regarded social VR as a risk free social space for freely sharing information with others; while some others had reservations about sharing information and were reluctant to self-disclose in social VR.

For example, some participants did not have any concerns about privacy so they freely shared personal information in social VR, as P23 (Trans Woman, 21) pointed out:

> "I mean, besides the usual suspects like I don't
> say my bank information. so I don't really have
> privacy issues."

According to P23, she adhered to the general consensus on what should not be shared regardless of online or offline. Yet she did not have any extra concerns about talking to people about her personal information in social VR. P15 (Cis Male, 26), like P23 was not concerned about sharing personal information at all:

> "I wouldn't give someone, say like my social
> security number. But I honestly don't really have
> too many concerns about sharing stuff about me
> online."

According to P15, only the most important personal information such as social security number should be kept private online. For him, he felt rather open about the personal information that he shared and expressed little safety or privacy concerns.

In contrast to these participants, some others expressed serious concerns about sharing any kind of information on social VR platforms. For instance, P25 (Cis Female, 20) mentioned that she preferred to always stay anonymous: *"I keep things pretty anonymous."* For her, this strategy of being anonymous significantly limited any potential privacy issues. P20 (Cis Male, 20, White) employed a similar strategy. He pointed out that he was not willing to share information about where he was living: *"I don't disclose the specifics of where I live and stuff like that."* By not disclosing the country or

area where he lived, P20 seemed to assume that this would prevent him from being identified.

Some other participants even went so far as to not share any personal information at all. For example, P30 (Cis Male, 43) believed that even user names should only be shared with people whom he knew:

> "You can control who can see your username in
> social VR. so I have decided to only allow certain
> people whom I know to see my username. It's
> always good to be careful Online."

P30 is a privacy-centric user, for him, the safe way to engage in social VR was to share the least amount of information as he could, including his username that was only a pseudonym. In his opinion, he only felt comfortable displaying his username with those whom he already knew. This may protect him from being identified by strangers since people would not be able to find him on other online platforms (e.g., social media) by searching his username.

5 DISCUSSION

To answer the two research questions that we proposed at the beginning of this paper, our findings have shown: 1) social VR users showed three patterns regarding self-disclosure: sharing based on familiarity, anonymity, or open sharing regardless of familiarity and anonymity; overall users felt comfortable and encouraged about disclosing emotions and general life experiences in social VR; but sharing sensitive private stories and personal details was more complicated (RQ1); 2) we also highlight conflicting viewpoints on concerns about privacy and self-disclosure in social VR, one considering social VR risk-free for disclosing information and the other showing cautions for revealing information in social VR (RQ2). We now discuss the implications of this work for contributing to existing literature on privacy, self-disclosure online, and social VR.

5.1 New Perspectives on Self-disclosure and Privacy in Social VR

As we described at the beginning of this paper, little to no work has investigated privacy and self disclosure in social VR. One of our goals was to explore how and in what manner self-disclosure happens in social VR environments. Our findings demonstrate both the nuances of self-disclosure that are specific to social VR and similarities to other technological platforms (e.g., virtual worlds, social media) and offline interactions.

On the one hand, we saw strikingly similarities to social media and online forums where users are comfortable sharing positive and negative emotions and feelings [31, 43, 54]. Additionally, users' concerns about self disclosure in our findings are similar to those in other social mediums [15, 55, 56]. Yet still, social VR and social media alike facilitate environments where users feel comfortable sharing of experiences [6, 28, 29]. In our findings, there was no consensus on what type of information users shared, some choosing to disclose only *personal* information and others only disclosing *emotion*, this could be because of the vast diversity of users regarding age, gender, sexuality, and culture.

On the other hand, social VR introduces new ways of self-disclosure and unique challenges associated with them. One such new way is the mandatory self-disclosure embedded in the system design

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of social VR - to use the service, all users have to give up part of their personal information by default such as voice. Our participants noted that voice chat in social VR can reveal identifiable information of gender, age, and ability. While voice chat is not a new phenomenon, interactions in social VR highly depend on voice chat, which provides specific constraints for communication when other communication modalities are not available. Such mandatory disclosure may sometimes cause awkward situations, especially when the voice expectations are different from avatar appearance. In this sense, voice chat in social VR becomes a trade off - more efficient interpersonal interaction and communication but higher degree of self-disclosure and less privacy.

Similarly, social VR's focus on immersive and embodied experiences not only offers unique opportunities for users to present themselves and communicate with others in nuanced ways but also causes new privacy risks. As our findings show, while other online media like virtual world and online gaming are also avatar-based systems, social VR users are motivated to create avatars that are similar to their physical self. In this way, they could enjoy more engaging social VR experiences through full-body tracking (i.e., one's physical body actions would correspond to his/her avatar body actions). However, creating an avatar that is similar to one's physical self inevitably discloses important personal information about one's offline identity, including height, race, appearance, and gender. Such disclosure make social VR users more identifiable and less anonymous, which may also lead to potential privacy risks (e.g., stalking).

