SCHOOL OF PSYCHOLOGICAL SCIENCES & HEALTH

University of Strathclyde Humanities & Social Sciences

Technologies for assessment of cognitive and functional abilities: from the lab to the real world

Dr Mario A Parra

Technologies for Brain Health and Dementia Prevention Workshop

13-14 June 2022

Technology and Innovation Centre, University of Strathclyde

Scottish Dementia Research Consortium

Digital Health & Care Innovation Centre

Challenges & Needs

University of Strathclyde
Humanities & Social Sciences

Technologies for assessment and intervention of cognitive and functional abilities face important challenges:

1. **Lack of theory** – existing systems are not theory driven with little evidence of performance measures and sustained improvements post-intervention.
2. **Poor ecological validity** – available tools do not promote transfer to real life situations.
3. **Rigid intervention platforms** – most work focuses on a one-size-fits-all solution, unsuitable for personalised interventions.
4. **Non-adaptive system** – one of the most difficult aspects of living with dementia is changes and fluctuations in cognition and behaviour which are overlooked by available technologies.

Challenges & Needs

University of Strathclyde
Humanities & Social Sciences

Person-centred approach

ICT solutions (VR Environments, Assistive Living Settings, Robot Companions, etc.) must provide opportunities for meaningful interactions with the affected individual.

From cognitive sciences

Routledge
Taylor & Francis Group

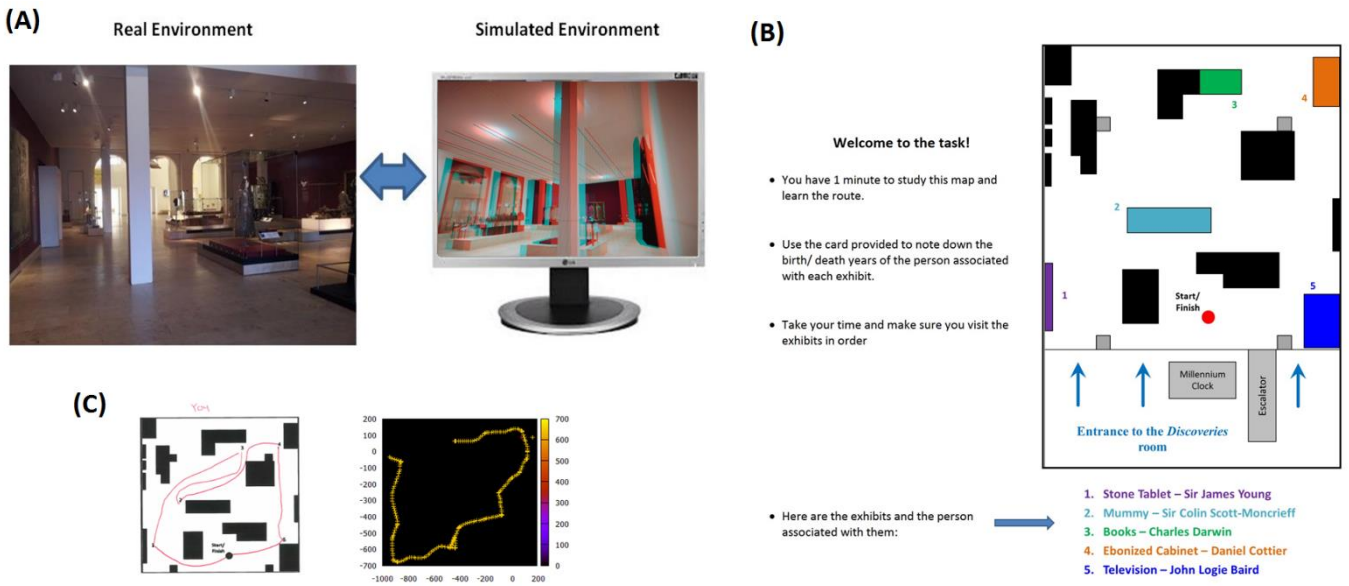
Experimental Aging Research

An International Journal Devoted to the Scientific Study of the Aging Process

ISSN: 0361-073X (Print) 1096-4657 (Online) Journal homepage: https://www.tandfonline.com/loi/uear20

Predictors of Performance in Real and Virtual Scenarios across Age

Mario A. Parra & Rini I. Kaplan



Key findings:

1. Testing environment effected efficiency but not accuracy (longer distances in RE than in VE).
2. Task order effect (when RE first better performance than when VE first).
3. Older adults showed similar accuracy and efficiency to younger adults but needed more cognitive resources (visuospatial abilities).
4. Older adults performance correlated to Activities of Daily Living.
5. Knowledge transfer between RE and VE in younger but not in older adults.

From cognitive sciences

University of Strathclyde Humanities & Social Sciences

VRAIS – Virtual Reality Assessment and Intervention System

This project investigated the cognitive profiles that characterise the normal age-related decline of IADL. We aimed to gather evidence of the cognitive functions that account for successes and failures during IADL performance across age.

From cognitive sciences

VRAIS – Virtual Reality Assessment and Intervention System

Subtask 1: Prepare a cup of tea	Item
1.Take the kettle	
2. Turn on the water tap	
3. Fill the kettle	
4.Turn on the kettle to boil water	
5. Take a tea cup - black with white circles	
6. Put a tea cup on the counter top	
7. Pick up a Yorkshire tea bag	
8.Put a tea bag into the teacup	
9.Take the kettle	
10.Put boiling water into the cup	

