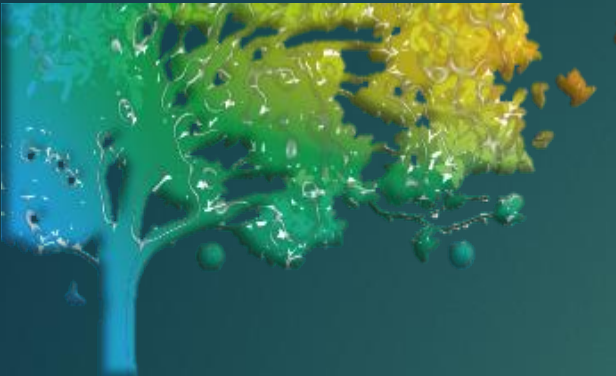




Cognitive Rehabilitation Devices in Ischemic Stroke Therapy

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Tabriz, Iran



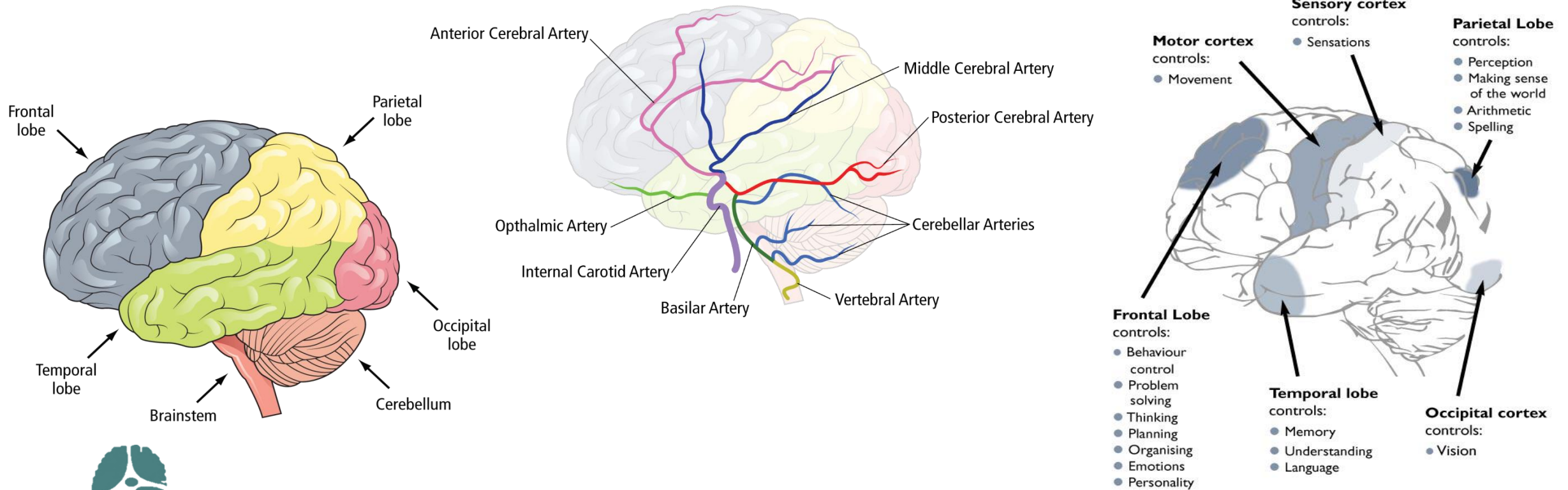
Neurosciences Research Center
Tabriz University of Medical Sciences

