06/04/2025-10/04/2025
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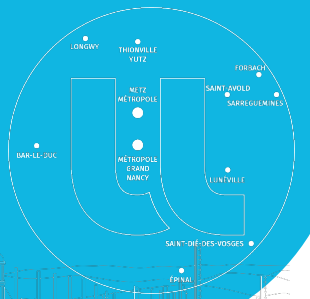
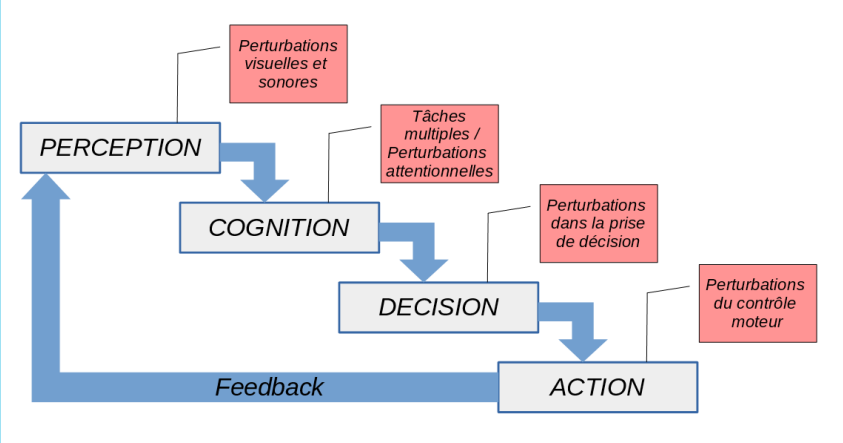
Towards Personalized Mobility Assessment and Rehabilitation: A User Centered Designed VR/XR-Based Solution for Older Adults

Yann Morère, **Jérome Dinet**, Fabien Clanché,
Thierry Bastogne, Matthieu Casteran, Lucas Detto ,
Matthieu Burtin, Frederic Bousefsaf, Kaoutar El Ghabi



Loss of autonomy in everyday life: a consequence of aging

Aging is accompanied by a set of sensorimotor and cognitive alterations that can affect human abilities such as mobility, memory, psychological state and behaviors in the environment, affecting daily activities and tasks.



Biomarkers of mobility to assess performance of the perceptual - cognition - decision - action loop?

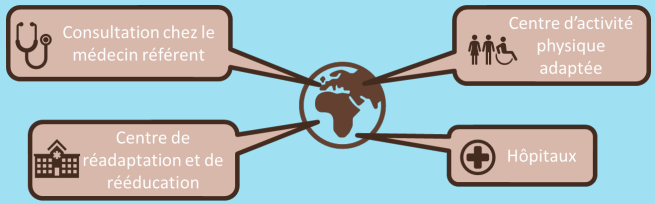
Current Tests to Assess Mobility and Functional Abilities

- A 2-step exam:

1. Discussion with the patient

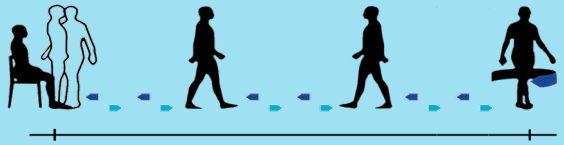
- ✓ Fall in the last 12 months?
- ✓ Daily activity?
- ✓ Malnutrition? Walking aid? Etc.

Location of assessment

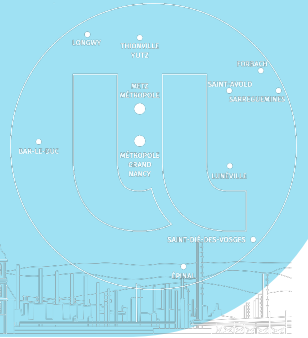


2. Functional Abilities Assessment

- ✓ TUG : timed up & go test ; Timed test
- ✓ Tinetti test; Practitioner-led qualitative analysis
- ✓ AGGIR Grid
- ✓ Activities of Daily Living (ADL) Scale



LIMITATIONS: Late, subjective, partial, and decontextualized evaluations



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Bodily remobilization programs

Tracking daily activities

Biofeedback

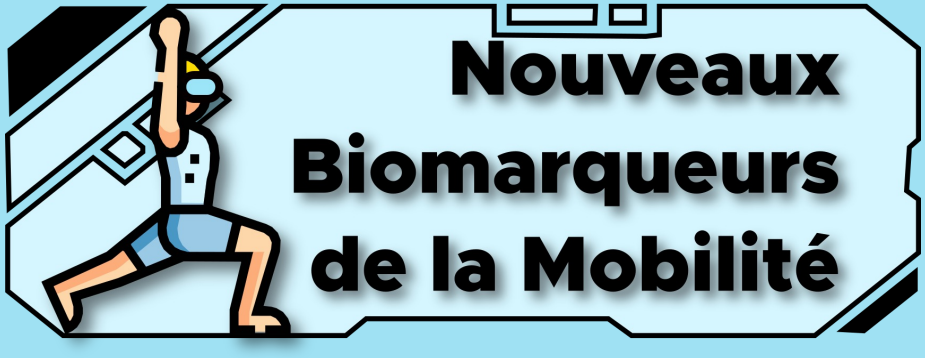
Virtual reality

Needs & Capabilities

What technological solutions are available to assess mobility and maintain functional abilities in the elderly?

