Artificial Development Approach to Presence

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Abstract

Introduction

What is that make us feel the sense of being there? What is at the basis of our everyday phenomenological experience? What is the sense of "presence" made of? These and the like are questions that, besides being of practical relevance, delve deep into the very essence of human sensorial experience. We contend that any scientific endeavor of understanding presence should address, at least in part, three basic aspects:

- It should provide understanding of the neural basis of first-person experience and how different cues are integrated to form a holistic perception.
- It should tell what are the physical mechanisms and the conditions that allow these processes to occur.
- It should provide hints of how the sense of presence is formed and how it unfolds over time because of development and/or learning.

We purposely do not address here the issue of how to reproduce the sense of presence since we believe that this is secondary. What is perhaps most fundamental is the understanding of the phenomenon. Subsequently, this might spur the realization of new technology and applications. To this aim we envisaged a multidisciplinary effort where aspects of philosophy of mind, psychology, computer science, and robotics are combined. This effort clearly requires creating synergies and developing a common language and scientific background. In particular, we foresee proceeding along a certain number of steps:

- **Philosophy**: provide a plausible scientific theory of first-person experience. This can be later proved or disproved, refined, modified, etc. It is unlikely though that starting so much high-level the details be worked out from the very beginning. **Representation, intentionality, and causality** are seen as the keywords in describing the approach. Investigating presence is also seen as equivalent of investigating the nature of **consciousness** (for some of the aspects see [1-3]).
- **Psychology and neuroscience**: devise experiments within the tentative theoretical background to address specific issues raised

and/or predicted by the theory. Also, the mechanisms of the cognitive **development** of representations should be investigated. The study of development might reveal to be the sole mechanism to shed light on the constituents of the representation of the "sense of presence".

- **Modeling and robotics**: provide a firm empirical basis for testing and refining the theory. By employing a synthetic methodology [4-5] we can investigate how the representation of "being there" can be constructed.

These steps are not to be intended as strictly separate but rather as a possible interdisciplinary synergy.

Experimental setting

Within this setting, we will study the development of multimodal representations. In particular, we will investigate how haptic, auditory, visual, and motor cues are integrated by the brain to convey the holistic perceptual experience of everyday life. In order to render the problem more tractable, we focused on the smaller problem of the interaction with the **physical world of objects**. This is believed to be a crucial aspect both for human development and for human cognition. It is also this very embodiment that plays a definite role in shaping our reasoning skills even at very abstract levels (see for example [6]). The theoretical basis is of course general enough to encompass a much broader spectrum of possible subfields of investigation. On the other hand to devise experiments and provide models requires a clearer intent and a focused domain.

Experimentally we are investigating the development of the representation of objects in young infants and, simultaneously, building physical instances of the same "abilities" in a robotic platform. The representation of objects is multi-sensorial and it has been shown that also motor and behavioral components play a role [7-8]. The nature of this multi-sensory representation can be investigated by exploring the inter-modal transfer between the different modalities: sound, vision, and touch. Experiments are being conducted on different groups of infants ranging from 3 days to 12 months of age. Further, the relationship of perception and behavior (e.g. the contribution of motor cues) can be probed by exploring imitation of affordant vs. non-affordant use of objects [9-11].

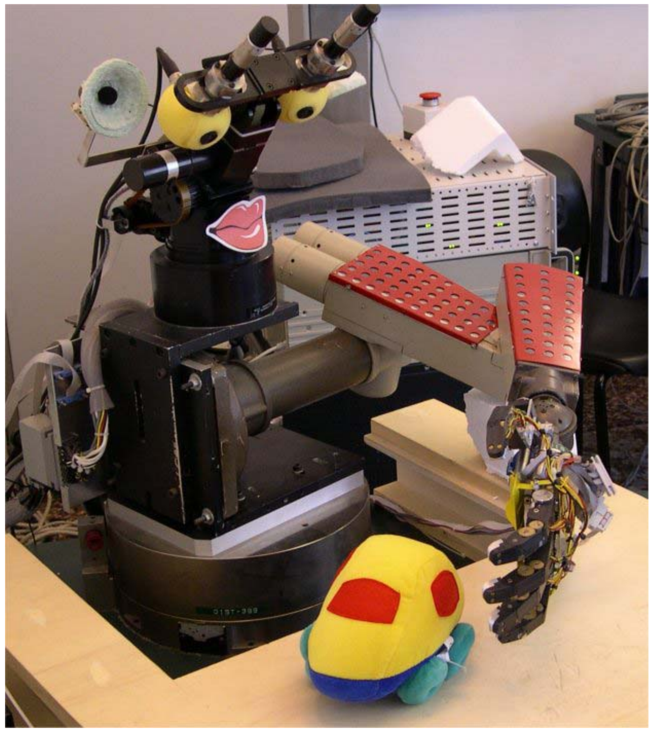

Figure 1: The humanoid robotic platform. It consist of a robot head, arm, and hand for a total of 18 degrees of freedom. It is equipped with cameras, microphones, proprioception, and tactile sensors.

A similar set of experiments is expected to be implemented on a humanoid robotic platform. The robot's sensory system includes cameras, tactile sensing elements, proprioception, and microphones. In a first phase the robot explores objects visually and haptically and builds a multimodal representation of them. The robot is equipped with a set of behaviors and can acquire new ones by learning [12-13]. Imitation is then used in a successive verification phase where objects are tested in affordant and non-affordant situations. Figure 1 shows the experimental platform.

We will report of the current state of advancement of the project and the experiments carried out so far.

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