2022

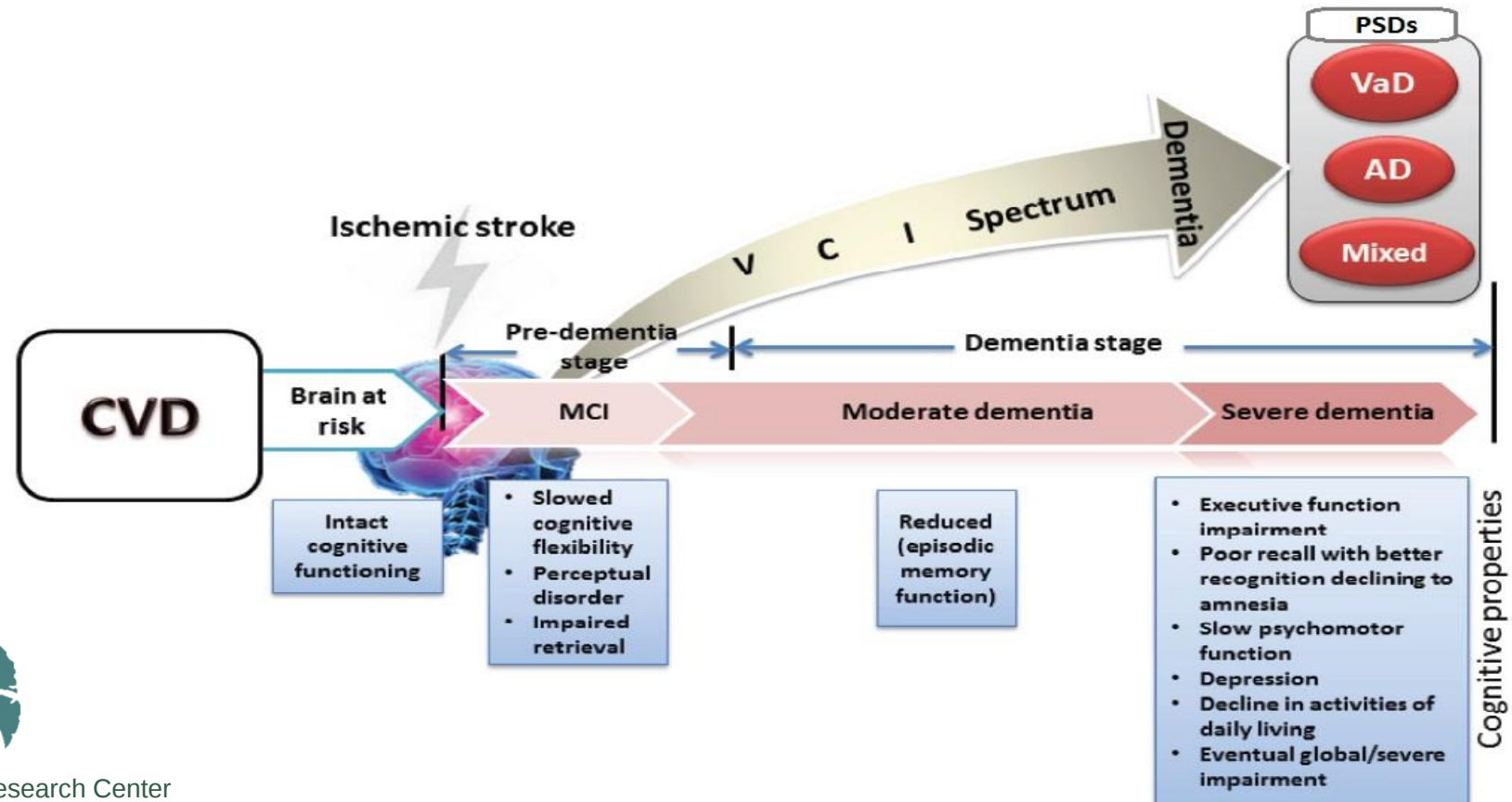
Stroke



Brain Anatomy & Cognitive Impairments



Vascular Cognitive Impairment Progress

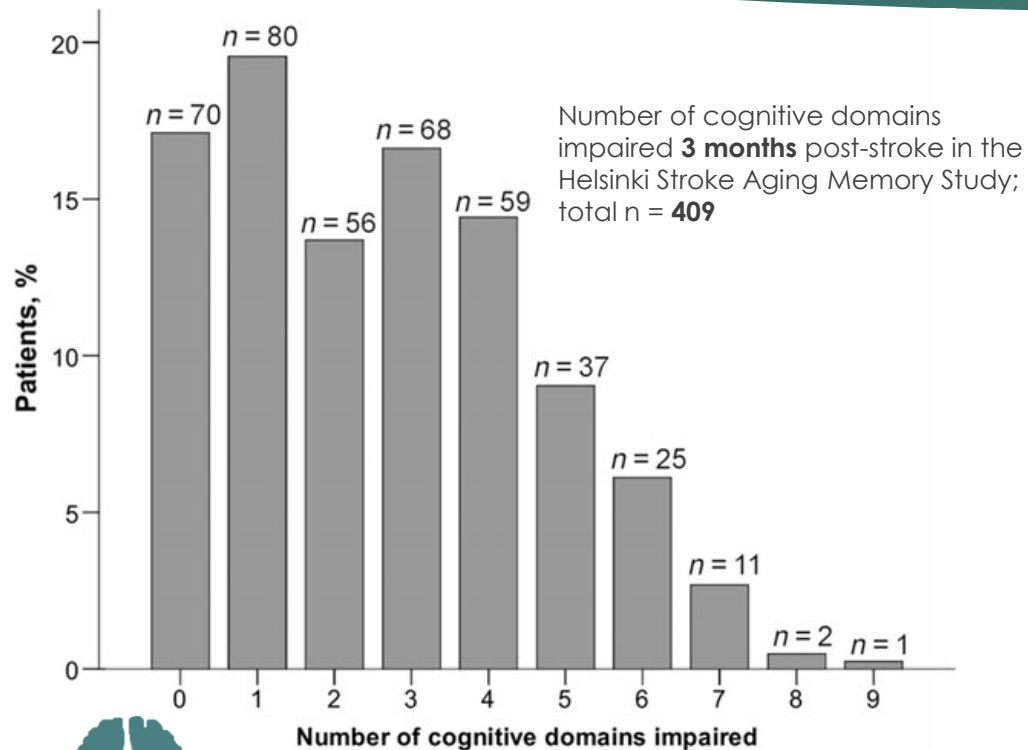


Stroke & Cognitive Impairments

- ✦ Up to **two-thirds** of stroke survivors have a **cognitive deficit** after the stroke.
- ✦ Approximately **one-third** of those develop **dementia**.
- ✦ Only **16 to 20%** of stroke survivors with **cognitive impairment** improve.



Cognitive Impairment Rate



Post-stroke cognitive impairment is common even after successful clinical recovery, European journal of neurology, 2015, al., Jokinen, et.

Cognitive domain	n (%)	
	All patients n = 409	Patients with mRS = 0-1 n = 152
Memory functions	227 (60)	77 (52)
Visuoconstructional and spatial functions	216 (55)	54 (36)
Executive functions and attention	181 (49)	52 (34)
Aphasia	114 (29)	23 (15)
Reading and writing	112 (30)	16 (11)
Abstract reasoning	106 (29)	26 (17)
Arithmetic	71 (20)	12 (8)
Neglect	29 (8)	2 (1)
Agnosia	13 (3)	1 (1)

Frequencies of impairment in each cognitive domain in the whole cohort and in a subgroup of patients with **excellent clinical recovery (mRS = 0-1)** 3 months after ischemic stroke in the Helsinki Stroke Aging Memory Study

The Nature of Cognitive Impairment Post Stroke

Attention	• Focus attention, sustained attention, selective attention, divided attention
Memory	• Visual memory, auditory memory, working memory, episodic memory, semantic memory, working memory, procedural memory
Executive Function	• Initiation, processing speed, problem solving, planning
Perception, praxis	• Visuo-spatial, visuo-perceptual, Unilateral neglect, inattention, apraxia, agnosia, prosopagnosia
Language	• Aphasia: Broca's, Wernicke's, transcortical motor/sensory or mixed, conductive, global