Mobility/ Exercises
Living environments
Transport

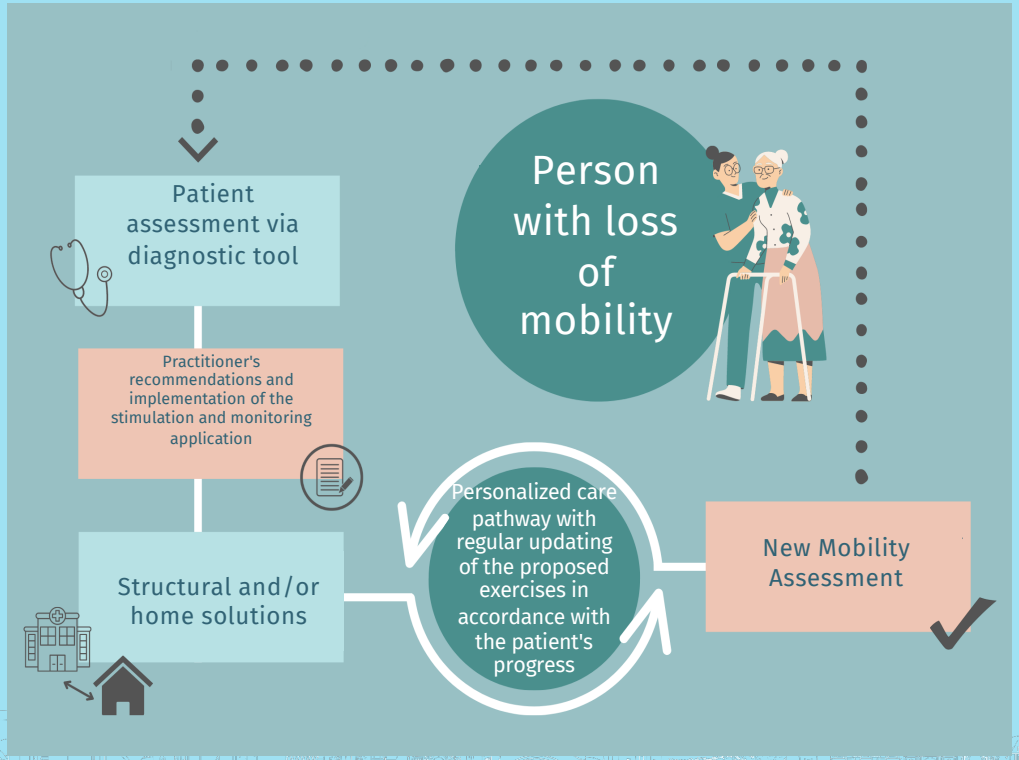
- Project objectives
  - Developing new biomarkers of mobility
  - Develop new methods and tools to Assess – Stimulate – Monitor
  - Develop a decision-support interface for a personalized patient journey
  - Develop a pathway with coordinated multi-professional health actions

