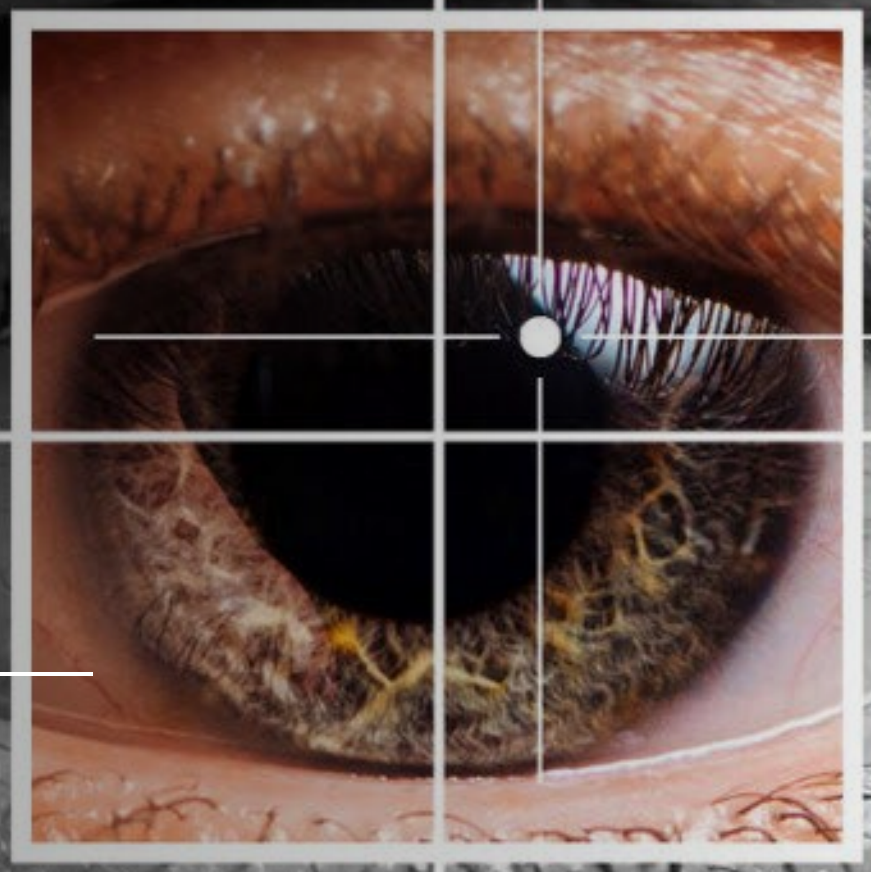
The Eyes Have It: Exploring Human-Robot Interactions Through Pupillometry



