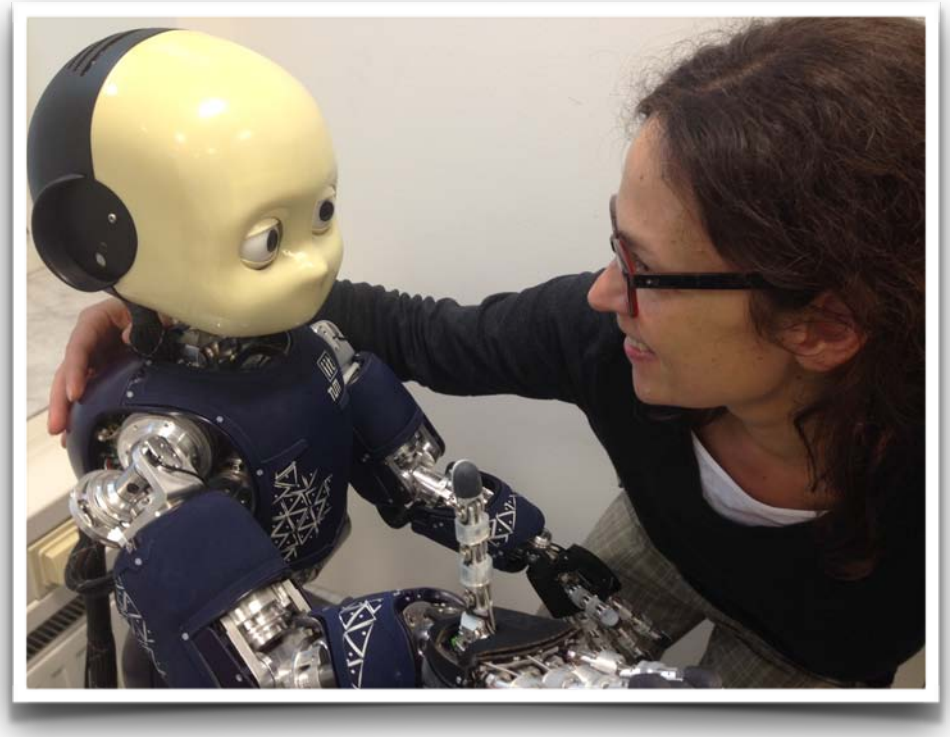
LINKING SOCIAL COGNITIVE NEUROSCIENCE WITH ROBOTICS FOR RELIABILITY OF RESEARCH IN HRI



AGNIESZKA WYKOWSKA

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agnieszka.wykowska@tum.de

USING METHODS OF SOCIAL COGNITIVE NEUROSCIENCE TO:

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- examine fundamental mechanisms of human sensing and human cognition in human-robot interaction

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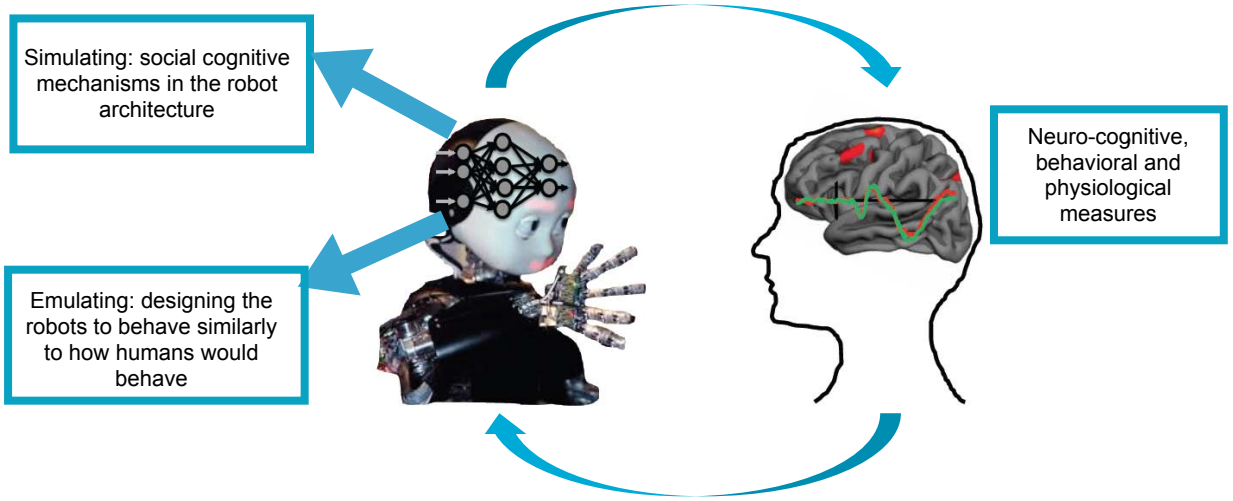
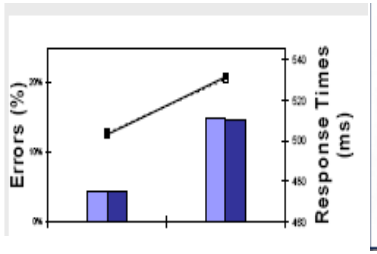
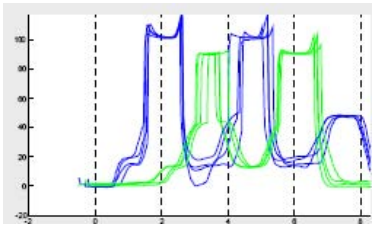
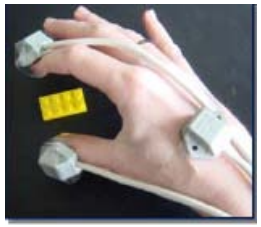


Behavioural measures

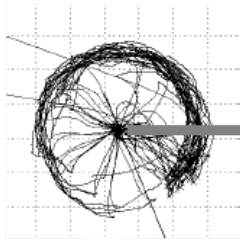


RTs/Errors

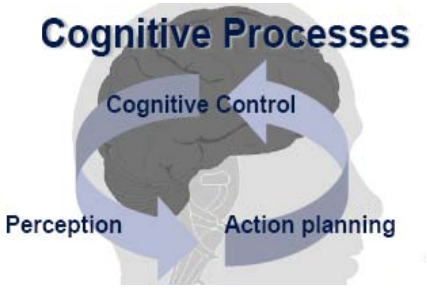




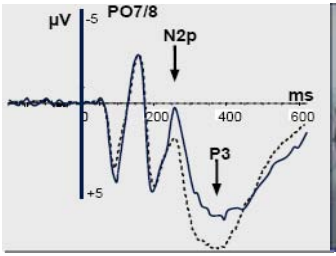
Motion tracking



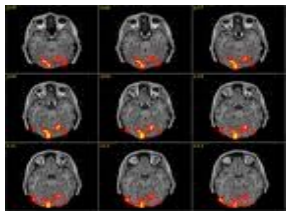
Eyetracking



Neuro-cognitive methods



EEG measurement



fMRI

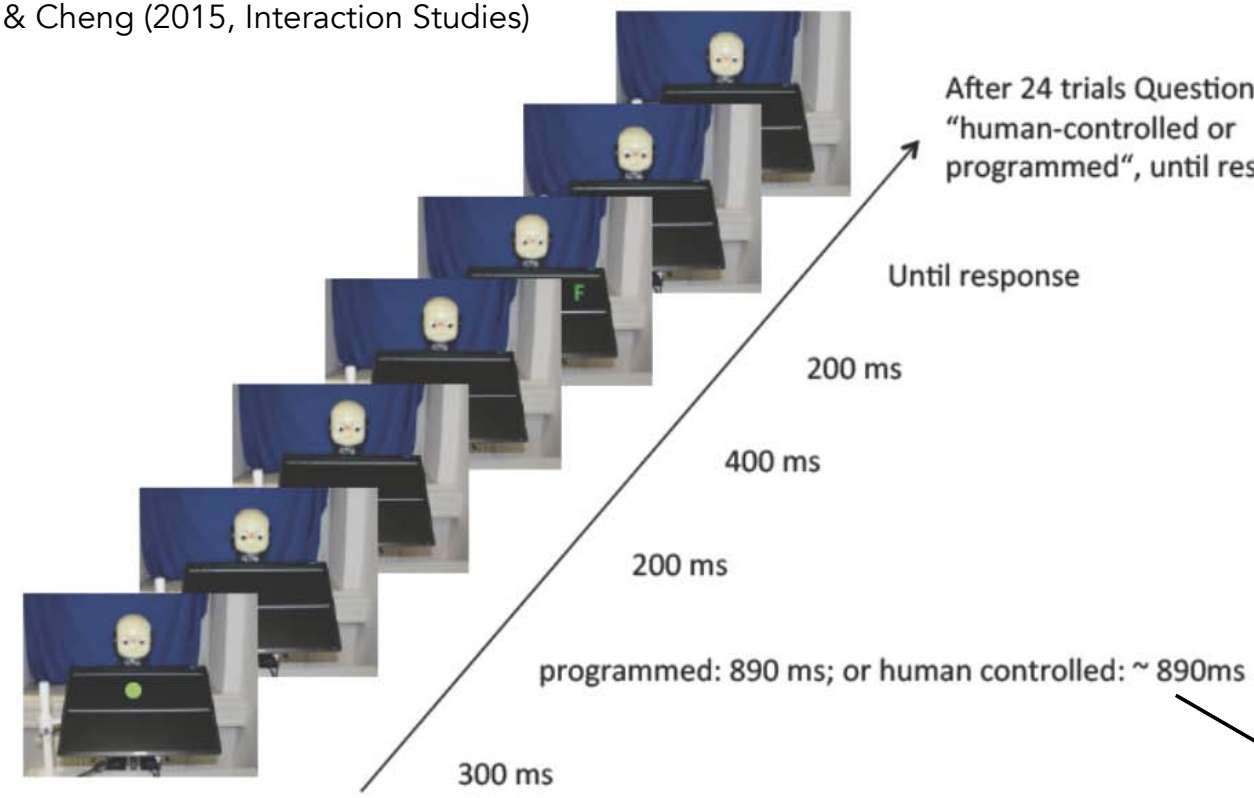
TMS Heartrate Galvanic skin response

Physiology

WHY OBJECTIVE METHODS

Implicit cognitive processes, not necessarily accessible to awareness

Wykowska, Kajopoulos, Ramirez-Amaro, & Cheng (2015, Interaction Studies)



