

A Virtual Reality Intervention on Chronic Spatial Hemineglect, Impulsivity and Working Memory Deficits: A Single Case Study

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INTRODUCTION

420.000 people in Spain have some form of acquired brain injury (ABI), sudden lesions in the brain, with different etiologies and a wide array of possible sequelae, caused most frequently by stroke.¹ Single case studies offer a new approach to explore rehabilitation protocols within the heterogeneity within ABI.

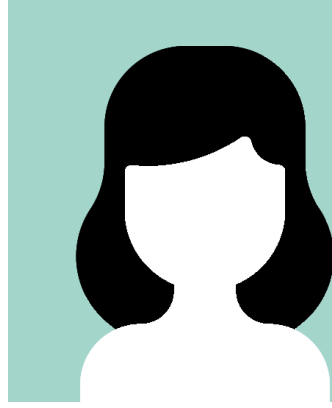
Virtual reality (VR) Head Mounted Displays (HMD) allow representing immersive real-life-like environments which allow for realistic, yet individually adjustable interventions; which have shown promising results within the realm of neurorehabilitation.²

OBJECTIVE

Study the effect of a VR intervention through a withdrawal design, on post-stroke spatial hemineglect, impaired working memory and impulsivity.

This study is pre-registered on the Open Science Framework (OSF): <https://osf.io/jvqn4>

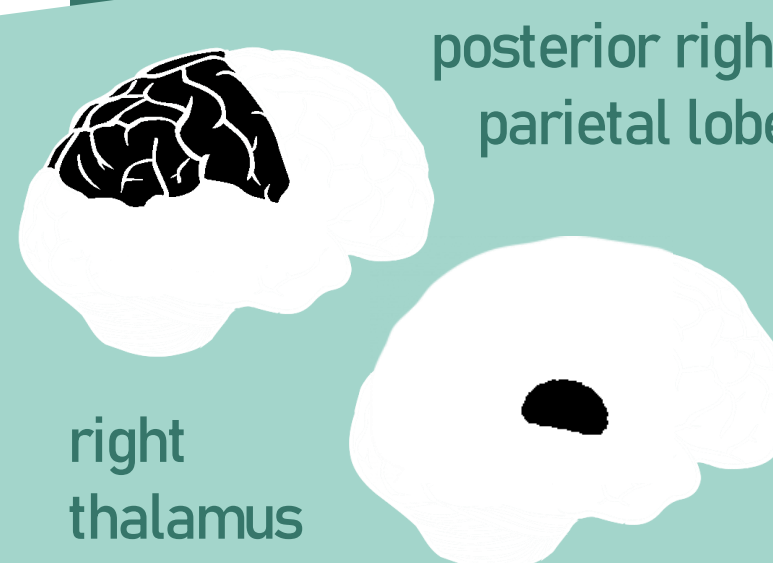
METHOD



CASE DESCRIPTION

Woman, aged 64

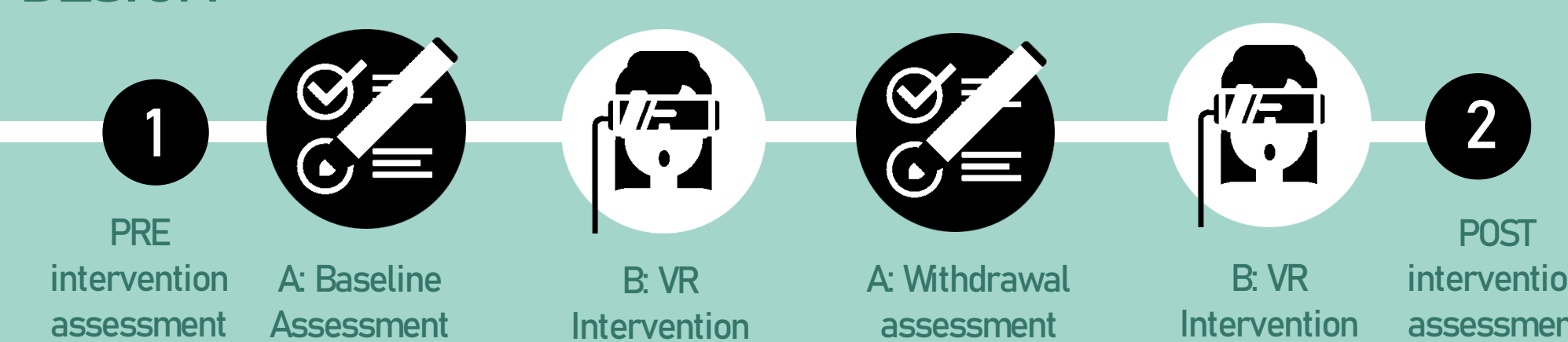
Ischemic stroke in the right middle cerebral artery (MCA) in 2008, injuring:



- Main cognitive sequelae:
- Spatial hemineglect
 - Impaired working memory
 - Impulsivity
- Other sequelae:
- Depression symptoms
 - Left-sided hemiparesis

STUDY DESIGN

- Withdrawal Design (ABAB Format)
- 5 Data points per phase



ASSESSMENT

Cancellation Task: a matrix of letters scattered over an A4 sheet. The letter to be cancelled and the matrix were randomized at each application.

