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A Youthful Metaverse: Towards Designing Safe, Equitable, and Emotionally Fulfilling Social Virtual Reality Spaces for Younger Users

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Abstract

Social VR refers to 3D multi-user immersive spaces where users are connected via head-mounted displays (HMDs) and are represented by full or partial body tracked virtual avatars. It is considered the modern evolution of Neal Stephenson's concept of the metaverse. These spaces have become popular online social environments where users can interact, socialize, and game with one another in new and immersive ways. As such, they have attracted diverse user groups, particularly a large number of young users (e.g., teens ages 13 to 18). For them, social VR provides incredible opportunities for social engagement, entertainment, education, and immersive play. However, it simultaneously raises considerable risks for their safety and well-being. As social VR continues to increase in popularity, it is important to investigate how teens understand and experience social VR as well as to design future social VR systems to mitigate potential risks that they may face (e.g., harassment and privacy).

To address these concerns, this dissertation research explores three research questions: RQ1: How do teens use social VR (e.g., frequency, experiences, and common activities)?

RQ2: How, if at all, does the use of social VR affect teens' social lives in various ways (e.g., risks of harassment, privacy concerns, friendships, romance, and psychological well-being)?

RQ3: What requirements, features, and mechanisms are needed to design safer and more supportive social VR spaces for teens?

To explore these RQs, four studies were conducted. Study 1 interviewed 30 adults on their perceptions of younger users in social VR. Study 2, a participatory observation study, explores the interaction dynamics between young users and their peers and between younger users and adults in social VR. Study 3 interviewed 30 teen users to investigate their unique perceptions, experiences, and challenges in social VR, and finally, Study 4 is a longitudinal diary study involving 13 teen users to explore trends in teens' experiences in social VR and to identify potential design recommendations for improving its design for this age group.

This dissertation research provides one of the first substantial bodies of work investigating teens' experiences in social VR and the broader metaverse, with the purpose of creating more emotionally fulfilling and safer experiences for this population. The scientific contributions of this research include 1) expanding the current HCI understanding of the social dynamics and the interactions of teens in emerging novel online digital spaces; 2) bridging two research areas that have not been widely studied in HCI, social VR and young users in social VR; and 3) generating design implications to inform the design of future social VR platforms to better support and protect teens' online social

experiences, results which may also apply to other emerging online socio-technical spaces such as augmented reality (AR) social interactions.

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Chapter 1

Motivations and Research Questions

Metaverse, a term of growing popularity refers to virtual spaces where users can interact and experience rich interactivity which mimics offline everyday life experiences (e.g., general everyday life), is upon us [1]. Although this term has become popularized today (2021), it existed long before the buzz of 2021[1]. It was first coined by Neal Stephenson in his novel *Snow Crash* [2]. Stephenson describes the metaverse as a place where human avatars and software agents interact in three-dimensional virtual spaces as they would in the offline world. Its more primitive forms are most commonly referred to as MUDs (Multi-user dungeons), Collaborative Virtual Environments (CVEs), Massively multiplayer online role-playing game (MMORPGs), and open-ended 3D virtual worlds, with specific examples including Sims, IMVU, Roblox, SecondLife, Runescape, ClubPenguin, Habbo, Fortnite, and World of Warcraft[3]. Additionally, an argument could be made that the internet itself and social media are existing metaverses. Thus, the concept of the metaverse has long existed and been improved with each iteration of technology.

In summary, this concept is attractive for a variety of reasons, primarily stemming from such affordances of the environment (e.g, what the technology offers an individual) [4] as experimentation through avatars [5–7], engagement in unique virtual experiences [8–10], and the opportunity to develop relationships that may create new social bonds or strengthen existing relationships [11–13]. As a result, the metaverse has evolved to become online digital spaces where individuals can be in touch and play and work together even when they are geographically apart [14].

In particular, the latest technological iteration of the *metaverse* is what we refer to as *social virtual reality (VR)*, a novel place for users to interact with one another as they would in the *offline world* (e.g., physical world). It is important to realize the distinction

between the *offline world* as opposed to *real world*. With this distinction, I assert that the relationships, experiences, and behaviors in the metaverse are perceived as *real*. The realness of these experiences also has been demonstrated in past research [15–18] and is even made more powerful through the use of VR technology. Therefore, when I refer to the *offline world* I am referring to the physical world (e.g., real world).

It should be noted that VR technology provides two main advantages that other 2D and 3D worlds do not: immersion and embodied avatars. Immersion refers to the objective level of sensory fidelity a VR system provides [19], the reason it can assist in phobia training [20] and exposure therapy for PTSD [21]. These virtual environments are powerful and provide experiences capable of influencing how one perceives the environments around them and the objects within them. An embodied avatar is a co-located 3D representation of a user (see Figure 1.1); in VR these avatars are capable of full body tracking in which the users' movements in the offline world correspond to the avatars' movements in the virtual world. Embodying an avatar can have extremely powerful psychological effects, including changes in a user's behaviors and perceptions [22–25]. For example, embodying an avatar of Albert Einstein led to increased cognitive task performance and decreased age bias [25]. It should be noted that the majority of these psychological effects exist during the experience and shortly after, emphasizing the need for more research on the long-term effects of avatars.

FIGURE 1.1: Full body tracked avatar represented by the user

Today social VR is an increasingly popular online social ecosystem, beyond just play and entertainment, where multiple users can interact with one another (via avatars) in 3D virtual spaces [26, 27]. In these open-ended 3D virtual worlds, users engage in cultivating

online social relationships, exploring diverse virtual places [28], experimenting with self-representation [29, 30], and enjoying immersive gaming. In this dissertation, I consider the term ***social VR*** as the modern rendition of ***metaverse***.

The diversity and richness of the activities afforded by social VR have attracted users of different age groups, and particularly a large number of young users (children and teens, ages 13 to 18); their presence across different social VR platforms has been substantiated through their relatively shorter avatars [31] and/or their higher-pitched voices [32]. For young users, social VR provides incredible opportunities for social engagement, entertainment, and *play* in a immersive and novel way. However, it simultaneously raises considerable risks for their well-being and safety. For example, social VR allows young users to build virtual intimacy and emotional connections, experience rich interpersonal interactivity beyond gameplay, and participate in nuanced group behaviors [32, 33]. However, these adolescent users are prone to sharing personal information, can be exposed to mature content and virtual sexual assault [33], and are known for their excessive use of social VR [32]. All of these point to the importance of designing interactive, safe, and emotionally fulfilling social VR spaces for young users while mitigating the potential risks that they may face in this novel emerging virtual space (e.g., harassment, privacy, and well-being). In response to these issues, this dissertation research aims to explore the following research questions:

RQ1: How do young users use social VR (e.g.,in terms of frequency, experiences, and common activities)?

RQ2: How, if at all, does the use of social VR affect the social lives of young users in various ways (e.g., risks of harassment, privacy concerns, friendships, romance, and psychological well being)?

RQ3: What requirements, features, and mechanisms can be identified for designing safer and more supportive social VR spaces for young users?

As these research questions indicate, this dissertation focuses on investigating and understanding the experiences of young users ages 13 to 18 and on how to design and create safe and emotionally fulfilling social VR spaces for children and teens. This investigation is composed of four studies, with the last three motivated by my initial findings from Study 1. From its results emerged the broader initiative of focusing on young users and designing the follow-up studies to provide insight into young users and how to co-design spaces for them.

In the first study, we interviewed 30 adult users about their perceptions and experiences of social VR. This study was part of a broader research project, and although there were no direct questions relating to young users or children, almost every participant made a

comment about children in the virtual world. These participants specifically mentioned that children were an inherent part of social VR and expressed both concerns about and frustration toward these young users. These comments motivated me to obtain in-depth, first-hand experience to confirm the findings from Study 1. Study 2 was a participatory observation study in which I embedded myself on social VR platforms to a gain broader understanding of the findings from Study 1. The findings from this second study demonstrated that young users are interacting in social VR beyond play and entertainment, making it a space for intimate emotional connections. Study 2 also demonstrated the considerable risks posed to younger users, including harassment and being exposed to mature content by adult users. While Study 1 and Study 2 demonstrated a few ways young users engaged in social VR, these findings were from the perspective of adults and did not yet explain how young users understand and experience social VR from their *own* perspectives, leading to Study 3 and 4. Study 3 interviewed young users, focusing on the benefits and disadvantages of social VR especially during the 2020-2021 COVID-19 global pandemic. However, it did not elaborate on the trends of youths' social VR use nor generate insights for design recommendations. This led to Study 4, a four-week diary study aimed at explicating the trends of youth in VR and social VR in addition to obtaining user-generated design recommendations.

This dissertation research presents one of the first empirical investigations into understanding young users' experiences in social VR and the broader *metaverse*. Its goal is to identify the challenges and risk young users face when using VR and to generate design recommendations for creating safer, more equitable, and more fulfilling experiences for them.

In doing so, this dissertation RQ's yielded the following highlights:

It should be noted that these highlights are based off of the participants in this research, which may not be representative of all youth not all Youth who use VR.

- For participants involved in this research, Social VR platforms are the most used forms of VR content for teenagers (e.g., games, education).
- Youth involved in these series of studies see social VR as a phenomenal tool for social development, well-being, and self-exploration.
- Youth involved in the last two studies spent a large amount of time in VR (22 hours/week in Study 3 and Study 4) and social VR (16 hours/week in Study 4), and self-reported use during the summer averaged 63 hours/week.

- For youth participants involved in this research, they believe the criticism of VR from adults is unwarranted and recommend the critics experience VR and social VR platforms.
- For youth participants involved in this research, they generated design recommendations focused on improving the design for the most vulnerable young users, performance recommendations, and more affordances relating to VR.
- Nine youth-generated design recommendations focused on ensuring a safe and emotionally fulfilling metaverse for young users.
- For youth participants involved in this research, sleeping in VR is a regular activity for youth using it.

It should be noted that concepts such as equity, care for participants, and ethics were of great importance in this dissertation. Often young users of technology have little to no input on the design, iteration, and age-appropriate considerations as technology is developed. In this dissertation, I focused on youth-centered innovation, placing the care and consideration of young users at the forefront of the nine recommendations this work has yielded. It is my hope that this work and others like it will provide youth-centered innovations that will not only have implications for the ever-evolving metaverse but also the field of human-computer interaction and immersive technology, all designed to support and empower youth.

Chapter 2

Related Work & Foundational Theories

This chapter focuses on the theoretical foundations relevant to the research conducted in this dissertation. The first set of theories (Sections 2.1-2.2) relates to the evolution of the *metaverse* and youths' involvement in it. The second set (Section 2.3) applies to the psychological attractions and fascinations with the metaverse. Section 2.4 focuses on the modern version of the metaverse, social VR and the prior work in the area, while Section 2.5 demonstrates the affordances that VR technology provides which makes social VR a visceral experience which closely mimics the offline world and finally Section 2.6 explores prior scholarship in the area of youth and virtual reality, concluding with a summary of research gaps in this work.

2.1 Online Social Experiences in the Early Metaverse (Traditional Virtual Worlds)

The term *Metaverse* was first coined by Neal Stephenson in his novel Snow Crash [2] as a place where human avatars and software agents interact in a three-dimensional virtual space as they would in the offline world. This concept of the metaverse, or interactivity via online computer-mediated interfaces which mirrors interactivity in the offline world, has existed in many forms. Long before the buzz of 2021 when Facebook announced its name change to Meta [1], metaverses have existed in more primitive forms most commonly referred to as MUDs (Multi-user dungeons), Collaborative Virtual Environments (CVEs), Massively multiplayer online role-playing game (MMORPGs), and open-ended 3D virtual worlds.

The earliest social experiences in online spaces were conducted via rich text-based interactions (MUDs) [34] through which users immersed themselves in various activities such as role-playing, adventure quest, and reenacting famous scenes from movies [8, 9]. In addition to these entertainment experiences, text-based collaborative learning was also considered a significant activity in MUDs [10]. Such experiences were even heralded as a more efficient way of communication in workplace as they could maintain social relationships across different locations and schedules [35] and facilitate meaningful interactions and activities because they were real time, archivable, unobtrusive, multiuser, and exclusive [36]. However, an important limitation of text-based social activities was the inability to convey and interpret rich social cues through posture, gestures, and voice intonation.

Collaborative Virtual Environments (CVEs) are considered important online digital places and spaces where people can be in touch, play together, and work together even when they are geographically apart [14]. Early work by Bailenson and colleagues on the social dynamics in CVEs demonstrated the nuances of CVEs similar to face-to-face interactions [15], including the use of nonverbal cues in a virtual environment [16] and the transformed interpersonal communication [17, 18]. These studies demonstrate the nuances of sociality in CVEs highlighting the potential future use of these online social environments. However, they were primarily conducted in a controlled lab environment, limiting the implications of their findings to non-traditional settings (e.g., labs vs real world).

Group activities and collaboration constitute essential social activities, especially in MMORPGs [11]. where groups can be short- or long-term and of diverse sizes ranging from 3 to several hundred. Very often, the size and goal of the group can lead to different types of activities. For example, temporary groups (i.e., "parties") tend to have short-term goals that focus on activities like completing a quest or defending against another party rather than socialization [37]. In contrast, long-term groups such as guilds are highly organized to generate more dynamic and intimate relationships [12, 13]. Members of a guild were noted to share intimate details about family, significant others, and personal lives [37]. As a result, in these groups members also engage in social activities unrelated to the actual in-game tasks or goals, leading to more socially intimate experiences. For example, prior studies have highlighted that collaboration between two or more members, whether in a group, guild, or dyad, may create substantial emotional bonds of friendship, intimacy, affection, and online romance, making online activities meaningful and enjoyable for the users [38–40].

The more modern MMORPGs and virtual worlds are avatar-based systems, and experimenting through avatars has become a significant part of users' online experiences and

activities. For these users, avatars are not only central to how they communicate and express themselves online but also afford novel activities for constructing completely new identities or reaffirm existing ones [5, 6]. For example, Ducheneaut et al. found that users enjoyed the act of experimenting with a different digital body, leading to "creative freedom" [7]. Such freedom also afforded cross-gender/queerness gameplay via avatar customization [5, 41]. As Freeman et al. demonstrated, users tended to use cross-gender play to escape from stereotypes when playing games that mimic traditional offline gender roles [39, 42]. To many users, the act of presenting, creating, and customizing their avatars has become a key experience for them to socialize, explore, and experiment in an online social space.

In summary, this scholarship has highlighted that the evolution of Stephenson's concept of the *metaverse* where experiences in online social spaces have expanded to include affordances (i.e., what the environment offers the individual) [43] specific to a cetain system, either through the mode of communication, the support of group/collaborative behaviors, or avatar creation and customization. In 2021. the date of this dissertation, we find a variety of Metaverses ranging from SecondLif, and Roblox to VR specific metaverses like RecRoom, VRchat, and AltspaceVR. In light of this evolution, this dissertation considers social VR as a modern form of the Metaverse.

2.2 Youth's Experiences in the Metaverse

A body of research has also explored how children use and experience the metaverse, or the virtual worlds. Such worlds in the form of Multi-User Domain Object Oriented (MOOs), MMORPGs, and open-ended digital social spaces have been used by children since the late 90s [44]. In more recent years, many virtual worlds have been designed specifically for children[45], for examples *Neopets, Barbie Girls, Club Penguin, and Habbo Hotel.* These worlds tend to focus on playful designs and child-centric activities, including imitative role-play and make-believe with both objects actions and situations [46–49].

One example is Habbo Hotel, one of the largest social virtual worlds for teenagers (e.g., 10 times more users than Second Life) [50], popular due to three features [51]. The first facet is the ability to co-create social context, meaning users do not have to rely on in-game interactivity but can spontaneously create interactivity among one another. Second, it uses the virtual world as a spaces of digital artifacts, for example avatars, items, and experiences such as escapism, voyeurism, and self-image. Third, the anonymity and safety in an environment allow for freedom of self-expression and experimentation with various avatar skins and social events involving identity. These feature suggest

that teenagers perceive certain aspects of social virtual worlds as less risky compared to the offline world for experimenting with identity and largely use these environments for social experimentation [50], creating interesting challenges and opportunities around identity construction because for most children, engaging in a virtual world may be the first time when they can control an avatar. In this process, they have the opportunity to construct, re-construct, and learn how to perceive themselves and others in an online world [46].

This process of self exploration may not be all positive as unwanted interactions such as harassment, cyberbullying, and sexual misconduct [52] still occur in these virtual worlds, raising safety concerns for children who engage in them. Nonetheless, these child-centric virtual worlds have been generally perceived as safer and preferred by parents as oppose to traditional online gaming (e.g., *World of Warcraft*). For example, Marsh mentioned parents saying, *"I let my kids use Club Penguin and i think its perfectly safe"* [46]. One reason why Club Penguin was perceived as a safer environment compared to other platforms where adults are present such as Second Life [52] could be the *Ultimate Safe Chat* feature, which is designed to protect children from predators. However, it dramatically reduces the players' abilities to meaningfully engage and connect with others in the space [53]. As this limitation highlights, questions remain about how to design safe and fulfilling virtual spaces for young users without limiting their experience.

2.3 Psychological Attraction for the Metaverse

As early virtual worlds, metaverses, and online social platforms have become increasingly popular since their inception, the question becomes what attracts users to these platforms and why are these forms of interactivity preferred over offline forms of interactivity. One theory to help address this question is the Self-Determination Theory (SDT), a psychological macro-theory of human development, encompassing human motivation, growth, well-being, and innate psychological needs [54–56]. It is a core scientific theory [54] supported by extensive scholarship [57] that both generalizes and specifies an individual's motivation, well-being, and decision making unspecific to their demographic. For example, Ryan et al. demonstrated that SDT applies to a variety of individuals regardless of the cultural, political, and economic conditions of their development [54]. According to SDT, extrinsic motivation and organismic integration are core for the development of an individual. The core of development is a cycle of motivation, internalization, and well-being which feeds into core psychological needs of autonomy, competence, and relatedness. The foundation of SDT is comprised of six sub-theories: cognitive evaluation theory, organismic integration theory, causality orientations theory,

basic psychological needs theory, goal contents theory, and relatedness or relationship motivation theory. Below I briefly explain the relevance of Basic Psychological Needs Theory, Goals Content Theory, and Relationship Motivation Theory to this dissertation's focus on the metaverse and HCI [58, 59].

Basic Psychological Needs Theory (BPNT) is comprised of three psychological needs that energise organismic processes: competence, autonomy, and relatedness. Competence refers to a feeling of having an effect, while autonomy is a sense that actions are self-endorsed and performed willingly and relatedness is a sense of reciprocal care, value and belonging in relation to other social figures and collectives [60]. An individual's *satisfaction* in one of these areas promotes intrinsic motivation, internalization, and well-being. On the other hand, the lack of satisfaction with these needs promotes *frustration* and feelings of being incapable or controlled or ostracised by otheriteryan2017basic.Related to video game enjoyment and play, *need satisfaction* has repeatedly been found to predict in-game emotional fulfillment [61–63]. Another intersecting theory of SDT in games and media is the *need density hypothesis*, which proposes that individuals whose basic needs are poorly satisfied are more likely to develop an unhealthy preference for "dense, consistent, and immediate" [64] experiences in virtual environments and video games [65].

Thus far, I have detailed the "what" of SDT and how it relates towards BPNT. The next theory pertinent to this dissertation is the Goals Contents Theory (GCT), which explains "why" a goal is pursued centering around the core motivation [56, 66]. The general motivations for a goal fall into either intrinsic or extrinsic: intrinsic goals are aspirations of oneself such as personal growth, emotionally fulfilling relationships, and community, whereas extrinsic goals are defined as popularity/fame, appearance, and wealth [67].For SDT intrinsic goals are commonly associated with outcomes resulting in positive well-being. A second sub-theory is the Relationship Motivation Theory (RMT), which focuses on the interplay of an individual's relationships on their well-being. This theory posits that relationships with others are not only desirable for most people but also *essential* essential for their well-being because they provide satisfaction for the need of relatedness.

In conclusion, it is hypothesized that through the metaverse users are potentially able to fulfill the core needs relating to SDT and have profound developmental experiences ranging from social experiences and growth to well-being in a manner that is not adequately achieved, or afforded, in the offline world.

2.4 Social Virtual Reality – The Modern Metaverse

This section introduces social Virtual Reality (VR), the closest modern resemblance to Stephenson's original metaverse. At its core, social VR, which provides an incredible number of experiences for users to socialize, interact, and grow, has become 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 [26, 27] and can be traced back to concepts in primitive virtual worlds [10, 68].

The growth of in the number of commercial social VR applications has led to an emerging research agenda in HCI as well as being credited as the new era of computing. Prior studies on social VR have focused on design strategies [27, 69, 70], communication and interaction modes [26, 28, 71–73], long-distance couples' and children's experiences [32, 33, 74], exploration of self-representation [29, 30], and harassment including potential solutions [31]. They have also highlighted three main sociotechnical characteristics of social VR. First, it affords full body movements and gestures in real time, high-fidelity 3D immersive virtual spaces with 360 degree content. Second, it supports vivid spatial and temporal experiences and a range of emotional states similar to face-to-face interaction. Third, it mediates aspects of both the online world and offline world, affording a broad range of social activities via embodied interaction[26–28, 33, 70, 71, 74]. More specifically, in most social VR applications users can create, craft, and customize their avatars to enter the virtual spaces and interact with others. Their avatars can support full body tracked or partially tracked avatars (e.g., upper-body) rather than merely being controlled by mouse, keyboard, or joystick on a computer screen.

Using such avatars, social VR users can engage in and enjoy real-life like social activities such as walking in public spaces, playing a game, watching a movie, playing or singing in a concert, and having a party in highly realistic simulated 3D virtual environments. Examples of popular social VR platforms include AltSpaceVR, VR Chat, Rec Room, Facebook Spaces (discontinued in 2019), High Fidelity VR, among others. They tend to afford diverse activities and social atmospheres. For example, social VR platforms have attracted users representing diverse demographics including age, and although social VR is a generally positive experience, a few studies have raised concerns regarding potential safety and psychological and safety threats against users, primarily involving harassment [31], inappropriate behavior and other concerns for children [32, 33], and privacy trade offs for users[75]. The primary theme of this scholarship highlights the introduction of complicated social dynamics and threats due to the advent of the immersive experience and the full-body avatar, for example, the harassment of women, racial minorities, children, and members of the LGBTQ community due to their avatar

gender, voice, expectations of the avatar, and/or natural behavior [31, 33, 72]. Other studies have highlighted offline forms of harassment such as invading personal space, sexual gestures via avatars, and unwanted flirtatious glances and actions [33, 72].

2.4.1 Popular Social VR Platforms

The majority of social VR platforms provide virtual events, places, and spaces to create and attend events. Each platform has a different level of customizability for its avatars with varying levels of fidelity. Below I describe a few popular platforms:

AltspaceVR. Microsoft's AltspaceVR is "the premier place to discover the next frontier of entertainment and community." In AltspaceVR users can attend live events and meetups such as open mic night, improv comedy, meditation, yoga, LGBTQ meetups, or VR church; in addition, users can also host their own events. Events on AltspaceVR can also be accessible via a PC. Adults tend to prefer AltspaceVR.

RecRoom. RecRoom is considered most popular among minors [32]. The primary activities in RecRoom center around games (e.g., paintball and basketball). Users can create their own private rooms. They can also venture into a central hub called the Rec Center and from there go into different rooms for gaming.

