Enacting the Pleasurable Feeling of Experience: Skillful Sensemaking in Human-Robot-Interaction (HRI)

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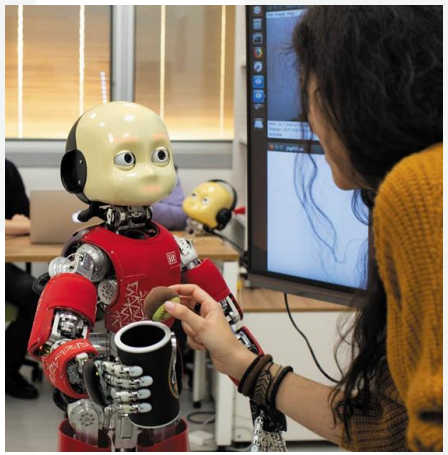
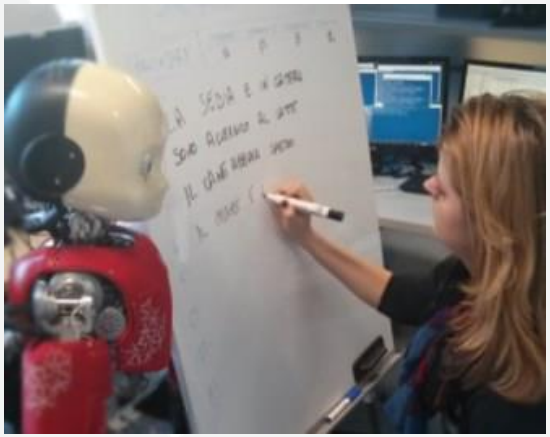
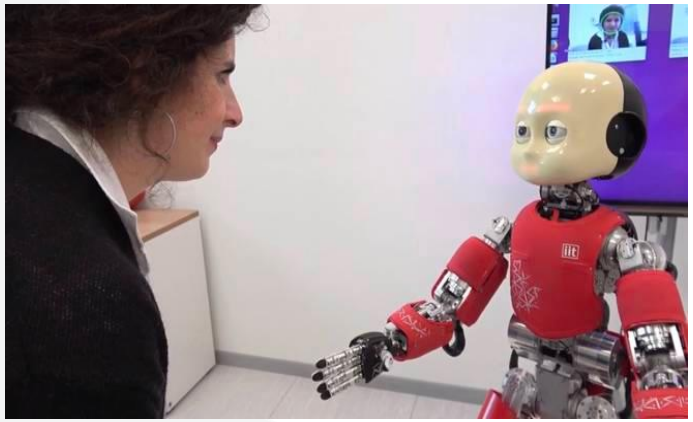
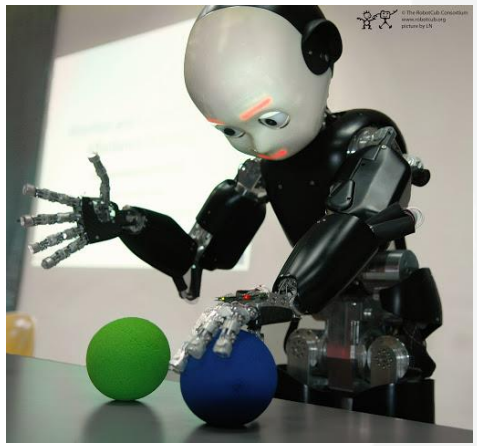
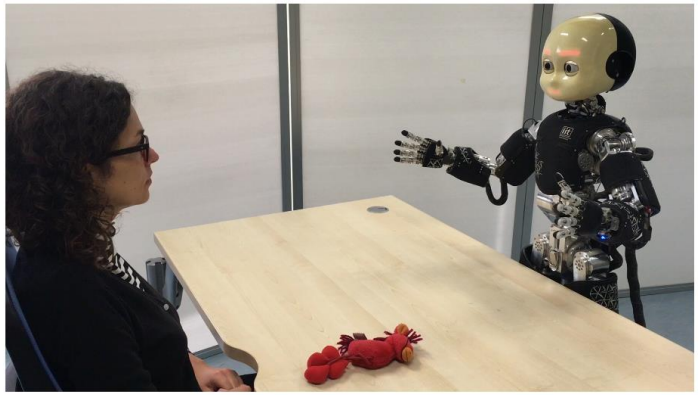

Enacting the Pleasurable Feeling of Experience: Skillful Sensemaking in Human-Robot-Interaction (HRI)

Main general research questions:

1. Does the **human agent** tend to manifest a **positive pleasurable feeling** of the interaction itself when **the movements** of the social robot in the teaching process become **familiar** or when the human learner realizes that **the learning of new (sensori)motor skills** is **successful**?
2. How does **interaction change** when the **human learner** accepts and **enjoys** the robot teacher?

