



Cognitive assessment in a digital area: Current state-of-the-art in neuropsychological outcome measures (preliminary results)

E. Bousché^{1,3}, C. L. Southcombe^{1,3}, I. K. Gosselt², L. A. Spreij², A. F. Ten Brink¹, H. Huygelier^{1,4} & T. C. W. Nijboer^{1,2}

¹ Experimental Psychology, Helmholtz Institute, Utrecht University, Utrecht, The Netherlands.

² Center of Excellence for Rehabilitation Medicine, Brain Center Rudolf Magnus, University Medical Center Utrecht, Utrecht University and De Hoogstraat Rehabilitation, The Netherlands.

³ Department of Cardiology, Wilhelmina Children's Hospital, Utrecht, The Netherlands.

⁴ Department of Brain and Cognition, KU Leuven, Leuven, Belgium



Introduction

Cognitive impairment is currently assessed with neuropsychological paper-and-pencil tasks.

However:

- Mild impairments are often not objectified
- They have a moderate ecological validity
- Mostly use total scores
- Fine-grained measures are often not used

Special focus:

- Acquired Brain Injury
- Memory
- Attention
- Executive Functions

Categories of neuropsychological outcome measures

Accuracy

Correct responses, errors (false alarms, omissions), total score, correct target selection, correct bought items

Duration

Reaction time, completion time, time target is found, mean time on road, hit reaction time

Efficiency

Effective strategy, rule violations, cues needed, wrong directions, selected rooms in right order

Eye movement features

Eye fixations, duration fixations, number of gazes, fixation duration in particular zone, saccadic movements, gaze positions left/right

Methods

A systematic review was performed (2010-2021) using PubMed and Scopus. Neuropsychological outcome measures regarding memory, attention and executive functions were extracted from different testing methods: Computer Tasks, Real-life tasks, Serious Games, Augmented Reality and Virtual Reality. In total, 515 articles were found. After reviewing titles, abstracts and full-texts, 46 articles were included. Serious Game and Augmented Reality articles are still to be assessed.

We searched for neuropsychological outcome measures derived from alternative tasks that were compared to standard NPA



Virtual Reality (VR)



Computer Tasks (CT)



Serious Games (SG)



Real Life Tasks (RLT)



Augmented Reality (AR)

Results

Table 1 Preliminary findings

		Accuracy	Duration	Efficiency	Eye movement
COMPUTER	n=15	87%	60%	0%	0%
<i>memory</i>	n=7	86%	29%	0%	0%
<i>attention</i>	n=7	86%	100%	0%	0%
<i>EF</i>	n=1	100%	0%	0%	0%
REAL-LIFE	n=9	50%	30%	40%	0%
<i>memory</i>	n=6	50%	17%	50%	0%
<i>attention</i>	n=1	100%	0%	0%	0%
<i>EF</i>	n=3	67%	67%	67%	0%
VIRTUAL REALITY	n=22	77%	55%	32%	23%
<i>Memory</i>	n=11*	82%	46%	55%	18%
<i>Attention</i>	n=13*	77%	69%	8%	39%
<i>EF</i>	n=2*	100%	100%	50%	0%

*4 articles included two cognitive domains

Conclusion

- VR tasks include eye movement measures, unlike **Computer** and **Real-Life** tasks.
- **Accuracy** and duration are the most common outcome measures.
- We found more studies about **Computer** and **VR** tasks that focused on **memory** and **attention** than **executive functions**.
- The neuropsychological outcome measures we found are utilized to measure multiple cognitive domains; e.g. - **accuracy** is not merely used for assessing **memory**, it is also used for assessing **attention** and **executive functions**.

Discussion and future

- **Accuracy** and **duration** are used most often, even though technological advances in **computer tasks** and **VR** simulations allow for novel (potentially more sensitive and ecologically valid) outcome measures.
- The potential of **computerized assessment** and **novel outcomes measures** is currently not sufficiently utilized.