Virtual Games, Real Interactions: A Look at Cross-reality Asymmetrical Co-located Social Games

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Figure 1: There are currently three main types of VR gaming possible. A. All players have VR and are co-located. B. Players are remote and use VR to play together. C. Players might or not have VR to play together in a much more multi-device and hybrid approach. Note: images are partially generated with AI prompting.

ABSTRACT

Multiuser, multi-device environments in extended realities (XR) enable synchronous social interactions. With the freedom and flexibility to choose the most suitable device, we allow for inclusive environments where even spectators can be involved. However, existing research has mostly been conducted in controlled laboratory settings, which limits the applicability of the findings to naturalistic scenarios. We conducted a mixed methods study with social XR experts to explore situated and asymmetrical modalities in the context of XR gaming for enabling social interactions in naturalistic social settings, focusing on two games. We considered variations in available devices, spatial constraints, and users' motivations and expertise. Our research suggests that asymmetrical interfaces may reduce barriers to entry for XR, support social connection, and promote cross-platform communication and collaboration. Together, our findings provoke critical discussions for future work on the effective deployment of asymmetrical interfaces in naturalistic scenarios and address potential technical, spatial, and social challenges.

CCS CONCEPTS

• **Human-centered computing** → **Virtual reality**; **Collaborative interaction**; **Mixed / augmented reality**; **Empirical studies in collaborative and social computing**; • **General and reference** → **Empirical studies**.

KEYWORDS

Social XR, Hybrid Gaming, Asymmetric XR, Virtual Reality, Co-located XR, Multiplayer VR, Multi-device

ACM Reference Format:
Alexandra Kitson, Sun Joo (Grace) Ahn, Eric J Gonzalez, Payod Panda, Katherine Isbister, and Mar Gonzalez-Franco. 2024. Virtual Games, Real Interactions: A Look at Cross-reality Asymmetrical Co-located Social Games. In *Extended Abstracts of the CHI Conference on Human Factors in Computing Systems (CHI EA '24), May 11–16, 2024, Honolulu, HI, USA.* ACM, New York, NY, USA, 9 pages. https://doi.org/10.1145/3613905.3650824

CHI EA '24, May 11–16, 2024, Honolulu, HI, USA

ACM ISBN 979-8-4007-0331-7/24/05
https://doi.org/10.1145/3613905.3650824

1 INTRODUCTION

Asymmetrical cross-reality interfaces involve multiple users sharing a synchronous experience (e.g., gaming, collaborative work, meeting) in the same virtual environment using different modalities [12, 24, 49]. Users can be co-located or physically separated [55], and may each be using a different device, each positioned on a different point in the reality-virtuality continuum [41], to engage in some form of interaction with other users, agents, and objects. The limited, albeit rapidly growing, body of literature [4] notes that the asymmetry introduces flexibility and user agency in how experiences are shared [26]. It also provides an inclusive environment wherein even bystanders can be involved in the shared experience [25]. Asymmetrical interfaces reflect the evolution of user experiences in extended realities (XR) that have traditionally focused on single-user applications to multi-user, multi-device environments that allow users to engage in synchronous, social interactions with the agency to select the device that they feel most comfortable using or best meets their interaction goal.

Extant literature has largely investigated this work both formally and informally in a controlled laboratory setting, limiting the generalizability of applying prior findings to the design and implementation of asymmetrical interface products. The current study is a preliminary foray into observing the implementation of two asymmetrical interface games in a naturalistic social setting. The current mixed-methods case study sheds insights into the ecological validity of asymmetrical interface deployment in an everyday setting where variances in available devices, problems of space and place, and user motivations and expertise are introduced. We hope that the research questions and preliminary findings introduced in this "prequel" serve as the impetus to critical conversations on how asymmetrical interfaces can be effectively deployed in the field and preemptively consider how the technical, spatial, and social barriers may be overcome. Therefore, we pose the following research questions:

RQ1: What do player experiences look like for asymmetrical cross-reality VR games in a real-world social setting with multiple co-located players?

RQ2: What are key design elements in asymmetrical cross-reality VR games that (a) promote enjoyable play experiences for all players, and (b) hinder enjoyment during gameplay?

