

**Developmental and Social Mechanisms in Reasoning About Mirrors: A Comparison Between Adults, Typically Developed Children and Children With Autism Spectrum Disorder**

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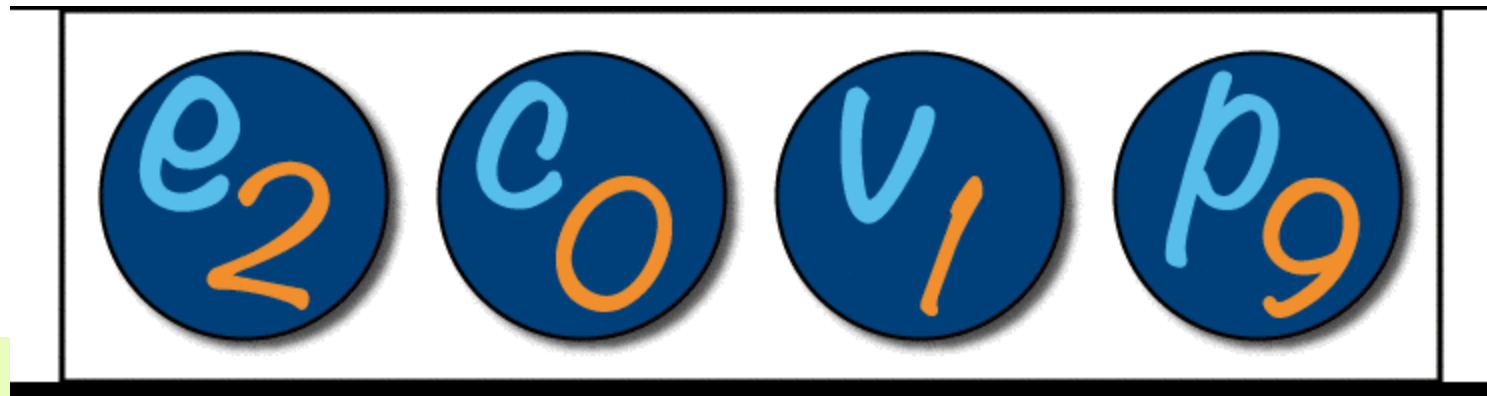
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# Developmental and social mechanisms in reasoning about mirrors: A comparison between adults, typically developed children and children with autism spectrum disorder



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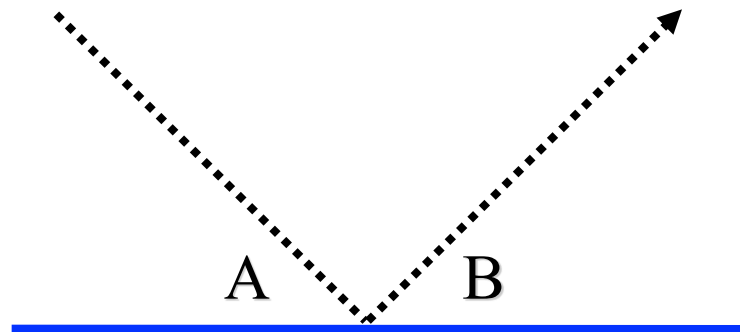
**Sheffield  
Hallam  
University**



# Reflection

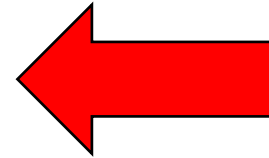
Reflection is easy (compared to refraction) and the basic principle that angle of incidence and angle of reflection are equal was already known to Euclid (c. 300 B.C., that is 900 years before the laws of classical mechanics).

Psychology undergraduates know about this principle.



# Two types of difficulties when reasoning about mirrors

(1) Viewpoint-dependent information.



The overestimation error

- people feel/think that they can see more than what can actually be seen (Venus effect)

(2) Information not located at the distal object

- The size on the mirror error

# The Venus effect

Pictures can show a mirror more or less accurately. But even accurate pictures can be misread by the observer in terms of what is shown.

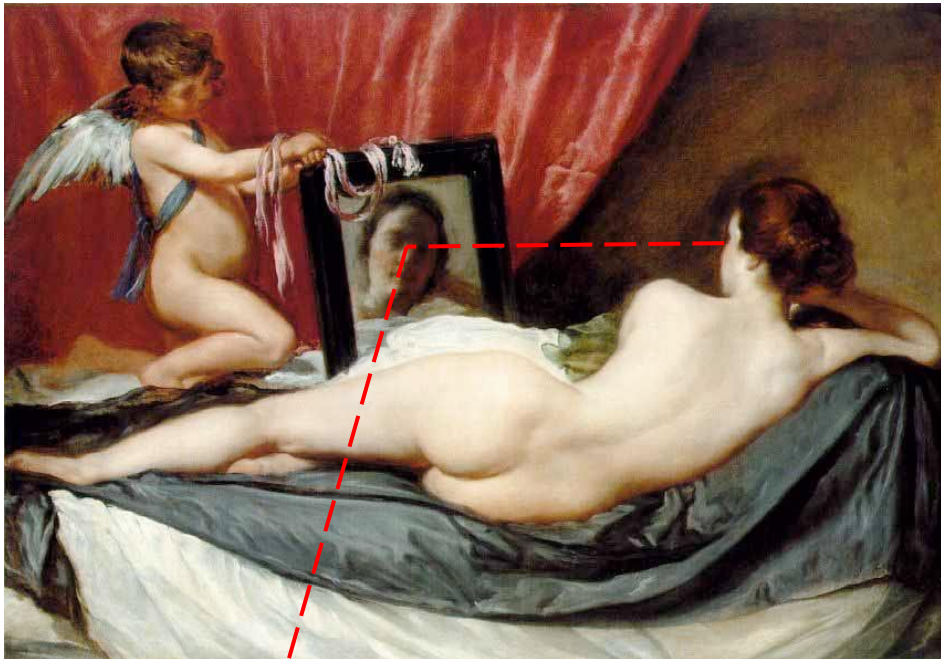
Example: Velázquez: “La Venus del espejo” (1647-1651)