Horizon World formerly Facebook Horizon. Currently, Facebook's Horizon is the newest of the platforms; its original social VR platform, Facebook Spaces, is now discontinued. Horizon is a sandbox universe where users can create and craft their environments and games as well as socialize with current Facebook friends or other users on the platform.

*VRchat.*Like the others, VRchat, owned by HTC, affords minimal activities but features uniquely designed rooms (e.g., a spaceship and a Japanese Shrine) that attract a variety of users. Its avatars offer the most sophisticated customization compared to Recroom and AltspaceVR. VRchat is also ranked as one of the most popular applications on the Steam game marketplace.

GorillaTag. GorillaTag is a popular game accessed via steamVR; it is known for its unique locomotion involving only hands and arms. Unlike other platforms, it has no buttons, sticks, or teleportation. User are able to play a game of tag, where they embody a gorilla and tag other players. According to the lead developer, "the game is great because unlike other games it doesn't force interactivity, users do not have to play tag, they can chat and hangout." GorillaTag grew to 675,000 unique active players over a span of months [76]; the game is especially popular with the youth.

NeosVR. Neos VR is another modern metaverse similar to the other platforms already mentioned, but with more emphasis on user-generated content (e.g, avatars and accessories). It also features a virtual camera in game camera and twitch integration. NeosVR also allows for naturalistic creation in the VR with world and unique avatar building (e.g., full body IK and blendshapes).

2.5 Social Presence Illusion, Virtual Embodiment, and The Proteus Effect in today's Metaverse

In the previous sections, I have introduced the early versions of the metaverses, explained the psychological attraction towards the metaverse, and shed light on social VR the closest resemblance to Stephenson's metaverse. In this section I will expound on foundation VR concepts. They may offer more insight towards the visceral and immersive experiences that VR affords and why the experiences in social VR are most applicable to the offline setting.

The core reason for social interactivity in Social VR is due to presence and immersion. The concepts presence and immersion have been long studied [77, 78] in the context of virtual environments both on a physiological [79] and behavioral level [80], which demonstrate a core reason behind illusions of VR. The interaction between immersion and presence has been disputed since the late 90s by Slater, Witmer and Singer [77, 81]. However, in this dissertation we adopt the ideology of Slater et al. and assert that "immersion provides boundaries within which [presence can occur" [82]. Presence and Immersion combine to create the sense of "being there" (place presence), "being there together" (social presence), and "feeling presence over an entity" (embodiment/self presence). In laymen terms, you must be immersed in an environment to then experience presence.

Social Presence Illusion. The experiences in social VR can sometimes be described to have *real* sensations, which have distinct similarities to offline sensations of connectivity with another person. These sensations can be referred to as social presence, which generally refers to feeling connected with another person. Prior scholarship has disputed the definition of social presence [83]. However, recent work by Skarbez et al. demonstrates a convergence over terms regarding social presence, and the coining of a new term "social presence illusion", it refers to *illusory (false) feeling of being together with and engaging with a real sentient being* [84]. This term is similar to the terms in an offline context (e.g., real-world) for co-presence illusion it refers to the feeling of being together and interacting with a real person in the real world [85]. Today modern social VR platforms

incorporate all the above mentioned concepts of presence (e.g., place, social, self) with an emphasis on *social* concepts. Most if not all social VR platforms are marketed as social experiences, in which one can experience immersive activities *together* or with others. These social platforms facilitate the majority of social presence illusion by way of mimicking offline interactivity such as non-verbal communication [72], and users enacting similar offline activities [28]. Therefore, social presence illusion is the key towards social experiences in social VR and broader immersive social interactivity.

Virtual Embodiment. Virtual embodiment, sometimes refered to as "self presence" which describes the representation of a user within a virtual environment scholars Benford et al. describe embodiment as the provision of users with appropriate body images to represent them to others (and also to themselves) in collaborative situations [68]. Embodiment can be induced via body ownership illusion, which can be described as a procedure where users enact movements to strengthen their ownership illusion over the virtual entity. The rubberhand illusion is an example of body ownership illusion in the offline world [86], which has been repeated in virtual reality [87]. These body ownership illusions contribute to increasing a users self presence, which is the users' mental model of themselves in the virtual world[88]. In most if not all social VR platforms users are represented by a virtual entity where in which they are able to control which their physical movement are mirrored by the virtual entity. It is important to note that embodiment is a different concept from self-presence Slater at al note embodiment can be felt with tools, but that does not lead to a sense of ownership [89].

Proteus Effect. A large body of work has demonstrated the influence of a virtual avatar on one's perception, behavior, and cognition [22–25]. One well known effect is the *proteus effect*, which describes how the behavior of an individual within virtual worlds is changed by the characteristics of their avatar [24]. For example, embodying a child-like avatar can create influences of child-like behavior and changes in perception for the person embodying the avatar [90]. The proteus effect is true for 2D and 3D world. Peña et al. suggested an alternative explanation for the lingering effects of the proteus effect explaining the situational cues on which individuals focus in virtual environments prime them to think and act in certain ways, due to individuals memories or common stereotypes associated with these cues [91]. This effect points towards the affordances of VR, where inhabiting another body can fulfil the needs relating to SDT and provide experiences beyond the limitations of the physical world. The proteus effect, has evolved out of the self-perception theory and deindividuation theory, it can be described as people who infer their own attitudes and beliefs from observing themselves as if from a third party [92] and deindividuation is described as when antinormative behavior, in which people act differently in a group compared to when to their behavior as individuals [93].

2.6 Younger Users and Virtual Reality

As this dissertation's focus is on youth, it is important to understand the scholarship relating to Youth in VR. Prior investigations into children and VR has largely focused on two contexts: medicine and education. For example, previous studies have suggested that VR is effective for children to manage pain through gamification and the emergence of remote healthcare [94–97]. However, it is important to note that these studies did not include any social aspect. Rather, they were experimental investigations with a sole user. In the area of education, VR as a tool has been shown to help children develop cognitive skills and abilities. For example, Vogel et al. developed an application to teach the hearing-impaired [98] and Loiacono et al. created a game to enhance social skills with children with neurological disorders [99]. Other studies aimed at understanding how children learn and collaborate in VR. Roussos et al. created a narrative-based, immersive, constructionist/collaborative environment and yielded three design recommendations for how to create effective VR educational simulations for children: 1) focusing on deep learning problems, which require the rejection of inadequate and misleading models based on everyday experience; 2) the learning goal must be plausibly enhanced by the introduction of immersive VR technologies; and 3) VR-based learning environments must be informed by contemporary research in the learning sciences [100]. Collectively, this body of research has explored VR as a tool to assist children, mainly in experimental settings. Recent work by Bailey et al. and Schmitz et al. demonstrates that minors respond differently to virtual reality as compared to traditional media [101, 102]. However, these studies focused on minors age four to six, and it is unknown how children at different developmental stages respond to VR. Additionally, few studies focus on what minors do and how they are perceived in VR, which raises various ethical concerns [103].

2.7 Research Gaps

There are a few limitations in the above-mentioned work. First, little is known as to what extent the experiences of younger users in traditional online spaces can, if it all, apply to the modern metaverse (e.g., social VR). Second, the majority of prior research involving adolescents in traditional virtual worlds focuses on virtual worlds where adolescents interact with other adolescents. Little is known about how mixed virtual environments where adolescents and adults co-exist (e.g., social VR), and how such co-existence may shape adolescent's experiences in virtual worlds. Third, the unique characteristics of social VR seem to introduce more immersive, real-time, and embodied interaction as compared to traditional virtual worlds. Yet little is known regarding how these unique technologies affordances may affect younger users' online social experiences

and interactions by introducing new challenges and risks. More research, therefore, is needed to mitigate potential risks for younger users in social VR so as to design and create safer social VR experiences for these users. The above mentioned concerns lead to the three research questions that guide this dissertation research.

Chapter 3

Study 1: Adults' Perceptions of Children in Social VR

Motivated to understand the experiences of younger users in social VR, we collected data from interviews with 30 adults. In this study we focus on how adults users perceive and interact with young users across various social VR platforms. Social VR as an emerging phenomenon has led to a number of new questions, including

RQ1: *What are common social interactions experienced by young people in social VR?*

RQ2: *how do adults perceive and understand young users in social VR?*

It also causes a variety of ethical and privacy concerns as young people may experience problematic online situations in social VR, including but not limited to interactions with online strangers, requests for personal information, and misunderstood communication [104]. Therefore, exploring how adult users perceive and interact with younger users is not only important for better understanding the complicated social dynamics supported and facilitated by social VR but also for informing the design of future social VR as safer online spaces. We also aim for better understanding the complex social interaction dynamics afforded by social VR and discuss potential design implications of a more child-centered design for future social VR platforms.

As this, to the best of my knowledge, is the first paper in the field, this initial work highlights the pressing need to investigate younger users in social VR, the findings from this intial study showed:

1) young users are an inherent part of the social VR experience; 2) adults showed concern for young users; and 3) the importance of designing separate social spaces catering to

different age groups. This study also shed light on a variety of ethical and privacy concerns as young users may experience problematic online situations in social VR.

3.1 Methodology

This research is part of a broader investigation on social experiences in social VR and has generated multiple publications including [28–30, 32, 72, 75]. Interestingly, although no direct questions related to young users, almost every participant provided information about them.

Regarding this specific study involving young users, I personally analyzed the data and identified themes relating the children and the adults. Participants were recruited via popular online social VR forums (e.g., Reddit-RecRoom, Reddit-AltspaceVR, 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. As a result, we conducted 30 semi-structured, in-depth interviews via text or audio chat through Discord, Skype, or Google Hangouts from October 2019 to November 2019. The average length of the interviews was 60 minutes. Among the 30 participants, 21 are cis male, five are cis female, and four are trans women. Of the 29 participants who shared their ethnicity, 20 are White, two are Black, five are Asian, and two are Hispanic. 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). 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*, among others.

Our interview questions focused on participants' social interactions, activities, and social experiences in social VR. An important note is that there were no direct questions about interactions with children or adolescents. However, experiences, tensions, and frustrations when encountering such users emerged as one of the main themes in our data. This interesting phenomenon, therefore, motivated this research and led to the research questions we proposed at the beginning of this paper.

We used an empirical, in-depth qualitative analysis of the data collected to explore our research questions [105]. We closely read through the data collected to acquire a sense of the entire picture and collectively identified thematic topics and sub-themes. We then collaborated in an iterative coding process to discuss, combine, and refine themes and features to generate a rich description.

3.2 Findings

3.2.1 The Complexity of Interacting with Young Users in Social VR

Our participants noted both positive and negative experiences involving interacting with young users in social VR. They highlighted the complexity of how to perceive and interact with these users in a social VR environment: 1) young users were on most social VR platforms and were inherently part of the user base; 2) immature or naive behavior was understandable and expected though both may lead to tension and frustration in online social interactions; and 3) interacting with young users, especially when they were family members, could be an enjoyable experience that supported and improved family relations.

Young People as Essential Social VR Users. Participants acknowledged the essential role of young people in the social VR ecosystem. They also considered young people to be the majority of users on particular platforms such as *RecRoom*. For example, P12 (Cis Male, 49, Asian), P14 (Cis Male, 32, Hispanic), and P26 (Cis Male, 30, White) all mentioned: *"a lot more kids in rec room"*(P12), *"rec room one is also filled with kids"* (P14), and *"on rec room there is a large amount of kids."* Some participants pointed out that *RecRoom* may attract a large number of young people due to its focus on play and games. Although games are prevalent on social VR platforms, other areas of activities including taking part in workshops, collaborating in a virtual spaces, embodying different avatars, and doing VR specific activities are all appealing to both adults and young users. For example, P20 (Cis Male, 20, White) explained, *"as opposed to online multiplayer games, I think it [social VR] is still kinda niche, and people really want it. Even the young kids, they're interested in it."* According to P20, social VR, as a relatively new and novel social platform, provided meaningful experiences that were different but similar to the real world. The differences and similarities result from a fusion of offline physics and first person perspective coupled with online features such as ease of accessibility, imagination, and other online-specific affordances. This unique fusion of affordance inevitably attracts both adults and young people, creating an interesting social dynamics between these different user groups.

The Prevalence of Immature or Naive Behavior in Social VR. As mentioned previously, this new online social dynamic afforded by social VR further blurs the boundary between the offline world and virtual worlds unlike the traditional virtual worlds such as *SecondLife, Runescape, and Club Penguin*. In this context, it is more likely and natural for young people to demonstrate immature and naive behavior that is more immersive, vivid, and rambunctious. However, the prevalence of such behaviors in social VR can be unwanted and annoying to more mature users. P22 (Cis Male, 32, White) shared

his experience: *"kids in social VR often run around and scream. It's just irritating."* P14's story echoed this sentiment: *"so there's something that that happens quite a lot and most with when there are kids, and it's that they try to break the game, when they tried to break the game and I don't know get super tall or super short or the floor or just start screaming and doing silly stuff."* However, some other participants expressed understanding and tolerance toward these behaviors and did not find interacting with young people frustrating. For them, these immature and naive behaviors were merely a natural part of their social VR experiences.

As P11 (Cis Male, 21, White) explained, *"most people that I've encountered in social VR are just kids. So they interact in any kids' way. They're loud and obnoxious. They just behave like kids. For example, they do things for attention and make noises. They do not bother me. I never get off [social VR] because of an unpleasant social experience with kids."* P11 understood that children were just children. Specifically, he pointed out that part of the joy of youth was being able to explore and interact within social VR in their own way.

An Enjoyable Experience to Improve Family Relations. For some participants, interacting with young people in social VR was an extremely enjoyable experience, particularly when those young people were their family members. P27 (Cis Male, 45, White) told us that since he was disabled, interacting with younger family members in social VR was an extremely rewarding experience: *"I'm in social VR with my family, such as younger nieces and nephews. We all just watch movies and play games together. Or I just go in there and talk to them."*

Without the physical efforts needed to leave the house, he could take advantage of the various activities supported by social VR to maintain and support bonding and ultimately feelings of closeness with his family members, which would be more challenging for him in the offline world because of his disability. In addition, P26 (Cis Male, 30, White) commented on using social VR platforms with his own children: *"I do enjoy playing with my kids all the time and I can imagine when they are in college we can meet up to see each other and have a chat."* Others also shared similar stories. P13 (Cis Male, 46, Black) noted, *"Occasionally I play with my kids in social VR. It is more of a friendly and inviting environment."* For both participants, social VR seemed to transform the relationship dynamics with their own children. For P26, though he and his children may not be physically co-located, the presence and richness of interactions could still be experienced through social VR technology. According to P13, social VR appeared to foster a friendly and inviting atmosphere that both he and his children enjoyed.

In summary, these quotes collectively depict adult users' experiences with young people in social VR. Despite some negative and frustrating interactions, participants who had relational ties to children and adolescences, in fact, found that experiencing social VR with young people was a rewarding and enjoyable intimate experience, which could create and reinforce strong family connections.

3.2.2 Safety Concerns for Young Users in Social VR

While adults regarded their interactions with children and adolescents in social VR as complex social experiences, they expressed various safety concerns for these young users, ranging from harassment and privacy, exposure to negative social environments, and excessive use.

Harassment and Privacy. Like any other online platforms, harassment is emerging as an important issue in social VR platforms[31]. Our participants noted that children and adolescents were often easy targets of harassment from older users. P20 (Cis Male, 20, White) described his concerns when asked about harassment: *"not so much to me, I wander around and don't modulate my voice. But the female avatars and the kids get harassed a lot, they get called squeakers. I tell my friends that I wish social VR had come out when I was younger. But I'm so glad it didn't, because I would just have a terrible time because people would be mean to me all the time because I'd be a little kid. It's really rough for the kids in social VR."*

According to him, women and young people are often considered part of the marginalized community in social VR: children are made fun of or called "squeakers," a derogatory term that mocks their unique voice before they reach puberty.

P14 (Cis Male, 32, Hispanic) also raised concerns about young people's privacy: *"my concern is that young people often get too personal on the first introduction. For example, I could say, 'hi, what's the name of your teacher?' and they would just tell me such information."* P14's account indicates, a major safety concern for young social VR users was that they did not understand how to protect their privacy online, how much information they could share, and how to set up appropriate boundaries with online strangers in social VR.

Exposure to Negative Social Environments. Others also shared concerns about how young people in social VR were inevitably exposed to negative or even hostile social landscapes. For example, P4 (Trans Woman, 32, White) worried about the use of profanity in social VR: *"it's still a little bit like the wild wild west out there. And by that I mean that it's largely unchecked. When people are talking in chat or using*

foul language, you can hear their voice. And you're like, that's probably not a kid older than 14 or 15. And you know, if you've ever seen little kids who were just nasty to each other, it's the Internet. It's their first time, and they have literally no consequence.“ Her comments highlight an important but troubling fact that social VR may be a child's first experience of online social spaces today. While such an experience can be perceived as exciting and exploratory, children often lack the necessary guidance from parents or peers to understand online ethics.

As P4 noted, without fully understanding the ethics and norms of online social spaces, young people may inevitably be exposed to negative social environments such as foul language and inappropriate social behaviors.

Excessive Use. Another safety concern focuses on how often children and adolescents use social VR. As P22 (Cis Male, 32, White) pointed out, *“usually screaming, you get that a lot in rec room cause there's a lot of kids. I guess I can't believe these kids have VR. If I had that when I was a kid, I would've failed school. Maybe in small doses it's fine. But you could tell a lot of these kids are playing it for six or eight hours a day. I'm not sure that's probably the best for them.“* For him, young people's excessive use of social VR made him worry about their health and academic performance. While most adults may not have the flexibility to spend large amounts of time in social VR, some children and adolescents seemed to be addicted to it. For many adult users, the amount of the time that young people spent on these platforms was an alert: Would such excessive use perhaps limit their development in other critical areas such as education, physical activity, or social maturity because of a lack of in-person interaction with their peers?

These concerns also led to some participants' reflections on how to refine safe online social spaces for young people. For example, P1 (Cis Male, 19, White) noted that a more careful regulation of junior accounts could be a solution: *“I'm not sure how they can make sure kids use junior accounts. You can report people for being under 13 but it doesn't usually do anything.”* For P1, the key issue was that in social VR, children and adolescents encountered social interactions far beyond their maturity level while the current features employed to protect them were ineffective. This dilemma allowed young people and adults to co-exist in the same online social spaces they would not normally be in, perhaps creating certain awkward and unwanted social dynamics. P2 (Cis Male, 23, White) described this situation: *“I mean there are age differences in social VR. I remember when I was eight years old, I would just go up to people online and say 'do you want to be my friend?' But now if I saw a kid [in social VR], I wouldn't want them to come up to me to say 'oh, we're going to be friends.' and right now in social VR there are lots of both adults and children. There's a point now where these two groups approach*

people and making friends becomes awkward." Obviously, such social interactions can provide feelings of uneasiness for adults and potentially unsafe interactions for young people.

3.2.3 Expectations for More Catered Social VR Experience

As we have shown, our participants often noted that social VR platforms tended to situate users of different ages within the same digital social spaces. As a result, many also expressed expectations and a strong demand for creating separate spaces that could better cater to different age groups.

P22 (Cis Male, 32, White) further explains such a demand: *"I was looking for things that I could play. I found rec room and played some of the games. I really enjoyed it. But I didn't really stick with rec room because it's mostly like kids and they're kind of annoying. Then I found altspace. I really kind of fit in better there. Altspace is more mature while rec room is mostly for kids."*

He clearly expressed his frustration and his unsatisfying experiences when being in the same social space with young people (e.g., *RecRoom*). He left *RecRoom* due to the feeling of displacement though he enjoyed the actual content that this platform provided (e.g., gaming). He found he "fit in better" in *AltspaceVR* rather than *RecRoom* because of the level of maturity around him.

This level of maturity may come from the content that *AltSpaceVR* offered such as professional development activities, meetups, and concerts. These events are often more appealing to adults than children. This observation, therefore, led to an interesting question: how can different social VR platforms carefully design the content that they offer in order to create more catered social experiences for different age groups?

Other participants also shared their thoughts regarding age appropriate social VR spaces. For example, when asking P26 (Cis Male, 30, White) why he preferred *AltspaceVR*, he said, *"Altspace has things you can do and be productive and the community is much nicer and supportive. In contrast, in Anyland or VR Chat, you get more people screaming and younger kids."*

For him, a sense of supportive community was valuable and meaningful for adult social VR users and key for attracting and retaining them. Yet such a feeling may not be considered important for young people. In this sense, it is crucial for social VR platforms to foster different social atmospheres to cater to different age groups.

Especially for some participants such diverse social experiences across different social VR platforms was what they enjoyed most. P12 (Cis Male, 49, Asian) reflected, *"I*

like Bigscreen just because it allows me to do things like watching a game or having a conversation over movie with friends who are far away. I like RecRoom because it has a social component and has the best games though it also has many kids. I'm a little more apprehensive about VR Chat. It has more adults but your experience is dependent on which room you end up in."

Here P12 highlighted how each social VR platform had different aspects that people may enjoy and that it was important for people to have a wide range of choices in content, entertainment, and user base as they collectively contributed to an enjoyable social VR experience. In summary, though some platforms employ certain design features to differentiate between adults and minors, strategies that were rather ineffective as P1 and P4 pointed out previously. How to accommodate users' expectations and demands for a more catered and age appropriate social VR experience, therefore, requires more research.

3.3 Discussion & Chapter Conclusion

In this study, we have highlighted three main findings. First, young users in social VR constituted an inherent part of the social experience, which included both positive and negative aspects of their behaviors. Second, adults showed much concern for young people in this novel online social ecosystem, including harassment and privacy concerns, exposure to negative social environments, and excessive use.

In the end, the participants believed it was important to design separate social VR spaces which could better cater to different age groups.

The Importance of Children for Future Social VR Technologies. Our findings demonstrate that children are particularly noticeable on social VR platforms. This work represents one of the first empirical studies highlighting the important role of children in commercial social VR platforms. Compared to adult users, children and adolescents seem to have more freedom and time to explore social VR. As diverse social VR platforms become increasingly popular and more accessible, it is plausible that the population and influence of young social VR users will continue to grow. This emerging phenomenon may follow other similar technology trends (e.g., social media use), where young users were found to be the most likely to use social media [106].

Thus, it is important for VR researchers and designers to take the growing population of young VR users into account when developing future VR technologies/platforms.

Online Spaces for Children and Parents. Our findings confirm and extend previous findings on children's online behavior with regard to harassment, privacy concerns, negative social exposure, and excessive use [107–110]. Prior literature has also discussed ways to address these negative aspects of children's online social lives. Specifically, Cook discussed how an online environment where both parents and children could co-exist and co-consume content could help alleviate these negative experiences for children [111].

Such an environment is important because it has been noted that parents and guardians appear at times to be unaware of the kind of social and cultural worlds that young people are creating online [112].

Our adult participants also suggested that this co-existence may be one reason why they enjoyed playing with their children in social VR. A focus on designing this co-experience in future social VR platforms, thus, may create more comfortable and safer social experiences for both parents and children.

