



COGNITIVE ASSESSMENT IN VIRTUAL ENVIRONMENTS *HOW TO CHOOSE THE NATURAL USER INTERFACES?*

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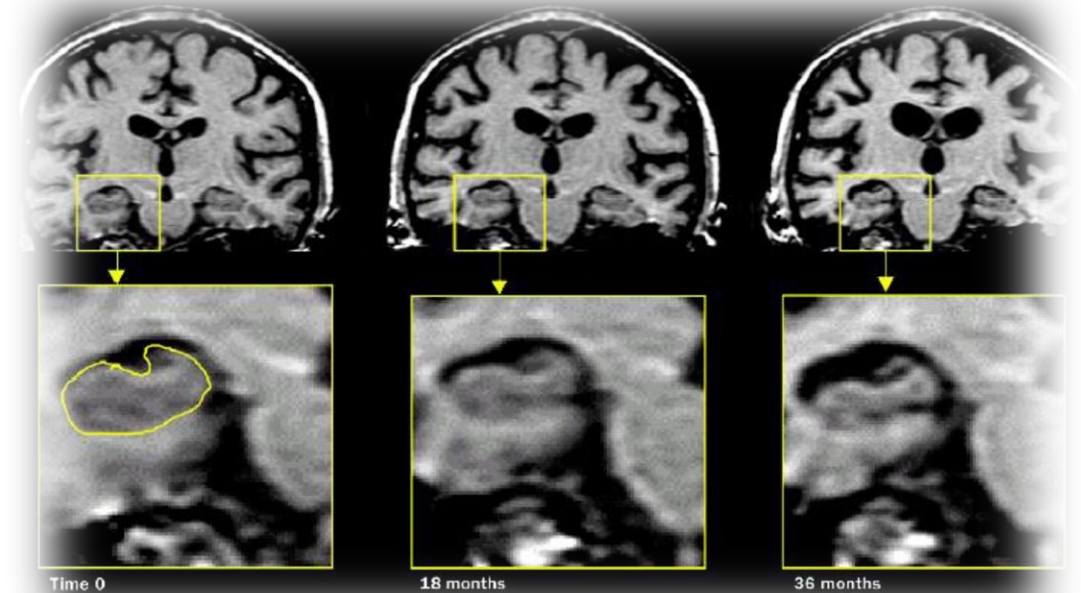
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PARIS-SACLAY

Conflicts of interests

None

Alzheimer's disease

- ▶ 1907: first description by Alois Alzheimer
- ▶ 2015
 - ▶ 47 million of patients
 - ▶ 723 billion €
 - ▶ Gross domestic product n°18
 - ▶ No treatment
- ▶ 2050
 - ▶ 132 million of patients
 - ▶ 1 767 billion €
 - ▶ GDP n°9



Cognitive assessment

▶ Numerous paper tests

▶ Mini Mental Status Examination (MMSE)

▶ *Folstein and al, J Psychiatr Res (1975)*



▶ Montréal Cognitive Assessment (MoCA)

▶ *Nasreddine ZS and al, J Am Geriatr Soc (2005)*



▶ Five words of Dubois (F5D)

▶ *Dubois B and al, Presse Med (2002)*



New evaluation tool

Maronnat F and al, Cognitive tasks modelization and description in VR environment for Alzheimer's disease state identification.

10th International Conference on Image Processing Theory, Tools and Applications (IPTA 2020), Nov 2020, Paris, France. pp.1-7,

[10.1109/IPTA50016.2020.9286627](https://doi.org/10.1109/IPTA50016.2020.9286627)

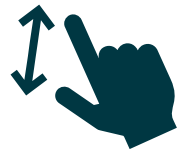
[hal-03404812](https://hal.archives-ouvertes.fr/hal-03404812)

New evaluation tool

- ▶ New immersive virtual tool
- ▶ Cognitive assessment based on MMSE, MoCA, and F5D
- ▶ Find the most adapted **Natural User Interactions** for older adults with **cognitive impairment**



Navigation



Manipulation



Selection



Application control

Choice of material



Oculus technologies. (2019).
Metaquest.
<https://www.oculus.com/>



Choice of material

Desired characteristics

Full immersion

Possibility of **appearance of hands**

Sounds compatible with hearing impairment or **hearing aids**

Compatible with glasses (vision impairment)

