

## PERCEPTUAL EGOCENTRISM AND MENTAL ROTATION IN PRIMARY SCHOOL AGE: THE INVISIBLE MAN PARADIGM PROPOSAL

### EGOCENTRISMO PERCETTIVO E ROTAZIONE MENTALE IN ETÀ SCOLARE: LA PROPOSTA PARADIGMATICA DELL'UOMO INVISIBILE

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#### Abstract

The capacity to imagine what a scene, an object or an array of objects looks like when seeing from a different viewpoint is crucial in everyday life. It allows imagining what another individual sees and then better understanding his or her intentions, actions, and emotional reactions. The ability of perspective-taking, taken individually, does not seem sufficient to demonstrate the ability, in the child, to have a coherent representation of the space, to allow the manipulation of viewpoints. The ability to assume an allocentric perspective, in this view, is not reducible to the mechanical assumption of another's position in space. The central node is the of performing a mental rotation on ourselves by maintaining a main perspective of the environment. In this view, leaving perceptive egocentrism resides in the ability, based on the mental rotation skills, to simultaneously use egocentric, allocentric and heterocentric perspectives. Starting from this assumption, the present research project intended to investigate the relationship between age, perspective taking skills and mental rotation.

La capacità di immaginare come appare una scena, un oggetto o una serie di oggetti quando si guarda da un punto di vista diverso è fondamentale nella vita quotidiana. Permette di immaginare ciò che vede un altro individuo e quindi di comprendere meglio le sue intenzioni, azioni e reazioni emotive. La capacità di assumere una prospettiva, presa singolarmente, non sembra sufficiente a dimostrare la capacità, nel bambino, di avere una rappresentazione coerente dello spazio, per consentire la manipolazione dei punti di vista. La capacità di assumere una prospettiva allocentrica, in quest'ottica, non è riducibile all'assunzione meccanica della posizione di un altro nello spazio. Il nodo centrale è quello di compiere una rotazione mentale su noi stessi mantenendo una prospettiva principale dell'ambiente. In questa visione, l'abbandono dell'egocentrismo percettivo risiede nella capacità, basata sulle abilità di rotazione mentale, di utilizzare simultaneamente prospettive egocentriche, allocentriche ed eterocentriche. Partendo da questo presupposto, il presente progetto di ricerca ha inteso indagare la relazione tra età, capacità di presa di prospettiva e rotazione mentale.

#### Keywords

Social Robot; Autism Spectrum Disorder; Virtual Reality; Social Stories; Emotion.  
Robot Sociale; Disturbo dello Spettro Autistico; Realtà Virtuale; Storie Sociali; Emozioni.

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<sup>1</sup> The entire contribution is the result of the shared reflection and joint work of the authors. However, with regard to the writing of the text, Pio Alfredo Di Tore is the author; Michele Domenico Todino and Stefano Di Tore are the co-authors; Maurizio Sibilio and Alain Berthoz are the scientific coordinators.

## **Introduction**

The capacity to imagine what a scene, an object or an array of objects looks like when seeing from a different viewpoint is crucial in everyday life. It allows imagining what another individual sees and then better understanding his or her intentions, actions, and emotional reactions (Lambrey, Doeller, Berthoz, & Burgess, 2012).

Imagining what another individual sees is an important and early-developing mechanism that ultimately supports higher level social-cognitive processes, such as behavioral inferences (Frith & De Vignemont, 2005; Samson, Apperly, Braithwaite, Andrews, & Bodley Scott, 2010), empathy (Decety & Lamm, 2009) and building an identity in a social context (Berthoz, 2014).

In other words, our ability to represent the world as experienced by others is one of the hallmarks of human evolution (Kaminski, Call, & Tomasello, 2008; Premack & Woodruff, 1978).

This ability has been investigated using a number of paradigms, ranging from simple visual perspective-taking tasks (Piaget & Inhelder, 1948; Vogeley & Fink, 2003) to reasoning tasks (Baron-Cohen, Leslie, & Frith, 1985; Perner, 1991).

All of the above paradigms require the representation of others' views, and many focus on Perspective Taking.

According to Sulpizio et al., "in the visuospatial domain, perspective taking is the ability to imagine how a visual scene appears from an external observer's viewpoint, and can be studied by asking subjects to encode object locations in a visual scene where another individual is present and then detecting their displacement when seeing the scene from the other's viewpoint" (Sulpizio et al., 2015). Seeing the scene from the other's viewpoint, according to Vogeley & Fink, simply requires a translocation of egocentric point of view (Vogeley & Fink, 2003).

