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An Exploration of Theatre Rehearsals in Social Virtual Reality

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ABSTRACT

Virtual Reality (VR) offers potential for theatre makers to rehearse remotely in settings which are uniquely immersive. In collaboration with a major drama school in the United Kingdom, a longitudinal diary study was completed to examine the utility of consumer-grade VR for theatre rehearsals. Utilising commonly affordable headsets and general-purpose Social VR applications, 10 experienced students (2 directors, 8 actors) rehearsed scenes in VR over 3 weeks, before performing them in person. Participants detailed their experiences in diary logs and interviews, expressing the ability to work through spatial arrangements (blocking) as a full body avatar to be positively beneficial. Limitations included the absence of facial expressions and gestural nuance. Our overarching conclusion is that low-tech VR can be a useful aid in theatre rehearsals and early stages of production. In conclusion we outline design recommendations for a) using VR in theatre production and b) research and development of Social VR.

CCS CONCEPTS

• **Virtual reality**; • **Performing arts**; • **Empirical studies in collaborative and social computing**; • **Psychology**; • **User studies**;

KEYWORDS

theatre rehearsals, remote rehearsals, acting, social interaction, avatars, presence

1 INTRODUCTION

In a world experiencing a growing number of global challenges, such as climate change and the Covid-19 pandemic, understanding and improving remote social interaction is vital. Social Virtual Reality is a communication paradigm designed to foster embodied socialisation in immersive digital settings, that offers the promise of a perceptually immersive remote interaction, which is closer to face-to-face than any other form of mediated communication [5, 18]. Whether and how this potential can be realised is a key question in human-computer interaction.

In a longitudinal diary study, conducted in collaboration with the Bristol Old Vic Theatre School, one of the worlds leading film, TV and theatre schools, we gather in-depth experience data and design recommendations from actors and directors who conducted multiple remote rehearsals in Social VR. This research is the first to demonstrate that a complex social interaction—rehearsing a theatre scene—can be accomplished in basic Social VR, without requiring precise space tracking and motion tracking. We provide a detailed analysis of design features, existing and envisioned, and their contribution to a successful rehearsal process.

The basis for this collaboration came from our partners' interest to introduce creative technology into their curriculum. Students have become more familiar with the use of motion tracking, for instance in the development of acting and performance techniques alongside its uses for driving and embodying avatars. The arrival of the Covid pandemic and resulting lockdowns raised the conversation of whether creative technology could support remote rehearsing whilst aiding the work of Directors in the production phase.

Our immediate research question of whether actors and directors can successfully rehearse in VR is also a question of the extent to which individuals can successfully connect, cognitively and emotionally, convey and perceive emotions and intentions, coordinate, interact in XR platforms and immersive VR environments. As a user group, theatre professionals can be considered domain experts in social interactions and therefore uniquely suited to evaluate Social VR and provide design recommendations. We chose Altspace and VR Chat, two widely used applications for non-tethered headsets, which differ substantially and thus allow participants to experience a broad range of features and design characteristics.

2 RELATED WORK

2.1 Social Virtual Reality

Social Virtual Reality is a communication paradigm designed to foster embodied socialisation in immersive digital settings, arguably better described as a simulation of face-to-face, rather than computer-mediated, communication [5]. Evidence that individuals in Social VR behave as they would in real life comes from studies successfully replicating known patterns of behaviour in collaborative tasks [13, 18], close relationships [22], and dance [17]. For example, a longitudinal study on close relationships, found that during interactions with familiar others (e.g., relatives, friends, long-distance couples) users experienced a range of emotional states in VR broadly similar to those that they would experience face-to-face in the same groups [14]. A survey conducted during the Covid-19 pandemic identified an association between Social VR use and psychological benefits, including feelings of connectedness and self-transcendence [2].

The functionality and affordances of Social VR have been examined in several studies, including a taxonomy of design features based on 29 commercial and prototypical applications [8], inventory of nonverbal expression like gestures and facial expression [23], avatar design [10]. With one notable exception [12], these papers do not involve user evaluation. Within the broad array of social features currently available on such platforms, limitations include intuitive control over facial expressions, effective avatar movement and appearance.