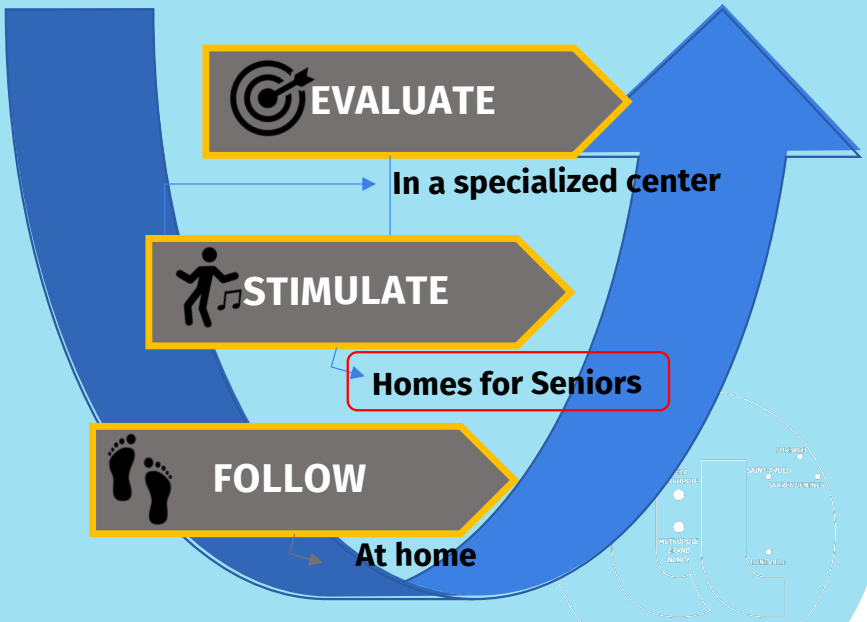


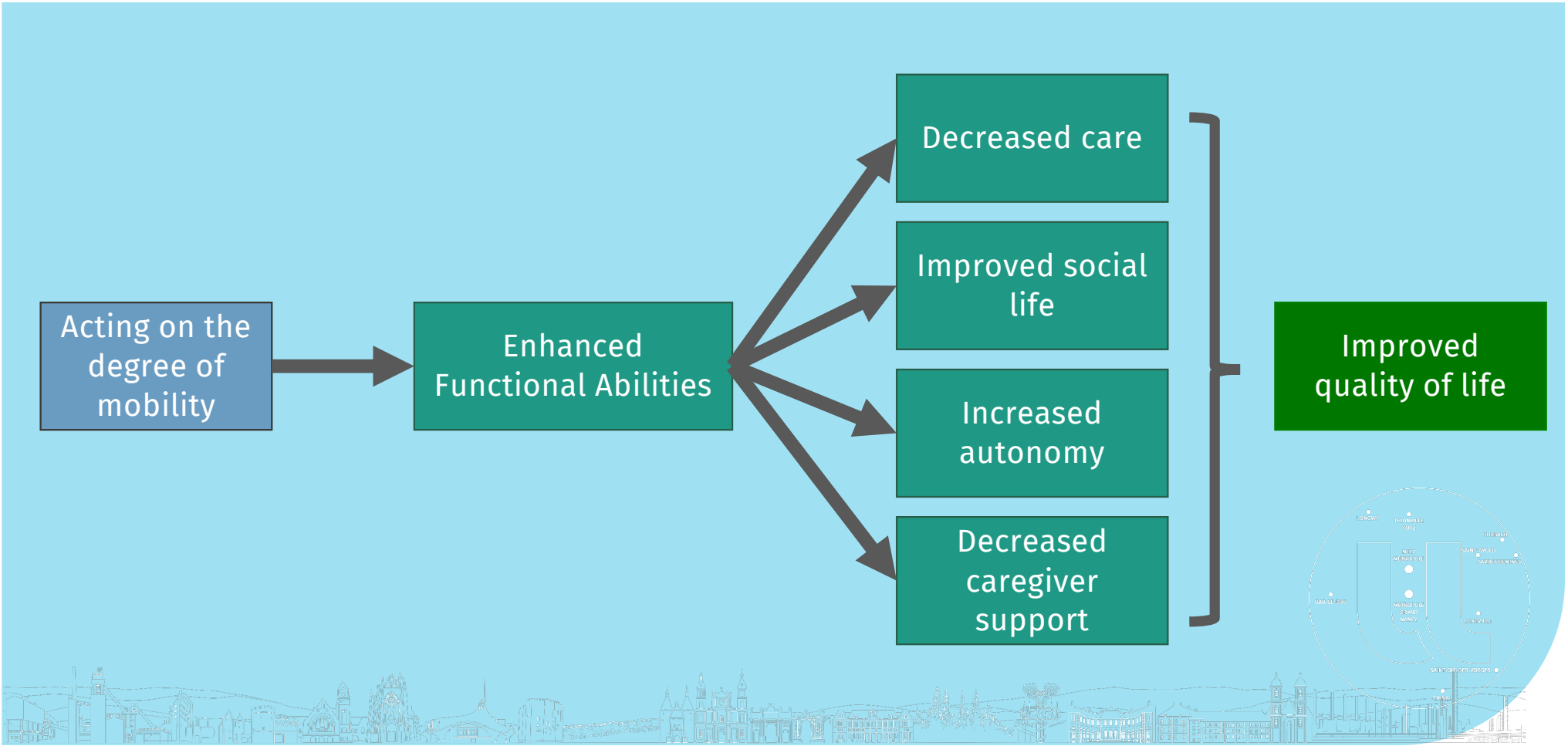
- **EVALUATE** : a diagnostic application based on the TUG enhanced through a virtual reality immersion + evaluation of physiological signals.
  STIMULATE : An immersive virtual reality retraining app that is patient controllable to set up a virtual prescription with a list of exercises.
  FOLLOW : An application interfaced with an inertial measurement unit worn by the patient at home to monitor the person's behavioral strategies in his or her environment.

https://biomarqueurs-lcoms.univ-lorraine.fr/

- Developing new biomarkers of mobility

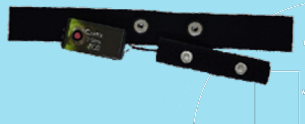


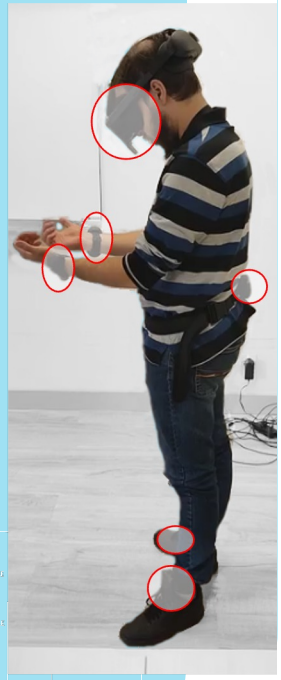



Acting on the degree of mobility
Enhanced Functional Abilities
Decreased care
Improved social life
Increased autonomy
Decreased caregiver support
Improved quality of life

HTC XR Elite and trackers

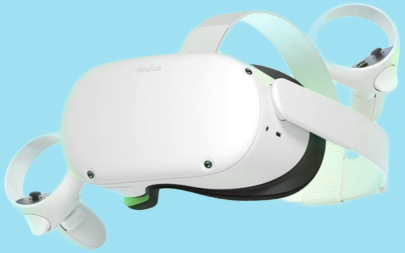
Wireless TEA Captiv Sensor (AED, T°, ECG, Respiration)





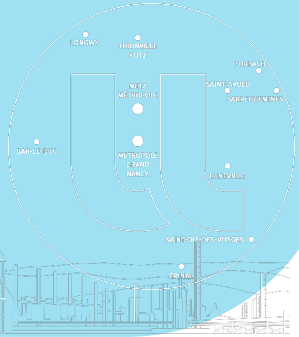
Axis 2: Patient remobilization via exergame VR/AR

A VR headset, configurable and deployable in less than three minutes, wireless, with a battery life of 1 hour, rechargeable in 15 minutes

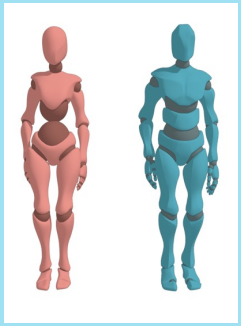


Auroria, the medical application to configure, personalize the treatment, control the immersion and collect data

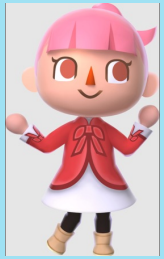
A collection of therapeutic games, designed in collaboration with doctors, researchers and experts to meet the different needs of patients during their care pathway (pain, anxiety, rehabilitation, mediation, etc.)