The ability of perspective-taking, taken individually, does not seem sufficient to demonstrate the ability, in the child, to have a coherent representation of the space, to allow the manipulation of viewpoints. Berthoz, in this regard, relates the abandonment of perceptive egocentrism with a more complex mechanism than the perspective-taking.

The ability to assume an allocentric perspective, in this view, is not reducible to the mechanical assumption of another's position in space. The central node is the of performing a mental rotation on ourselves by maintaining a main perspective of the environment (Berthoz, 2011).

According to Berthoz, leaving perceptive egocentrism resides in the ability, based on the mental rotation skills, to simultaneously use egocentric, allocentric and heterocentric perspectives. Starting from this assumption, the present research project intended to investigate the relationship between age, perspective taking skills and mental rotation.

The hypothesis about the relationship between age and skills under investigation, gained in the study of the scientific literature, is that these skills are developed in a very extensive range, from 4/5 to 11/12 years of age, and covers, in fact, much of the first cycle of education.

In particular, if the skills of perspective taking begin to occur early as three years old, the ability of mental rotation, that allows to integrate the different perspectives into a coherent functional representation of space, fully manifests itself only at the turn of the ten/eleven years, confirming the view taken by Piaget and Inhelder in 1948 (Piaget & Inhelder, 1948).

## **The Invisible Man**

The project included the development from scratch of a non-invasive research tool (a videogame), designed to be meaningful to the target and to take advantage of the full potential of space representation offered by the new media and of the confidence that the current generation of primary school students shows to possess with such system:

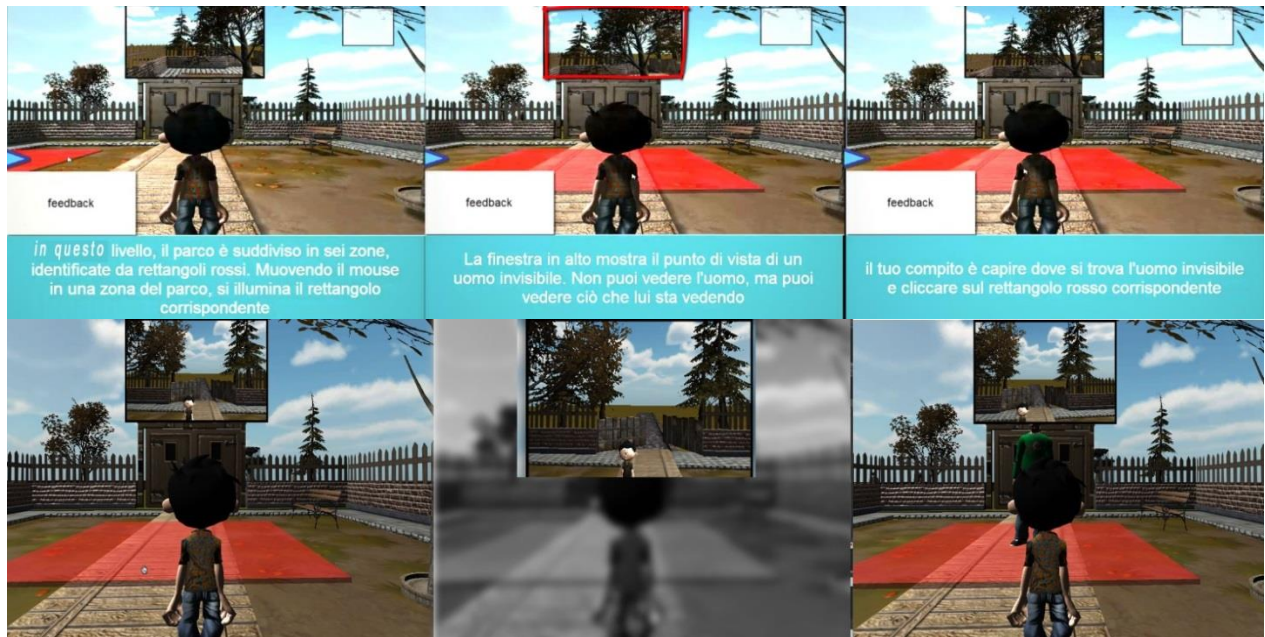
"Interaction with virtual avatars also means changing perspective, and many virtual games require the capacity to change places with a mental agility that young people today seem to possess in spades" (Berthoz, 2021).

This work presents a preliminary study on an *in fieri* paradigm that insists on the related abilities of perspective taking and mental rotation, but differs from the above because presents a scene where another individual is present but is not visible.

In this game:

- the situations requires the user to navigate in three-dimensional space through an avatar;
- the player's default view is a semi-subjective view, with the avatar seen from behind.

In the task, the user is struggling with an invisible man. The player cannot see the man in the park, but can see, in the top window, what the man in the park is seeing. The area of the park has been divided into six zones. By moving the mouse, the user can select the area of the park in which he believes to be the man whose perspective is shown in the top window.



