Robots As Intentional Agents: Using Neuroscientific Methods to Make Robots Appear More Social

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SAPIENZA
UNIVERSITÀ DI ROMA

Reference Paper

- **Robots As Intentional Agents: Using Neuroscientific Methods to Make Robots Appear More Social** *by Wiese, E., Metta, G., and Wykowska, A. (2017). Front. Psychol. 8:1663. doi: 10.3389/fpsyg.2017.01663*

Secondary References

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Reference For The Examples Mentioned in slide 13

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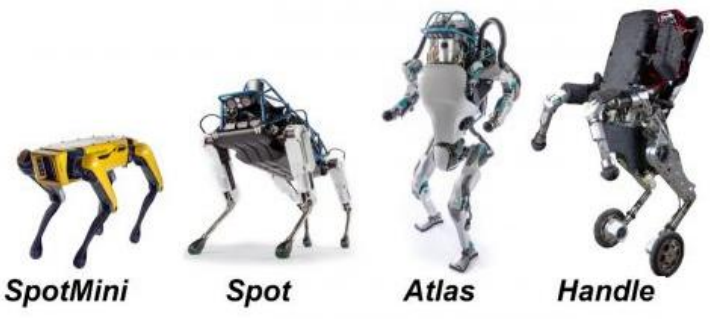
OUTLINE

- INTRODUCTION
  - context, key idea, and goals
- CAN ROBOTS BE PERCEIVED AS INTENTIONAL AGENTS?
  - Starting from human–human to arrive robot-human interaction (is it possible to activate "social brain areas" in a similar manner ?)
- " THE IMPORTANCE OF BEING AN INTENTIONAL AGENTS"
  - How attribution of intentionality produce positive effects in human–robot interaction.
  - How attribution of intentionality might be disadvantageous.
- COLLABORATION BETWEEN NEUROSCIENCE AND ROBOTICS
  - Some successful examples that used neuroscience methods in the design and evaluation of social robots
  - A look to the future
- FINAL CONSIDERATIONS

Introduction



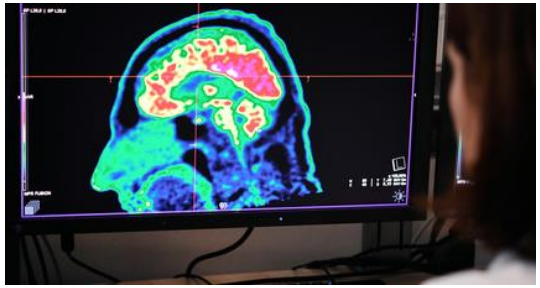
"More than three D"

- The use of robots is spreading more and more in our society, and not only in tasks of the three D's : dirty, dangerous, dull. The technological development is making possible use them for task more "social ", like entertainment, assistance for the children, health care, ...

"Worried about..."

- Despite this , general attitudes versus robots are not always positive . In fact, the general public can be quite skeptical respect to the introduction of robot assistants in everyday life : they can felt it as something of strange, or , in worst case a threat that cause worried.

Introduction



"How a robot can be accepted as a social companion "

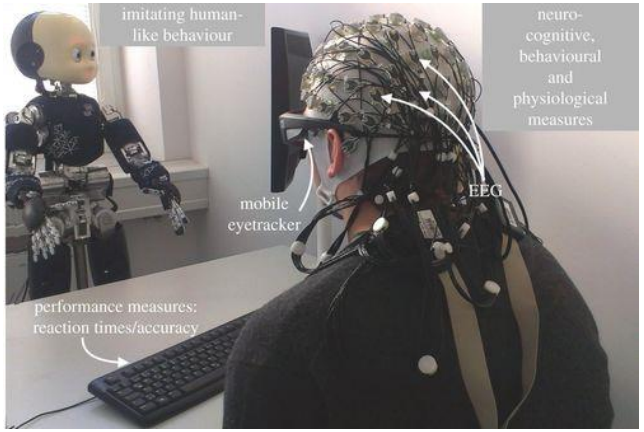
- Many studies reveal that humans may be willing to accept social robots but under certain conditions.
- This paper suggest addressing this issue by using physiological neuroscience methods in robotics research: for measuring how humans react to robot agents, how they perform tasks with robots, and how they develop mutual understanding.

"Final goal : be more social"

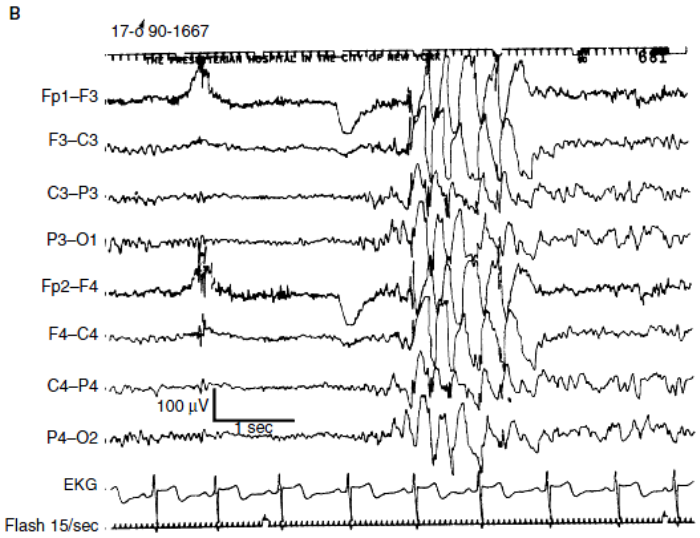
- Designing robots that activate areas in the human brain involved in social-cognitive processing in a similar manner of human-human interaction: so to make the robot easily accepted in social context