Subtask 2: Prepare a sandwich

Subtask 3: Prepare a bowl of cereals

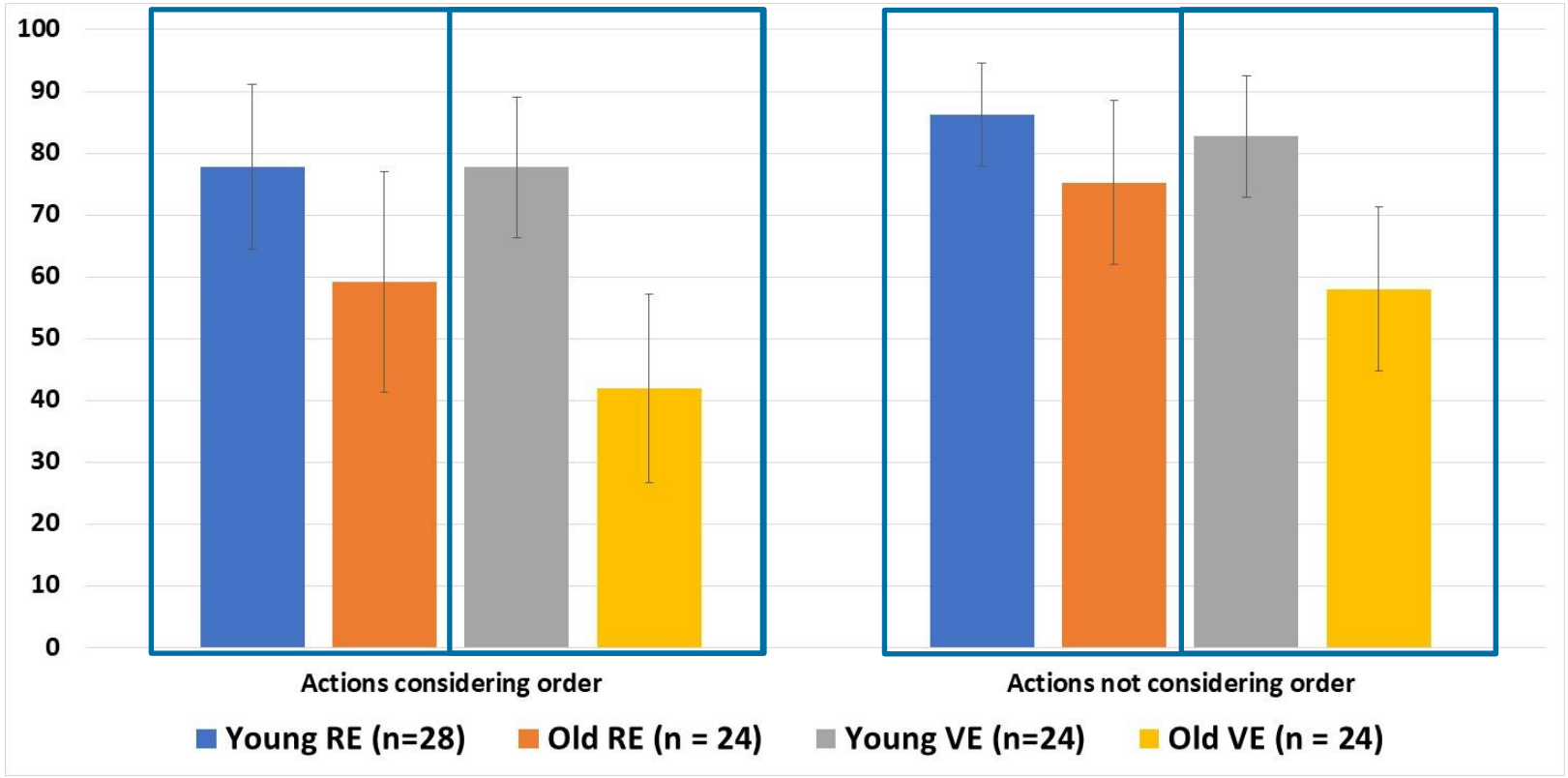
Subtask 4: Set the table

Subtask 5: Wash the dishes

Subtask 6: Clean the Kitchen

From cognitive sciences

VRAIS – Virtual Reality Assessment and Intervention System



$F = 9.18$, $p < 0.005$, $\eta^2_p = .087$

$F = 8.55$, $p < 0.005$, $\eta^2_p = .082$

$F = 1.755$, $p = 0.188$, $\eta^2_p = .018$

Older adults performed more poorly than younger adults.

The age-related decline was more pronounced when:

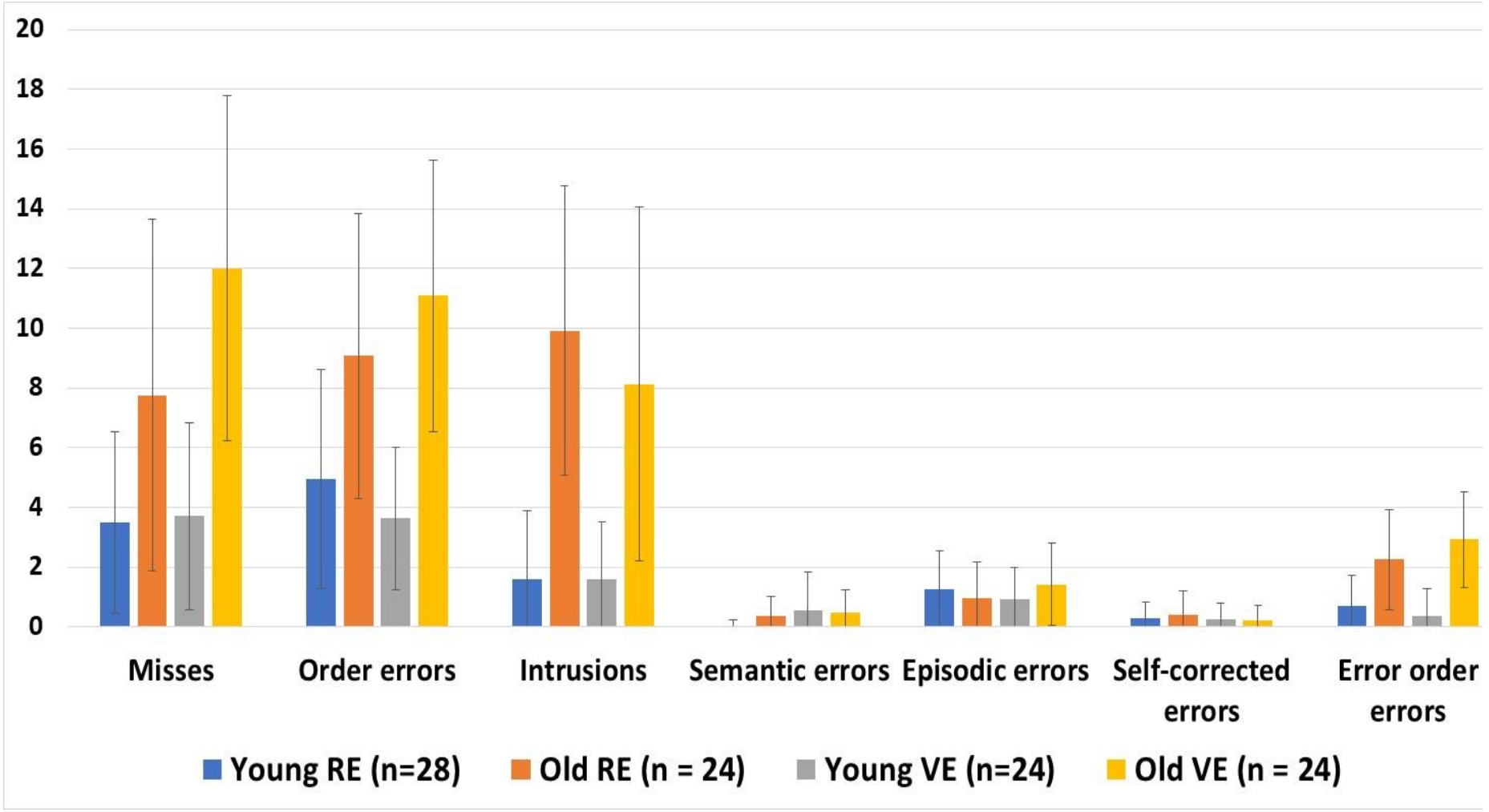
- Serial recall of actions was considered.

- The task was performed in the virtual environment.

These effects were independent.

From cognitive sciences

VRAIS – Virtual Reality Assessment and Intervention System



Older people missed more tasks. They also had more intrusions and order errors (VE > RE).

Was this because aspects of the task were unfamiliar to them?

- Unfamiliar sequence.
- Unfamiliar items.

From cognitive sciences

VRAIS – Virtual Reality Assessment and Intervention System

University of Strathclyde Humanities & Social Sciences

Table 5. *The number of misses, unrelated intrusions and related intrusions made by healthy younger and older adults on the everyday kitchen tasks in either the real environment or the virtual (VR) environment.*

	Real environment		VR environment		Main analysis			Post-hoc comparisons			
	Young (n=28) Mean (SD)	**Old (n = 24)** Mean (SD)	**Young (n=24)** Mean (SD)	**Old (n = 24)** Mean (SD)	**Group** F, *p*, η^2_p	**Environment** F, *p*, η^2_p	**Interaction** F, *p*, η^2_p	$Y_{Real} - O_{Real}$ *p*, *d*	$Y_{VR} - O_{VR}$ *p*, *d*	$Y_{Real} - Y_{VR}$ *p*, *d*	$O_{Real} - O_{VR}$ *p*, *d*
Misses	3.50 (3.05)	7.75 (5.89)	3.71 (3.13)	12.00 (5.77)	F = 46.05, ***p* < .001**, η^2_p = .324	F = 5.819, ***p* < 0.05**, η^2_p = .057	F = 4.78, ***p* < 0.05**, η^2_p = .047	***p* < .01**, *d* = 0.38	***p* < .001**, *d* = 0.63	*p* = 1.00, *d* = 0.03	*p* < .05, *d* = 0.28
Unrelated intrusions	0.39 (0.63)	2.04 (2.26)	1.13 (1.80)	1.92 (1.98)	F = 12.18, ***p* = 0.001**, η^2_p = .113	F = 0.754, *p* = 0.387, η^2_p = .008	F = 1.502, *p* = 0.223, η^2_p = .015	***p* < .005**, *d* = 0.96	*p* = .154, *d* = 0.35		
Related intrusions	1.21 (1.85)	8.00 (4.78)	0.58 (1.18)	6.25 (5.43)	F = 69.69, ***p* < 0.001**, η^2_p = .421	F = 2.548, *p* = 0.114, η^2_p = .026	F = 0.563, *p* = 0.455, η^2_p = .006	***p* < .001**, *d* = 1.76	***p* < .001**, *d* = 1.41		

Note 1: Post-hoc Bonferroni correction for multiple comparisons leads only to a significant result if the p-value is below 0.0083 (0.05 / 6 comparisons).
Note 2: Significant findings are indicated in **bold**.

Older adults tended to replace unfamiliar tasks/items with tasks/items familiar to them.