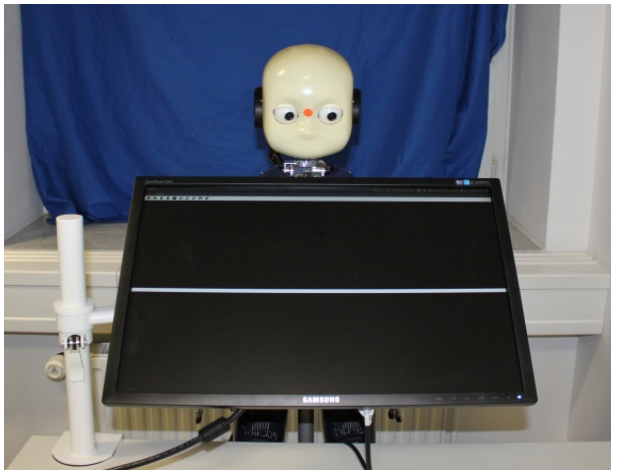
iCub Robot designed at Italian Institute of Technology

Wykowska, Kajopoulos, Ramirez-Amaro, & Cheng (2015, Interaction Studies)

Pre-programmed

vs.

Human pre-recorded

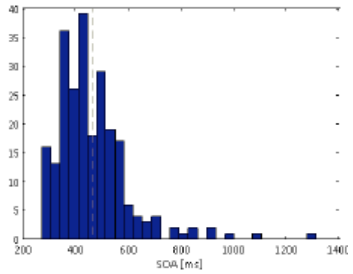


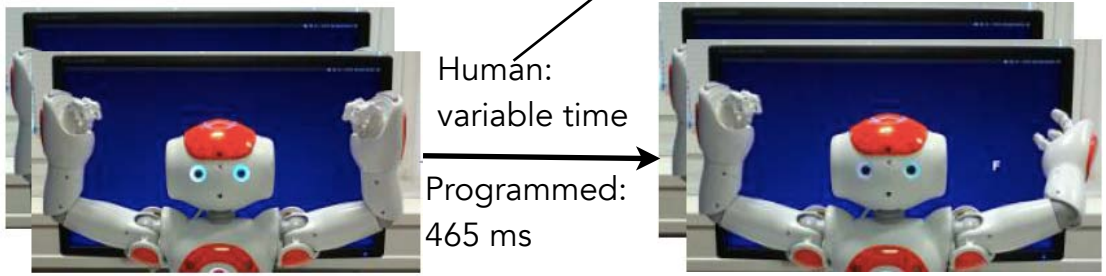
Results:

- Sensitivity to the human-like behaviour (humanness judgment accuracy: significantly above chance, 54%)
- Lack of awareness of the correct hint

WHY OBJECTIVE METHODS
Reliability and Replicability

Wykowska, Kajopoulos, Kajopoulos, J., Obando-Leitón, M., Chauhan, S., Cabibihan, J.J., Cheng, G. (2015, International Journal of Social Robotics)





Validity: 50%

Results:

- Sensitivity to the human-like behaviour (humanness judgment accuracy: significantly above chance, 57%)
- Lack of awareness of the correct hint