2 RELATED WORK: ASYMMETRY IN VR EXPERIENCES

With the rapid advancement in immersive technologies, the implementation of virtual worlds is expanding into a continuum [51], evolving from the clear boundaries of VR and AR that scholars have worked within for many years. The multitude of devices on the spectrum being used to access these virtual worlds creates inherent asymmetries. Asymmetry, characterized by discrepancies in capabilities or interfaces among players [27], can manifest in several ways in multi-player experiences. Ouverson and Gilbert [43] define five dimensions of asymmetry: spatial co-presence, transportation, informational richness, team interdependence, and balance of power. Such asymmetry can be leveraged for strategic and biometric interdependence, greatly enhancing engagement even when some players lack access to head-mounted displays (HMDs) [24, 33, 35, 49]. While asymmetry is an inherent part of several VR games (see Figure 2 for examples), it has been largely understudied in research (e.g., only 25 such papers were identified in [49], a review of extant literature until 2021). Research that does study the effects of asymmetry tends to be conducted in controlled lab environments. Broadly, we are interested in exploring how asymmetrical VR play experiences could be leveraged to improve group social dynamics in a real-world setting. Here, we introduce some background on hybrid multi-device asymmetrical systems, a specific understudied aspect of asymmetry (user scale), and how previous work has leveraged asymmetry to include spectators.

2.1 Hybrid Multi-device Asymmetrical Systems

With an increasing number of devices in an average user's tech ecosystem, researchers are exploring ways of bridging interactions between devices (e.g., [45]). At the same time, users are learning to interact and collaborate synchronously across different forms of extended realities and interfaces (e.g., VR and AR; VR and desktop). This hybrid form of multi-device collaboration is anticipated to gain popularity as everyday consumers attempt to integrate immersive technologies into their life and work routines. Academically, concurrent users playing synchronously, with each user entering the same VR space with different devices, introduces questions of asymmetrical or cross-reality interfaces (c.f. [3, 49]). Researchers have explored such device asymmetries between a VR player and desktop [35], tablets [9], and robots [8]. These questions are interesting because each user brings with them a different set of media affordances [18], [2], wherein users strategically leverage the unique features of media platforms that allow a certain range of actions.

For example, HMD users with hand controllers will be able to use each of their hands freely to pick up and grab objects whereas tablet users may not have the same capability. On the other hand, tablet users may easily be able to get a birds-eye perspective of the world map whereas HMD users can only look around the world through their stereoscopic lenses [9]. Earlier work has found that the action possibilities, combined with the way users decide to leverage these features, can largely determine user experience outcomes [30], requiring more intensive communication and coordination when users are on different devices [35]. The emerging body of literature seems to generally point to positive user responses from this hybrid, multi-device form of gameplay [35, 49]; however, sociotechnical hurdles introduced as users attempt to coordinate across the varied media affordances of asymmetrical interfaces are bound to cause friction, particularly in naturalistic settings without tight experimenter control.

2.2 Asymmetry of Scale and Embodiment Illusion

Scale is a particularly interesting element in the Player Experience in asymmetrical device systems which has been particularly understudied. Virtual worlds are often populated by users manifesting as avatars [22, 23, 46, 47]. A differentiating factor for avatar embodiment in VR as compared to non-immersive media is the first-person perspective [36], which makes studying scale-related asymmetry particularly interesting when one of the players is using immersive VR. Some of the documented effects of embodiment include enhanced sensory experiences such as haptics [20]; cognition can also be enhanced when using an avatar [44, 54]; the self-avatar follower effect [21], by which the avatar movements can influence the participants; or the Proteus effect [61]

This type of plasticity allows easy modifications to the body schema and body ownership, first demonstrated by the rubber hand illusion [10]. This effect was then reproduced in large mannequins [16, 39] and it has since been found quite easy to substitute a real body with a virtual one [50, 53]. The plasticity of the illusion is very large—as such, embodiment works even if the avatar has altered sizes of body parts (e.g., creating large belly illusion [42], long arms [37], Pinocchio illusions [6], Barbies or giant dolls [59]). Giant avatars have an additional impact on aspects such as locomotion [15], simplifying a traditionally complex problem of having to move around a very large virtual environment while constrained in a small physical space [1]. While other ways to speed in large spaces might produce motion sickness, as shown in [1], being a giant allows users to reach much further while maintaining 1 to 1 motions.