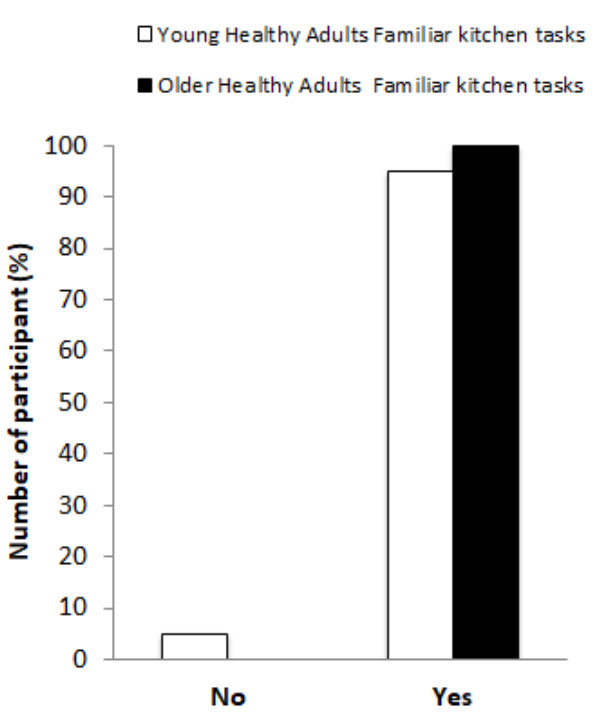
From cognitive sciences

VRAIS – Virtual Reality Assessment and Intervention System

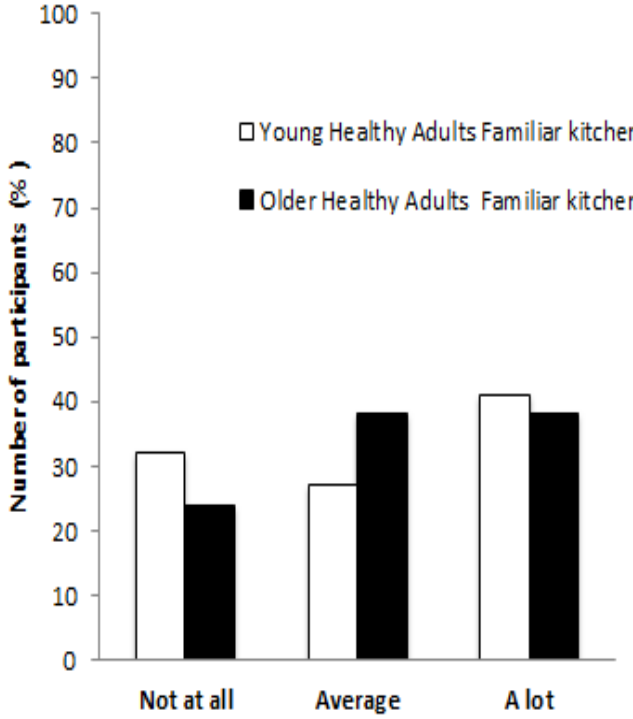
University of Strathclyde Humanities & Social Sciences