# The Venus effect

The effect is present also in the first documented description of the painting, in the collection of the Marqués del Carpio in 1651.

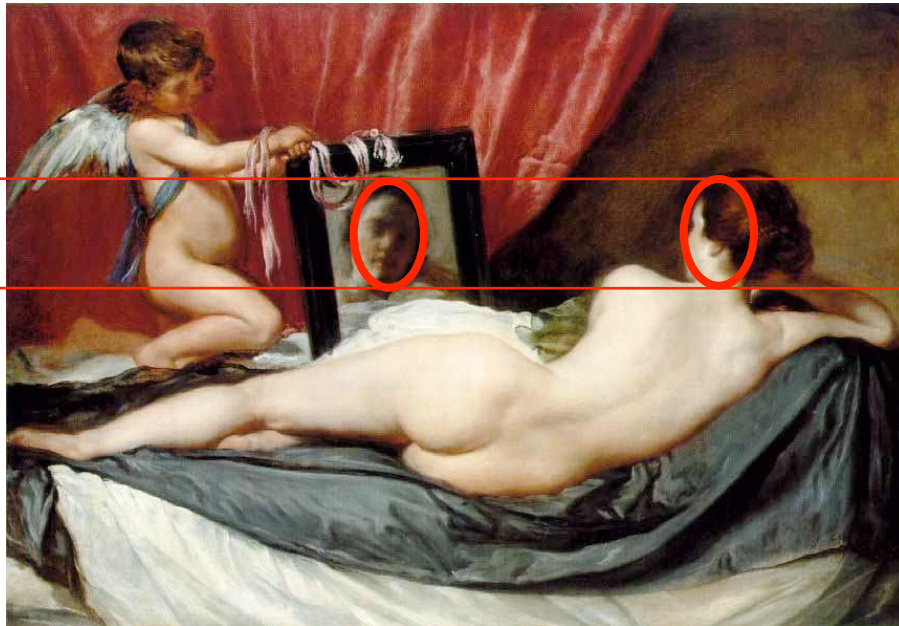
*“..una muger desnuda tendida sobre un paño pintada de espaldas recostada sobre el brazo derecho **mirándose** en un espejo”*



# (Venus effect: there is also difficulty 2 – size on the mirror)

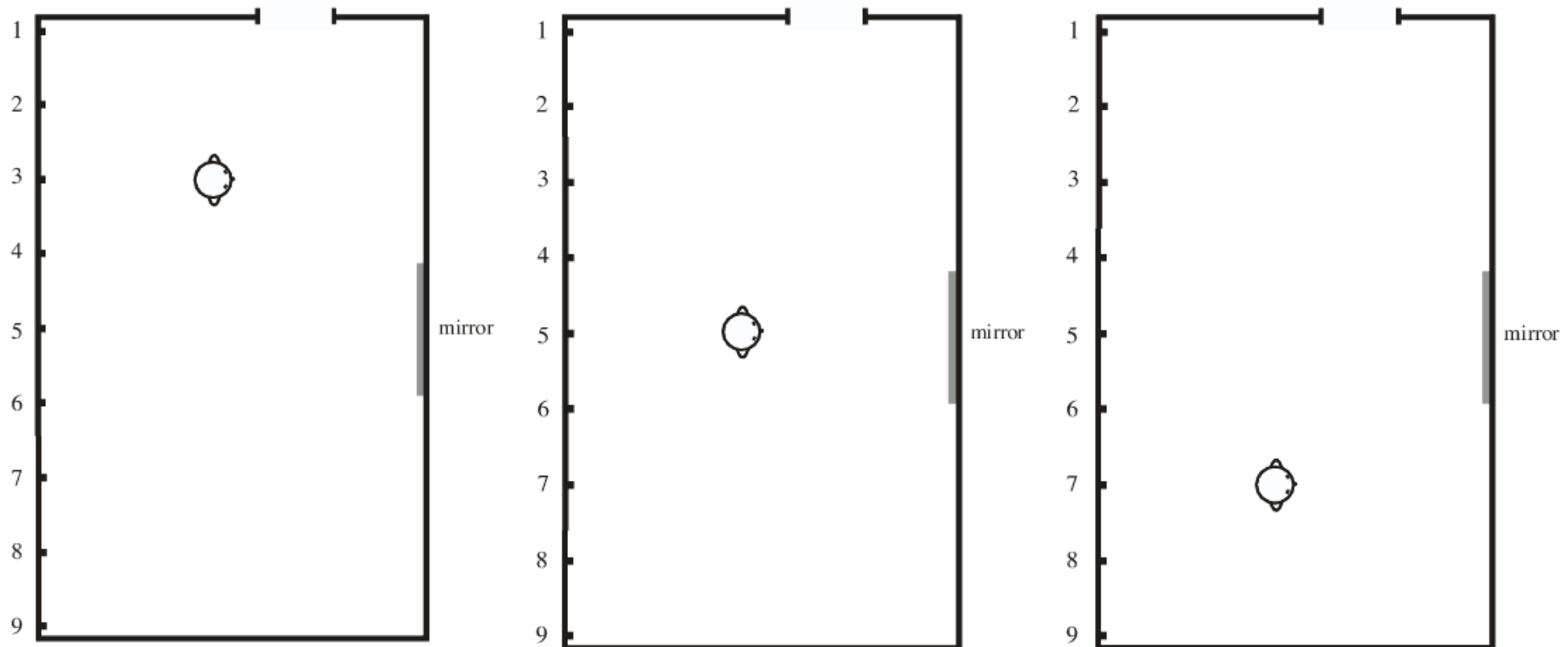
“As the mirror is farther away than her face, the image is with legitimate artistic license at least twice the size it should be”

