Ersilia Vallefuoco

Tutor: Prof. Alessandro Pepino

XXXII Cycle - III year presentation

A personalised serious game to improve daily living skills in people with Autism Spectrum Disorder

Ersilia Vallefuoco

- **Graduation**: MSc in Biomedical Engineering – University of Naples Federico II

- **Fellowship**: DIETI-SInAPSi

- **Research Field:** rehabilitation engineering

- **Research Activity:** serious games for people with Autism Spectrum Disorder

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Summary of the credits obtained attending modules and seminars and doing research activities.

	Credits year 1								Credits year 2								Credits year 3									
	Estimated	1 bimonth	2 bimonth	3 bimonth	4 bimonth	5 bimonth	6 bimonth	Summary	Estimated	1 bimonth	2 bimonth	3 bimonth	4 bimonth	5 bimonth	6 bimonth	Summary	Estimated	1 bimonth	2 bimonth	3 bimonth	4 bimonth	5 bimonth	6 bimonth	Summary	Total	Check
Modules	20	4	3			3	6	16	15		3			0,4	3,2	6,6	21		6	2				8	31	30-70
Seminars	8	2,8	1,4	0,2	0,2	0,4	0,4	5,4	6			2	0,8	0,9	0,4	4,1	12		0,5					0,5	10	10-30
Research	32	5	5	7	7	5	6	35	39	10	7	8	9,2	9	6,6	50	30	10	6,5	8	10	10	10	55	139	80-140
	60	12	9,4	7,2	7,2	8,4	12	56	60	10	10	10	10	10	10	61	63	10	13	10	10	10	10	63	180	180

Autism Spectrum Disorder (ASD)

1. DEFINITION

a **set** of **neurodevelopmental chronic disorders** characterised by two main categories of symptoms:

- **deficits** in **social communication** and social **interaction**
- **restricted patterns** of behaviours

2. EPIDEMIOLOGY

- 1 in 59 children aged 8 years in US
- **1 in 89** children aged 7-9 years **in Europe**
- males have been shown to be affected by ASD four times more often than females

3. ASD HETEROGENEITY

- **variability** of the **intellectual ability**, of the **severity levels** of disorder, and of the associated psychiatric **comorbidities**
- **ASD symptoms** appear in early childhood and can **change** over the years **with diverse** developmental **pathways**

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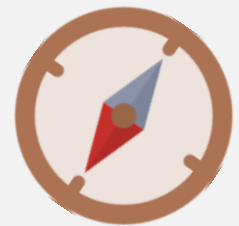
Autism Spectrum Disorder (ASD)

4. LIFELONG DISORDER

- **ASD symptoms** appear in early childhood but generally persist **throughout life**.
- A small percentage of people with ASD become independent in adult age

5. TREATMENT

The primary goals of treatment are to **minimize** the **core features** and associated deficits, **maximize functional independence and quality of life**, and alleviate family distress

6. INTERVENTIONS

- rehabilitation and educational programmes
- **individualised** programmes
- implementation of strategies to apply learned skills to new environments and situations (**generalisation**)

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Serious Games

Serious games (SGs) represent an innovative tool to support children and adults with ASD.

Serious Game: a simulation with a videogame structure whose purpose is to promote the development of essential skills and knowledge in the users.

- motivate the player
- facilitate the learning of skills and the training of actions and behaviours that can then be transferred to real life.

Learning

Play

Simulation
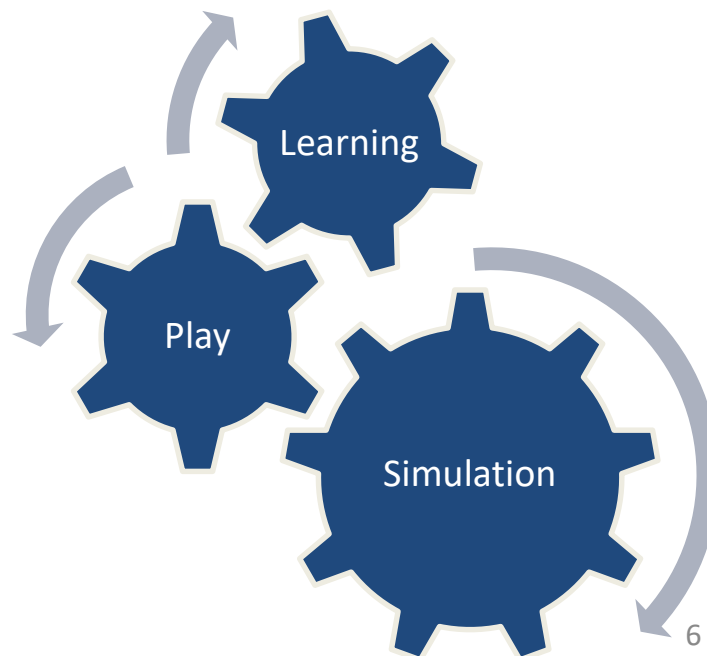
ASD & Serious Games

LIMITS:

- **restricted range** of topics and genres for SGs
- the majority target **high-functioning ASD** individuals only
- their **clinical validation** has **rarely** met the evidence-based medicine standards
- lack of **personalised** approach
- SGs have **rarely** proven their efficacy on the **generalisation** process
- lack of **multidisciplinary** approaches in SGs design

Research Aim

Investigate new methodologies and techniques to improve autonomy and independence in people with ASD through personalised serious games.

- Validate the use of SGs in rehabilitation context with standardised tools

- Assess the generalisation of trained skills in a real-life environment

- Define a framework to develop personalised SGs for people with ASD

Idea

A rehabilitation SG-based intervention for people with ASD was carried out for enhancing skills related to a specific daily living activity: **shopping in a supermarket**.

https://www.youtube.com/watch?v=aPknwW8mPAM

Multidisciplinary Team

- Biomedical engineering knowledge and experience

- Medical knowledge and experience of a neuropsychiatric

- Rehabilitation knowledge and experience of a psychologist

- Rehabilitation knowledge of therapists

Participants

10 children and teenagers with ASD were recruited from the medical centre "Centro Medico Riabilitativo Pompei"

INCLUSION CRITERIA:
1. clinical diagnosis of ASD, in keeping with the diagnostic criteria of DSM-V
2. chronological age between 8 and 16 years
3. no physical impairments
4. a rehabilitation plan already underway in accordance with the study's goals.

ID	ASD Level	Sex	Age	FSIQ
P1	L1	M	11	93
P2	L1	M	8	93
P3	L2	F	16	58
P4	L2	F	12	58
P5	L2	M	10	57
P6	L2	M	16	53
P7	L3	M	12	50
P8	L3	M	11	45
P9	L3	M	14	40
P10	L3	M	9	40

Procedure

1. Pre-intervention
- first real-life experience to evaluate the participants' performance in a real environment

- The participants went to a supermarket accompanied by a therapist
- The real-life experience was recorded via traditional camera
- **Shopping List**
  1. pick up the ingredients to cook a dish
  2. pick up personal care products
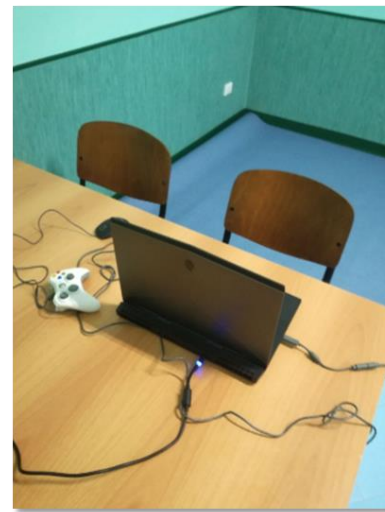 3. pick up a product to organize a party

Procedure

2. Intervention

- virtual training with the individualised serious game to train, experiment, and practice behaviours and actions.

- The game sessions were led by each participant's therapist
- 10 game sessions, one per week, for no more than 30 minutes.

Procedure

3. Post-intervention

- second real-life experience to evaluate the improvements achieved by the participants after the training.

- The participants went to a supermarket accompanied by a therapist
- The real-life experience was recorded via traditional camera

ShopAut

- 3D game conceptually based on classic 3D life simulation games
- Aimed to:
  1. teach the procedure of a shopping activity
  2. reinforce object categorization and recognition in a supermarket
  3. improve attention, orientation, and problem-solving skills
  4. help the player engage in simple economic transactions.