All tasks used during the assessments are shown in Table 1

VR (HMD) INTERVENTION WITH RE-COGNITION



Re-cognition is an immersive virtual environment software, operating on Oculus Quest VR Headset, functioning as a Head Mounted Display (HMD). The participant interacts with objects laid out on a desk, following a set of growingly more complex instructions. Re-cognition allows to train attention, interference control and memory.

Click [here](#) to see the Re-Cognition environment

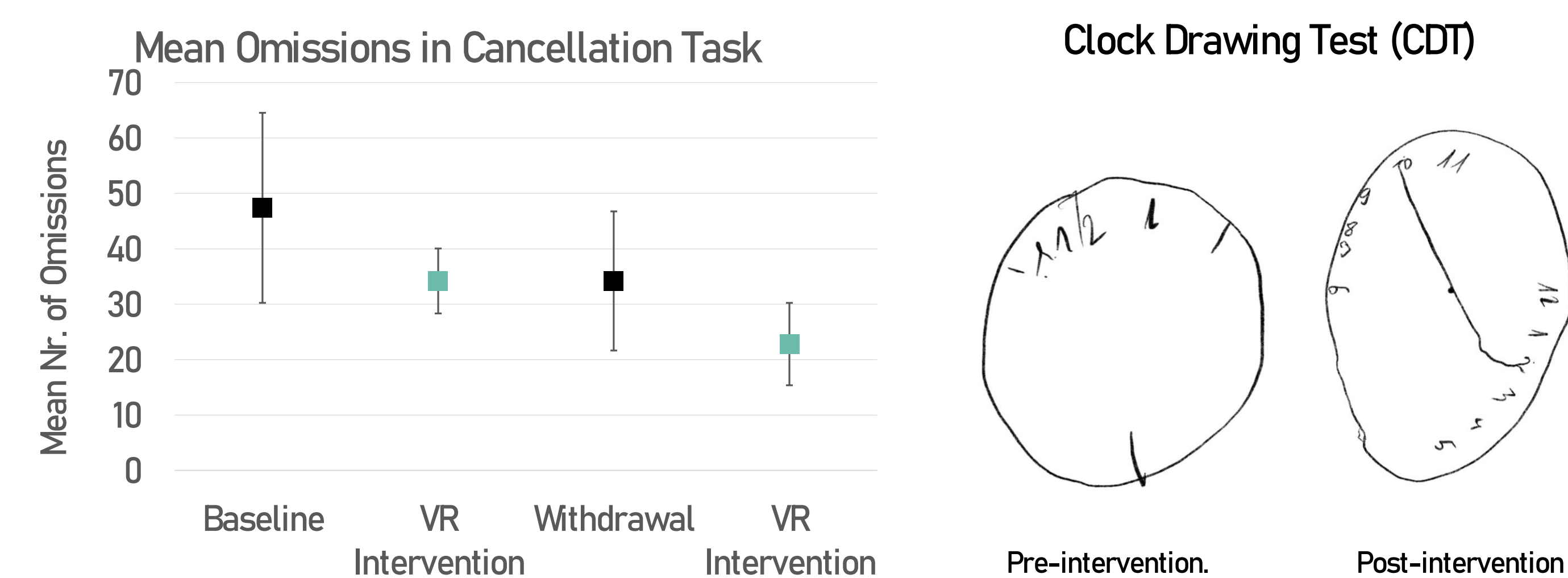
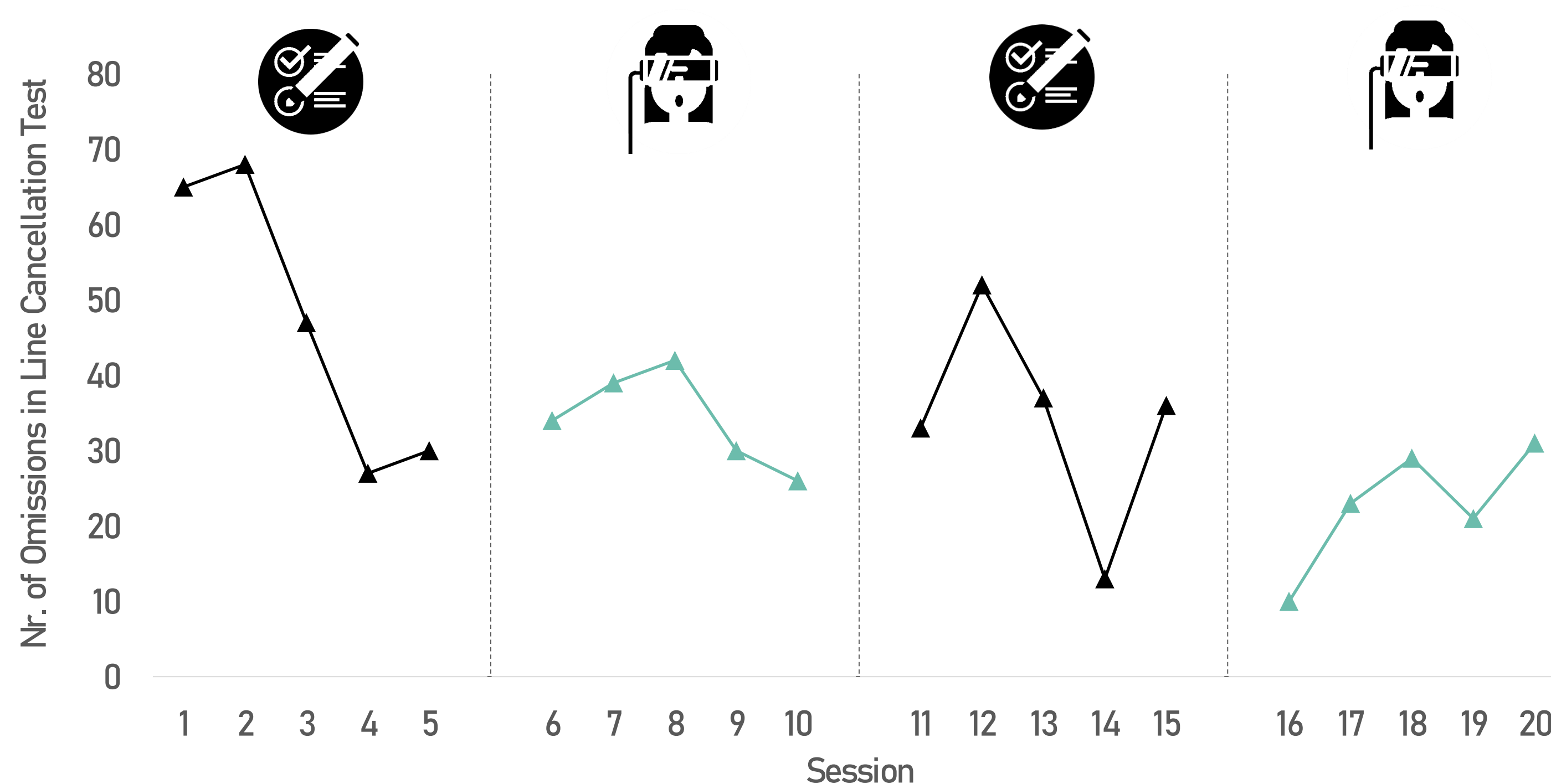
RESULTS