Gregory (1997) p.21



# What is visible from a mirror?

## RAMP: Room And Mirror Perspective test

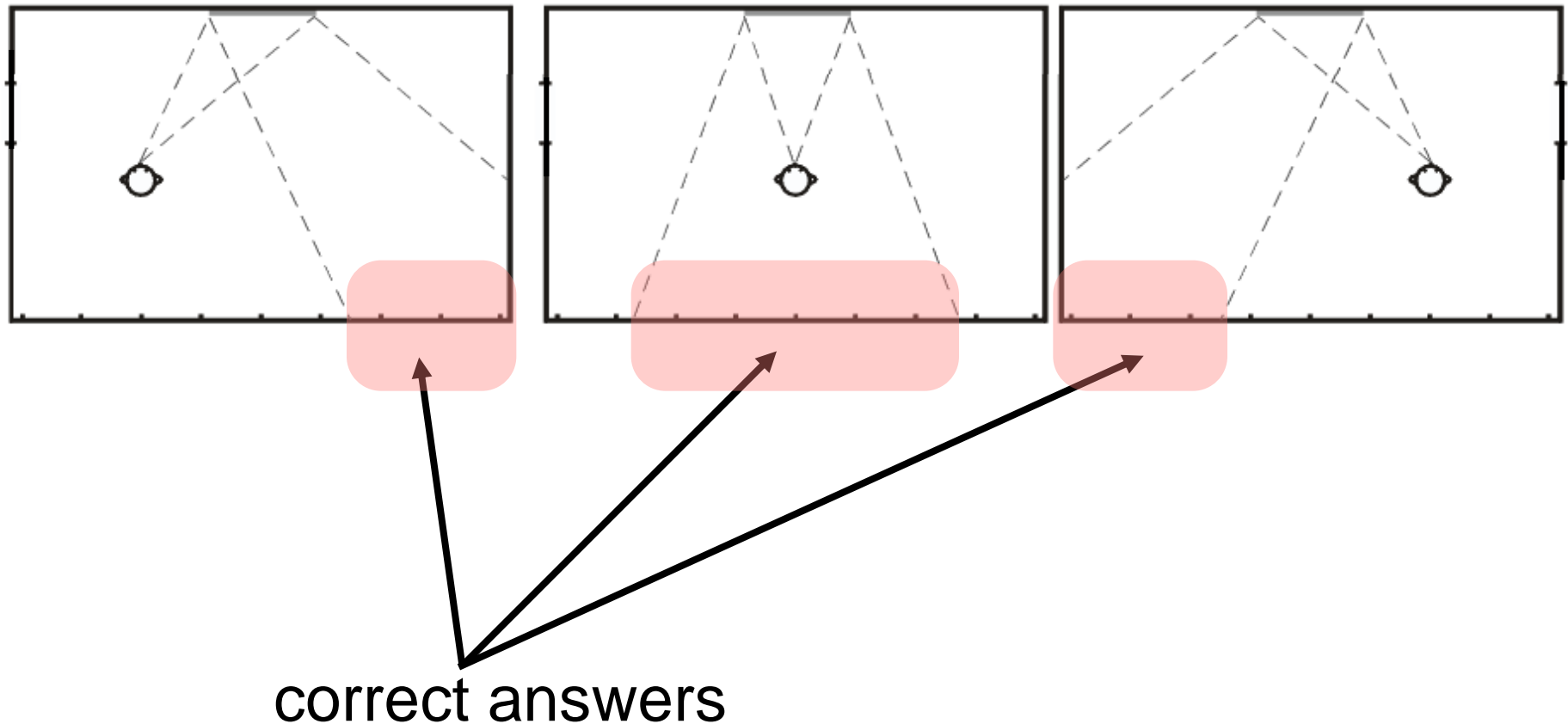


A top-down drawing of a room with a person facing a wall with a mirror, and objects on the opposite side of the wall. Participants task is to select which objects the person could see in the mirror from different viewpoints