- The shopping game experience is interactive
- 10 Game Levels
- Game score: accuracy of game actions
- The game was developed using Unity as a game engine

ShopAut: Personalised Design

- **Personalisation**
  - ○ **Contents**
  - ○ Difficulty
  - ○ Scenario
  - ○ User Interface

- **Customisation**
  - ○ Input Devices
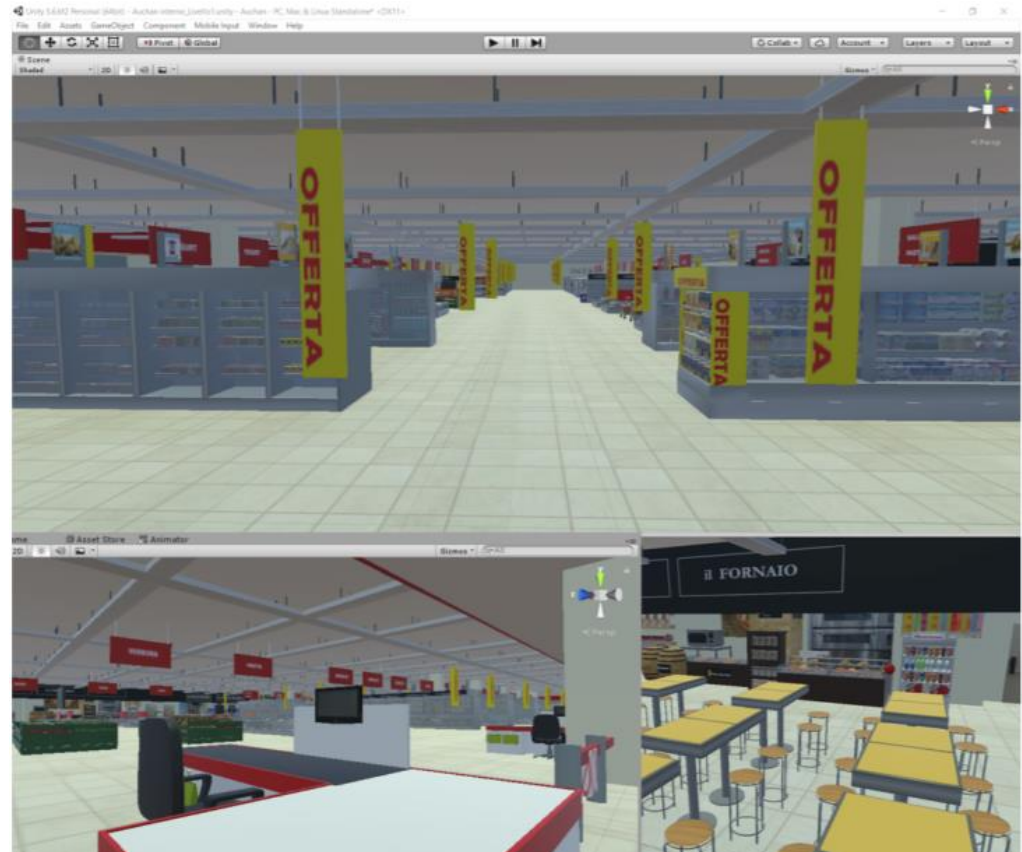 - ○ Player Character
  - ○ Game mode

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Game Levels	Game Difficulty
2-4	The shopping list provides only one item based on the main three tasks. The player is tasked with buying a specific product (e.g., specific colour or brand) or a specific number of products.
5-7	The shopping list provides only two items based on the main three tasks. Simple economic transactions are required. Real-life sounds are reproduced in the game, including noise (e.g., music, traffic noise). Unexpected elements are introduced (e.g., aisles being locked due to works).
8-10	The shopping list provides the three tasks and the player can choose among all available products without specific directions. The economic transactions required are more complex. Interactions with avatars are introduced. A timer limit is introduced.

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Selecting options Shooting

Back and Forth Left and Right

Jump

Back and Forth Left and Right

Moving Camera

- **Customisation**
  - ○ **Input Devices**
  - ○ Player Character
  - ○ Game mode

Selecting options Shooting

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ASD Severity Level	
Level 1	Requiring support
Level 2	Requiring substantial support
Level 3	Requiring very substantial support

Outcome Measures

- **Real Life Experiences**: *International Classification of Functioning, Disability and Health – Children & Youth version* (ICF-CY)
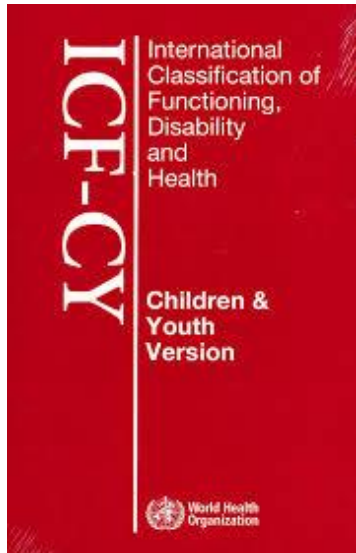
ICF-CY codes		
Shopping Activities	d166	Reading
	d310	Communicating with - receiving - spoken messages
	d315	Communicating with - receiving - nonverbal messages
	d440	Fine hand use
	d445	Hand and arm use
	d460	Moving around in different locations
	d860	Basic economic transactions
General Shopping Experience	d161	Directing attention
	d175	Solving problems
	d177	Making decisions
	d2201	Completing multiple tasks
	d250	Managing one's own behaviour
	d6200	Shopping
	d730	Relating with strangers