Effective avatar appearance is a longstanding challenge addressed in numerous studies [6, 7, 11]. There is mounting evidence that full-body avatars are preferred to disembodied heads and hands from research using full-body motion tracking [1, 11, 16]. It remains to be seen whether this preference remains when full body motion is inferred from head and hands (inverse kinematics) as is the case with current all-in-one headsets. With regard to appearance, photorealistic avatars may lead to increased sense of embodiment [11] but can also be seen as uncanny and less attractive compared to stylized representation. Research into effective avatar appearance in still ongoing.

2.2 Theatre Rehearsals in Virtual Reality

As early as 2000, Slater and colleagues [20] had directors and actors in remote locations use a non-immersive virtual environment, akin to a desktop video game, to rehearse a scene and later attempt to perform it in person. Follow-up interviews revealed that the level of success in the live performance could not have been achieved through learning of lines or video conferencing. Subsequent studies reached similar conclusions using more advanced technology, such as virtual reality head-mounted displays and immersive-projection caves [15, 21]. Other studies have tested specific aspects of virtual environments. Studies have compared the effects of different avatars [7, 9]. All forementioned studies relied on advanced bespoke technology, such as full body tracking and exact set replicas and a limited number of participants and sessions.

Participants in existing studies broadly agree on the potential of VR to support rehearsals, in one case estimating reductions in cost and production time as large as 25% [21]. Yet there is little discussion of how specific design features contribute to the success of social interaction and how existing systems can be improved. Importantly, it remains unclear whether the benefits of VR are obtainable only via advanced technology, such as motion tracking and space mapping.

The present research seeks to address these limitations by inviting theatre professionals to engage in multiple rehearsals and provide an in-depth reflection on their experiences. Through semi-structured diary logs and focus groups, we encouraged a discussion of the factors and design features underlying the experiences of presence and embodiment and produced a series of design recommendations.

3 METHOD

3.1 Participants

Participants were students at the Bristol Old Vic Theatre School: two directors, male and female, enrolled in the Directing Master's programme, aged 24-35; and eight actor students, aged 24-35, five female, two male, and one non-binary, with little or no prior experience using VR.

3.2 Procedure and technical setup

The two participating directors were provided with 3 Oculus Quest 2 headsets and trained to use Altspace VR and VR Chat in two training sessions (2 hours each), conducted remotely on consecutive days. For the rehearsals, each director worked with two pairs of actors. Each group conducted three 2-hour sessions, meeting in person or via a video conferencing software, before switching to VR. The first session was an onboarding session where actors were introduced to the study and to VR.

The structure and content of rehearsals were determined by each director, with one director choosing to rehearse a scene (a dialogue from Pride and Prejudice) and the other director choosing improvisation. Both directors incorporated comparison between virtual and in-person acting, whereby actors rehearsed in VR and subsequently performed the rehearsed scene in person.

3.3 Measures and analysis

After each rehearsal session, each participant filled out a 20-minute diary questionnaire, including open-ended questions whether and how the VR and avatar technologies facilitated or hindered acting. Closed-ended questions on motion sickness, presence, and co-presence were also included to check for notable differences across sessions. Since comparing session was not the primary objective of this research, we used bespoke single-item measures to reduce workload on participants and allow them to focus on the key, open-ended questions. For a full list of questions, see Appendix.