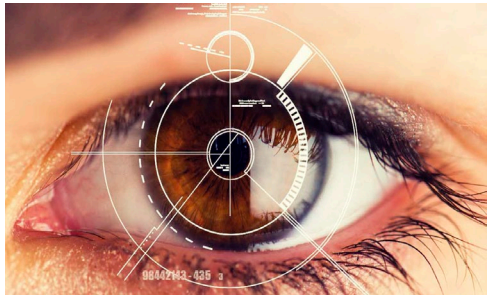
Marieke van Otterdijk

Human-Robot Interaction uses many measurement tools to understand the users

Surveys

Qualitative measurements

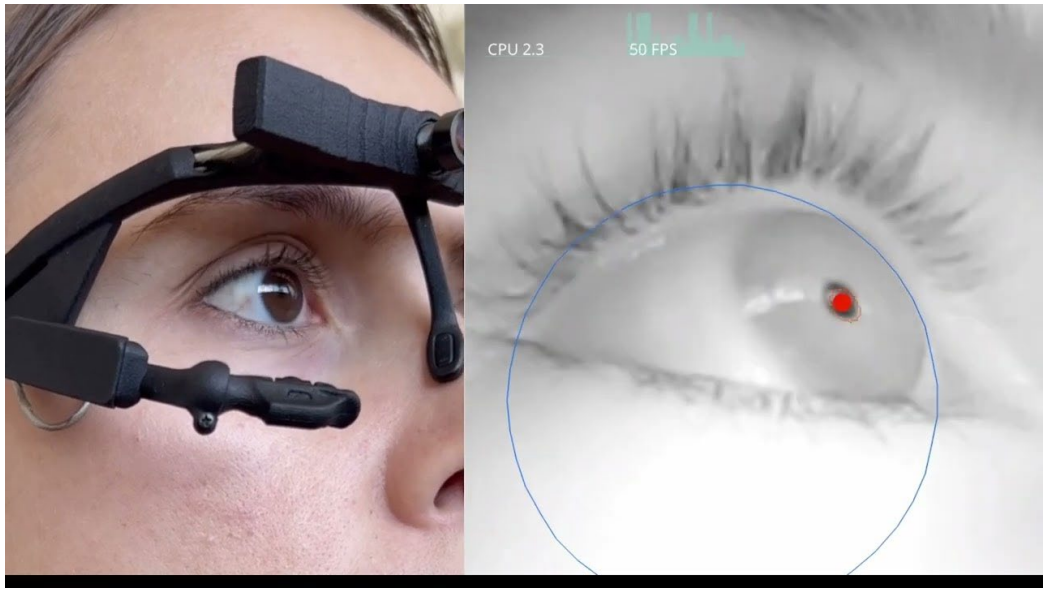
Biosignals/ sensors



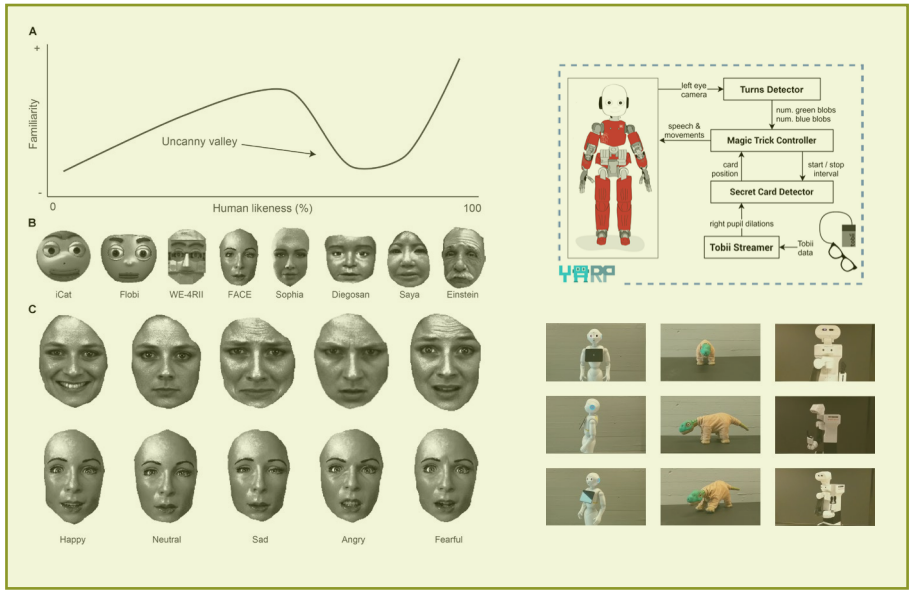
Eye tracking

This presentation will discuss the following topics

Pupillometry

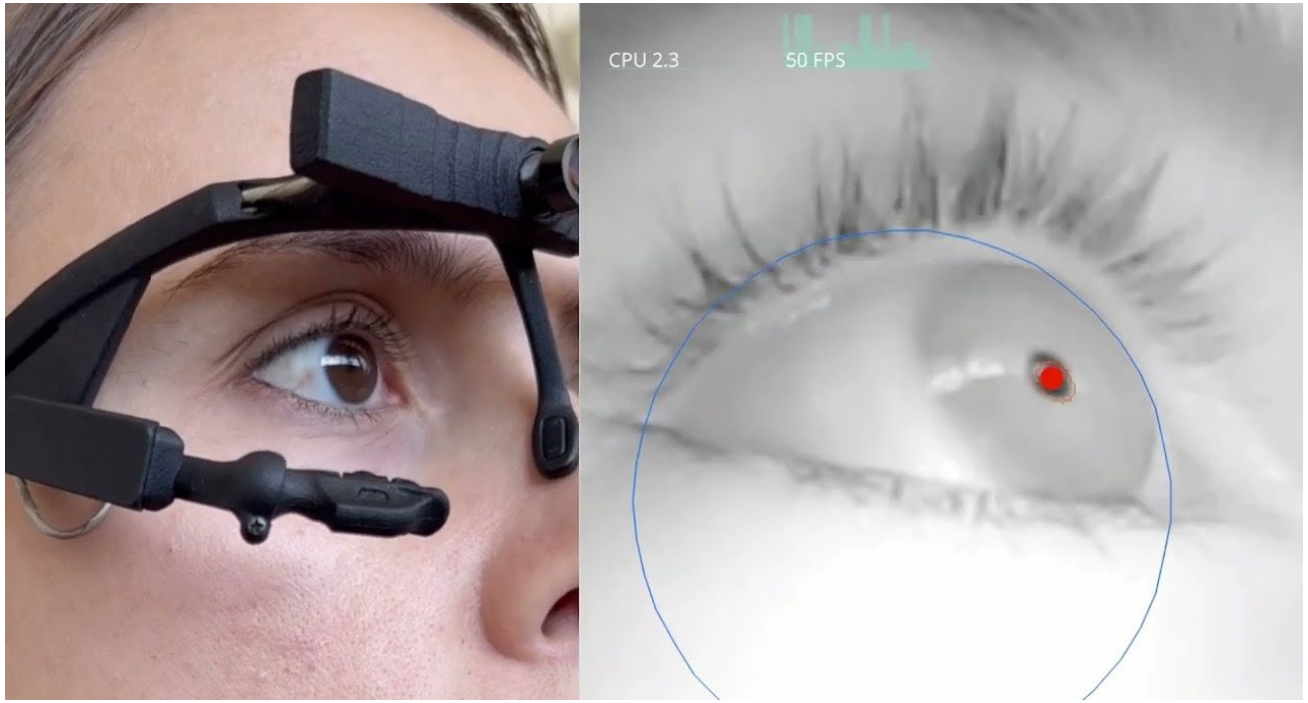


Pupillometry studies in HRI



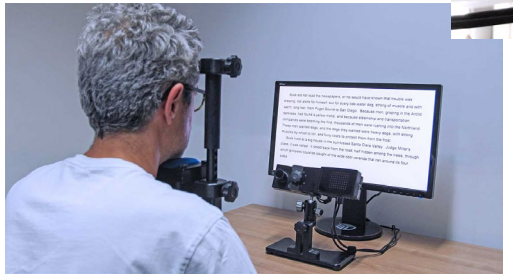
Pupillometry enables the researcher to understand the user's cognitive processes