- **Self-Report Measure** – Awareness of the Aroused Lived Body in Embodied Sensemaking (Multi-Item Scales) – *Pleasurable Feeling*

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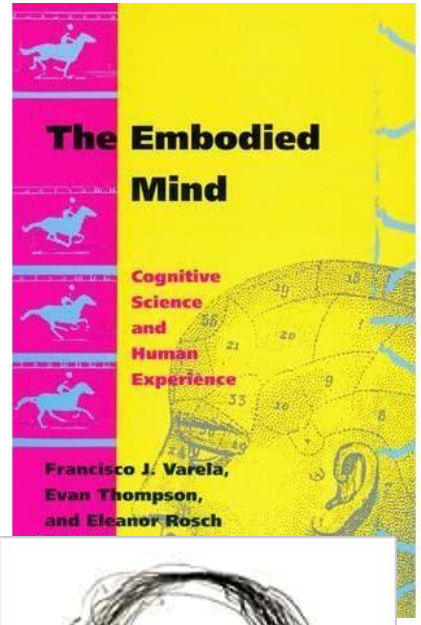
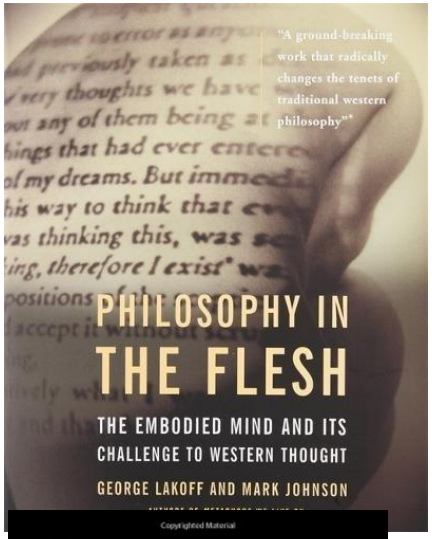
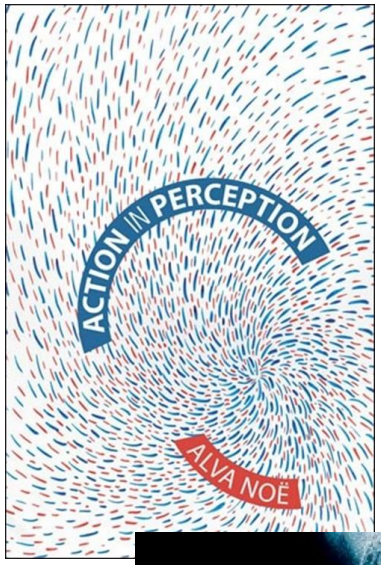
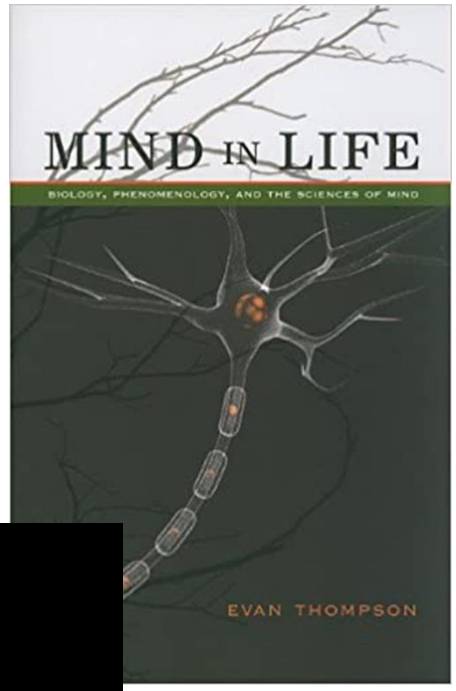
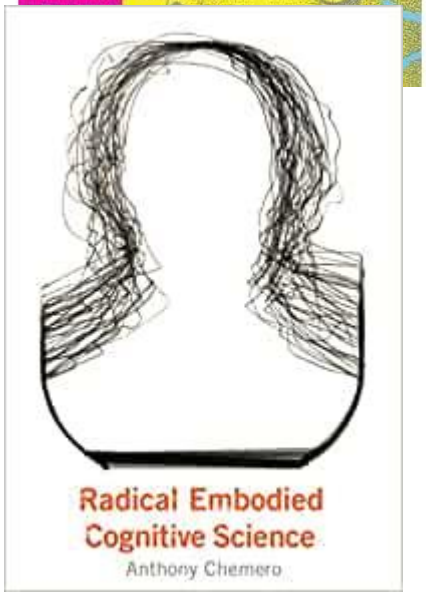
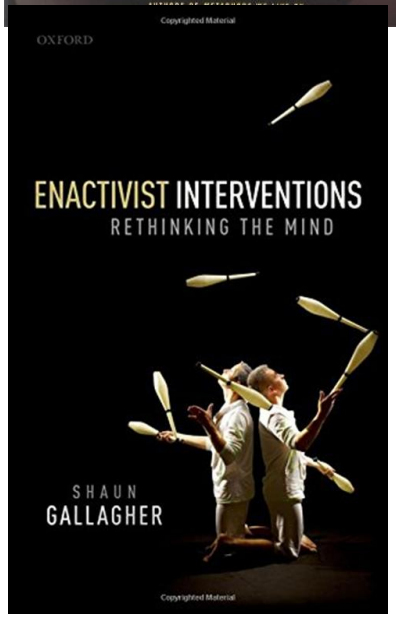