Subjective experiences

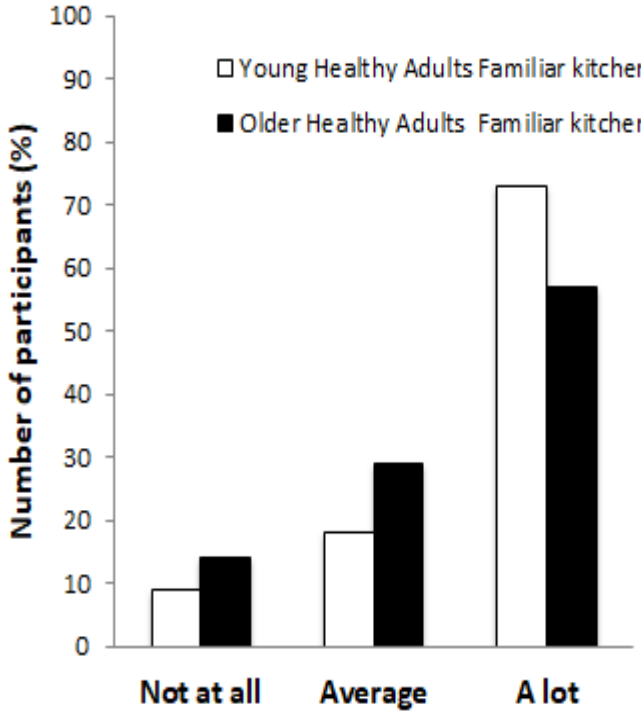
Easier to perform in real environment



Sense of being in a real environment



Enjoying the VR environment



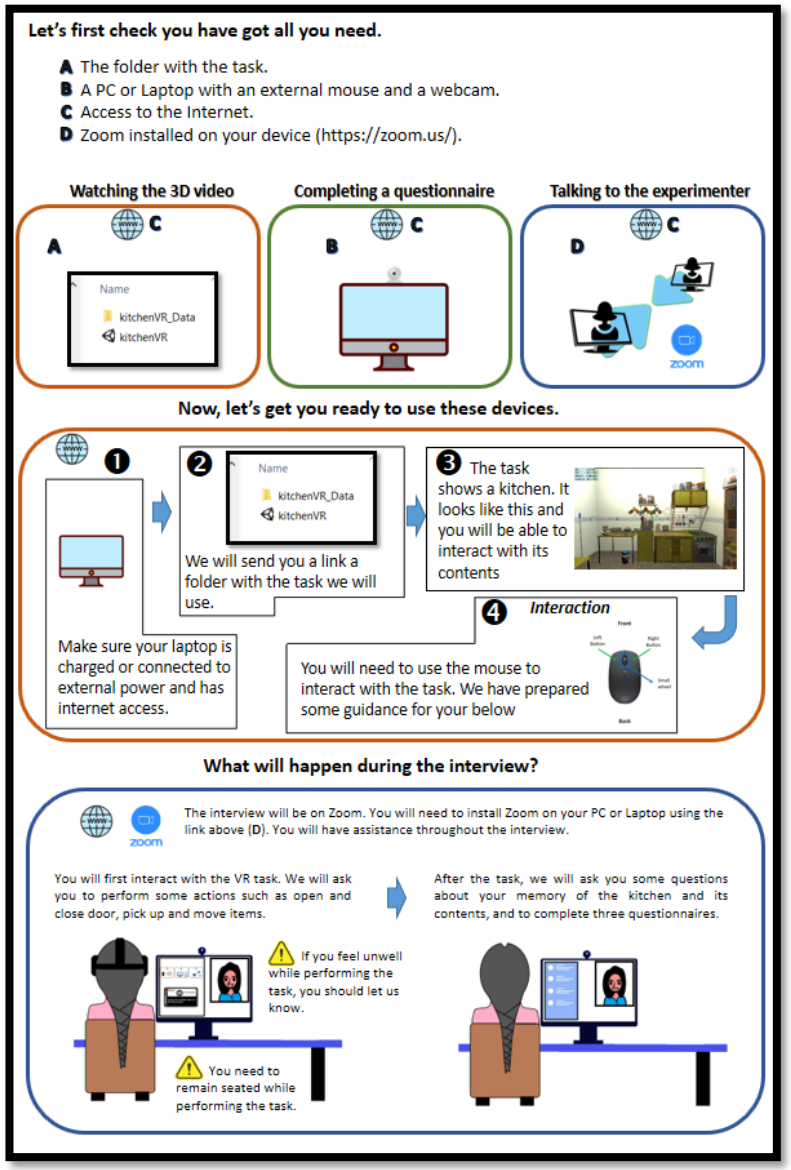
From cognitive sciences

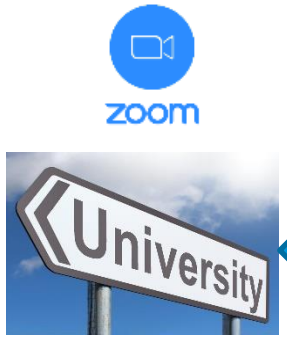
VRAIS – Virtual Reality Assessment and Intervention System

University of Strathclyde Humanities & Social Sciences

1. VR offers a reliable tool to assess functional abilities (IADL) in older people.
2. Older people's experiences, preferences, and cognitive abilities need to be considered and incorporated in VR tools.
3. Meaningful VE can offer optimal scenarios to assess the cognitive underpinnings of functional decline in old age.
4. **Future research should focus on how to enhance meaningfulness, personalization, and optimal interfaces for visualization and interaction.**

From the lab to the real world





From the lab to the real world

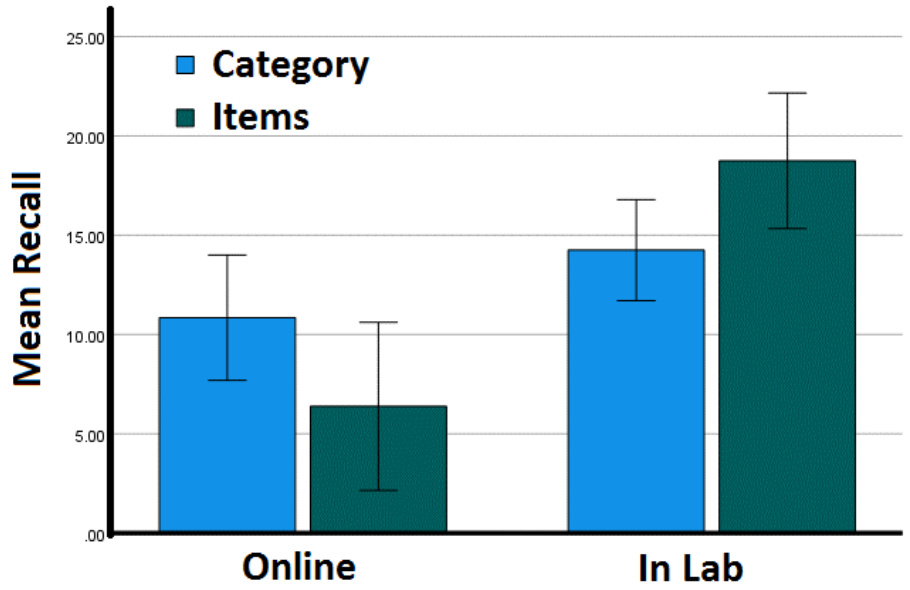
University of Strathclyde Humanities & Social Sciences

VR Kitchen Task: The task consisted of navigating a VR kitchen environment to explore its contents. Separate groups performed the task across settings (lab and home) and visual experiences (3D vs 2D). Memory was then assessed across levels of representation (Category and Item).

Expeirment		N	Mean	Std. Deviation
Age	Online	13	46.42	20.24
	In Lab	20	46.50	23.86

F/M: 40/60%

Education: 77% >=High school



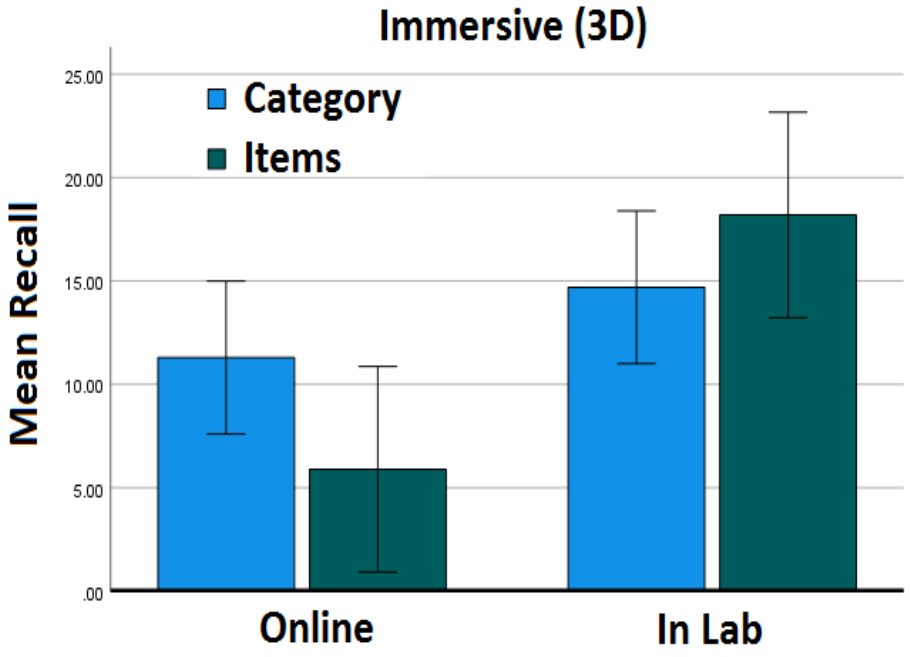
Exp x Type Memory: $F(1,31)=7.21$, p=**0.012**, η^2 =.19 , β=74%