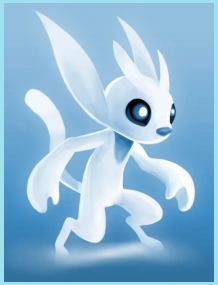


Axis 2 - Choice of an artistic direction with the focus groups



Les compagnons





Les environnements

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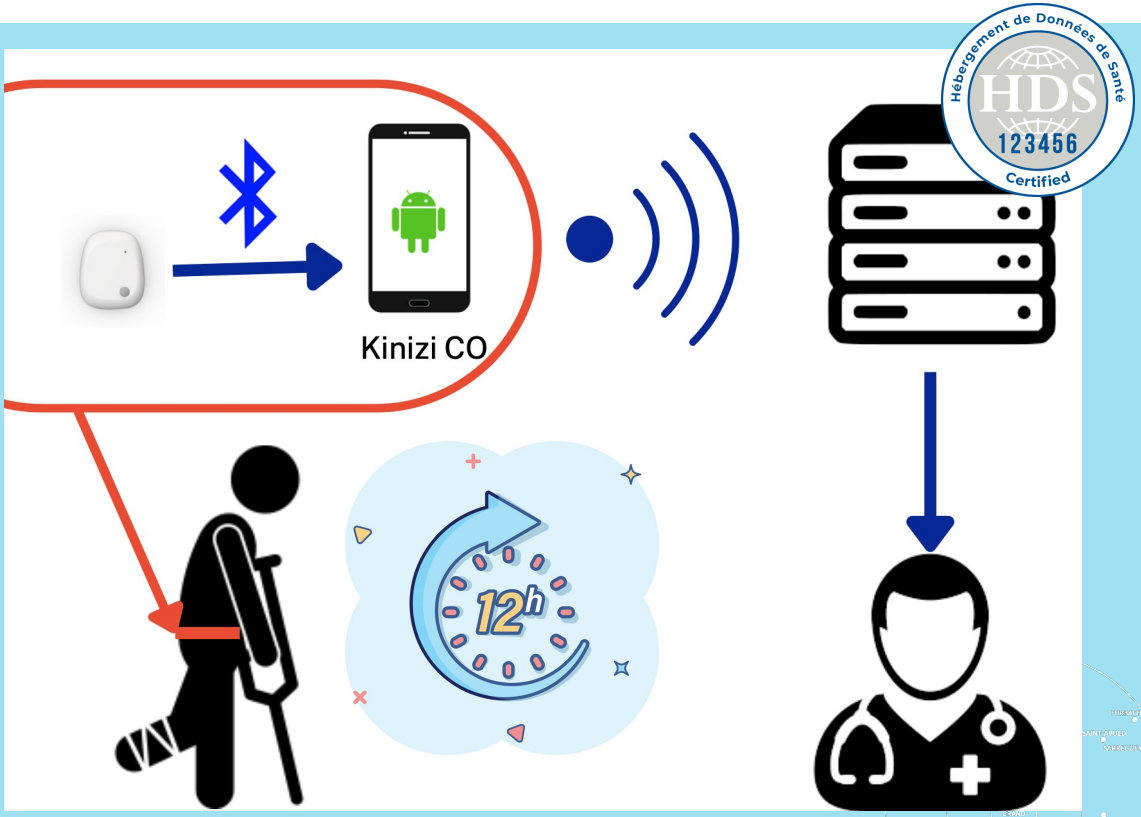
Usage scenario

- The patient wears the sensor (11g) on the belt from morning to night
- It has an Android mobile phone or tablet that retrieves data from the sensor locally
- The phone performs pre-processing and sends the results to the HDS server
- The server processes the information and stores it in a database
- The patient and their caregiver have separate accesses to view the results of the mobility tracking



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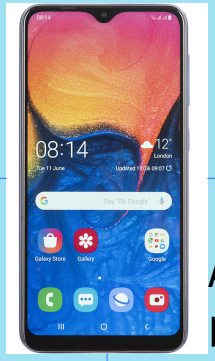
Development hardware

An inertial measurement unit



A phone portable

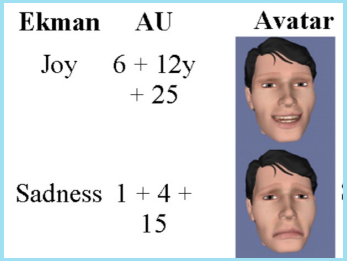
plesk

A server:
OVH (CYBERNANO)

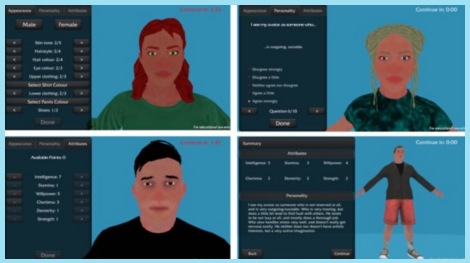
An app
Mobile: KINIZI

A web application: KINIZI

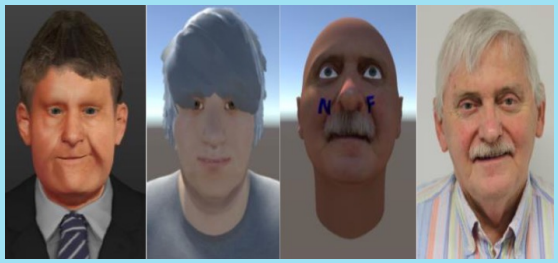
An age-old question still being addressed ...