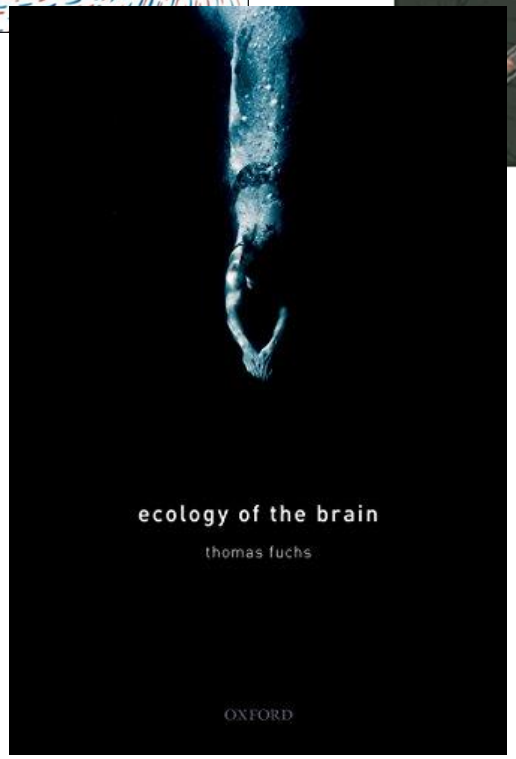












1. What is *Enactive Cognitive Science*?

Enactive cognitive science is a framework to rethink the mind.

It acknowledges the importance of the body and studies perception, cognition, and action as necessary embodied phenomena, using explanatory tools that do not posit mental representations. (Chemero 2009)

1. What is *Enactive Cognitive Science*?

«We can begin by noting a relatively weak and uncontroversial sense of representation. This sense is purely semantic: it refers to anything that can be interpreted as being about something. This is the sense of representation as construal, since nothing is about something else without construing it as being some way. A map, for example, is about some geographical area; it represents certain features of the terrain and so construes that terrain as being in a certain way.» (Varela & Thompson & Rosch 1991)

1. What is *Enactive Cognitive Science*?

«A strong sense [of representation] arises when (…) we assume that the world is pregiven, that its features can be specified prior to any cognitive activity. Then to explain the relation between this cognitive activity and a pregiven world, we hypothesize the existence of mental representations inside the cognitive system. (…) We then have a full-fledged theory that says that (…) the way in which we cognize this pre-given world is to represent its features and then act on the basis of these representations.» (Varela & Thompson & Rosch 1991, 135)

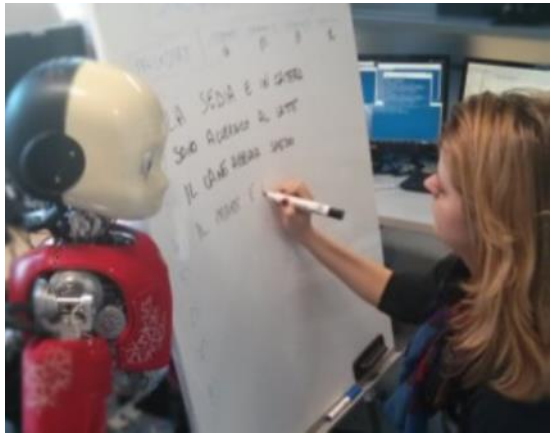
1. What is Enactive Cognitive Science?

4Es Cognition: embodied, embedded, enactive, extended

Otto's notebook as a mind enhancing tool

1. What is Enactive Cognitive Science?

4Es Cognition: embodied, embedded, enactive, extended



The social robot extends the possibilities of engaging with the environment in a sensorimotor loop.

1. What is Enactive Cognitive Science?

«Enaction is the idea that organisms create their own experience through their actions. Organisms are not passive receivers of input from the environment, but are actors in the environment such that what they experience is shaped by how they act.» (Hutchins 1996).

«I am therefore I think» – Karl Friston

1. What is Enactive Cognitive Science?

Are brain-centered approaches appealing for enactivists?

- ✓ The naturalistic fallacy
- ✓ The mereological fallacy
- ✓ The localization fallacy

«The organism and its specific environment are linked in a process of co-evolution. (…), the entire system consisting of organism and environment is reconfigured with each interaction, so that the respective presence of a living organism cannot be fully described without resorting to the history of its experience» (Fuchs 2018).

2. Cognition as Embodied Action: Sensemaking in Enactivism

Living beings and their surroundings constitute an interactive system, with each constituent being reciprocal to the other:

- what we perceive are not objects as such but objects to deal with, or the functional relations between self and world.

2.1. The Role of the Body and of Sensorimotor Skills

What defines our embodiment – our being an embodied subject – is the relation of the living body – the organic object body, one's body as the living organism – and the lived body. The lived body is your own body as experienced by yourself.

2.1. The Role of the Body and of Sensorimotor Skills

One's own body shows itself to be a material thing animated from within by sensation and motility. The example of a cup of hot tea. (Thompson 2007)

2.1. The Role of the Body and of Sensorimotor Skills

In the same way as the pre-reflective lived body allows the experience of becoming aware of my body as that through which, for example, the motor experience of typing on the computer is possible, it is also the pre-reflective backdrop against which the cognitive-emotional evaluation of the experienced world takes place.

The body is hence animate, it feels and senses itself from within, and this self-affection is the basis of the subject's perceiving and acting relation to the environment.

2.1. The Role of the Body and of Sensorimotor Skills

The interaction with the environment has a **circular structure**: perception implies movement and action and takes place by making use of the skillful exploration of the environment (e.g., looking, touching) and by grasping the results.