Designing Social VR Spaces for Children. Based on our findings, we also highlight potential design implications for social VR spaces for children. One implication focuses on a target age group as each group has their *own unique developmental needs*. Age groups are generally separated into young children (under 5 years old), children (between 6 and 10 years old), tweens (10 to 12 years old) and teens (13 to 18 years old). The idea of targeted age groups was supported by Beals and Bers in their description of six important design features for creating virtual worlds for children and youth: *purpose, communication, participation, play, artifacts, and rules* [113]. Depending on the particular age group, one of the six design features may be of more value than the others. For example, purpose for teens revolves around "identity," while purpose for a young child should mirror their "real life goals." In addition, another implication emphasizes a framework of *affordance*, *interaction*, and *content*. As Southgate et al. pointed out, the special affordances of the technologies, modes of social interaction within the environment, and content in the environment should be used to evaluate the developmental appropriateness of any immersive environment for children [103]. As our findings have shown, the novel affordances of social VR, the complicated interaction dynamics that it supports, and the diverse content and activities that it provides have collectively constituted both challenges and opportunities for creating nuanced online social experiences for children. How to better balance and manage these three aspects in designing and developing future social VR, therefore, opens a new research frontier.

Chapter Conclusion. Building on this study, our future work could involve interviewing children to obtain their perspectives and understanding of social VR experiences. More research is also needed to identify strategies and methods for addressing harassment in social VR, primarily toward children. In addition, our future work would

continue to explore design implications for creating more socially equitable spaces. The themes we observed here help strengthen the foundation of work regarding younger users in social VR as this, to the best of my knowledge, is the first paper in the field. This initial work highlights the pressing need to investigate young users in social VR as this study showed 1) younger users are an inherent part of the social VR experience; 2) adults showed concern for younger users; and 3) the importance of designing separate social spaces catered to different age groups. The findings from this study motivated the following studies as they shed light on a variety of evolving ethical and privacy concerns younger users may experience in online situations when using social VR.

Chapter 4

Study 2: Exploring Children's Experience in Social Virtual Reality

To address the prior limitations and confirm the findings from Study 1, this study aims to gain in-depth, first-hand experience of young users in social VR through observations. The co-existence of minors and adults in social VR presents unique challenges and opportunities regarding how these two groups interact with each other in these shared virtual social spaces. Of particular relevance to this work is the variety of privacy and ethics concerns raised by problematic online interactions minors may have in social VR, including but not limited to interactions with online strangers, requests for personal information, and misunderstood communications [104]. Thus exploring how minors experience social VR and how they interact with adults in these shared social spaces is not only important to better understand the complicated social dynamics that are supported and facilitated by social VR but also to inform the design of future social VR and broader HCI to ensure safer online spaces.

To address prior lack of scholarship in this area [32] and limitations in previous work, Study 2 explores the following research questions using a participatory observation approach [114, 115]:

RQ1a: How do minors perceive and interact with other minors in social VR?

RQ2a: How do adults and minors perceive and interact with one another in social VR?

4.1 Methodology

I used a participatory observation approach to collect data for this study [114, 115]. This work was approved by Clemson University's Institutional Review Board (IRB) for research ethics. both the explicit and ambiguous aspects of their life routines and experiences [114–116]. In this sense, the observer is a genuine participant [116] who both engages in the environment and observes others' behaviors and interactions surrounding him/her.

This method has been widely used in previous scholarship on online virtual worlds and MMORPGs [117–119]. To help identify minors in social VR, I adopted methods used in prior work such as voice [32], avatar height [31], and the context of the interaction to determine whether a user was a minor or an adult (e.g., if one calls the other a kid).

Research Site. In this study, I engaged in three social VR platforms (AltspaceVR, RecRoom, and VRchat), conducting participatory observation sessions on each platform for three months (February to April 2020). These platforms were selected as our research sites for three reasons: they are three of the most popular and most representative social VR platforms; they are popular with both minors and adults; and the culture and affordances of each differ greatly. Additionally, all platforms are free, making the barrier to entry low. I briefly summarize the differences among these three platforms below.

Participatory Observations. Observations generally took place in the evenings from 4-8 PM every day as these are considered the peak times for using social VR. In addition, observations were also conducted during weekends to access a diverse user population. To conduct these observations, the first author created an account on each of the these platforms and attended platform specific events such as games, social activities, and open events. He also spent time in open public spaces to examine leisurely behaviors and interactions. In total, he conducted 80 hours of observation.

Screenshots, video recordings of observations/interactions, hand-held voice recorded notes, and field notes were captured during the periods of observation. The field notes were documented immediately after a specific observation session using a spreadsheet, which recorded the date and time of the observation, the platform where it took place, and a detailed narration of the activities and interactions observed along with personal insights. Observed/recorded chat logs that were particularly relevant to our research were further transcribed for additional analysis.

Data Analysis. As I adopted a participatory observation method, my observations and analysis as the primary observer are what made this method and the data collected relevant and powerful [120]. According to McDonald et al.'s guidelines for qualitative

analysis in CSCW and HCI practice [121], it is, therefore, important to take the main observer's experiences into account rather than seeking inter-rater reliability.

The data collected were analyzed using an iterative process of open coding [122], which focused on identifying themes emerging in minor-to-minor and adult-to-minor interactions in social VR. Our analytical procedures focused on yielding concepts and themes (recurrent topics or meanings that represent a phenomenon) rather than agreement because even if coders agreed on codes, they may interpret the meaning of those codes differently [121]. I examined the data collected to gain a broader understanding of the common interactions among minors and other minors as well as between minors and adults. I then identified initial themes and common features related to these interactions. Subsequently, all three authors collaboratively examined and reviewed these themes and sub-themes and refined them. Finally, all three collaboratively engaged in an iterative process to discuss, combine, and refine themes and concepts to generate a rich description synthesizing minor-minor interaction and minor-adult interaction in social VR.

4.2 Findings

This section presents our findings regarding our themes of minor-to-minor and adult-to-minor interactions in social VR based on our field notes, screenshots, and videos for our observations.

4.2.1 Minor to Minor Interaction: An Enjoyable Play Experience in Social VR

As described previously, minors were identified based on their relatively shorter avatars and/or particularly high pitched voices.

I found that most minors seemed to find engaging in social VR with other minors an enjoyable *play* experience. Specifically, their interactions with other minors focused on 1) building virtual intimacy and stronger emotional connections; 2) building rich social interactions beyond just gameplay; and 3) engaging in nuanced group behaviors. In addition to these overall positive experiences, minors also 4) experienced harassment and bullying when interacting with other minors.

Virtual Intimacy and Emotional Connections. Similar to traditional online virtual worlds and MMORPGs, social VR allows for intimate connections between users through their controlling the movements of the body of their avatars. However, unlike

other virtual worlds, social VR affords immersive full body tracked avatars, establishing a direct "mirroring" between one's physical body and the avatar's. Furthermore, it creates the potential for true "face-to-face" interactions experienced from a first-person perspective. The combination of these factors creates the potential for heightened emotions and feelings of presence compared to traditional online virtual worlds [123].

In our observations, I witnessed that minors benefited from using their bodies as a direct interface to communicate with one another for a several reasons. First, through full body tracking, their interactions in social VR, similar to face-to-face communication in the offline world, made it easy and natural for them to communicate with one another. Their expressions, intentions, and actions in social VR generally could mirror those in the offline world. some minors seemed to enjoy communicating with one another through non-verbal methods (e.g., using body movements). In our observations, I frequently saw that minors used fist bumps, high-fives, poking, and touching on the shoulder to communicate with one another.

Through the similarity to face-to-face interaction and the affordance of rich non-verbal communication, social VR seemed to afford more natural and intimate interactions between minors. For example, I observed that minors tended to give each other virtual "hugs" to display a sense of intimacy and closeness as the following chat log shows:

Minor 1: my Mom says I have to log off now
Minor 2: aw okay
Minor 1: wanna play tomorrow?
Minor 2: yea!
Minor 1: okay see ya
Minor 2: wait give me a hug!
Minors hug, and one exits the platform
(two minors on RecRoom)

In this example, these two minors demonstrated full awareness that social VR afforded intimate interactions such as hugging. They also understood that they could physically perform "hugs" using their immersive avatars and that embodied avatars afforded them the ability to share and exchange illusions of touch and intimate behavior. Rather than just saying goodbye, they intentionally chose to perform a "hug," which required them to physically perform the action of "hugging" in the offline world. For these minors, merely saying goodbye seemed inadequate when a virtually embodied hug could instead be used to express feelings of closeness and intimacy.

In this sense, this quote further highlights the similarities between offline behaviors and the behaviors in social VR such that digital communication and physical touch become synthesized to facilitate minor-to-minor interaction.

In addition, minors also employed ways of showing intimacy and emotional connections which, in our observations, did not always follow traditional forms of intimate behavior (e.g., hugs and kisses) but rather the platform afforded intimate behaviors or child-like intimacy. For example, as seen in Figure 1, fist bumping was a common method used by minors to make friends and show close friendship (Figure 4.1). A fist bump in RecRoom

FIGURE 4.1: Minors fist bumping to become friends on RecRoom

allows two users to become official friends on the platform. After that, they can engage in specific activities such as inviting each other to personal private spaces, receiving notifications acknowledging when each is online, and teletransport with each aother. After users became friends, interactions such as fist bumps and high fives were used to represent spontaneous physical interaction and the establishment of friendship. While adults tended to use this method with caution, it was a popular way among minors to quickly build friendships and remain connected.

In another example, virtual intimacy also reflected child-like expressions and behavior, where minors would display intimate behaviors specific to their demographic. For example, in one of our observations I observed two minors playing a simple game of "jump and catch" together in RecRoom and exploring the boundaries of the platform:
Minor 1: I'm going to climb to the top and then jump off, then you catch me okay?
Minor 2: haha okay, i'll catch you
Minor 1: alright i'm going to jump!

Minor 2: jump jump!
Minor 1: ahhh (jumps)
Minor 2: see I caught ya!
Minor 1: that was fun! okay your turn!
(two minors on RecRoom)

One might not consider catching another person from a balcony a form of intimacy. However, based on our observation, these two minors seemed to regard it as a special way for children to demonstrate intimacy: to them, catching someone jumping off a balcony required trust, interdependence, and teamwork. It was a game that also demonstrated intimacy and emotional closeness to children, displaying trust and togetherness. Experiencing these interactions and activities in the immersive social VR environment makes them appear much more personal compared to those in traditional online games and virtual games for these minors and, thus, creates stronger emotional connections with others.

Rich, Emergent Social Interactions Beyond Gameplay. Minors also seemed to enjoy the rich, emergent social interactions with others. For them, social VR afforded a wide range of activities and experiences that enriched their online social lives, making it much more than merely a virtual place for playing games. An additional reason why we believe minors viewed the interactions and connections afforded by social VR positively was the ability to have rich social interactivity with other minors. These interactions were mainly governed through the affordances of the specific platform. However, minors seemed to enjoy different types of interactions based on their maturity levels: ranging from (mature to less mature) old teenagers, young teenagers, and young children, based on the first author's subjective perception. Since there is no way to officially verify users' actual age in social VR, the criteria used here to identify the minor's approximate age included the level of maturity shown in conversations, behavior, and interaction; their voices (e.g., an older teenage boy's voice may be different from a young boy's due to puberty), and the type of users (e.g., user who showed similar or different behaviors) with whom they frequently interacted.

Older teenagers were commonly seen together or in clusters, and their interactivity primarily focused on making crude and vulgar jokes to make their peers laugh, for example frequently commenting on one another's avatars or the general topics of drugs, sex, alcohol, and recent events in the offline world (e.g., COVID-19). Here is an example of their interactions: *"He deserves to die from the coronavirus by just looking like that [reference to his avatar]. That avatar is lame as f**k, who the f**k has a 1D avatar, haha"* (an older teenage boy on VRchat).

The avatar that this user referred to is the right image in Figure 4.2. It was a one dimensional cat avatar, which entertained many members in this teenage group and made them laugh. Older teenagers enjoyed gaining the reputation of being the entertainer of their peers – having so-called *social clout*. To these minors, the richness of their social interactions seems to stem from the ability to be able to converse and interact as they normally would in the offline world as jeering is a common behavior among teens. However, social VR also further allows them to access novel content and affords behaviors such as creating, customizing, and switching between various immersive, full-body tracked avatars, often leading to diverse social interactions and experiences for fun, thus allowing them to interact with the virtual environment with more ease compared to offline.

FIGURE 4.2: Older teenagers interacting together on VRchat

Based on our observations, young teenagers were perceived as interacting and playing more in the environment more than older teenagers and young children. In fact, young teenagers were perceived to play the most games and be heavily engaged on RecRoom and AltspaceVR as well as in sharing content (e.g., avatar appearance) with others. Their interactions focused on exploring the novelties surrounding VR game play and bartering items. The three minors in Figure 3 4.3 were perceived as young teenagers bartering with one another for avatar items:

Minor 1: what's up with that silver chain?

Minor 2: I'll give it to you for some tokens?

Minor 3: No way you told me I could have it for my butterfly wings!

Minor 2: oh yeah i did...wait how many tokens?

Minor 1: hmmm not sure yet?

Minor 3: that is my chain, you told me i could have it!

(minors on RecRoom)

FIGURE 4.3: Young teenagers interacting together on VRchat

In this example, these minors were sitting in a virtual place with a cafeteria/lunch room setting. Very likely, this environment appeared to be similar to their offline social world (e.g., a school lunchroom). Situating in such an environment, they seemed to enjoy exchanging their experiences of gameplay and in-game content (e.g., tokens, a silver chain, and butterfly wings). For them, this became a unique interactive experience, blurring the boundaries of offline lives and online gameplay.

In contrast, young children under 10 were perceived to typically focus on and enjoy interactions centered around other minors their age/maturity level and exploring the technological affordances and the interactability of the social VR platform together. In another interaction two minors on RecRoom grabbed a bottle filled with liquid. They then proceeded to throw the bottle as high in the air as they could and tried to catch it. Next, one of the minors says, *"pour the drink on me."* And the other poured the drink while the first pretended to drink it, represented by small brown dots simulating the liquid leaving the bottle. As this example illustrates, social VR platforms provide limitless forms of rich interactions for this particular group of minors because most young children on these platforms are seeking to understand what they were capable of doing within the environment. In particular, based on our observations, they appeared happy and wanted to interact with and explore their surroundings with other children of the same age rather than teenagers.

Nuanced Group Behaviors. Regardless of diverse maturity levels, I found that one aspect all three groups of minors shared was using social VR as a collaborative learning environment and as a virtual place for sharing aspects of their personal lives in their interactions. Across all three social VR platforms, I observed that minors shared knowledge and openly collaborated with one another. For example, Figure 4.4 shows

a popular event in AltspaceVR where users situated in a theatre could upvote which 30-second video of a funny meme they would like to display on the big screen. This event attracted more minors than adults. In our observation, I witnessed that these minors openly collaborated to choose which meme would be shown on the screen. In addition, these minors frequently teach one another how to quickly interact with their specific VR device (e.g., Quest or Vive) to choose which meme would be shown on the screen in a openly collaborative manner.

FIGURE 4.4: Minors watching memes on AltspaceVR

In another observation, one minor on RecRoom was humming the popular American song "Roxanne." Within seconds, another minor nearby started humming the song. This quickly led to a eight minors singing the same song. Most of them were not in near physical proximity but instead walked over to join the group. Based on our observations, those minors did not have any prior knowledge of one another before singing that song. Interestingly, for minors unfamiliar with the song, some of the singers paused to mention the song's name and told them to "look it up" so that they could sing along. This example highlights the nuanced group behaviors of minors in social VR because such behaviors not only spontaneously emerged in interacting with online strangers but also were mediated and supported by it. In this example, this nuance group behavior is afforded because of the spatial audio in social VR as well as the ability for users to localize the audio and sing/hum in real time.

It should be noted that minors' collaborative learning did not always involve entertainment. Rather, it included some more personal and in-depth aspects such as *exploration of identity*. It was very common for minors to dress their avatars similarly and create a social VR clan (see Figure 4.5). However, in our observations we noticed minors explored aspects of identity such as gender together. For example, in one occurrence two male minors whose genders were perceived as male (via voice) were chatting about their

perceptions and understandings of gender roles in social VR:
Minor 1: We should switch our avatar to look like a girl.
Minor 2: Why? That's weird.
Minor 1: Because more people will talk to us!
Minor 2: Why would they talk to us?
Minor 1: Because everyone talks to girls more.
(Two male minors on AltspaceVR)

In this example, the two male minors shared with each other their own understandings of how gender played an important role in social VR. Minor 1 understood that a common social norm in social VR was *"everyone talks to girls more."* Therefore, he considered it completely reasonable to investigate using a female avatar while being a male and educated his peer (Minor 2) about this norm. In contrast, Minor 2 regarded gender switching as *"weird"* and wondered why such behavior was needed in social VR. Through this interaction, they both learned different perspectives of gender and gender switch in social VR.

Minors' nuanced group behaviors also included disclosing intimate details with one another and reflecting on significant global events (e.g., the current pandemic). For example, they were seen to share with one another how COVID-19 was affecting themselves and their families. In these observations, they were open to sharing feelings of discomfort, uncertainty, and general angst about the pandemic, such as frustrations situated around being virtually home-schooled, having to share the computer or VR headset with their sibling, and not being able to go outside. It is important to note that there were minors who mentioned positive aspects of the pandemic, including seeing others on the platform consistently and being able to spend more time in VR. Both positive and negative observations suggested that minors use social VR as a place to continue their common regular everyday interactions together during a crisis in virtual settings and in particular to enjoy social VR experiences *together*.

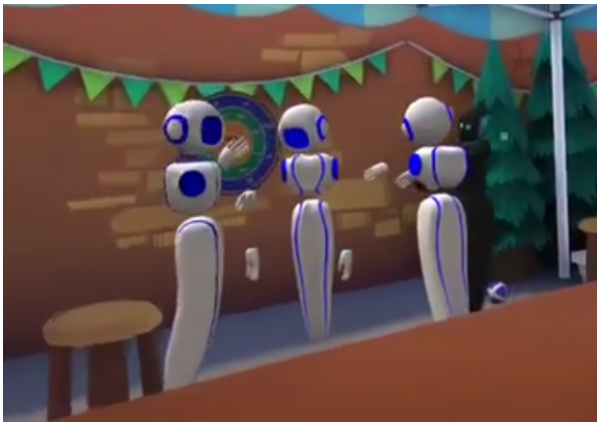

FIGURE 4.5: Minors switching to basic default avatars on AltspaceVR

Dealing with Harassment/Bullying. Based on our observations, minors consider their interactions with one another in social VR as positive and enjoyable overall. However, like in traditional online virtual worlds and MMORPGs, I also observed harassment and bullying among minors on these platforms. It should also be noted that I observed profanity, foul language, and derogatory comments such as *n***er, b**ch, h**, th*t.* However, these words were generally perceived as being used by more mature minors, and it was unclear if these words were meant to upset and offend other minors. In fact, I found that other terms such as *lame, loser, noob, squeaker* were perceived to offend minors more than this more explicit language. Specifically, harassment/bullying often fell into two categories: harassment of older minors towards younger minors and harassment of young girls.

In one occurrence on VRchat, the first author observed what was perceived to be a younger minor interacting with a group of older minors in a VRchat virtual place (i.e., "Mirror Room") primarily used for displaying and commenting on avatars. In this interaction, we observed that the younger minor was harassed because he was using an Oculus Quest and its technical apparatus did not allow for the viewing of certain avatars on this platform. Instead of displaying the avatar as a vivid 3D figure, it appeared as a generic robot with the avatar image on the center of its chest.

A dialogue of the interaction is below:
Minor: check out my master chief avatar, isn't it cool.
*Older Minor 1: HA! your avatar is lame as f**k*
Older Minor 2: Yeah I bet you can't even see my avatar can you?
Minor: Uh no...you have a robot...
Older Minor 1: probably using VRchat on a Quest...what a lame haha
(Minors on VRchat)

In this interaction, the group of older minors were able to guess that they "talking" with a younger user based on his voice. They then proceeded to harass him simply because of the VR device he was using, i. e. his boyhood. It is not obvious how these older users were able to perceive that the younger minor could not see their avatars. The insults toward the younger minor continued, and eventually the younger user moved to the far end of the room and left. This younger users was verbally upset, and the first author perceived him as being bullied. Later, other users in the room stepped in and commented, "*wow kids get bullied for not having a high tech headset. That's ridiculous.*" This case demonstrates the unpredictable challenges for younger social VR users – harassment may not only come from adults but also from their peers.

Female minors were also frequently targeted for harassment and bullying. In the campfire world in AltspaceVR, I observed that a group of male minors harassed a female minor

because she was concentrating on interacting with another user rather than with this group. In this observation, we first perceived what appeared to be a pair of two minors, one boy and one girl, chatting with each other and laughing and joking. Then a group of male minors came up to them and wanted to join the conversation. However, the pair did not want to interact with the group. After realizing this, the group of boys began to circle the girl, followed her, yelled at her, and made negative remarks about her avatar. Other users on the platform came to the girl's defense,and the group of boys dispersed and went to another world. It was unclear to us whether the pair and the group of male minors knew each other before the incident. Yet, this case describes the scrutiny female minors can face on AltspaceVR.

Similarly on AltspaceVR, a pair of two female minors who were chatting in the theatre room were perceived to want to leave the room but to remain together. One of them dropped a portal so that they could both travel to the new area. However, then what was perceived as a group of male minors saw the portal and said, *"Guys there's a girl over there and she just dropped a portal and wants someone to play with her. Come on guys, I need to go we need to go!"* Shortly after, one of the male minors in the group walked over to the female pair and said that he wanted to go with them. The female minors declined his request using body language, but the male minor kept bothering them. Eventually, the female pair had to block him and leave.

In this case, the female minors clearly did not want the attention from the group of male minors or to hang out with that group. Yet, even though they showed their unwillingness and directly rejected this request, the male minors still persisted in the unwanted behaviors. In this sense, female minors seem to be even more vulnerable in online social interactions than young male minors in social VR.

4.2.2 Adult-to-Minor Interaction: A Complex Social Dynamic

The three social VR platforms where I conducted observations are open to anyone, meaning both minors and adults can create an account and engage in the virtual social spaces and, therefore, these two groups can freely interact with each other. Compared to minor-to-minor interaction, I found that adult-to-minor interactions showed a more complex social dynamic. Both groups also seemed to have mixed sentiments about each other. Specifically, I identified four themes that emerged in how adults and minors coexisted, interacted, and perceived each other in social VR: barriers, tensions, and frustration of co-existence; mutual learning; social distancing; and inappropriate content exposure or loss of innocence.

Barriers, Tensions, and Frustration of Co-existence. Some adults perceived that minors in social VR as an annoyance and a disruption of their experience. During our observations, I constantly heard such negative comments about interacting with minors in social VR as *"screaming, loud, and obnoxious."* One adult commented on his experience in AltspaceVR: *"Dude kids are everywhere, I remember when Altspace used to be great but now its so annoying. Kids break everything and try to just get attention. I just come in here after work to chill. Its f***ing frustrating."* This comment expresses the potential tensions and frustration emerging because of the co-existence of adults and minors in the same social VR platform. For this adult user, the goal of his interaction and engagement in social VR was to *"chill"* after work. In contrast, in his opinion, many minors tended to *"break everything"* to gain attention. Such conflicts of their social needs made his experience *"annoying"* and *"frustrating."* Because most minors are immature compared to adults on the platform, they enact behaviors to seek attention, and how they sought this attention was one of the primary reasons why many adults considered interacting with minors in social VR disturbing as they disrupt others' experiences. Figure 4.6 shows an image of a minor who has figured out how to change the floor height of his avatar, and now he is above everyone. Based on our observations, this minor was trying to get attention from others and proceeded to interrupt their conversations by floating above them, behavior exemplifying the adult user's previous quote.

