Ergonomic Challenges and Benefits of Enhanced Cultural Application with Augmented Reality for People with Autistic Spectrum Disorder

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Resume of the presenter

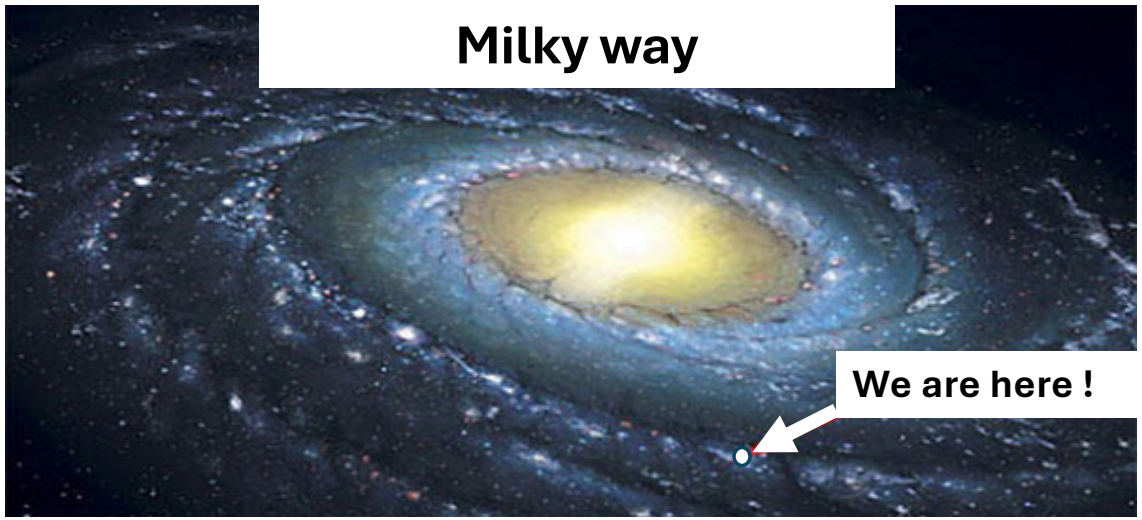
Armand Manukyan is a research manager at the **Association Jean-Baptiste Thiéry** in Nancy, France, an institution for people with special needs (autism, multiple disabilities). He leads multidisciplinary research to improve practices. He collaborates closely with the **2LPN (Laboratoire Lorrain de Psychologie et Neurosciences de la dynamique des comportements)** at the **University of Lorraine**, focusing on the development and evaluation of **innovative tools**, including **social robots**, **augmented reality devices**, and **alternative communication systems**.

His work bridges the gap between research and field practice, particularly in educational settings for people with disabilites, aiming to create experiences that support autonomy, cognitive engagement, and inclusive access to art and public spaces.

He works with Jérôme Dinet, professor in psychology, expert in this field of studies, who present this work.

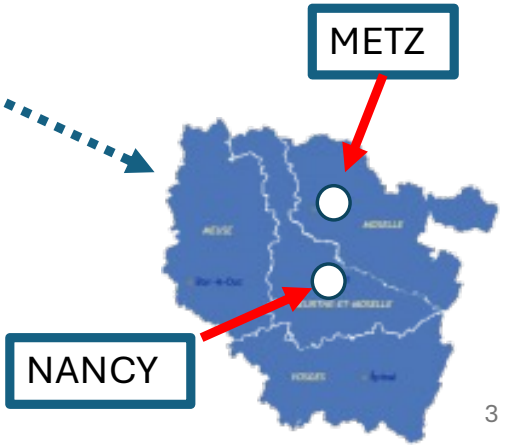
A brief introduction of the 2LPN

Lab of Psychology and Neurosciences about Dynamics of Behaviours



France in Europe
フランス

Lorraine in France



University of Lorraine : 69,000 students; 7 000 staff members;
43 teaching departments and 60 research ;
Two main locations (Metz & Nancy)

