Towards Understanding Sense of Inclusion in Social VR Onboarding

Shitao Fang
The University of Tokyo
Tokyo, Japan
fst@iis-lab.org

Koji Yatani
The University of Tokyo
Tokyo, Japan
koji@iis-lab.org

ABSTRACT

Being included in social interactions is a fundamental human need in both physical and virtual worlds. However, it is overlooked in the context of social VR user experience. Based on social psychology, we define the sense of inclusion as the degree to which an individual perceives a sense of belonging and authenticity from a group. We initially use non-verbal behavior, which is commonly used in social VR, as an entry point to understanding the role of the sense of inclusion in social VR. We examine how the reactive behaviors of existing community members would influence the sense of inclusion during social VR onboarding. Our between-subject experiment (N=39) with three reactive behavioral conditions confirms that positive responses from existing community members increased the sense of inclusion. And the sense of inclusion positively mediates several user experiences including enjoyment and immersion. We highlight potential design implications and future research for social VR.

CCS CONCEPTS

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

KEYWORDS

Social VR, Sense of Inclusion, Non-verbal Behavior

ACM Reference Format:
Shitao Fang and Koji Yatani. 2023. Towards Understanding Sense of Inclusion in Social VR Onboarding. In *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems (CHI EA '23), April 23–28, 2023, Hamburg, Germany.* ACM, New York, NY, USA, 8 pages. https://doi.org/10.1145/3544549.3585751

1 INTRODUCTION

Social virtual reality, or social VR, offers various virtual spaces where people gather, interact, socialize, and enjoy a broad range of activities [40]. One critical factor for successful social VR environments is users' engagement [38, 40]. Unlike conventional VR environments (e.g., VR games), content and experience are also generated through grass-root efforts by individual users in addition to top-down work by community owners and administrators. Therefore, mechanisms to engage more users can contribute substantially to the diversity, sustainability, and vitality of social VR communities.

The user experience in social VR space is one critical factor for users to determine whether they would like to stay connected in a community [38]. Socialization, which is one of the important activities in social VR [52], plays an essential role in shaping the experience [15, 20]. Research has focused on qualitatively understanding different aspects of the user experience of social VR, by examining avatar representation [23, 30], interaction models [39, 41], and social norms [9, 37], or measuring user experience in certain social VR activities combining play experience and social presence [34, 35, 51]. While this has greatly advanced our understanding of social VR, there is inconsistency or a lack of focus on the experience that describes users' need of being included by existing users in the community.

In this work, we have adopted the term "sense of inclusion" from social psychology, which refers to an individual's perception of a feeling of belonging and authenticity [26]. To preliminarily uncover its role in social VR user experience, we take the reactive behavioral traits as a starting point. Reactive behaviors like having eye contact and waving hands are commonly performed both in the real world and virtual space gathering [39]. We designed and conducted a controlled, between-subject study (N=39) to compare three levels of reactive behavioral traits of existing community members on the sense of inclusion and other user experience perceived by users who newly join a social VR community. Our results confirmed that positive reactive behaviors significantly increased the perceived sense of inclusion. Our mediation analysis uncovered that sense of inclusion mediates several aspects of user experience and willingness to include other members. Finally, we discuss design improvements and future research directions related to the sense of inclusion in social VR environments.

2 RELATED WORK

2.1 User Experience in Social VR

Designs of collaborative virtual environments have been an important research agenda in HCI [5, 6, 10, 12]. As commercial social VR platforms become more popular among general users, understanding user experience in these VR environments, which afford various social activities for communication and interaction, has recently become a focus. Research has examined different aspects of social VR, including avatar and self-presentation [23, 30], non-verbal behaviors and interaction modes [39, 41], and special social dynamics in diverse activities [9, 22, 37, 38] to guide the future design of engaging social VR experiences [28, 40]. These empirical findings all emphasize the positive role of pro-social interactions

CHI EA '23, April 23–28, 2023, Hamburg, Germany

ACM ISBN 978-1-4503-9422-2/23/04.
https://doi.org/10.1145/3544549.3585751

and a sense of co-presence or social presence [43, 60] in shaping user experience.

Quantitative approaches with self-reported questionnaires were also widely adopted to evaluate user experience in social VR. Considering that social VR sometimes falls under the scope of game, user experience can be measured through instruments for play experience, such as the Immersive Experience Questionnaire (IEQ) [27], the Player Experience of Need Satisfaction (PENS) [47], and the Intrinsic Motivation Inventory (IMI) [46].

In addition to common experience like immersion or avatar identification [8], social VR's unique metric mainly revolved around the social presence of users [2, 33, 34]. Although social presence can evaluate the level of the feeling of "being there together" and positively correlates to enjoyment, trust, and pro-social behaviors [41, 43], it does not fully capture one's sense of centrality in social interactions. Therefore, it is important to have a metric that describes how well an individual engaged with a community. In this work, we take a quantitative approach to expand subjective scales for evaluating user experiences in social VR by introducing statements related to a perceived sense of inclusion.