At the end of the study, participants completed 45-minute closing interviews, conducted individually or in pairs. Four interviews were conducted in pairs, capturing data from six actors and both directors. In addition to the interviews, we analysed a recording of a public panel held with the directors. The questions for the interviews and panel were on the topics covered in the diary questionnaire (Appendix), with further probing into the comparison between VR and other forms of rehearsing (in-person and video conferencing), as well as envisioned features.
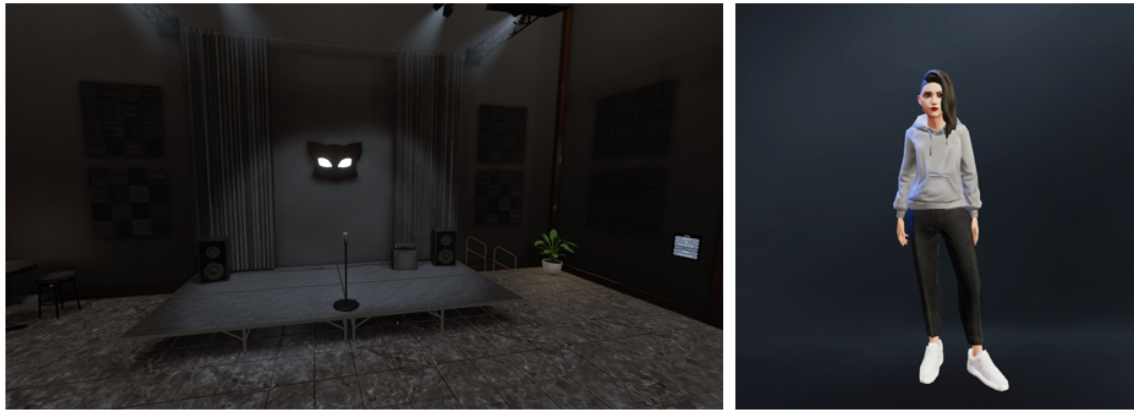
Figure 1: Illustration of preferred rehearsal space (left) and avatar appearance (right) in VR Chat. The study participants could select from a wide selection of designs. Simplistic interiors and humanoid full-body avatars were consistently preferred.

The interview transcripts and open-ended diary-logs were analysed using a combination of inductive and deductive thematic analysis [4], beginning with a set of predefined themes, based on our research question of benefits, hinderances, and envisioned features. In the process of analysis, data within those categories were further grouped into concepts. The analysis was conducted by the first author and reviewed by the second author. Quantitative data on motion sickness, presence, and rehearsal quality revealed no systematic individual and temporal differences. Group means are reported in the respective sections.

4 RESULTS

Our sample of expert participants concluded that VR is a useful tool in both remote and in-person rehearsals. When asked whether the VR rehearsals session met its objective, participants in the vast majority of cases responded with "Entirely" (47%), followed by "Mostly" and "Somewhat" (27% each). No participant responded "Not at all."

Key benefits and limitations of VR for theatre rehearsals were obtainable though affordable, consumer-grade technology. Our in-depth methodology revealed additional benefits and limitations not discussed in previous research, along with guidelines and design recommendations. Humanoid full-body avatars and visually simple interiors were conducive to successful rehearsals (Figure 1). An overview of extracted themes, frequency and representative quotations can be seen in Table 1.

Participants provided unique insight into the subjective qualities of VR rehearsals. Despite finding rehearsed behaviour transferred to in-person acting, participants observed that VR influenced their choices in non-trivial ways. They deemed the experience to be "*not like comparable, it's two completely different ways of being in an understanding*" and drew analogies to "*neutral mask acting,*" "*an immersive radio drama,*" and "*puppeteering*".

The most immediate and pressing issue participants faced with the VR technology in our research was usability. Even with training and practice, setting up accounts and navigating the selected social VR platforms required extensive troubleshooting. General usability was not the focus of the research, but it is important to note that even though we used the most user-friendly, consumer-grade technology available, the technical setup was challenging and time consuming..

4.1 Benefits of VR rehearsals

Participants consistently referred to **blocking**—rehearsing the positioning, direction, and movement of actors and objects in a scene, **embodiment**—the ability to use and perceive full bodies, and **social bonding**—connecting as a company easily and organically. Participants also brought up having fun, feeling more engaged, and overcoming nervousness.

To test the utility of VR for rehearsing blocking and physicality, participants performed scenes in person, after rehearsing them in VR. They also compared the VR rehearsal to prior experiences of remote rehearsals via video conferencing. Successful blocking was achieved without having exact set replicas and full body tracking. "*When we then did the same scene in real life they were a lot more confident. They also remembered the blocking.* " Similarly, motion tracking was not required for embodiment to be beneficial: "*when you're in your full body and you can like move as your character [. . .] It makes you feel more in touch with the character you're playing.*"

4.2 Challenges and limitations in VR rehearsals

The main challenges participants faced when rehearsing in VR were around the absence of facial expression and eye contact, which limited their ability to express emotions. Not being able to easily upload and view text in VR was another commonly mentioned hinderance. Some participants were able to mitigate the lack of facial cues through imagination and reliance on vocal cues, comparing VR to "*neutral mask acting*" and "*an immersive radio drama.*" These observations carry design implications, addressed in the respective section.