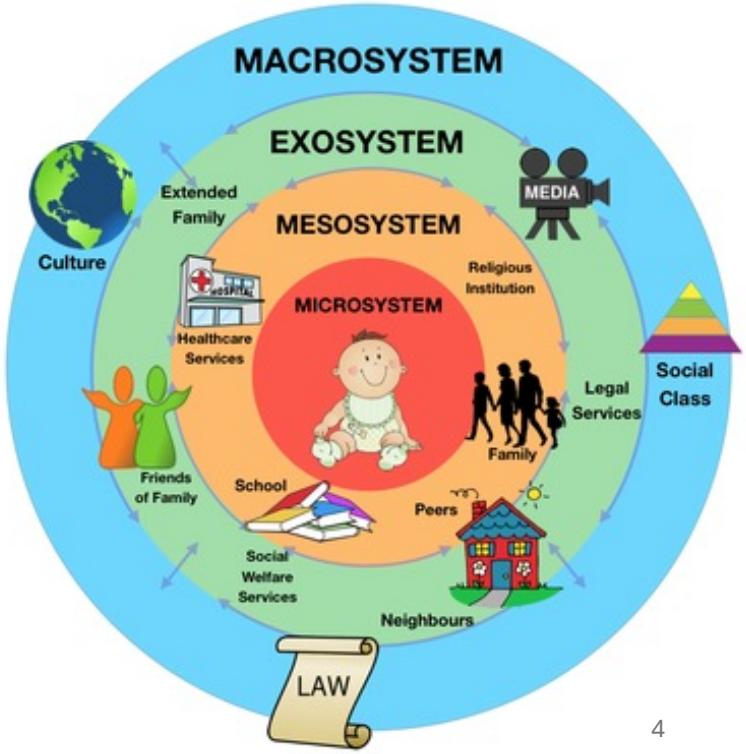
Our lab : 70 members

Our mixed scientific approach in our Labs

Scale (s)	Time units	System	World (theory)
10^{7}	months		Social band
10^{6}	weeks		
10^{5}	days		
10^{4}	h	Task	Rational band
10^{3}	10 min	Task	
10^{2}	min	Task	
10^{1}	10 s	Unit task	Cognitive band
10^{0}	1 s	Operations	
10^{-1}	100 ms	Delibate act	
10^{-2}	10 ms	Neural circuit	Biological band
10^{-3}	1 ms	Neuron	
10^{-4}	100 µms	Organelle	

Main competencies:

- **Developmental psychology**
- **Cognitive Psychology**
- **Social psychology**
- **Methodology**
- **Neurosciences**

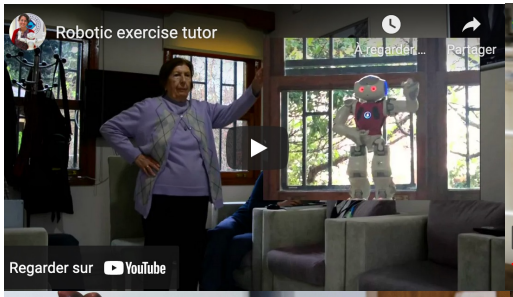


A focus on users with specific needs
➔ young children with autism & elderly people

A double (r-)evolution

What is ASD / mental deficits and how to help individuals?

Robotics and IA



The same questions :

- ✓ **UTILITY ?**
- ✓ **USABILITY ?**
- ✓ **ACCEPTABILITY ?**

Inclusive innovation as the cornerstone of value creation: application of design thinking

TRIAL PARTICIPANTS

Adjustment based on cognitive, behavioral, and sensory profiles, among others.

CRITICAL USERS

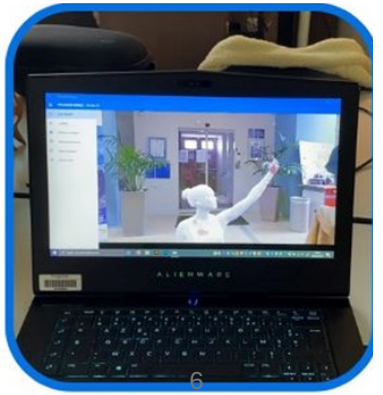
Feedback on the usability and acceptability of the suggested tools

BENEFICIARIES

Users of modified programs.

DEMONSTRATORS

Presentation of the solution by users to various audiences



Context and Objectives of our studies

- People with ASD face barriers in cultural spaces due to sensory, cognitive, and social challenges.
- Museums, though rich pedagogical environments, lack inclusive design for ASD.
- Augmented Reality (AR) offers immersive and tailored experiences that can improve accessibility.
- Objective: Evaluate the ergonomic relevance and educational benefits of AR headsets in a museum context for people with ASD.

To what extent can augmented reality be implemented in a museum exhibition to enhance comprehension for individuals with ASD?