Assessment of Cognitive Impairment Post Stroke

- **Mini-Mental Screening Evaluation (MMSE):** attention, calculation, recall, language, ability to follow simple commands, orientation
- **Montreal Cognitive Assessment (MoCA)**
- **Clock-Drawing Test (CDT):** visuospatial, praxis, attention
- **Addenbrooke's cognitive examination (ACE-R):** attention, memory, verbal fluency, language and visual- spatial orientation.
- **Stroke Impact Scale (SIS):** hand function, memory, emotion, mobility, communication and social participation.
- **Domain-Specific Neuropsychological Tests**
- **CANTAB**



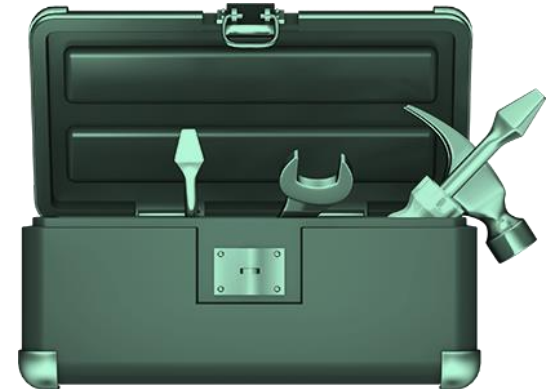
Cognitive rehabilitation interventions aims

1. Reinforce, strengthen or **re-establish previously learned patterns of behavior.**
2. Establish new patterns of cognitive activity through **internal compensatory cognitive mechanisms** for impaired neurological systems.
3. Establish new patterns of activity through **external compensatory mechanism** such as external aids, or environmental structuring and support.
4. **Enable persons to adapt** to their cognitive disability.



Rehabilitation toolbox

- **Pharmacological agents** → **Medical intervention**
 - **Paper and pencil tools** → **Traditional tools**
 - **Mental Imagery**
 - **Software and games**
 - **Virtual reality**
 - **Repetitive transcranial magnetic stimulation (rTMS)**
 - **Transcranial direct-current stimulation (tDCS)**
 - **Neurofeedback**
 - **Acupuncture**
- **Novel tools**



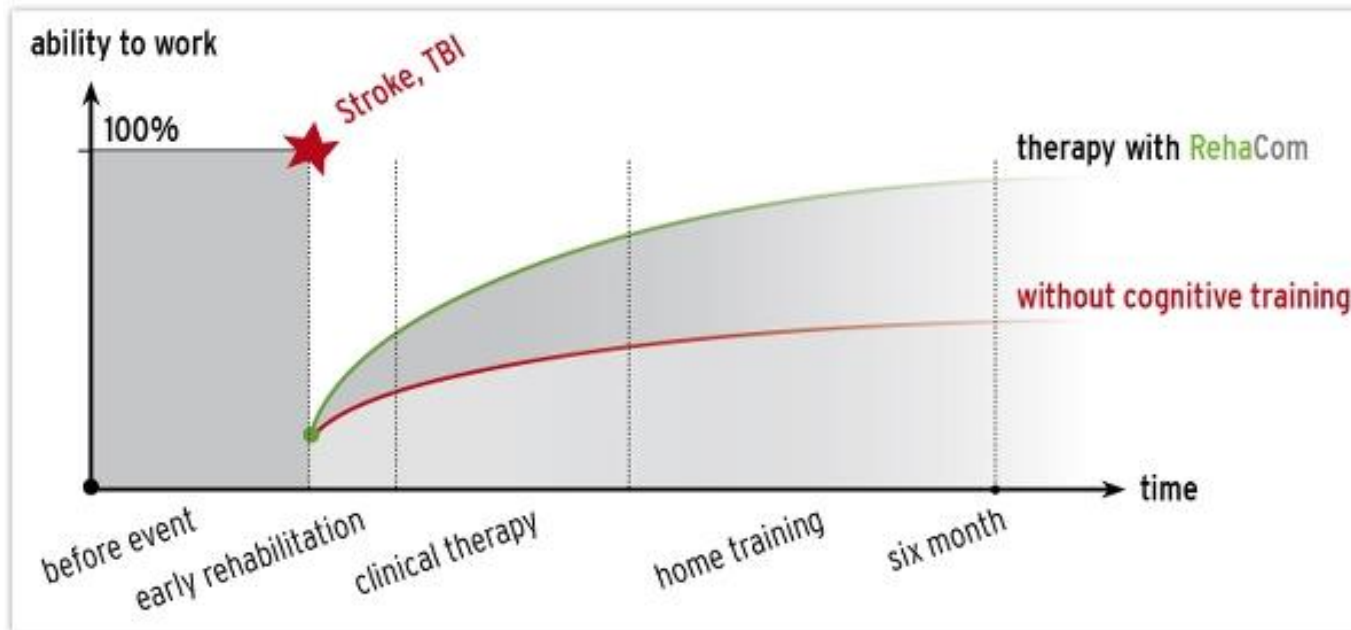
Software and games



Commercial approved and available Software



Software and games



Commercial approved and available Software



Software and games

- Problem-solving
- Working memory
- Divided attention
- Flexibility



Commercial approved and available Software



Software and games

Targeting the specific areas of attention

A promotional banner for SMARTMIND 3. The left side has a dark blue background with white text. The right side features a stylized illustration of a human head in profile, filled with a glowing blue brain, surrounded by a network of white dots and lines, with several white plus signs floating around it.