2.2 Inclusion in Social VR

Socialization is one of the most critical activities in social VR [52]. It is a process of linking a group to the self [26]. Prior social psychological studies have pointed out that being included in groups is essential to satisfying human social needs [13] and benefits individuals by enhancing self-esteem and forming more distinctiveness [11, 32]. Conversely, exclusion can cause social pain, which has been shown to be similar to physical pain in brain reaction based on behavior experiments conducted in the Cyberball program [58] with neuroimaging [17].

Prior social VR work has used the term "inclusion," meaning to design and build an environment that offers equity for under-represented users, such as female users [44], LGBTQ users [1, 21], elderly users [3, 4], and users with disabilities [48]. While such a research direction is important to broaden the participation in social VR, our primary interest in inclusion better aligns with the definition by Jansen et al., "the degree to which an individual perceives that the group provides them with a sense of belonging and authenticity" [26]. Our study thus investigates a sense of inclusion as user experience perceived by individuals. Unlike belongingness as a long-term human emotional need, sense of inclusion emphasizes a short-term feeling. Though the term "social engagement" may reflect some aspects of inclusion in our target context and scenarios, existing studies mainly use it for describing the level of participation in collaborative activities [38, 56]. We therefore use the term *sense of inclusion* in this work.

As a first step, this work uses reactive behavioral traits as an entry point to explore the sense of inclusion as it is a typical way of understanding user experience with an interaction-centered view [19] and non-verbal behavior plays a vital role in social VR interactions [39, 57]. There are factors besides behavior toward new members that may impact the sense of inclusion, such as the appearance of the environment, avatar designs, and content of conversations. Behavioral traits are publicly observable features that stem from individual community members, and are not as uncontrollable as a conversation. We examine two research questions: *RQ1* How is the sense of inclusion affected by the reactive behaviors of existing community members? *RQ2* What role does the sense of inclusion play in the social VR experience?

3 COMPARATIVE STUDY

We conducted a controlled user study to answer our research questions. This user study was approved by our Institutional Review Board. We have two hypotheses with respect to the sense of inclusion and the reactive behavioral traits:

- *H1* Reactive behaviors would increase the sense of inclusion in an onboarding context. This is because reactive behaviors usually indicate attention and are natural cues to initiate interaction both in the online and real world [39].
- *H2* Improved sense of inclusion would mediate other user experiences like intrinsic motivation, need satisfaction, and avatar identification. This is because sense of inclusion posits that user experience driven by intrinsic needs can be satisfied through interaction within a group [14].

3.1 Experimental Design

To validate the two hypotheses above, we defined three behavioral conditions to represent different levels of expressions of welcomeness (See Figure 1), leveraging fundamental non-verbal behaviors like gaze and gestures [39]. These three conditions basically represent the situations that users encounter when onboarding, based on our observations of social VR platforms. We designed a between-subject comparative study as a substantial learning effect would be inevitable if we designed a within-subject experiment.

- **Ignore**: The avatars of existing community members would not pay direct attention to a new member (participants) and keep performing their own activities.
- **Notice**: The avatars of existing community members would gaze or have a glance at a new member. But they would not perform other non-verbal behaviors.
- **Welcome**: The avatars of existing community members would look at a new member and wave hands to them.

3.2 Questionnaire and Evaluation Metrics

We employed multiple questionnaires as the post-experimental survey. All the questions in the following questionnaires were on a 7-point Likert scale (*-3: Strongly disagree – 0: Neutral – 3: Strongly agree*). We developed three statements (SI1–3) about sense of inclusion for H1. We also included 9 statements (SE1–9) to measure the overall user experience of the given condition and made 4 statements (SW1–4) to measure the willingness for future engagement and inclusive actions for H2. All 16 statements are summarized in Table 1.

3.2.1 Sense of Inclusion (SI1–3). . To better fit our context, we developed our own questionnaire based on Jansen et al.'s conceptualization of inclusion and the perceived group inclusion scale (PGIS) [26]. We initially create a basic model of sense of inclusion composed of three components, perceived acceptance, attention, and support from existing community members. Acceptance has deep social effects on emotional, cognitive, behavioral,

(a) *Ignore* **(b) *Notice*** **(c) *Welcome***

Figure 1: The three behavioral conditions tested in our user study.

ID	Category	Statement	χ^2	p-value	η^2
SI1	Perceived acceptance	I feel like I was easily accepted by other users	27.640	< .001	0.712
SI2	Perceived attention	I feel like other users have paid much attention to me	30.762	< .001	0.799
SI3	Perceived support	I feel like I can get help easily if I needed in this community	26.212	< .001	0.673
SE1	IMI-Enjoyment	I enjoyed doing this activity very much	16.029	< .001	0.390
SE2	IMI-Effort	I put a lot of effort into this	8.685	< .05	0.186
SE3	IMI-Pressure	I felt very tense while in social VR space	12.343	< .01	0.287
SE4	IMI-Value	I believe social in such community could be of some value to me	21.046	< .001	0.529
SE5	PENS-Autonomy	This social VR community provides me with interesting options and choices	9.451	< .01	0.207
SE6	PENS-Immersion	When playing the game, I feel transported to another time and place	11.350	< .01	0.260
SE7	PENS-Intuitiveness	Learning the social norms in such space was easy	26.613	< .001	0.684
SE8	PENS-Relatedness	I find the relationship in social VR fulfilling	18.886	< .001	0.469
SE9	PIS-Identification	When in this social VR space, it is as if I become one with my character	13.145	< .01	0.310
SW1	Preference for future use	I would like to spend more time in such social VR community in my spare time	11.104	< .01	0.253
SW2	Willingness to accept	I feel comfortable to accept others in such community	8.685	< .05	0.186
SW3	Willingness to pay attention	I am willing to pay attention to people around me	19.567	< .001	0.488
SW4	Willingness to support	I would like to help others in such social VR community	15.889	< .001	0.386