FIGURE 4.6: Minor floating in between two Adults

Examples like this often led adults to deter minors from interacting with them. For example, in another observation in AltspaceVR, one adult user told a group of minors: *"Hey you better get out of here. They don't allow children in here so if the moderator finds out [pointing gesture in moderator's direction] that you're in here, you're going to be banned from AltspaceVR. Do you want that? No? well,then go! Leave!"* This adult knew that there was no moderator present at that moment. However, he wanted to

"scare" the minors away from hanging out in this space. For adult users like this one, avoiding interacting or co-existing with minors in the same virtual space was important.

Mutual Learning. However, these negative perceptions of minors were not the sentiment of all adults; in fact, some seemed to enjoy interactions with minors, and this cohabitation led to mutual learning. For example, in one observation (Figure 4.7), a minor was ignored by adult users on VRchat. Yet, one adult decided to initiate a conversation with the minor: *"Oh they don't want to talk to you. I'll talk to you. Where are you from?... i'm from [omitted]. What games do you like to play? I like to play..."* This interaction highlights that adults and minors could coexist in social VR and engage in relationship building and learning about one another. Further, how this interaction was initiated demonstrates that some adults perceive minors as equal participants on the platform and that a minor should not be ignored because of their age.

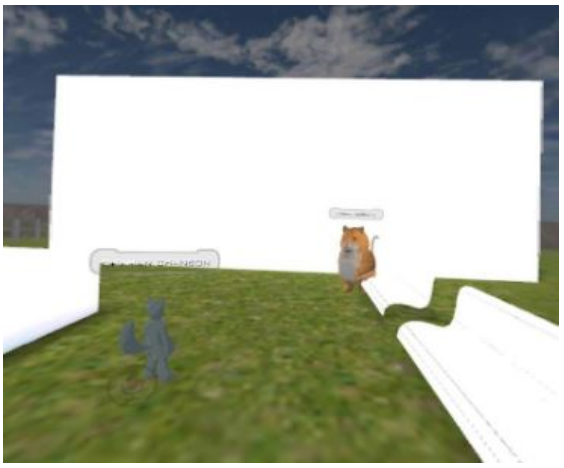

FIGURE 4.7: Minors and adults on VRchat chatting

In particular, such interactions between adults and minors could lead to mutual learning. *Cultural learning* between minors and adults was observed between the two groups, generally when minors interacted with international users. In one observation, a minor was learning Japanese from a native of Japan; and in another, a minor was learning about cultural norms in Greece. These observations of cultural learning were open and inviting, demonstrating interest from both the minors and adults. In both examples, the minors benefited from learning about a different culture, and the adults benefited by sharing and practicing their English.

Such mutual learning also happened in other contexts such as gaming. For example, an adult VRChat user talked about his experience with minors during our observation: *"Dude VRchat is so cool, and I understand why kids like it. Look at this cool skin some kid gave me! I wouldn't have this without him. Yeah kids can be annoying but I are all exploring so what's the big deal? Kids are going to be kids."* This adult user was given a customized Scooby Doo avatar by a minor, and he greatly appreciated this favor.

His sentiments towards minors were centered around understanding that this is a novel interactive space where both minors and adults should have equal access to enjoy the environment and experiences. His comment also highlights that adults could benefit from having minors in the same space, for example learning from them about how to use the platform, avatar customization, and gaming.

In another example, when observing minors on RecRoom, the first author encountered a few challenges with its user interface. After spending more than 15 minutes trying to figure out a solution, two minors approached him, volunteered to help, and explained to him what he needed to do.

In general, our observations show that the co-existence of adults and minors may still lead to forms of positive interactive experiences, which involve aspects of mutual learning such as sharing details about different cultures, languages, experiences, and content on the platform.

Social Distancing. In contrast to the first two themes, I also found that different social VR platforms seemed to afford diverse social dynamics between adults and minors. Minors seem to distance themselves from adults in RecRoom, and adults seemed to distance themselves from minors on AltspaceVR, whereas on VRchat the two groups mingled with each other. It should be noted that while both groups on RecRoom and AltspaceVR interacted with each other, such as through small talk or short interactions, our observations suggested that these interactions were noticeably superficial and lacked in-depth communication, leading to our interpretation of social distancing.

It appears that social distancing between minors and adults on RecRoom was due to the number of the former in the user base. Minors also generally prefer to interact with other minors as I have shown in previous sections. Similarly, the majority of the users of AltspaceVR are adults, who often interact with other adults. In our observations, one adult shared his opinion on social distancing from minors: *" It's like a bar atmosphere or massive social event. It's not that I ignore kids but I'm here to interact with more mature people. Interacting with kids requires more work because you have to be careful about what you say."* In this sense, social distancing seems to be a common norm in some social VR platforms as a way to manage the co-existence of adults and minors – both groups need different social atmospheres, dynamics, and even languages to fully enjoy their social VR experiences.

Exposure to Inappropriate Content. Some adults did not censor themselves or acknowledge the ramifications of a minor overhearing a particular vulgar conversation or seeing an imitation of grotesque behavior. The co-habitation of adults and minors brought about instances where mature content was discussed openly, perhaps exposing

minors to inappropriate content when interacting with adults. During one observation, two adults openly talked about becoming intoxicated in VR:

Adult 1: Bro did you bring your beer? are we drinking in VR right now?
Adult 2: I am dude! It's one hell of a day and I wanna just keep chugging beers.
Adult 1: why not, like this is pretty chill.

As this quote demonstrates, the adults appear to feel free to discuss content that might not be suitable for minors. However, It also highlights a unique challenge: it may not be obvious to adults that minors were present nearby. In general, minors can be identified in social VR by their voice and height. If they choose not to speak, it would be difficult to identify them, and height only provides evidence of a young person since there are no other mechanism available.

In other observations, there were instances of political hate speech and conversations involving sex. I observed one clear instance of sexual harassment between adults and a minor:
Minor: I'm trying to figure out how to show certain avatar, do you know how to do that?
Adult 1: Oh you're new to VRchat, oh you better watch out. There's a lot of stuff kids shouldn't see on here.
Adult 2: yeah all types of stuff!
Minor: like what?
Adult 1: hmm like VR rape. It's serious. I got raped the other day...haha (being sarcastic)
Minor: What's VR rape?
Adult 2: It happens when someone comes up to you really close and then (adult proceeds to hump and make sexually explicit movements on this child's avatar and then laughs).
Minor: oh this is weird...(moves backward and changes to a different topic)"

As this example shows, minors could be exposed to inappropriate content (e.g., sex and rape) and behaviors (e.g., an adult making sexually explicit movements) when interacting with adults in social VR. Regardless whether the adults intentionally introduced such content or behaviors, these minors unwillingly or unwittingly faced risks of harassment, sexual assaults, or negative social influences.

While verbal harassment was common among minors, we observed fewer instances of adults intentionally harassing minors verbally.

In summary, though we did not encounter any adult-to-minor harassment in this study, these observations highlight three potential challenges for adult-to-minor interactions in social VR. First, the unpredictability of social VR interactions may lead to unwanted behaviors towards minors. Second, this novel immersive interaction space allows adults

to exploit the naivete of minors. Third, there are few to no consequences if adults expose minors to inappropriate content or conduct unwanted behaviors toward minors as they are cloaked with online anonymity.

4.3 Discussion and Conclusion

To answer the two research questions that I proposed at the beginning of this paper, our findings have shown the following: 1)most minors consider engaging in social VR with their peers as an enjoyable play experience focused on virtual intimacy, rich interpersonal interactions, and nuanced group behaviors despite risks of harassment/bullying (RQ1); and 2) adult-to-minor interactions demonstrated a complex social dynamic, including barriers, tensions, and frustration of co-existence; mutual learning; social distancing; and possibilities for minors to be exposed to inappropriate content (RQ2). I now use these findings to discuss the implications of this work and extend our current knowledge of children's engagement with technology, especially their experience in social VR.

4.3.1 The Uniqueness of Minors' Experience in Social VR vs. Traditional Virtual Worlds and Media Platforms

As I described at the beginning of this paper, little to no work has investigated minors' experiences, perceptions, understandings, and interactions in social VR. How these emerging virtual spaces are increasingly shaping today's digital youth and children's social lives needs more research attention from the HCI and CHI PLAY communities. Most important, our findings have highlighted the uniqueness of minors' experience in social VR compared to traditional virtual worlds and media platforms.

Minors in Social VR vs. Traditional Virtual Worlds. extend existing work related to on minors in online digital spaces and traditional games/virtual worlds. Specifically, our findings highlight a number of similarities and differences between children's' experience in social VR and in traditional online games/virtual worlds.

One similarity between our findings and traditional games is the wide range of activities offered in both types of virtual environments and the high levels of engagement. In our observations, minors interacted with other minors in social VR by gaming, sharing of content, and mimicking offline behaviors. Similar observations were also made by Marsh in traditional virtual worlds [46, 124]. Yet, a uniqueness is that social VR seems to support the development of emotional and interpersonal connections among minors in an more immersive way. These findings demonstrate why social VR is such an attractive online digital space to minors, but it does not explain why minors were able

to develop emotional and interpersonal connections. We are not asserting that minors cannot develop emotional connections in traditional virtual worlds, but instead that the similarities of social VR to the offline world appear to facilitate relationship building among minors in a natural way. Previous scholarship demonstrates that VR systems are capable of creating feelings of intimacy and other interpersonal connections between two users [125]. However, we also attribute these feelings to minors perceiving these interactions in virtual worlds as *real*. This phenomenon was observed by Valentine and Holloway [126] where children perceived the virtual world as of equal value to the offline world. Furthermore, Sharar et al. demonstrates that minors between 6 and 18 years old reported higher levels of presence and "realness" in the virtual environment compared to adults ages 19 to 65 [127]. This may explain why most minors in our observations focused on virtual intimacy, rich interpersonal interactions, and nuanced group behaviors, and why they were visibly upset when bullied and harassed.

Our findings also reveal aspects of bullying and harassment found in social VR similar those found in traditional games and virtual worlds, especially those specifically targeting female users. Our work mirrors previous scholarship and demonstrates that male minors tended to conform to masculine norms and roles of social dominance [128]. Though bullying and harassment could happen between older and younger male minors, female minors seemed to be harassed and bullied more often by male minors of all age groups. Although harassment/bullying can occur, our findings demonstrate that engaging in social VR seems to be a generally positive experience for minors, especially in unusual times. For example, we found that minors relied on social VR as a way to maintain regular interaction and social lives during the current COVID-19 outbreak. This phenomenon, therefore, points to the need to further study on how social VR, an emerging immersive social space, affects minors both in and outside the virtual environment.

Minors in Social VR vs. Traditional Media Platforms. One of the primary differences between social VR space and traditional games and virtual worlds is the immersive virtual world and the fully embodied virtual avatar. While the majority of scholarship regarding virtual avatars and immersive worlds has focused on adults demonstrating the powerful effects on their behaviors, perceptions, and cognition [23, 25, 129], little is known about how immersive virtual environments effect minors and to what degree. In our observations, full-body tracked virtual avatars and immersive worlds seem to affect minors in various ways, including mirroring behaviors of the offline world, changes in emotional states, and perceptions of harm. Our work alludes to effects that are capable of happening to minors such as mirroring behaviors of the offline world, changes in emotional states, and perceptions of harm. These changes may due to the fact that minors are still developing their personality and understandings of self, others,

and the world, which may make them respond to VR differently compared to traditional media platforms [101, 102]. Prior work has also demonstrated that minors can struggle with digital representations when solving task compared to what they perceived while watching directly [130]. This may explain why minors considered their behaviors, interactions, and experiences in social VR, a more natural and immersive virtual space, more similar to the those in the offline world compared to other traditional media platforms.

This also raises interesting questions about the impact of social VR on adolescent development and identity building. Prior work has shown that minors in virtual environments perceived virtual versions of themselves as their real identities and were more likely to create "false memories" [131]. In our study, minors tended to perceive their experiences in social VR as similar/realistic as in the offline world. It is plausible that some of them may have difficulty differentiating from the offline and online world, which presents new challenges for developing more child friendly social VR technologies and platforms.

4.3.2 Understanding the Co-Existence of Minors and Adults in Online Social Spaces

A variety of similar behaviors and interactions commonly found in traditional gameplay was identified in our investigation. I observed that adults had mixed sentiments about co-existing and interacting with minors in social VR.

For example, some adult users enjoyed their interactions with minors for a variety of reasons, including improving their English, learning about a different culture, and gaining knowledge about content creation and gaming, while conversely others disliked the interactions with minors. In fact, some even treated minors as equals in social VR and behaved the same way as they would towards other adults.

Although some findings were positive, our work also highlighted adults' irritation and annoyance from interacting with minors. Some adults in our observations were noticeably upset because the presence of minors on these platforms was prevalent and often disrupted the adults' social experience. As minors are generally curious, their behaviors were not always accepted as curiosity by adult users but as immaturity and were mostly perceived as an annoyance, often triggering tensions between the two groups. Such tensions, combined with the foci and affordances of specific platforms, can lead to a natural separation (e.g., social distancing) between adults and minors on a certain social VR platform. This observation, therefore, also implies that the design of the social VR platform can naturally discourage or facilitate interactions between groups of people, a useful lesson for designing and developing future social VR technologies.

In our findings I did not observe any verbal harassment between minors and adults; however, I did observe sexual harassment between a minor and adults, which ultimately led to a form of sexual assault with few to no consequences to the assaulter. It should be noted that of the 80+ hours of observation, this type of interaction was observed only once. Yet, it still raises concerns about the potential risks for minors interacting with adults and being exposed to adult content in social VR. It also leads to a number of questions and challenges for designing and developing a safe social VR platform for minors:

What are the consequences to adults who introduce undesirable behavior or content to minors in social VR? Who should monitor and mitigate these undesirable behaviors or content when social VR users come from different countries and adhere to laws of different governments? Should legal guardians/parents of the minor be informed of these risks, and will this lead to new considerations and regulations for minors' engagement in social VR?

4.3.3 Design Implications for the Future of Social VR

Grounded in our findings and insights from prior work on the online safety of minors [132–136], I identify a few preliminary directions for designing child-friendly social VR platforms in the future.

Regular practice & implementation exiting VR. As I discussed earlier, minors seem to have difficulty differentiating between the offline and the social VR worlds. Therefore, a useful potential design for minors would be acknowledging and practicing how to exit social VR (e.g., taking off the headset) when appropriate. In our observations, it was not always evident to minors that they could physically exit social VR just by taking their headsets off. While this may conflict with the interest of the social VR platforms, it may afford minors better control of their engagement in social VR by giving them more agency in particular situations.

Experiencing social VR together with loved ones and friends. In our previous study [32], I found that parents and guardians experienced social VR platforms openly with their children. This seemed to help minors interpret and better manage unwanted and/or unfamiliar interactions. It also seemed to strengthen the relationship between parents/guardians and minors. In this sense, design features that encourage minors to experience social VR with their loved ones and friends would be helpful for protecting minors from risks in social VR as well as help them better deal with misinformation

and unwanted experiences. Additionally, prior work by Ringland et al. has demonstrated that the involvement of parents or guardians in children's virtual experience helps children distinguish between "real" and "unreal" experiences [136].

Educating minors on digital literacy. Continuous education on social VR and broader immersive technologies is also needed for creating safe online social spaces for minors. Such technologies are rapidly becoming more available and are increasingly embedded into young people's everyday social lives. In this sense, tutorial and training modules specifically designed for minors seem to be necessary. As VR itself can be commonly used for training of stressful situations [137], platform specific training involving interaction safety could help mitigate potential risks.

Safety implications for minors in co-habitation with adults. The active engagement of both adults and minors in social VR and the active interaction between these two groups present interesting challenges for designing social VR as a virtual space for all. Adults co-habitating with minors in social VR presents interesting challenges between the two groups which raises ethical and privacy questions. Above all, social VR platforms should strive for transparency on what types interactions are permitted. However, existing platforms do not provide sufficient information on this aspect. For example, AltspaceVR and RecRoom privacy policies state that all publicly available areas should be treated as public spaces. It is challenging for users, especially minors, to fully understand such information as the boundaries between private and public spaces online are often blurred. For VRchat, even less information regarding how to protect one's privacy is provided. More straightforward and well-explained guidelines appropriate for minors' reading and literacy levels are urgently needed.

In addition, as social VR is different from traditional virtual worlds and games, traditional methods for mitigating harassment (e.g., temporary ban of account) may not be effective. Instead, users who violate certain platform-related policies should be required to complete immersive education training.

Furthermore, as Ringland et al. have shown, aiming to reduce risks often creates complications, such as prioritizing certain risk over others, increasing other risks, and infringing on a child's personal growth [135]. Therefore, social VR developers and designers should be cautious when creating safety measures for minors; in social VR, providing safety for both children and adults is a process requiring continual negotiation, and a balance between risk and autonomy in a given situation is needed [135].

4.3.4 Motivations for Future Work

The findings from this work confirm and expand previous findings from Study 1 and further motivate Study 3 and Study 4. More specifically, the next steps will involve conducting in-depth interviews with minors and adults regarding their experiences and interactions in social VR.

This work represents our first endeavor to explore children's experiences in social VR. I aim to use observational data to identify trends and behaviors for future investigations combined with interviews, surveys, or other methodologies. For example, one way to substantiate and confirm our findings in future work would be conducting in-depth interviews with minors and adults regarding their experiences and interactions in social VR. Second, I acknowledge that the second limitation involves the number of hours spent on observations; more hours of observation combined with in-depth follow-up interviews with minors are needed to further verify our findings. Another area of future work could focus on what attracts minors to different platforms. I observed minors of different age groups, cultures, and backgrounds. Yet, it is not obvious why they chose to actively engage in and interact with one or multiple platforms. The gendered perspective of social VR is also another interesting area requiring research. For example, another question requiring research is why there were more female users (minor and adult) on AltspaceVR compared to the other two platforms. The potential risks of harassment of minors in social VR also needs further investigation.

Chapter Conclusion. Our study has identified four themes regarding how minors interact with other minors in social VR: building virtual intimacy and stronger emotional bonds; experiencing rich social interactivity beyond gameplay; engaging in nuanced group behaviors; and managing harassment/bullying. I have also discovered the complicated social dynamics in adult-minor interaction in social VR, including barriers, tensions, and frustrations of co-existing; mutual learning; social distancing; and the risk for minors to be exposed to inappropriate content.

This work makes a number of contributions to HCI, HCC, and child-computer interaction. First, our focus on understanding the social dynamics and interactions of minors expands current literature on HCI and child-computer interaction relating to online digital spaces. Second, I offer first-hand empirical data on what makes interactions in social VR unique and socially desirable for minors, especially compared to traditional virtual worlds (MMORPGs) and traditional gaming environments. This points to an emerging research agenda that has not been widely studied. Therefore, I contribute to addressing the two previously mentioned limitations in prior literature on children and VR. Third, I highlight potential design implications that aim at addressing the safety

concerns for younger users. These may inform the design of emerging social dynamics between minors and adults in future social VR and broader online social spaces.

The findings from this study have prompted and motivated Study 3, which proposes to explore how youth perceive and understand social VR from their own perspective.

Chapter 5

Study 3: An Interview Study with Younger Users

To further address the overarching research questions and confirm findings from the previous studies, I conducted an interview study with youth ages 13 to 18 on social VR platforms. Prior work involving young users has not investigated their understanding and interpretation of social VR from their perspectives, but rather from the adults' third-person perspectives of their experiences. Gaining an understanding about how young users are interpreting and experiencing social VR is of pressing importance as these users have been known to face both psychological and physical harm [32, 33]. To address these issues, Study 3 conducted 20 in-depth, semi-structured interviews with young users to explore their unique understanding, experiences, and challenges in social VR.

The findings from this work will not only help us better comprehend the complicated social dynamics of young users in this space but also inform the design of future social VR to ensure these social spaces are safe and emotionally fulfilling for them. In Study 3, we seek to further explore RQ1 and RQ2 introduced in Study 1 through two foci: 1) the common experiences of young users in social VR; and 2) how if, at all, such experiences affect younger users' safety and well-being as well as how they can assist in the design of future social VR spaces with young user safety at the forefront. The specific research questions explored here are the following:

RQ1b: What are the common experiences of younger users in social VR?

RQ2b: How, if at all, do experiences in social VR affect younger users' safety and well-being?

5.1 Methodology and Research Ethics

Recruitment and Procedure. This study was approved by Clemson University's Institutional Review Board (IRB) for research ethics. We posted a recruitment message on three popular online forums for social VR (e.g., Reddit-RecRoom, Reddit-AltspaceVR, and Reddit-Oculus) to recruit teenagers ages 13 to 18 who engaged in social VR weekly. In the recruitment message, we also included a link to a Google form that provided a brief overview of the study. After completing a Google form expressing their interest, participants were sent an email that provided more details of this study and a consent form. After confirming their interest in the study and acknowledging that they had read the consent form, participants completed initial demographic questions and were sent a calendar link to select a time for an interview. Complying with IRB requirements, we did not conduct interviews through voice or video chat to protect participants' privacy (i.e., no voice or facial data were collected). Rather, we conducted interviews via synchronous text chat through an open collaborative co-edited Google document. For each interview, the interviewer typed interview questions in the document and participants typed their responses. The interviewer then typed appropriate follow-up questions. Sample questions included "*How did you first learn about social VR platforms? What do you normally do in social VR (entertainment, learning, hanging out, etc)? Have you ever had negative, awkward, or unpleasant interactions with people in social VR? How did you deal with it?*" The average interview lasted 65 minutes, and participants were given a $20 gift card after completing the interview. We acknowledge that this is an unconventional method and may have limitations such as the depth of responses written; however, as our questions were open-ended, we believe this method is both appropriate and responsible for both protecting the youth and collecting the data. Additionally, this research follows the guidelines outlined for conducting ethical research in social VR [138].

Participants. We conducted interviews with 20 participants: 15 cis-male, four cis-female, and one person who identified as non-binary. Of the 17 participants who shared their ethnicity, nine were white, four Hispanic/Latino, and four Asian. Of those who shared their geographic location, 17 were located in North American, two in Europe, and one in Africa. The participants' ages ranged from 13 to 18, with an average age of 15. The average weekly time spent in social VR platforms was 23 hours. Participants used a wide variety of VR devices to access social VR, including HTC ViVE, Oculus Quest 1 and 2, Oculus Rift, PSVR, and Valve Index. They also engaged in various social VR platforms, including RecRoom, AltspaceVR, VRchat, Bigscreen, and Facebook Horizons.

Data Analysis. We used an empirical, in-depth qualitative analysis [122] of the data collected to explore teenagers' experiences in social VR. Based on McDonald et al.'s [121] guidelines for qualitative analysis in HCI studies, our analytical procedures focused on yielding concepts and themes (recurrent topics or meanings that represent a phenomenon) rather than agreement because even if coders agree on codes, they may interpret the meaning of those codes differently [121]. Therefore, we did not seek inter-rater reliability in our analysis but identified recurring themes of interest, detecting relationships among them and categorizing them into clusters of more complex and broader themes. Our coding and analytical procedures involved the following steps: 1) I closely read through the data collected to acquire a sense of the entire picture as regards to what motivated to engage and dissuade teenagers from engaging in social VR; 2) I then identified thematic topics and common features in the data for further analysis; 3) I subsequently carefully examined and reviewed the thematic topics and developed sub-themes; and 4) all three authors then collaborated in an iterative process discussing, combining, and refining themes and features to generate a rich description synthesizing how and why teenagers are motivated to engage or not in social VR.