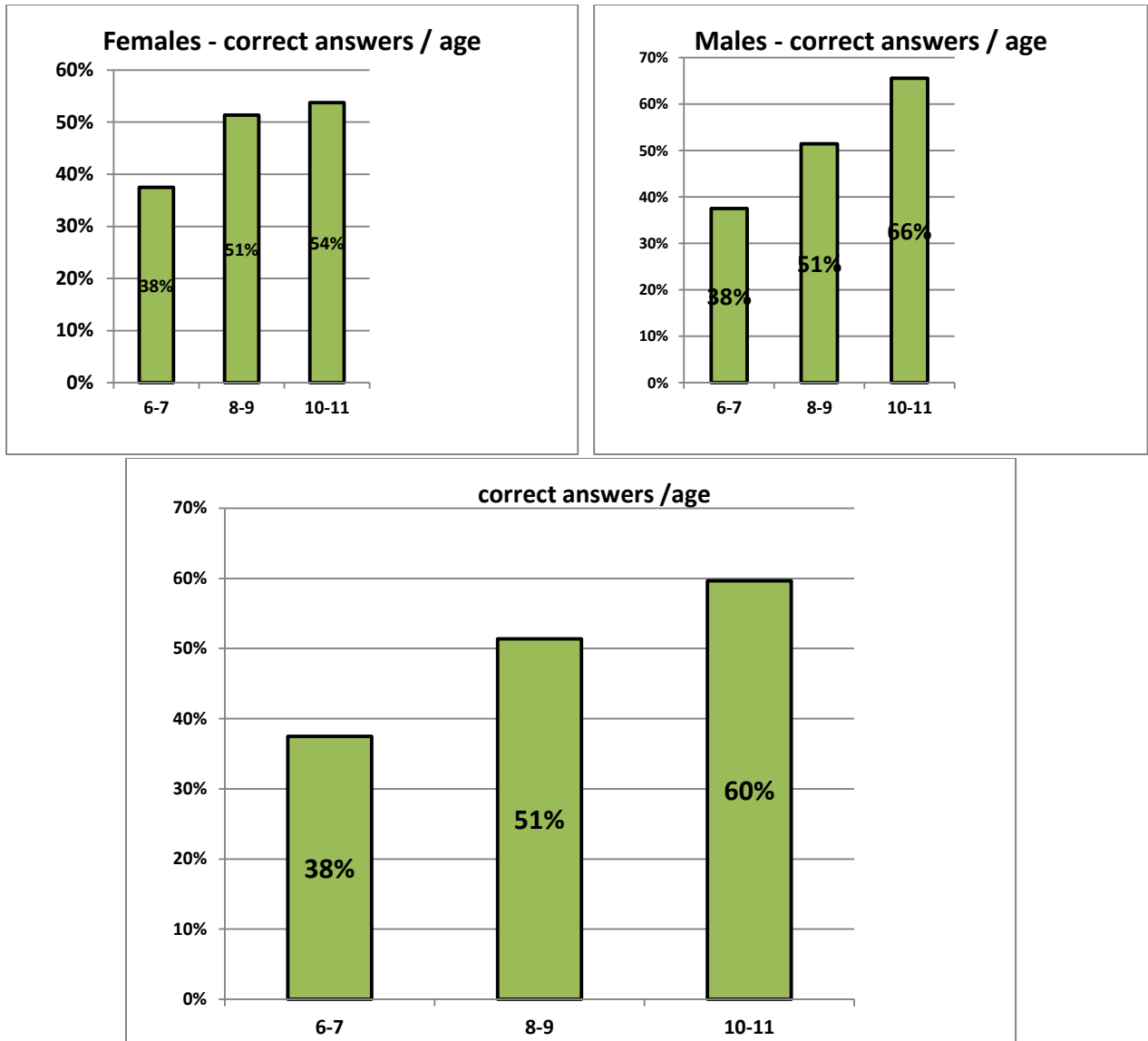
The software records the beginning of each game, the user data (age and gender), and, during the game, time for each attempt and the result (success / failure) of the attempt. Group composition by age and sex, and the overall scores obtained for individual tasks are readable in the Appendix.

This appears to be coherent with the ability of user to make a mental rotation on himself, in relation to the environment or to an object of the environment, maintaining the main environmental perspective in question (Berthoz, 2011).