The agent acts upon the environment and the environment acts upon the agent in the process of active perception. In other words, an agent can consciously experience the objects of the physical world having a spatial presence when he or she **perceptually explores one's environment.** An agent is an embodied self whose borders do not stop at his/her skin.

2.1. The Role of the Body and of Sensorimotor Skills

One of the best-known examples in the enactive literature to illustrate the role of sensorimotricity is that of perceiving the softness of a sponge.

The "Spongeman" by K. O'Regan (2011)

2.1. The Role of the Body and of Sensorimotor Skills

The enactive approach to cognition regards perception as **a process of active sense-making:** by interacting with the environment (moving their head and eyes, touching a surface, walking toward a goal, grasping a fruit, etc.), living beings make sense of their surroundings.

2.2. Embodied Sensemaking, Participatory Sensemaking

Enactivism distinguishes between **embodied or bodily sensemaking** and **participatory sensemaking**.

A subject – a so called sense-maker or agent – is involved in interactions with her environment in which the objects or events become meaningful for the subject in the process of actively relating to the world by her own exploratory activity and orientation toward a course of action that is adequate to the subject.

2.2. Embodied Sensemaking, Participatory Sensemaking

For example, a person who wears skis or snowboards acquires different possibilities for the perception of the environment. This coupling changes the possibilities of actions and hence of embodied cognition and experience of a subject as a skier.

An actively perceived slope becomes hence meaningful for a sense-maker wearing skis in relation to the opportunity for setting off down the ski run. The sense-maker establishes a perspective on the world and participates in the generation of meaning through its body, bodily mediated perception and action.

➢ She enacts a world that makes sense for her.

2.2. Embodied Sensemaking, Participatory Sensemaking

An actively perceived **slope** becomes hence meaningful for a **sense-maker wearing skis in relation to the opportunity for setting off down the ski run.** The sense-maker establishes a perspective on the world and participates in the generation of meaning through her body, bodily mediated perception and action. She enacts a world that makes sense for her as a skier.

2.2. Embodied Sensemaking, Participatory Sensemaking

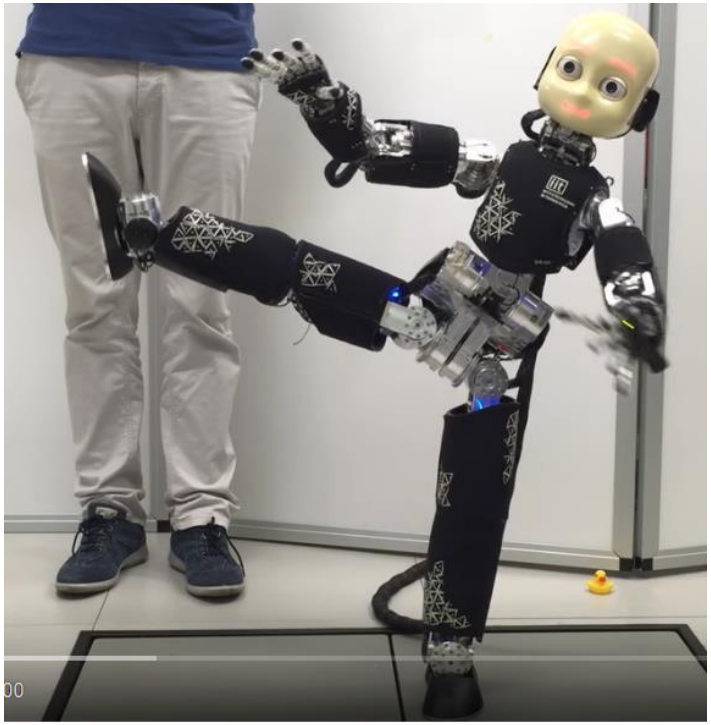
The situation in which the sense-making of two or more autonomous agents is mutually modulated as they engage in an interactive encounter is called **participatory or social sense-making.**

Interactions are understood as fundamental to sense-making, which shapes how living systems engage with the world as autonomous entities.

2.2. Embodied Sensemaking, Participatory Sensemaking

Let's think now for a while about the interaction between a social robot like the iCub robot and a human agent in the scenario in which the robot has the role of showing the human learner new motor skills.

2.2. Embodied Sensemaking, Participatory Sensemaking



For example, the robot can **Tai Chi** movements and the human agent would like to learn them in interaction.

2.2. Embodied Sensemaking, Participatory Sensemaking

In the interaction, humanoid robot and human agent are performers or sense-makers with different degrees of expertise.

What is relevant for my concern and for enactivists is how the humanoid robot and the human agent actively participate in the development of their shared motor meaning-making through bodily movement in their interaction and in **this way co-create a new familiarity**, new familiar movements the human agent becomes aware of.

2.2. Embodied Sensemaking, Participatory Sensemaking

Each musician (and the audience) actively participates in the development of the shared communication and meaning-making through bodily and facial gestures. As a coupled system, musicians and audience can form and transform each other's sense-making. (Schiavio & De Jaegher 2017)

2.2. Embodied Sensemaking, Participatory Sensemaking

Learning a new skill – the acquisition of a new skill – means hence regulating action in perception. **It is the refinement of embodied adaptation processes, achieved by perceiving the performance body and action capabilities.** (Scarinzi 2011)

- ✓ It is not the establishment of an internal state or representation of an act stored somewhere.