Neuroscientific method : Electroencephalography (EEG)

- In figure : investigation of human-robot interaction using EEG and eye-tracking during interactions with the robot iCub
- EEG is a technique used to measure the electrical activity of the brain
- EEG does not record the activity of single neurons, but detects the signals created when populations of neurons are active at the same time (Precisely signals from small areas of the brain surrounding each electrode)



Output EEG



Can Robots Be Perceived As Intentional Agents?

" From human–human interactions to… "

- During human–human interactions, we activate some brain areas responsible for social-cognitive processing : making inferences about what others think, feel and intend (Frith, 2006). However, before we usually make inferences about this, we need to perceive others as intentional beings, with having internal states.

- Attributing internal states in social interactions is the default mode for human, but this might not automatically happen during interactions with robot.

- …so the first question is: "mind perception" can also be triggered by robot?

Can Robots Be Perceived As Intentional Agents?

" Mind is in the eye of the beholder "

- The human tendency to attribute human form or personality to things not human (anthropomorphize) is strong
- Think about people talking to pets assuming that they can understand; or think about some portraits that seem to stare you, giving the sensation of following you with the eyes.
- In line with these common experiences, psychological research (Gao et al., 2010) has shown that mind perception is a process quite common , usually triggered just by human-like apparence and human-like motion . (Curiosity : the process allow to distinguish intentional agents / non-intentional require about 100 ms).

- …. so these studies suggest that non-human agents have the potential to activate mechanisms of social cognition in the human brain. <u>But how and under which conditions ?</u>

Can Robots Be Perceived As Intentional Agents?

"Some assumptions for be social"

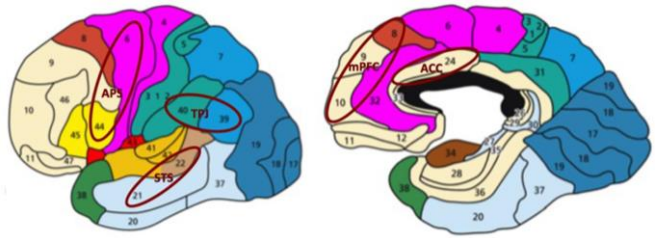
Basically the authors of the paper make two assumptions:

- First, assume that mental states are visible in behavior. For attribute intentionality → it would be sufficient perform certain actions in certain ways. (For go in depth about the relationship between movement features and perceived mental states see also paper : Becchio et al., 2017) [1]

[1] https://www.sciencedirect.com/science/article/pii/S1571064517301458?via%3Dihub

- Second, they think that in order to decide if a person is attributing intentionality to an agent, it is enough to look at neural activity in certain areas of the subject's brain. In particular they identified two macro area involved, in a bottom-up processing :

Can Robots Be Perceived As Intentional Agents?



"Low-level mechanisms of social cognition"

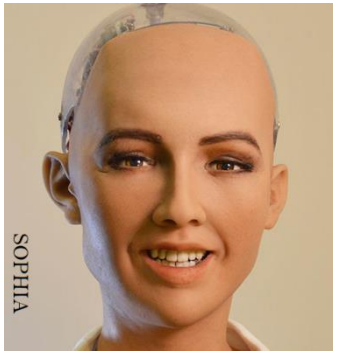
- One area (i.e., APS) its activation is related to physical factors: like the appearance and movement profile. This is "easier " to activate : can be reach in human–robot interaction the same levels of activation of human–human interaction.

"High-level mechanisms of social cognition"

- The other (i.e., mPFC, TPJ, insula) related to empathizing (i.e., understand how others feel) and mentalizing (i.e., what other intend to do). Those are "harder" to activate : can get activated by robot but to a lesser degree than human → further studies are necessary to identify the activation conditions (e.g., behavioral features like head-eye coordination, frequency and length of gaze toward a human …)

Note: this in line with common sense, people seem to be willing to treat robots as entities with agency (i.e., ability to plan and act), but are reluctant to perceive them as entities that can experience internal states

“ The Importance Of Being An Intentional Agents”

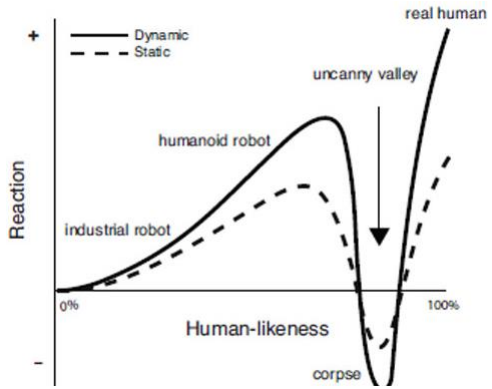


“Positive effects of mind perception in social interactions”