Outcome Measures
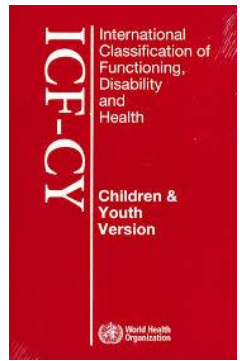
d440 Fine hand use: Performing the coordinated actions of handling objects, picking up, manipulating and releasing them using one's hand, fingers and thumb, such as required to lift coins off a table or turn a dial or knob.

Items	Pre-intervention Performance							Post-intervention Performance						
Taking the coin for the shopping cart	0	1	2	3	4	8	9	0	1	2	3	4	8	9
Putting the coin in the shopping cart	0	1	2	3	4	8	9	0	1	2	3	4	8	9
Gathering the money at the register	0	1	2	3	4	8	9	0	1	2	3	4	8	9
Opening the shopping bag	0	1	2	3	4	8	9	0	1	2	3	4	8	9
Removing the coin from the shopping cart	0	1	2	3	4	8	9	0	1	2	3	4	8	9
d440.	**0**	**1**	**2**	**3**	**4**	**8**	**9**	**0**	**1**	**2**	**3**	**4**	**8**	**9**

xxx.0	NO difficulty (none, absent, negligible, …)	0-4 %
xxx.1	MILD difficulty (slight, low, …)	5-24 %
xxx.2	MODERATE difficulty (medium, fair, …)	25-49 %
xxx.3	SEVERE difficulty (high, extreme, …)	50-95 %
xxx.4	COMPLETE difficulty (total, …)	96-100 %
xxx.8	not specified	
xxx.9	not applicable	

Outcome Measures

- **Clinical tools**: *Vineland Adaptive Behavior Scale II* (VABS-II)
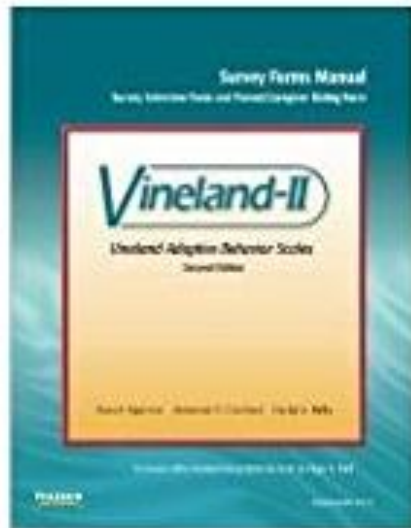
VABS-II domains:
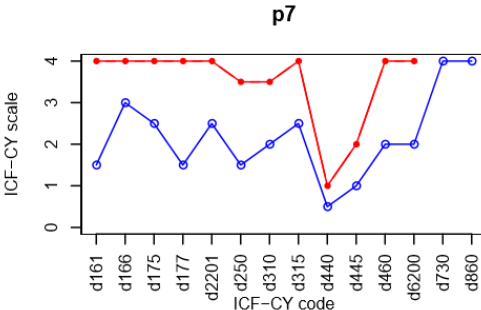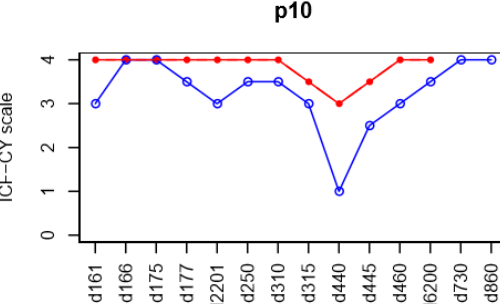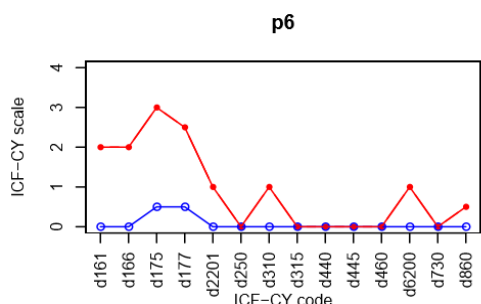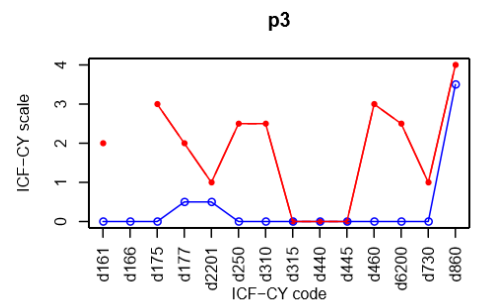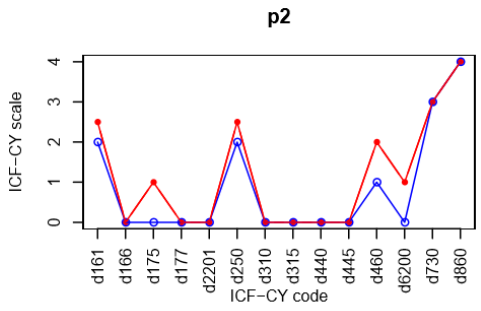1. Communication
2. Daily Living Skills
3. Socialization