3. Enacting the Pleasurable Feeling of Experience: John Dewey's Pragmatist Approach

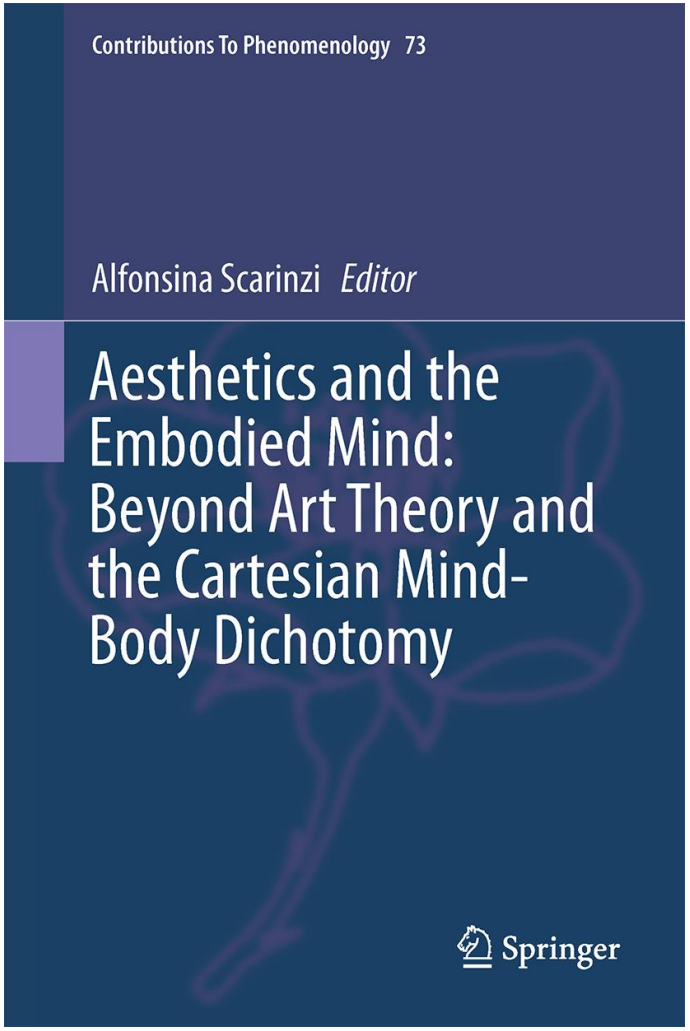
«The sense of a thing, on the other hand, is an immediate and immanent meaning; it is meaning which is itself felt or directly had. When we are baffled by perplexing conditions, and finally hit upon a clew, and everything falls into place, the whole thing suddenly, as we say, "makes sense." In such a situation, the clew has signification in virtue of being an indication, a guide to interpretation. But the meaning of the whole situation as apprehended is sense.» (J. Dewey)

3. Enacting the Pleasurable Feeling of Experience: John Dewey's Pragmatist Approach

John Dewey points out that living the enjoyment of a period of harmony is a temporary savored sense of culmination – a feeling of wholeness – because it is the beginning of a new relation to the environment that implies the disruption of the achieved equilibrium and hence a new tension between disorder or disruption and the search for a new harmony, which is the rhythm of organic life.

ADVANCED STUDIES

Enacting the Pleasurable Feeling of Experience: Skillful Sensemaking in Human-Robot-Interaction (HRI)



«Sense meaning involves an immediate qualitative consummatory appreciation and perhaps enjoyment of the referent of signification once secured. It retains some of the habits of action acquired in securing the referent as well as the **feeling of consummatory unity** the referent brings by helping to coordinate action.» Jim Garrison on Dewey's approach (2015)

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- **Enacting the Pleasurable Feeling of Experience: John Dewey's Pragmatist Approach**

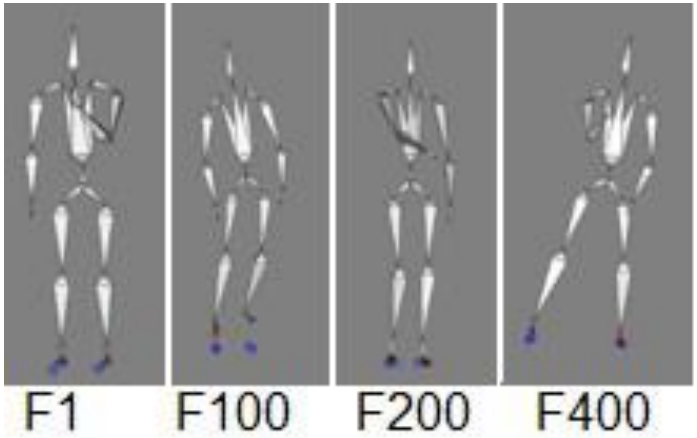
- **What is enjoyed is a sense of intrinsic completion of an experience, which is its closure.**

- The term **"closure"** does not refer to the ending of an experience. Rather, it refers to **a closing together which holds within it a new perspective on the world.** It is the sense that the parts of an experience fit.