Interview Questions: The research questions used in this study and their corresponding sections are listed below:

Demographics

- What is your age:
- How do you self-identify (Male, Female, Trans, etc):
- Where are you currently located (geographic location):
- Do you attend school? If so public or private school:

Frequency and Activities

- What VR headsets have you used or are currently using (Oculus Quest, HTC Vive):
- Which social VR platforms have you used (AltspaceVR, RecRoom, VRchat, Facebook Horizons):
- How did you first learn about social VR platforms?

Social and Psychological Impacts

- Do you think social VR helps you make new friends or stay connected with existing friends?
- Do you face any challenges in social VR (for example, difficulties using social VR, hard to find people to talk with, etc.)?
- In general, do you consider using social VR a positive or negative experience?

Avatar

- Describe your avatar in social VR.
- Does your avatar look like other avatars?
- Do you think your avatar teaches you anything about yourself?

Harassment

- Have you ever had negative, awkward, or unpleasant interactions with people in social VR?
- If so, how did you deal with them?
- Is bullying, racism, and sexism common in social VR?

Younger Users Informing Adults

- What do you think adults should know about your experience as a child?
- What do adults not know about being a child in social VR?
- If adults could change one social VR feature (technical or design feature) to make social VR safer for children, what would it be?

5.2 Findings

Using quotes from participants' accounts, we present our findings in this section in three parts. First, we identify the common ways in which teens were introduced to social VR. Second, we explore popular engagement activities that draw teenagers into social VR. Third, we highlight risks and challenges that teenagers encounter when using social VR that may dissuade their engagement in it.

5.2.1 Introduction to Social VR via Youtube, Friends, and Low Barriers to Entry

Of the teenagers we interviewed, most were introduced to social VR within the last two years, probably because of its explosive growth in popularity. For example, VRchat has been featured as one of the most popular games on Steam Game engine since 2018 (currently it is December 2020), and RecRoom, the number one downloaded application on Xbox ahead of Rocket League, Warzone, Fortnite, and Roblox [139], is extremely popular with youth in VR. The immense popularity of social VR has created interest in a wide variety of teenagers ranging in age from 13 to 18. The majority of our participants were attracted to social VR via Youtube channels, personal friends, or because most social VR platforms are free to use.

The Youtube Effect. Similar to the current teen gaming trends such as watching streamed video games on Twitch, Youtube or Mixer, watching social VR seemed to be a common entry point for teenagers to learn and become excited about potentially engaging in social VR. For example, P4 (15, Male, Ethnicity not reported) and P11 (14, Male, White) mentioned that they both first learned about Social VR via Youtube: *"I watched youtube videos that were on VR Chat"* (P4), and *"I learned on youtube with games like vr chat and rec room"* (P11). It seems as though Youtube is a popular means for learning about social VR platforms as well as being a general tool for keeping up to date with popular trends on such platforms. Some teenagers also mentioned that they were introduced through channels especially catered towards VR related content. For example, P3 (16, Male, White) said, *"Youtube and friends is how I first learned [about social VR], the channels I watched were 'Your Narrator' and 'tfmjhonny.'"* For P3, watching videos from both of these channels allowed him to learn about social VR from other users. Both *tfmjhonny* and *Your Narrator* are popular Youtube channels featuring VR videos on various topics including entertainment, crude entertainment, jokes, anime, and adventure.

The youthful spirit of these channels seems to be what attracts teenagers to social VR as P19 (18, Male, Hispanic) shared: *"I first learned about social VR platforms from Youtube. It wasn't someone I was subscribed to or watched regularly, so I may get their name wrong. I believe it was VRtrapman, and they were using voicemods to prank people in VRchat."* According to him, YouTube channels are a common way not only to learn about social VR but they can also lead to the urge to participate by simply watching someone engage in social VR as entertainment. This is also how P5 (Female, Asian) was attracted to social VR: *"I watched a YouTuber DanTDM play one of the games (Rec Room) so when I finally got VR that's one of the first games I downloaded, especially since it was free."* For P5, regularly watching DanTDM's channel gave her the exposure

to social VR, specifically RecRoom. Though DanTDM's channel features a variety of gaming not solely VR, it made P5 willing to experience RecRoom. In general, these comments demonstrate the powerful effect Youtube can have on attracting teenagers to social VR.

Influenced by Offline Friends. Many participants also mentioned that their offline friends attracted them to social VR. For example, P10 (16, Female, Ethnicity not reported) explained, *"It was around over a year ago when I watched youtubers play vr. Then my friends told me about it even more."* For him, the videos in addition to information from her friends was what attracted her to social VR. The experience of friends introducing other friends to social VR seemed to be a popular phenomenon as P1 (16, Nonbinary, White), P20 (15, Male, Hispanic), and P2 (14, Male, White) all detailed similar experiences: *"Some of my friends convinced me to buy a VR headset to play with them 2 years ago, and one of the first games they showed me was Rec Room. Since then I've been playing the game fairly frequently"* (P1); , *"Well once my friend had convinced me to buy the quest he showed me RecRoom and it took me a few weeks to like it"* (P20); , *"I saw Rec Room on my friends oculus and wanted to look into it, and ended up getting hooked"* (P2). In all three examples, friends played an influential role in introducing newcomers to social VR, resulting in P1, P20, and P2 enjoying and regularly participating in it. These quotes demonstrate the process by which teens' offline friends heighten the appeal of and attraction to social VR and, in some ways, lowers the barriers to entry into the space.

Lowest Barrier of Entry Some teenagers we spoke to were introduced to social VR platforms due to the low barriers of entry. P14 (17, Male, White) and P7 (18, Male, White) explain their experiences: *"Buying a PSVR left me a bit drained on money so I started looking for free games. RecRoom was the first one that appealed to me"* (P14), and *"I started using social VR since it was among the free VR apps available. After checking out some gameplay on YouTube, I decided to download Rec Room"* (P7). Both P14 and P7 mention the relatively high barriers of entry to *use* VR: most VR headsets cost anywhere from $299 upwards of $1000 leaving little monetary room left for the actual engagement into games and other experiences. This is why most, if not all, of the top social VR platforms are free-to-play, giving users like P14 and P7 the ability to still experience social VR without having to pay-to-play.

Additionally, some VR devices like the Oculus Quest (owned by Facebook) have unique app stores built into the headset. This was another way teenagers found out about social VR platforms. P9 (15, Male, Ethnicity not reported) and P12 (15, Female, White) mentioned how they were attracted to various social VR platforms in this way: *"I found it in the oculus store and I wasnt sure what it was but I decided to give it a try"* (P12), and

"Through the Oculus store, they are typically free games so they were an easy thing to get into" (P9). According to them, learning about social VR via the Oculus store and other free applications is quite common among teenagers as it is an easy way to have immersive experiences without barriers such as payment. In summary, these quotes highlight three ways which initially attracted teenagers onto social VR platforms: browsing YouTube channels and videos, personal offline friends, and the free-to-play business model.

5.2.2 Immersive Engagement Opportunities as Main Attractions for Teens

Our participants further highlighted that the plethora of immersive engagement activities afforded by social VR was the main attraction for them to both initially engage and then continue in social VR. Social VR differs from traditional gameplay because it both affords aspects of the offline world (e.g., full body movements) and aspects of traditional gameplay (e.g., limitless in-game artifacts). For example, mundane activities such as sleeping are considered fun and engaging in social VR. [28]. In this sense, social VR attracts teenagers based on the unique affordances and the immersive interactivity it provides. Our participants' enjoyed using social VR as a popular social hub, engaged in a multitude of building and crafting opportunities, and appreciated the ability to still remain connected during the COVID-19 global pandemic.

An Immersive Social Hub. One of the notable points of attraction to social VR for teenagers is the wide variety of games and opportunities designed for *play* offered by those platforms. For example, RecRoom is famous for providing a wide variety of popular gaming experiences. P1 (16, Non-Binary, White) mentioned his experience with RecRoom: *"Rec Room has a lot of games that you can play with other people, so usually when I'm playing with my friends we go into a game and just have a good time playing it together."* In this case, the games in RecRoom act as a social lubricant to help P1 and friends connect and play. Many social VR platforms are also designed as social hubs that attract teenagers. For example, AltspaceVR has a campfire and RecRoom, a Rec Center, spaces designed as social gathering-hubs where users can come together. P4 (15, Male, Ethnicity not reported) mentioned, *"I like to play test parkour and mess around in the rec centre."* According to P4, he enjoyed the Rec Center because it was an open place that facilitated socialization, offering virtual places to chat, a basketball hoop, a ping-pong table, a vending machine, and sports equipment. The Rec Center is also a relatively large open space with many structural objects, the reason why P4 enjoyed parkour there. Furthermore, the rich gaming experiences in social VR, specifically RecRoom, allow and facilitate a variety of social experiences. P5 (Female, Asian) detailed her experience with gaming and socializing in RecRoom: *"I think I do a mixture of both, since usually*

we talk and stuff while playing the games. I like to do the quests, especially Golden Trophy since it's easy enough where we can talk while not worrying about dying." For her, the casual socialization during gameplay with her friends was laid-back, inviting conversation and socialization rather than focusing solely on gameplay.

In general, most teenagers we talked to enjoyed the unstructured mix of socializing and gaming in social VR. This was particularly true for P3 (16, White, Male): *"I usually see what servers are activate and just mess around in the places I find, I normally start for entertainment and it usually branches off into talking with people. Sometimes, I play some of the minigames within the games like VRChat and see what other people are messing around with.*" P3 enjoyed adventuring onto different servers (e.g., rooms) in VRchat. For him, his choice in social VR activity depended on both the social atmosphere of the server (e.g. room) and the particular facet (e.g., talking/gaming) that appealed to him at the time.

Other teens were attracted to social VR simply to talk to and connect with people. For example, P18 (13, Male, White) detailed his social VR use: *"I spend a good chunk of my time just hanging out and talking to people and sharing experiences, etc. I'd say I spend a good 80% of my time in VR just talking to people. The other 20% is playing competitive VR games."* For him, one of the key attractions of social VR was the ability to connect with others as it allowed him to meet new people and share experiences that he may not have already had but was able to experience in social VR.

Immersive Building and Crafting Digital Artifacts. In our study, many teenagers not only participated in a single activity such as gaming or socializing but also a mixture of activities dependent on the social context. One activity that attracted them was building and creating artifacts in the environment. For example, P12 (15, White, Female) mentioned, *"I hangout with friends, play games, and design my own stuff. There are a few things I do. I either play games with other people, or we just go to custom rooms to hangout, or I design my own room or props."* For P12, the variety of activities available drew her to social VR, and the ability to have unique experiences such as creating her own prop, room, or artifact anchored her to the platform.

In RecRoom, teens are able to create customized rooms and objects which they can share with friends and sell to others. P7 (18, Male, White) detailed what he liked to create: *"I create fictional weapons and occasionally some art, my art varies from abstract to a monochromatic style."* For him, the ability to have a variety of creative experiences ranging from crafting weapons to artwork demonstrates the broad use cases of social VR and the key points of attraction for teenagers.

In addition, some social VR platforms allow for the creation and customization of user-generated games. This feature was one of the highlights for a few of our participants. As P9 explained, *"I also like to create in social VR applications. For example, Rec Room offers an in game 'Maker pen' that allows you to create your own environments and games. So far I have created a hangout room that takes place on a beach, A small adventure game where you travel space, and a wacky boxing game."* P9's account detailed the broad range of creative affordances available in social VR. Because of these, teens have more control in creating a pleasantly unique experience tailored to what they want. The building and creating games is also a common phenomenon in RecRoom. For example, P16 (13, Male, Asian) and P10 (16, Female) shared their experiences: *"I play and make games in rec room I'm usually with friends in the rec center which is the "hub" for rec room"* (P16), and *"Mostly I build things and hangout. Sometimes we play pvp games or play other people's games. There's also competitions that we do too. Horror games are always a go to! And visually appealing games too, more like art rooms. Well, if it's for a contest then there's a specific build theme. Most times we just build for fun like memes or to mess around"* (P10). For both P16 and P10, building, creating, and crafting in social VR were relatively common phenomena and very enjoyable experiences. They also highlighted that they not only enjoyed building objects but also playing user-generated games, demonstrating the community aspect of their social VR engagement.

Socially Connected During COVID-19/Global Pandemic. The data for this research project were collected in 2020 when the COVID-19 virus brought the world to a halt, shutting down local businesses and shifting the world towards remote learning and socialization. Our teenage participants, who were from different geographic regions (e.g., North America, Africa, and Europe), mentioned how COVID-19 impacted their VR use. In general, it was very popular during the pandemic. For example, the Oculus Quest 2, at the time one of the newest VR headsets, was sold out for the majority of 2020. Teenagers were no exception to the excitement for social VR. In fact, all 20 participants we interviewed were very grateful that they could use social VR to stay connected and communicate with others.

Our participants particularly highlighted how social VR significantly helped them through isolation despite the lack of regular in-person social activities and challenges for keeping in touch with their offline friends due to the COVID-19 panic. P12 (15, Female, White), P9 (15, Male), and P13 (15, Female, Hispanic) all explained how they used social VR during the pandemic: *"I think the pandemic helped a ton because I think a lot more people got involved with VR since the pandemic as an easy way to socialize"* (P12); *"When COVID-19 shut down schools, I didn't have very many people to talk to or hang out with. I used social VR as a substitute for that. I would find people around my age and*

just simply, talk to them " (P9), and *"it helped me with the isolation of staying home"* (P13). Given the inherent sociability of social VR, P12, P9, and P13 all seemed to view social VR as a positive means of social connection and engagement during the pandemic as it mitigated the feelings of isolation and of being "left behind" when people of their age were often under quarantine.

Regarding safety during the pandemic, P1 (16, Non-Binary, White) and P11 (14, Male, White) both commented on using social VR from a personal safety standpoint: *"I do think that having a safe outlet [social VR] to socialize with people has helped me through not being able to see my friends and extended family as much"* (P1), and *I find a lot of my lockdown time in social vr has helped me a lot. I can still talk to people and be social while being completely safe from a health related standpoint*" (P11). For these two participants, the use of social VR seemed even beneficial as it did not place either user at the health risk of contracting the virus while still allowing them to socialize in a rather natural way.

P6 (16, Male, Hispanic) also thought that social VR was ideal for the quarantine situation: *"I think VR is perfect for the type of situation we're in now because since we're not able to interact in real life, we can still interact in the virtual world without any repercussions. My friends aren't very social outside of VR anyways. It makes me feel productive and more in touch with the world, especially since we're all stuck on lockdown during this pandemic."* P6 used social VR as a means of *normalizing* himself and his engagement with others during the global pandemic. For him, engaging in social VR allowed him to feel more connected to the world although he was in"lockdown" in his home.

Likewise, P19 (18, Male, Hispanic) shared: *"I haven't really hung out with any real life friends since the start of the pandemic, so VR has kinda been my only outlet for that sort of experience. I feel like because I have my vr and I'm able to hang out with my friends in that sort of realistic-ish way, I'm dealing with the pandemic better than others. Or at least easier."* His comments highlight why social VR is an attractive means of social engagement specifically for teens. For P19 and others, it provides the ability to simulate experiences of "hanging out" in a *"realistic-ish way,"* helping them cope with the heightened sense of isolation during the pandemic. P20 (15, Male, Hispanic) expressed these sentiments: *"It helps me stay in touch with my friends that we can't talk to in person anymore, its with with friends I can't see even though they live less than 10 minutes away."* For him, the isolated lockdown was especially frustrating due to the difficulty to meet up with friends who were geographically close. Fortunately, social VR provided him with an outlet with more in-depth forms of communication compared to phone calls or video chats.

Some teenagers even mentioned that socializing in social VR helped them develop new social connections and friendships. As P12 (15, Female, White) and P14 (17, Male, White) mentioned, *"It has helped me make so many new friends, especially since the pandemic started. Recroom has become so much more popular since the start of the pandemic and some of my friends only joined because of the pandemic as a way to socialize"* (P12), and *"Not being in school has giving so much free time. I've used that time to both make friends and make maps in RecRoom"* (P14). According to P12 and P14, in some ways the global pandemic positively impacted their social VR experience because it allowed them to make new friends they may never have met. This also grew the user base of social VR, specifically RecRoom in this case, because other teenagers, also in isolation, were seeking new means of social connection.

In some instances, social VR strengthened existing relationships for teens. For example, as P8 (16, Male, Asian) shared, *"Especially during COVID times, I have stayed connected with my friend that plays VRChat way more than my other friends. Lockdown gets boring so hopping into VR with my friend definitely helps us remain connected and I believe it strengthens our friendship. I use social VR way more often due to COVID-19 lockdown as it is a way to keep me socially active. Without social VR, I would definitely feel a lot less lonely. Although you can speak to friends in a discord call, there's nothing like being able to see their movements and interact with them in a world."* P8 believed that social VR helped him and his friends strengthen their relationships since they were able to remain socially present in one another's lives versus those who did not have VR or did not actively communicate using social VR. For P8, social VR was the best possible outlet for social communication, much better in terms of being able to perceive body language, gestures, and other facets of offline face-to-face communication.

In addition to immersive socialization as a means of coping with COVID-19, one participant mentioned using social VR to attend an event that under normal circumstances would be held in his school. P17 (15, Male, White) explained, *"One fun experience i had in vr was when someone hosted a virtual homecoming dance since real life ones can't happen due to covid. It was really fun and i had a great time."*

In summary, social VR facilitates a wide variety of engagement experiences ranging from normal socializing to attending traditional activities like a virtual homecoming dance with classmates and friends. Our data demonstrate that social VR is a popular and attractive form of immersive social engagement for teens, which includes engagement in immersive social spaces, playing games and quests, and building player content and user-generated games, while also maintaining old friendships and creating opportunities for making new friends despite being physically apart or isolated. All of these engagement and activities, therefore, make social VR especially appealing to teenagers.

5.2.3 Notable Pitfalls of Social VR To Dissuade Teens

Our participants also mentioned two facets of social VR that seemed to dissuade their use: the normalcy of harassment and the unique tensions between social VR and the offline world.

Harassment and Bullying. Social VR platforms attract a broad range of users, with demographics extending across age, race, and geography. Often this is a benefit of social VR. However, this range of demographics can sometimes create unique tensions between and frustration with users, particularly regarding age discrepancies and maturity. In fact, most teenagers that we spoke to noted varying forms of harassment from explicit harassment such as bullying and naming calling to forms unique to social VR such as physically stalking someone through rooms/worlds. All 20 of the teens we interviewed were aware of platform specific ways to address harassment such as blocking and/or reporting the harasser.

Our participants commented on the various types of harassment they experienced, ranging from slurs to sexual comments. P1 (16, Non-binary, White) and P4 (15, Male, Ethnicity not reported) shared their experiences: *"Sometimes people just start saying slurs or being rude to other people, and I think there's always going to be people like that. In Rec Room its really easy to just report and block these kinds of people though, so it's never really an issue"* (P1), and *"Just sexual comments, i just walk away. That's all"*(P4). Both P1 and P4 mentioned the seemingly normal occurrence of harassment in Rec Room, which they seemed to think would never change. Fortunately, P1 had confidence in the tools available for addressing harassment in social VR, whereas P4 preferred to remove himself from the physical vicinity.

The differences in approaches for dealing with harassment may stem from the variations in the tools on or the governance of the platforms. For example, common tools for countering harassment in social VR are blocking, personal space bubbles, muting, and reporting players. However, these features can be manipulated and misused by other users. For example, P7 (18, Male, White) talked about an instance he witnessed: *"I have interacted with a person who was being homophobic to a person after finding out their sexuality, repeatedly using slurs and not leaving that person alone. They also falsely reported that player for being rude to others, despite that player being quiet until this interaction started."* P7 alluded to the fact that offline forms of harassment can creep into social VR. His experience further demonstrates the lack of the trustworthiness of the system tools for dealing with harassment as P7 believed that people in social VR can be wrongly reported. Other teens felt that the platforms sometimes were misguided when it came to implementing punishment based on harassment. P12 (15, Female,

White) detailed her opinion: *"Yes I have [dealt with harassment], but that's kind of expected, because in the real world people are the same too. Some are nice and some are not so nice, and some are just straight up evil. If its not that bad then I will just deal with it because there is no point to do anything about it, but if its really bad, then I just report them, block them, and leave the server. Unfortunately the recroom staff is not good with banning the right people, unless they have been mass reported or there is video proof."* Here P12 first depicted that harassment in social VR is similar to traditional harassment in the offline world. She also explained the varying degrees of harassment which can occur in social VR, ranging from minimal to severe. Finally, P12 talked about the difficulty platforms have in distinguishing between sometimes subjective comments and interpretations of harassment, an enforcement role unique to social VR.

Another particular issue regarding bullying and harassment in social VR is that the harassers are often perceived to be relatively young. P6 (16, Male, Hispanic), P10 (16, Female), and P2 (14, Male, White) mentioned: *"I've experienced harassment in VR. The people who bully are my age I'd presume. I deal with it by blocking them"* (P6); *"People my age it's normally just them trying to get reactions, so I simply laugh and use the report button"* (P10), and *"Really the only people who mess with me a lot are kids who aren't even old enough to play"* (P2). These quotes suggest that harassment in social VR from young users may stem from a lack of maturity rather than malicious intent. According to P10 and P2, these behaviors were enacted to provoke and agitate. Though these agitators are blocked, it may not solve the problem or correct their behavior, especially since often harassment in social VR is a grey area. As P18 (13, Male, White) explained, *"Not really, but sometimes people in social VR apps just chase me around, and it's kind of annoying, but I don't block them, I just go to another lobby. Sometimes people just want to be funny or something, most of the time people dont chase others around as harassment, they do it as a joke, for example they play meme songs through their microphones and run after people."* According to P18, funny behavior in social VR should not be taken as an offense, and he preferred not to block or report these users. It should also be noted that based on P18's age (13), he most likely uses junior accounts, which are specific to the youngest of social VR users (normally ages 13-14), perhaps explaining why he normalizes this type of behavior.

Additionally, P19 (18, Male, Hispanic) shared his uncertainty about harassment in social VR: *"There's lots of times where people give weird complements, or do some weird actions, or get a little too touchy. I just usually block them or get out of there. Maybe if it seems accidental or harmless ill just try to talk through it. I have been told many times i have a 'cute, gay sounding voice' which combined with my flashy outfits and stuff in game are probably going to attract some people. It's weird, but sometimes its innocent. I only really mind when its creepy."* As P19 explained, he was not always able to

perceive someone's intentions and that the interactions often came off as "weird," which created interesting dynamics of harassment: an action that one user did not perceive as harassment another did. P19 also briefly mentioned one facet of harassment in social VR that may place teenagers at additional risk, the harassment of the avatar body. This type of interaction has been observed in my prior work with adolescents [33]. In summary, harassment in social VR is similar to that in offline world and the traditional forms of harassment in the online world.

In social VR it can sometimes be difficult to decipher, predict, and discipline teens' harassing behaviors, perhaps discouraging some teens from engaging in social VR or driving them away altogether. However, most, if not all, teenagers use the platform tools available and have strategies for addressing harassment.

