Development of a self-model and its implications for a dynamic body schema

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In this poster, we consider the importance of interaction (sensorimotor and social) between two individuals (humans or artificial agents) and its effect on the development of a self-model. Body knowledge is more than a static representation of body parts, but includes the ability to adaptively use sensorimotor contingencies (smcs) (O'Regan and Noë, 2001) to generate continuous actions. These smcs develop during the interaction of an individual with itself, its environment and, crucially, also with others.

In previous experiments with Aibo robots, we showed how a robot can develop a body schema based only on the information available from its sensors during an interaction with the environment. (Kaplan and Hafner, 2006). To create these body schemas, information distances between sensor pairs were computed. The body schemas are a representation of both the body structure, the current behaviour and the environment of the robot. In an extension of this experiment, we coined the term *interpersonal map* (Hafner and Kaplan, 2008) for a body representation of two interacting individuals. Such an interpersonal map consists of two distinct clusters when there is no interaction between the individuals, and a closely linked map when there is tight interaction (e.g. imitation). This is in line with an enactive and intersubjective approach (Thompson and Varela, 2001) to self-development in humans, according to which the self emerges as an organizational distinction among psycho-social individuals based on prior immersive or closely attuned social interaction loops. But instead of being a static center of individuation, a self is also seen as that which allows humans to collaborate and engage with others. It thus involves a two-fold basic norm: distinction (a tendency for emancipation from or in certain relations) and participation (a tendency for immersion and participation in certain others). On the enactive view, the self is thoroughly relational and necessarily open to perturbations and change (Kyselo, 2014). Since the body is not simply the seat of the self but rather its mediator and dynamic matrix (Di Paolo and Thompson, 2014) of psycho-social behaviour, the sensorimotor contingencies involved in an adaptive self-model must therefore not only remain dynamically open but also extend beyond individual bounds, sometimes merging with the sensorimotor loops of other agents.

By bridging robotics, psychology and cognitive science, we will tackle the following questions:

- How can a dynamic, fluid, and adaptive body representation be developed?
- What is the effect of (social) norms?
- How can these interactions be tuned and what are the conditions for a more efficient generation of a stable self-model?

We will test these considerations in a prototypical scenario consisting of a cooperative task between two individuals that would benefit from the ability to model both self and other.

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