It is not surprising, then, that several multiplayer games use giant avatars for VR players (see Figure 2). The giants in these games are often stationary or have minimal mobility requirements, reducing issues stemming from locomotion. The immersion through a VR HMD enables a powerful embodiment illusion that increases the presence plausibility of the experience [52]. At the same time, the players using the other device modality typically control a smaller-scale avatar with high mobility. This is true for both the games we studied in this paper: DAVIGO [1](desktop users control avatars who can move quickly and attack the VR giant) and Acron [2] (mobile phone users control small squirrels to steal acorns from a giant oak tree embodied by the VR user).

We chose these games due to access, and since both of these games manifest asymmetry along most of the dimensions defined in [43] (*spatial co-presence*: in Acron, the squirrels share a playing field while the giant tree is alone; *transportation*: the VR player in both games had minimal mobility whereas non-VR had more movement agency; *informational richness*: information exposed to players was dependent on their roles; *team interdependence*: both games had an adversarial VR vs. non-VR mechanic, with each group bringing their own goals; and *balance of power*: the VR giant had abilities like picking up and throwing the non-VR users, while non-VR players could use powerups in both games).

2.3 Including Spectators in VR Experiences

Large screens have often engaged otherwise passive spectators in-game experiences (e.g., [31, 48]). When one of the participants in the experience is in VR, it allows us to further blend the reality between player and spectator, particularly when they are co-located in the same physical space. One approach involves instrumenting rooms with projectors and depth cameras, to expand the basic capabilities of rooms, creating experiences like IllumiRoom [34], or RoomAlive [60]. This allows for greater spectator experiences as well as more awareness of the player's immediate space. This same technology can blend the VR world for the user. For example, in remixing reality, the physical space can be used to improve the experience of the VR player [29, 40], and to reproject the view of the VR headset to the spectators who don't have HMDs (e.g., MeetAlive [19]). In RealityCheck [29] users can also transition in and out VR seamlessly thanks to the physical augmentation of the virtual worlds. Blending the physical space into an HMD-wearer's reality comes naturally with Mixed Reality (MR) headsets. This was used in Astaire [62]—a collocated two-person play experience where one person is 'in headset' with one controller, and the other person wears the other controller and they do a "partner dance", making spectators an active part of the experience.

[1]DAVIGO on Steam: https://store.steampowered.com/app/1116540/DAVIGO_VR_vs_PC/
[2]Acron on Steam: https://store.steampowered.com/app/1094870/Acron_Attack_of_the_Squirrels/

3 METHODS AND MATERIALS

We conducted an informal user evaluation and compared the VR user to the PC/Phone users and Spectators, as well as compared the use of a projector (PC) to no projector (Phone). We used DAVIGO and Acron on two different days. Both games are similar in that the PC/Phone players join efforts to attack the VR Player, who is a giant (Figure 2). We use the term "co-located" because all players observed in the study playing the same game were physically in the same room. During gameplay, there were interactions and verbal communications with the other co-located players that may or may not be related to the game. While both games make use of VR headsets, we use the term "XR" as a general term that incorporates the spectrum of experiences across the reality-virtuality continuum. In both games, VR is one endpoint, while the other is either a PC or phone. In our case, the PC was not isolated because of spectators and the gameplay was broadcast over a projector. Also, there was substantial interaction between phone users in terms of strategizing. Therefore, both games argue for the usage of the term XR as well as the value of discussing co-location.

3.1 Study Design

We employed a mixed-methods case study approach to investigate situated and asymmetrical modalities in the context of XR gaming for enabling social interactions. Our embedded design involved observations and a post-experience questionnaire using standardized metrics (see below). Qualitative data were thematically analyzed and quantitative data were analyzed using descriptive tests. Integration of findings was achieved through triangulation to allow for a comprehensive interpretation of the ecological validity of asymmetrical interface deployment in an everyday setting.

