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Cognitive effects of a treatment combining prismatic adaptation and serious games in stroke patients

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An interdisciplinary approach

BACKGROUND

Prismatic Adaptation (PA) is a widely used technique in the rehabilitation of visuospatial deficits (e.g., neglect)[1], but some studies suggested it could lead to additional ameliorations in other cognitive functions [2]. Indeed, PA may exert neuromodulatory effects on the cerebral hemisphere ipsilateral to the deviation induced by prisms, inducing higher cortical excitability, particularly in the frontoparietal network [2,3].
Recently, **MindLenses Professional,** a new tool combining PA with digital cognitive tasks (*serious games* - SG) has been applied for the rehabilitation of both visual and cognitive deficits in neurological patients. MindLenses is based on the **hypothesis** that PA could non-invasively modulate brain activity to enhance the beneficial effects of cognitive training [4]. Preliminary findings have shown that this device is promising for the rehabilitation of cognitive symptoms in patients with stroke [4].

The **main aim** of the present study was to disentangle the additional effects of PA on cognitive training. We report the effects of treatment using MindLenses in a cohort of stroke patients admitted to neurorehabilitation, compared to a treatment using only SG or standard cognitive rehabilitation.

METHODS

Participants

32 Stroke patients consecutively admitted to IRCCS San Camillo Hospital were randomly allocated to the three treatment groups:

A. Combined treatment (PA+SG – Mindlenses Professional): n=10
B. Treatment with only SG: n=11
C. Standard cognitive rehabilitation (SCR): n=11

Treatment

10 30-minute sessions (5 sessions per week).

- PA+SG: PA was performed at the beginning of each session with leftward/rightward deviating prisms (see Fig. 2a), and was followed by 20 min of SG focused on attention, executive functions, memory and language (Fig. 1)
- SG: the same SG performed by the PA+SG group were administered, without performing the PA procedure.
- SCR: computerized cognitive rehabilitation with the Rehacom® software.

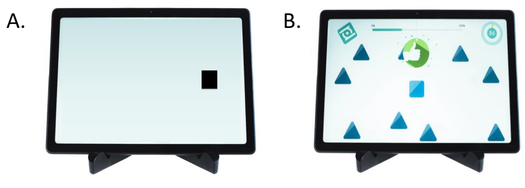
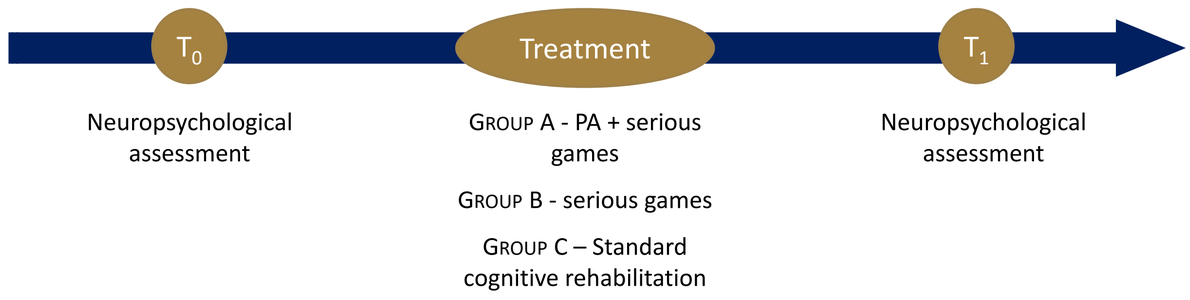


Figure 1. Examples of (a) PA' pointing task and (b) serious game (visual search) on MindLenses's tablet

Neuropsychological Assessment

A comprehensive neuropsychological battery was administrated to assess patients' cognitive performance before (t0) and immediately after the treatment (t1).