Table 1: The sixteen statements were used in our post-experimental questionnaire. This table also includes Kruskal-Wallis test results. All statements showed significant differences among the three behavioral conditions.

and biological responses, it is a fundamental need for positive and lasting relationships in groups [16, 49]. Perceived attention is people's perception of the amount or frequency of others' attention to them. The coordination of each other's attention is a prerequisite for social interaction [31]. Perceived support represents the perception of one is part of a mutually supportive social network [53] and was proved to have an indirect association with subjective well-being [54] Although there was no circumstance where explicit support from existing community members was necessary, we included this item as participants would be able to judge as one type of community atmosphere.

3.2.2 Overall Experience (SE1–9). To obtain participants' overall experience of the given condition, we included questions from the IMI [46] and the PENS [47]. More specifically, we drew four statements related to perceived enjoyment, effort, pressure, and value from IMI, and took four statements related to autonomy, immersion, intuitive controls, and relatedness from PENS. Among the eight statements, SE2 and SE3 represent negative experiences (see Table 1). We reversed the responses for the analysis and report in this paper so that all the results are consistent in sentiment (i.e., positive and negative scores mean favorable and unfavorable perception or experience, respectively). In addition, we drew embodied presence of avatar identification from Van et al. [55] to evaluate the users' self-concept with the given condition.

3.2.3 Willingness of Play and Actions (SW1–4). . We also measured how willing participants would be to continue engagement in the given condition and perform social interaction. We drew the statement (SW1) that is strongly related to the intention of return from Ryan et al. [47] In addition, we measured how strongly participants would feel like performing inclusive behavior. Corresponding to our measurement of the perceived sense of inclusion, we measure the willingness to accept, the willingness to pay attention, and the willingness to support (SW2–4).

3.3 Apparatus and Implementation

We used Oculus Quest 2 as the VR headset hardware. We built our custom social VR space to accommodate the three behavioral conditions. We implemented it using Ubiq [24], a Unity social VR toolkit. In our experiment, we used floating-style human-like avatars because they are commonly used in existing social VR platforms (e.g., RecRoom, AltspaceVR, Meta Horizon Worlds).

Figure 2: The top view of our simulated social VR environment.

We also introduced pre-recorded dummy avatars to simulate the presence of existing community members. To generate natural behavior for dummy avatars, the experimenters played the roles of existing community members and performed actions that were associated with the three behavioral conditions. We recorded the motions of avatars and generated various animations for each avatar that corresponded to the conditions assigned to the participants. There were in total 12 avatars in groups of different sizes and F-formations (see Figure 2), interacting with other existing community members. When a participant approached and reached the trigger boundary of each group of existing community members, the dummy avatar performed reactive behaviors in the *Notice* and *Welcome* conditions.

3.4 Participants

We recruited 39 participants (23 males and 16 females) with an average age of 24.3 (*SD*=3.1) from the local community and university through social media and recruit webpage. They were recruited under the pretext of experiencing social VR without information about the experimental purpose and conditions. In the entry form for study participation, they were asked to self-rate their experience with VR and social VR in a 5-Likert scale (*1: Very Inexperienced – 5: Very Experienced*). The means of the responses were 2.44 (*SD*=0.94) and 1.46 (*SD*=0.76) for VR and social VR, respectively. They were split to one of the behavioral conditions while ensuring the six self-claimed experienced VR users were distributed across the conditions equally. Our ANOVA test did not find a significant difference across the conditions on prior VR experience ($F(2,36)=0.36$, $p=.70$, $\eta^2=.02$) and prior social VR experience ($F(2,36)=0.94$, $p=.40$, $\eta^2=.05$).

For determining an appropriate number of participants, we conducted power analysis prior to the experiment. We performed a sample size estimation with the assumptions of a between-subject design, an effect size of 0.5, $\alpha=0.05$, and 70% power for H1. We performed Monte Carlo simulation for mediation analyses [50] to test H2 with a 95% confidence level, 1000 seed-randomized replications, and an assumption of a large effect size (0.5) in each path for a 70% power. The estimated sizes were 36 and 33 for our expected ANOVA and mediation analysis, respectively. Therefore, our participant number was appropriate for testing both hypotheses.

3.5 Procedure

After signing the consent form, participants were first asked to go through instruction about how to use Oculus Quest2 and how to navigate our social VR environment. Once they confirmed that they were comfortable with the apparatus, we moved to an actual task.

Participants were instructed to freely explore the given social VR environment as if they were joining this community for the first time. To encourage their explorations, we gave them a task of finding four balls at the corners of the given social VR environment. Participants were allowed to leave the environment at any time five minutes after the beginning of this task as long as they felt confident about their impressions of the community. They were not informed of which behavioral condition was given.