- Measurement of pupil
- Arousal and mental effort
- Psychology
  - Kahneman & Beatty (1966)

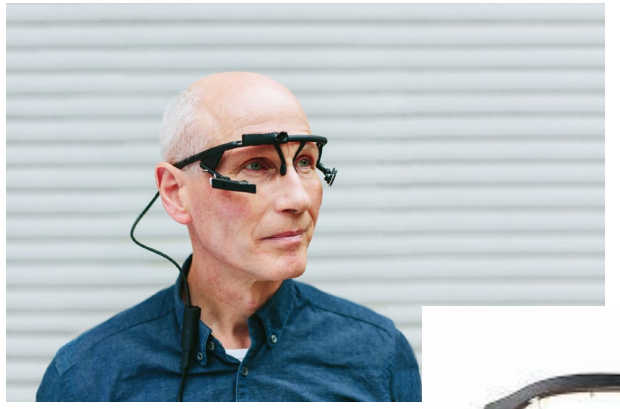


Kahneman, D., & Beatty, J. (1966). Pupil diameter and load on memory. Science, 154(3756), 1583-1585.

There are different devices that can be used for eye tracking



Stationary trackers



Wearable trackers

This presentation will discuss the following topics

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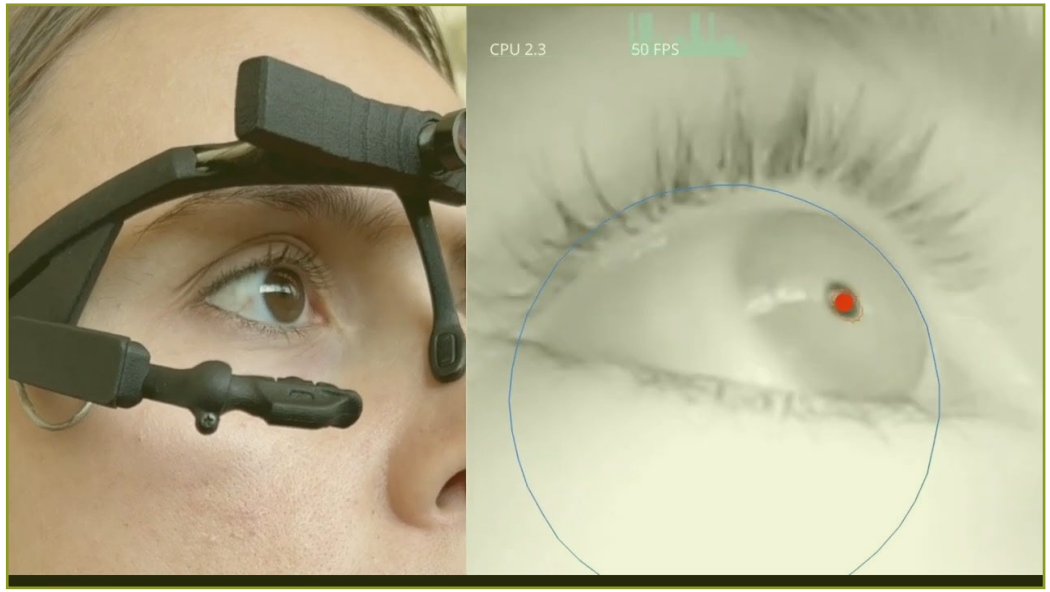
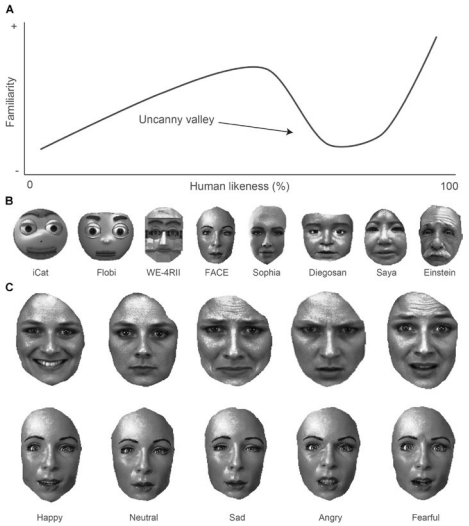
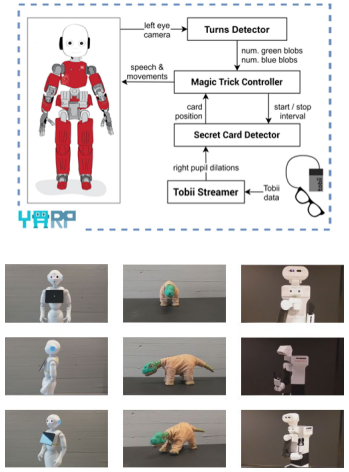