Another issue raised was the inadequate physics of interpersonal contact. When touching or colliding with another avatar, participants passed through them rather than experience the expected

Table 1: Category Frequencies

Name	Definition	N
Benefit Acting	**Ways in which VR supports acting**	
blocking	Understanding and rehearsing the positioning, direction, and movement of actors and objects at any time in a scene: "*After rehearsing the scene in VR I asked the actors to repeat the scene in reality without the headsets. We found the actors were easily able to replicate the same blocking we had established in VR*"	8
physicality embodiment	VR allowed actors to experience and engage their full body: "*the opportunity to actually like be in your body and know that you're moving around, and you're able to interact with things in the world, rather than just [...] the head and neck*"	6
confidence / bold choices	In VR, actors felt more confident and made bolder choices: "*VR took away a lot of the anxiety or vulnerability that comes with acting a scene for the first time*"	5
engagement & creativity	VR improved engagement and inspired creativity: "*it allowed for different ways of thinking*", "*You kind of focused a little bit more, because there was somebody there*"	4
social bonding	VR facilitated social connection: "*It allowed us to instantly bond over a mutual experience and it felt friendlier quicker.*"	4
exaggerated physicality*	VR led actors to exaggerate voice and gestures: "*it made so much of the scene so much more dynamic vocally [...] you would usually have to offer a few suggestions or notes to get to that level that quickly.*"	3
virtual space	VR helped actors feel present in a shared space: "*allowed me to not feel as though I was in my bedroom,*" "*one thing that was really cool and interactive was the fact that where we were in this space*"	3
privacy	VR was better for privacy compared to video conferencing: "*allowed me to keep my privacy whilst meeting up with director/actors*"	1
Hinderance Acting	**Ways in which VR hinders acting**	
emotional connection	VR prevented emotional connection and nuance: "*the subtlety and the nuance within the acting is lost, I think, especially in facial expressions*"	7
face and eye contact	Difficult to act against a static face and without eye contact: "*difficult to actually rehearse the emotions of the scene due to the non responsive faces*"	6
fatigue physical strain	VR can be tiring; using VR when tired can be difficult: "*it drained me a lot to use the vr*"	3
director presence	Directors lacked distinct presence and ways of signalling: "*I found it quite hard not to be able to make eye contact [...] being able to check in quite subtly [...] have like private conversations*"	
changes acting*	Acting in VR is different and not directly comparable to other forms of acting: "*to me, it's not like comparable, it's two completely different ways of being in an understanding*"	2
distracting	VR felt distracting: "*Actors fed back that the game-like quality of the world made it difficult to focus.*"	2
text	Not currently possible to easily upload text in VR	2
Envisioned Features	**Features to enhance the experience of acting in VR**	
	set simulation (3), interactivity (3); props and light (2), finger movements (2), on and off boarding; transitioning (2), text (3), director presence and signaling (2), personal space / intimacy direction (2), audience visualisation / sightlines (1), record and replay (1), easier switching between VR and IRL; AR XR (1), lighter headset (1), neutral abstract design (1)	

[a] N = Number of documents (interview transcripts, survey responses) featuring category; * = neutral valence (neither beneficial nor hindering).

obstruction and haptic feedback. On occasion, fatigue and physical strain were reported, as well as the motion and graphics of the VR environments being distracting. One participant voiced the concern that wearing a headset can cause neck strain and interfere with voice work: "*[Heavy headset] can cause neck strain. And that's not good for voice work. Because if you have a tense neck, it can lead to vocal problems.*"