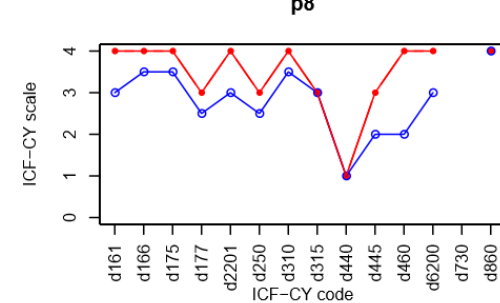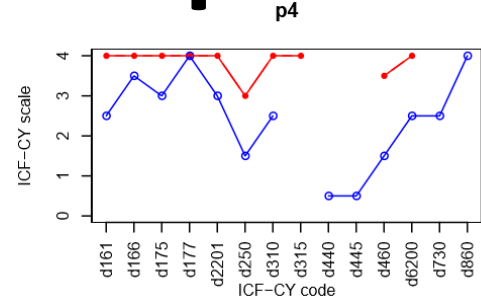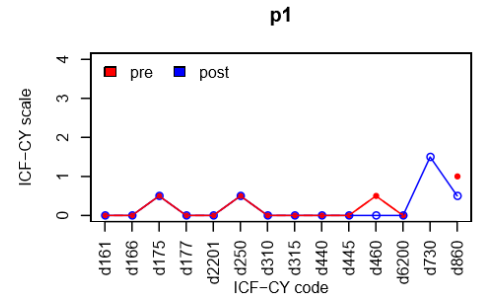