3.2 Metrics

We collected data on participants' self-reported user experience, embodiment [17], enjoyment (adopted from [7, 11, 38]), task difficulty [28], social presence [14], and mediated social communication[58] using a questionnaire based on existing, validated metrics. We used existing questionnaires to inform our survey since validated questionnaires that capture all of our constructs of interest without putting significant time demands on participants do not yet exist. Readers should note that we did not score our survey as the original assessments; therefore, comparisons should be made cautiously. We compared different modalities of XR gaming interactions in asymmetrical settings. Additionally, we considered participant demographics such as age, gender, prior gaming experience, and gamer type (based on [5]) to explore potential individual differences. User

Figure 2: A selection of games that use giant avatars, including Acron and DAVIGO (highlighted), which we chose to use for our study.

experience was captured through several aspects of user preference and engagement with the XR experience. We evaluated gaming preferences using open-ended questions about which role they liked the best, what they thought was key in making this gaming experience inviting, and if they liked having the projector. User engagement was operationalized through observable behaviours such as time played, collaborative interactions and voluntary participation. Participants rated their XR gaming experience using a 5pt-Likert scale from "I do not agree at all" to "I fully agree." For a breakdown of all questions, please see Appendix A. The quantitative measures were intended to be descriptive for this case study; inferential statistical tests were not conducted due to the small sample size.

3.3 Apparatus

DAVIGO took place in a multi-purpose room designed for social gatherings, roughly a 6m by 4m room with columns down the middle with two long tables on either side. The VR players used the Meta Quest 2 standalone head-mounted display with Meta Quest 2 Touch controllers. The PC players used an ASUS ROG Zephyrus G15 laptop with a 15.6-inch display, Ryzen 9 5900HS CPU, GeForce RTX 3050Ti GPU, and a wired three-button mouse. The spectators who were not playing on devices could also watch the gameplay through a laptop connected to a projector that displayed a (roughly) 1.5m picture on one of the room's walls.

Acron took place in a separate games room, roughly a 15m by 6m space with benches on either side. We used the Meta Quest 3 standalone head-mounted display with the Meta Quest Touch Plus controllers for the VR user. Each person used their mobile phone to play the Phone side of the game. There was no projector set up in this room.

3.4 Participants

We used convenience sampling to recruit participants during an international seminar on Social XR: The Future of Communication and Collaboration. This seminar gathered junior and senior academics and practitioners from different disciplines to address open challenges of immersive interaction including the ethical, legal and societal aspects of possible futures. Participation was voluntary and no monetary compensation was given. Observing the seminar attendees provided an opportunity to focus on the gameplay without losing traction on initial technical difficulties typically experienced by novice players who have never encountered asymmetrical cross-reality interface situations. 14 participants were present for the social XR games, and 9 of those completed our survey (5 women and 4 men). Ages ranged from 20-29 (N=2), 30-39 (N=6), and 40-49 (N=1) years. Three participants self-identified as non-gamers, four as casual gamers, one as a core gamer, and one as a hardcore gamer. Self-identified gamer types were explorer (N=4), socializer (N=3), achiever (N=1), and killer (N=1) [5].

3.5 Procedure

We invited all seminar attendees to play DAVIGO while socializing in the multi-purpose room. Participants could choose from VR, PC, or spectator roles; and some people played multiple roles in different game sessions throughout the evening. Although this game allowed for up to four PC players, we only played with one PC player for simplicity. The starting players individually completed the in-game tutorial before competing against each other, while spectators watched how to play on the projector. After that, the reining players passed on control mappings to subsequent players. The average playtime per person was about 10 minutes and the game was available to play for about 1.5 hours. The next evening, all researchers were invited to play Acron in the games room. Researchers could choose from VR, Phone, or Spectator roles. Acron allowed up to eight Phone players, and we played with 4-6 Phone players for each round. There were no tutorials in this game; instead, players jumped right into taking turns playing the VR character. We played similar average match time and total game time compared to DAVIGO. For both games, we took videos, photos, and observation notes. One week after the seminar, we sent out an online questionnaire that invited researchers at the seminar who were present for one or both of the game nights to complete.

4 RESULTS

Of the nine participants who completed our survey, some played only DAVIGO (*N*=2; both PC) or only Acron (*N*=2; one Phone-only and one both Phone and VR), while others played both DAVIGO and Acron (*N*=3; one played it all and two played all but PC Knight) or only watched others play games (*N*=2). The results of the post-test questionnaire and the descriptive statistics for VR players are summarized in the appendix Table 1 and Figure 3.

We identified three themes: inclusive gameplay–importance of the spectator role, cross-reality media affordances, and the power and limitations of co-located asymmetric social play.