Tensions with the Offline World. Social VR is entirely immersive, meaning everything the user sees and hears is computer generated. As noted earlier in the paper, this can create compelling engagement activities. However, teens in our study noted a few tensions between their social VR use and their offline lives that sometimes discouraged them from engaging in the platform. For example, a few participants mentioned that spending large amounts of time in social VR may not be beneficial. P17 (15, Male, White) said, *"I mean, I spend less time in the real world,"* and P10 (16, Female, Ethnicity not reported) said social VR use normally *"takes up my time and school time."* As P17 and P10 are still in their developing years, their time management skills may not be as adequately refined as they may hope. The overuse of social VR may have an effect on the normalcy of their offline lives. The effect of social VR and VR in general on adolescents

is still understudied. Therefore, it is unclear how using social VR may impact teens in their offline lives. One of the teenagers, P8 (16, Male, Asian) acknowledged this point as well, saying *"As virtual reality is very new, we are still not 100% sure of the health effects, but that doesn't worry me personally. One main disadvantage is it sometimes distracts me from homework and forces me to procrastinate more. However, I would say that I am very good at procrastinating so it isn't the biggest deal."* As a sixteen-year-old, P8 was more concerned about the high level of appeal of social VR distracting him from his homework than its potential health effects. Another participant echoed this sentiment: *"I feel like the main disadvantage is that I end up ignoring the real world for like six hours a day. I usually end up skipping things like drawing and practice such just to play"* P19 (18, Male, Hispanic). This comment demonstrates the potential of social VR to fall into the category of addiction because P19 chose to ignore his offline commitments.

P7 (18, Male, White) and P4 (15, Male, Ethnicity not reported) also mentioned that social VR disconnected them from their family and friends: *"It annoys my family members, as they feel as if using a VR disconnects me from them"* (P7), and *"Potential disconnects me from my real world friends"* (P4). These teenagers allude to the fact that actively engaging in social VR creates challenges in their offline interactions and relationships. Likewise, P15 (16, Male, Asian) worried that his offline social skills may be affected by social VR use: *"I always worry that my real life social skills might get worse haha. Also I don't want it to replace my real life interactions."* P15 made the clear distinction between social VR and the offline world and in some ways which he prefers. For him, the more he engaged in social VR, the more he worried about its potential for affecting his offline life and real world skills. In summary, some teens may be dissuaded from using social VR due to the risks of new and familiar forms of harassment, disconnection with the offline world, potentially addictive behavior, unique challenges with loved ones and friends because of social VR use, and the fear of losing offline social skills.

5.3 Discussion and Conclusion

In summary, the findings from this study highlight several implications addressing the *attributes that contribute towards attracting and/or dissuading teenagers towards social VR.* First, teenagers were introduced and attracted to social VR by way of their friends, watching videos on Youtube, and the low barriers of entry after acquiring the VR headset. In particular, teens were primarily drawn to social VR because of the immersive activities it affords and supports, such as engaging in popular immersive social activities, a multitude of building and crafting opportunities, and the ability to remain connected during the 2020 COVID-19 global pandemic. We also report findings on some challenges perceived by teenagers, which may dissuade them from engaging in social VR, including harassment and the unique tensions it creates related to the offline world. Next we analyze how these findings shed light on adolescents' new trends of online social engagement and discuss potential design implications for supporting safe and fulfilling social VR for teens.

5.3.1 Adolescents' New Trends of Online Social Engagement

Our findings extend existing scholarship involving teenagers in online digital spaces. Specifically, we observed several similarities and differences between teenage experiences in traditional online spaces (e.g. games/virtual worlds) and those found in prior social VR scholarship. We observed similarities in the interactions [46, 124] and the ability to

create virtual possessions [51, 140, 141]. However, our study demonstrates that virtual possession includes not only artifacts but can extend to user-generated games and rooms. This difference is probably due to the variety of affordances available in social VR such as the ability to design from a naturalistic, 360-degree viewpoint. Additionally, our finding relating to user-induced activity supports previous scholarship, specifically that younger users enjoy the ability to spontaneously create social interactivity with one another, not solely relying on the game. The consistency of our findings with previous work on traditional virtual worlds highlights that creativity, exploration, and the freedom to generate their own content and artifacts are the main attractions drawing adolescents into online digital spaces. Therefore, new systems and platforms that better afford and support such activities would be more appealing to these users.

In addition, to the best of our knowledge, little to no work has interviewed teenagers on their use of social VR. Therefore, this study presents one of the first studies investigating teenagers' use of social VR from their perspectives. Our findings also confirm my previous scholarship on adolescents in social VR [32, 33], specifically the rich interpersonal interactions among teens beyond gameplay such as crafting and building in these environments. My prior study also briefly mentioned the use of social VR to cope with COVID-19. This study expands on the reasons why and how teens engaged in social VR during the pandemic such as the ability to remain connected and sociable with friends and family members. Our study also confirms previous findings from my prior work on social VR [28] regarding VR specific and mundane activities engaged in social VR as teens enjoyed just hanging out with people. However, our findings further highlight that teenagers enjoy the community aspect of not only playing but also building their own games in social VR. The unique forms of harassment our participants mentioned in social VR have also been reported in both Blackwell et al.'s [31] and my work [72]. In our study, teenagers seemed to consider the platform specific tools for addressing harassment generally effective. Yet they still noted that the entire reporting process could be improved.

One uniqueness of our findings is how teens recognized the tensions between their social VR use and offline lives. In previous studies [28, 30–32, 72, 74, 75], users did not mention the unique tensions and feelings of uneasiness or social constraints caused by the daily use of social VR although this phenomenon has been observed before in the context of mobile technologies [142]. Blackwell and colleagues also mentioned the *technology tensions* between teenagers and their parents, with parents generally underestimating their children's use [143]. However, our study demonstrates the self-reflection of teenagers who recognize the potential harm from potential overuse of social VR and the resulting lack of connection with the offline world. One potential reason explaining why teenagers

felt disconnected from the offline world may be because social VR creates a sense of *occupied* state, where teens are not readily perceiving information from the offline world. This sense of connection, or "availability," is defined as the sociotechnical state of being constantly connected and accessible to others [144], suggesting that the current state of social VR allows teenagers to connect to the online immersive world but distinctly disconnect from the offline world. How these tensions evolve is an important question in understanding the evolution of teenagers in digital social spaces.

5.3.2 Social VR As A Promising Application for Teens in the Changing World

At the time of this study, December 2020, social VR is in the early stages, with the most popular platforms being created in the past seven years and only in the most recent years gaining in immense popularity due to the decrease in the number of barriers for obtaining a VR headset (e.g. price and equipment). However, this study along with previous research involving adolescents [32, 33] demonstrates the immense opportunity and consequent challenges for the future of social VR. In particular, our study highlights the opportunity for connection in an ever-changing online world where social VR affords the opportunity for rich and current context (e.g., COVID-19 global pandemic) and socialization. For example, our findings show that teenagers were able to keep in touch with friends and family members fairly normally despite the isolation and health risks during the pandemic.

Our findings also suggest that the daily and weekly use of social VR demonstrates a shift in in-home technologies where VR use is being normalized similar to video games [145], TV's, and media centers [146]. This normalization may create opportunities for familiar and unfamiliar dynamics in both interpersonal and offline relationships. Such familiar dynamics may include more discussion regarding autonomy vs regulation, how to establish a common ground for parental and teen self-regulation [147, 148],and more help in encouraging conversations about harassment and other risks in social VR [149]. Also, unforeseen relationship dynamics may emerge, such as the ability to develop nearly normal connections and relationships with others from around the world and the ability to develop and sustain meaningful relationships beyond gaming and entertainment. In this sense, social VR presents a promising opportunity for teenagers in the changing world. Yet, we do not fully understand the effects of prolonged VR use, especially for teenagers. Additionally, YouTube streamers seem to significantly control and affect the narrative as to how teenagers may first interpret and experience social VR. This presents a challenging balancing act, where parents, guardians, and educators must encourage curiosity while cautioning possible misinterpreted information from online sources.

Finally, regarding the harassment found in our study and prior studies involving young users [28, 32], it is important for HCI and VR researchers to explore more effective tools for addressing online harassment in social VR beyond just blocking it. In our study, most, if not all, teenagers were aware of platform specific tools and had different strategies for dealing with harassment. Of those mentioned, *blocking* and *reporting* were the most widely used features. However, teens in our study also noted that these tools were not always effective and sometimes poorly monitored and managed by the platforms. Additionally, some participants mentioned the varying perceptions of harassment in social VR. Some saw it as joking behavior while other as more serious forms of harassment. As teenagers are still developing, there may be cases where one teen perceives inappropriate behavior while another one believes the behavior is a joke. This dynamic should be treated as an opportunity for *civil and equitable mediation* and learning rather "than out of sight out of mind," which does not inform the potential harasser of the repercussions of their actions nor provide room for mutual understanding. We are not asserting that blocking is not a effective tool as we believe many circumstances require it. However, we also want to highlight that the process of quickly blocking someone may promote *cancel culture* among teenagers.

5.3.3 Designing Social VR for Teens

Grounded in our findings, we identify three potential design implications for further supporting teenagers' engagement in social VR. These implications are neither complete nor exhaustive as they are primarily directions emerging from our participants' accounts. However, we believe that they may benefit teenagers, parents/guardians, educators, designers, and developers who want to improve and maintain the well-being of both teenagers and social VR.

Tools for Creating In-Game Interactivity. One of the key highlights in our findings is how teens enjoyed and engaged in various creative activities in social VR. Engaging in designing an in-game artifact (e.g., art, items), building a mini-game, or creating a custom room facilitated *social interactivity* among users. In this sense, the process of creation and design yielded social currency with other users, perhaps because of the uniqueness of their design style and their imagination which are not featured elsewhere in the platform. To encourage rich social engagement for teens, future social VR platforms should implement and provide a variety of creative tools and activities for their users.

Increased Outside Connection Within Social VR. Our users mentioned that the daily use of social VR created tensions between themselves and their offline relationships. One way to reduce tensions and support family and friend engagement is to create tools that

allow users from the offline world to actively participate in the social VR environment, for example tools that actively stream content to another device and the ability to collaboratively build and play games with one person in social VR and another not wearing the VR HMD.

Civil and Equitable Mediation To Address Continued Harassment. Social VR platforms have unique roles in monitoring and managing harassment, including providing features of blocking and reporting this activity. However, our participants noticed several issues with the process, which led to a lack of trust and feelings of unfair treatment, thus discouraging them from engaging in social VR. Our participants also mentioned the varying viewpoints on what is perceived as harassment. Therefore, to design safer social VR spaces for teens, we suggest a *civil and equitable mediation*, which would allow both parties involved in an altercation to explain what happened from their point of view. This civil discourse may facilitate mutual understanding and lead to fewer instances of harassment. This mediation would be conducted by a qualified on-call platform moderator who would mediate the discussion between the two parties. To encourage this form of mediation, platforms could provide in-game currency to encourage and promote discussion, which would, in turn, foster a more understanding and empathetic community base.

Chapter Conclusion. Social VR has become an appealing online social space for teenagers to interact, socialize, and connect with one another in an immersive environment. In this paper, we investigated the common experiences of 20 teenagers that attracted them to or dissuaded them from social VR. Our findings show that teenagers were first attracted to social VR through their friends, watching videos on YouTube, or the particularly low barriers of entry (e.g., cost). In addition, social activities, immersive building opportunities, and the ability to remain connected during the 2020 COVID-19 global pandemic were key attractions of social VR for them to engage in a novel online social space. We also discovered such challenges associated with social VR as nuances of harassment in an immersive space and the unique tensions created by using social VR with themselves, friends, and/or family members, both of which may drive teenage users away. Our focus on first-hand empirical data from teenagers' own points of view contributes to the growing scholarship on young users in social VR. We hope that our findings contribute to a better understanding of the unique experiences of teenagers in social VR and aid in the designing of safer, more fulfilling experiences in social VR for this population. While the findings from this study further investigate the foundational questions of this dissertation, a two areas remain to be explored and have motivated Study 4. The first is quantifiable data on trends of how teens use VR and social VR, and the second is a set of user-generated design recommendations for social VR.

Chapter 6

Study 4: Four-Week Longitudinal Diary Study

The final study in this dissertation is a longitudinal diary study with 13 teen users over the course of four weeks. Its goals are two fold: it aims, first, to explore and quantify the trends of Teens' experiences in social VR and second, to identify potential user-generated design recommendations to better design social VR for Teens, subsequently confirming and combining insights from previous studies to generate youth-centered design recommendations. Each participant spent a total of four weeks answering questions about their VR experience per week, their weekly social VR use, and their recommendations of areas for improvement.

These findings from this work are the first to identify youth-generated design recommendations for VR and social VR and to provide insight into how often and in what manner Teens use social VR. Due to COVID-19, this study was conducted through computer-mediated methods to ensure the participants' safety and privacy and to comply with Clemson University's IRB policy. It addresses the following research question:

(RQ3): *What requirements, features, and mechanisms can be identified for designing safer and more supportive social VR spaces for younger users?*

6.1 Methodology

Recruitment and Procedure. This study was approved by the Clemson University's Institutional Review Board (IRB) for research ethics. We posted a message on popular online forums for social VR from August to September of 2021 to recruit teenagers aged 13-18 who engage in social VR weekly. In this recruitment message, we also included

a link to a google form that provided a brief overview of the study. After completing this form expressing their interest in the study, participants were sent an email detailing the study further and asking them to confirm their acknowledgement of the attached consent form and to answer initial demographic questions. After confirming their interest in the study, obtaining parent/guardian approval and acknowledging that they had read the consent form, participants were compensated $20 per week for a total of $80 for completing the entire study. Complying with IRB requirements, we did not conduct interviews through voice or video chat to better protect participants' privacy (i.e., no voice or facial data were collected). Rather, we collected information via synchronous and asynchronous text chat through an open collaborative co-edited google document to protect the privacy of participants and anonymize their voice and facial data. Each week participants were given a set of questions to answer on the google form regarding their social VR and VR use as well as asking for their input on design recommendations. Sample questions included the following:

- How many hours did you use VR this week? Social VR applications?
- Whom did you play with during this time (solo, friends, both)?
- What is your favorite VR game/app, this week and why?
- How did your family feel about you playing VR this week?
- Do you wish your family played VR with you?
- What do you wish parents knew about VR this week?
- What would you like the game/app creators to know this week?
- Should there be better safety controls? If so what?
- What can we tell parents or adults that they may not understand about VR and social VR?

We acknowledge that this is an unconventional method and may have limitations such as the depth of responses written; however, as these are open-ended research questions, we believe this method is an appropriate and responsible approach for both protecting the youth and collecting data. Additionally, this research follows the guidelines outlined for conducting ethical research in social VR [138] and similar procedures for diary studies in HCI [150] as well as prior diary studies with youth [151].

Participants. Of the 25 participants who began the four-week diary study, only 13 completed it in its entirety, of 13 who did, 10 identified as men, one as Woman, and

Participant ID	What race do you identify as?	What gender do you identify as?	What region of the world do you live?	What platforms do you spend the majority of your time?	How old are you?	Approximately how many hours do you play VR per week?
1	White	Non-Binary	Poland	Vrchat	16	50
2	White	Man	Italy	Recroom	15	12
3	Black	Man	Britain	VRchat	16	8
4	White	Man	UK	Recroom	14	16
5	White	Non-Binary	North America	GorillaTag	14	25
6	White	Man	Brazil	Recroom	18	6
7	White	Woman	North America	Recroom	16	40
8	White	Man	Europe	RecRoom, Vrchat	15	24
9	White	Man	New Zealand	VRchat, EchoVR	18	20
10	Mixed	Man	US	VRchat	15	14
11	White	Man	US	GorillaTag, RR, Vrchat	13	40
12	Latinx	Man	US	Vrchat	18	15
13	N/A	Man	US	RecRoom	14	N/A
				Average	15	22.5

FIGURE 6.1: Table of Participants' Demographics

two as non-binary. Nine of 13 participants were White and one identified as each Black, Mixed, and Latinx. The majority of participants were from North America and Europe with one from New Zealand and one from Brazil. Participants used a wide variety of VR devices including Oculus Quest, HTC VIVE, and PSVR. The average weekly time spent for this group was 22.5 hours. The ages of users ranged from 13 to 18, with an average age of 15. Table 6.1 provides the demographic information of our participants.

6.2 Findings

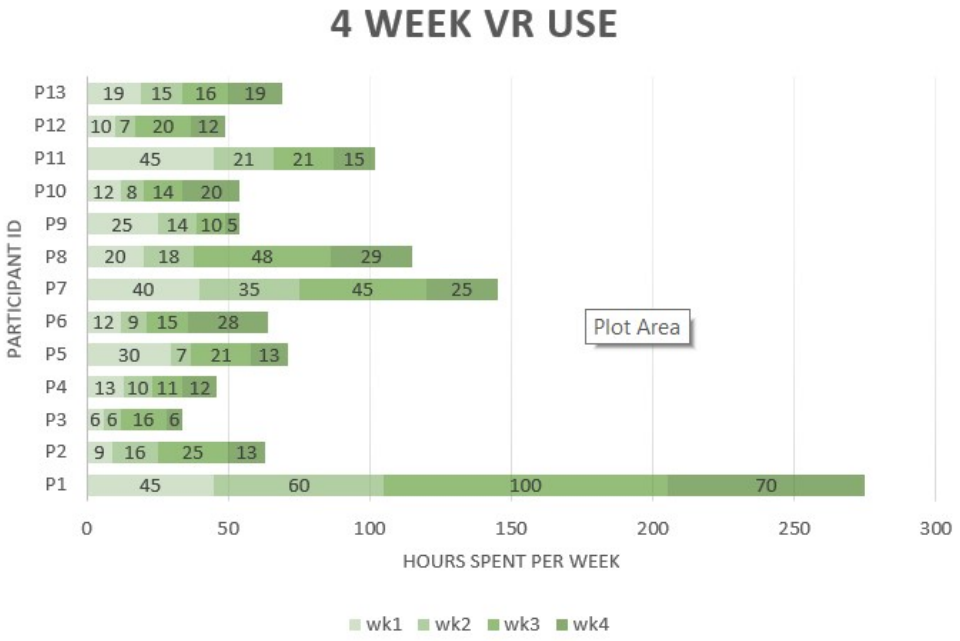

FIGURE 6.2: VR Weekly Use over One Month

Time Spent in VR and on Platforms. We start with a descriptive analysis of the data. One overarching question was how often do Teens spend in VR and social VR.

Figures 6.2 and 6.3 demonstrate that the average time spent in VR over the course of four weeks was 22 hours and 16 hours per week for social VR; however, omitting P1 (a heavy user) brings the average down to 18 hours in VR and 11 in social VR. It should be noted that these times were reported when all participants spent part of their day in school or another educational setting. When participants were asked to self report how many hours they spent in VR during the summer (e.g., outside of school education), the average reported time increased to 63 hours per week. The primary findings from these data demonstrate that the majority of time spent in VR was in social VR applications, with more than 68% of the time spent in the latter.

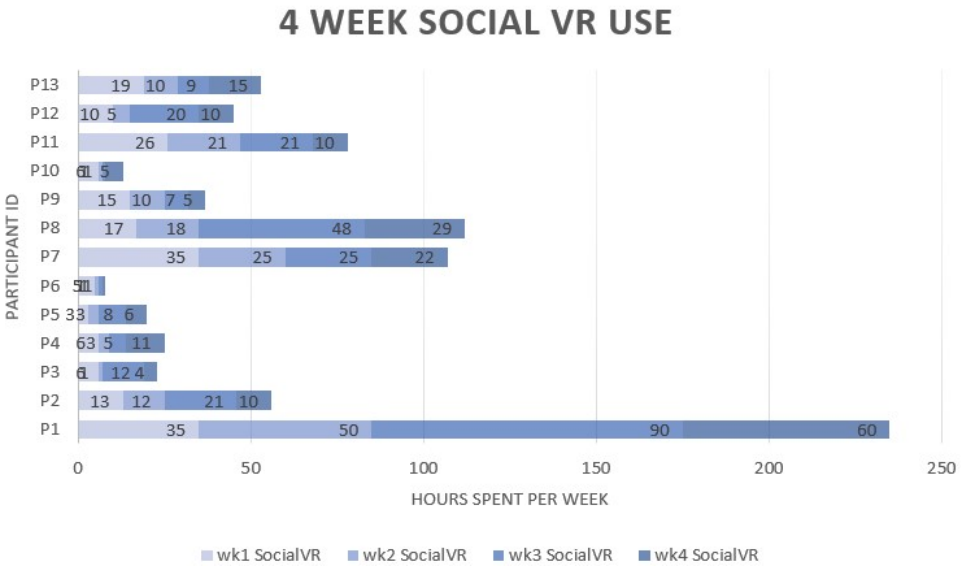

FIGURE 6.3: Social VR Weekly Use over One Month

Collaborative vs Social Play. Participants categorized playing VR based on the number of players as solo-play, co-play (with others), or mix play (both solo and co-play), co-play does not take into account when the relationship was formed. Co-play both with offline and online friends, family, and partners accounted for more than 60% of the interactivity with others in VR, followed by solo-play at 19% and mix-play at 18% as seen in Figure 6.3. For teenagers part of the emotional fulfillment in social VR is the interactivity with others whether these are familiar relationships or new experiences. For example, P7 says *"I think the most favorite things I did this week was just playing with people on echo. I made some pretty cool friends on there this week,"* and P4 said, *"I played VRchat with my best friend (played some avatar worlds first and then some flying) and a little bit of rec room (setting up my dorm to prank for my teachers when the next COVID-19 lockdown happens)."* These interactions do not just span from online and offline friends but also more intimate relationships like family members and partners; as P11 explained, *"One of my favorite things was playing GorillaTag with my Dad,"* and P1 said, *"This week I got to spend time with and fall asleep in VR with my partner."*

Teens are using VR as a opportunity to enrich already existing relationships as well as seek new social relationships (e.g., make friends).

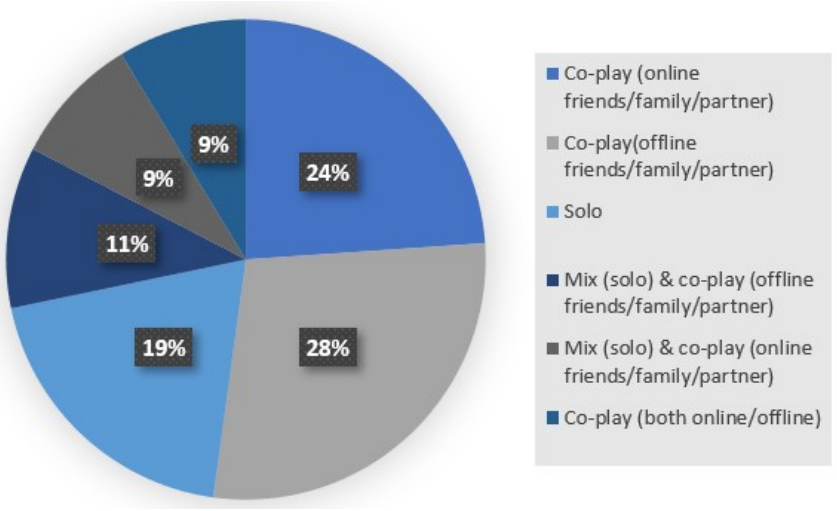

FIGURE 6.4: Solo, Co-play, and Mix

VR Applications. Over the course of four weeks, the most popular VR applications reported were BeatSaber, RecRoom, VRchat, and GorillaTag as can be seen in Figure 6.5. Users were asked what their favorite games/apps were each week. P12 enjoys the uniqueness of BeatSaber because as he explained, *"I enjoy BeatSaber for two reasons, it has really cool mechanics and I really enjoy rhythm games."* His enjoyment comes from the unique affordances of the game. The attraction of social VR was due to the unpredictable interactions and experiences on the platforms; for example, as P1 said, *"I experienced multitude of vrchat worlds like the virtual market 6, I also climbed to the top 200 players of beat saber in my country"*, and when asked about the draw of social applications, P6 said, *"I like that you can fly, go fishing, and even climb a very high mountain in VR."* For most Teens, social VR provides unlimited possibilities for interactivity, which are not easily accessible in the offline world.