SMARTMIND 3™

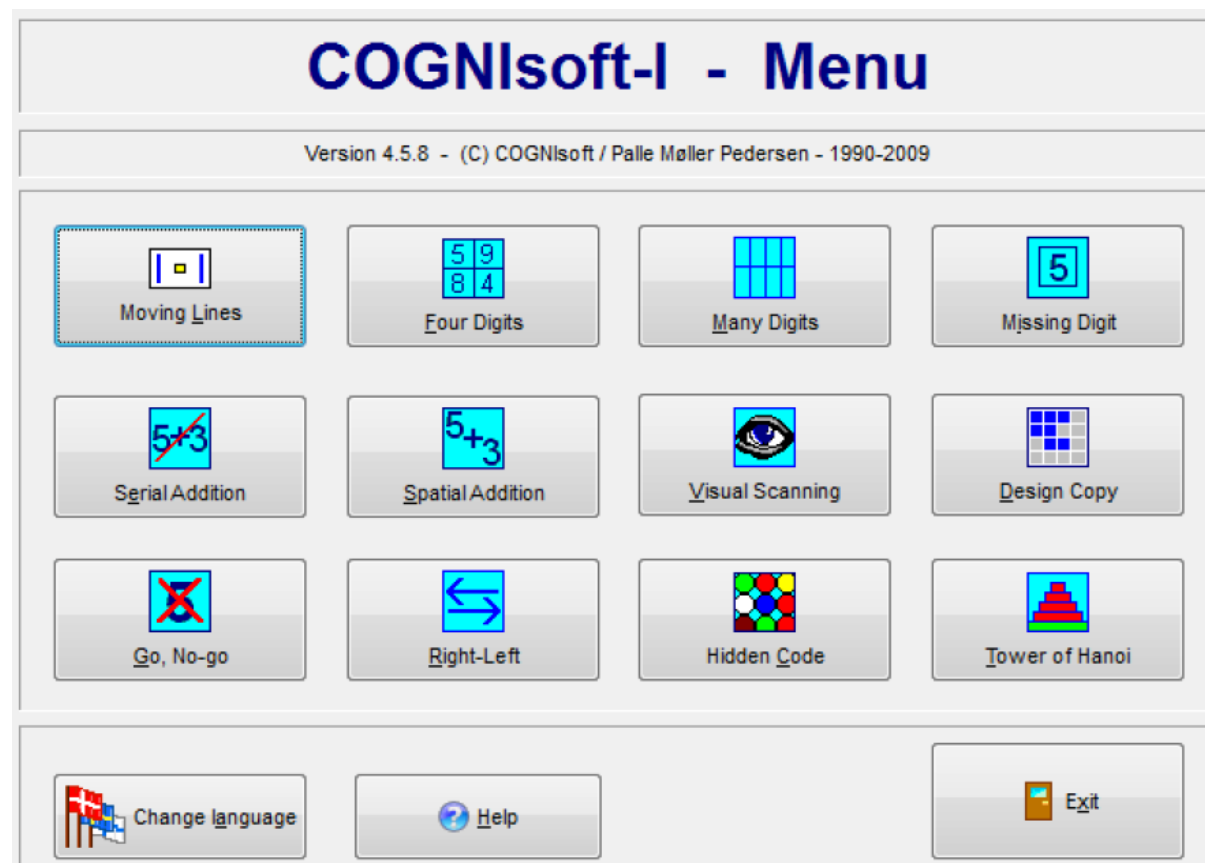
Artifact-free neurofeedback technology
EEG Biofeedback combined with Cognitive Training

[LEARN MORE](#)

Commercial approved and available Software



Software and games



**Study-dependent
designed software**



Software-based Cognitive Rehabilitation

Lin, Z., Tao, J., Gao, Y., Yin, D., Chen, A., and Chen, L. (2014). Analysis of central mechanism of cognitive training on cognitive impairment after stroke: Resting-state functional magnetic resonance imaging study. *J. Int. Med. Res.* 42, 659–668

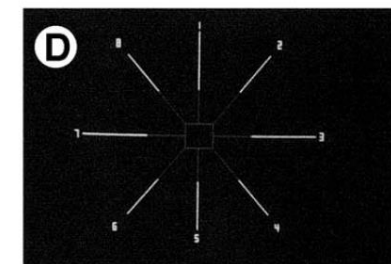
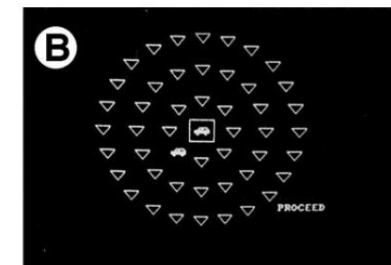
Lin et al., 2014	Stroke, post-acute (6–10 m) with EF and memory deficit	<i>N</i> = 34: IG = 16 pCG = 18	RehaCom software package (EF, memory)	1 h, 6 d/w, 10 w = 60 h (unkn.)	Rehab.?	WMS:		
						Information	–	–
						Orientation	–	–
						Mental control	–	+
						Logical memory	–	+
						Digits forward and backward	–	±
						Visual reprod.	–	+
						Assoc. learning	–	+
						Memory quotient	–	+



Software-based Cognitive Rehabilitation

Prokopenko, S. V., Mozheyko, E. Y., Petrova, M. M., Koryagina, T. D., Kaskaeva, D. S., Chernykh, T. V., et al. (2013). Correction of post-stroke cognitive impairments using computer programs. *J. Neurol. Sci.* 325, 148–153.

Prokopenko et al., 2013	Stroke, acute—post-acute (<2 w) with mild cognitive impairments to mild dementia	N = 43: IG = 24 CAU = 19	Neuropsychological computer training (sustained, selective, divided, and alternating att.)	30 min, 7 d/w, 2 w = 15 h (unkn.)	Rehab.	Schulte's tables	±	±
						Clock drawing	—	±
						MMSE	—	±
						MoCA	±	±