Ortiz et al., 2007



Birk et al., 2016

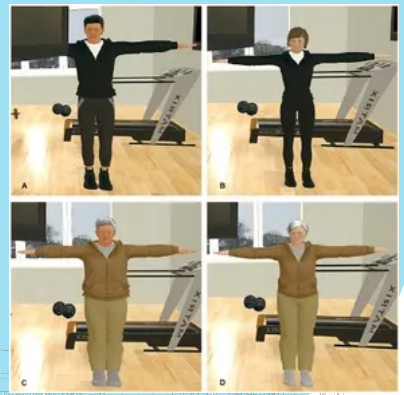


Puri et al., 2017

Baker et al., 2021

... which confirm the impact of several factors, including the "Proteus" effect or the Uncanny Valle

Lin & Wu, 2021

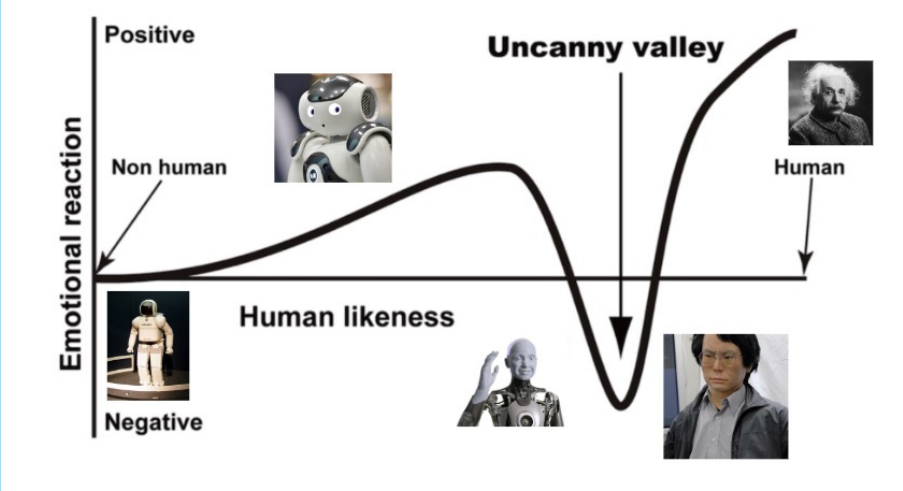


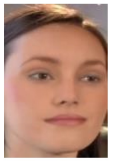
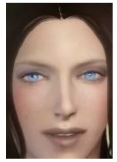
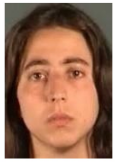
Proteus" effect the avatar is not just a costume but a "***full and complete representation of the self***" that enables two processes (Guegan *et al*., 2017) :

- deindividuation = alteration of self-awareness and the ability to reason about one's actions in a self-critical way.
- Rationalization = the individual self-influences and rationalizes his or her attitudes and behaviors within the virtual environment, in line with the identity cues conveyed by the avatar.

Guegan ab, J., Buisine bc, S., & Collange a, J. (2017). Effet Proteus et amorçage: ces avatars qui nous influencent. *Bulletin de psychologie*, *70*(1), 3-16.

"Uncanny Valley"□ discomfort we may feel when faced with avatars or robots that appear **"too close"** physically to humans (Dinet & Vivian, 2014)
→ Less marked for the elderly (Tu *et al.*, 2019) ?

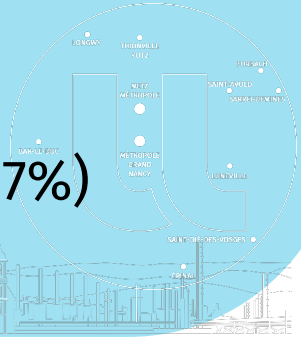


Gender(Sex)	Real	High	Mid1	Mid2-Low
Female	 Rose	 Emily	 Ilana	 Liliwen
Male	 Rycroft	 Ira	 Victor	 Macaw

Dinet, J., & Vivian, R. (2014). Exploratory investigation of attitudes towards assistive robots for future users. *Le travail humain*, *77*(2), 105-125.
Tu, Y. C., Chien, S. E., Lai, Y. Y., Liu, J. C., & Yeh, S. L. (2019). The Uncanny Valley Revisited: Age-Related Difference and the effect of function type. *Innovation in Aging*, *3*(Supplement_1), S330-S330.

Participants :

- ✓ *N* = 35 (-> seven focus groups with 5 participants each)
- ✓ Mean age = 73.2 years (*SD* = 5.7 years)
- ✓ Minimum age = 68.3 years; maximum age = 82.1 years
- ✓ Distribution: 29 women (82.8%)
- ✓ Level of education: before BAC (82.8%); BAC (8.5%); BAC + 2 (8.7%)



Protocol :

1- Welcoming participants (5 per focus group)

oral instructions with contextualization of the study ("To help us choose characters and environments for virtual environments for people over 70").

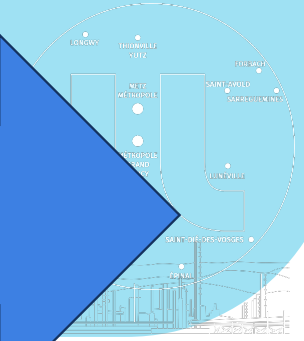
Task 1 = presentation of 5 items -> free verbalizations -> ranking (preference scores)

Task 2 = presentation of 5 items, -> free verbalization, -> ranking (preference scores)

Free debriefing (verbatims) and end of the study

1 2 3 4 5

Average duration of each focus group = 75 minutes (SD = 11 minutes)



Independent variables (factors manipulated) :

1. IV "AVATAR", 5 modalities
2. IV "ENVIRONMENT", 5 modalities

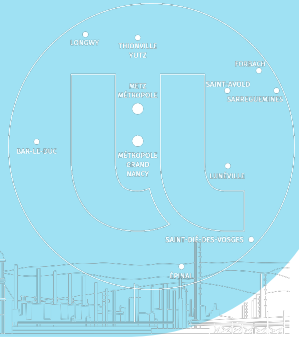
Dependent variables (measurements) :

