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Objective

Several studies have indicated VR cognitive training improves the cognitive function of patients with stroke, and many of them focused on its clinical efficacy. However, in the actual clinical setting, when attempting VR cognitive training with patients with cognitive impairments, many of them cannot engage effectively in training and struggle with digital literacy. Few studies have quantitatively evaluated usability and virtual reality sickness. Therefore, we aimed to quantitatively evaluate the usability and sickness associated with virtual reality cognitive training and identify factors influencing them.

Methods

This study enrolled 30 participants, including 20 rehabilitation professionals (five physiatrists and 15 occupational therapists) and 10 patients with stroke. Two physiatrists (HS Kim and MH Bang) with over 10 years of clinical experience drew inspiration from existing computer cognitive training and developed five cognitive training contents focusing on memory, attention, executive function, and visuospatial function (Figure 1). The participants wore a Head-Mounted Display (Meta Quest2) and consecutively underwent five cognitive training for more than 30 min. After the training, participants completed three questionnaires: the Systemic Usability Scale (SUS), User Experience Questionnaire (UEQ), and CyberSickness in Virtual Reality Questionnaire (CSO-VR).

Results

The mean age (standard deviation [SD]) of the rehabilitation professionals and patients was 30.0 (4.8) years and 64.1 (13.6) years, respectively. Among the 20 rehabilitation professionals, six (30.0%) had experienced VR before the study, whereas 14 (70.0%) had no experience. None of the patients had prior experience with VR. The mean SUS score (SD) for rehabilitation professionals was 55.1 (16.2), and for patients, it was 52.3 (19.2). Although the patient’s mean score was slightly lower than that of rehabilitation professionals, the difference was not statistically significant (Table 1.). The UEQ scores for rehabilitation professionals and patients did not show statistically significant differences in each item, there was a slightly higher score for patients in novelty. In contrast, rehabilitation professionals had slightly higher scores in the other items. The mean CSQ-VR score (SD), which assesses the degree of VR sickness, was 18.6 (7.8) for rehabilitation professionals and 19 (12.9) for the patients. We compared the subgroup of rehabilitation professionals who had prior VR experience (N=6) with those who had no prior experience (N=14) to examine if there were differences in each item. There was no statistically significant difference between the two groups in SUS, EUQ and CSQ-VR scores (Table 2).