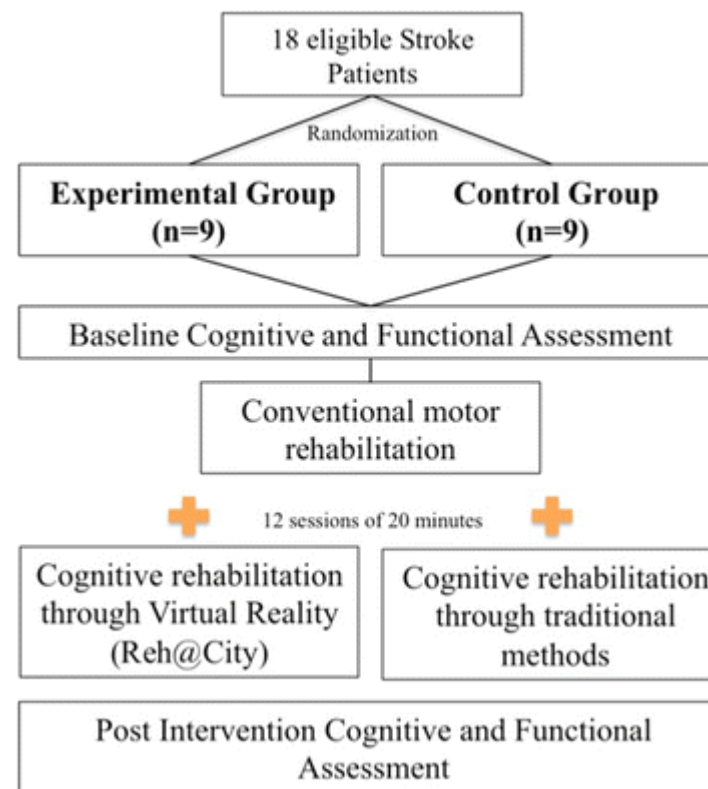


Virtual reality



Virtual reality-based Cognitive Rehabilitation

Faria, Andrade, Soares, Badia. Benefits of virtual reality based cognitive rehabilitation through simulated activities of daily living: a randomized controlled trial with stroke patients
Journal of Neuro Engineering and Rehabilitation (2016) 13:96



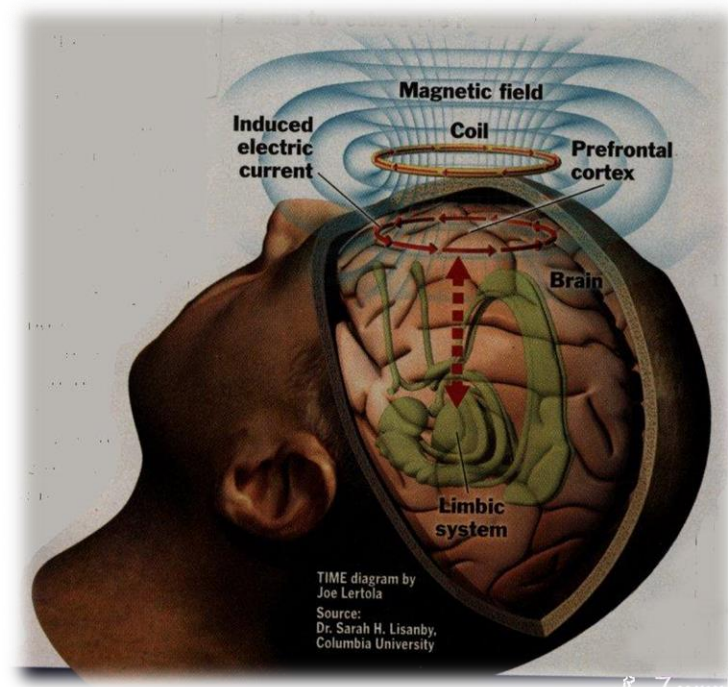
Virtual reality-based Cognitive Rehabilitation

	Experimental (n = 9)				Control (n = 9)					
	Pre	Post	W	p	Pre	Post	W	p	MW	p
ACE-Total	72 (61–75.5)	81 (68–86.5)	44.000	.011	66 (54.5–81)	69 (58–78)	24.000	.398	13.500	.014
MMSE	23 (20.5–26)	29 (25–29)	34.000	.025	23 (20.5–26)	26 (21–26.5)	28.500	.136	18.000	.050
ACE-Attention	15 (14–16.5)	18 (16.5–18)	28.000	.018	14 (12–16.5)	16 (12.5–17)	13.500	.518	17.500	.040
ACE-Memory	15 (13–18)	18 (15–21.5)	28.000	.017	18 (11–19.5)	18 (12.5–21)	11.000	.336	23.000	.136
ACE-Fluency	5 (2.5–6)	6 (4–7.5)	27.000	.196	6 (4–8)	5 (2.5–5.5)	2.500	.027	13.000	.014
ACE-Language	22 (21.5–23)	24 (21–26)	33.500	.191	19 (16–22)	21 (17–24.5)	22.000	.168	32.500	.489
ACE-Visuo-spatial	12 (7.5–14.5)	14 (13–15)	28.000	.017	12 (7.5–13.5)	14 (7–15.5)	16.000	.246	26.500	.222

p < .05 is indicated in bold



Repetitive transcranial magnetic stimulation (rTMS)



rTMS-based Cognitive Rehabilitation

Park and Yoon, The effect of computer-assisted cognitive rehabilitation and repetitive transcranial magnetic stimulation on cognitive function for stroke patients, 2015, J. Phys. Ther. Sci. 27: 773–776.

Material	Intervention	Before	After
		Mean±SD	Mean±SD
K-MMSE	rTMS (n=10)**	17.90 ± 2.470	19.50 ± 2.369
	Cogrehab (n=10)**	18.00 ± 1.886	20.30 ± 2.058



Transcranial direct-current stimulation (tDCS)



WIRED UP

In transcranial direct-current stimulation, electrodes placed on the scalp deliver low currents that can penetrate the skull and affect brain tissue. Differing effects have been documented, depending on the placement of the anode (+) and cathode (-).

MOTOR CONTROL

Anodal stimulation over the motor cortex on the side of the brain affected by stroke has been shown to improve movement for arms and hands.

- Up to 4 milliamps for as long as 20 minutes.