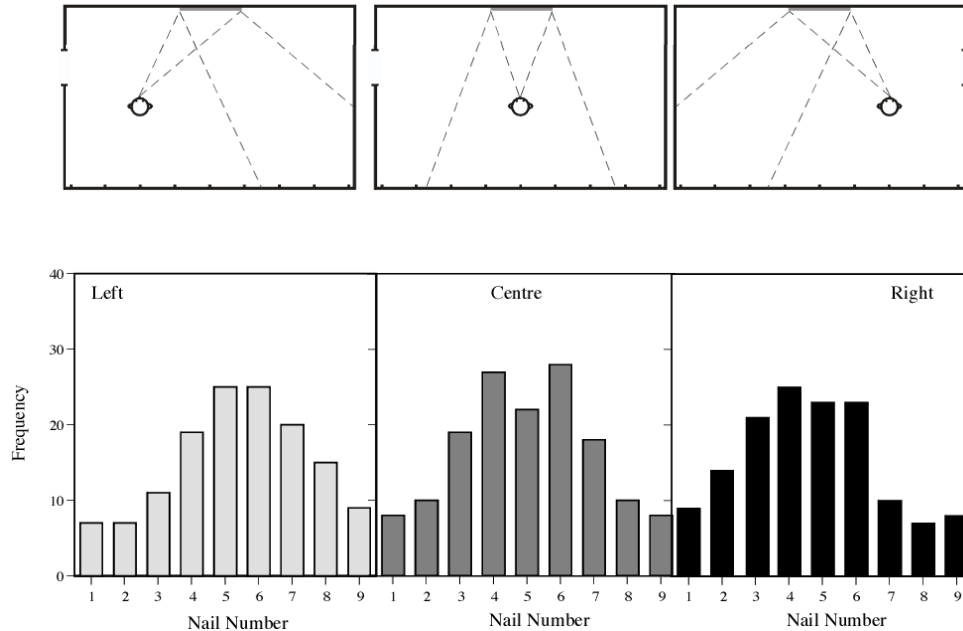
Bertamini, Lawson, Jones, Winters, APP 2010



# RAMP: Room And Mirror Perspective test



# RAMP test shows OVERESTIMATION

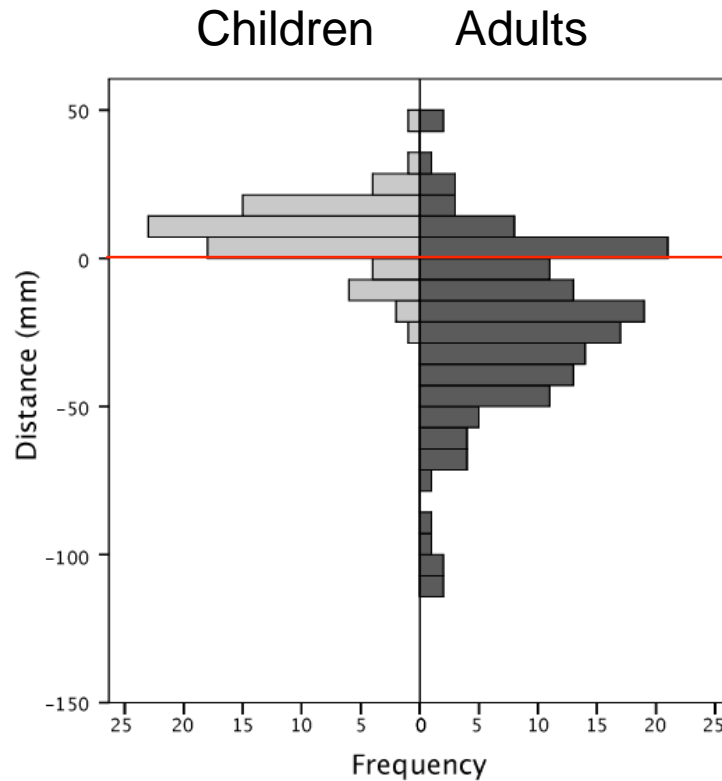


**There are two sources of errors when people are tested on RAMP:**

- 1) Poor knowledge about mirror reflections (sensitivity to optics)
- 2) Poor knowledge that what is visible vary with viewpoint (sensitivity to viewpoint)

**These results indicate a poor sensitivity to viewpoint as people did not change their answers in respect to the position of the viewpoint**