4.3 Avatars, presence, and motion sickness

By using the two social VR environments, participants got to experience different types of avatars: a) cartoonish humanoid torsos with floating hands and b) video-game-like full-body avatars which could be humanoid but also take the appearances of various animate and inanimate objects. There was a consensus regarding the preferred appearance of avatars: full-body, humanoid, and abstract. Participants preferred full-body avatars, as opposed to torso and floating hands, even when only hands are tracked and remaining

limbs simply inferred (inverse kinematics): "*I find [full body avatar] helpful because it allows me to get the closest approximation of what it would be like to have that in real life.*" While self-similar avatars were preferred, "*The person who used an avatar that didn't look like them gave me the sense of someone using a puppet rather than performing themself!*" static faces were seen as uncanny, "*off putting because the faces were just like [frozen expression], all the time.*"

Participants experienced a high degree of engagement, presence, and co-presence, with averages scores on the shortened presence questionnaire of 2.9 (SD = 0.7), where 1 is none and 4 is highest possible presence. Some participants commented that the experience resembled a video game or "*cartoon world*" and required wilful suspension of disbelief, but with a consensus that of high psychological immersion: "*because the world is so detailed and quite realistic it wasn't hard to forget where I am in reality at all,*" "*It felt like we were all in the same space.*" Presence was greatly enhanced by interactivity: "*Being able to interact with things in the world made it easier to feel present.*" Experiences which broke the sense of presence included technical glitches ("*I only felt lack of presence when connection became unstable*"), violated physics (e.g., if a body part is rendered incorrectly and suddenly disappears or appears in an incorrect location), and witnessing others move through teleportation ("*harder to pin people down because they can teleport*").

Motion sickness was not a major issue in the study. Across 10 sessions and 10 participants, there were 40% reporting "None or hardly any" motion sickness, 22% "Barely noticeable", 37% "Slight", and no reports of severe motion sickness. When experienced, motion sickness did interfere with participants' ability to stay engaged in the rehearsal and had to be resolved—something participants accomplished through taking breaks and drinking water. Named triggers of motion sickness included continuous first-person motion, sudden movements, and being fatigued.

4.4 Envisioned features

Participants made original and helpful suggestions for ways to make virtual environments better suited for rehearsals.

- **Displaying text.** A feature considered essential was the ability to upload text. Streaming of lines in the form of subtitles or a virtual prompter were seen as particularly helpful, but even bulk text appearing anywhere in the virtual space was considered a benefit.
- **Set design.** At a minimum, an empty rehearsal room would work well. Additional suggestions were: a) a database where theatres around the world upload virtual replicas of their stages; b) linking the software used for rehearsals to that used by set designers and be able to rehearse in the space as it is being modelled.
- **Library of props.** With the strong link between interactivity and engagement, participants expressed an interest in seeing a library of everyday objects (e.g., sofa, mirror) which can be accessed and added to virtual rehearsal spaces, e.g. through development packages such as Unity.
- **Director signalling.** Directors recounted the necessity to issue subtle social signals through which to provide feedback, potentially privately: "*some kind of indicator that could*

instantly tell everyone we're going to pause, have a quick chat and then carry on."
- **Control over facial expressions.** According to our participants, controlling expressions externally would not hinder acting: As concluded by Tanenbaum et al. the challenge lies in designing a control system which is intuitive and easy to access: "a lightweight facial puppeteering interface" [23].
- **On and off boarding.** Participants discussed the need to create more effective ways of entering VR. Onboarding designed to enhance embodiment; offboarding to help mitigate adverse experiences (harassment, motion sickness).

5 DISCUSSION

A key insight from our work is that Social VR, at the fidelity and features rate of current applications, can support effective interpersonal interactions, vastly outperforming video conferencing in the context of remote theatre rehearsals. As experienced students in a leading drama school, our participants can be considered experts in social interaction. That they accomplished successful VR rehearsals, shows not only that there is an immediate use case for Social VR in theatre, but also that the functionality of current, affordable technology, can support psychologically effective interactions. While there is no doubt that advanced technology, such as full-body motion tracking and mixed-reality environments will lead to even better interaction, our research provides a clear justification for research and development within the spectrum of basic, off-the-shelf Social VR.