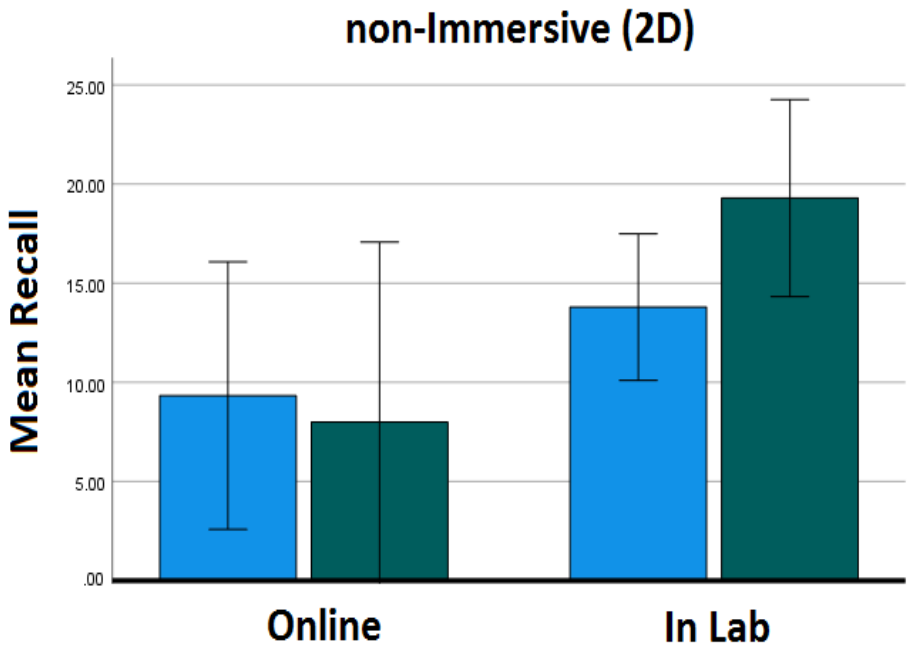
People tended to perform better in the Lab than at home.

Performing the task in an uncontrolled environment (i.e., at home) particularly affected memory for detailed information (item-based).

From the lab to the real world

VR Kitchen Task: We also assessed whether exploring the kitchen environment during immersive (VR headset) vs non-Immersive interactions had an effect.





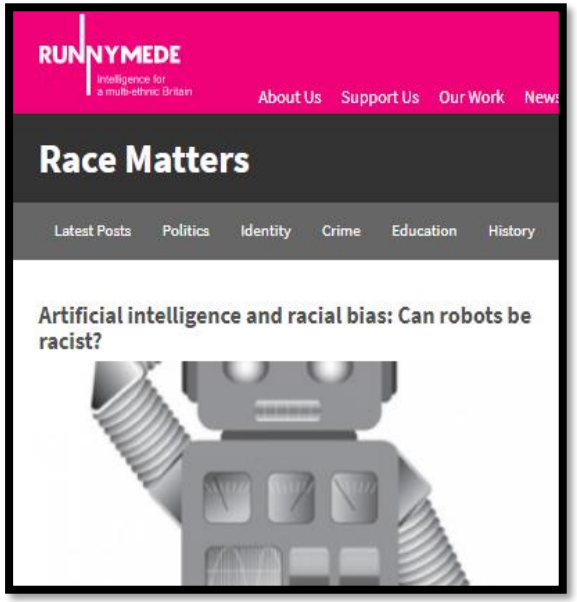
These effects seem to be independent of whether people experienced the task in an immersive (3D) or o non-immersive (2D) environment.

Exp x Type Memory: $F(1,31)=4.25$, p=**0.048**, η^2 =.13 , β=51%

Exp x Type Memory x Vis Experience: $F(1,31)=0.73$, p=**0.788**, $\eta^{2=}$=.03, β=6%

From the lab to the real world

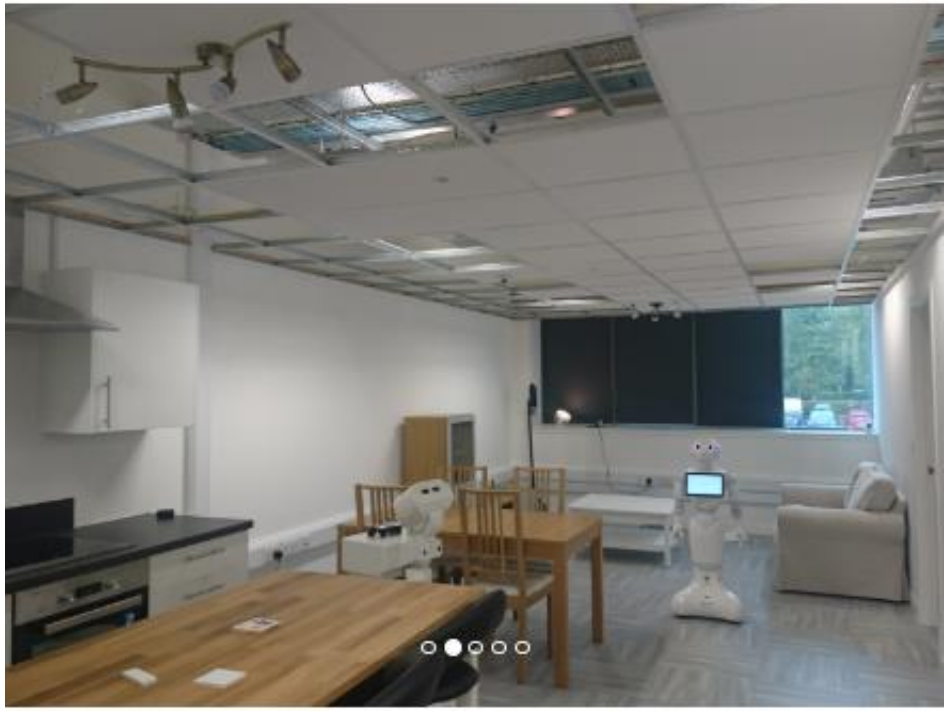
University of Strathclyde Humanities & Social Sciences



