PP-462

Reliability and Validity of Virtual Box & Block Test in Healthy Adults and Patients with Stroke

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Purpose

✓ The study aimed to investigate reliability and validity of the virtual reality Box & Block Test (VR BBT) in healthy adults and patients with stroke.

Methods

Participants

Patients with stroke

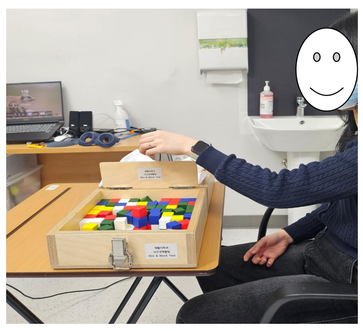
- **Inclusion Criteria**
  - Adults aged 19 years or older
  - Patients diagnosed with ischemic or hemorrhagic stroke
  - Patients capable of maintaining stable sitting posture
- **Exclusion Criteria**
  - Severe cognitive impairment (MMSE-K ≤10)
  - Upper extremity impairment caused by conditions other than stroke
  - History of severe dizziness or uncontrolled epilepsy

Healthy adults

- **Inclusion Criteria**
  - Adults aged 19 years or older
  - Individuals who voluntarily agree to participate in the study
- **Exclusion Criteria**
  - Individuals with neurological or orthopedic disorders affecting upper extremity motor function
  - Individuals with any other comorbidities deemed by the researcher to hinder participation in the study

Assessments

BBT



&

VR BBT





(HTC Vive Pro 2)

- Participants performed each of the three test versions in a **randomized order**.
- Each hand was tested twice for each test condition.

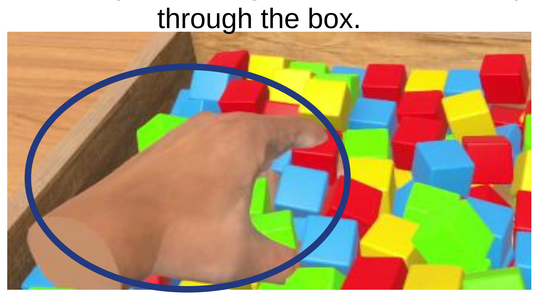
Physical interaction

Virtual objects (hand and blocks) follow the laws of real-world physics.



No physical interaction

The virtual hand does not physically interact with blocks; it can pass through blocks but cannot pass through the box.



Results

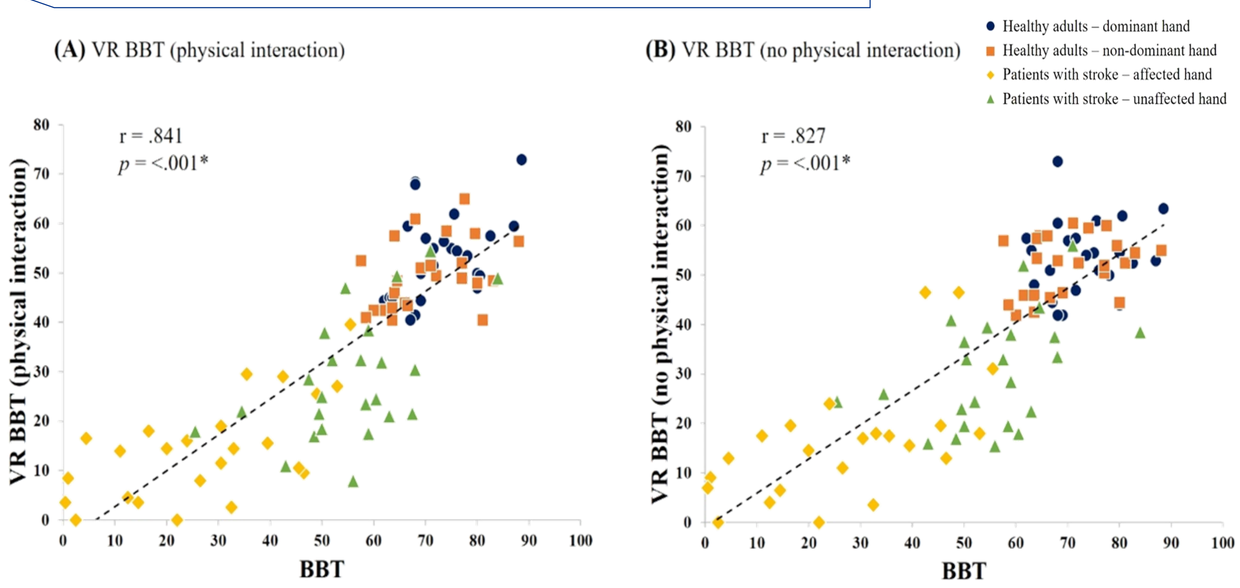
- **Characteristics of participants (N=48)**

	Patient with stroke (n=24)	Healthy adults (n=24)
Male/female (n)	9/15	16/8
Age (yr)	55.63 ± 14.10	43.75 ± 8.29
Disease duration (mo)	64.95 ± 77.21	-
Mini-mental state examination - Korean	27.63 ± 3.63	-
Fugl-Meyer Assessment – upper extremity	47.25 ± 10.97	-
Type of lesion (ischemic/hemorrhagic)	10/14	-
Side of lesion (right/left)	13/11	-