WHY OBJECTIVE METHODS

Fundamental mechanisms

WHY OBJECTIVE METHODS

Fundamental mechanisms

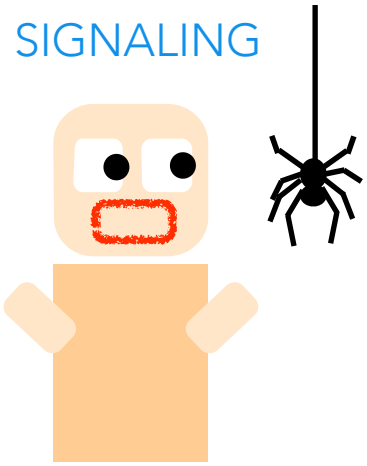
SOCIAL ATTENTION - GAZE FOLLOWING/SHARED ATTENTION

WHY OBJECTIVE METHODS

Fundamental mechanisms

SOCIAL ATTENTION - GAZE FOLLOWING/SHARED ATTENTION

SIGNALING

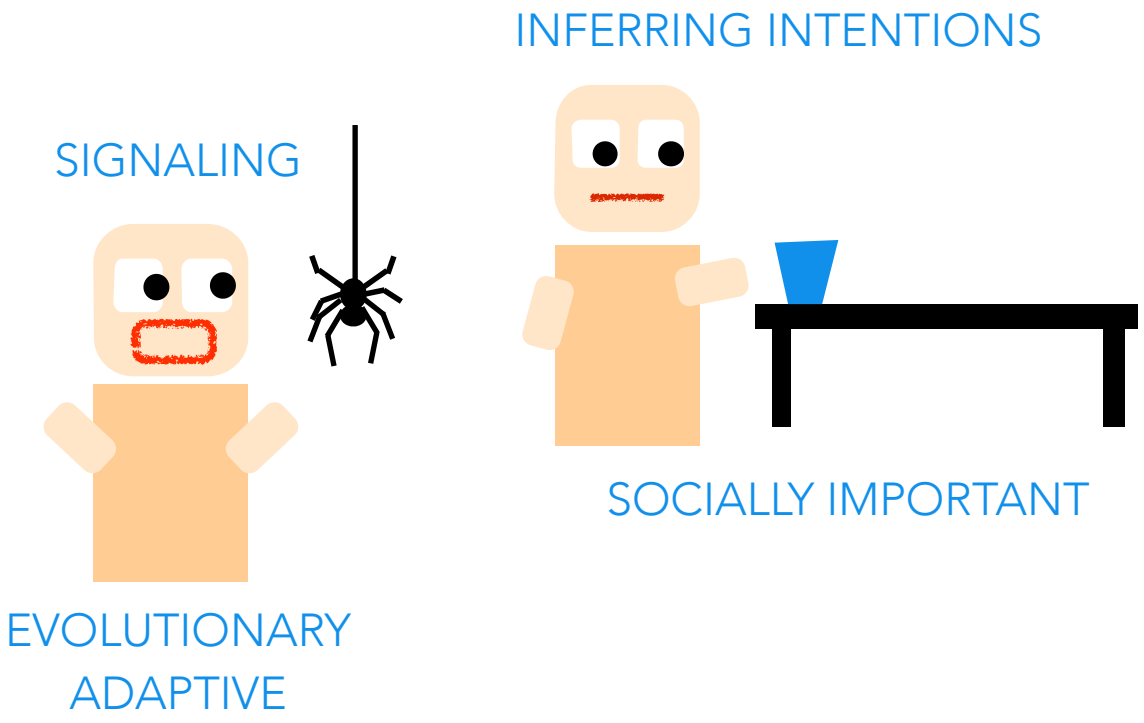


EVOLUTIONARY
ADAPTIVE

WHY OBJECTIVE METHODS

Fundamental mechanisms

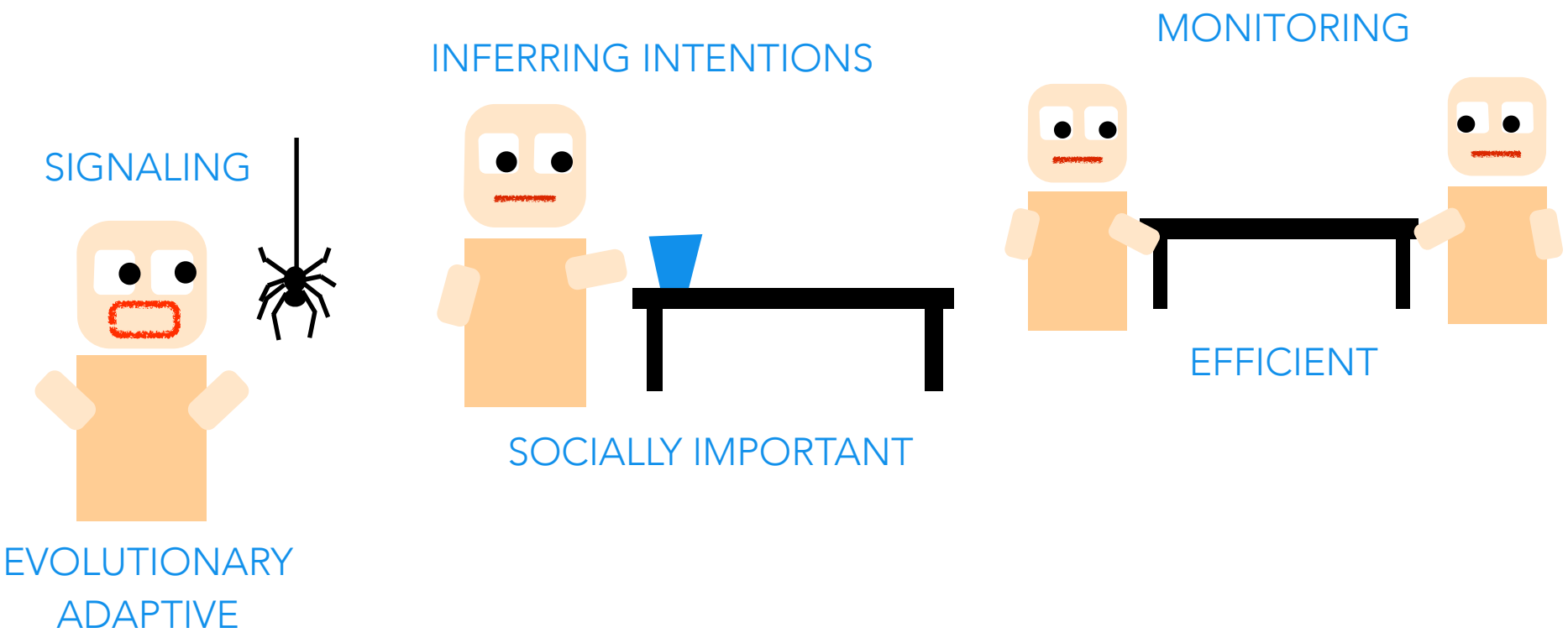
SOCIAL ATTENTION - GAZE FOLLOWING/SHARED ATTENTION



WHY OBJECTIVE METHODS

Fundamental mechanisms

SOCIAL ATTENTION - GAZE FOLLOWING/SHARED ATTENTION

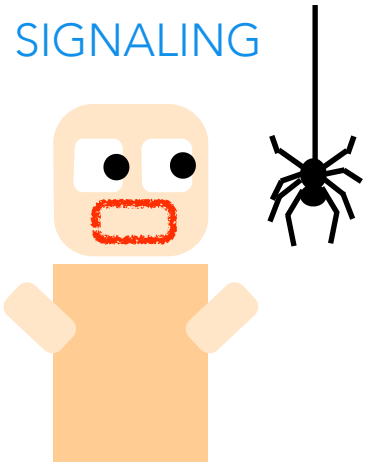


WHY OBJECTIVE METHODS

Fundamental mechanisms

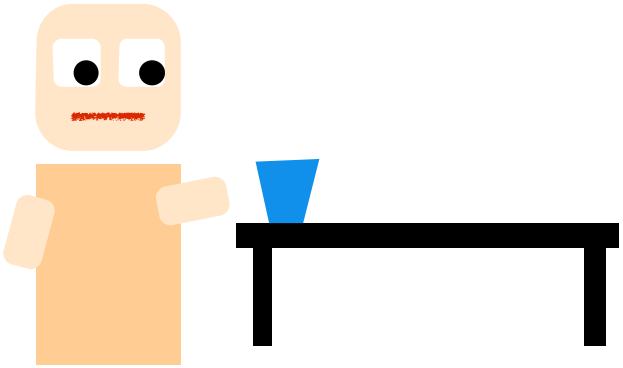
SOCIAL ATTENTION - GAZE FOLLOWING/SHARED ATTENTION

SIGNALING



EVOLUTIONARY
ADAPTIVE

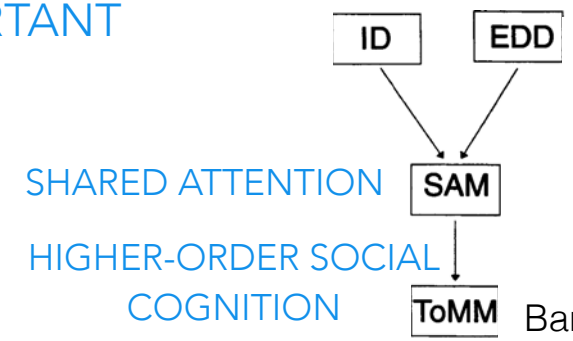
INFERRING INTENTIONS



SOCIALLY IMPORTANT

MONITORING

EFFICIENT



SHARED ATTENTION

HIGHER-ORDER SOCIAL
COGNITION

Baron-Cohen (1995)

SOCIAL ATTENTION - GAZE FOLLOWING/SHARED ATTENTION

Posner cueing

SOCIAL ATTENTION - GAZE FOLLOWING/SHARED ATTENTION

Posner cueing

→

SOCIAL ATTENTION - GAZE FOLLOWING/SHARED ATTENTION

Posner cueing

→ T

SOCIAL ATTENTION - GAZE FOLLOWING/SHARED ATTENTION

Posner cueing

T

Validly cued target

SOCIAL ATTENTION - GAZE FOLLOWING/SHARED ATTENTION

Posner cueing

→ T

Validly cued target

→

SOCIAL ATTENTION - GAZE FOLLOWING/SHARED ATTENTION

Posner cueing

Validly cued target

T 

SOCIAL ATTENTION - GAZE FOLLOWING/SHARED ATTENTION

Posner cueing

Validly cued target

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Invalidly cued target

SOCIAL ATTENTION - GAZE FOLLOWING/SHARED ATTENTION

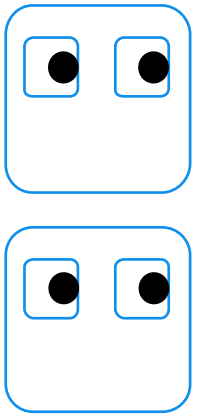
Posner cueing

Validly cued target

T

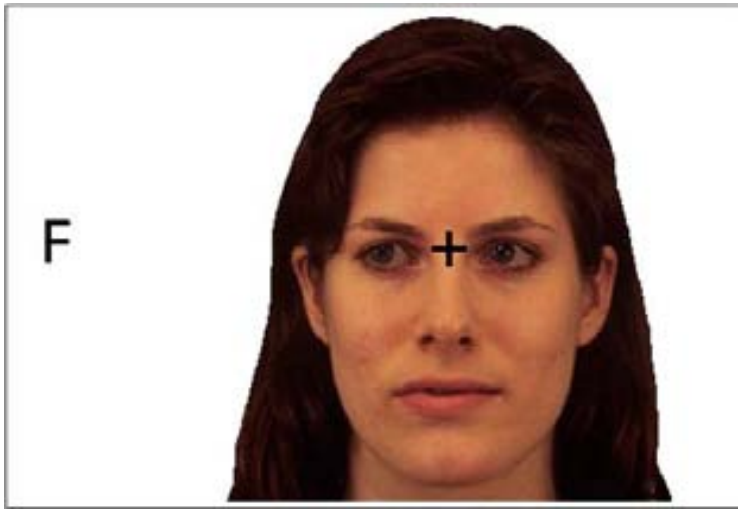
Invalidly cued target

Gaze cueing

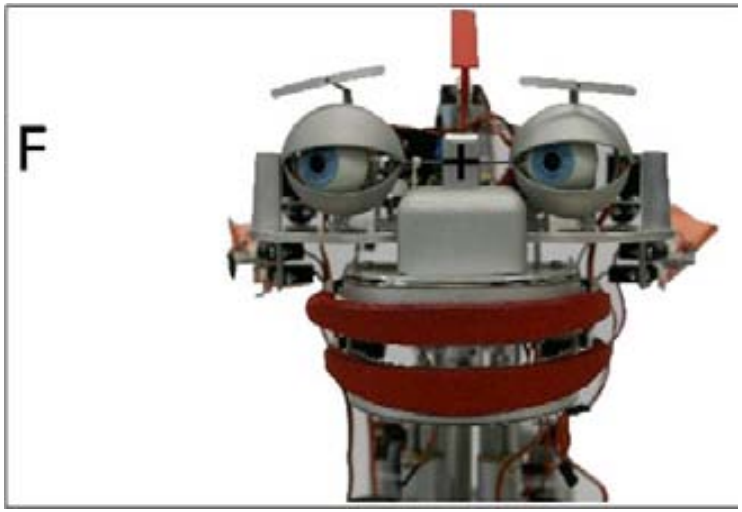


SOCIAL ATTENTION - GAZE FOLLOWING/SHARED ATTENTION

Wiese, Wykowska, Zwickel & Müller (2012, PloS One)



Karolinska Directed Emotional Faces database
(KDEF, Lundqvist, Flykt & Öhman, 1998)

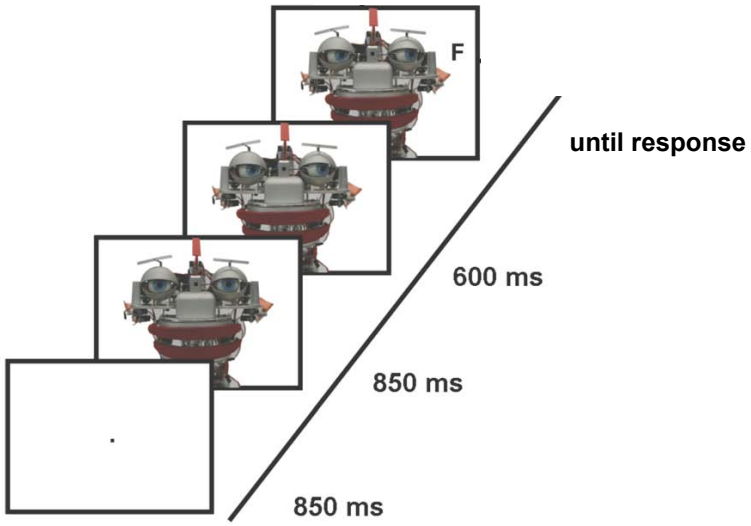


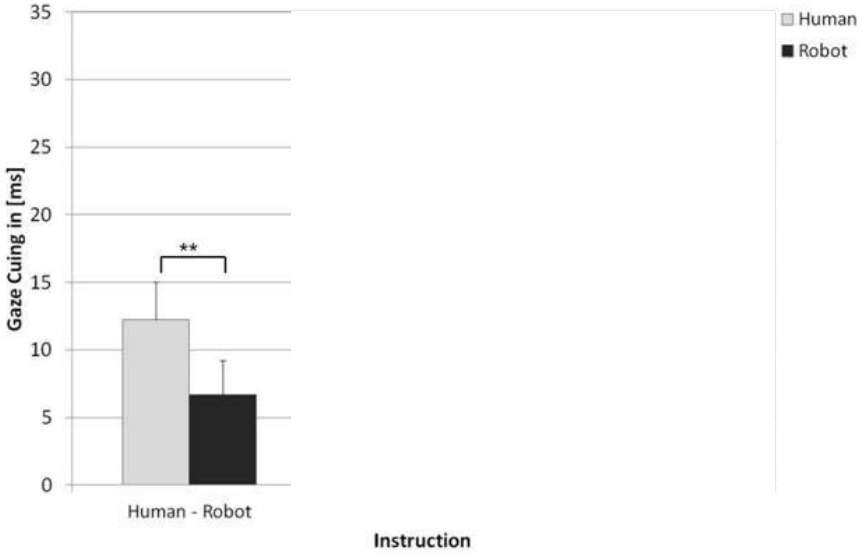
(c) LSR, TU München

Task: discriminate the letter F/T

SOCIAL ATTENTION - GAZE FOLLOWING/SHARED ATTENTION

Wiese, Wykowska, Zwickel & Müller (2012, PloS One)