VISUAL PERCEPTION

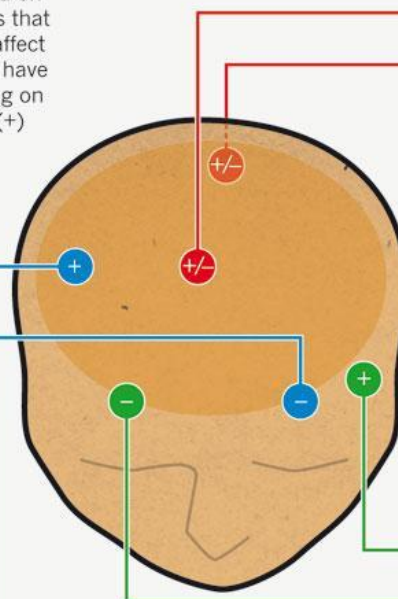
Alterations in visual perception have been noted under both cathodal and anodal stimulation of the occipital lobes.

- Up to 2 milliamps for as long as 15 minutes.

WORKING MEMORY

Anodal stimulation of the dorsolateral prefrontal cortex has been associated with improved working memory and verbal fluency.

- Up to 2 milliamps for as long as 20 minutes.





tDCS-based Cognitive Rehabilitation

Yun, Chun, Kim, The Effects of Transcranial Direct-Current Stimulation on Cognition in Stroke Patients, Journal of Stroke 2015;17(3):354-358.

Left fronto-temporal anode stimulation

current intensity 2 mA, for 30 minutes

A 3-week program



tDCS-based Cognitive Rehabilitation

	Left-FTAS	
	Before	After
K-MMSE	20.1±4.8	23.9±3.0*
FDST	4.6±1.4	5.0±1.2
BDST	2.8±0.9	3.0±0.9*
FVST	3.3±0.5	3.6±0.8*
BVST	2.6±1.2	3.3±1.4
ViLT-R	32.6±17.0	36.7±15.7
VeLT-R	16.1±11.2	27.6±14.3*
VCPT (second)	0.5±0.1	0.5±0.1
ACPT (second)	0.7±0.1	0.6±0.2
K-MBI	59.0±22.7	68.7±21.2*

K-MMSE, Korean version of the Mini-Mental State Examination *

FDST, forward digit span test

BDST, backward digit span test *

FVST, forward visual span test *

BVST, backward visual span test

ViLT-R, visual learning test-delayed recall

VeLT-R, verbal learning test-delayed recall *

VCPT, visual continuous performance test

ACPT, auditory continuous performance test

K-MBI, Korean version of the modified Barthel Index *

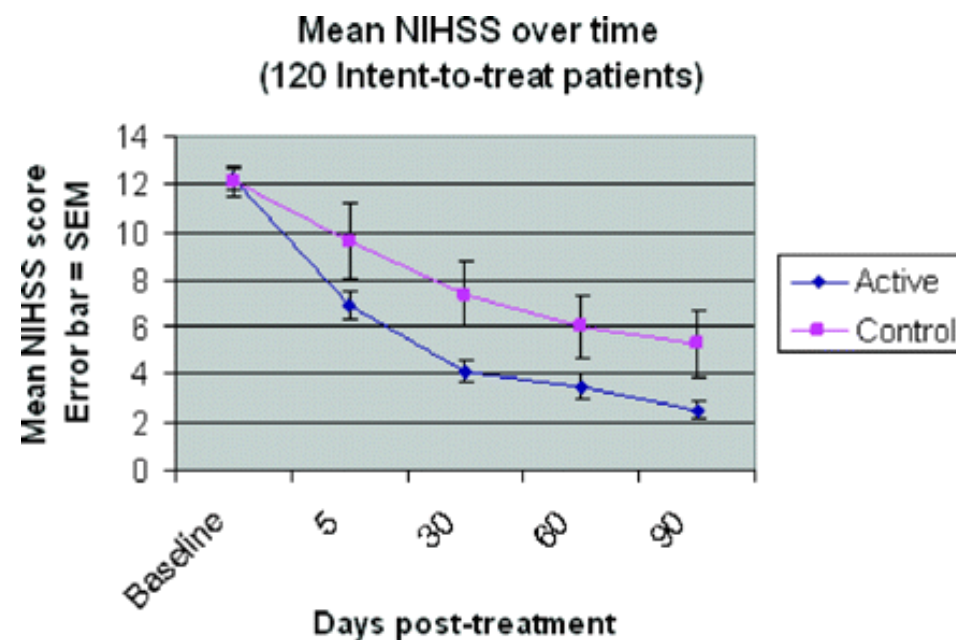
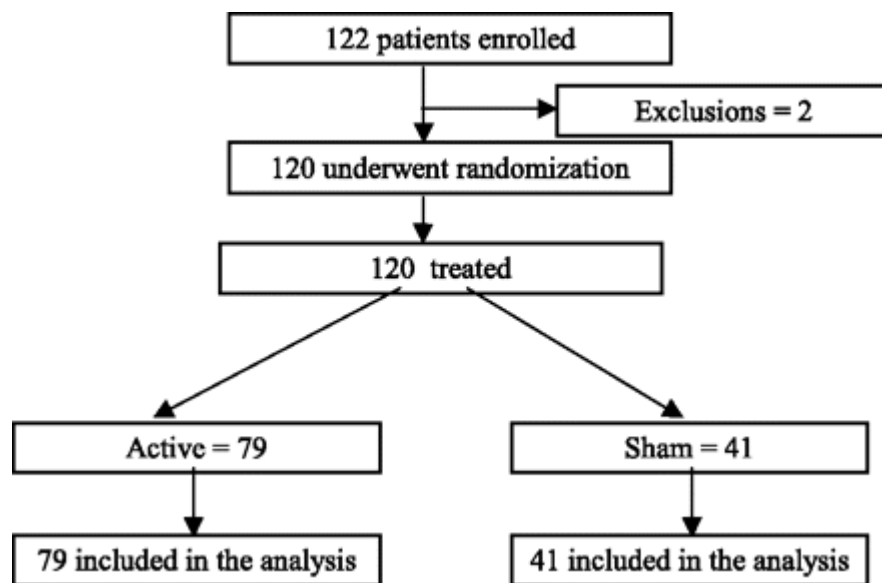