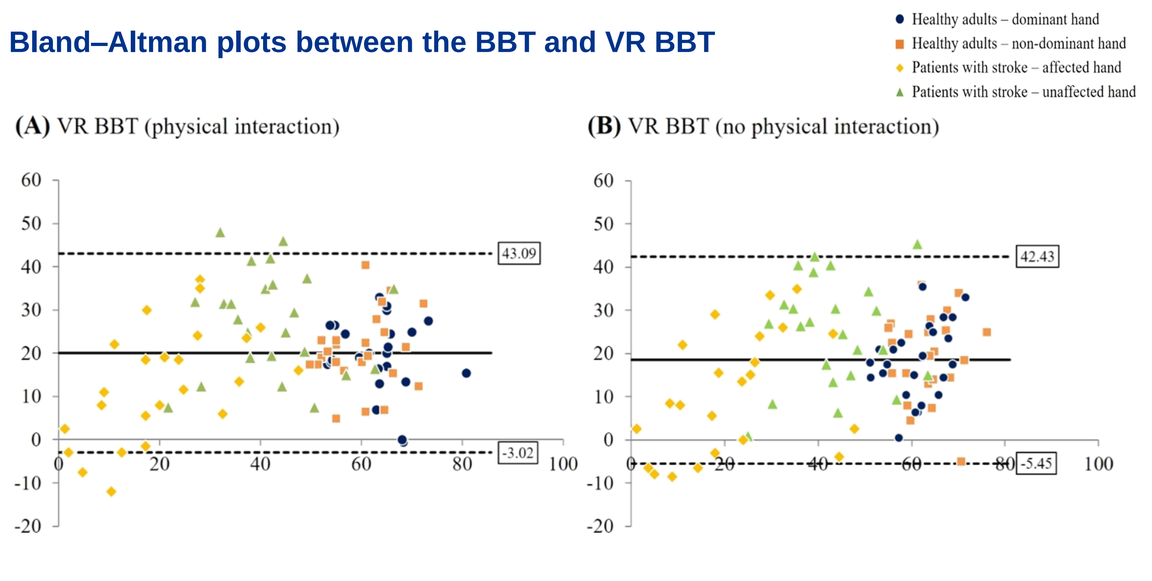
- **Performance on BBT and VR BBT (N=48)**

			Patient with stroke (n=24)	Healthy adults (n=24)
Box & Block Test		**Unaffected; dominant hand**	55.65 ± 12.04 [range: 25.5 – 84.0]	73.06 ± 7.33 [range: 62.0 – 88.5]
		Affected; non-dominant hand	27.04 ± 16.88 [range: 0.0 – 55.5]	70.27 ± 8.49 [range: 57.5 – 88.0]
Virtual reality Box & Block test	**Physical interaction**	**Unaffected; dominant hand**	28.40 ± 12.44 [range: 8.0 - 54.5]	53.69 ± 8.62 [range: 40.5 – 73.0]
		Affected; non-dominant hand	14.19 ± 10.24 [range: 0.0 - 39.5]	49.60 ± 6.97 [range: 40.5- 65.0]
	No physical interaction	**Unaffected; dominant hand**	30.69 ± 11.29 [range: 15.5 – 56.0]	53.21 ± 7.72 [range: 42.0 – 73.0]
		Affected; non-dominant hand	16.21 ± 11.92 [range: 0.0 – 46.5]	51.96 ± 5.94 [range: 42.0 – 60.5]

Correlation between BBT and VR BBT



- **Bland–Altman plots between the BBT and VR BBT**



Movement parameters from the VR BBT in patients with stroke

	Physical interaction				No physical interaction				
	Unaffected side	Affected side	p	r with FMA-UE	p	Unaffected side	Affected side	p	r with FMA-UE	p
Distance (m)	0.19983 ± 0.06115	0.21571 ± 0.07084	.055	-.382	.079	0.20057 ± 0.05241	0.22693 ± 0.06689	**.033***	-.466	**.029***
Distance-max (m)	0.41455 ± 0.07610	0.39256 ± 0.06219	.733	-.477	**.025***	0.33806 ± 0.08241	0.37776 ± 0.11077	.120	-.438	**.041***
Speed (m/s)	0.27149 ± 0.14132	0.18386 ± 0.08880	**<.001***	.487	**.022***	0.28164 ± 0.08194	0.21256 ± 0.07665	**<.001***	.454	**.034***
Acceleration magnitude (m/s²)	0.16698 ± 1.51791	0.13310 ± 0.83288	.300	.193	.390	0.14609 ± 0.08632	0.13155 ± 0.08664	.578	.319	.148

Reliability and validity of BBT and VR BBT

✓ Test-retest reliability: The VR BBT demonstrated excellent test-retest reliability, comparable to the BBT, with ICCs of .940 and .943 for the physical and non-physical interaction versions, respectively.

✓ Concurrent validity: In patients with stroke, both VR BBT versions showed significant concurrent validity with the FMA-UE (r = .657–.878, p < .001), supporting their clinical applicability.

Conclusion

✓ The VR BBT demonstrated strong reliability and validity despite differences in performance counts compared to BBT.

✓ In patients with stroke, the affected hand showed greater movement distance but lower speed, indicating inefficient motor control. These parameters were significantly associated with FMA-UE, suggesting their potential as objective markers of upper limb motor impairment.

✓ These findings suggest that the VR-BBT could serve as a complementary tool for motor function assessment, with potential applications in tele-rehabilitation and virtual reality-based rehabilitation.

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