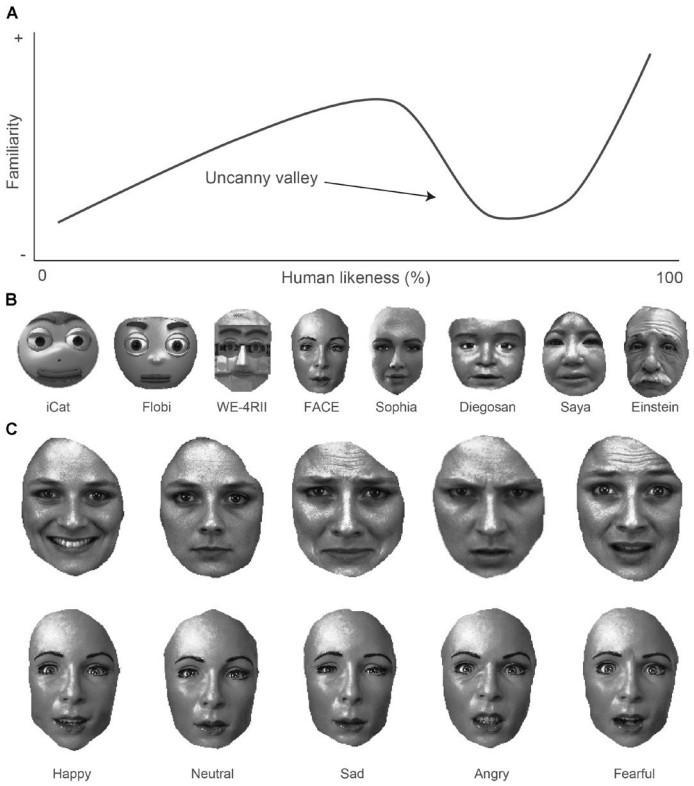
Pupillometry studies in HRI





Using pupillometry to test the uncanny valley and media equation theory

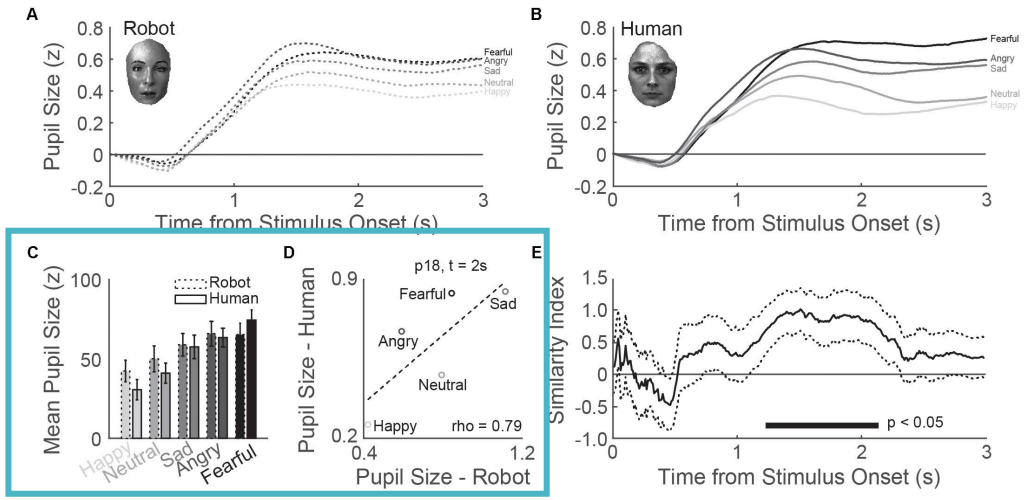
- Feelings of uncanniness and comparable emotional responses
- Pupillometry is an easy way to confirm these theories