1. Preference score (0 to 10)
2. Frequencies and occurrences of adjectives and nouns produced

Analysis plan: S_{35} * $AVATAR_5$ * $ENVIRONMENT_5$

Control variables :

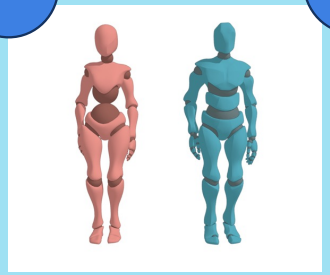
1- counterbalancing of items for each task (to avoid an order effect)
2- counterbalance the two tasks (to avoid an order effect)
3- same avatars and same environments presented
4- "limited" experience with digital environments (online games, smartphone games)
5- no severe cognitive impairment
6- always the same moderator for all focus groups
7- avatars and environments are presented according to a number (to avoid the vocabulary effect)
8- same video projector (1800 lumens)
9- same projection size (75-inch screen)
10- same distance between participants and screen
11- no known or known language disorders
12- declared correct vision (correction for 80% of participants)
13- data collection during July 2024



Materials :

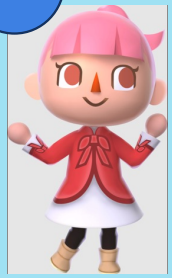
AVATARS

1



MIXAMO

2



Animal C

3

Iremia

4

LIFESTRANGE

5

ORI

ENVIRONMENTS

1

FF14

2

Ring Fit

3

Mario

4

Animal C

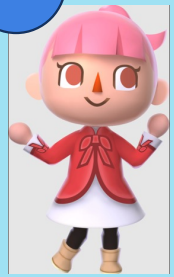
5

Iremia

Avatars (preferences, from 0 to 10) :

