Designing Multiuser VR Rehabilitation Games: Balancing Semi-Structured Play and Clinical Structure for Engagement and Care Support

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Abstract

Virtual reality (VR) can increase motivation and access in stroke rehabilitation, but designers must balance engaging play with clinically meaningful activity. We present En-ACT, a multiuser VR system for Meta Quest headsets combining semi-structured social play, structured assessment-style tasks, and an AI-supported virtual physiotherapy assistant. We report an early Patient and Public Involvement (PPI) evaluation with six health professional lecturers and a consultation with two NHS occupational therapists. Feedback was strongly positive: participants highlighted the motivational benefits of playful shared activities, the clinical relevance of structured tasks such as a virtual Box and Block Test, and the potential of multiuser VR to reduce isolation and support remote care. We argue that future platforms should treat social presence, adaptable game mechanics, and measurable therapeutic tasks as complementary rather than competing goals, with the multiuser layer acting as "social glue".

1. Introduction

Stroke is a leading cause of long-term disability, and many survivors require sustained upper-limb rehabilitation to recover functional movement [Langhorne et al., 2011]. Conventional therapy can be effective, but access is often constrained by transport, staffing, geography, and the challenge of maintaining motivation across long recovery periods. VR has been widely explored as an adjunct to rehabilitation because it can provide repetitive practice inside motivating environments and support home-based delivery [Soleimani et al., 2024]. Yet a persistent design problem remains: highly gameful systems may improve adherence while offering limited clinical structure, whereas assessment-driven systems can be clinically useful but less engaging over time.

This paper addresses that tension through EnACT (Enhanced Active Therapy), a multiuser VR platform built on three linked ideas: playful activities that make repeated movement feel social and rewarding, structured tasks that resemble established assessments and let progression be observed, and multiuser interaction that may reduce isolation while supporting encouragement, shared attention, and remote supervision [Charles et al., 2020]. It asks how health professionals view semi-structured versus structured VR tasks, what value they place on multiuser interaction, and how such a system fits within rehabilitation practice.

Multiuser and collaborative VR for rehabilitation is an active area: recent systems bring clinician-supervised therapy into stroke survivors' homes [Thielbar et al., 2020] and use collaborative serious games to raise motivation and social interaction [Oliveira et al., 2025]. EnACT's contribution is integrative rather than a single new technique. To our knowledge it is the first platform to combine genuinely multiuser sessions, controller-free hand tracking, both semi-structured play and validated clinical assessment, and a bounded conversational assistant within one standalone system.

2. Enact system

EnACT was developed in Unity (Netcode for GameObjects) for standalone Meta Quest hardware. It supports up to four users in a shared session, typically one clinician and up to three patients, allowing supervised home use or small-group activity. A core decision was to use hand tracking rather than handheld controllers, lowering barriers for users with limited grip strength while making manipulation feel closer to everyday reaching and grasping. The experience spans four spaces: a lobby for orientation and avatar customisation, a living room for social tabletop activities, a physio gym for therapeutic and assessment-style tasks, and a meditation scene for relaxation.

Activities fall into two complementary categories. Semi-structured play foregrounds engagement: in "Rob the Nest", a competitive game, players collect objects from a shared central area into personal containers, encouraging repeated reaching and transfer; other social activities include cooperative tasks, shared drawing with virtual pens, and joint video viewing. These support repetition without making the experience feel overtly clinical.

Structured clinical tasks provide a clearer therapeutic rationale: a virtual Box and Block Test based on the standardised dexterity assessment [Mathiowetz et al., 1985], plus arm range-of-movement and guided grab-and-place exercises with adjustable demands. These support progression, comparability across sessions, and future therapist-facing analytics.

The platform also includes Emma, an AI-supported virtual physiotherapist that explains activities, answers simple rehabilitation questions, and directs users to appropriate exercises. In the prototype it is a conversational guide rather than an autonomous clinical decision-maker, supporting confidence and adherence while keeping the therapist central, in line with emerging conversational agents for stroke rehabilitation that leave clinical decisions to therapists [Retevoi et al., 2024].

3. PPI study

3.1. Method

An initial PPI session was held with six health professional lecturers from Ulster University (physiotherapy, exercise physiology, radiotherapy, and therapeutic radiography). The aim was not to measure patient outcomes but to gather informed feedback on whether the concept, tasks, and interaction model appeared credible and useful from a professional perspective. The session comprised an introduction and tutorial, a demonstration of the AI assistant, a multiplayer VR experience across the environments, and a facilitated group discussion; five participants later completed an online questionnaire.