- On mood :
  - Treating others as agents with a mind makes us feel socially connected with them
- On behaviors :
  - decreased cheating
  - motivates others to adhere to moral standards
  - increased generosity

  About that : agents not being perceived as having a mind, (i.e., incapable of internal states), this makes people feel less guilty when performing harmful acts toward them
- Improve performance during social interactions:
  - Believing that an agent has a mind increase the relevance ascribed to its actions E.g.,people follow the eye movements of an agent more strongly when they are believed to reflect intentional, compared to random or programmed behavior.

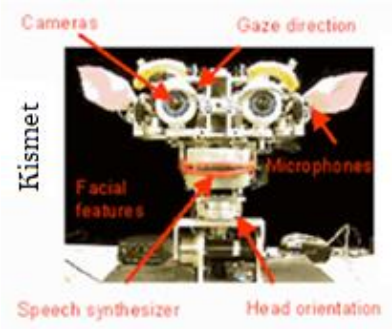
“ The Importance Of Being An Intentional Agents”



“ The disadvantages of mind perception “

- When the mind status of an agent is ambiguous and evokes categorical uncertainty (I mean : no possible to classify the agent as human or robot) :
  - This produces a cognitive conflict processing ,which need cognitive resources to try to be resolved; in performing task this phenomenon produces increasing response times and decreasing accuracy; and , of course, it complicates a lot interaction with the robot. (Cheetham et al., 2011, 2014)

Collaboration Between Neuroscience And Robotics



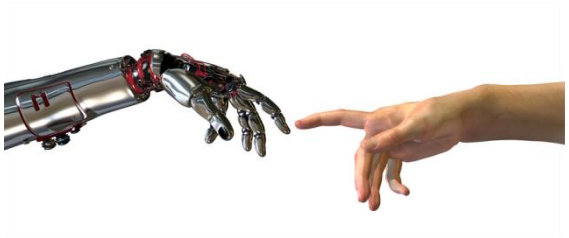
"A bit of successful history"

- **Breazeal and Scassellati (1999)** using Kismet to study how an expressive robot , by displaying attention, generate social responses in humans . They also identify some of the requirements of the visual system of such robots for the task : e.g., eye contact (and therefore detecting the eyes of the user in the visual scene)

- **Scassellati (2002),** based on empirically derived model of mentalization (by Baron-Cohen _1997), used robot Cog to developed a similar to human-like attentional system that identifies *living* agents and *non-living* objects by optical flow. (In particular, the model relies on an Intentionality Detector (ID) that labels actions as intentional based on their goal-directedness.)

- Discovery (Gallese et al., 1996 of Università di Parma) of mirror neurons in non-human primates and their involvement in action understanding → drive robotics focus on developing models for action recognition and imitation.**Metta et al., (2006).** Basically it attempts to implement a mirror neuron system into artificial agents using machine-learning methods and neural networks (Oztop et al., 2006; Demiris, 2007)

Collaboration Between Neuroscience And Robotics



"Future (near?) expected step "

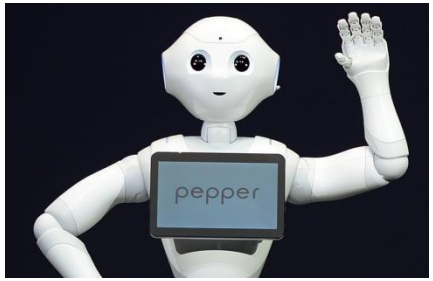
- Identify a minimal set of physical and behavioral robot features that can activate the same areas in the human brain as human interaction partners (this not guaranteed that the exact functioning of the human neural system can be emulated , but it at least increases the probability that robot agents are treated as intentional agents)

"My reviews about paper"

- It is an interesting effort to give a "fair" measure to the human - robot interaction; as integration of the classical evaluation protocol based on interviews and questionnaires; but of course we need to go in depth in the knowledge of the brain mechanisms'(this is principal limitation).

- I expect future developments in neuroscience field continue to bring important innovations in human – robotic interaction design.

Final Considerations about the project HRI Robot receptionist for museum



It would be very interesting to use neuroscientific methodologies for evaluation and understand what happens in users' brains during iteration with Pepper receptionist and then improve its behavioral design, but I don't expect it to happen, at moment.

What I expect is to exploit two things :

- " Positive effects of mind perception" → Pepper showing attention to user : answering his questions, eye contact, ..., it can create a pleasant experience in user and try to involve him in the museum visit.

- " The disadvantages of mind perception" → Avoid producing the sensation of ambiguity (when agents is perceived "human-nonhuman") in the user. Pepper it clearly looks a robot, so avoid behavior " too much human ".

Not to fall into the uncanny valley phenomenon!

Thanks For Your Attention