# Developmental data



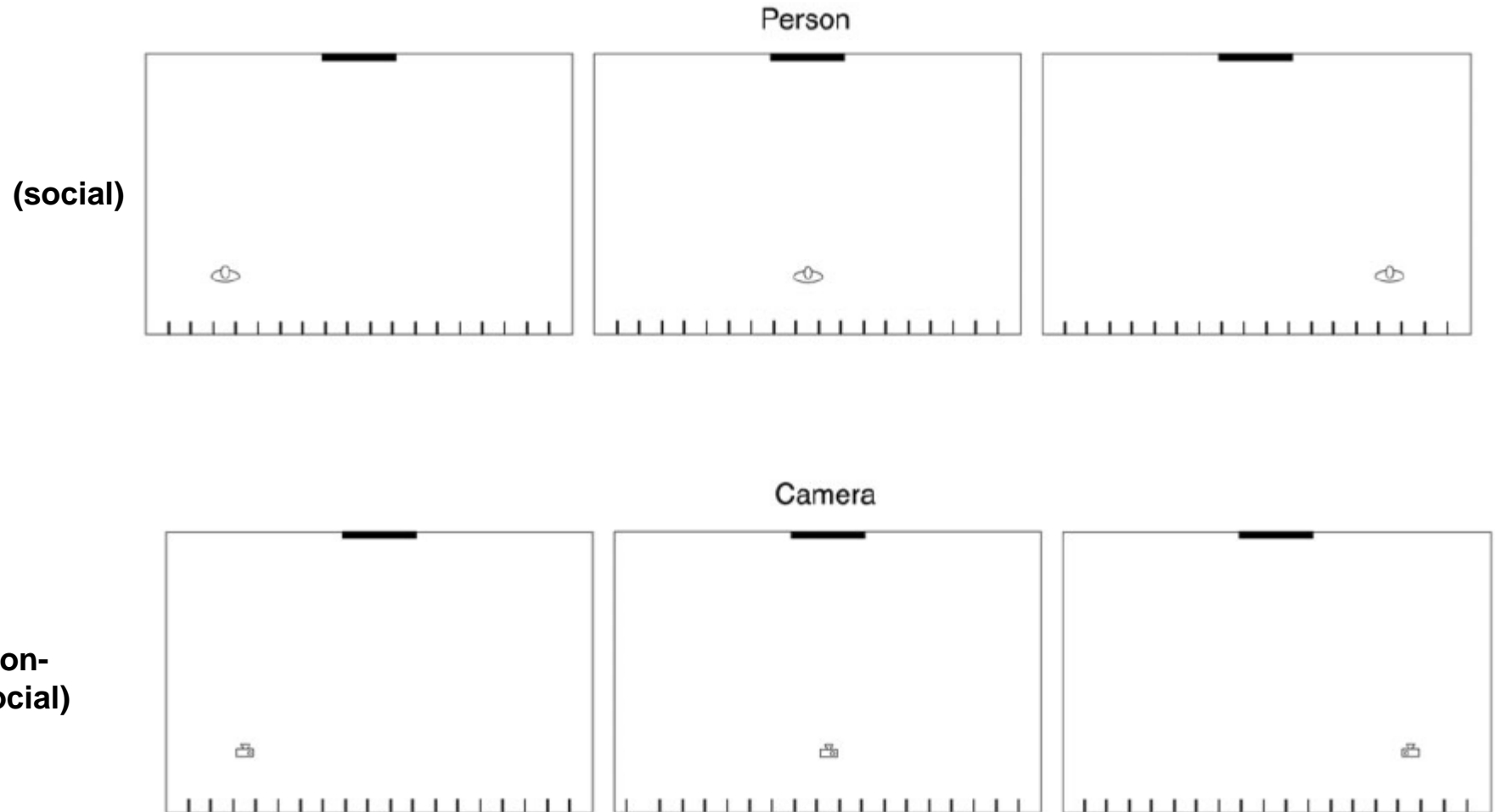
Children outperform adults. Adults committed more overestimation errors than children (we will come back to this)

Bertamini & Wynne, 2009

# The role of the viewpoint

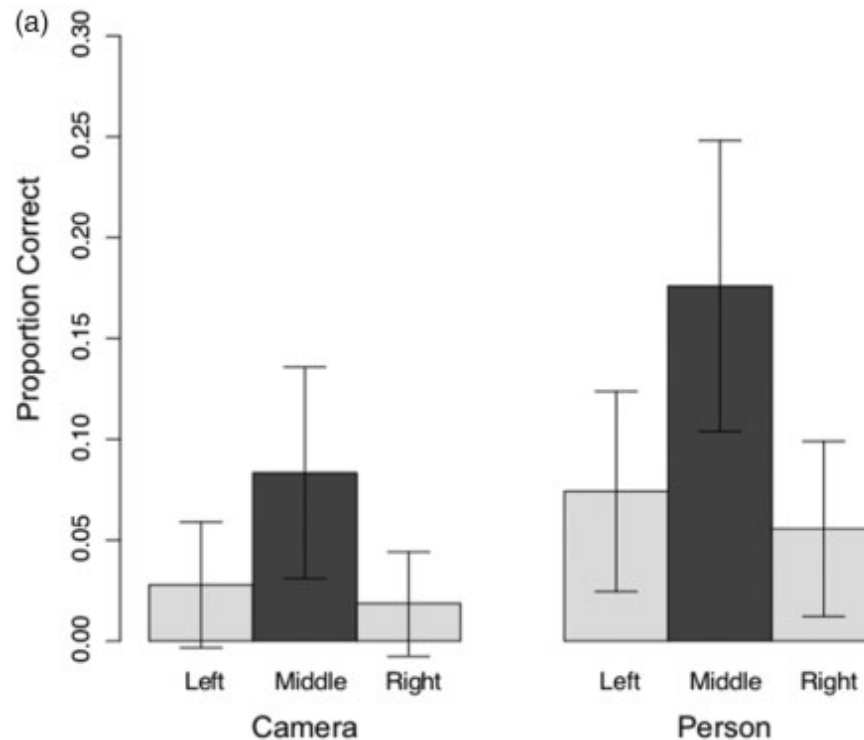
- Many people make errors in predicting what is visible in a mirror. Even though people have great familiarity with the task
- The Venus effect and overestimation error and have in common that the difficulty is related to understanding the role of the viewpoint

# The role of the viewpoint



Bertamini & Soranzo (Perc, 2018)

# The role of the viewpoint



Participants were more accurate when the viewpoint was a Person than a Camera

Bertamini & Soranzo (2018)