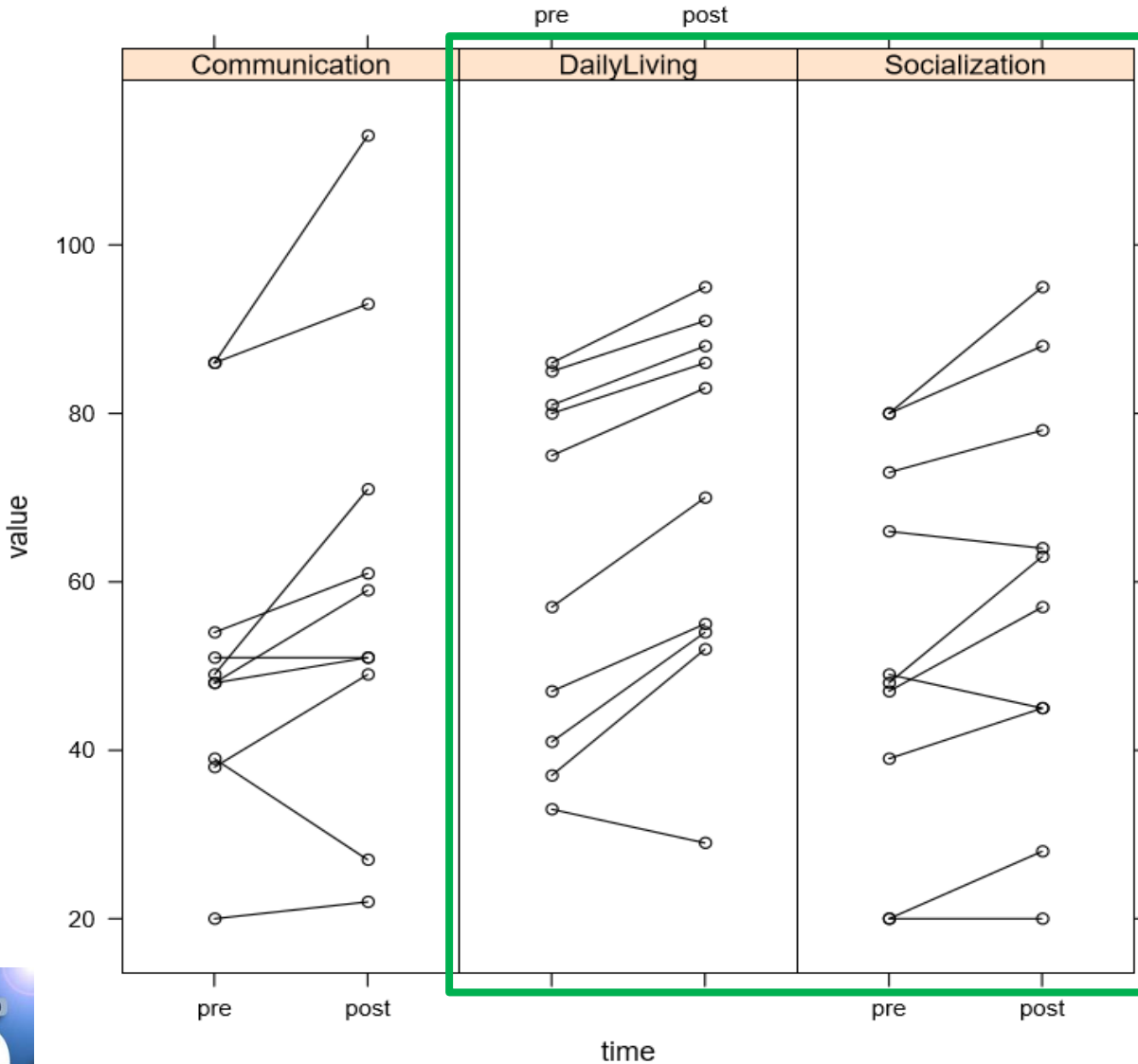# Real-life experience results
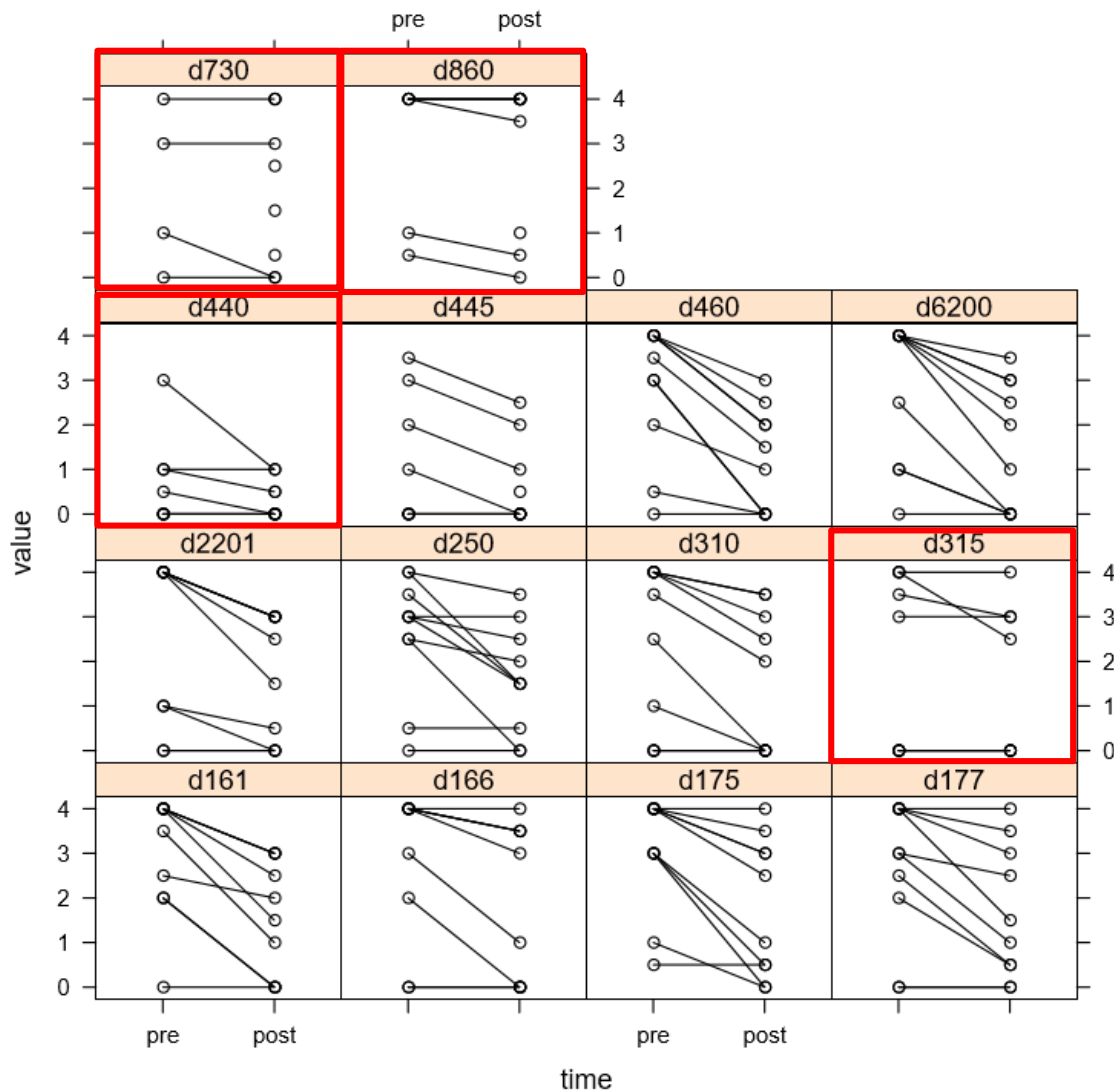
P > 0.05