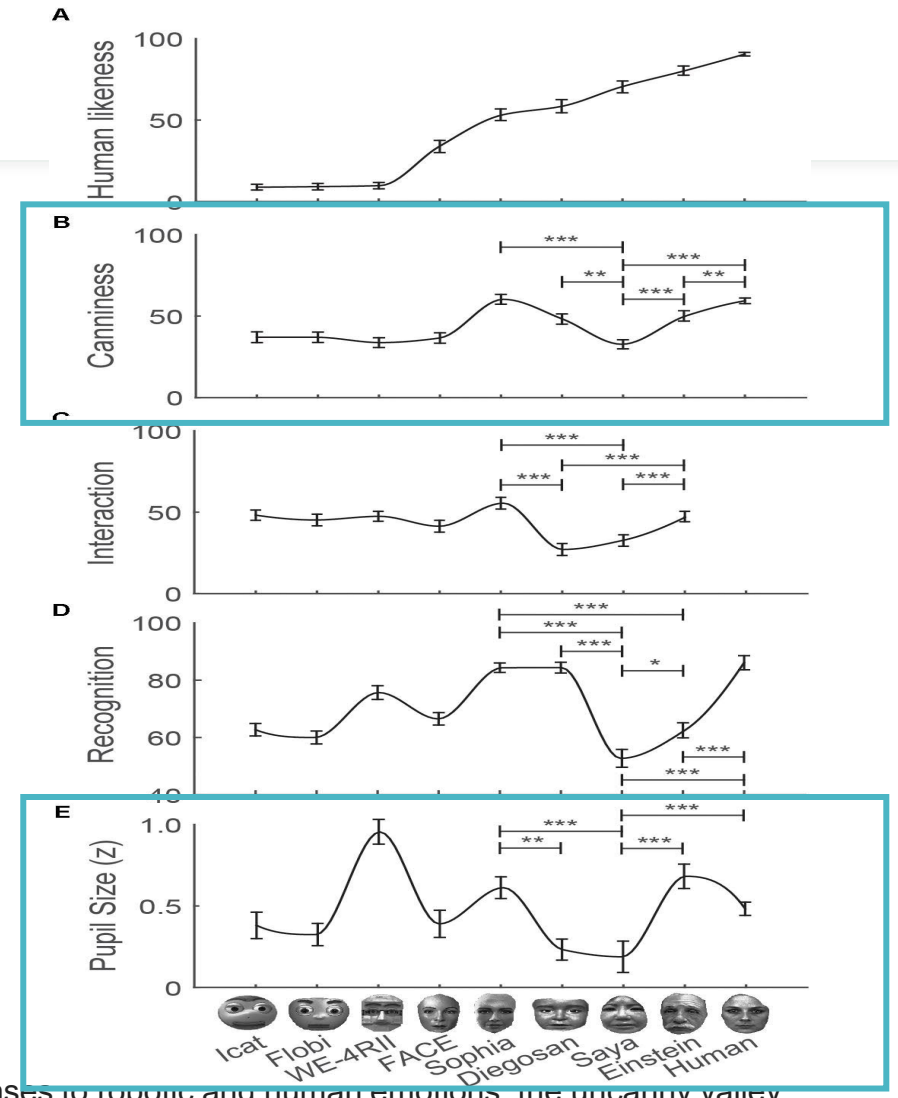


Reuten, A., Van Dam, M., & Naber, M. (2018). Pupillary responses to robotic and human emotions: the uncanny valley and media equation confirmed. Frontiers in psychology, 9, 774.

Using pupillometry to test the uncanny valley and media equation theory

- 40 people observed expressive facial expressions by humans and robots





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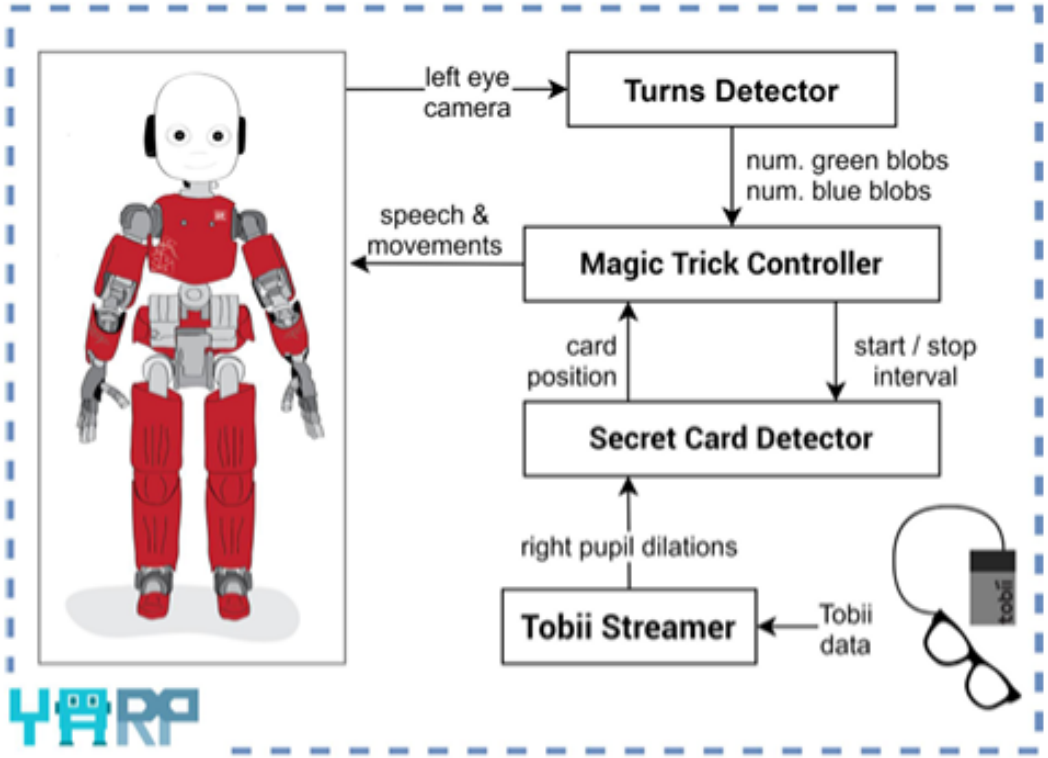
Using pupillometry detect participants lying to the robot