Autism Spectrum Disorder

Etiology :

40% genetic (200 genes currently involved)

40% developmental

Factor entanglement: 20%

- *France has approximately **700,000 people** with Autism Spectrum Disorders (ASD), including **100,000 children**.*
- *People with autism are a very **heterogeneous group** and it is difficult to list defining symptoms.*

Sources : DSM-V (2013)
Santé Publique France (2017)

Virtual Reality?

It is a device that enables users to immerse themselves in digital realms and engage in first-person experiences. The environments are 360 degrees, allowing the user to rotate and observe their surroundings as if they were in the physical world.

or

Augmented Reality?

This technology projects three-dimensional elements into the physical environment surrounding us through devices such as headsets, tablets, or smartphones.

Methodology

- Participants: 30 children (8–16 y.o.) and 10 adults (18–35 y.o.) with ASD from local centers.

- Tools:

- Ergonomic assessment grid (hardware, software, content, behavior, side effects).

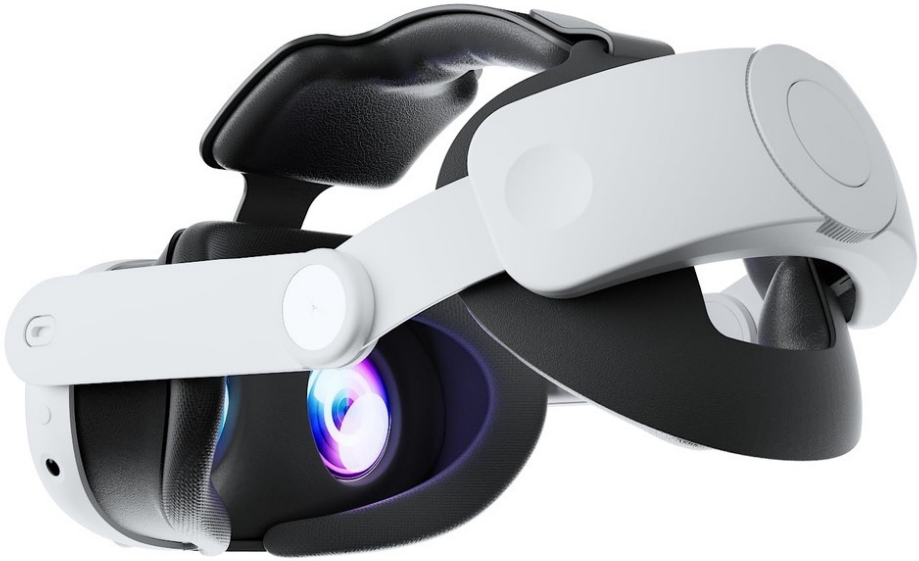
- Psychometric tests (Stroop effect, short-term memory).

- Protocol: Themed museum tours (flora/fauna) using AR vs traditional visit.

Materials

META QUEST 3 HEADSET

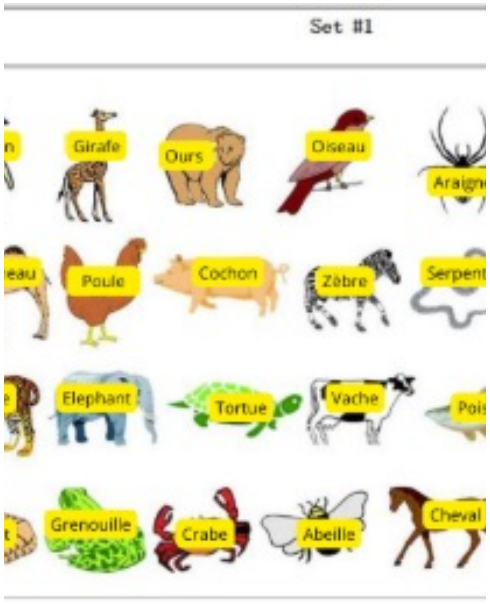
A high-quality virtual and augmented reality headset from the Meta brand, featuring advanced features and capabilities.