Despite these embedded features that force people to reveal personal information, we see contradicting viewpoints about self-disclosure in social VR. A group of our participants found social VR a safe environment and they did not perceive any privacy concerns when revealing information about themselves to other users. And another group of participants stated that they were cautious about sharing their information in social VR, and persisted to not disclose themselves. We also see striking contrast between the types of information that they shared, such as location, emotions, and personal experiences vs choosing not to share at all. These behaviors demonstrate the *privacy paradox*, where users choose to disclose some parts of information and conceal others [5]. One potential explanation for could be how much users trust different social VR platforms. Users that choose to share information may trust these platforms more than users who share less [24]. This can be a key insight for social VR developers and designers to create experiences that are transparent and demonstrate trust, allowing for more open and candid interactions among users. Another reason for the disparities in self disclosure could be due to the broad range of users in terms of culture, location, age, and gender. In this sense, design strategies for crafting experiences for a broad range of age and ability, such as Story et al.'s [49], would be insightful for designing future social VR platforms, which specifically focus on creating *equitable* experiences and stress the key of *flexibility* and *simplicity*.

In summary, our study suggests that as social VR affords similarities (e.g., naturalistic modalities) to offline instances of self disclosure, it also extends disclosure in traditional online mediums (e.g., social media) and to some degree, inherently places user personal and bio-metric data at risk. How to balance the quality of social interaction and communication in an immersive VR environment and the need to better protect user privacy and safer self-disclosure, therefore, becomes an important question for social VR designers and developers.

5.2 Implications for Social VR Design & Development

Grounded in our findings, we identify four potential design directions to further support privacy and safe self-disclosure in social VR. These design directions are neither complete or exhaustive as they are mainly directions emerging in our participants' accounts. Yet, we consider that they may benefit developers/designers who endeavor to design safer and more socially supportive VR technology in the future.

5.2.1 Educating the User. The technical affordances of social VR allow for user information such as voice, avatar presentation, and motion tracking to be personally identifiable. The manner in which this information can be collected is not always cognizant to users. Additionally, different users may have different privacy concerns and may not be aware of what information can be disclosed in social VR. Therefore, a useful potential design would be giving users appropriate guidelines about potential harms that the lack of privacy can come along with. For example, social VR platforms can implement an onboarding process that involves Tutorial and training modules, which show how a user can be tracked and identified based on certain types of important information as well as the consequence of revealing such information. Such an onboarding process would be helpful for protecting users from disclosing too much personal or private information.

5.2.2 Platform Embedded Voice Modulators. Voice chat is a social VR feature users enjoy but this feature reveals identifiable voice data. Therefore, platform provided voice modulators, which make users' voices anonymous and generic, would allows users who have privacy concerns to remain anonymous. In this way, this feature would allow for the concealment of gender, ability, and age. Currently, these features are available as modifications on certain VR devices but are not always accessible for all user. Additionally, developers can adopt more advanced methods such as re-targeting [20] to protect other forms of biometric data such as facial expression, gestures, and gait.

5.2.3 Platform Generated Non-Identifiable Avatars. Our participants noted that self-disclosing information in social VR was often times complicated, especially regarding scrutiny or unwanted attention via their avatars. To aid users, social VR platforms can offer a wide variety of non-identifiable and non-conforming avatars. Using such avatars will help users not to be identified via avatar gender, avatar race, or stereotypical cultural traits.

5.2.4 Adapting Social Media Privacy Sharing Settings. Many social media platforms allow users to set up and control the levels of personal information that they want to share. Such level-ed privacy settings can also be added and adapted for social VR. For example, a potential feature would be only allowing friends and certain contacts to view where the user is in social VR (e.g., world, personal room, and public room) on the platform. This would allow users to

have varying degrees of social circles with regards to what information they share. It would also allow for different levels of social engagement and interaction between users.

6 LIMITATIONS

A few limitations of this study should be noted. All interview participants were recruited from online forums or social media. There is a potential bias towards social VR users who maintain an active social media account. Another limitation is the lack of even distribution between participants' age, culture and gender, which affect how they perceive and understand self-disclosure and privacy in social VR. Future work should aim to recruit a broader pool of interviewees with more diverse age, gender, and cultures to capture a more comprehensive picture of the effect of self-disclosure and privacy concerns in social VR. A large scale survey can also be conducted in order to distinguish results based on different categories of users in terms of age, gender, and type of social VR platform.

7 CONCLUSION

Commercial social VR platforms are becoming increasingly popular. Yet the rapid growth of these emerging novel digital social spaces can lead to new challenges understanding potential privacy concerns when users interact and share information with one another. In this paper, we have investigated how users disclose themselves in social VR, what types of information they tended to reveal, and their concerns regarding self-disclosure in social VR. Our key findings include: first, users are comfortable to disclose their emotions, personal experience, and personal information in social VR. However, they also acknowledged that disclosing personal information in social VR was an inevitable trade-off: giving up bio-metric information in order to better use the system. Second, users show contradicting attitudes toward privacy concerns in social VR. Some did not perceive any privacy concerns in disclosing information while others were cautious about the scope and content of information that they would share. We hope that these insights would lead to a more in-depth and comprehensive understanding of self-disclosure and privacy concerns in social VR and inform future directions for designing safer and more satisfactory social VR platforms.

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