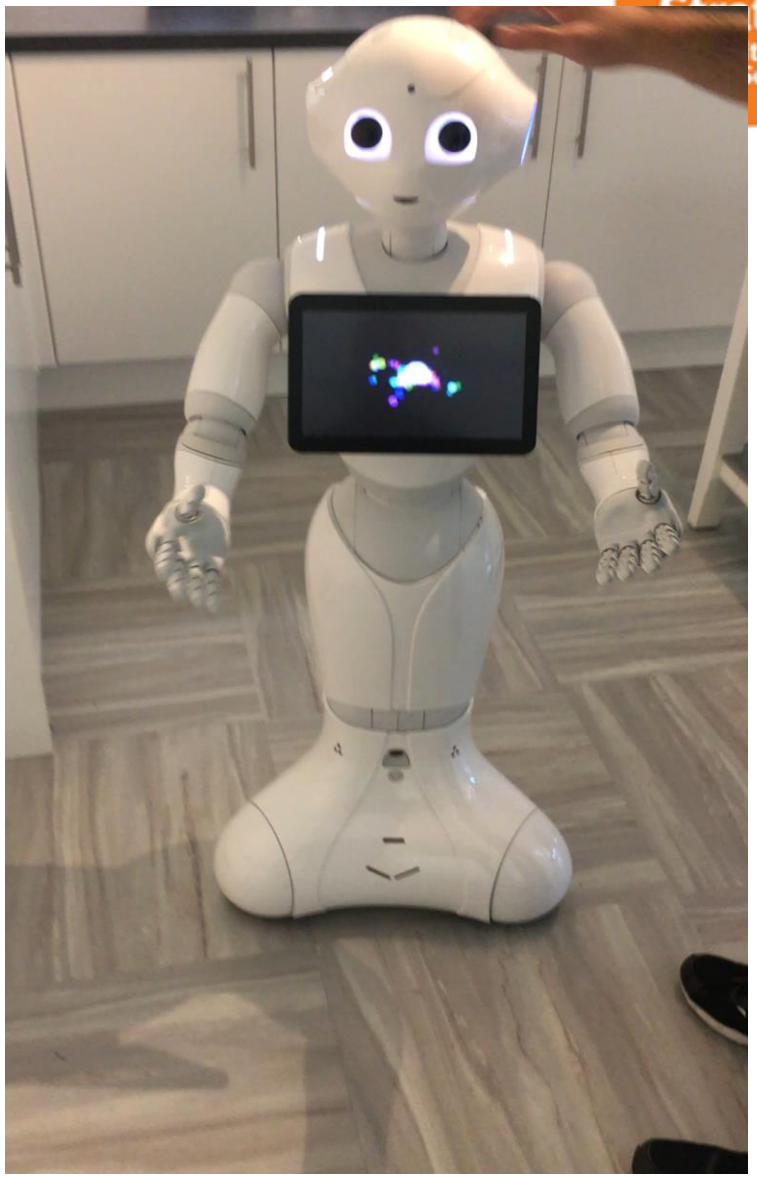
For ICT Solutions to be real solutions, they must be culturally and linguistically valid, ethically and socially viable.

From the lab to the real world

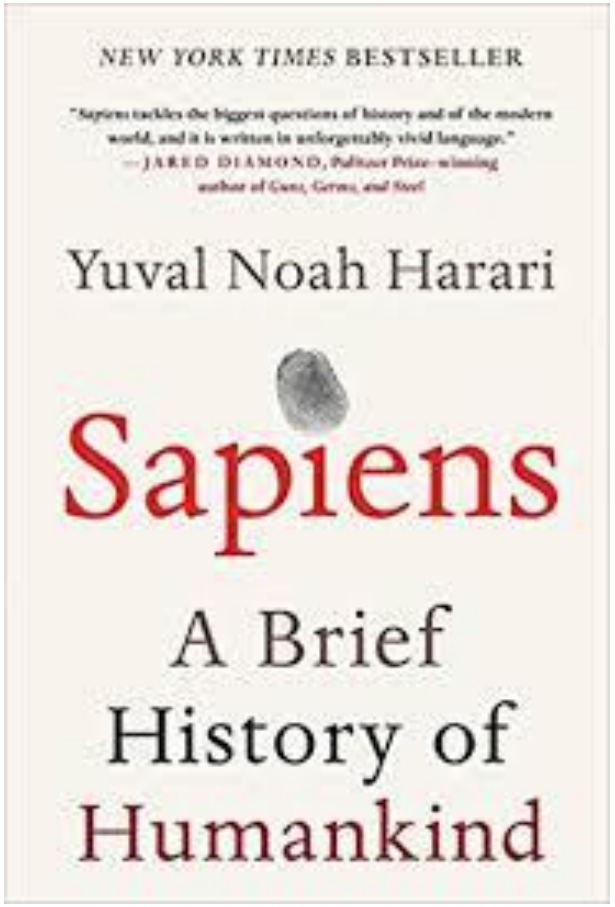
Dr Mauro Dragone
Assistant Professor
ENGINEERING AND PHYSICAL SCIENCES
INSTITUTE OF SENSORS, SIGNALS AND SYSTEMS