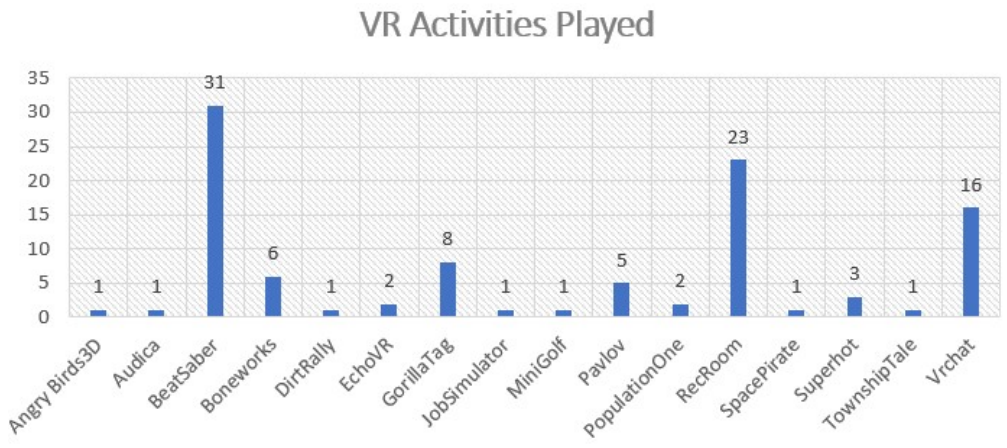

FIGURE 6.5: Favorite Activities Over One Month

Recommendations from Teenagers. Each week Teens were asked for their recommendations concerning VR for adults and game developers, and for any information that would improve the overall VR experience for everyone. All the recommendations were categorized as either hardware, safety, VR-specific, performance, or recommendations for addressing misconceptions of VR.

Recommendations about the misconception of VR. Throughout the four weeks, all 13 participants recommended that more adults and critics of the technology should venture into VR to see for themselves the benefits of it and its experience. The primary complaint of the youth was that the criticism of VR is from individuals with little to no experiences of it. P7 detailed her perspective:

> *People criticize VR and say that its not safe, but it is safe except for some toxic and inappropriate people but those people are also in the real world and you can't just every stop those kind of people and get rid of them so it's something you just have to learn to accept. It is really fun and offers a large variety of different entertainments. VR is also really cool because it can help people in ways that people don't realize. Like for some things I've seen, it can really help people grow. It can help people become more socially adept and more comfortable with people, it can help them learn to trust people [...and not trust people], etc, so there's lots of ways it can help people, more people need to try it out.*

P2 made similar comments: *"I wish adults tried it, then they would know that the VR is not simply a game, but a great experience for socialize and play with everyone. The social VR games are very safe, with a great moderation and filters; playing in VR lets you learn a big amount of things (for example you can learn programming with it) and its not harmful at all."* P2 and P7 express the criticism that VR and social VR get is from outsiders. P9 echoes their comments, saying *"There's so much you can do with VR, people just need to try it, a lot of older people don't realise the true extent of things VR can achieve. Parents usually think that VR is just for games, but it's actually a lot more than that, and has many different aspects, including social."* As P9 explains, the average adult views VR as only a gaming device whereas to teenagers it is so much more: it provides limitless interactivity. P3 blames the both the hacker stereotype for why people are resistant to entering into VR and *"the old stereotype of a 40 yr old living in his mom basement is simply not true most of gamers and VR players are young like me."* Finally, there were misconceptions on the realness of relationships in VR. According to P8, *"my brother doesnt think that real friendships over vr are actually real, but just because you dont live near the person doesn't in any way degrade the quality of said relationship."*

This comment from P8 and the overwhelming majority of teenagers recommend two things: first, that adults should spend quality time in social VR to fully understand the experiences and second that the experiences that youth and others have on these platforms are real even though the experience is computer-mediated.

Recommendations on safety. The majority of recommendations regarding safety fell into the category of vulnerable youth on the platform. Ten of our 13 participants commented on safety issues multiple times over the course of the four-week study. Most older teenagers aged 15-18 felt that there are particular experiences in social VR not appropriate for youth. For example, P3 said, *"blocking underage users by default, there is no barrier so kids can just log in and hear adult convos."* P3 is explaining that in most social VR platforms, it can be the equivalent to a teenager walking into a bar filled with adults. Most platforms are open world, with no spaces specifically designed youth. Another set of recommendations suggested increasing co-play with parents/guardians. As P1 explained, *"Parents should be present when their kids play any social game if said kids are younger than 14."* P7 summarized the issue of safety and youth on the platform:

> *This is a controversial subject in the VR world, especially in social games. I think that there should be measures in place that prevent children from being in certain worlds and/or games. In games like VRChat children can be exposed to offensive and illegal material for their age, which could lead to a lot of problems like infliction of emotional distress, cyberbullying, and harassment to these minors. This currently is a big problem in VR games, since a lot of these multiplayer games have no systems in place to censor unwanted material before exposure.*

P7 demonstrates the pressing need of better safety implementations in social VR and the potential harm that can occur to this vulnerable population.

Another line of safety recommendations from youth involved measures that could be taken to ensure less harm is done. P5 commented on this, saying *"Sometimes we forget that people can't hear you if you are muted and that it is VR so they can't hurt you or find you, they really can't do anything to you but people forget that."* P5 explains that often the experiences in social VR can be so immersive that youth forget that they are not actually in any physical harm. Finally, there were some VR specific safety considerations involving sleeping in VR: P12 and P8 reported that *"apps such as VRChat should be aware that the players fall asleep in their game"* and *"there should be a dim feature or night mode, because sometimes I have trouble falling asleep because of the brightness."* Falling asleep in VR is a common activity in social VR, yet these Teens feel that these systems could be improved to create a better experience

Recommendations on VR performance, hardware, and VR specific affordances. Teenagers also had recommendations on the overall performance of VR, expressing frustration with performance issues relating to their VR experience and emphasizing that developers should improve the existing infrastructure. For example, P13 and P2 explained, *"Focus on bugs instead of adding new things"* and *"theres always new stuff thats great but sometimes the game glitches up and its frustrating, they need to fix the old stuff."* P13 and P2 were speaking about their experience in VRchat and how the overall experience could be improved by fixing the bugs. P10 spoke about frustration with tracking, saying *"I want more base stations so that tracking can be better."* Here P10 is referring to the HTC Vive hardware which uses stationary cameras to track the position of the user; with more cameras comes better tracking, and P10's main concern is improving the tracking in the VR system.

There were also recommendations on VR hardware as P9 comments, *"We need new headsets, there should be new headsets coming out, bringing new technology to the industry. If companies are actively introducing new headsets into the market, the technology in them will only evolve, get better and also become less expensive and more accessible for the general public."* P9's recommendations focus on reducing the barriers to VR, such as expense, and the need for competition in the market. P3 made similar comments about hardware: *"We need way more headsets because any competition for facebook is good."* P3 is referring to the current monopoly Meta (formerly Facebook) has over the entire VR industry in both software and hardware.

Finally, there were recommendations for curating more VR specific affordances in VR experiences. Youth do not want to simply experience what they could have in the offline world or in a 2D format; they want more curated VR content as P13 and P9 explained, *"we need to have teleport mode in all games"* and *"the quest should have full body tracking."* Both of these quotes highlight the unique affordances VR allows, first person teleportation and the ability to have your body tracked within the environment. Other comments focused on the specific applications themselves; P12 and P10 said, *"We're running out of stuff to do over here. Give us some original multiplayer content, not just more VRChat rip offs. Literally any game with good controls, a decent player base and low ping servers, im all for"* and *"social games need more to do. VRChat is slipping into a boring space where people just stand in front of a mirror all day. Give us things to do."* These teens want more nuanced social activity that differs from current platforms and more interactivity on VRchat because this feature lacks richness.

6.3 Discussion and Conclusion

This research uncovered several trends about teenagers using social VR and some of their recommendations. In summary, the teens in this study spend a significant amount of time in VR, with the majority being spent on social VR platforms. These trends fall in line with youths' high use of digital technology [152], especially with youth averaging 60 hrs per week during the summer months (e.g., without school). It should be noted that this participant group is highly selective group of teenagers who are enthusiastic of VR technology. However, VR seems to be the ideal tool to serve as a social lubricant for interactivity with both offline and online friends, partners, and family members. Finally, the most popular applications used over the four weeks of this study were BeatSaber, RecRoom, VRchat, and GorillaTag. Additionally, teens' primary recommendations focused on getting more people onto VR to change the current misconceptions, address the safety considerations for the younger users on the platform, demonstrate the benefits of the interactivity, and improve the hardware, performance, and VR-specific affordances. It should be noted, that over the course of this diary study, there were no significant changes in teens' use and/or experience over time.

This work represents, the first academic scholarship providing quantifiable data involving trends of social VR use by teenagers, and it also serves as the first to include user-generated quotes from participants' own perspectives.

Quantifiable Trends of Youth in VR. The quantifiable trends that emerged from this research project both confirm and extend prior work, primarily the popularity of social VR platforms demonstrated in prior work by myself and colleagues [32, 33, 138]. It should be noted that while a relatively high number of hours per week spent in VR (22 hours/week) was found when the youth were in an education setting (e.g., school), the average self-reported hours during the summer was much higher at 63 hours per week. However, 22 hours per week is approximately only three hours per day, spent either after or before school as indicated as the common times for teens to engage in VR. Because of COVID-19 in 2021, it is also possible that these numbers are inflated due to the quarantine measures in place, suggesting that VR and social VR was the most practical avenue for youth to engage in social activities with others. This analysis would also explain the findings seen in 6.4, which demonstrated that more than 50% of the interaction spent in VR was spent with online or offline friends. Although exacerbated by the isolation of the global pandemic, social VR seemed to offer familiar aspects of interpersonal communication and interactivity beyond what the offline world could provide. This phenomenon of the emotional fulfillment realized from engagement with familiar people is true for traditional gaming with friends and family [153, 154], one naturally creating a positive social engagement and very rarely resulting in behavior

that harms the relationship [153]. In fact, family-centered video gaming is a common phenomenon [155] that has been found to be beneficial for the parent/guardian and child relationship, perhaps even resulting in encouraging the former to assume guidance and teaching roles [156].

Recommendations of Youth in VR. The teenagers in this study offered several recommendations about VR, with the overwhelming majority being rooted in the misconceptions of VR held by adults with little to no experience. In particular, teens urged adults to give VR a fair and open-minded chance, primarily citing that adults view VR as purely a gaming mechanic when it is in actuality much more dynamic. The rhetoric from adults stems from the numerous negative video gaming studies which, although they have largely been disproven, demonstrate bias towards publishing negative results [157–159]. However, the actual problem that the youth seem to uncover is not that adults do not want to try social VR as there are adult users actively engaging in it [28, 30, 72, 138]; it is that there are barriers to the entry of more adults on these social VR platforms. For example, the current (2021) premiere VR headset, the Oculus Quest 2, costs between 300 and 400 USD, which is a significant expense, especially when competing with the more reasonable 2D media sources such as phones, tablets, and laptops.

Other recommendations involved safety on these platforms; it should be noted that most of the teens in this study acknowledge the existence of "creepy/weird" adults on platforms, but they also acknowledge the presence of such individuals in the offline world. However, the safety considerations these teenagers suggested involved protecting the youngest youth on the platforms. Interestingly, they did not recommend banning the youngest groups, just providing more protections for their safety, a view point that does not align with prior adult recommendations to remove youth from social VR [32]. Rather these Teens stress involving parents/guardians in the social VR experience with the youngest groups. However, if this sort of cooperative play is poorly done, it can have negative ramifications on their relationship with their child [160]. For this type of interaction, it may be best to allow exploration, space for questions, and the development of trust which will, in turn, lead to nurturing and sharing of knowledge [156].

The last set of recommendations involved better performance experiences, continued improvements to VR hardware, and VR specific affordances. At first these recommendations from teenagers may seem surprising; however, they are not for two reasons. The first is that social VR, although extremely popular, is still an emerging genre, meaning there are bugs, glitches, and poor performance issues. The second reason, supported by prior scholarship, demonstrates that youth are digitally intuitive or tech savvy [161], meaning gestures such as tap and swipe are common occurrences in their lives as they

group with tools such as chromebooks, iPads, and smartphones. As a result, the argument can be made that this group has higher technology expectations than other generations. This would explain the comments on the need for high quality graphics and better performance. Additionally, prior scholarship demonstrates that higher degrees of visual presence leads to increased self-perceptions of presence and immersion [162]. The expectation of high fidelity in the environment is also likely due to the quality of the interactions in the environment as prior scholarship demonstrates youth perceive interactions in social VR as "real" or rather on the same level with interactions in the offline world [33]. Therefore, to youth, high quality interactivity must be equally met with high quality graphical fidelity. Finally, there were recommendations on methods for more VR specific interactivity, the cause of this stemming from teens being bored in some social VR platforms, something that again can be explained by the high level of expectation due to Teens' level of digital and technological intuition. It is also important to note that the interactivity does not need to be extravagant; it can be simple and tied to the mechanics of the game such as in GorillaTag or even sleeping, a rather mundane activity that serves as an example of a VR specific affordance that is not extravagant.

Limitations. This study has three main limitations, the first being the sample size. The typical size for a diary study is approximately 20 participants [163]; however, its noted that research conducted with youth [151] creates challenges that are not always present with adult participants and, thus, may reduce the sample size. Another limitation is the lack of participant diversity; although geographically diverse, there was little racial and gender diversity. Prior scholarship in VR has demonstrated the lack of representation in VR research participants [164]. Finally, given the anonymous nature of this study, participants and their parents/guardians were asked to self-identify as a user between age 13-18 and also self-report on their individual behavior; it is possible that the Teens in this study did not provide accurate information.

Chapter Conclusion. This is one of the first research projects to detail trends of youth in VR. It found that teenagers in this study spent an average of 22 hours per week on VR platforms or more than 68% of their time. In addition, over 50% of their VR experiences are done with online or offline friends, family, or partners, and BeatSaber, RecRoom, and VRchat were the most popular games over the course of this four-week study. Additionally, teen's recommendations for improving VR centered around getting more users on the platform to disprove misconceptions; improving safety mechanics for the youngest youth; addressing the bugs, glitches, and other performance issues; and finally continue pushing the boundaries towards more VR specific activities.

Chapter 7

Summary of Study Findings and Implications

Through these four studies I have demonstrated the unique nuances of social VR and broader VR for youth. This chapter highlights some of the key findings, demonstrating how these four studies address the three overarching research questions of this dissertation and tie them to the evolving metaverse.

Below is a brief summary of the three research questions posed in the beginning of this dissertation and key findings related to them:

RQ1: How do youth use social VR (Frequency, experiences, and common activities)?

- Youth in these studies spent ample time in VR (22hrs/week) and social VR (16hrs/week), with self-reported use during the summer averaging 63hrs/week (Studies 1, 3, 4).
- Social VR platforms were found to be the most frequently used forms of VR content for teenagers in these studies (e.g., games, education).
- Youth are digitally intuitive and use social VR in unconventional manners such as sleeping in VR.

RQ2: How, if at all, does the use of social VR affect the social lives of young users (e.g., risks of harassment, privacy concerns, friendships, romance, and psychological well-being)?

- Youth see social VR as a phenomenal tool for social development, including both positive (e.g. confidence, interpersonal communication) and negative aspects of sociality (e.g., anxiety, bullying, inappropriate social behaviors) (Studies 1-3).

- Overall youth feel socially empowered in the offline world because of their interactions in social VR (Studies 2, 3).
- Social VR is is viewed as a tool for well-being and self-exploration (Studies 2, 3, 4).

RQ3: What requirements, features, and mechanisms can be identified for designing safer and more supportive social VR spaces for young users (Study 4)?

- Youth believe the criticism of VR from adults is unwarranted and impedes the progression of VR, and they further recommend critics experience VR and social VR platforms.
- Youth generated nine design recommendations for improving the design for the most vulnerable young users, the performance of VR, and increasing the number of affordances.

The following section connects the foundational theory to these findings.

7.1 Further Analysis of Findings

7.1.1 The Modern Playground for the Digitally Intuitive

Why would a teenager choose to sleep in VR? The answer to this question and to RQ1 stems from youth being *digitally intuitive* [161] because, unlike adults who had instructions on how to use technology and the norms in them, youth have no such reference point when it comes to technology. Therefore, their efforts, behaviors, and motivations are guided solely by their intuition and the affordances offered by the technology and environment [4], explaining why a grown adult would find sleeping in VR odd but a teenager would not. Teens do not limit VR to solely a gaming platform; in fact, at times VR offers, or affords, experiences that the offline world is incapable of or experiences which would seem difficult for such reasons as money, time, safety, endurance, distance, and convenience.

Teens sleep in VR for a several reasons, the first being it is a unique experience that easy to engage in and experience. Sleeping is an everyday activity for most, involving fairly mundane mechanics, so falling asleep is an easy, familiar task. Second, is the experience itself; in VR users sleep in worlds specifically designed for this activity, ones that include soft soothing music, dark backgrounds/settings, and, in some, changes in

the environment creating the experience of waking up in a different place. Further, in these worlds others do not typically bother the sleeper. The third reason for sleeping in VR is the ability to feel connected to others. Rice et al. demonstrate how the exploration of sociality and relationships is core to adolescent development [165], further explaining why sleeping in a room with strangers is important to teens: It helps them feel connected to other human beings in a safer environment than the offline world. A close equivalent in the offline world to sleeping in VR is sleeping on a plane and arriving at a new destination. However, for teenagers, there are a several reasons why these two are not the same. First, sleeping on a plane requires money; most teenagers do not have the expendable income for frequent plane rides where they wake up in entirely new places. The second reason is time; although a flight duration can vary, it requires additional time to travel to and from the airport. Sleeping in VR is much less cumbersome, and teens can sleep without leaving home. The third and arguably the most important reason is safety; the United Nations, the US Federal Aviation Administration, and numerous airlines consider unaccompanied minors a vulnerable population when traveling alone due to the risks they are exposed to, and care is taken to ensure minors are protected. Sleeping in VR is a much safer option for this population. It is one of the many activities explaining why social VR is the modern playground for teens, a phenomenon that can be explained by the Basic Psychological Needs Theory.

As discussed in Chapter 2, the Basic Psychological Needs Theory (BPNT) states that we as humans have three psychological needs, competence, autonomy, and relatedness. Competence refers to a feeling of having an effect, while autonomy is seen as the perception that our actions are self-endorsed and performed willingly, relatedness involves a sense of reciprocal care, value and belonging in relation to other social figures and collectives [60].

Social VR allows teens to have considerable influence in the space because of the technological affordances detailed in Section 2.5, including influence via natural competences such as speaking, gestures[72], and presence. It can also be described as competence through self-representation via making a statement using an avatar or a phenomenon of the illusion of social presence as described in Section 2.5, where other entities in the environment such as avatars or inanimate objects that are human controlled react to the user's presence. Autonomy and competency, although similar in social VR, differ because competency focuses on influence in the space whereas autonomy represents the will of an individual. Similar to the offline world, in social VR users have full autonomy over their actions, behaviors, and interactions on the platform. Most autonomy in social VR stems from the mediation of an avatar; however, these avatars afford much more than the physical human body, including different genders, skin tones, voice inflections,

and inhuman appearances (e.g., animal avatars), providing an additional layer of autonomy. Additionally, a core piece of autonomy stems from adolescents being in the developmental stage, a time when teens strive for independence [166, 167]. In this stage, which usually starts at age 12 [168] and continues into adulthood, teens strive for a sense of *self-reliance*, or the subjective feeling of making decisions without excessive social validation [169]. Social VR provides a platform with few to no serious repercussions to ones' offline connections or life, meaning in this sense teens are truly autonomous: they are able to act, think, and behave as they choose. Of course, this independence has serious implications such as bullying [32, 33] and other negative ramifications of full autonomy. The last piece of BPNT is the sense of relatedness or what is referred to here as *sociality*; it includes experiences that create warm bonding and satisfied feelings of connectedness with others [170]. While the next section will develop this further, social VR inherently provides opportunities to meet, play, and connect with others in a naturalistic manner that other mediums fail to reproduce. The 3D immersive nature of the interactivity in addition to the first-person representation of an avatar makes connecting with others an easy and natural phenomenon in social VR. Additionally, the number of youth in social VR [32, 33] provides the opportunity to relate to a wide-range of peers in a variety ways.

For these reasons coupled with the ramifications of COVID-19 in 2021, social VR is the modern playground for the digitally intuitive, explaining the number of youth who regularly engage in social VR (22hrs/week) and why they engage in social VR more than any other type of VR content or platform. In the study reported in Chapter 5, we learned that through VR and primarily social VR teens were able to remain connected due to VR headsets. When these data were collected, the global health crisis resulted in people all over the world being quarantined in their homes. Furthermore, at this point teenagers were not eligible for the COVID-19 vaccine, adding to their isolation. Some teens heralded social VR as a "life saver" with such comments as "I don't know how I would've gotten through COVID-19 without VR." Their comments demonstrate that social VR was a core necessity in their day-to-day lives. The comparison with modern playgrounds stems from their development [171, 172] as they progressed from wide open spaces with trees to objects where youth could climb upon to more complex structures affording more social activities such as games and monkey bars to now what I believe is the modern version of the playground, social VR, a place to play, socialize, and develop with affordances respective of the time period. Each iteration of the playground has shifted toward the current development needs of the youth, and our current shift, irrespective of the global pandemic, does the same, engaging youth in socialization and play in a new but still familiar way.

7.1.2 Social VR: The Ultimate Social Developmental Tool

Over the course of this dissertation, I have spent time researching adult perceptions of youth in social VR, conducting hundreds hours of participatory observations, speaking with them individually, and in the final study tracking their use over the course of a month. In each stage of this research, one glaring fact has repeatedly emerged: social VR is a phenomenal tool for *social development*. It is important to note that it incorporates both the positive (e.g., well-being, confidence, interpersonal communication) and negative (e.g., anxiety, bullying, inappropriate social behavior) aspects of social development as evidenced by comments from the participants; however, a quote from one in Chapter Six highlighted the benefits of sociality, regardless whether positive or negative, because it is experiential learning:

> *"VR is also really cool because it can help people in ways that people don't realize. Like for some things I've seen, it can really help people grow. It can help people become more socially adept and more comfortable with people, it can help them learn to trust [...and not trust people]."*

I am not asserting that negative experiences are beneficial to teenagers but rather the experiential learning that occurs from these interactions is because youth are able to role-play in a manner where the social situations have little to no harm on their offline lives or physical health. Interestingly, in addition teenagers also commented on how practicing in social VR translates to the offline world, leading to the question about why and how would youths' social adeptness in social VR translate to the offline world.