3. Enacting the Pleasurable Feeling of Experience: John Dewey's Pragmatist Approach

Savva & Bianchi-Berthouze & Scarinzi (2012) - *Continuous recognition of player's affective body expression as dynamic quality of aesthetic experience* -

The Wii Nintendo Grand Slam Tennis game was used for this experiment. We had 9 participants for the scenario.



Clips of computer-animated avatars were used, instead of the videos of the actual human participants, to create **faceless, non-gender, non-culturally specific 'humanoids' in an attempt to eliminate bias in the evaluation of the body expressions.**

3. Enacting the Pleasurable Feeling of Experience: John Dewey's Pragmatist Approach

Savva et al. (2012) - *Continuous recognition of player's affective body expression as dynamic quality of aesthetic experience* -

- We argued that the affective expressions that the players unconsciously portray through their body movement have a strong bias on their experience through proprioceptive feedback.

3. Enacting the Pleasurable Feeling of Experience: John Dewey's Pragmatist Approach

Savva et al. (2012) - *Continuous recognition of player's affective body expression as dynamic quality of aesthetic experience* -

The motion-capture system used recognizes the variety of emotions the player expresses in the course of the passage from disturbance to harmony.

- The occurring patterns of expressions could be used to infer the readiness to reach a closure and hence the fulfilment of the experience. In a word, **to reach the unifying feeling – the pleasurable feeling.**

3. Enacting the Pleasurable Feeling of Experience: John Dewey's Pragmatist Approach

Savva et al. (2012) - *Continuous recognition of player's affective body expression as dynamic quality of aesthetic experience* -

In this study, the affective message conveyed by the body movement of an expresser was investigated from the point of view of an external observer.

- The observer can have access to the variety of emotions the players are going through or assigning (i.e., creating meaning) to the gameplay events, which represents the rhythmic dynamics of the overall experience the player experiences subjectively.

3. Enacting the Pleasurable Feeling of Experience: John Dewey's Pragmatist Approach

Savva et al. (2012) - *Continuous recognition of player's affective body expression as dynamic quality of aesthetic experience* -

Enactive research has shown that the **first-person approach** allows the subject to have access to the lived experience of **the felt quality of an experience** and to its pre-conceptual, pre-reflective dimension that is cross-modal, as the same experiential patterns can appear in different sensorial modalities and convey **the felt quality of an experience**.

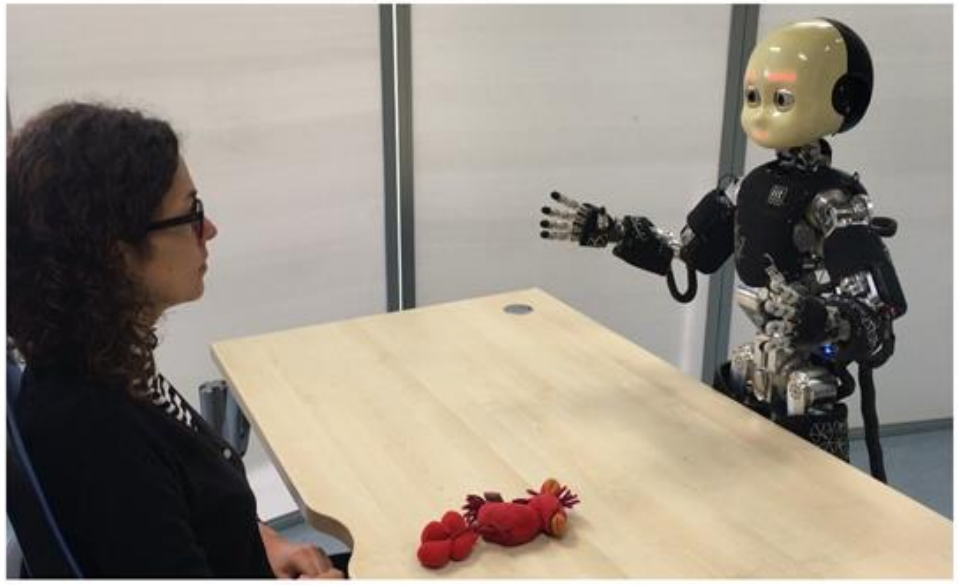
3. Enacting the Pleasurable Feeling of Experience: John Dewey's Pragmatist Approach

The methodological focus lies now on **how to investigate the awareness of the human agent's aroused subjectively lived body in the process of sense–making** after bodily experiencing the pleasurable feeling in the engagement with a humanoid robot. We are now interested in investigating where mind and body make contact in experiencing the closure of a pleasurable experience. **A self-report measure (Multi-item Scales) is a promising solution.**

3. Enacting the Pleasurable Feeling of Experience: John Dewey's Pragmatist Approach

Now, let's think again about the scenario in which a human agent in the role of the learner interacts with a social robot in the role of a teacher.

4. The case of HRI: The iCub teacher meets the human learner. Towards Self-Report Measure (Multi-item Scale)



4. The case of HRI: The iCub teacher meets the human learner. Towards Self-Report Measure (Multi-item Scale)

- What kind of abilities does the robot teacher need in order to contribute to a smooth interaction as such before contributing to the human agent's pleasurable feeling in the interaction itself?