Own storage

Free movements (**no cables**)

Could be proceeded while sitting

Low weight

Characteristics of OQ

Six degrees of freedom

Two touch controllers with four integrated cameras

3D positional audio directly broadcasted from the headset

OLED screen

1440 × 1600 Resolution Per Eye

72 Hz Refresh Rate Supported

Glasses Compatible

128 GB

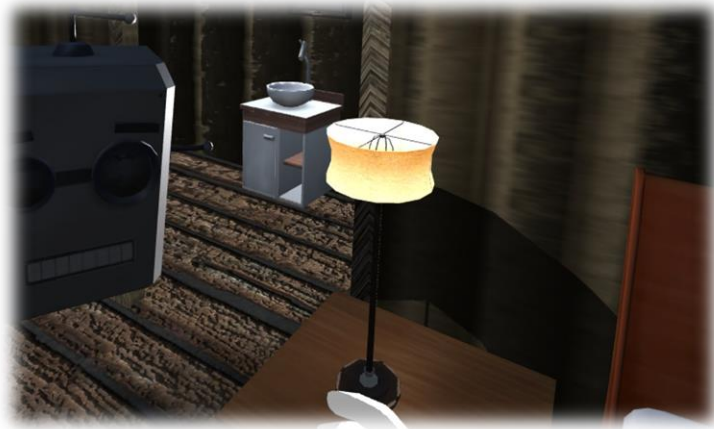
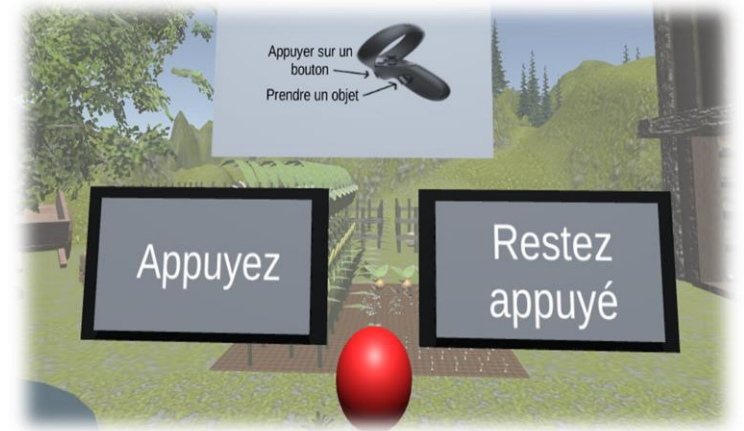
Battery included

Possible

Less than 600 grams

Welcome and training task

- ▶ Discover the environment
- ▶ Discover the material
- ▶ Test the interactions
- ▶ Oral instructions