Factors:

- cue type (robot vs. human)
- validity (valid vs. invalid)

Gaze cueing: $RT_{invalid}$ - RT_{valid}

SOCIAL ATTENTION - GAZE FOLLOWING/SHARED ATTENTION

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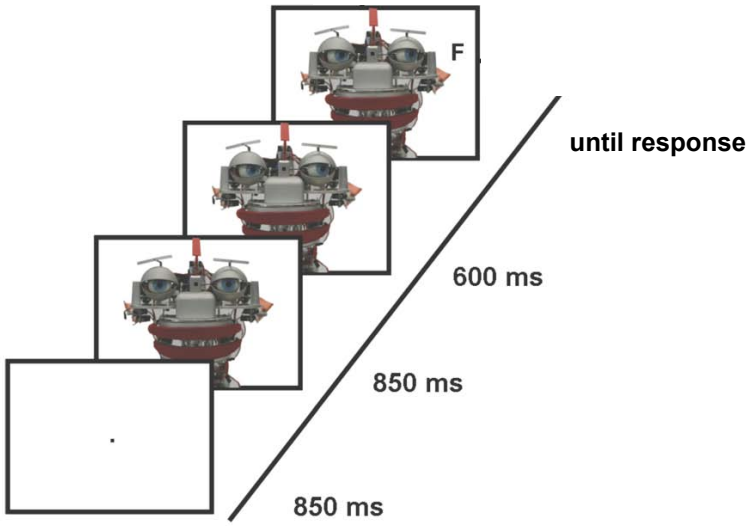

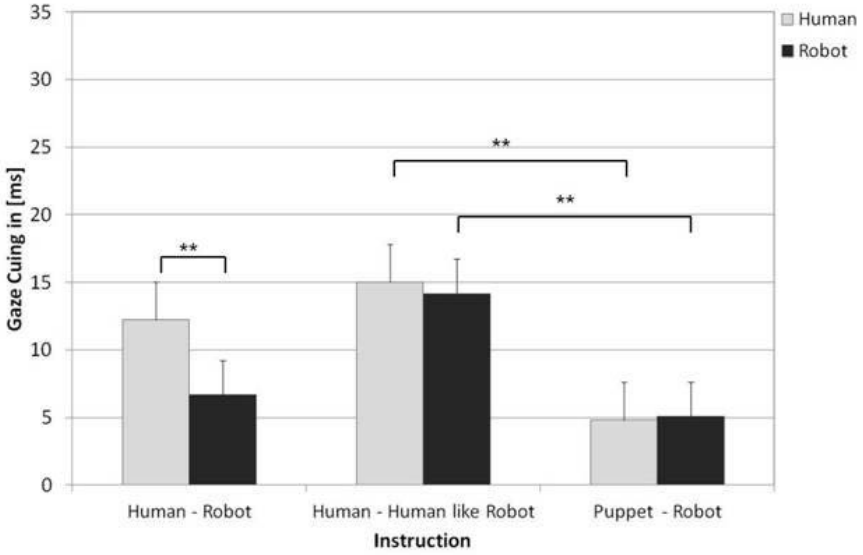

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SOCIAL ATTENTION - GAZE FOLLOWING/SHARED ATTENTION

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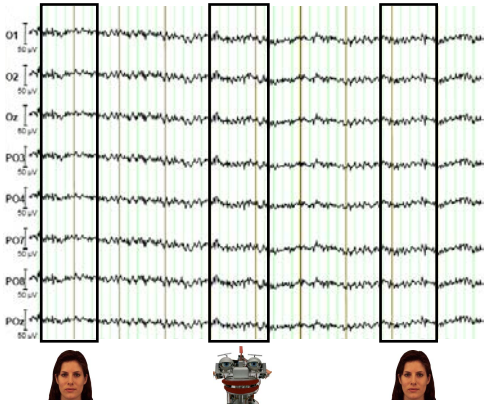
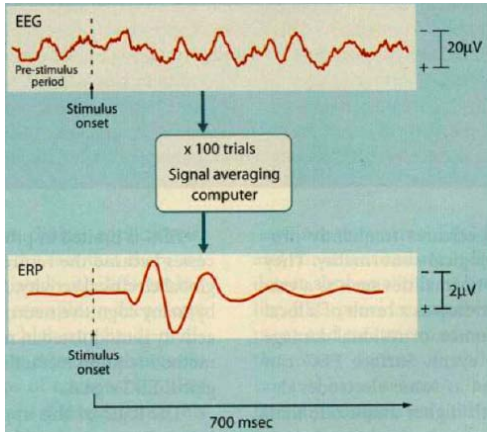
ERPs of the EEG signal

SOCIAL ATTENTION - GAZE FOLLOWING/SHARED ATTENTION

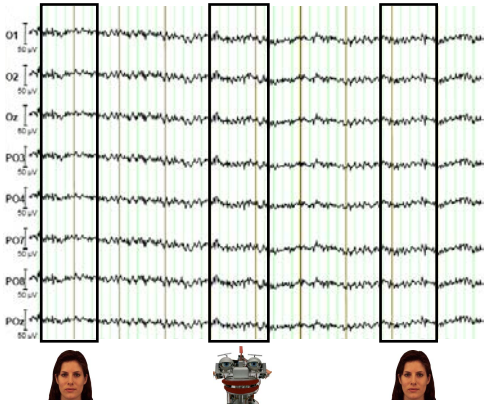
ERPs of the EEG signal

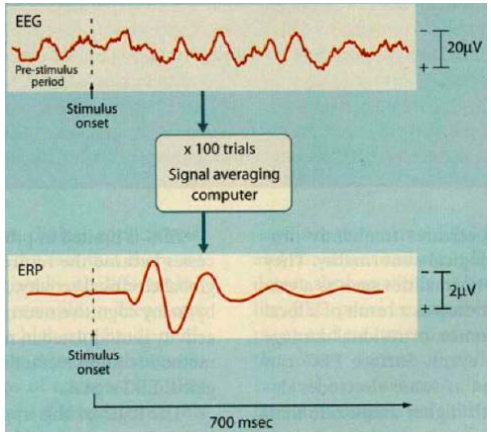




SOCIAL ATTENTION - GAZE FOLLOWING/SHARED ATTENTION

ERPs of the EEG signal

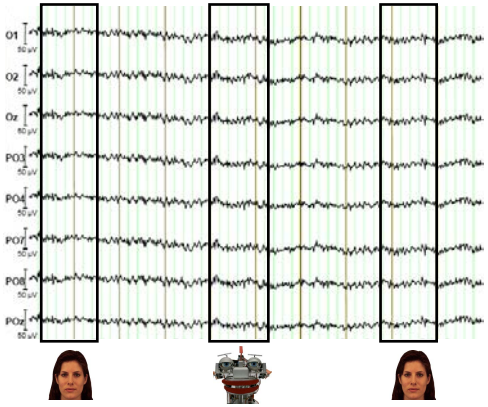


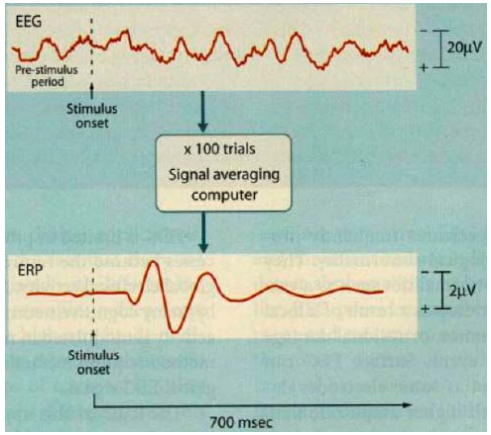


ERPs are more informative than just behavioural data

SOCIAL ATTENTION - GAZE FOLLOWING/SHARED ATTENTION

ERPs of the EEG signal





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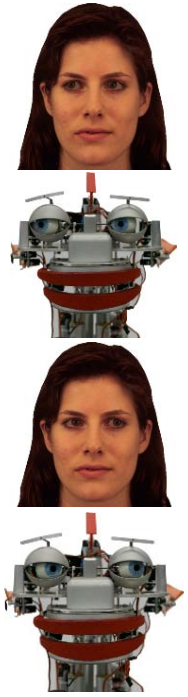
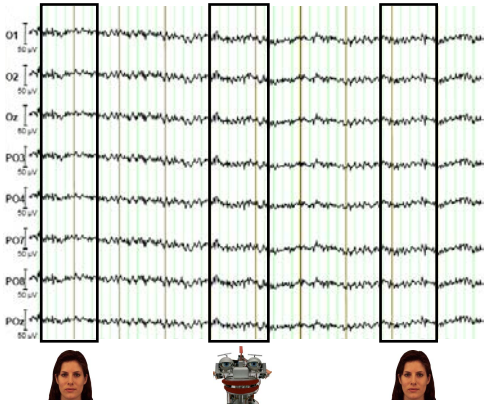
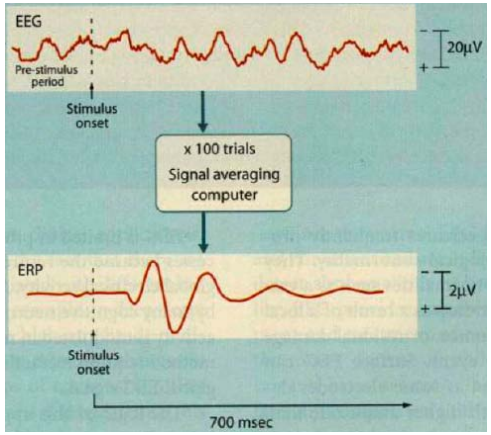