Real-life experience results
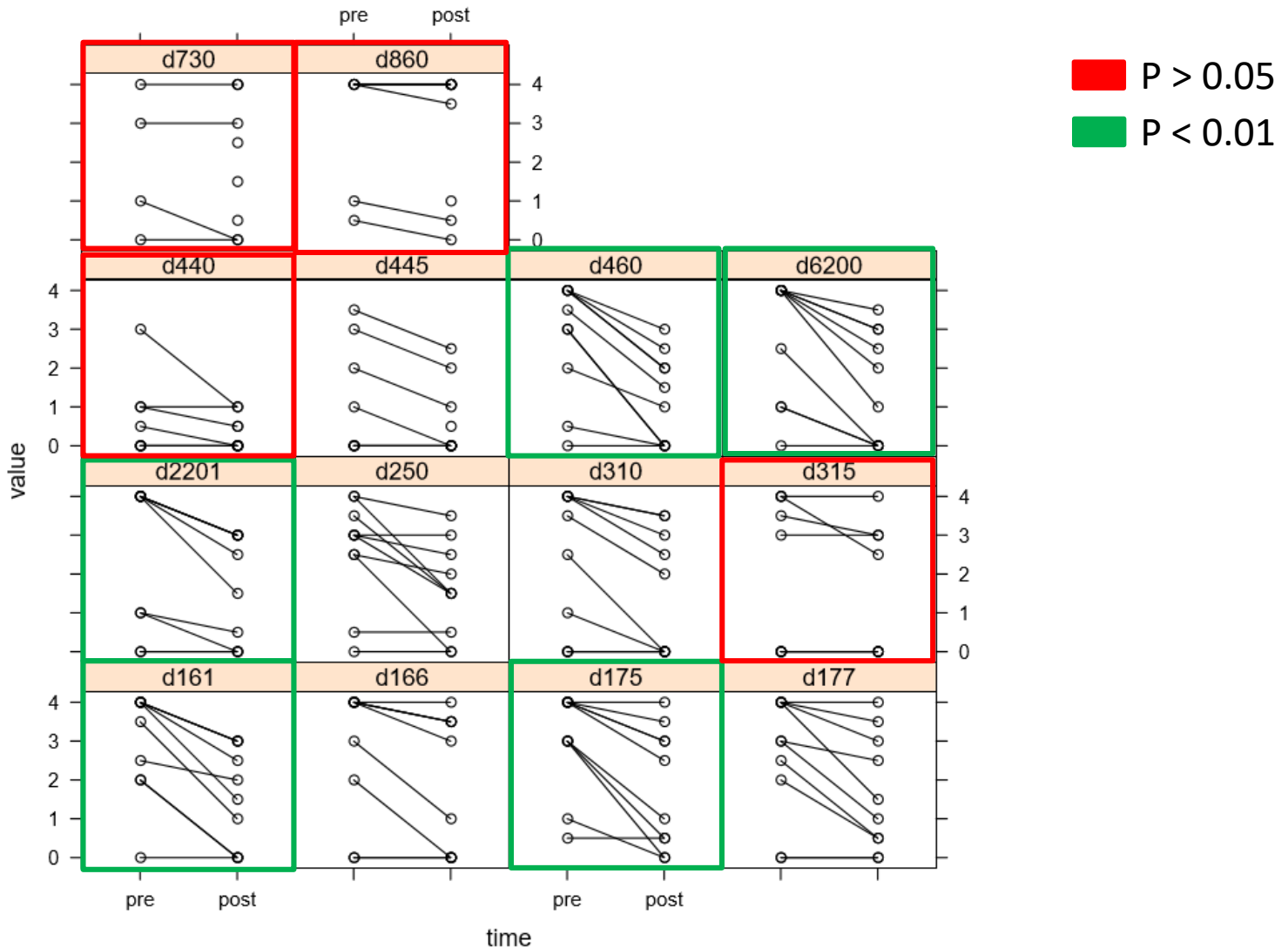
Real-life experience results
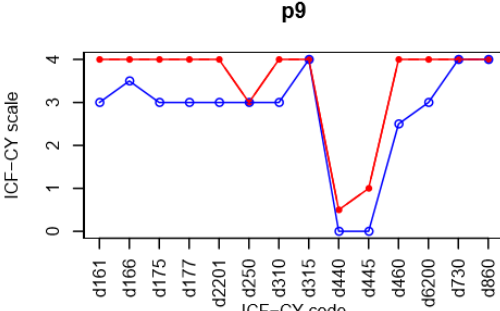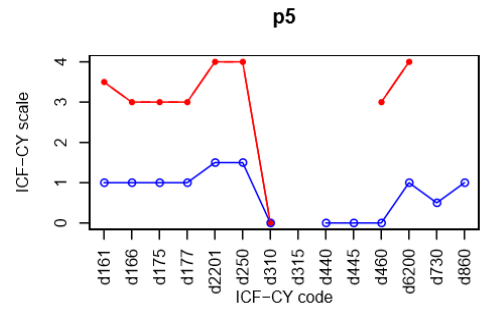
Clinical results