The questionnaire captured overall impressions of VR for rehabilitation, ratings of the environments, appraisals of individual activities, perceived impact on motivation and home use, and open-ended comments. Given the formative aim and small sample, closed responses were summarised descriptively as counts and percentages (the sample size precluded inferential testing), and discussion notes and open comments were examined thematically to identify recurring topics. This PPI approach was chosen because early stakeholder feedback can shape later design decisions and help identify adoption barriers before larger trials. As an involvement activity rather than a study of human participants, the work did not require formal research ethics approval, consistent with national PPI guidance. A follow-up consultation was conducted in February 2026 with two occupational therapists working in NHS stroke services, who experienced the updated platform and completed a structured feedback questionnaire.

3.2. Findings

Overall responses were strongly positive. Five of six participants rated both VR for rehabilitation and the multiuser approach very positively. The living room was the strongest performer for engagement and perceived effectiveness and the physio gym for appropriateness and therapeutic focus; no environment was rated below the scale midpoint.

Table 1 summarises the main quantitative signals, which support both sides of the design strategy. structured tasks were consistently rated beneficial and usable within rehabilitation plans, while playful, social activities also scored highly for enjoyment, adherence, and confidence.

Measure	**Result**
Overall impression of VR rehabilitation	83% very positive
View that multiuser VR could enhance rehab	83% very positive
Grab-and-place and virtual Box and Block tasks	100% positive on understanding, benefit, and plan use
Rob the Nest game	92% easy to understand, 83% beneficial, 92% usable in plan
Agreement that VR could improve motivation	80% highest agreement
Agreement that patients could benefit from home use	60% highest agreement

Table 1: Selected findings from the PPI evaluation.

The discussion data added nuance. Participants repeatedly described the multiuser element as "social glue" supporting motivation and emotional wellbeing as well as exercise, valued remote shared activity for those isolated between appointments or unable to travel, and welcomed hand tracking for lowering barriers for users who struggle with controllers.

Participants also flagged practical considerations: visual correction, headset comfort, independent donning of hardware, and the need for playful tasks to connect clearly to therapeutic purpose. The occupational therapy consultation reinforced the findings: both therapists rated all activities 5/5 for appropriateness, classified the system as a therapy tool, and called the multiuser capability a "game changer" for supporting multiple patients remotely, also identifying applications in perceptual deficits and cognitive sequencing.

4. Discussion

Across both stages, the findings suggest that semi-structured play and structured clinical tasks are complementary rather than competing design modes. Playful activities create the conditions for sustained engagement, being social, less intimidating, and more likely to make repeated movement feel worthwhile; structured tasks contribute legitimacy, measurability, and alignment with therapist expectations.

Our central proposition is that multiuser VR can act as "social glue" for rehabilitation: connective tissue that links patient to peer (belonging and reduced isolation), patient to clinician (remote supervision and continuity between appointments), and patient to programme (sustained engagement across a long recovery). This extends prior work on gamified rehabilitation and social presence in virtual environments [Sánchez-Gil et al., 2025, Oh et al., 2018]. The benefit may reach the therapy itself, not only the experience of it: multiuser stroke training has yielded longer sessions and greater arm movement than solo practice [Thielbar et al., 2020]. The social and clinical goals are thus mutually reinforcing, the social glue sustaining participation long enough for the structured, measurable tasks to do their work.

The prototype AI assistant was received positively, but its future role should remain carefully bounded: most useful as an interface aid that explains, prompts, and encourages rather than a replacement for clinical judgement.

The initial PPI is limited by its small, non-probability sample and by participants being health professional educators rather than stroke survivors; the occupational therapy consultation partly mitigates this but remains small in scale. Exposure was brief and the findings perceptual, with no behavioural or clinical outcomes measured, so they should be read as early-stage design guidance rather than evidence of efficacy. Deliberately, this is the first stage of a staged, user-centred process: next steps are co-design with stroke survivors, patient-facing feasibility studies, and longer deployments capturing the data the system already records (Box and Block Test levels, arm range of movement, session adherence) alongside therapist dashboards linking in-world activity to progress indicators.

5. Conclusion

EnACT shows how a multiuser VR platform can combine social play, structured therapeutic activity, and lightweight AI support in one coherent experience, an approach that early PPI feedback and the occupational therapy consultation suggest is promising. We argue that the multiuser dimension acts as "social glue" linking patient, peers, and clinician, and that this is what holds engagement and clinical structure together. VR rehabilitation need not force a choice between the two; instead, social, playful interaction can sustain participation while embedding tasks that therapists can interpret, adapt, and trust.

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