Photo bio-modulation based Cognitive Rehabilitation

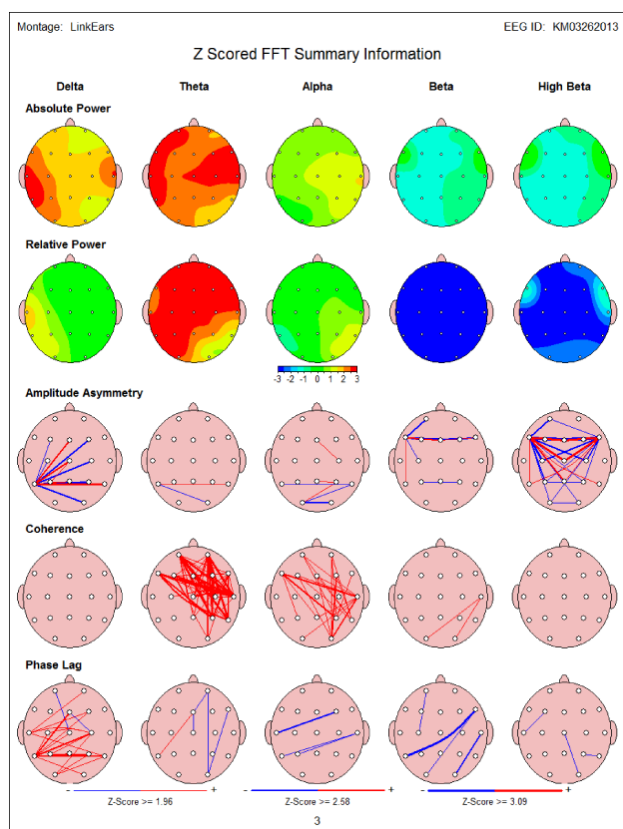


Photo bio-modulation based Cognitive Rehabilitation

Lampl, Yair, et al. "Infrared laser therapy for ischemic stroke: A new treatment strategy." *Stroke* 38.6 (2007): 1843-1849.



Neurofeedback



Neurofeedback-based Cognitive Rehabilitation

Cho, Kim, Jung, Effects of neurofeedback and computer-assisted cognitive rehabilitation on relative brain wave ratios and activities of daily living of stroke patients: a randomized control trial, 2016, J. Phys. Ther. Sci. 28: 2154–2158,

FIM	NFB		CACR	
	pre	post	pre	post
Motor	58.0 ± 13.1	59.6 ± 13.1**	54.6 ± 18.6	56.9 ± 17.6***
Cog	24.4 ± 5.2	25.8 ± 4.5**	24.5 ± 5.3	25.4 ± 5.2***
Total	82.4 ± 17.6	85.5 ± 16.2***	79.1 ± 21.8	82.3 ± 21.0***

Comparison of activities of daily living (ADL) of the groups

NFB: neurofeedback training group,

CACR: computer assisted cognitive rehabilitation training group,

FIM: functional independent measure,

Motor: motor subscale score,

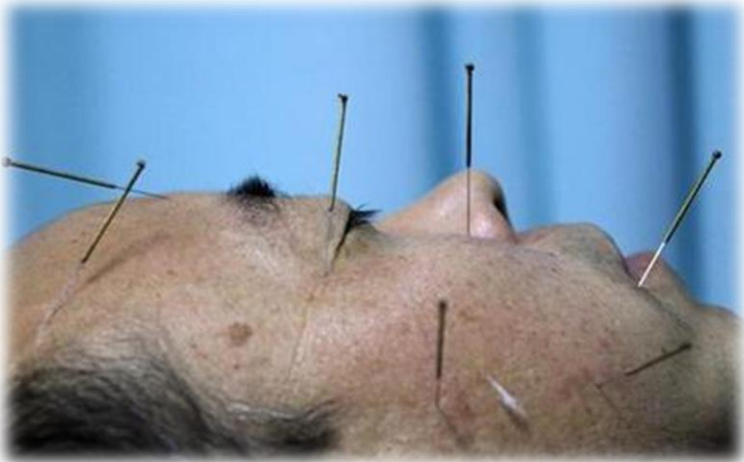
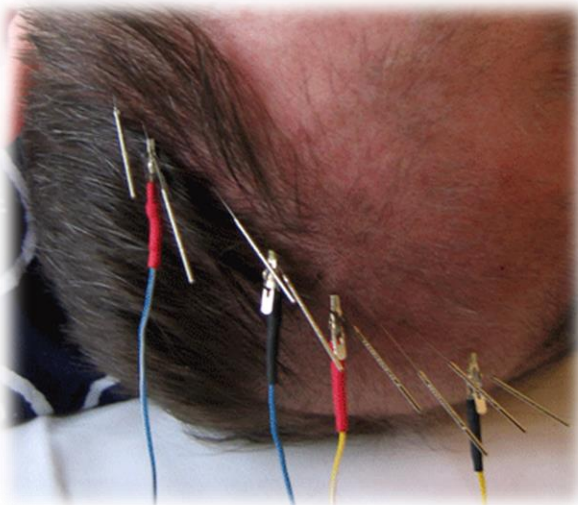
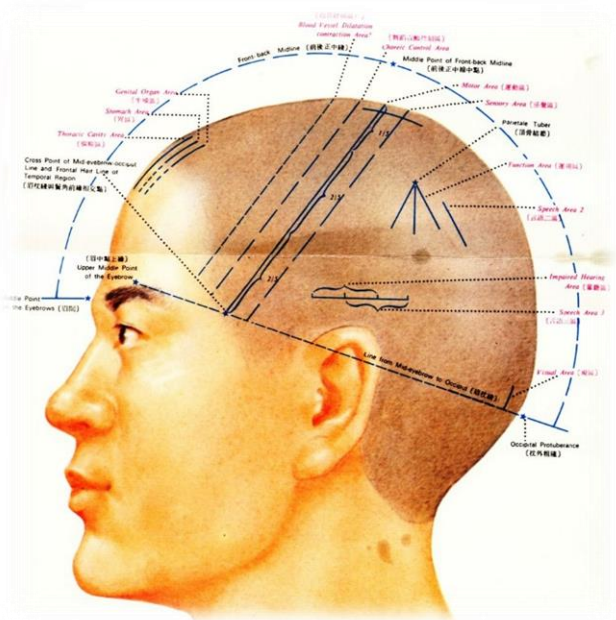
Cog: cognition subscale score,

Total: functional independent measure total score.