When participants left the social VR environment, post-experimental questionnaires popped up, and participants were asked to fill them through the VR controllers. To avoid the possible systematic bias in participants' subjective responses due to break in presence [45], we used VR questionnaires for more reliable self-reports. Participants were offered approximately 12 USD in their local currency at the end of the experiment. The experiment generally took 30 minutes.

4 RESULTS

4.1 Sense of Inclusion as User Experience

Because all the quantitative data were ordinal, we used Kruskal-Wallis tests with Mann-Whitney for post-hoc pairwise comparisons. We employed Bonferroni correction for the pairwise comparison to adjust p values.

Figure 3 shows the means and standard deviations of the responses across the conditions and statements. Our statistical test revealed significant differences in all 16 questions (Table 1). Figure 3 also presents all the significant differences observed in our post-hoc tests. We found 14, 2, 16 significant differences between *Ignore* and *Notice*, *Notice* and *Welcome*, and *Ignore* and *Welcome*, respectively. In particular, we observed significant differences between *Ignore* and the other two conditions in all three statements related to the sense of inclusion. These results confirmed that reactive behavior significantly increased the perceived sense of inclusion. It is noteworthy that even subtle eye contact would create an improved sense of inclusion. In the statement of perceived attention (SI2), there was also a significant difference between the *Notice* and *Welcome* condition, which is clearly in line with the different degrees of attention controlled by the conditions. Based on our results, we concluded that H1 was supported.

4.2 Role of Sense of Inclusion

We next examined the relationship between sense of inclusion and perceived user experience, ultimately hypothesized in H2. For this purpose, we executed a parallel mediation analysis. Mediation analysis is commonly used to explore an underlying process between controlled conditions or factors and outcomes [36]. It examines mediating effects of multiple factors (mediating variables or mediators M) between independent variables (X) and dependent

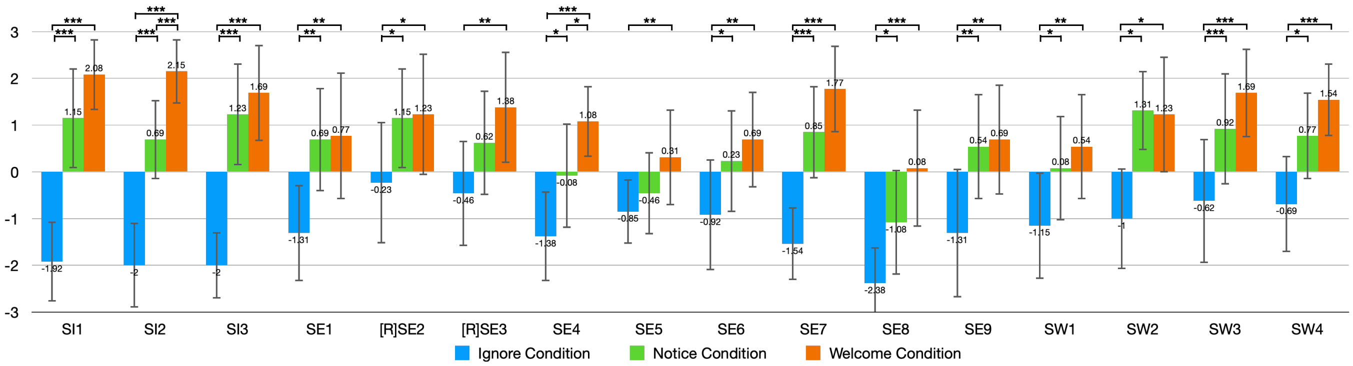

Figure 3: The means and standard deviations (error bars) of the responses to the 16 statements in the post-experimental questionnaire. Note that the responses of SE2 and SE3 are reversed so that all the results are consistent to represent favorable perception and experience with positive scores. The observed significant differences are indicated with $*$, $**$ or $***$ ($p < .05$, $p < .01$, and $p < .001$, respectively).

	Significant Path	Regression Coefficients			Total Effect
IMI-Enjoyment	$X \rightarrow M_3 \rightarrow Y$	$a_3 = 1.846^{***}$	$b_3 = 0.428^{*}$	$a_3b_3 = 0.790$	1.039^{***}
IMI-Effort	$X \rightarrow M_1 \rightarrow Y$	$a_1 = 2.000^{***}$	$b_1 = -0.496^{*}$	$a_1b_1 = -0.991$	-0.7308^{**}
PENS-Immersion	$X \rightarrow M_3 \rightarrow Y$	$a_3 = 1.846^{***}$	$b_3 = 0.478^{*}$	$a_3b_3 = 0.882$	0.8077^{***}
PENS-Intuitiveness	$X \rightarrow M_3 \rightarrow Y$	$a_3 = 1.846^{***}$	$b_3 = 0.375^{*}$	$a_3b_3 = 0.692$	1.6538^{***}
	$X \rightarrow Y$		$c' = 1.207^{*}$		
Willingness to pay attention	$X \rightarrow M_2 \rightarrow Y$	$a_2 = 2.308^{***}$	$b_2 = 2.308^{*}$	$a_2b_2 = 1.479$	1.1538^{***}
Willingness to support	$X \rightarrow M_3 \rightarrow Y$	$a_3 = 1.846^{***}$	$b_3 = 0.340^{*}$	$a_3b_3 = 0.628$	1.1154^{***}

Table 2: The significant mediation results among behavioral traits (X), perceived acceptance (M_1), perceived attention (M_2), perceived support (M_3), and other metrics of user experience (Y). The significant differences are indicated with $*$, $**$ or $***$ ($p < .05$, $p < .01$, and $p < .001$, respectively). The total effect of X on Y is the sum of direct effect and indirect effect through all mediating variables.