AVATARS

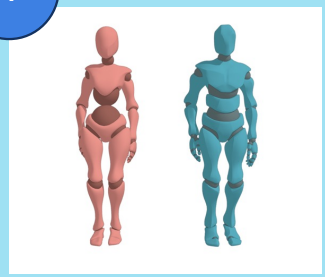
8.1



7.6

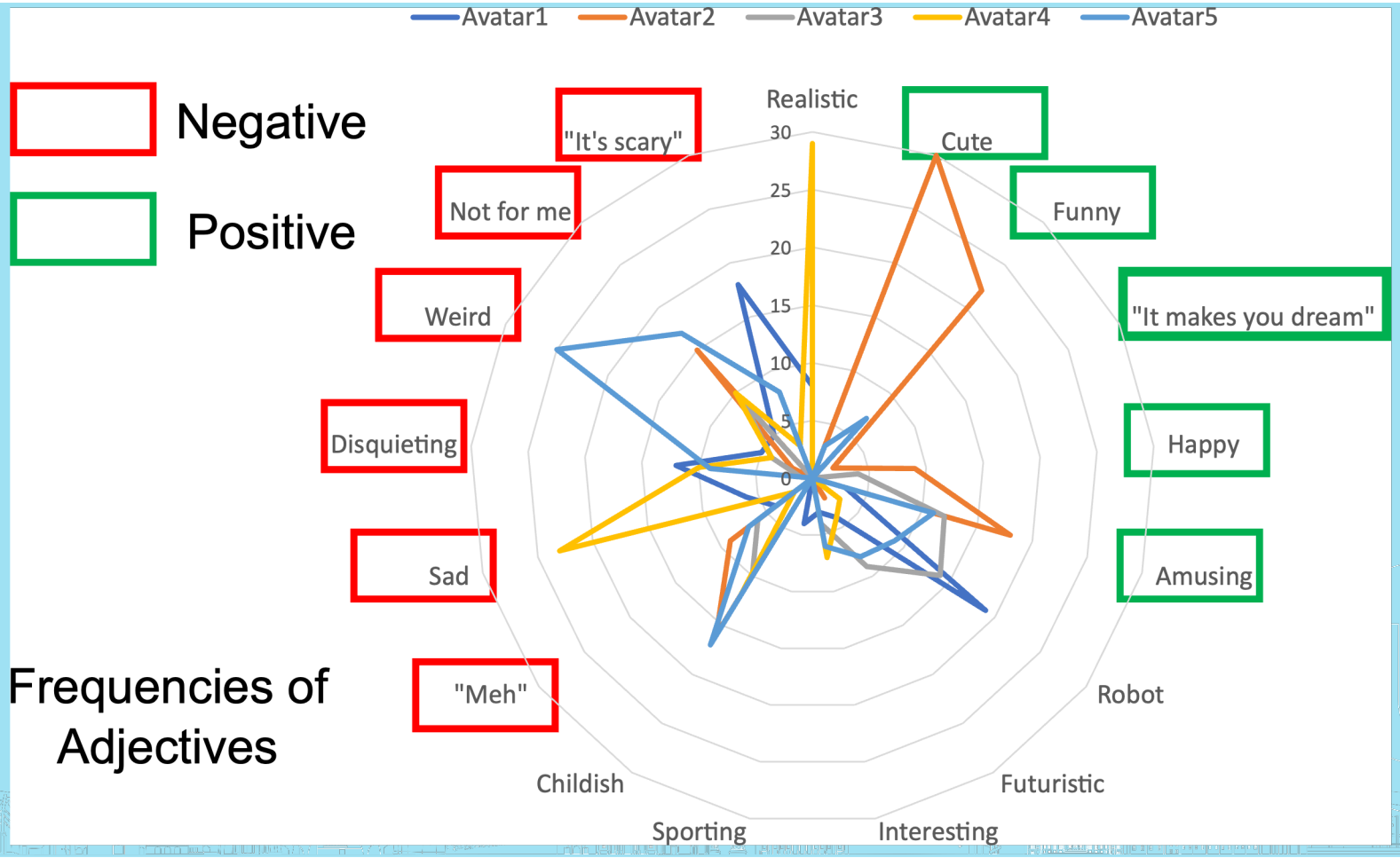
6.8

2.5



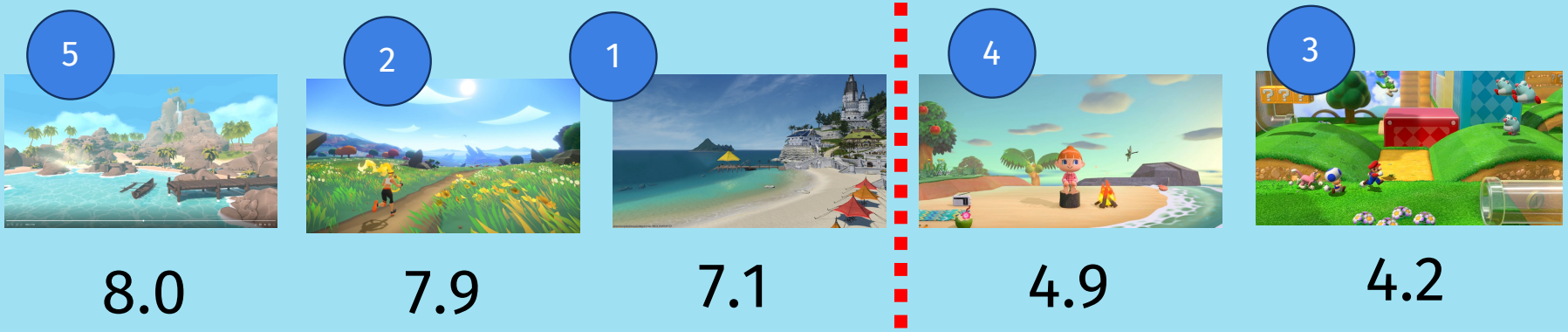
1.3

- ✓ Strong preference for 3 avatars ("3", "2" and "4")
- ✓ Strong disappointment for 2 avatars ("5" and "1")
- ✓ Clear difference between the two categories ("4" *vs.* 5", *p*<.001)
- ✓ Existence of inter-individual differences (Proteus effect)