SOCIAL ATTENTION - GAZE FOLLOWING/SHARED ATTENTION

ERPs of the EEG signal





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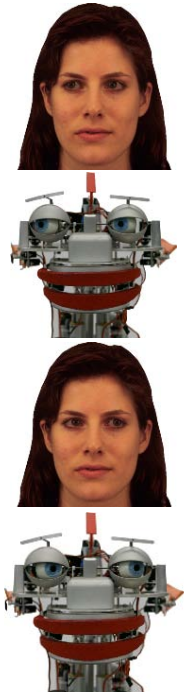


474 ms

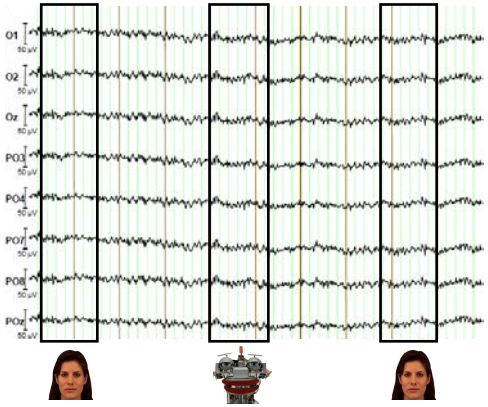
473 ms

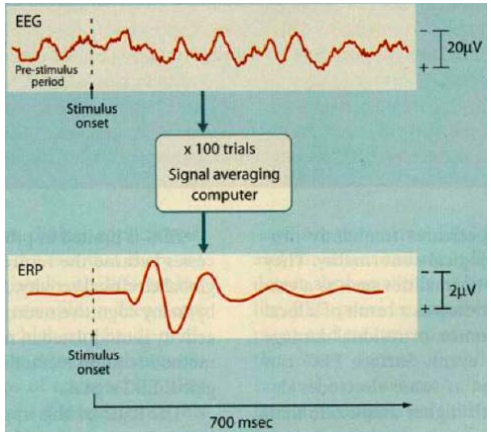
457 ms

455 ms

SOCIAL ATTENTION - GAZE FOLLOWING/SHARED ATTENTION

ERPs of the EEG signal





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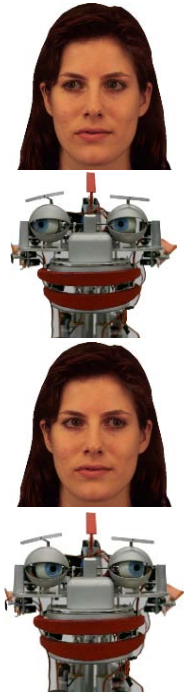

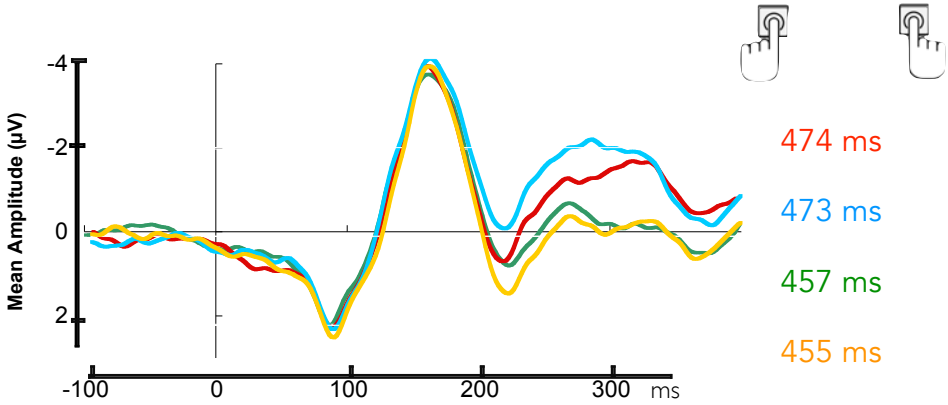

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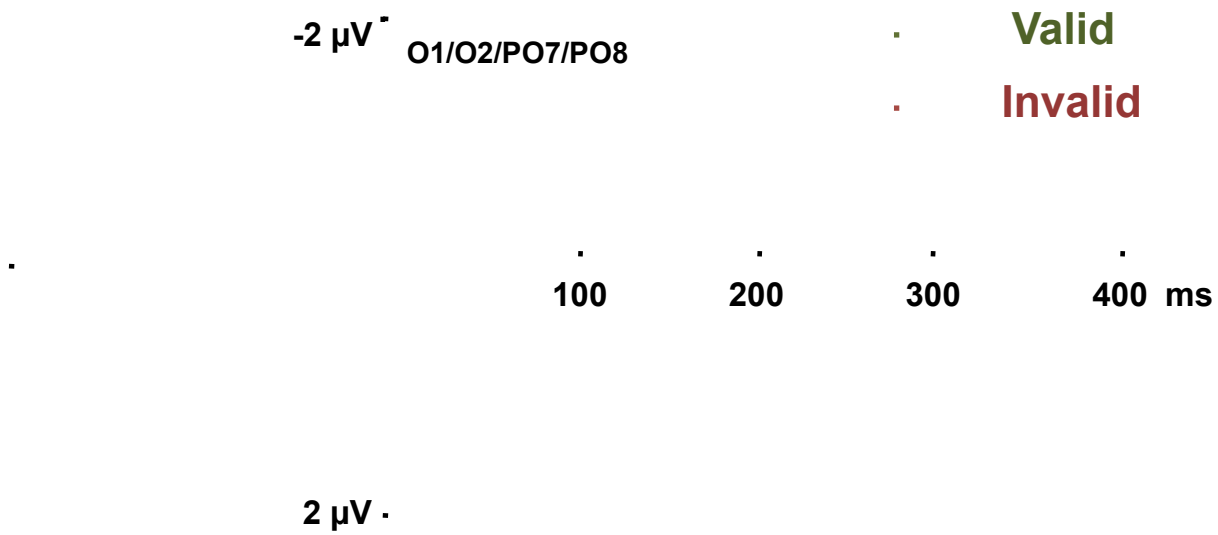
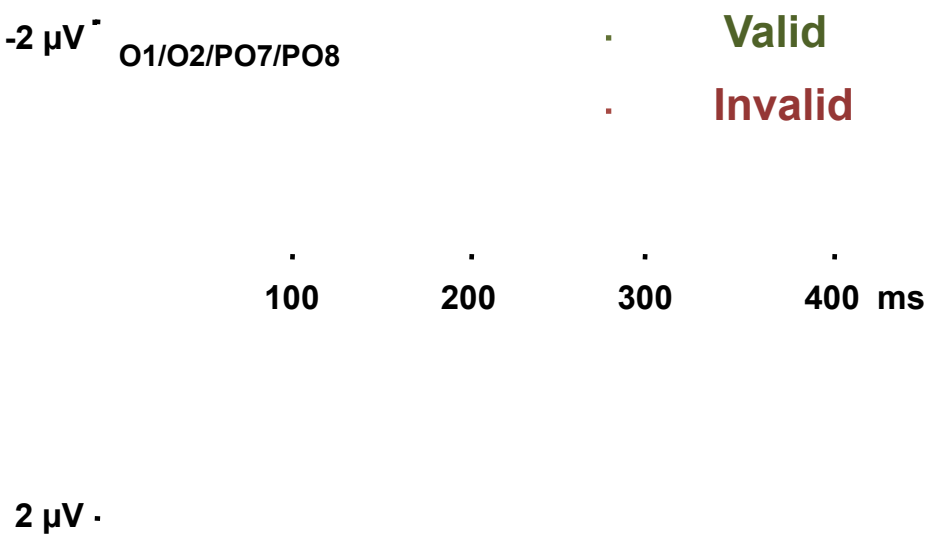


- Within-participants instruction manipulation
- Physically identical stimuli across conditions

SOCIAL ATTENTION - GAZE FOLLOWING/SHARED ATTENTION

Wykowska, Wiese, Prosser & Müller (2014, PLoS One)



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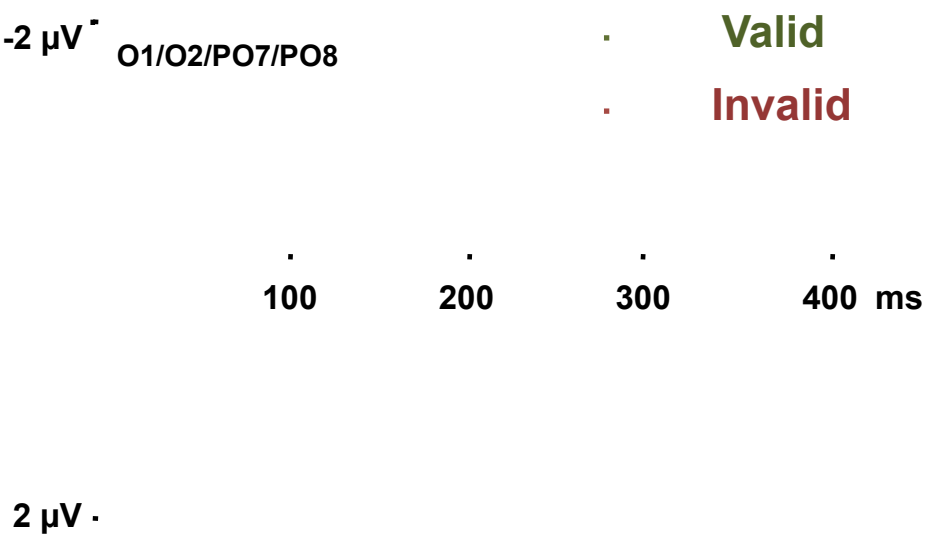