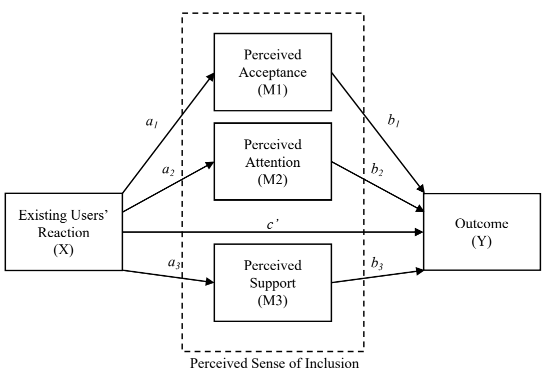

Figure 4: The parallel mediation model tested in our analysis.

variables (Y). The mediating variables (M) serve to transmit effects of X on Y.

We tested the mediation model illustrated in Figure 4 after confirming that our data satisfied the assumptions for a parallel mediation analysis [7] followed Kao et al.'s procedure [29]. The X was the representation of the three reactive behavioral conditions. We included the three sense of inclusion components as the mediators. For the outcomes Y, we used the responses of the remaining 13 statements.

A 95% bias-corrected confidence interval based on 5000 bootstrap samples was used as a significant threshold of mediating effects. Table 2 summarizes significant paths we found in our analysis. The results suggest that the sense of inclusion mediates six items, namely enjoyment, effort, immersion, intuitiveness, willingness to pay attention, and willingness to support.

For instance, perceived acceptance fully mediates reactive behaviors' effects on perceived effort. As can tell from the regression coefficients, reactive behaviors from existing community members led to a high perception of being accepted ($a_1 = 2.000, p < .001$), and less effort felt in social VR space was subsequently related to more sense of inclusion ($b_1 = -0.496, p < .05$). The other results on the mediating variables confirmed their positive effects on outcomes. In the case of intuitiveness, the direct effect of the dependent variable on the outcome was also significant (c'=1.207, p <.05) while the path via perceived support was significant as well. Therefore, partial mediation was confirmed in this case, and a positive effect of sense of inclusion existed.

Overall, sense of inclusion played a pivotal role in enhancing the positive user experience of enjoyment, effort, immersion, and intuitiveness. It also made participants more willing to pay attention to and support existing community members. We, therefore, conclude that H2 was partially supported.

5 DISCUSSION

Our quantitative results confirmed that the reactive behavior of existing community members would positively contribute to the generation of a sense of inclusion in an onboarding context. Furthermore, our mediation analysis also showed that the sense of inclusion would mediate different aspects of user experience in social VR environments. These results suggest different design implications and future research directions in social VR with respect to the sense of inclusion.

5.1 Fostering Reactive Behavior for Generating Sense of Inclusion of New Members

Grounded on our findings of the sense of inclusion, we outline several design implications for social VR platforms and communities to raise the sense of inclusion of new members by fostering reactive behaviors.

Spotlighting new members: Our results suggest that even short notice would greatly lead to the generation of a sense of inclusion. Giving new members special spotlights would help them perceive more sense of inclusion. While current platforms provide a certain space and time buffer for onboarding to help users have smoother transitions in emotional states before socializing [40], this also diminishes the visibility of new members to existing members. Therefore, new members find it hard to join ongoing social activities, and existing members do not know who to greet or who to help. Luckily, Social VR fairly provides high embodied visibility opportunities for every user [21].

Quantifying welcomeness: A unique capability social VR environments offer is that a system administrator can easily track detailed behavioral traits of users without employing sensing infrastructure (e.g., collect a proxemic dataset for exploring social interactions [59] and detect bullying behaviors for governing harassment [18]). This could also be useful to gauge the degree of "welcomeness" at both an individual and community level. The quantification of "welcomeness" could help both existing and new users to form better social tactics.

Using AI agents to promote the community atmosphere: There have been numerous practices of using NPCs in games to facilitate player play [25, 42], but not much use in social VR. Our results revealed the virtuous cycle between the perceived sense of inclusion and willingness to include others. Therefore, pro-social interactions and a sense of inclusion triggered by AI agents will finally benefit real users.

5.2 Considering Sense of Inclusion in Social VR User Experience Evaluation

Our mediation analysis uncovered that sense of inclusion mediates several aspects of user experience, namely enjoyment, effort, immersion, and intuitiveness. This result suggests that the sense of inclusion is an important metric to evaluate the user experience of social VR. While existing social VR research examined user experience using various metrics, our work offers further rigor in such evaluations. Since our work is only a very first step with a simple model of sense of inclusion, we expect future exploration and development of validated questionnaires for this user experience.