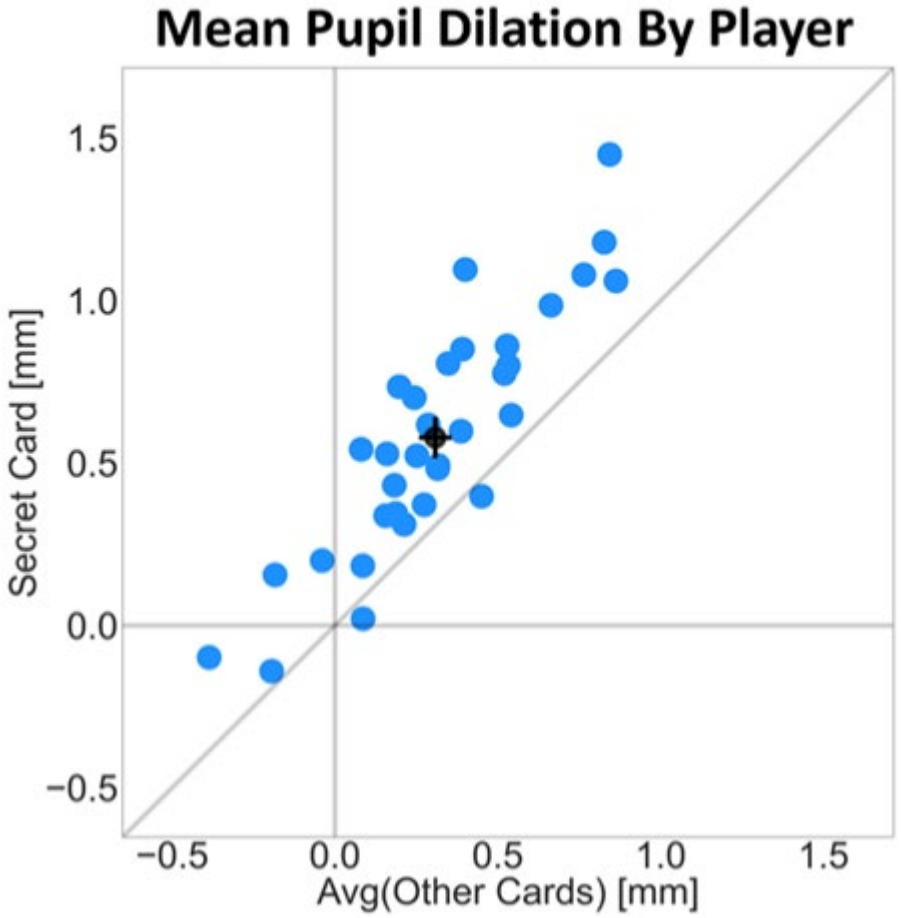
- Game robot interaction architecture
  - Natural way of measuring interaction
- Playing a card game
- Detect lies using Task Evoked Pupillary Responses



Pasquali, D., Gonzalez-Billandon, J., Rea, F., Sandini, G., & Sciutti, A. (2021, March). Magic iCub: A humanoid robot autonomously catching your lies in a card game. In *Proceedings of the 2021 ACM/IEEE international conference on human-robot interaction* (pp. 293-302).