Welcome and training task



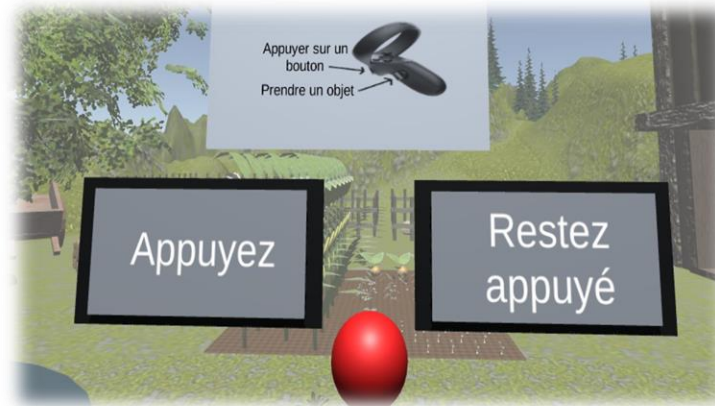
Navigation

Virtual hand

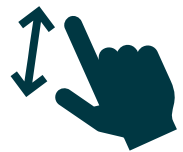


Selection

Body's movements
and gaze directed



None



Manipulation

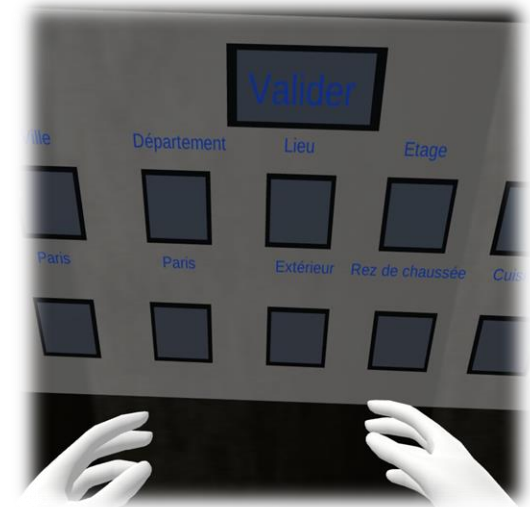
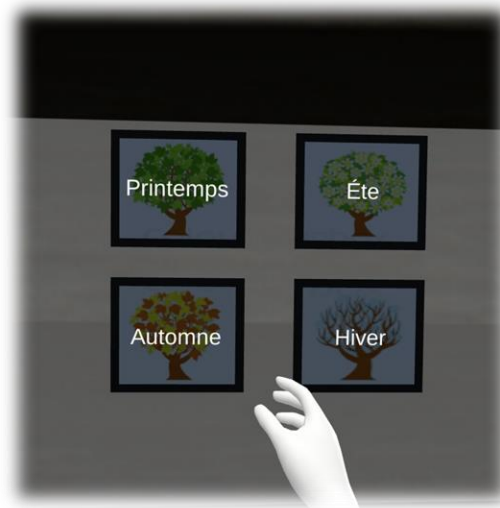
Virtual hand



Application control

Orientation task

- ▶ Original task: Spatio-temporal orientation
- ▶ Natural action: Oral answers
- ▶ Virtual action: Selection of items