# Viewpoint and theory of mind

- It has been suggested that taking another perspective is a social process related to Theory of Mind (Nielsen et al., 2015; Samson et al., 2010). It could be argued that the Person condition was easier because the person is a social entity, with a viewpoint, whilst the Camera has an artificial viewpoint
- To explore the role of Theory of Mind together with the developmental aspect, in a new experiment we varied **age** [children (8-11) vs adults (18+)] and **type of development** [typically developed children (TD) vs children with a diagnosis of Autism Spectrum Disorder (ASD)]

# Participants

- 60 children 8-11 years old

(matched for age, sex and academic ability)

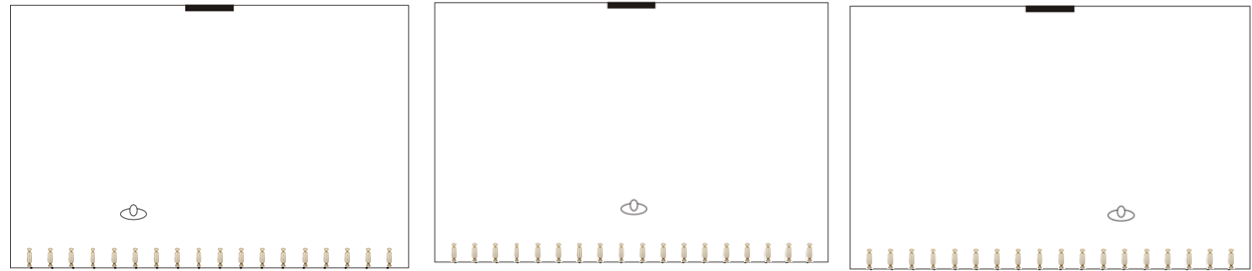
- 30 Autism Spectrum Disorder (ASD)
- 30 Typically developed (TD)

- 60 adults (TD)

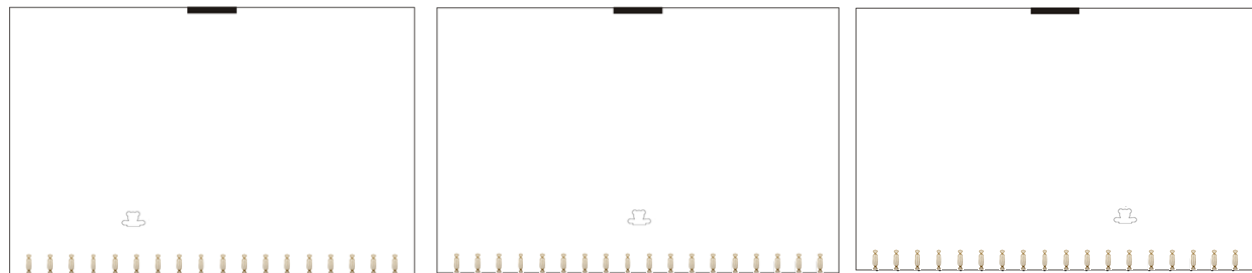


# Top-down diagram of RAMP (adapted)

Child



Teddy bear



# Top-down diagram of RAMP (adapted)



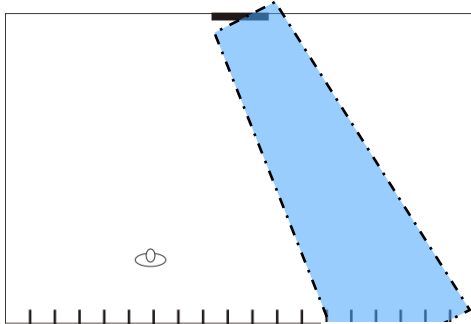
Diagram was presented to the children and adults before running the test on paper

# Results

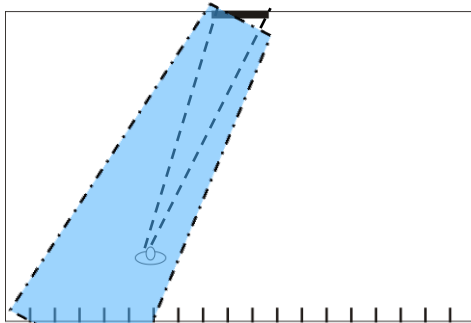


All groups of participants made a large number of errors. If we consider a strict criteria (selecting **all** the correct sweets and **only** the correct sweets) nobody was perfect! Therefore we proceeded with some data transformation

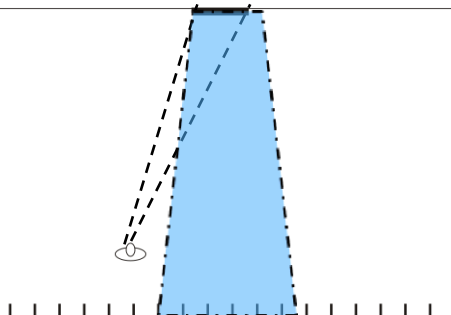
# Transformation 1: type of sensitivity



**TYPE 1: Sensitivity to View Point + Sensitivity to Optics**  
Considering the point of view of the object  
&  
Considering reflection



**TYPE 2: Sensitivity to View Point only – No Sensitivity to Optics**  
Considering the point of view of the object  
&  
NOT Considering reflection