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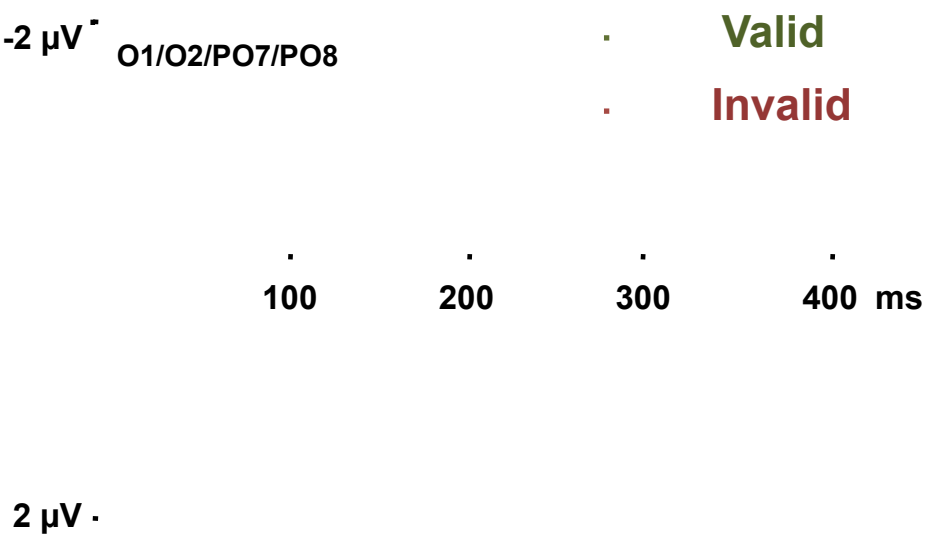

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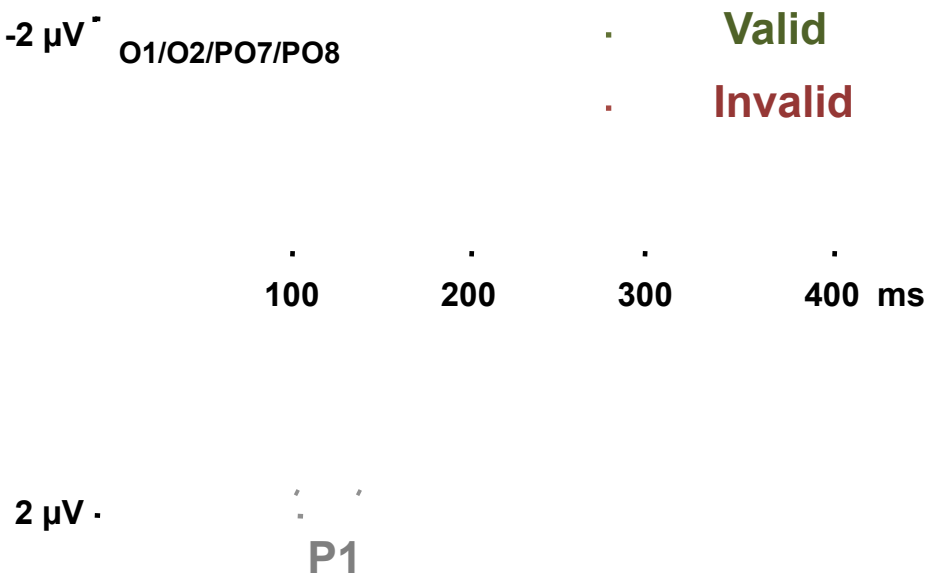

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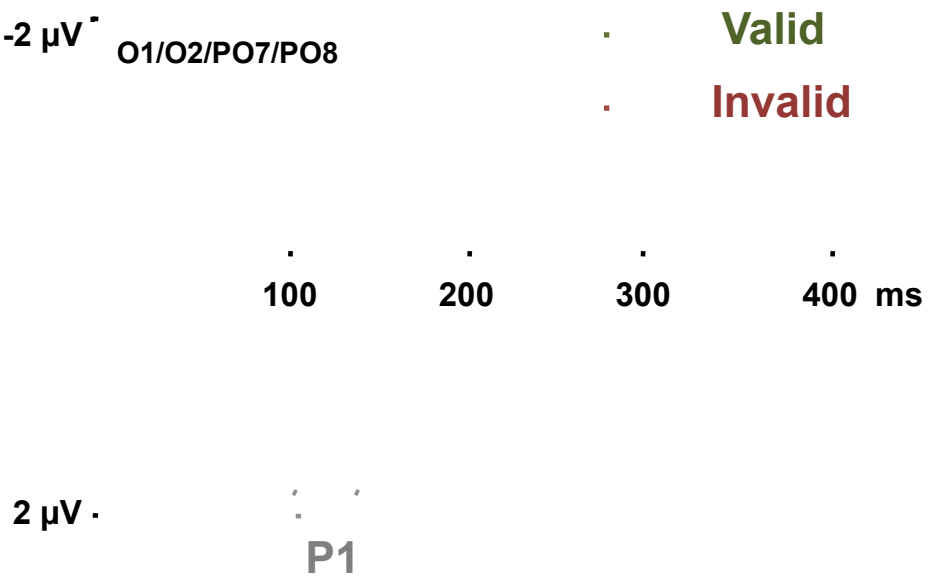

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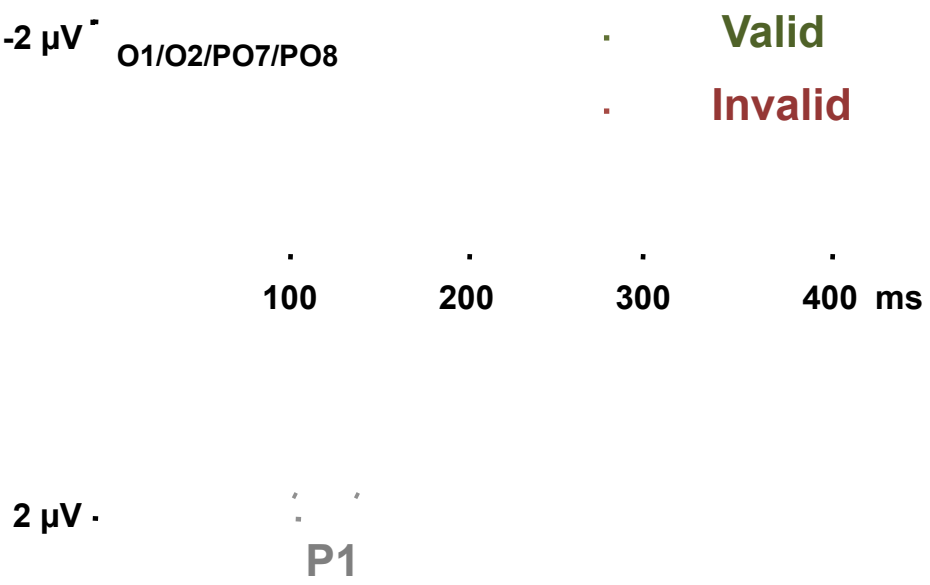

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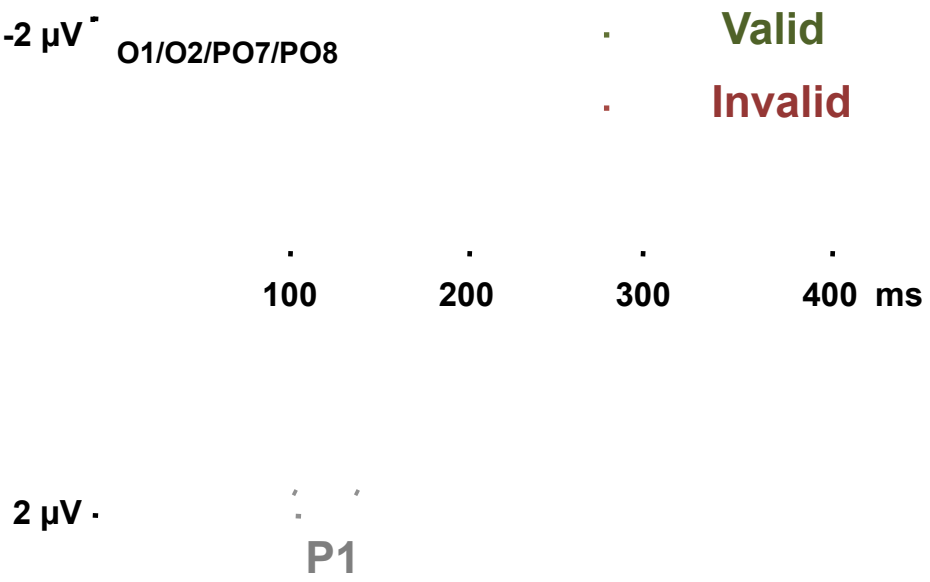
SOCIAL ATTENTION - GAZE FOLLOWING/SHARED ATTENTION

Wykowska, Wiese, Prosser & Müller (2014, PLoS One)