Orientation task



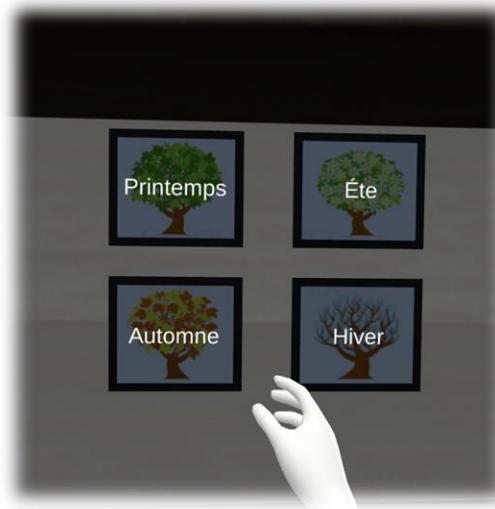
Navigation

Virtual hand

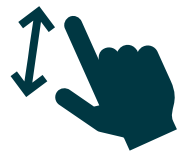


Selection

Body's movements
and gaze directed



None



Manipulation

None



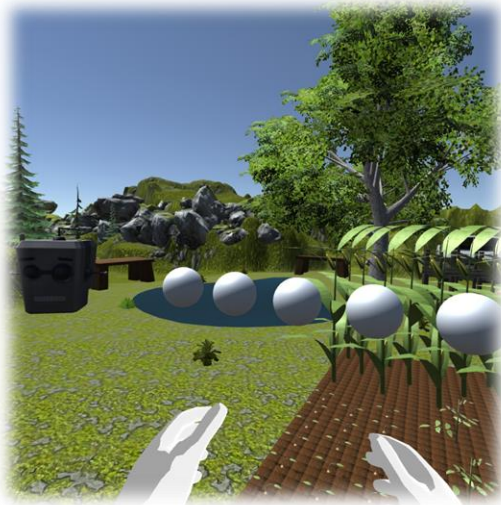
Application control

Attention tasks

▶Original task:
Calculation

▶Natural action:
Oral answers

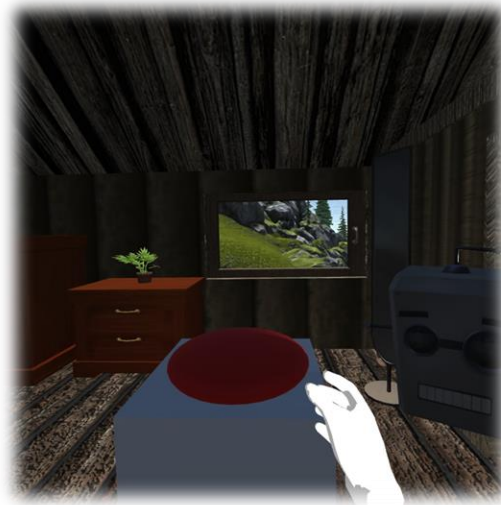
▶Virtual action:
Selection of
items



▶Original task:
List of letters

▶Natural action:
Movements

▶Virtual action:
Push on a
button



▶Original task:
Number series

▶Natural action:
Oral answers

▶Virtual action:
Selection of
items



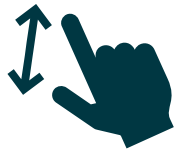
Attention tasks



Navigation



Selection



Manipulation



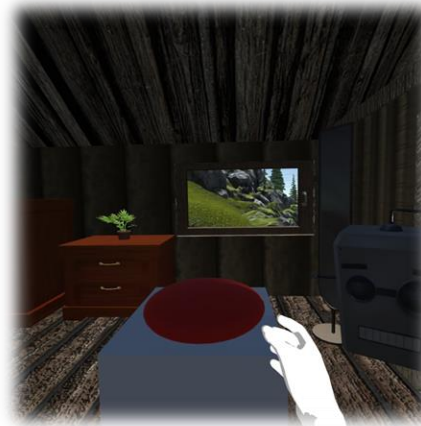
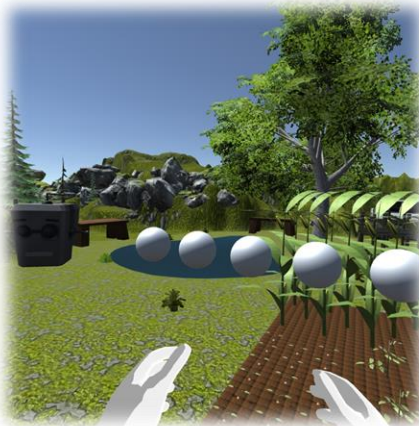
Application control

Body's movements and gaze directed

Virtual hand

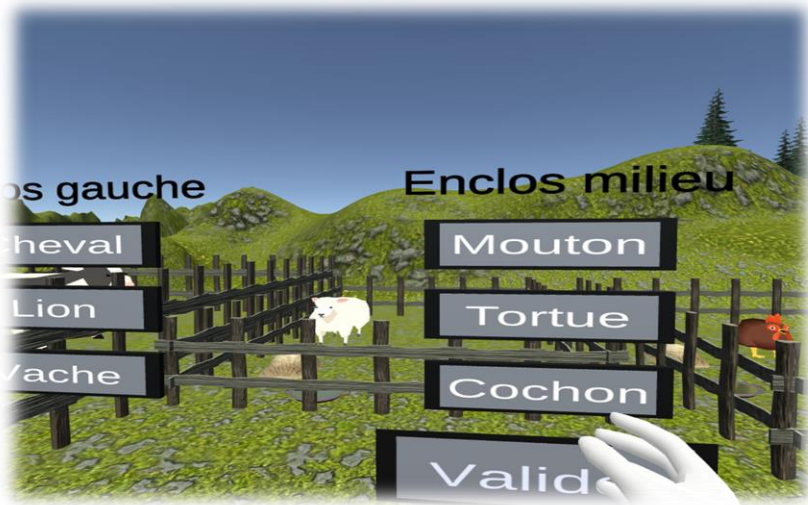
None

Virtual hand



Language tasks

- ▶Original task:
Name objects
- ▶Natural action:
Oral answers
- ▶Virtual action:
Selection of items



- ▶Original task:
Written order and lecture
- ▶Natural action:
Movements and writing
- ▶Virtual action:
Selection and movements of items



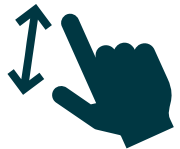
Language tasks



Navigation



Selection



Manipulation



Application control

Body's movements and gaze directed

Virtual hand

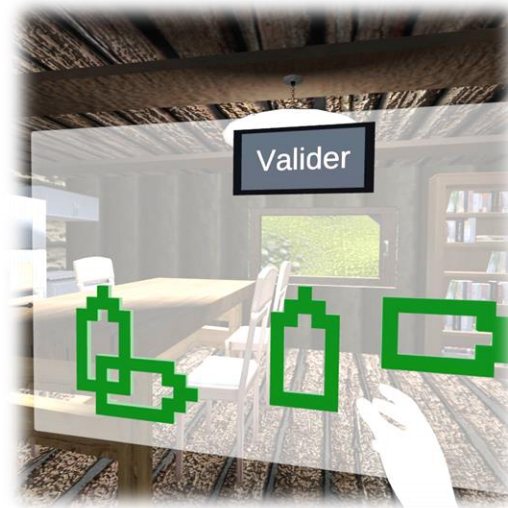
None

Virtual hand



Praxis task

- ▶ Original task: Drawing
- ▶ Natural action: Draw a figure
- ▶ Virtual action: Selection and movements of items