PRE and POST intervention assessments

Domain	Test	PRE	POST	Significative Change	RCI
Attention	CTT 1	195	183		5,2
	CTT 2	275	197	***	
	Line Bisection Test	0,2	0,13		
	Line Cancellation Test (Omissions)	3	0	***	
	5DT - Reading	38 (0)	30 (0)		
Executive Functions	5DT - Counting	37 (1)	35 (0)		4,45
	5DT - Choosing	112 (14)	72 (5)	***	
	5DT - Alternation	85 (34)	90 (14)	*** errors	
	5DT - Inhibition	74	42	***	
	5DT - Flexibility	47	60		
	Key Search (BADS)	4	4		
	WCST	> Pc 1	> Pc 1		
Memory Span & Working Memory	Digit Span Forward	4	4		
	Digit Span Backward	2	2		
	Visual Span Forward	3	3		
	Visual Span Backward	2	2		
Functional Outcome Measures	Lunch Box Task (NAT subtask) ³	4/10	9/10	***	
Depression Symptoms	Goldberg Depression Questionnaire	4/9	1/9	***	

RCI: Reliable Change Index; CCT: Colour Trail Test; 5DT: Five Digit Test; BADS: Behavioural Assessment of the Disexecutive Syndrome; WCST: Wisconsin Card Sorting Test; NAT: Naturalistic Action Test

Omissions in Cancellation Task during ABAB phases



ANALYSIS OF CANCELLATION TASK RESULTS

Visual analysis: the means of omissions are lower during the intervention periods.
Statistical analysis: significant effect of the VR Intervention on omissions:

- PEM (percentage of data points exceeding the median) = 1
 - Non-overlap of all pairs (NAP): 0,88 (strong effect)
 - Tau-U: 0,76 (medium effect), $p = .0472$
- Effect size measures

DISCUSSION

1 The VR intervention using the app Re-cognition has shown to be an effective tool in this single-case study, improving performance in the patient's altered cognitive domains. Most notably on the **executive attention** components:

- Alternation (CCT 2)
- Inhibition (5DT)
- Better visual tracking and localization

3 The patient's **mood** significantly improved throughout the intervention, as evidenced in the Goldberg Depression Questionnaire; which could have played a key role in the motivation and disposition showed by the patient throughout the intervention.

2 Intervention benefits were observed in more functional tasks (Lunch Box Task), showing a **generalization** of the results and a transfer towards skills not directly trained during the intervention

CONCLUSION

The present study shows that VR environments offer a valuable tool for neurorehabilitation, highlighting the utility of future developments of virtual environments

FUTURE LINES OF RESEARCH

- Design randomized controlled trials (RCTs) with VR interventions
- Explore the combined effect of VR interventions with other neuromodulation techniques (such as transcranial direct current stimulation (tDCS))
- Further study the role of mood and motivation in these interventions

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