Statistical analysis

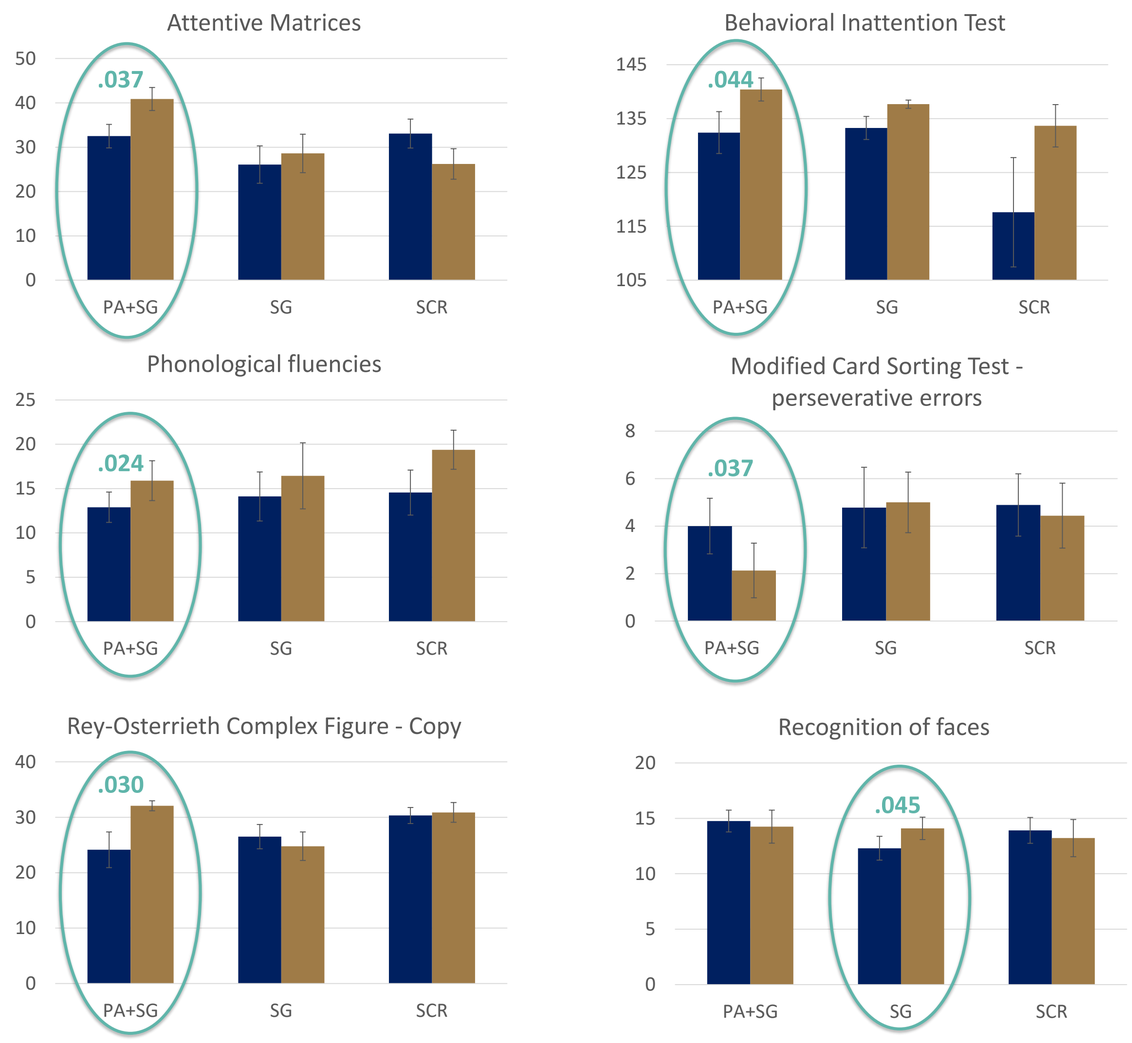
One-way ANOVAs and Chi-square tests were run to explore baseline differences in demographic characteristics and cognitive performances among treatment groups. To investigate changes in cognitive performances after the treatment, repeated measures ANOVAs with a within-between design were conducted, setting the time of the assessment (pre vs post-treatment) as a within-subject factor and the group (type of treatment received) as a between-subject factor. Post hoc tests were applied using Bonferroni correction.

RESULTS

All groups had similar age, education level, or gender distribution. At baseline, no significant differences were observed in the cognitive tests across groups (*p*s>.05).

	PA + SG (N=10)	SG (N=11)	SCR (N=11)	F/X² (p-value)
Age (SD)	69.30 (9.12)	65.91 (13.03)	73.09 (5.96)	1.471 (.246)
Education (SD)	9.00 (4.78)	11.18 (4.53)	11.54 (4.46)	0.869 (.430)
Gender (% F)	4 (40)	5 (45.4)	5 (45.4)	0.083 (.959)

- At the repeated measures ANOVA, significant **interactions of TIME*GROUP** were observed in the domains of attention and executive functions
  - Attentive matrices: F=4.706; p=.020
  - MCST –perseverative errors: F=5.389; p=.015
- After post hoc correction:
  - the Mindlenses group improved in attention, executive function, and visuospatial abilities.
  - The SG group improved in a single memory test.
  - The SCR group showed no significant changes



DISCUSSION

Mindlenses may be an effective tool for cognitive rehabilitation in stroke patients, inducing improvements in attention, visuospatial abilities, and executive function

consistent with the literature reporting that PA may exert an excitatory **modulation of the frontoparietal network** [2,5].

findings confirm the hypothesis that PA may non-invasively modulate brain activity to **enhance** the beneficial effects of **cognitive training** [4].

FUTURE DIRECTIONS

PA might be affected by factors such as the lesion site [6]
→ Identification of patients that could benefit more from interventions employing PA

The effects of PA + SG may be driven by neuroplastic changes
→ Investigate whether Mindlenses is associated with increased BDNF levels

Future studies should extend present findings also in other neurological pathologies, such as neurodegeneration

References

[1] Rossetti, Y., Rode, G., Pisella, L., Farné, A., Li, L., Boisson, D., & Perenin, M. T. (1998). Prism adaptation to a rightward optical deviation rehabilitates left hemispatial neglect. *Nature*, 395(6698), 166-169.
[2] Magnani, B., Caltagirone, C. & Oliveri, M. Prismatic adaptation as a novel tool to directionally modulate motor cortex excitability: evidence from paired-pulse TMS. *Brain Stimul*. 7, 573–579 (2014).
[3] Bracco, M., Mangano, G. R., Turriziani, P., Smirni, D., & Oliveri, M. (2017). Combining tDCS with prismatic adaptation for non-invasive neuromodulation of the motor cortex. *Neuropsychologia*, 101, 30-38.
[4] Oliveri, M., Bagnato, S., Rizzo, S., Imbornone, E., Giustiniani, A., Catania, A., & Turriziani, P. (2023). A novel digital approach for post-stroke cognitive deficits: a pilot study. *Restorative Neurology and Neuroscience, (Preprint),* 1-11.
[5] Saj, A., Cojan, Y., Vocat, R., Luauté, J., & Vuilleumier, P. (2013). Prism adaptation enhances activity of intact fronto-parietal areas in both hemispheres in neglect patients. *Cortex*, 49(1), 107-119.
[6] Danesin, L., Oliveri, M., Semenza, C., Bottini, G., Burgio, F., & Giustiniani, A. (2023). Prism adaptation in patients with unilateral lesion of the parietal or cerebellar cortex: A pilot study on two single cases using a concurrent exposure procedure. Neuropsychologia, 184, 108557.