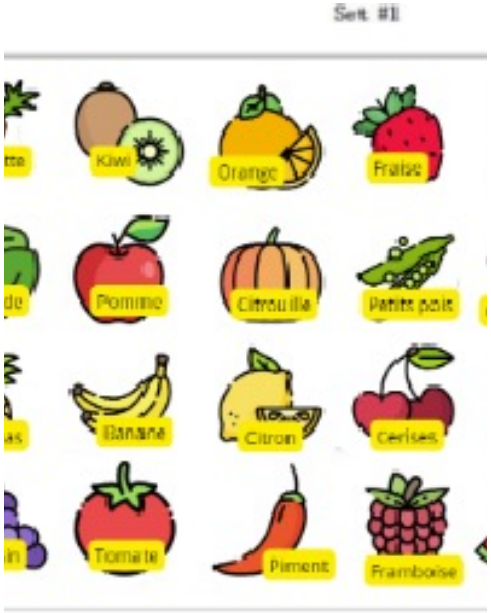


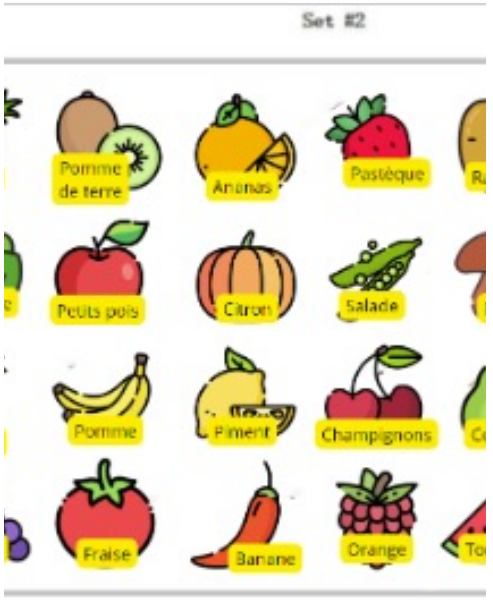
ADDITIONAL STRAP ATTACHMENT

A specialized strap that can be clipped onto the Meta Quest 3 headset to provide better balance and support.

Test of the Stroop Effect with Animal and Plants Boards *Fang et De Bot (2015)*







TWO BOARDS

We will be using two boards, one for the control condition (Set.1) and the other for the interference condition (Set.2).

STOPWATCH

A stopwatch is required to measure the time taken by the participant to complete the two boards.

PRESENTATION ORDER

The control condition (Set.1) board will be presented first, followed by the interference condition (Set.2) board.

ANIMAL OR PLANT IMAGE NAMING

The participant will be asked to name the animal or plant shown in the image, rather than reading the word displayed.

- *Inhibition will be assessed **before** and **after** the museum route.*
- *Each word from the boards has been chosen because of its **simplicity** and **small number of syllables**.*

Evaluating Short-Term Memory in Museum Experiences

The assessment of the cognitive cost of visiting the museum involves evaluating a second dimension: short-term memory.

To this end, a short-term memory test called 'Animal Race' has been extracted from the literature and has been adapted to the theme of flora for the plant-based route of the wildlife trail application.

- *Short-term memory will be assessed **before** and **after** the museum route.*
- *Each word from the text has been chosen because of its **simplicity** and **small number of syllables**.*

Longueur 2	Loup- singe
	Chien- lion
	Lion- singe
	Ours- chat
Longueur 3	Singe- chien- chat
	Lion- ours- loup
	Loup- chien- singe
	Chat- ours- coq
Longueur 4	Coq- chat- loup- chien
	Ours- lion- chien- singe
	Lion- chien- singe- ours
	Singe- coq- loup- chat
Longueur 5	Ours- coq- singe-loup- chat
	Chat- lion- coq- ours- singe
	Coq- singe- lion- chien- ours
	Chien- lion- ours- coq- loup
Longueur 6	Chien- coq- ours- lion- loup- chat
	Singe- loup- chat- coq- ours- lion
	Coq- chat- lion- singe- chien- loup
	Chien- ours- singe- loup- lion- coq
Longueur 7	Coq- singe- lion- loup- chat- ours- chien
	Chat- coq- chien- ours- singe- loup- lion
	Singe- ours- loup- lion- coq- chien- chat
	Loup- chien- chat- lion- singe- coq- ours

Example of works of art in augmented reality

*Those **virtual objects** displayed by the AR device are **superposed to the real environment**.*

Expected Benefits and Insights

- Better comprehension and spatial orientation during visits.
- Enhanced motivation, focus, and social interaction through immersive AR experiences.
- Identification of key ergonomic adjustments for AR headset use by ASD users.
- Data to guide future inclusive cultural and educational digital tools.

Conclusion and Perspectives

This study bridges digital innovation and inclusive culture.

AR headsets have potential to transform museum access for neurodiverse populations.

Future steps:

- Finalize testing phase
- Analyze data to validate ergonomic and educational outcomes
- Develop inclusive AR design guidelines for cultural institutions

THANK YOU !!