Using pupillometry detect participants lying to the robot

- 34 participants
- Lie detecting in human participants [88.2%]



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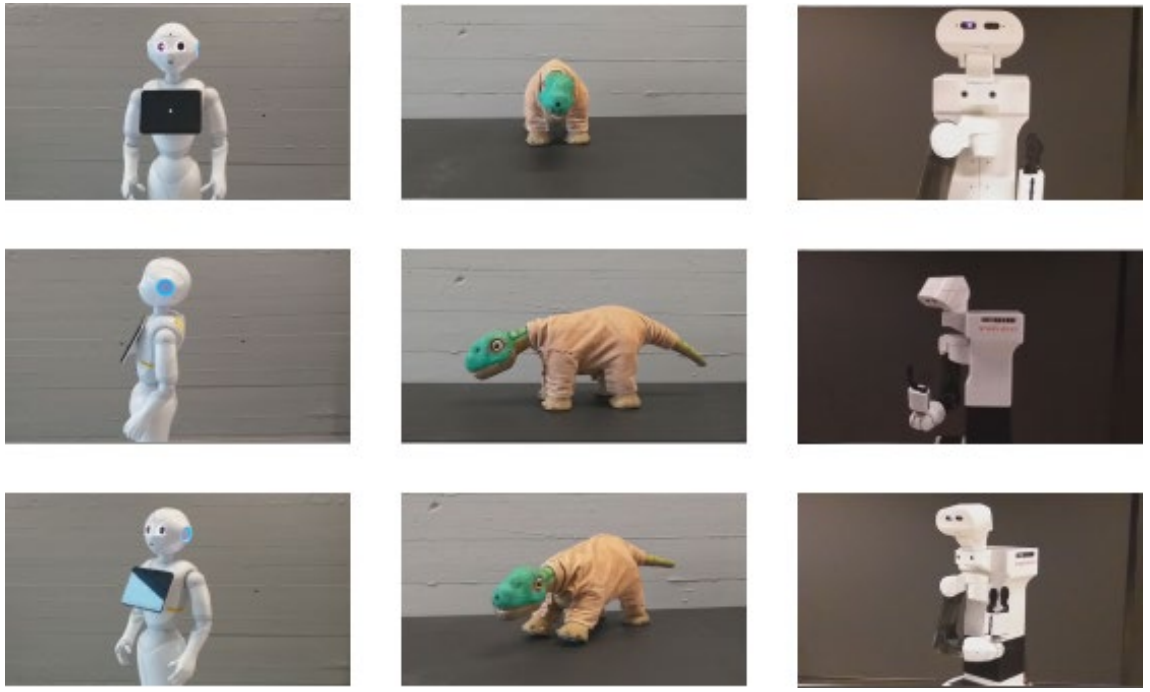
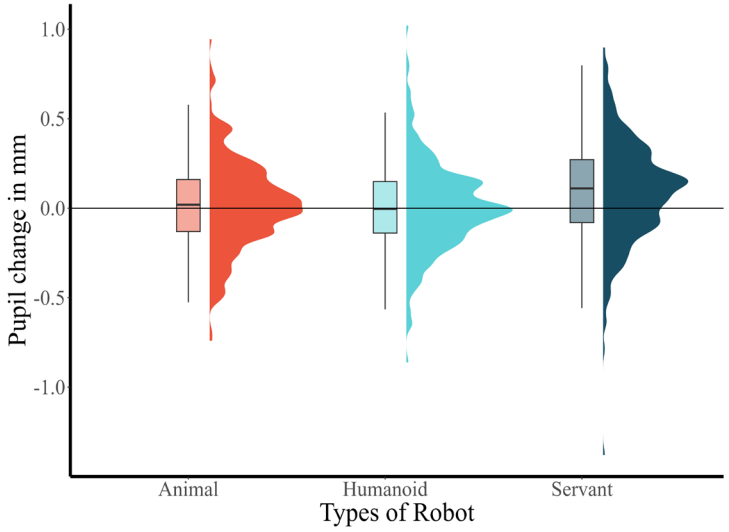
Using pupillometry to measure mental effort in understanding robotic motion

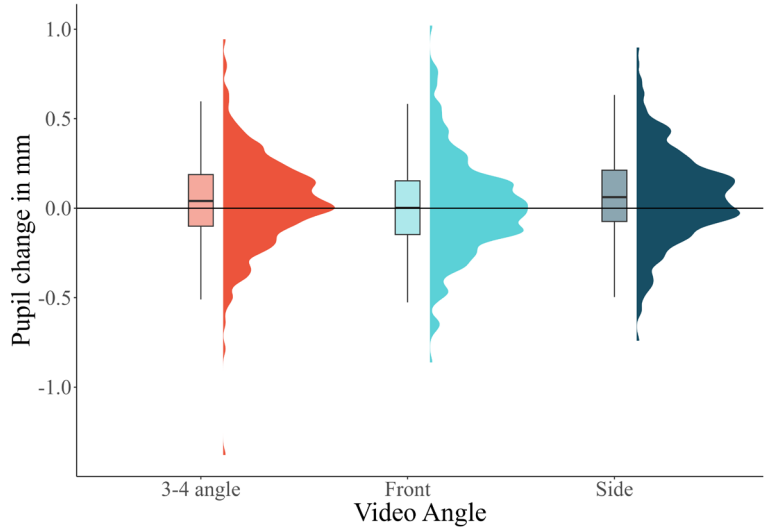
- Intuitive robot interactions
- 50 participants observed expressive robot motion by 3 different robots