The present research offers the novel and surprising insight that successful rehearsing of spatial arrangements, known as blocking, and gesturing might not require on-the-horizon developments such as haptics, facial and full body tracking used in prior studies [3, 15, 19, 21]. This finding is of major practical significance: Theatres which may have not been able to prioritise investing in cutting-edge bespoke technology, may consider affordable solutions akin to the ones used in the present research. Further research would be required to identify solutions with good usability and develop clear guidelines. Our expert participants provided original and valuable observations about what would enhance their experience of Social VR and provide increased utility.

Of the few studies reviewing Social VR features [8, 23] and evaluating them with users [12–14, 17, 18], none has attempted social interaction as complex and challenging as a theatre rehearsal, with authors specifically calling for testing interactions in more challenging contexts. Theatre rehearsals constitute a conservative test of the Social VR medium and theatre professionals are a valuable user group.

The present research led to the formulation of practical design recommendations for Social VR. Visual design, especially that of avatars, is a long standing problem. Our participants offered two novel and promising directions. Avatars design can be informed by the neutral masks of theatre pedagogue Jacques Lecoq [24, 25]. Albeit not as direct, the analogy between VR acting and immersive audio dramas may serve as an inspiration for the visual design of spaces—darker, minimal features may naturally draw away from missing visual cues and towards auditory ones.

Having the unique opportunity to work with a sample of participants who are leaders in their field, we adopted a less prescriptive research design, allowing participants to make creative decisions on how to incorporate the VR technology into their process. This flexibility posed certain limitations. A stricter experimental design comparing different media or types of acting (dialogue vs. combat) would be necessary to further understand the role of VR in theatre making.

Social VR, and especially its intersection with the creative sector, is an emerging and vastly exciting area of research. Key outstanding questions concern specific design features (e.g., visual design and basic interactivity) and as such would be particularly well suited for rapid prototyping and experimentation (A/B testing). Academics and creative practitioners would greatly benefit from a platform where key features can be easily customised. Identifying an appropriate existing platform or developing one from scratch is an important direction of future research.

6 CONCLUSION

Social VR offers a new and enhanced way to connect remotely. The spatial, embodied social co-presence afforded by the technology led to stronger emotional connection. We observed this in the context of theatre rehearsals, where VR technology helped actors and directors achieve richness of interaction beyond what would be possible through video conferencing. We also saw that at least some of the factors that hinder social interaction are solvable by design. These findings lead us to conclude that theatre production would benefit from adopting VR, as would other domains of interpersonal interaction. Importantly, we discussed feasible design features, which are likely to improve interactions even further. An especially valuable next stage would be the development of a simple, customizable social VR platform to allow for rapid prototyping and research into the elements of social interaction.

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APPENDIX

A QUESTIONNAIRE ITEMS

- Did you experience any motion sickness in the VR environment [Yes, intense; Yes, slight; Perhaps, barely noticeable; None or hardly any]
- If you experienced motion sickness, please tell us more about it: How severe was it and how did you handle it? How did it affect your rehearsal? Anything else
- Based on your expectations / objectives, How successful was today's rehearsal? [Not at all, Somewhat, Mostly, Entirely, Other. Please clarify]

- Did the VR technology hinder you or the session? In what way?
- Did the VR technology benefit you or the session? In what way?
- What avatar did you use today? Was there any particular reason?
- When you interacted with someone, were you affected by their avatar? How?
- Were you affected by your own avatar? Were you aware of what you look like to others?
- The next question is about your experience of Presence / Immersion (when you were in the virtual world, feeling that the virtual world is real and you are in it, losing track of

time and your physical surroundings). To what extent did you feel present / immersed during the rehearsal? [Not at all; Hardly; No idea; Mostly; Fully]
- Feel free to clarify or share any thoughts on presence / immersion
- The next question is about the experience of Co-presence (when interacting with the others feeling like you are interacting with real people; like they are in the same physical space with you). To what extend did you feel the others were real / present? [Not at all; Hardly; No idea; Mostly; Fully]
- Feel free to clarify or share any thoughts on co-presence
- Demographics: Age, Gender, Year of study, prior experience with technology (VR, technology in general, gaming)