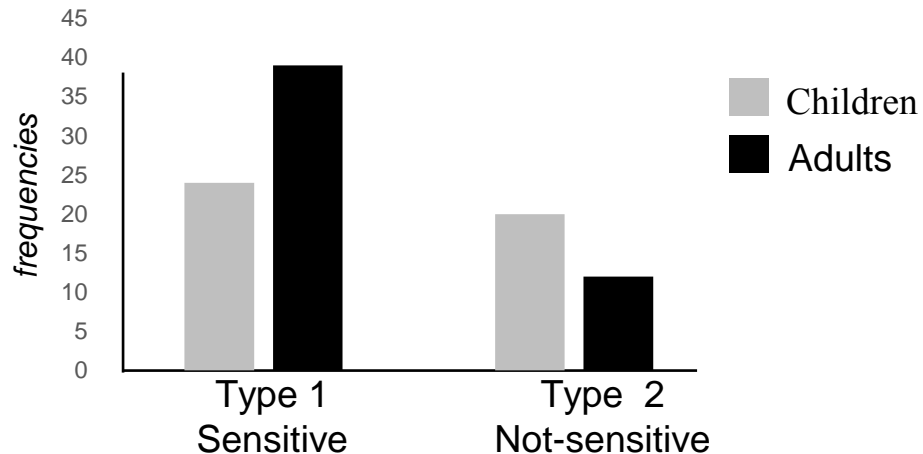


**TYPE 3: No Sensitivity to View Point – No Sensitivity to Optics**  
NOT Considering the point of view of the object  
&  
NOT Considering reflection

# RESULTS ON FREQUENCIES

## AGE: Adults vs TD-children

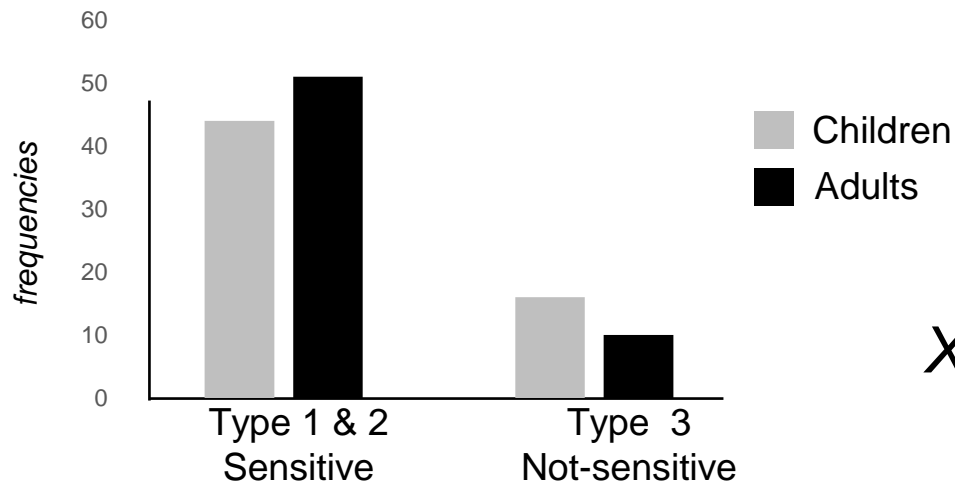
### SENSITIVITY TO OPTICS



$$\chi^2_{(2)} = 5.08; p < .05$$

- More adults than children demonstrated sensitivity to optics
- (conflicts with previous findings)

### SENSITIVITY TO VIEWPOINT



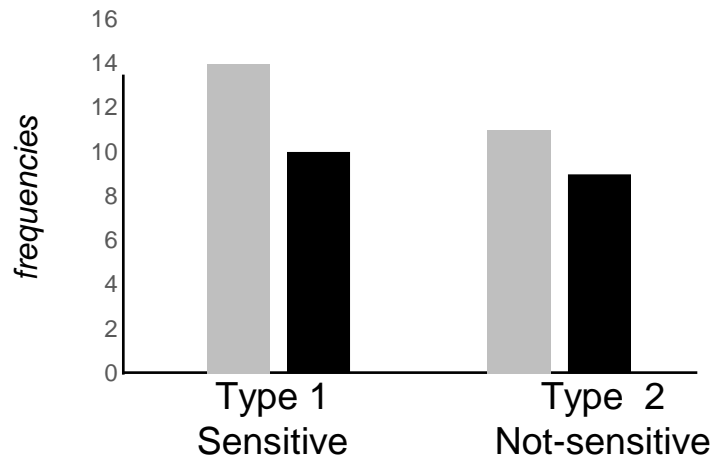
- About the same number of adults and children demonstrated sensitivity to viewpoint

$$\chi^2_{(2)} = 1.89; p = .16$$

# RESULTS ON FREQUENCIES (8-11 Children)

## TD vs ADS

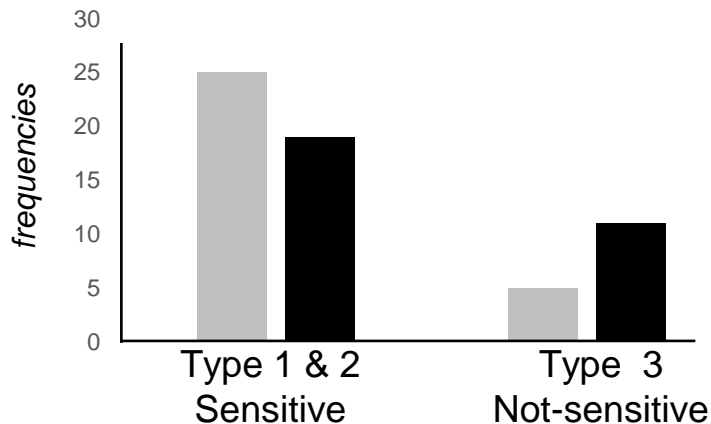
### SENSITIVITY TO OPTICS



$\chi^2_{(2)} = 0.05; p = .82$

- About the same number of TD and ASD children demonstrated sensitivity to optics