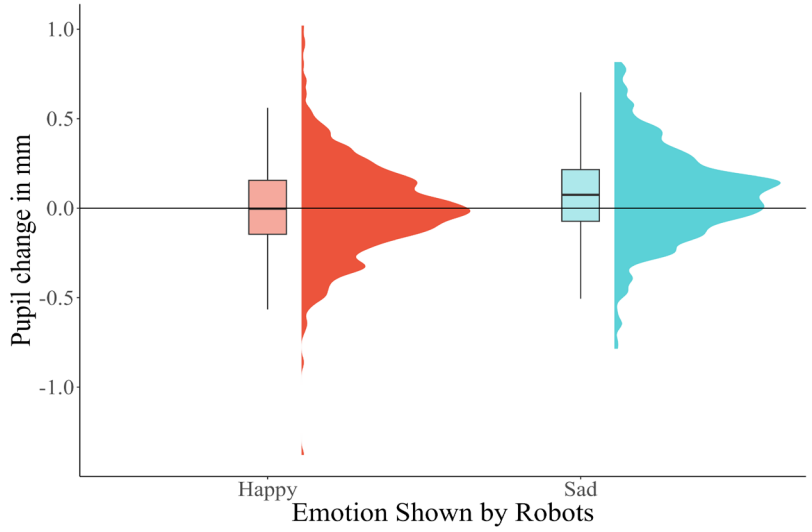


Van Otterdijk, M. T. H., Leang, B., Saplacan Lindblom, D., & Torresen, J. (under review). Effect of Expressive Robot Behavior on Users' Mental Effort: a Pupillometry Study on Intuitive Thinking.

Using pupillometry to measure mental effort in understanding robotic motion







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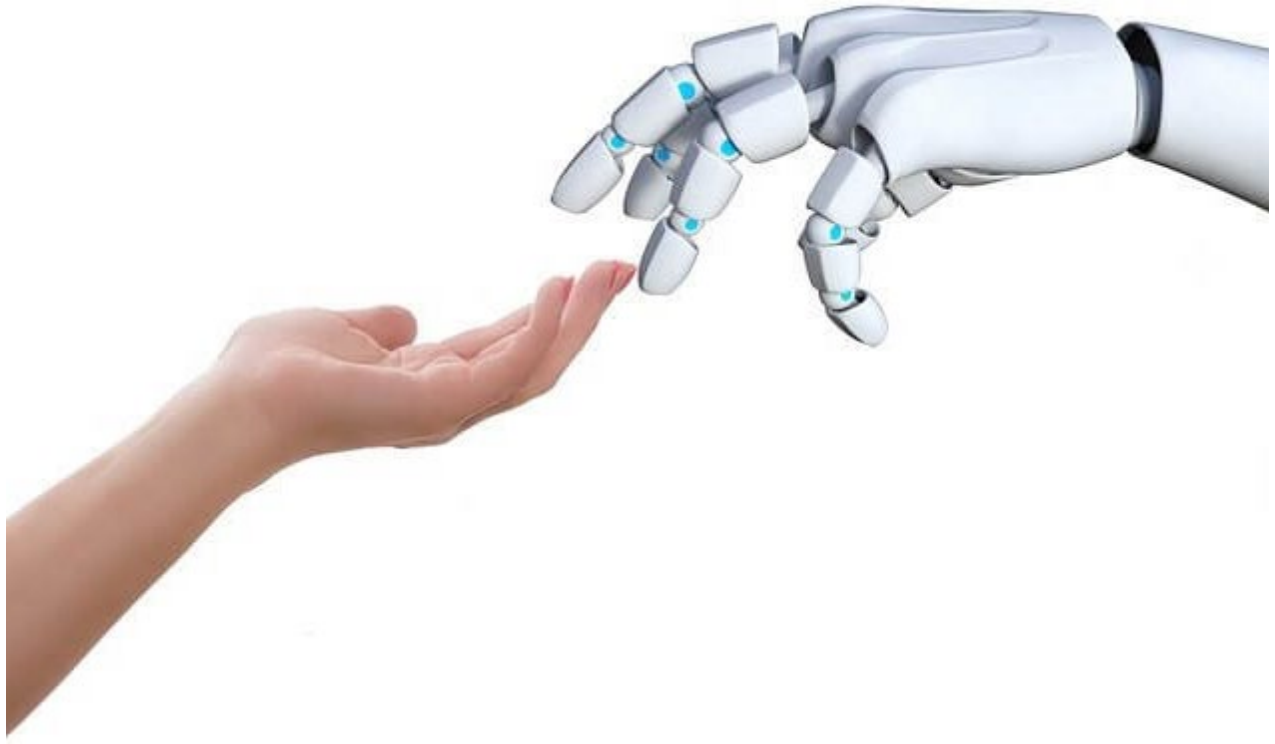
In summary, eye tracking is a valuable tool to use for user research and robot control



Eye tracking provides a non-invasive way to measure arousal and mental effort in participants

Questions?