4. The case of HRI: The iCub teacher meets the human learner. Towards Self-Report Measure (Multi-item Scale)

The investigation of the mechanism supporting **mutual understanding** in human-robot interaction becomes central to identify **the minimal verbal and non-verbal signals necessary to coordinate** – or adapt – with humans as humans do.

4. The case of HRI: The iCub teacher meets the human learner. Towards Self-Report Measure (Multi-item Scale)

iCub has already had the role of a teacher in two specific situations especially:

- ✓ in a situation in which the iCub demonstrates the human learner movement sequences

and

- ✓ in a situation in which the iCub dictates brief sentences in a foreign language (in English) to train the human learner.

4. The case of HRI: The iCub teacher meets the human learner. Towards Self-Report Measure (Multi-item Scale)

In the first scenario, participants were required to learn a sequence of movements taught by the robot. The iCub demonstrated one sequence of movements which the participant was required to observe, memorize and repeat (Vignolo et al. 2019)

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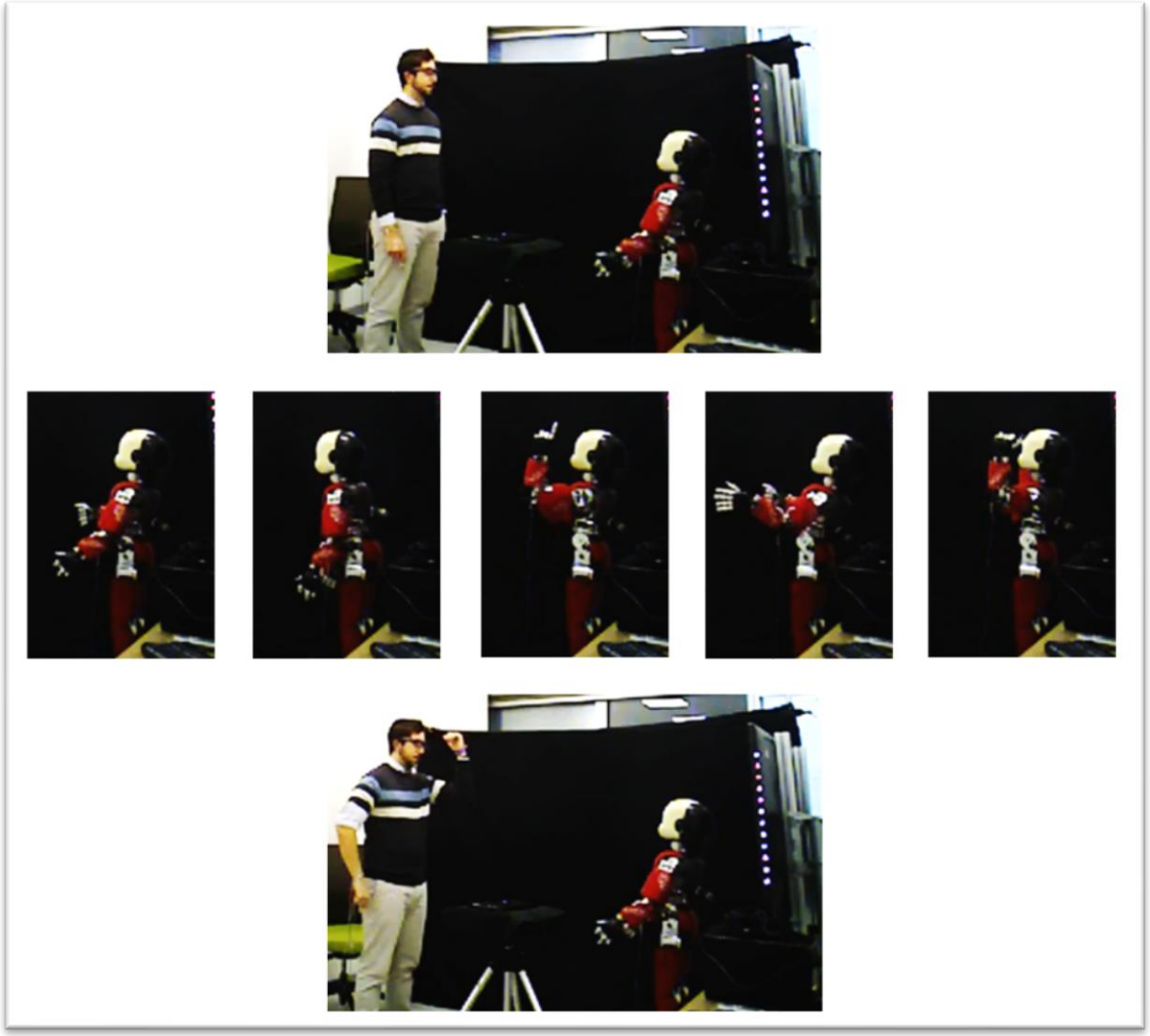

4. The case of HRI: The iCub teacher meets the human learner. Towards Self-Report Measure (Multi-item Scale)

The study shows that when the iCub slowed down his movements and adapted its demonstrations effortful – with more commitment - participants experienced him as more helpful.