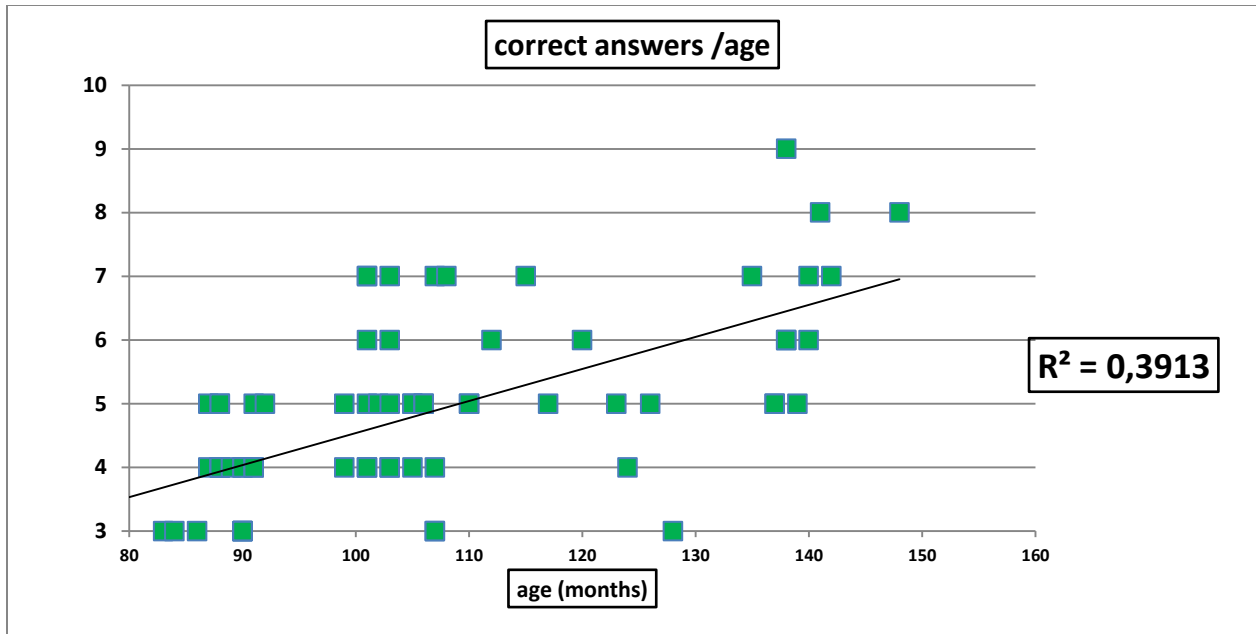
## Results

Percentages of success in the task were then calculated in relation to the age groups

Age	6-7	8-9	10-11
Percentage correct answers females	38%	51%	54%
Percentage correct answers males	38%	51%	66%



We calculated the Pearson correlation coefficients and coefficients of determination between the variables age (calculated in terms of months) and scores at the task ( $R = 0.63$ ,  $R^2 = 0.39$ ). The data seem to indicate the presence of a moderate correlation with respect to age and the scores obtained in the. The analysis of the data seems to support the hypothesis that between 6 and 11 years the scores significantly increase.



ANOVA was conducted on the number of successes in the task 3 using as BETWEEN FACTOR age and dividing the sample into three groups (6-7 years, 8-9 years, 10-11 years), the results indicate a significant difference in the performance of the subjects relating to the factor examined [ $F(2,67)= 18,43$ ,  $p<0,001$ ]. The data seem to suggest a significant difference in the number of successes achieved in the third task in relation to the age of the subjects.

Correct Answers / age					
All groups		6-7	8-9	10-11	
	Breadth	24	29	17	70
	Mean	3,75	5,14	6,00	4,871428571
	Std.Dev.	0,90	1,22	1,54	1,483449061
	Groups				3
Intragroup		30,18244898	2,059683322	21,65244898	26,94729064
Intragroup		18,50	41,45	38,00	1,46
	SSQa/(G-1)	26,94729064			
	SSQe/(n-G)	1,46			
	Test				18,43287651
	Alpha				0,05
	Quantile F				0,051332583
	H_0	medie =			
	H_1	medie <>			
	p-value				0,0000004185

We conducted a T-Student test on scores obtained by females and males. The results did not highlight significant differences in the performance of the subjects relating to the factor examined ( $t [68] = 0.705$ ,  $p = 0.379$ ). The data seem to indicate that there were no differences in scores obtained on the third tasks ( $p > 0.05$ ) in relation to sex.

### Discussion & conclusions

The tests conducted regarding the relationship between age and performance show a significant difference obtained in relation to the age group selected; the success rates for the three age groups analyzed seem to indicate a gradual improvement in performance in relation to the increase of age.. The tests conducted regarding the relationship between gender and age show no significant difference in relation to sex. Success rates seem to indicate a gradual improvement in performance in the three tasks in relation to the increase in age for both sexes.

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