5.3 Limitations and Future Work

There are several limitations to clarifying the scope and generalizability of this work. Our work only focuses on sense of inclusion in an onboarding context. Sense of inclusion may be increased or decreased gradually after onboarding, and a longer-term examination would be necessary to identify what could contribute to the enhancement and degradation of the sense of inclusion over time.

This work only examined a small slice of the sense of inclusion. Future work can also examine more factors other than reactive behavioral traits to have a more comprehensive understanding of the sense of inclusion. Besides, authenticity in our definition of inclusion, which captures the degree to which the group encourages members to feel and act with their true selves [26], needs to be further explored.

Due to the nature of a controlled study, our experiment may not fully reflect realistic scenarios of social VR environments. For example, Maloney et al. found users easily deploy behaviors like dance and punch to approach strangers which is in different social norms with offline world [39]. Future studies may revalidate our findings through experiments in a real social VR onboarding process with more diverse social norms. Our work here would serve as a reference for such future studies by offering what reactive behavioral traits would need to be considered.

6 CONCLUSION

In this work, we included sense of inclusion as a user experience metric in social VR. We examined how reactive behavioral traits of existing community members would influence the sense of inclusion perceived by new members in an onboarding context. Our comparative study with three different behavioral conditions revealed that reactive behavior significantly improved the perceived sense of inclusion. Our mediation analysis also confirms that sense of inclusion can be a descriptive factor for several aspects of user experience in social VR. Our work therefore offers insights on design improvements and future research directions for better support of sense of inclusion.

ACKNOWLEDGMENTS

This work was a part of the collaboration research with DMM.com Inc. We sincerely thank the anonymous reviewers and all participants of our user studies.

REFERENCES

[1] Dane Acena and Guo Freeman. 2021. "In My Safe Space": Social Support for LGBTQ Users in Social Virtual Reality. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems*. 1–6.

[2] Sahar Aseeri and Victoria Interrante. 2021. The influence of avatar representation on interpersonal communication in virtual social environments. *IEEE Transactions on Visualization and Computer Graphics* 27, 5 (2021), 2608–2617.

[3] Steven Baker, Ryan M Kelly, Jenny Waycott, Romina Carrasco, Thuong Hoang, Frances Batchelor, Elizabeth Ozanne, Briony Dow, Jeni Warburton, and Frank Vetere. 2019. Interrogating social virtual reality as a communication medium for older adults. *Proceedings of the ACM on Human-Computer Interaction* 3, CSCW (2019), 1–24.

[4] Steven Baker, Jenny Waycott, Romina Carrasco, Ryan M Kelly, Anthony John Jones, Jack Lilley, Briony Dow, Frances Batchelor, Thuong Hoang, and Frank Vetere. 2021. Avatar-mediated communication in social VR: an in-depth exploration of older adult interaction in an emerging communication platform. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. 1–13.

[5] Steve Benford, John Bowers, Lennart E Fahlén, Chris Greenhalgh, and Dave Snowdon. 1995. User embodiment in collaborative virtual environments. In *Proceedings of the SIGCHI conference on Human factors in computing systems*. 242–249.

[6] Steve Benford, Chris Greenhalgh, Tom Rodden, and James Pycock. 2001. Collaborative virtual environments. *Commun. ACM* 44, 7 (2001), 79–85.

[7] William D Berry. 1993. *Understanding regression assumptions*. Vol. 92. Sage.

[8] Max V Birk, Cheralyn Atkins, Jason T Bowey, and Regan L Mandryk. 2016. Fostering intrinsic motivation through avatar identification in digital games. In *Proceedings of the 2016 CHI conference on human factors in computing systems*. 2982–2995.

[9] Lindsay Blackwell, Nicole Ellison, Natasha Elliott-Deflo, and Raz Schwartz. 2019. Harassment in social virtual reality: Challenges for platform governance. *Proceedings of the ACM on Human-Computer Interaction* 3, CSCW (2019), 1–25.

[10] John Bowers, James Pycock, and Jon O'brien. 1996. Talk and embodiment in collaborative virtual environments. In *Proceedings of the SIGCHI conference on Human Factors in computing systems*. 58–65.

[11] Marilynn B Brewer. 1991. The social self: On being the same and different at the same time. *Personality and social psychology bulletin* 17, 5 (1991), 475–482.

[12] Elizabeth F Churchill and Dave Snowdon. 1998. Collaborative virtual environments: an introductory review of issues and systems. *virtual reality* 3, 1 (1998), 3–15.

[13] Joshua Correll and Bernadette Park. 2005. A model of the ingroup as a social resource. *Personality and Social Psychology Review* 9, 4 (2005), 341–359.

[14] Edward L Deci and Richard M Ryan. 2012. Self-determination theory. (2012).

[15] Pieter Desmet and Paul Hekkert. 2007. Framework of product experience. *International journal of design* 1, 1 (2007).

[16] C. Nathan DeWall and Brad J. Bushman. 2011. Social Acceptance and Rejection: The Sweet and the Bitter. *Current Directions in Psychological Science* 20, 4 (2011), 256–260. https://doi.org/10.1177/0963721411417545 arXiv:https://doi.org/10.1177/0963721411417545

[17] Naomi I Eisenberger, Matthew D Lieberman, and Kipling D Williams. 2003. Does rejection hurt? An fMRI study of social exclusion. *Science* 302, 5643 (2003), 290–292.