4.1 Inclusive Game Play–Importance of the Spectator Role

Addressing RQ1, we found that asymmetrical cross-reality interfaces levelled the playing field for gamers at different levels of experience and gaming styles to enjoy the game together. On average, PC/Phone participants liked playing against a VR player (*M*=4.14, *SD*=0.69) [Q44] and did not prefer to play only against others using the same modality (PC/Phone) (*M*=1.14, *SD*=0.38) [Q45].

If someone did not want to play actively as a character in the game for various reasons–"engaged in discussions", "I had to work", "I don't like playing games. I was worried I wouldn't get the hang of it fast"–they could remain involved as a spectator through projection monitors. One participant said the lack of projection during Acron made them feel like they "could not take part in the story that took place, which made me feel like an outsider", whereas with the projection of DAVIGO, spectators could watch what the VR player was doing and found it "fascinating."

Remaining engaged as a spectator kept options open as the spectator's situation continued to shift. One participant said "I had to work... but I was super glad to be able to see the rest enjoy, and I watch quite often the projection." Some participants may have opted to remain a spectator due to a lack of confidence; however, we observed that others gradually built self-efficacy as they watched the game on the projection screen and eventually opted in to play more actively. While on PC/Phone, players found it relatively easy to communicate with the VR player (*M*=3.33, *SD*=1.37) [Q46] and afterward wanted to try the VR mode (*M*=3.71, *SD*=1.50) [Q47]. For spectators, if they had to play, they would have played VR giant (N=2) or the Phone squirrel (N=1), but not the PC knight.

Spectators have been considered in other video game modalities [32], but there has not yet been an in situ study of social settings where there are more people than there are XR devices in a gameplay scenario. Gaming in a casual social space with a projection system casting the XR content in our pilot study allowed spectators to focus on socializing or working while still being "able to see casually what they were doing." Our findings provide preliminary support for game design that takes the role of the spectator into account, in considering the overall social experience of XR play when players are co-located.

4.2 Cross-Reality Media Affordances

Our findings suggest that cross-reality media experiences in social settings are most enjoyable when the unique affordances of each medium are leveraged in the design of the game. Specifically, playing in the same room, having multiplayer capability, and having different options to play (VR and PC/Phone) made the game more enjoyable for the majority of participants (N=6, 66.7%). Additionally, for some participants, having the projection for DAVIGO was key (N=4, 44.4%) as well as playing with people you know (N=3, 33.3%). One participant liked playing as the squirrel in Acron because you are "part of a team."

Interestingly, most of the cross-reality games we surveyed and the two games that we observed in the current study opted to integrate a single VR user as a giant character (in size and role), relative to multiple PC and Phone users joining the same game (as an attacking knight or squirrel). One participant thought that "having the god-like view on the small knights was fascinating." The VR giant approach effectively addresses two conundrums of media asymmetry in these games. First, even with a clear boundary established, it may be difficult or dangerous for a sole VR player to be moving among a group of stationary PC or Phone players. We observed DAVIGO VR players running up against physical walls in the tight space. Second, employing a giant character is one way of alerting other users in the game that the user is on a different device (i.e., VR).

If both VR and PC/Phone users had to play the same game character, the asymmetry between media features may have caused a discordant play experience–for example, natural mapping in VR may allow for more accurate object throwing compared to the point and click of the mouse or tapping on the phone screen. Although it may seem counter-intuitive, intentionally designing game features to *highlight* these asymmetries and have users play different roles in the game if they are on different devices seemed to encourage users to accept the asymmetries as a natural part of the game. This, in turn, contributed to an enjoyable experience for everyone involved. This may be why the participants, even after playing with different devices for the same game, did not seem to display a clear preference. For example, one participant said "I preferred to play the role that was losing since it created a new challenge of being the one that was able to win." Another participant echoed these words, saying "there are clear pros and cons for both types of play (VR vs. non-VR) and I like each type for its own worth."

4.3 The Power and Limitations of VR for Co-located Asymmetric Social Play

Addressing RQ2, our findings suggested that challenges came with supporting asymmetric co-located play. Using multiple devices brought technical challenges related to interoperability–for example, getting the projector to work with the laptop that is driving the shared view of the game. Participants reported that "DAVIGO was more fun", but preferred Acron for its easier setup and accessibility for "more non-VR players via smartphones not via PC."