### SENSITIVITY TO VIEWPOINT



- Slightly more TD than ASD children demonstrated sensitivity to viewpoint

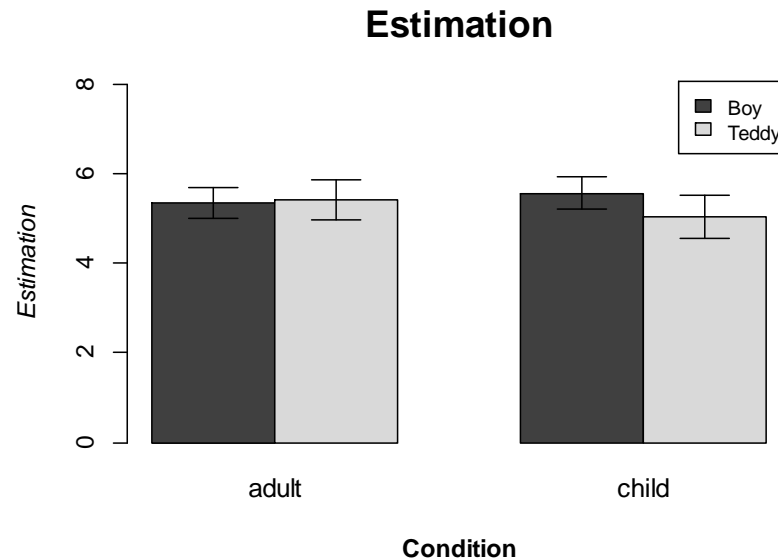
$\chi^2_{(2)} = 3.07; p = .079$

# Transformation 2: ESTIMATION ANALYSIS

- To further explore the differences between TD and ADS children and between the two age groups, we analysed the total number of sweets selected minus the correct number of sweets that needed to be circled

# RESULTS ON ESTIMATION (ADULTS vs TD CHILDREN)

**Estimation**: the number of sweets that the participants selected as visible from the mirror *minus* correct answer



*Overestimation error*

**There was no difference between adults and children in estimation.**

There was a small interaction age group vs object ( $p < .001$ ) with children being better with the teddy bear.

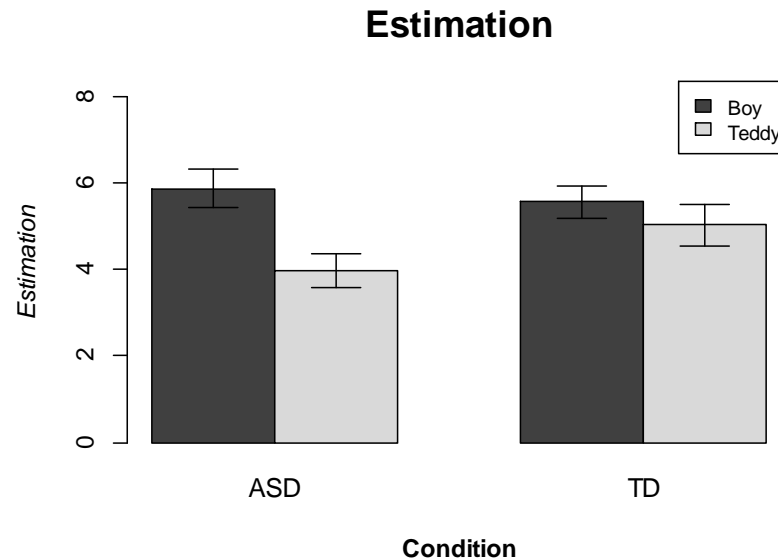
This can explain the apparent contradiction with Bertamini & Wynne (2009)'s study.

**Children have same (or better) sensitivity to viewpoint to adults, but adults have a better sensitivity to optics**



# RESULTS ON ESTIMATION (CHILDREN: TD vs ASD)

**Estimation**: the number of sweets that the participants selected as visible from the mirror *minus* correct answer



*Overestimation error*

There was an interaction between the Type of development and type of Object ( $p < .001$ )

**Overall, ASD outperform TD children especially when the object is *not* resembling a human figure**

# DISCUSSION

- The task is easier for everyone if the Object is a Person than a Teddy Bear
- Adults have slightly better sensitivity to optics than children
- No difference in sensitivity to **optics** between TD and ASD children
- TD have better sensitivity to **viewpoint** than ASD children
- ASD outperform TD children when presented with a Teddy Bear
  - It can be argued that TD benefit from the *social nature* of imagining a child. ASD instead can do well at the task (which is about geometry) and they can solve the problem quite well also for a Teddy Bear, not being influenced by the social nature of imagining a child

# SUMMARY

- We hold beliefs about mirrors that are systematically wrong
- We have poor sensitivity to both *optics* and ***viewpoint***
- Adults have better sensitivity to *optics* than children but they have similar sensitivity to the *viewpoint*
- TD tend to have a better sensitivity to the *viewpoint* than ASD children
- ASD outperform TD children . This is particularly true when the viewpoint does not resemble a human figure
  - **These results support an involvement of ToM when reasoning about mirrors**

- THANK YOU