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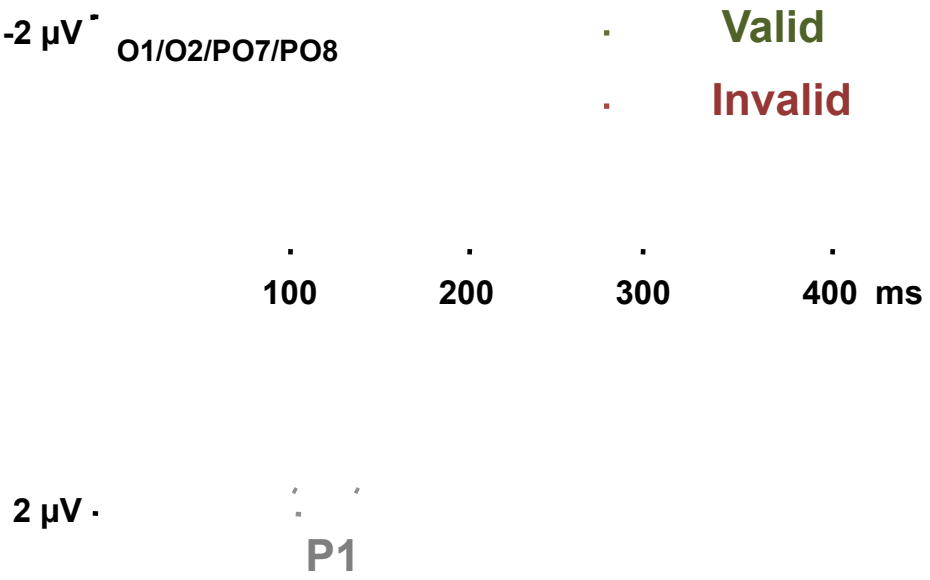

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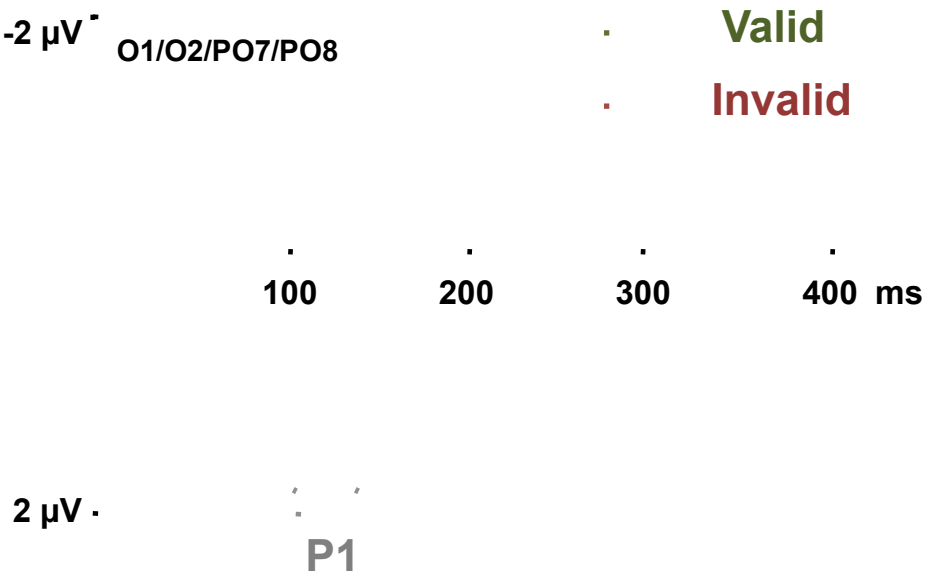

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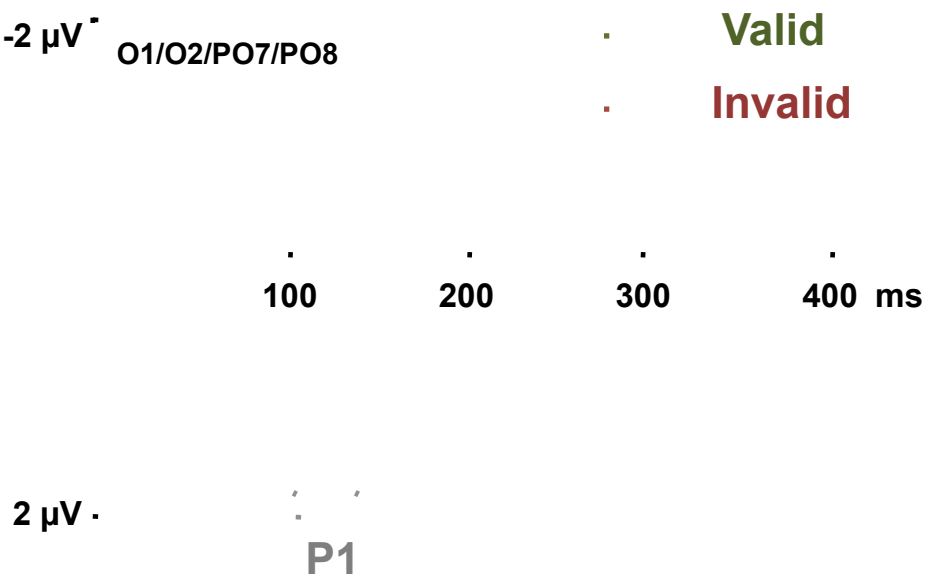

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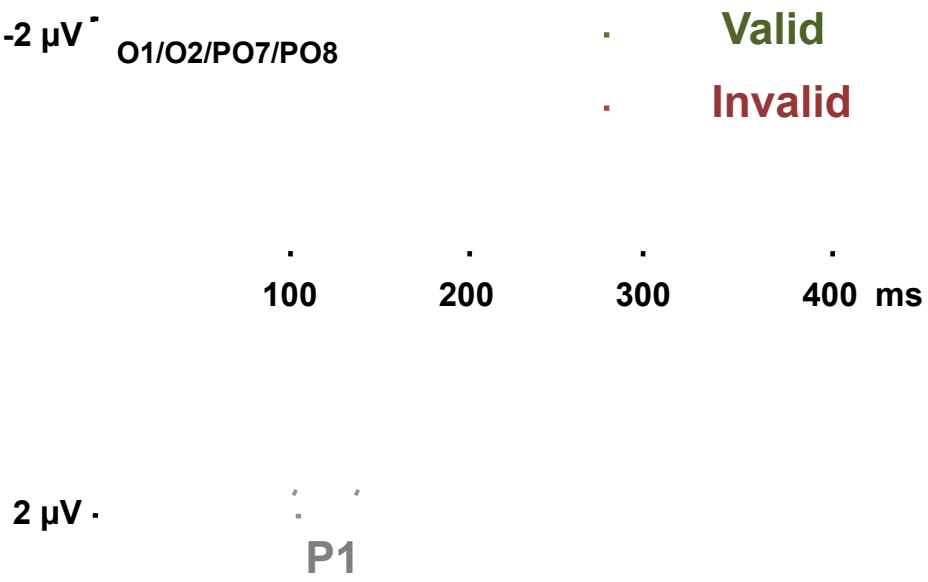

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Sensory gain modulated by higher-order social cognitive processes

OBJECTIVE METHODS - APPLICATION TO CLINICAL CASES

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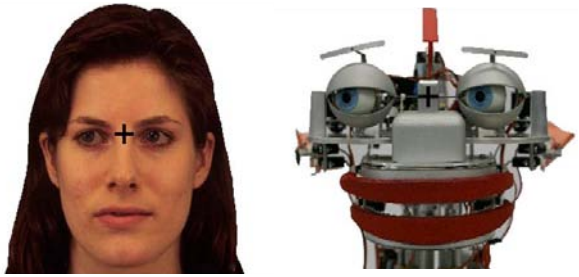
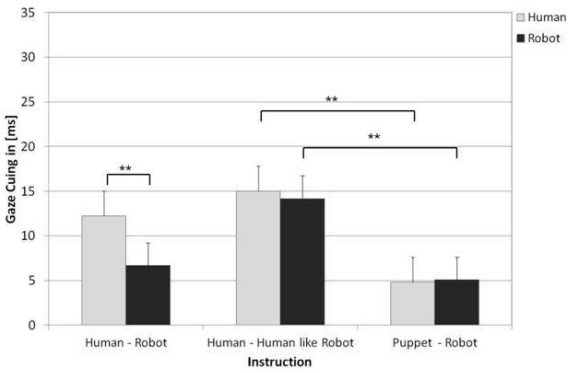
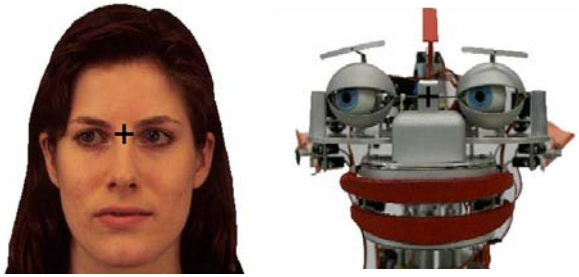
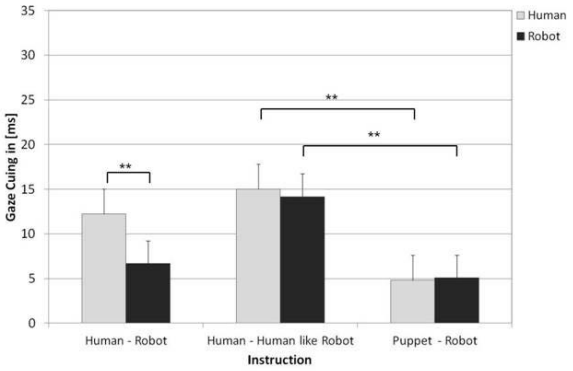