Bringing fully headset-immersed VR players into the mix introduced important spatial challenges–our play sessions included the practicalities of dodging pillars in the room. VR also increased physical effort for players who opted for this modality. One participant noted that "you are physically there and performing a theatre. That is uncomfortable for some and also takes a lot of physical effort even if you are fine with that."

The asymmetrical approach to co-located gaming with VR promoted enjoyable experiences for both players and spectators by demonstrating to PC/Phone players and spectators the usually obscured reality of the VR player. For some, watching others play in VR helped them to see what to do and prompted their curiosity to try VR for themselves. One participant commented that the projection was "a good way of showing that a game was going on in a dark room meant for another activity." However, one limitation we observed was that the VR player was blind to the presence of other players and spectators in the co-located space. One spectator reflected that "playing social VR games is still difficult due to the unknown social dynamics and everyone gets very vulnerable being the immersed person. It removes the anonymity (even if you know who is behind the nickname) of playing digital games together." Findings suggested that although the VR character was one of the most enjoyable experiences in the cross-reality game with high presence perceived while embodying a giant, in a co-located situation, it also induced some anxiety and feelings of vulnerability. Given the conflicting views of this role, we suspect that limiting the number of concurrent VR players in the same game is likely to be more conducive to an enjoyable gaming experience.

5 DISCUSSION AND CONCLUSIONS

As XR devices and platforms continue to evolve and diversify, user experiences and preferences regarding asymmetrical cross-reality interfaces become more crucial to understand, toward designing and supporting rich entertainment experiences that take legacy devices into account. The current field study with attendees of an international seminar on social XR yielded some critical insights concerning the strengths, weaknesses, and future opportunities for asymmetrical cross-reality gaming in the field.

Our results extend existing work that uses different combinations of infrastructure to enable multiple players, spectators and multi-device play in the same space [19, 29, 40, 57] by using a simple setup of a standalone VR headset together with a laptop PC connected to a projector (DAVIGO) or smart Phone (Acron). In doing so, we observed that participants selected the most suitable device and modality based on their gamer style and type, which is consistent with this emerging body of research [3, 35, 49, 56]. In our case study, participants reported high levels of embodiment and presence as the VR giant. We speculate that the plasticity of body schema and body ownership [50, 53] allowed users to quickly adjust to the giant's slow, cumbersome movements, suitable for social, co-located gameplay in a constrained space [1, 20, 52].

Players enjoyed the flexibility of moving between spectating and active participation, as well as the diverse play opportunities that the asymmetric controls provided. Despite the headwinds of added complexity involved in setup, playing these games was seen as worthwhile and enjoyable.

Overall, this in situ "prequel" study helps to clarify player experience preferences and key design elements in asymmetrical cross-reality VR games in the field. In a world in which not everyone will have or want a VR headset, game developers can benefit from a stronger understanding of supporting flexible play modalities, including considerations of spectator appeal. Future work could include expanding to include additional combinations of devices, studying different sub-genres of asymmetric VR games [13], looking into remote use, and examining different demographics, for example, intergenerational play scenarios and the consideration of accessibility across XR users with disabilities.

ACKNOWLEDGMENTS

We conceptualized the paper and ran the case study on the social evenings during the Dagstuhl seminar 23482 on Social XR: The Future of Communication and Collaboration (Nov 26 – Dec 01, 2023). Some participants of those evenings later agreed to contribute to the data sampling of this paper.