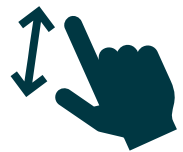


Praxis task



Navigation

Body's movements
and gaze directed



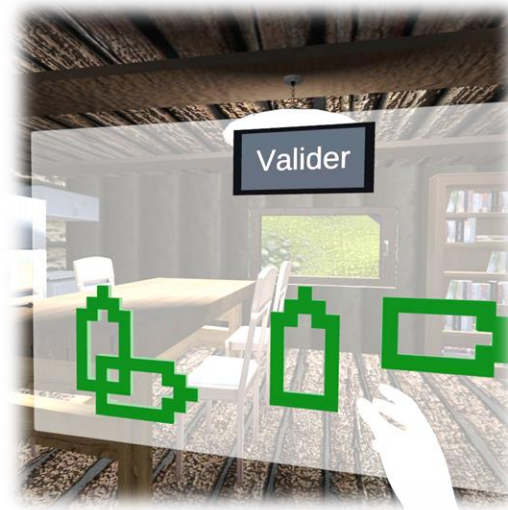
Manipulation

Virtual hand

Virtual hand



Selection



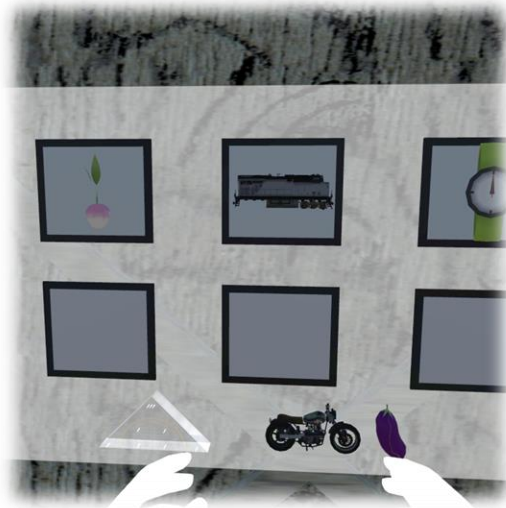
None



Application control

Abstraction task

- ▶ **Original task:** Find the similarity between items
- ▶ **Natural action:** Oral answers
- ▶ **Virtual action:** Selection and movements of items