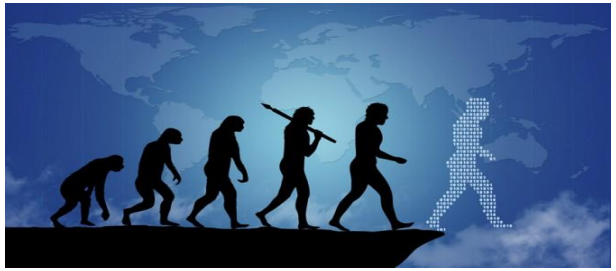


ICT-Robotic Independent Living Laboratory



From the lab to the real world





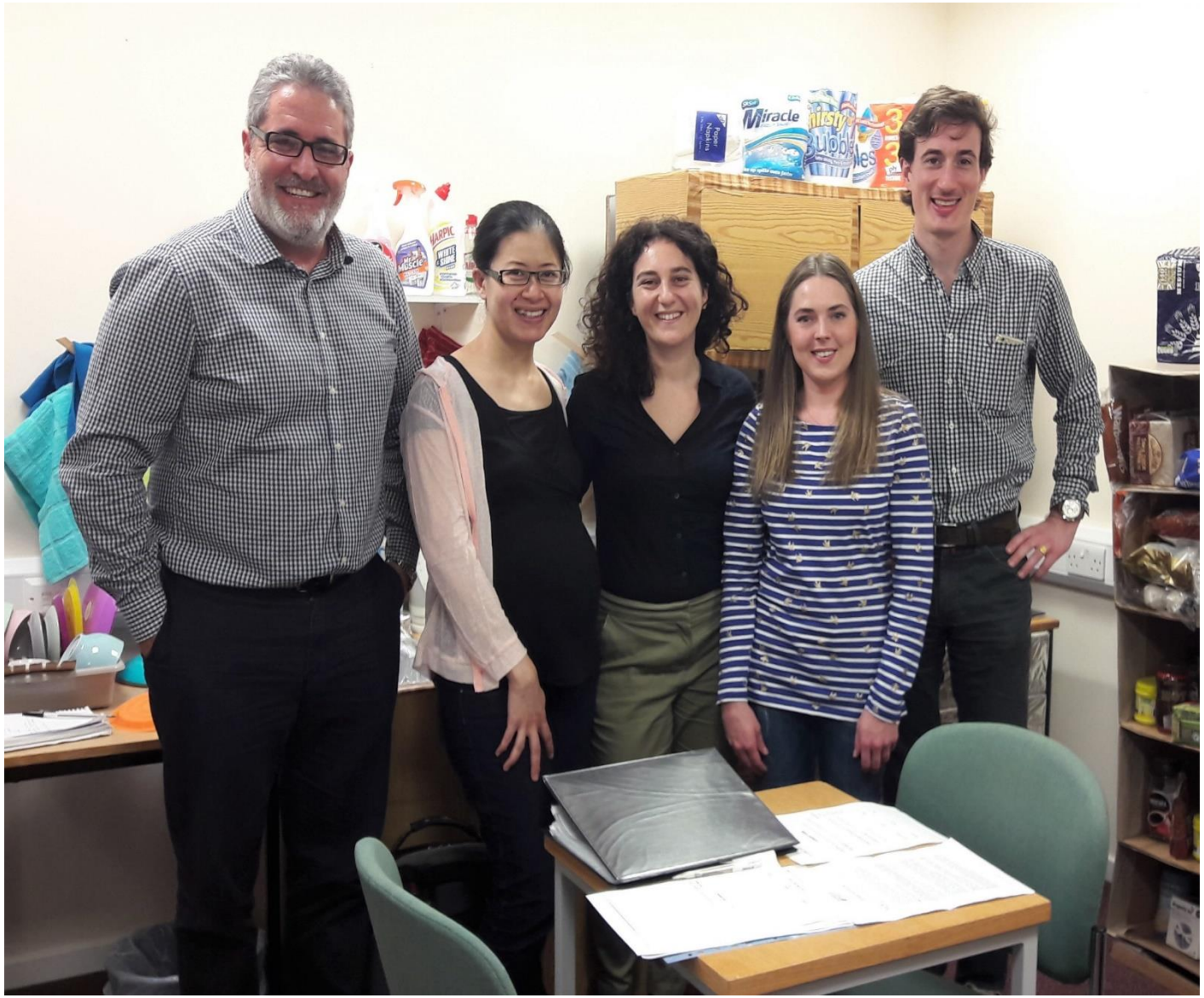
Chapter 20.

The End of *Homo Sapiens*

THIS BOOK BEGAN BY PRESENTING HISTORY as the next stage in the continuum of physics to chemistry to biology. Sapiens are subject to the same physical forces, chemical reactions and natural-selection processes that govern all living beings. Natural selection may have provided*Homo sapiens* with a much larger playing field than it has given to any other organism, but the field has still had its boundaries. The implication has been that, no matter what their efforts and achievements, Sapiens are incapable of breaking free of their biologically determined limits.

But at the dawn of the twenty-first century, this is no longer true: *Homo sapiens* is transcending those limits. It is now beginning to break the laws of natural selection, replacing them with the laws of intelligent design.

The VR team



HERIOT WATT UNIVERSITY

University of Strathclyde Glasgow

Prof Ruth Aylett

Dr Mauro Dragone

Dr Graham Wilson

Dr Kieren Egan

Q&A

University of Strathclyde Humanities & Social Sciences

Who needs the most support? Why?

What type of support is needed?

What are the current care support networks?

How might these change in the future?

What are the current barriers to technology-enabled care solutions like?

What would the socio-economic factors and privacy and other ethical issues might influence adoption/acceptance?

SCHOOL OF PSYCHOLOGICAL SCIENCES & HEALTH

University of Strathclyde Humanities & Social Sciences

Technologies for assessment of cognitive and functional abilities: from the lab to the real world

Dr Mario A Parra

Thank you