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A APPENDIX QUESTIONNAIRE

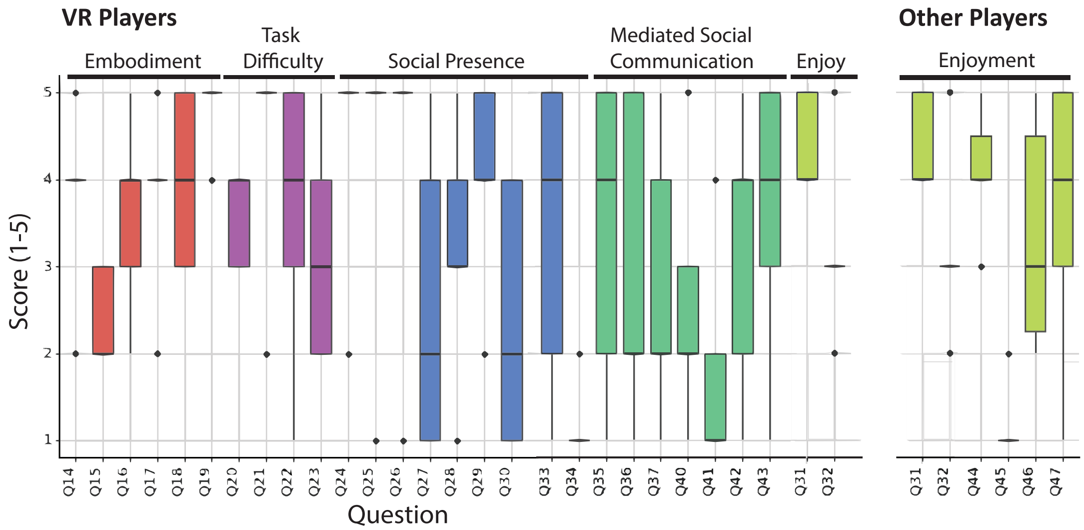

Figure 3: Boxplot of all the questionnaire responses.

Table 1: Aggregated Post-Game Questionnaire Results for VR Players

Question Type	Question # s	Average	SD
Embodiment	14-19	3.5	0.6
Enjoyment	19	4.8	N/A
Task Difficulty	20-23	3.7	0.5
Social Presence	24-34	3.4	1.0
Mediated Social Communication	35-43	3.0	0.6

Table 2: Post-Game Questionnaire and Corresponding References

#	Questions	Ref.
	Completed by All	
	Demographics	N/A
Q1	Age Range	
Q2	Gender	
Q3	Gamer Type	[5]
Q4	Gaming Style/Frequency	
	User Experience	N/A
Q5	Did you play the VR games DAVIGO and/or Acron?	
Q6	If yes, in which role(s)?	
Q7	If not, but you had to play, which option would you have preferred playing?	
Q8	If you played both games, which one did you prefer and why?	
Q9	If you played multiple roles, which one did you prefer and why?	
Q10	If you did not participate as the VR Giant, PC Knight, VR Tree, or Phone Squirrel, why is that?	
Q11	What do you think was key in making this gaming experience inviting?	
Q12	What are your thoughts on having the projection? Did you like it? Why or why not?	
Q13	For about how long did you play in each role?	
	Completed only by VR Players	
	Embodiment	[17]
Q14	Overall, I felt that the virtual body was my own body.	
Q15	It seemed as if I might have more than one body.	
Q16	I felt like my body was actually there in the environment.	
Q17	I felt like my bodily movements occurred within the environment.	
Q18	I felt like the environment affected my body.	
	Enjoyment	[7, 11, 38]
Q19	Playing DAVIGO/ACRON was enjoyable.	
	Task Difficulty	[28]
Q20	The task was mentally demanding.	
Q21	The task was physically demanding.	
Q22	I was successful in accomplishing what I was tasked to do.	
Q23	I felt insecure at the task.	
	Completed only by VR Players	
	Social Presence	[14]
Q24	What the others did affected what I did.	
Q25	The other players paid close attention to me.	
Q26	I paid close attention to the other players.	
Q27	I paid close attention to the spectators.	
Q28	I empathized with the other players.	
Q29	I felt connected to the other players.	
Q30	I felt connected to the spectators.	
Q33	I tended to ignore the spectators	
Q34	I felt revengeful of the other players	
	Preference/Enjoyment	N/A
Q31	I found it enjoyable to be with the other players.	
Q32	I found it enjoyable to have spectators	
	Mediated Social Communication	[58]
Q35	I communicated with the other players during the game.	
Q36	While communicating, my reasoning felt normal.	
Q37	While communicating, the reasoning of the other person(s) felt normal.	
Q40	I felt in direct contact with the real environment.	
Q41	The real and the virtual environment appeared blend.	
Q42	The virtual environment affected my thoughts just as its real counterpart would.	
Q43	My interaction with the virtual environment felt realistic.	
	Completed only by PC/Phone Players	
	Preference/Enjoyment	N/A
Q44	I liked playing against a VR giant.	
Q45	I would have preferred to play only against other using my same modality (PC/Phone).	
Q46	It was easy to communicate with the VR giant.	
Q47	Playing on this modality, made me want to try the VR mode more.	
	Completed by All	
	Open Feedback	N/A
Q48	Please use the space below to add any additional comments or observations.	