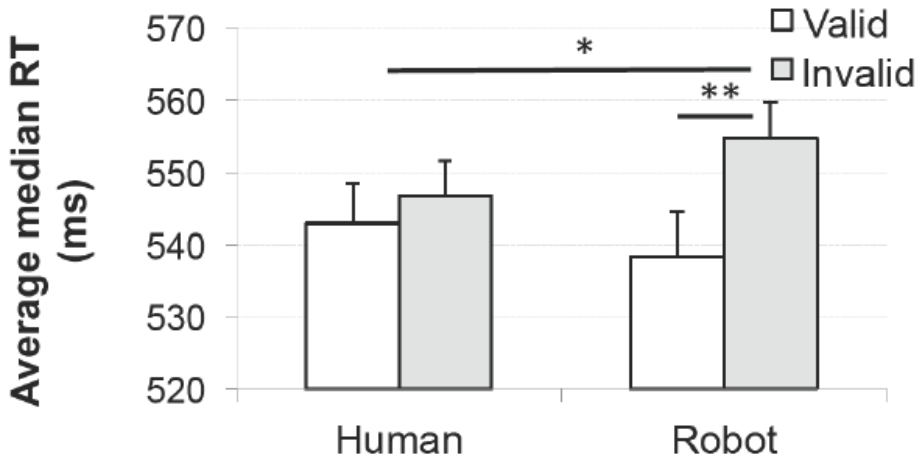


OBJECTIVE METHODS - APPLICATION TO CLINICAL CASES

Wiese, Müller, & Wykowska (2014). LNAI, 8755, 370-379







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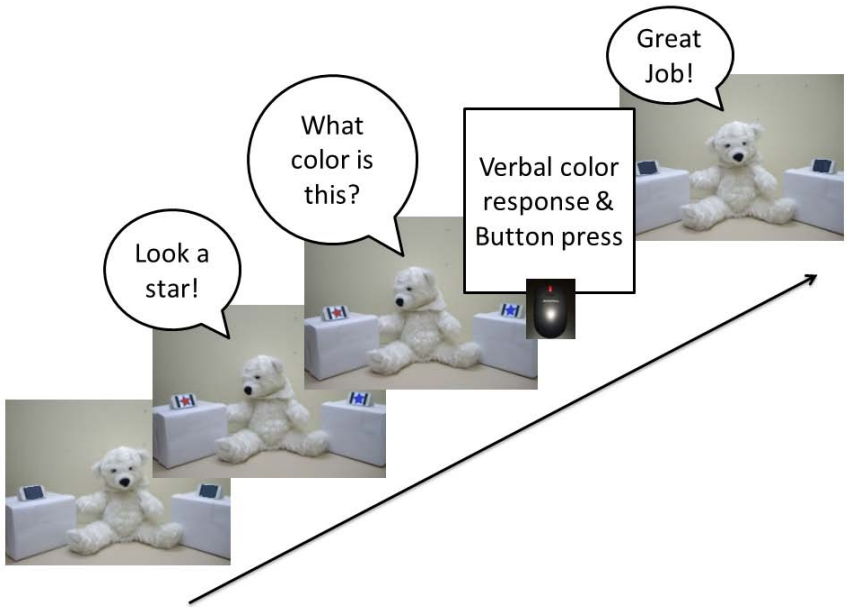

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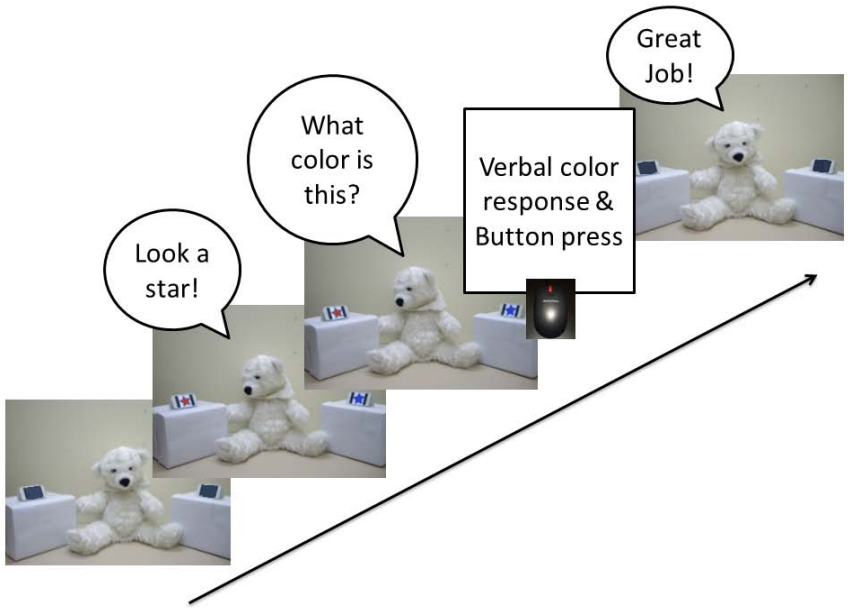
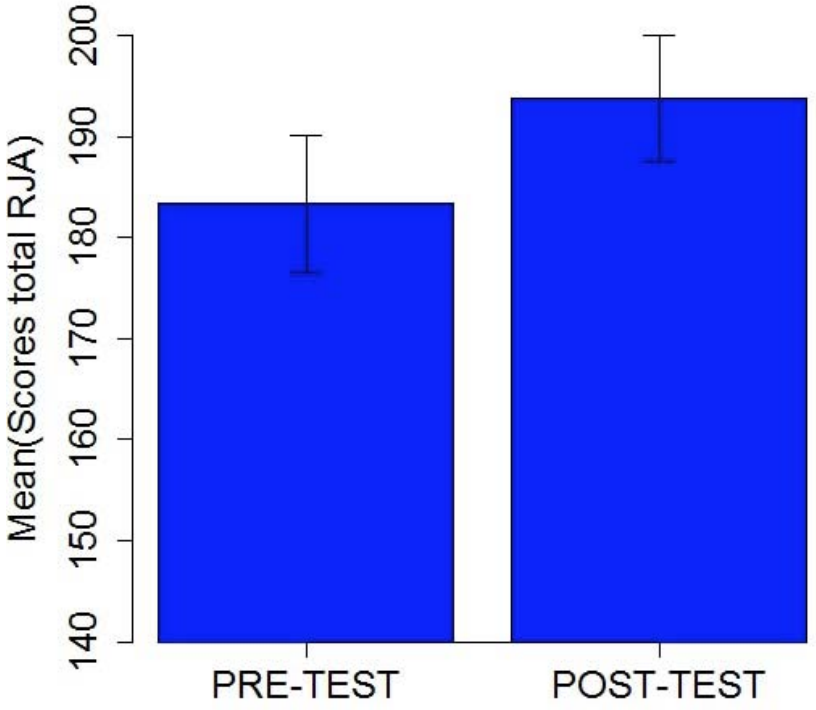
Responding to joint attention





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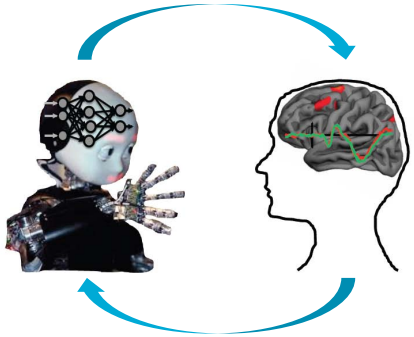
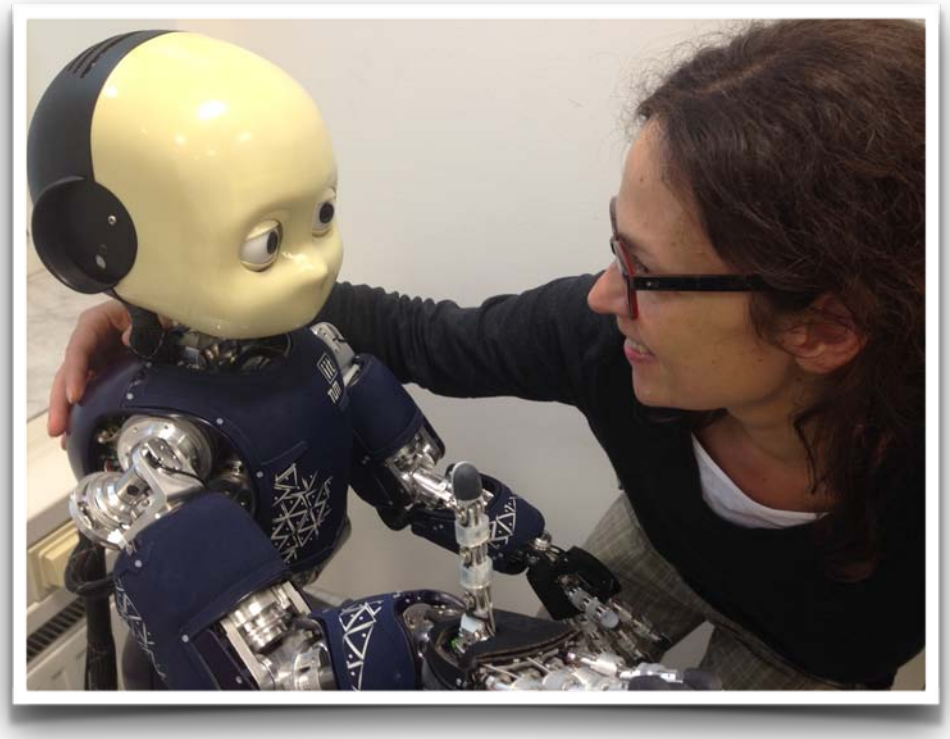


THANK YOU!



AGNIESZKA WYKOWSKA

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