[18] Cristina Fiani and Stacy Marsella. 2022. Investigating the Non-Verbal Behavior Features of Bullying for the Development of an Automatic Recognition System in Social Virtual Reality. In *Proceedings of the 2022 International Conference on Advanced Visual Interfaces*. 1–3.

[19] Jodi Forlizzi and Katja Battarbee. 2004. Understanding experience in interactive systems. In *Proceedings of the 5th conference on Designing interactive systems: processes, practices, methods, and techniques*. 261–268.

[20] Jodi Forlizzi and Shannon Ford. 2000. The building blocks of experience: an early framework for interaction designers. In *Proceedings of the 3rd conference on Designing interactive systems: processes, practices, methods, and techniques*. 419–423.

[21] Guo Freeman and Dane Acena. 2022. " Acting Out" Queer Identity: The Embodied Visibility in Social Virtual Reality. *Proceedings of the ACM on Human-Computer Interaction* 6, CSCW2 (2022), 1–32.

[22] Guo Freeman, Dane Acena, Nathan J McNeese, and Kelsea Schulenberg. 2022. Working Together Apart through Embodiment: Engaging in Everyday Collaborative Activities in Social Virtual Reality. *Proceedings of the ACM on Human-Computer Interaction* 6, GROUP (2022), 1–25.

[23] Guo Freeman and Divine Maloney. 2021. Body, avatar, and me: The presentation and perception of self in social virtual reality. *Proceedings of the ACM on Human-Computer Interaction* 4, CSCW3 (2021), 1–27.

[24] Sebastian J Friston, Ben J Congdon, David Swapp, Lisa Izzouzi, Klara Brandstätter, Daniel Archer, Otto Olkkonen, Felix Johannes Thiel, and Anthony Steed. 2021. Ubiq: A system to build flexible social virtual reality experiences. In *Proceedings of the 27th ACM Symposium on Virtual Reality Software and Technology*. 1–11.

[25] Julian Frommel, Cody Phillips, and Regan L Mandryk. 2021. Gathering Self-Report Data in Games through NPC Dialogues: Effects on Data Quality, Data Quantity, Player Experience, and Information Intimacy. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. 1–12.

[26] Wiebren S Jansen, Sabine Otten, Karen I van der Zee, and Lise Jans. 2014. Inclusion: Conceptualization and measurement. *European journal of social psychology* 44, 4 (2014), 370–385.

[27] Charlene Jennett, Anna L Cox, Paul Cairns, Samira Dhoparee, Andrew Epps, Tim Tijs, and Alison Walton. 2008. Measuring and defining the experience of immersion in games. *International journal of human-computer studies* 66, 9 (2008), 641–661.

[28] Marcel Jonas, Steven Said, Daniel Yu, Chris Aiello, Nicholas Furlo, and Douglas Zytko. 2019. Towards a taxonomy of social vr application design. In *Extended Abstracts of the Annual Symposium on Computer-Human Interaction in Play Companion Extended Abstracts*. 437–444.

[29] Dominic Kao, Rabindra Ratan, Christos Mousas, Amogh Joshi, and Edward F. Melcer. 2022. Audio Matters Too: How Audial Avatar Customization Enhances Visual Avatar Customization *(CHI '22)*. Association for Computing Machinery, New York, NY, USA, Article 165, 27 pages. https://doi.org/10.1145/3491102.3501848

[30] Anya Kolesnichenko, Joshua McVeigh-Schultz, and Katherine Isbister. 2019. Understanding emerging design practices for avatar systems in the commercial social vr ecology. In *Proceedings of the 2019 on Designing Interactive Systems Conference*. 241–252.

[31] H. Kozima, C. Nakagawa, and H. Yano. 2003. Attention coupling as a prerequisite for social interaction. In *The 12th IEEE International Workshop on Robot and Human Interactive Communication, 2003. Proceedings. ROMAN 2003*. 109–114. https://doi.org/10.1109/ROMAN.2003.1251814

[32] Mark R Leary and Roy F Baumeister. 2000. The nature and function of self-esteem: Sociometer theory. In *Advances in experimental social psychology*. Vol. 32. Elsevier, 1–62.

[33] Jie Li, Guo Chen, Huib De Ridder, and Pablo Cesar. 2020. Designing a social vr clinic for medical consultations. In *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems*. 1–9.

[34] Jie Li, Yiping Kong, Thomas Röggla, Francesca De Simone, Swamy Ananthanarayan, Huib De Ridder, Abdallah El Ali, and Pablo Cesar. 2019. Measuring and understanding photo sharing experiences in social virtual reality. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. 1–14.

[35] Jie Li, Shishir Subramanyam, Jack Jansen, Yanni Mei, Ignacio Reimat, Kinga Ławicka, and Pablo Cesar. 2021. Evaluating the User Experience of a Photorealistic Social VR Movie. In *2021 IEEE International Symposium on Mixed and Augmented Reality (ISMAR)*. IEEE, 284–293.

[36] David P MacKinnon, Amanda J Fairchild, and Matthew S Fritz. 2007. Mediation analysis. *Annual review of psychology* 58 (2007), 593.