This tells us nothing about how participants experience their lived body as a vehicle of a pleasurable feeling in interaction,

- but can tell us for example that **adaptation** (timing requirement/slow down) can be a positive factor **in experiencing interaction positively.**

4. The case of HRI: The iCub teacher meets the human learner. Towards Self-Report Measure (Multi-item Scale)

In the second scenario, more enactive elements are visible (Palinko 2015). The questions that were put into focus were

a) should a potential robot teacher follow **the pace** of students who are taking notes or should it impose a pace on them?

b) to what amount should the robot use **eye contact** to establish the timing of the interaction?

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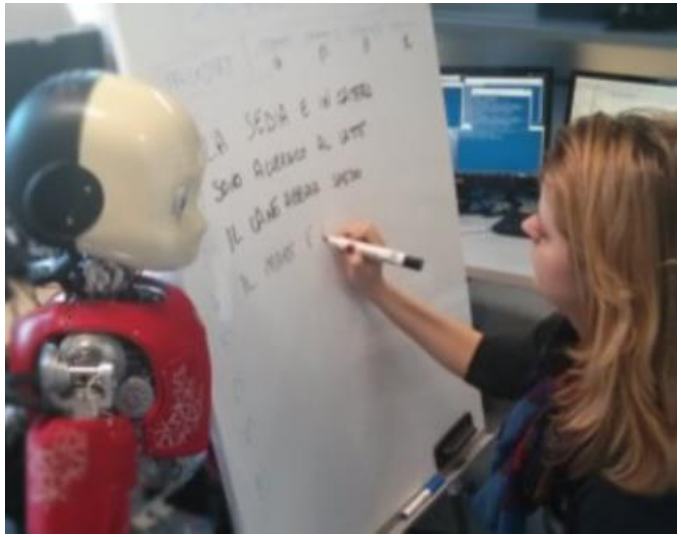


Gaze is an important implicit element of communication and **mutual gaze is important in turn-taking**. The study shows that when the robot pronounced a sentence after detecting that the subject was gazing at it, assuming that **mutual gaze would signal the readiness of the subject** to continue writing, a natural and seamless interaction was established.

4. The case of HRI: The iCub teacher meets the human learner. Towards Self-Report Measure (Multi-item Scale)

Participants **enjoyed** the condition in which they could use **eye contact** to interact with the robot.

The establishment of mutual gaze becomes for a robot an efficient mean to seamlessly interact with human partners with different needs in a turn-taking task. This has been experienced as positive by the participants.

4. The case of HRI: The iCub teacher meets the human learner. Towards Self-Report Measure (Multi-item Scale)

For our concern, this tells us that **mutual gaze** can be a relevant factor to create a situation of interaction with a sensorimotor loop of perception and action **influenced by mutual gaze rhythm** (the robot speaks when the human learner looks at him. After eye contact the human learner receives the sentences and can write again) establishing a **lived pleasurable feeling.**

4. The case of HRI: The iCub teacher meets the human learner. Towards Self-Report Measure (Multi-item Scale)

Focus on:

The feeling and emotions the role of the adaptation of the robot teacher in coordination (motor aspect) is accompanied with in the experience of the human learner

and

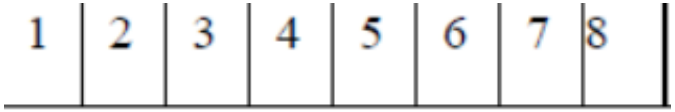
the feeling and emotions that accompany the experience of mutual gaze as a bodily way to control the subject's readiness to further engage in the interaction and negotiate the pace of the turn-taking.

4. The case of HRI: The iCub teacher meets the human learner. Towards Self-Report Measure (Multi-item Scale)

Exempli gratia:

"The active role of **my own body** in the turn–taking task led me to focus on a **feeling of satisfaction** after each turn-taking"

strongly agree



strongly disagree

5. Overview

We know that the social robot does not enhance the mind because it is not a tool **like Otto's notebook**.

It takes part in the constitution of a social interaction the feel of which we would like to investigate in the point of its "closure".

That **sensemaking in the engagement** with a nonhuman partner can lead the human agent to consciously focus on the role of her own lived body determining a pleasurable feeling of the interaction itself can improve the feedback she gives to the robot.

5. Overview

We could say that the human agent's pleasurable feeling of the experience itself has the potential to improve the development of the robot's capacity to assign meaning to the feedback of the human.

References and Copyright

The source of all pictures showing the iCub robot in different scenarios is the work done by the iit (Istituto Italiano di Tecnologia) in Genova (Italy). More precisely, the pictures used in this presentation were originally published by the iit team to illustrate the results of the following studies:

- Palinko, Oskar/Sciutti, Alessandra/Schillingmann, Lars/Rea, Francesco/Nagai, Youki/Sandini, Giulio (2015): Gaze Contingency in Turn-Taking for Human Robot Interaction: Advantages and Drawbacks. In: 2015 24th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN), Kobe, S. 369-374.

References and Copyright

- Vignolo, Alessia/Powell, Henry/McEllin, Luke/Rea, Francesco/Sciutti, Alessandra/Michael, John (2019): An Adaptive Robot Teacher Boosts a Human Partner's Learning Performance in Joint Action. In: The 28th IEEE International Conference on Robot and Human Interactive Communication (ROM-AN), New Delhi, India, S. 1 – 7.

- iCub performing highly dynamic Tai Chi while interacting with humans

  ✓ Youtube Video:
  https://www.youtube.com/watch?v=9XRI4BeXN78

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