P < 0.05

Conclusion

- Good evidence for the use of personalised serious games in interventions for children and teens with ASD

- Framework to design personalised serious games

- Robust methodology to assess serious games efficacy

- Assessment the generalisation of skills, trained through a virtual training

Products

International Journal

- **E. Vallefuoco**, G. Gison, C. Bravaccio, and A. Pepino (2020). "Improving daily living skills in people with Autism Spectrum Disorder through a personalised serious game". *Nature Scientific Reports* (under review).

National Journal

- **E. Vallefuoco,** C. Bravaccio and A. Pepino (2017). "Strumenti di immersive simulation rivolti a persone con Disturbi dello Spettro Autistico. Modellazione 3D di scenari interattivi". *Autismo e disturbi dello sviluppo*, vol. 15, n. 2, pp. 223-252, doi: 10.14605/AUT1521705.

- G. Gison, **E. Vallefuoco** and A. Pepino (2019). "Piattaforma digitale per la progettazione degli interventi nel Disturbo dello Spettro Autistico. SUPER (Sistema Unitario in una Piattaforma Educativa e Riabilitativa)". *IL TNPEE*, Erickson, vol. 1, n. 1.

Products

Conference

- **E. Vallefuoco**, C. Bravaccio and A. Pepino (2017). "Serious Games in Autism Spectrum Disorder: An example of personalised design". In *Proceedings of the 9th International Conference on Computer Supported Education*, vol. 1, pp. 567-572.

- A. Pepino, **E. Vallefuoco**, P. Cuccaro and G. D'Onofrio (2018). "Simulation model for analysis and management of the no-show in outpatient clinic". In *Proceedings of the 10th International Conference on Computer Modeling and Simulation*. *

- A. Pepino, **E. Vallefuoco** and F. De Nicola (2019). "Micro-simulation for learning by doing in medical education". In *TUTOR*, vol. 19.

- A. Pepino, M. Ronchetti, P. Peron, C. Freda and **E. Vallefuoco** (2019). "The lecture video recording in university: A case study". In *EMOOCs-WIP 2019*, vol. 2356, pp. 175-180.

- **E. Vallefuoco**, M. Mele and A. Pepino (2019). "A Serious Game to Support Decision Making in Medical Education". In: Cristani M., Prati A., Lanz O., Messelodi S., Sebe N. (eds) New Trends in Image Analysis and Processing – ICIAP 2019. ICIAP 2019. Lecture Notes in Computer Science, vol. 11808. Springer, Cham.

*Award best conference presentation

Game results