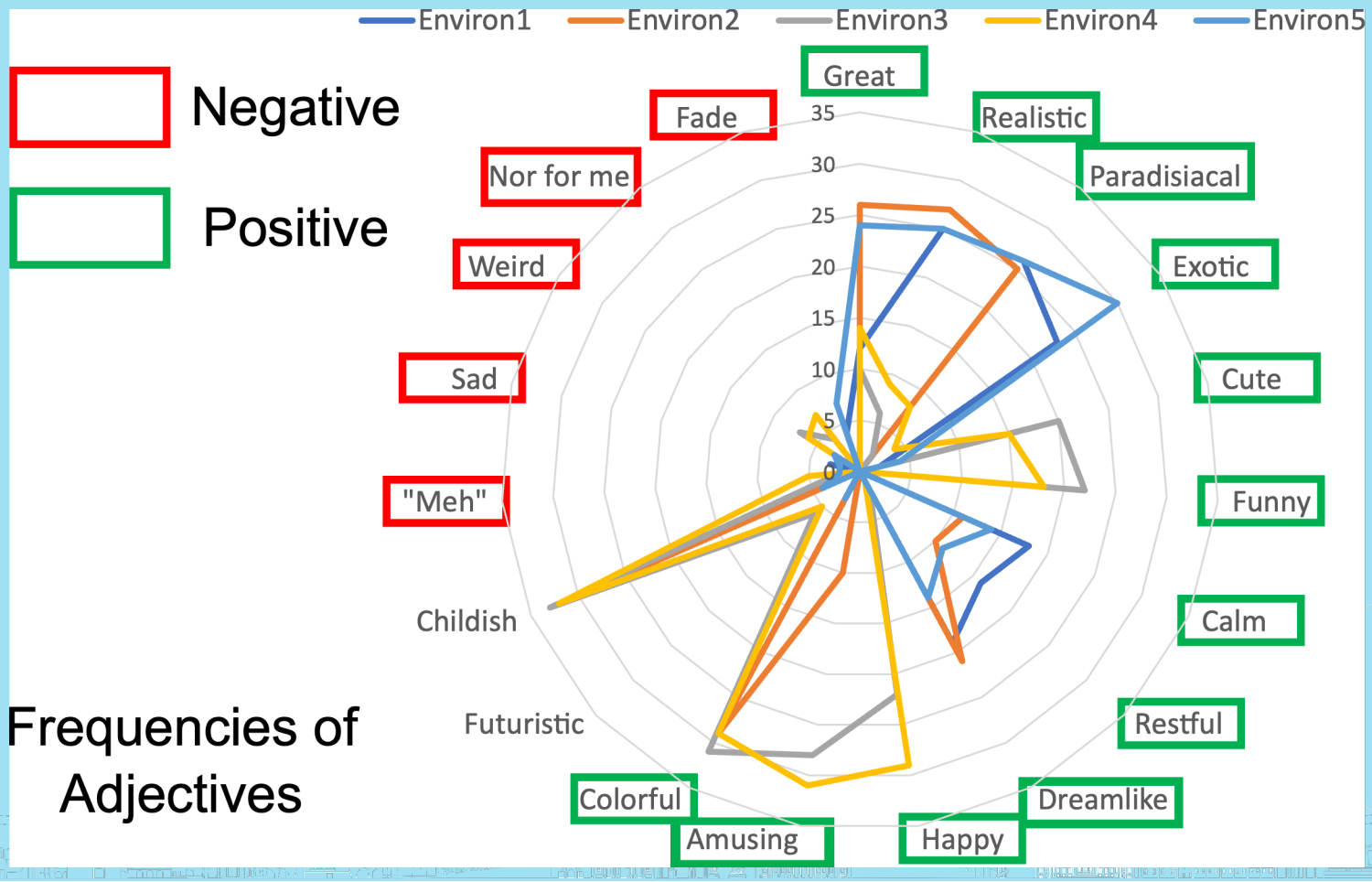

Avatar1
Avatar2
Avatar3
Avatar4
Avatar5
Negative
Positive
Frequencies of Adjectives
Realistic
Cute
Funny
"It makes you dream"
Happy
Amusing
Robot
Futuristic
Interesting
Sporting
Childish
"Meh"
Sad
Disquieting
Weird
Not for me
"It's scary"
30
25
20
15
10
5
0

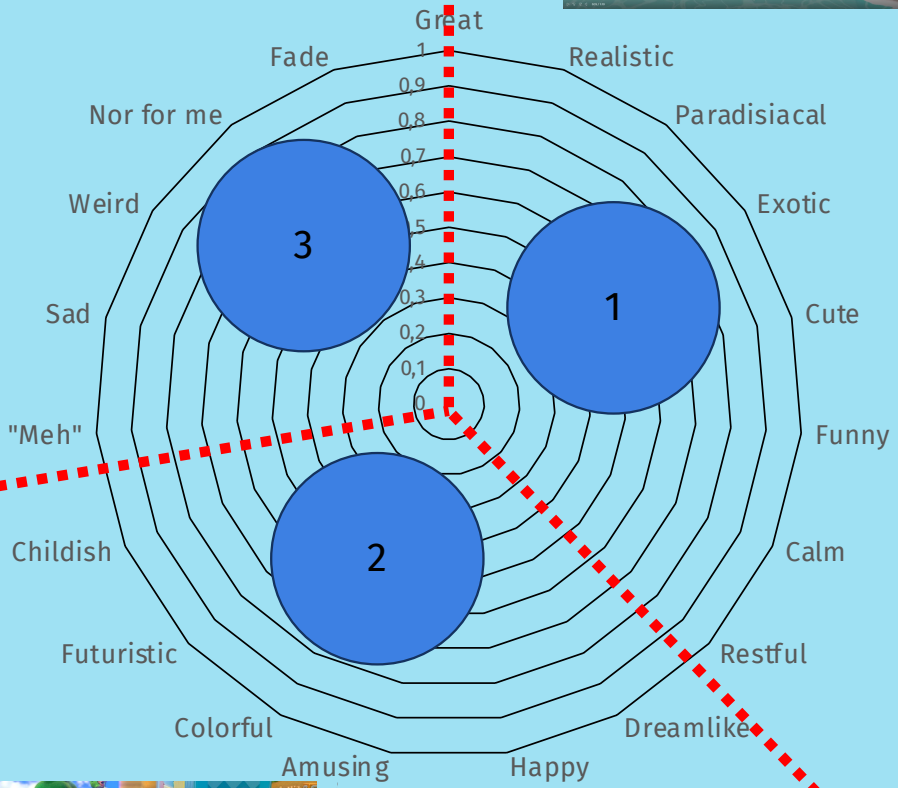
Environments (preferences, from 0 to 10) :

ENVIRONMENTS



- ✓ Clear preference for 3 environments ("5", "2" and "1")
- ✓ More reserved (average) opinions for two environments ("4" and "3")
- ✓ Clear difference between the two categories ("1" *vs.* 4", *p*<.001)
- ✓ Fewer inter-individual differences
- ✓ Many significant positive correlations


Environ1
Environ2
Environ3
Environ4
Environ5
Negative
Positive
Great
Realistic
Paradisiacal
Exotic
Cute
Funny
Calm
Restful
Dreamlike
Happy
Amusing
Colorful
Futuristic
Childish
"Meh"
Sad
Weird
Nor for me
Fade
35
30
25
20
15
10
5
0
Frequencies of Adjectives


Great
Realistic
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Cute
Funny
Calm
Restful
Dreamlike
Happy
Amusing
Colorful
Futuristic
Childish
"Meh"
Sad
Weird
Nor for me
Fade
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
1
2
3

Limits :

✓ Avatars and static environments
("It doesn't move", "What can it do?", "It's weird, everything's frozen...")

✓ Lack of precise contexts of use
("But what's it for?", "Is it for games?")

✓ Strong impact of personal experience
("With my grandson, I sometimes play this thing", "

✓ Pas d'évaluation objective de la sensibilité aux couleurs et aux contrastes
(« Je vois rien du tout », « Mais c'est quoi au fond, c'est de l'eau

✓ Effets de groupe non contrôlés (influence majoritaire, minoritaire, leadership, ...)
(« Ben, si les autres pensent ça alors ... », « Vous utiliseriez ça vous plus tard ? Et ben dites-donc ... »

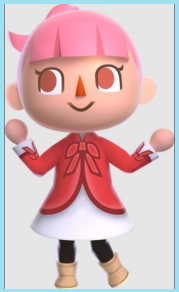
Conclusion:

✓ opinions and attitudes *A priori :*

➔ clear preferences for certain avatars (realistic, cute, etc.)

➔ less marked differences for environments

✓ Preferred combinations (for different reasons!) :



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Gameplay Trailer

- Thanks for your attention
- Any questions ?