Abstraction task



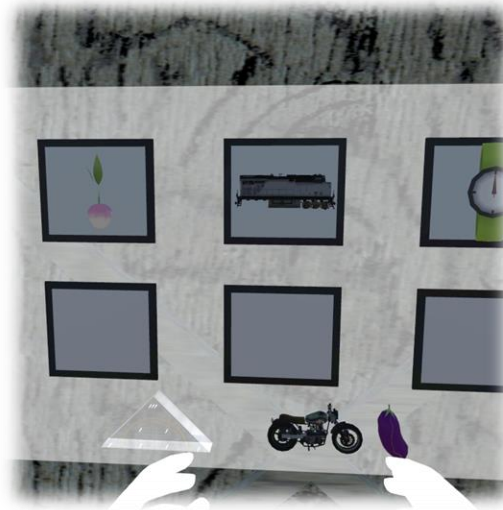
Navigation

Virtual hand

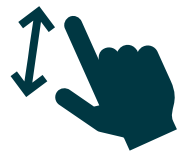


Selection

Body's movements
and gaze directed



None



Manipulation

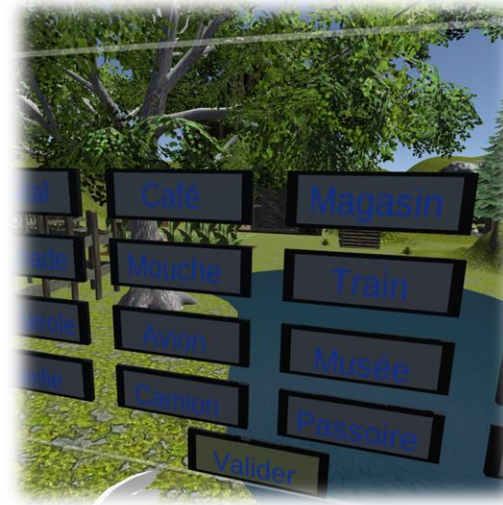
Virtual hand



Application control

Memory task

- ▶ **Original task:** Remembering five words
- ▶ **Natural action:** Oral answers
- ▶ **Virtual action:** Selection of items

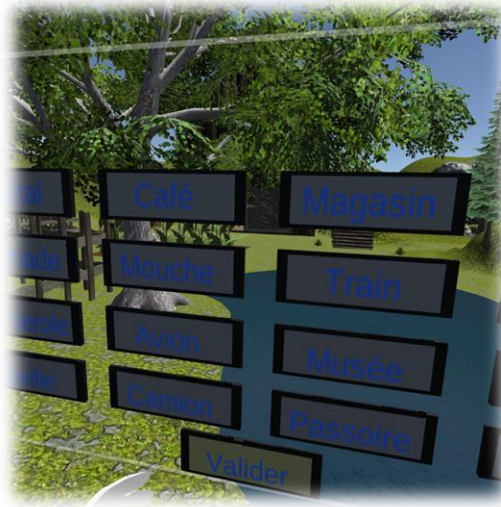


Memory task



Navigation

Body's movements
and gaze directed

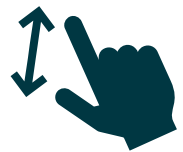


Virtual hand



Selection

None



Manipulation

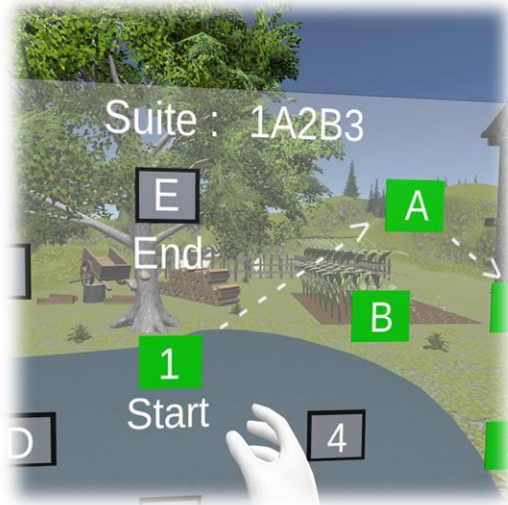
Virtual hand



Application control

Executive functions tasks

- ▶Original task:
Logical sequence
- ▶Natural action:
Draw lines
- ▶Virtual action:
Selection of items



- ▶Original task:
Clock test
- ▶Natural action:
Draw a clock (figures and arrows)
- ▶Virtual action:
Selection of items



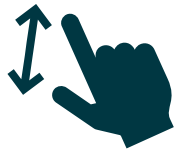
Executive functions tasks



Navigation



Selection



Manipulation

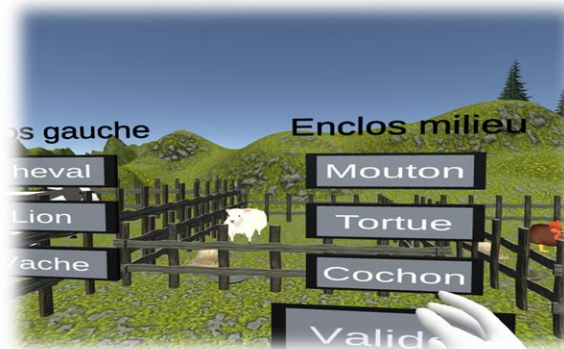


Application control

Body's movements and gaze directed

Virtual hand

None



Discussion and conclusion

- ▲ OQ already used in cognitive assessment
- ▲ **Autonomous system**
- ▲ Based on **classical tests**
- ▲ **Several cognitive functions**



- ▼ Use of hand controllers
- ▼ Limits in speech recognition
- ▼ No writing function
- ▼ Reading tasks
- ▼ Untested among an elderly population