[37] Divine Maloney and Guo Freeman. 2020. Falling asleep together: What makes activities in social virtual reality meaningful to users. In *Proceedings of the Annual Symposium on Computer-Human Interaction in Play*. 510–521.

[38] Divine Maloney, Guo Freeman, and Andrew Robb. 2021. Stay Connected in An Immersive World: Why Teenagers Engage in Social Virtual Reality. In *Interaction Design and Children*. 69–79.

[39] Divine Maloney, Guo Freeman, and Donghee Yvette Wohn. 2020. " Talking without a Voice" Understanding Non-verbal Communication in Social Virtual Reality. *Proceedings of the ACM on Human-Computer Interaction* 4, CSCW2 (2020), 1–25.

[40] Joshua McVeigh-Schultz, Anya Kolesnichenko, and Katherine Isbister. 2019. Shaping pro-social interaction in VR: an emerging design framework. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. 1–12.

[41] Fares Moustafa and Anthony Steed. 2018. A longitudinal study of small group interaction in social virtual reality. In *Proceedings of the 24th ACM Symposium on Virtual Reality Software and Technology*. 1–10.

[42] Alexander Nareyek. 2004. AI in Computer Games: Smarter games are making for a better user experience. What does the future hold? *Queue* 1, 10 (2004), 58–65.

[43] Catherine S Oh, Jeremy N Bailenson, and Gregory F Welch. 2018. A systematic review of social presence: Definition, antecedents, and implications. *Frontiers in Robotics and AI* (2018), 114.

[44] Jessica Outlaw and Beth Duckles. 2017. Why women don't like social virtual reality: a study of safety, usability, and self-expression in social VR. *The Extended Mind* (2017).

[45] Susanne Putze, Dmitry Alexandrovsky, Felix Putze, Sebastian Höffner, Jan David Smeddinck, and Rainer Malaka. 2020. Breaking the experience: Effects of questionnaires in vr user studies. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. 1–15.

[46] Richard M Ryan and Edward L Deci. 2000. Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary educational psychology* 25, 1 (2000), 54–67.

[47] Richard M Ryan, C Scott Rigby, and Andrew Przybylski. 2006. The motivational pull of video games: A self-determination theory approach. *Motivation and emotion* 30, 4 (2006), 344–360.

[48] Bektur Ryskeldiev, Yoichi Ochiai, Koki Kusano, Jie Li, Yamen Saraiji, Kai Kunze, Mark Billinghurst, Suranga Nanayakkara, Yusuke Sugano, and Tatsuya Honda. 2021. Immersive Inclusivity at CHI: Design and Creation of Inclusive User Interactions Through Immersive Media. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems*. 1–4.

[49] Barbara R Sarason, Gregory R Pierce, and Irwin G Sarason. 1990. Social support: The sense of acceptance and the role of relationships. (1990).

[50] Alexander M Schoemann, Aaron J Boulton, and Stephen D Short. 2017. Determining power and sample size for simple and complex mediation models. *Social Psychological and Personality Science* 8, 4 (2017), 379–386.

[51] Dong Hee Shin. 2009. The evaluation of user experience of the virtual world in relation to extrinsic and intrinsic motivation. *International Journal of Human-Computer Interaction* 25, 6 (2009), 530–553.

[52] Philipp Sykownik, Linda Graf, Christoph Zils, and Maic Masuch. 2021. The Most Social Platform Ever? A Survey about Activities & Motives of Social VR Users. In *2021 IEEE Virtual Reality and 3D User Interfaces (VR)*. IEEE, 546–554.

[53] Shelley E Taylor. 2011. Social support: A review. (2011).

[54] Vincent van Brakel, Miguel Barreda-Ángeles, and Tilo Hartmann. 2023. Feelings of presence and perceived social support in social virtual reality platforms. *Computers in Human Behavior* 139 (2023), 107523.

[55] Jan Van Looy, Cédric Courtois, and Melanie De Vocht. 2010. Player identification in online games: Validation of a scale for measuring identification in MMORPGs. In *Proceedings of the 3rd international conference on fun and games*. 126–134.

[56] Weijia Wang, Steven Baker, and Andrew Irlitti. 2020. Exploring the Effects of User Control on Social Engagement in Virtual Reality. In *32nd Australian Conference on Human-Computer Interaction*. 253–262.

[57] Xiaoying Wei, Xiaofu Jin, and Mingming Fan. 2022. Communication in Immersive Social Virtual Reality: A Systematic Review of 10 Years' Studies. *arXiv preprint arXiv:2210.01365* (2022).

[58] Kipling D Williams and Blair Jarvis. 2006. Cyberball: A program for use in research on interpersonal ostracism and acceptance. *Behavior research methods* 38, 1 (2006), 174–180.

[59] Julie Williamson, Jie Li, Vinoba Vinayagamoorthy, David A Shamma, and Pablo Cesar. 2021. Proxemics and social interactions in an instrumented virtual reality workshop. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. 1–13.

[60] Amal Yassien, Passant ElAgroudy, Elhassan Makled, and Slim Abdennadher. 2020. A design space for social presence in VR. In *Proceedings of the 11th Nordic Conference on Human-Computer Interaction: Shaping Experiences, Shaping Society*. 1–12.