Acupuncture

28



Acupuncture-based Cognitive Rehabilitation

Dependent Variables	Source of Variation	SS	df	Mean Square	F	P
Δ MMSE	Acupuncture	187.334	1	187.334	112.824	.000
	RehaCom	147.750	1	147.750	88.984	.000
	Acup * Reha	10.380	1	10.380	6.251	.013
Δ MoCA	Acupuncture	179.662	1	179.662	123.745	.000
	RehaCom	167.951	1	167.951	115.679	.000
	Acup * Reha	7.247	1	7.247	4.991	.027
Δ FIM	Acupuncture	509.116	1	509.116	61.220	.000
	RehaCom	477.784	1	477.784	57.452	.000
	Acup * Reha	52.537	1	52.537	6.317	.013

Mini-Mental State Examination (MMSE), Montreal Cognitive Assessment (MoCA), and Functional Independence Measure (FIM)

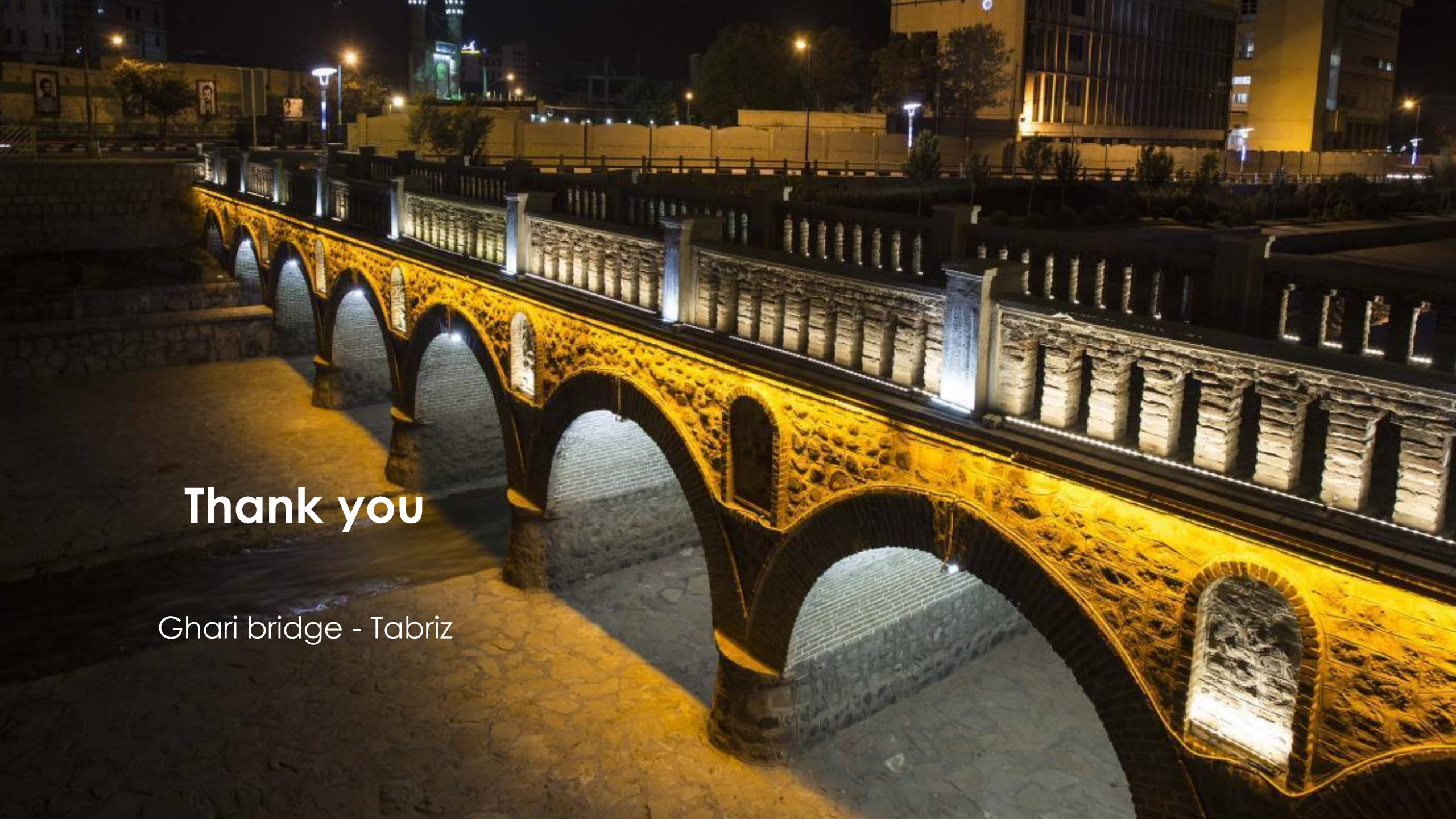
Jiang, Yang, Tao, Huang, Li, Ye, Chen, Hong, Chen, Clinical Efficacy of Acupuncture Treatment in Combination With RehaCom Cognitive Training for Improving Cognitive Function in Stroke: A 2 2 Factorial Design Randomized Controlled Trial, JAMDA 17 (2016) 1114e1122



Final notes

- Ischemia severity
- In period of 1-12 weeks
- Good cognitive assess tools
- Using appropriate cognitive rehabilitation tools (computer based techniques are common)





Thank you

Ghari bridge - Tabriz