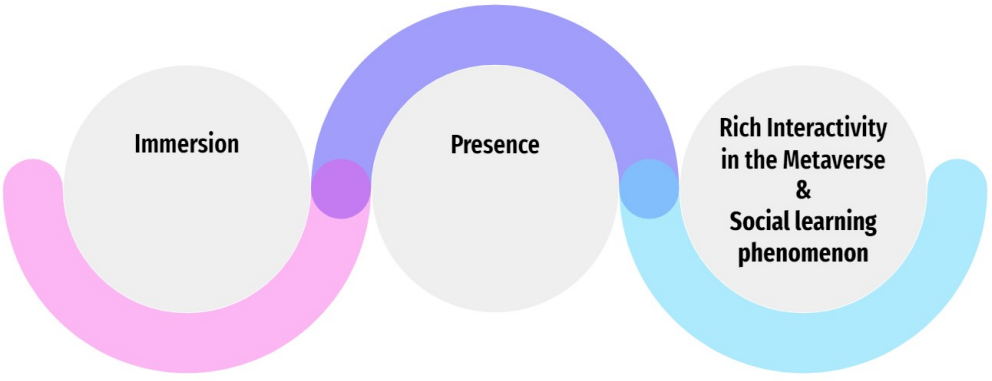

FIGURE 7.1: The connection between immersion, presence, and rich interactivity

A few theoretical reasons support and BPNT directly answers RQ2. The first and easiest connection is the concept of VR itself. Virtual reality is at its core a tool that, until

the recent developments of VR and primarily social VR, was mainly used for training, simulation, and exposure therapy [137, 173, 174]. These uses support and strengthen the claim that social VR is a phenomenal social developmental tool; in fact, VR has been recognized for its for experiential learning through training and repetition [175]. From this perspective, social VR provides different levels of experiential learning supporting social development, the first being the variability in the interaction and people one can encounter. Most, if not all, social VR platforms are open homogeneous worlds, meaning all of the users are on the same server and, thus, the opportunity for encountering others in a different time zone or from another part of the world is relatively high if both users are on the platform at the same time. The interactions also vary, again involving both social and antisocial behavior; for example, bullying has been documented in this dissertation as well as an instance of virtual sexual assault. However, the majority of interactions are social although they can differ across the range of *normal*. For example, in some cultures it is normal to stand close to someone when speaking with them [176]; this behavior and others are what teens are able to encounter in role play in social VR, which, in turn, prepares them for interactions in the offline world.

The second theoretical reason lies in the concepts of *immersion* and *presence*, meaning the relationships, interactions, and behaviors in the metaverse are considered *real* to the users. There are many possible explanations for this phenomenon, but in this dissertation I adopt Slater et al.'s definition that "immersion provides boundaries within which [presence can occur" [82]. This means that users must first be fully immersed to have presence, and from this presence other effects occur, such as the memory of a prior social interaction. Scholarship involving memory recall in VR has explored its effects on spatial memory in the virtual world [177] and informational memory in the offline world [178], but as of 2021 little to no work has explored the lingering social effects or social recall translated from the social VR environment to the offline world. However, prior work has demonstrated that higher levels of immersion and presence lead to behavioral, cognitive, and perceptual changes in a user [22–25]. One could conclude that due to the high levels of VR immersion and presence that the social interactivity facilitated by social VR demonstrates social learning which translates to the offline world as illustrated in Figure 7.1. However, it is important to note the opposite is not true as Slater et al. noted: immersion is the catalyst for presence [82] but the effect in reverse has not been widely studied.

The last theoretical concept supporting the claim of that social VR is a social development tool relates to Self-Determination Theory (SDT). SDT theory broadly encapsulates human development, innate psychological needs, and motivation[54–56]. As teenagers are still developing, I argue that via social VR, concepts within SDT are accelerated, specifically motivation, confidence, well-being, and innate teenage psychological needs,

irrespective of gender, culture, race, sexuality, political, social, or economic condition [54]. The evidence that this theory supports RQ2 is seen in the responses from teens about social VR. Approximately 90% of the teenagers who participated in the research conducted for this dissertation said social VR was a major benefit to their psychological well-being, helping them stay connected with friends, allowing for long-distance romance, and helping them to feel more *socially confident*. Overall, they view social VR as a positive experience. Based on these comments, my data suggest that the overwhelming majority of teens perceive social VR as a beneficial developmental tool. While there were documented accounts of bullying, harassment, and virtual sexual assault, these negative experiences occurred far less often then the positive experiences.

This raises the question of how does SDT connect to social VR and the development of teenagers? In the previous section I explained the connection between social VR and concepts in SDT, specifically the Basic Psychological Needs Theory. I stated earlier that social VR inherently provides the opportunity to meet, play, and connect with others in more naturalistic manner that other mediums fail to reproduce. While I touched on the technical affordances of VR that permit these opportunities, I will now analyze how social VR promotes SDT, specifically Goals Content Theory and Relationship Motivation Theory, through the design of the platforms and social culture.

Social VR platforms are designed for social bonding and social interactivity. Each platforms uses different means to achieve these results, with each design decision having its own advantages and disadvantages. For example, both AltspaceVR and RecRoom have a central hub for gathering, the campfire in the former and the rec center in the latter while VRchat does not have a central hub and GorillaTag currently only has one central location where all users are located. The design of a central hub where users enter these platforms immediately increases the likelihood for interpersonal communication. VRchat has a different approach for increasing the likelihood of social interactivity, user-generated content, specifically avatars. Compared to other platforms, VRchat allows more customization of avatars, even allowing users to import their own onto the platform. GorillaTag encourages social interactivity using two approaches: one is the game itself where the objective is to physically tag as many people as possible, immediately making them acquaintances and teammates, with the goal of having the majority of users represent your team (e.g., shown by color change of their avatar), thus naturally creating social bonds. GorillaTag also has unique game mechanics (e. g. the user must physically move their arms like a gorilla to move in the environment) that often causes players to become tired and physically commune in the same place as they catch their breadth; although likely unintentional by the developer, this creates sporadic social hubs on the map.

These examples show how through design, sociability is facilitated on the platform, which inherently promotes extrinsic motivation towards socializing and when repeated over time, leads to intrinsic interest, enjoyment, and inherent satisfaction. That is why the overwhelming majority of teenagers who participated in my dissertation said they felt less anxious, more comfortable, and generally more socially confident. The adapted version of Ryan at al.'s taxonomy seen in Figure 7.2 demonstrates that repetitive social experiences in social VR accelerates the move from extrinsic motivation to intrinsic motivation, explaining why teenagers' perceptions of social VR revolved around emotional fulfillment and inherent satisfaction with their experience and why teenagers felt that one of the main benefits of using social VR was the enhanced social development, something those who did not engage in social VR missed. As this analysis suggests, social VR appears to promote internal motivation in teens towards internal social confidence.

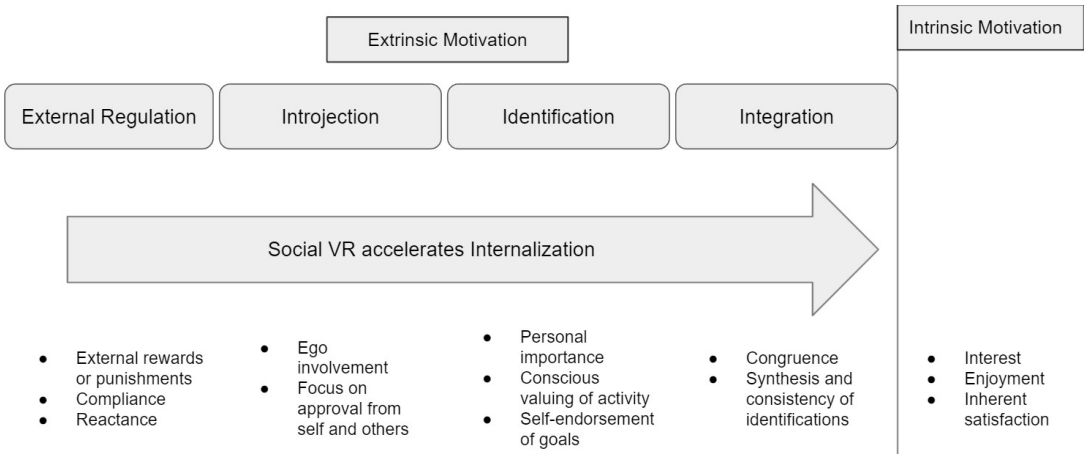

FIGURE 7.2: Adapted Version of Self-Determination Theory of Motivation

Another design decision that promotes SDT relates to the Goals Content Theory (GCT) which is centered around the core motivation of a goal [56, 66], for social VR the goal to socially interact or "meet people." The teenagers in this dissertation expressed the goals of meeting new people, interacting with offline friends, and generally having emotionally fulfilling experiences. One argument for GCT supporting the move from extrinsic toward intrinsic motivation is that after *social saturation*, or familiarity with the platform, norms, and social interactions, teens realize and develop their own interests and seek out experiences relating to the social interactivity that they found inherently satisfying as opposed to the random interactions from the onset of their social VR experience. This would explain why the teens in this dissertation displayed unique group behavior. These teens found individuals with similar interests and were motivated to spend time with them. Close relationships and community are commonly associated with the intrinsic motivation aspect of GCT.

The final sub-theory of SDT considered here is Relationship Motivation Theory (RMT), which encompasses the interplay between motivations and relationships, stating that some relationships are not only desirable for individuals but *essential* for their well being. As social VR is inherently social in its nature, a potential hypothesis is that social relationships in social VR are essential to one's well-being. Although most, if not all, participants used social VR to make and stay connected with friends, additional research into more solo oriented experiences in social VR is needed.

Finally, it should be noted that SDT intrinsic goals are commonly associated with positive outcomes, and although no physical harm was reported by the participants during the research conducted for this dissertation, teens commented that bullying and other forms of toxic behavior could cause deep emotional distress; their recommendations for addressing these and other issues in social VR are detailed in the next section.

7.1.3 Design Recommendations for a Safe, Equitable, and Emotionally Fulfilling Metaverse

In this dissertation, my goal was to consider design recommendations from teens themselves as opposed to generating them based on my results and prior scholarship. Thus, two thirds of these recommendations were generated by the teens themselves, speaking to the equity intent of this dissertation. The overarching challenges in social VR which prompted these recommendations address several areas. The first challenge is the number of youth of various ages on social VR platforms. The second is the lack of a full understanding of the potential of VR and the barriers to access it. The third are the challenges for constructing pro-social forms of the VR experience. Finally, youth urge for continued improvements in all areas relating to VR.

Recommendation One. *Naturally Self-Separate Via Environmental Design.* This first recommendation supports age-centered design and curate activities which focus on a target age group as each has their *own unique developmental needs* as seen in Figure 7.3. Age groups are generally separated into tweens (10 to 12 years old), teens (13 to 18 years old), and the over 18 population. The idea of targeted age group supports Beals and Bers, who provide six important design features for creating virtual worlds for children and youth: *purpose, communication, participation, play, artifacts, and rules* [113]. Depending on the age group, one of these six may be of more value than the others. For example, purpose for teens revolves around "identity," while purpose for a young child should mirror their "real life goals." In addition, another implication emphasizes a framework of *affordance*, *interaction*, and *content*. For example, the youngest users are likely to have more physical energy, and such games like GorillaTag which demand

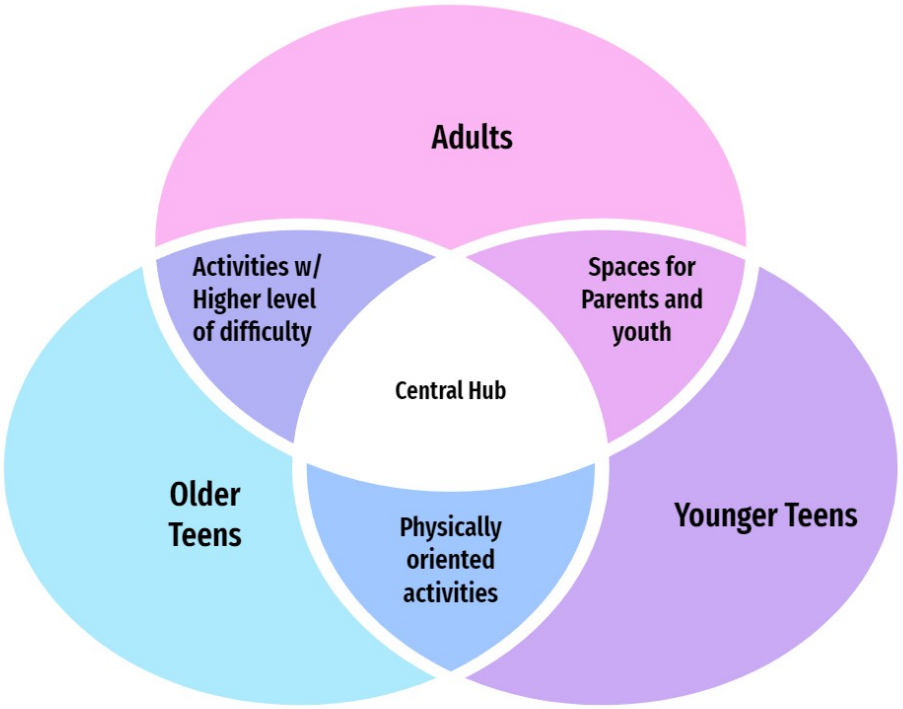

FIGURE 7.3: Design of Separated but Co-located Spaces

significant physical movement would be preferred for this age group. As Southgate et al. pointed out, special affordances of the technologies, modes of social interaction within the environment, and content in the environment should be used to evaluate the developmental appropriateness of any immersive environments for children [103]. It should be noted that this recommendation is **not** calling for separate social spaces but spaces that permit open entry to any age group; if designed correctly, the affordances of each age environment will attract the appropriate group.

Recommendation Two. *Experiencing Social VR Together with Loved Ones and Friends.* This dissertation highlights a few experiences of shared VR experience with parents and youth; for example, in Study 1 [32], I found that parents and guardians experienced social VR platforms openly with their children. This togetherness seemed to help minors interpret and better manage unwanted and/or unfamiliar interactions. It also seemed to strengthen the relationship between parents/guardians and minors. In this sense, design features that encourage minors to experience social VR with their loved ones and friends would be help protect them from risks in social VR as well as better prepare them to deal with misinformation and unwanted experiences. In addition, prior work conducted by Ringland et al. has demonstrated that the involvement of parents or guardians in children's virtual experiences helps children distinguish between "real" and "unreal" experiences [136].

Recommendation Three. *Educating Youth on Digital Literacy for VR.* Continuous education on social VR and broader immersive technologies is also needed for creating safe online social spaces for minors. Such technologies are increasingly embedded into young people's everyday social lives. In this sense, tutorial and training modules specifically designed for minors seem to be necessary. In addition, translating concepts from other forms of media such as sharing information online and setting strong privacy controls is needed. As VR itself has been commonly used for training for stressful situations [137], platform specific training focused on safe interactions could help mitigate potential risks.

Recommendation Four. *Transparency About Norms and Age-appropriate Digestible Content.* Above all, social VR platforms should strive for transparency about the types interactions permitted. However, existing platforms do not provide sufficient information on this aspect. For example, AltspaceVR and RecRoom privacy policies state that all publicly available areas should be treated as public spaces. It is challenging for users, especially minors, to fully understand such information as the boundaries between private and public spaces online are often blurred. For VRchat, even less information regarding how to protect one's privacy is provided. Straightforward and well-explained guidelines appropriate for minors' reading and literacy levels are urgently needed. These guidelines could be integrated into the design of the environment.

Recommendation Five. *Social Workers as Moderators and Non-tolerant Behavior.* Social VR platforms have unique roles in governing harassment, including providing features for blocking and reporting. However, our participants noticed flaws in the process, which led to a lack of trust and feelings of unfair treatment, discouraging them from engaging in the blocking and reporting process. Our participants also mentioned the varying viewpoints on what is perceived as harassment. Therefore, to design safer social VR spaces for teens, I suggest a *civil moderator* in the form of a social worker, which would allow both parties involved in an altercation to explain what happened from their point of view. This civil discourse could result in mutual understanding and lead to fewer instances of harassment. This conversation would be conducted by an "on call" platform specific moderator who would mediate the discussion between the two parties. To encourage this form of mediation, platforms could provide in-game currency to encourage and promote discussion, which would, in turn, foster a more understanding and empathetic community base. *The rewards would be based on the discretion of the moderator.

Recommendation Six. *Increased Outside Connection Within Social VR.* Our users mentioned that their daily use of social VR created tensions between themselves and their offline relationships. One way to reduce tensions and support family and friend

engagement is to create tools that allow users from the offline world to actively participate in the social VR environment. These could include tools which actively stream content to another device, the ability to collaboratively build and play games with one person who is currently experiencing social VR and another not wearing the VR HMD, or messaging from in VR to a person outside VR. It should be noted that as of November 2021, this recommendation has been implemented as a feature on Oculus, allowing users to chat and call friends on Messenger.

Recommendation Seven. *Tools To Create In-Game Interactivity and VR Specific Affordances.* One of the key highlights in my findings is how teens enjoyed and engaged in various creative activities in social VR. Engaging in designing an in-game artifact (e.g., art, items), building a mini-game, or creating a custom room created *social interactivity* between the user and others. In this sense, the process of creation and design yielded social currency with other users, perhaps due to the uniqueness of their design style, the affordances of the environment (e.g., moving arms in GorillaTag), and the bounds of their imagination not featured elsewhere in the platform. To encourage rich social engagement for teens, future social VR platforms should implement and provide a variety of creative tools and activities for their users. These futuristic experiences should aim to utilize the affordances of VR rather than replicating interactivity from a 2D format.

Recommendation Eight. *Increasing the Realism and Graphical Fidelity.* As previously stated, youth have higher expectations of realism and fidelity because of their *digital intuition* [161]. Bugs, glitches, and improper game mechanics reduce user satisfaction in a product, and the same is true for youth. Youth want realistic content both on the graphical level and in the interaction mechanics because to them the experiences, behaviors, and interactions that happen in the metaverse are perceived as *real*. In addition, prior scholarship demonstrates that higher degrees of visual presence led to increased self-perceptions of presence and immersion [162].

Recommendation Nine. *Lowering the Barrier to Entry.* One of the primary issues youth have with adults is that the latter tend to be overly critical of VR without giving it a *fair try*. A hypothesis from Study Four demonstrated that this may be due to the relatively high barrier of entry adults perceive for VR and their preconceived assumptions of gaming technology in general. The cost of VR headsets must approach affordability for the average family. Additionally, these headsets must be less cumbersome and more user-friendly. As demonstrated in this work, VR technology is popular with youth, but it may be difficult for non-tech savy adults.

7.2 Chapter Conclusion

Limitations of this Dissertation. Youth are an incredibly interesting group to study in this line of research; however, because of their age we included addition ethical protections to ensure their privacy was maintained and that we complied with research ethics and platform guidelines. Most of the data collected in this study were qualitative, with the final study quantifying the previous findings. In addition, as the data were collected anonymously to protect the identity of the participants, it is possible that the teenagers were not teenagers as users self-reported their age and information. The relatively high number of youth in social VR could be due to the fact that all social VR platforms are free-to-play experiences, potentially creating issues among groups. Additionally, as the work in this dissertation relates to ages 13 to 18, a particularly wide age range involving much growth and development, future work should explore changes using a smaller age range. I will add that the findings from this study may relate to youth younger than 13, as it is possible that Study 1 and Study 2 included younger age groups. Finally, these findings may not be representative of all teenagers as these participants were enthusiasts of VR technology and recruited from online groups where enthusiasts interact and, thus, may involve self-selection bias.

Future Directions. As this is the first work focusing on understanding youth in social VR with extensions to broader VR concepts, there are multiple avenues for future research investigating youth and immersive technology. In no particular order, I have outlined a few future directions remaining to explored:

- What are the effects of VR on various age groups under 18?
- How does VR integrate into home life (e.g., tensions, bonding)?
- How do VR and social VR affect youth on a physiological level?
- How do more marginalized youth perceive and use VR?
- What are the implications of a teen-centric environment?
- Who is the governing body for youth? (e.g., United Nations)?
- How can XR hardware be designed specifically for youth?
- How, if at all, can VR be integrated into educational environments?
- What, if any, are the physical effects of XR on youth?
- What are potential mitigation solutions for the harm caused to youth in the metaverse?

- How do we protect the anonymity and identity of youth in the metaverse?
- What are the long-term effects of XR on youth?

My goal for posing these questions is that they lead researchers to explore how XR technology and the broader metaverse can be developed to build experiences and devices which promote safety, equity, and emotional fulfillment for youth.

Chapter 8

Conclusion

In this dissertation, I call attention to social VR, the modern *metaverse* which is a novel digital space where users can interact, socialize, and game with one another in new and immersive ways. With a focus on investigating the experiences of younger users is vital to their safety, well-being, and emotional fulfillment in social VR. The research questions driving this dissertation are: (RQ1) How do younger users use social VR (e.g., frequency, experiences, and common activities)?; (RQ2) How, if at all, does the use of social VR affect the social lives of younger users in various ways (e.g., risks of harassment, privacy concerns, friendships, romance, and psychological well-being); and (RQ3) what requirements, features, and mechanisms can be identified for designing safer and more supportive social VR spaces for younger users?

To explore these RQs, four studies were conducted in this dissertation research. Study 1 is an interview study involving 30 adults on their perceptions of younger users in social VR. Study 2 is participatory observation study to explore the interaction dynamics between younger users and between younger users and adults in social VR. Study 3 is an interview study with 30 young users to investigate their unique perceptions, experiences, and challenges in social VR. Study 4 uses longitudinal diary study to identify potential new recommendations in social VR with younger users in order to create safe, equitable, emotionally satisfying social VR spaces for children. Study 4, also resulted in quantifiable trends of youths use in VR.

The main findings from this dissertation are as follows:

It should be noted that these highlights are based off of the participants in this research, which may not be representative of all youth not all Youth who use VR.

- For participants involved in this research, Social VR platforms are the most used forms of VR content for teenagers (e.g., games, education).

- Youth involved in these series of studies see social VR as a phenomenal tool for social development, well-being, and self-exploration.
- Youth involved in the last two studies spent a large amount of time in VR (22 hours/week in Study 3 and Study 4) and social VR (16 hours/week in Study 4), and self-reported use during the summer averaged 63 hours/week.
- For youth participants involved in this research, they believe the criticism of VR from adults is unwarranted and recommend the critics experience VR and social VR platforms.
- For youth participants involved in this research, they generated design recommendations focused on improving the design for the most vulnerable young users, performance recommendations, and more affordances relating to VR.
- Nine youth-generated design recommendations focused on ensuring a safe and emotionally fulfilling metaverse for young users.
- For youth participants involved in this research, sleeping in VR is a regular activity for youth using it.

These findings demonstrate how Social VR (e.g, metaverse) is the modern version of a playground in which it affords immense levels of interactivity and how it is the ultimate social developmental tool.

Contributions. The scientific and social contributions of this work go hand in hand. Scientifically, the contributions include: 1) it expands the current understandings of social dynamics and interactions of minors in online digital spaces; 2) focusing on younger users in social VR, contributes to two research areas not widely studied, social VR; and younger users in social VR (e.g., metaverse); and 3) generating design implications that would inform the design of platforms owned by companies like Microsoft, HTC, and Meta (e.g., Facebook), and may apply to other emerging online socio-technical spaces such as augmented reality (AR) social interactions. Finally, the social contributions are one of my primary motivations for doing this work and the social contributions are as significant as the scientific contributions. Traditionally in new technology phenomenons (e.g., internet, social media) research agendas largely focus on technical aspects and user experiences often emerges in later years, this is specifically true for marginalized groups in technology (e.g., minorities, women, children) and socially relevant topics (e.g., harassment, privacy, cyberbullying) are commonly afterthoughts within technology industries. In this dissertation, I sought to address potential threats and seek to *mitigate* these threats as social VR continues to grow. In doing so the social contributions of this

work have yielded: a set of nine recommendations for designers, developer, youth, and parents on best practices to engage in social VR.

Chapter 9

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