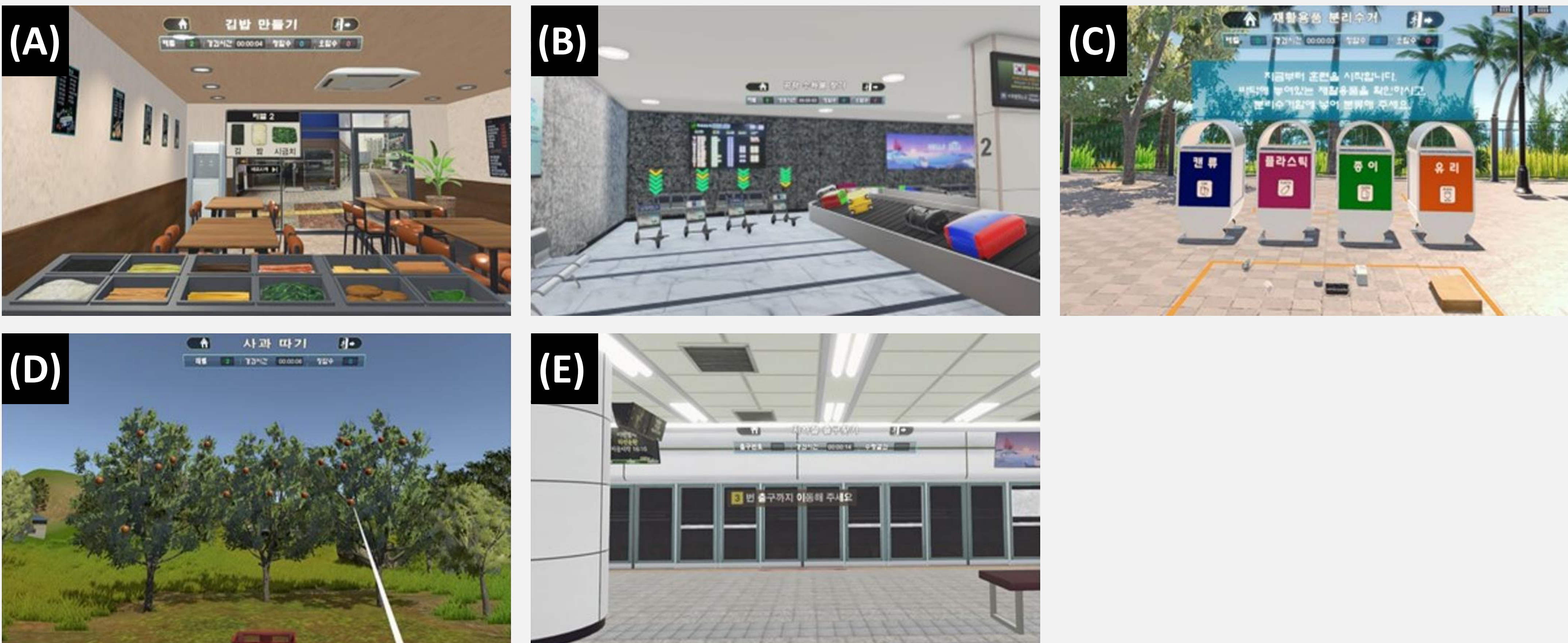


Figure 1. Representative scenes for the five cognitive training. (A) Making Gimbap (B) Finding luggage (C) Sorting recyclables (D) Picking red apples (E) Finding subway exit

Table 1. Comparison of Scores Between Rehabilitation Professionals and Patients

Scale	Subscale	Rehabilitation Professionals (N=20)	Patients (N=10)	P-value
SUS		55.1(16.2)	52.3(19.2)	0.914
UEQ	Attractiveness	0.9(1.3)	0.2(1.7)	0.350
	Perspicuity	0.6(1.4)	0.2(2.1)	0.983
	Efficiency	0.5(1.1)	-0.5(1.8)	0.169
	Dependability	1.2(1.3)	0.8(1.6)	0.650
	Stimulation	0.9(1.1)	0.4(1.9)	0.619
CSQ	Novelty	0.6(1.1)	0.8(1.4)	0.914
	Nausea	7.2(3.2)	7.2(4.3)	0.948
	Vestibular	4.8(2.8)	6.4(4.7)	0.559
	Oculomotor	6.7(3.2)	5.4(4.8)	0.198
	Total	18.6(7.8)	19(12.9)	0.713

Abbreviations : SUS; System Usability Scale, UEQ; User Experience Questionnaire, CSQ-VR; CyberSickness in Virtual Reality

Table 2. Comparison of Scores Based on Rehabilitation Professionals’ Virtual Reality Experience

Scale	Subscale	VR experience		P-value
		Yes (N=6)	No (N=14)	
SUS		57.9(13.2)	53.9(17.6)	0.718
UEQ	Attractiveness	1.2(1.1)	0.7(1.3)	0.602
	Perspicuity	0.2(0.9)	0.7(1.5)	0.494
	Efficiency	0.3(1.3)	0.6(1.1)	0.841
	Dependability	1.0(1.4)	1.3(1.2)	0.718
	Stimulation	0.8(1.5)	0.9(1.0)	0.602
CSQ	Novelty	0.8(1.4)	0.5(1.0)	0.547
	Nausea	5.3(2.2)	7.9(3.4)	0.109
	Vestibular	4.5(2.5)	4.9(3.0)	0.904
	Oculomotor	5.7(2.6)	7.1(3.4)	0.353
	Total	15.5(5.5)	19.9(8.4)	0.353

Abbreviations : SUS; System Usability Scale, UEQ; User Experience Questionnaire, CSQ-VR; CyberSickness in Virtual Reality

Conclusion

This study developed five new cognitive training programs using VR technology and quantitatively evaluated usability, user experience, and the degree of VR sickness through surveys. Both rehabilitation professionals and patients reported moderate usability and poor user experience, as well as average or below levels of VR sickness. Usability was higher in the rehabilitation professional group than in the patient group, whereas VR sickness was more severe in the patient group. For patients, older age often leads to lower digital literacy, resulting in reported lower usability. Moreover, patients have physical disabilities and experience VR for the first time, which may lead to reported severe sickness. These findings could be essential references for developing cognitive training using VR technology and applying it to patients in the future.