Modeling development is crucial for building really adaptive Companions [1]

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Our team is working on modeling the development in a cognitive science perspective. We use various robotic systems to test the behavioral consequences of our Neural Network models. At the end of the 90s, after several works on autonomous learning, we ended understanding that individual development could not be considered apart from social development. In robotics, Imitation is often considered as a useful "tool" allowing to speed-up learning. We showed that low-level imitation could be an emergent behavior resulting from the coupling of a homeostatic system and perception ambiguity. Discussions with J. Nadel, specialist in developmental psychology and children with autism (CNRS UMR 7593) have shown us that imitation has also (and mainly?) a communication function. It appeared that our Neural Network for low-level imitation could be used as a model of one of the first stages of the baby development.

From this starting point, we have used robots as an experimental platform allowing to test hypotheses about the development of an autonomous control architecture: what are the minimal and low-level mechanisms allowing a robot to imitate, to resonate emotionally, or to understand the intentions of others?
In parallel, we have used with our psychologists colleagues the same robotic platform as a central dispositive for psychological experiments involving human-robot interactions: adult-robots, baby-robot, child-robots and CWA[2]-robots experiments. For example, we have designed with Nadel's team a robotic head, duplicated in two exemplars in order to test the essential properties of early communication: The first exemplar was devoted to study human responses to an expressive robot (psychological experiments), while the second one was used to test the robotic responses to human expressions (how a robot can learn autonomously to recognize and imitate facial expressions).

Here, the robot is obviously a research tool, allowing refining a developmental model with feedbacks on:
- the failures of the model in robotic experiments,
- the results of the agent responses in psychological experiments,
- the relative and estimated developmental age of the model when compared to children and CWA.

In turn, advances with such developmental model allow a better understanding of the key properties underlying learning and communication. These works allow us to formulate new hypotheses on the role of mechanisms that we initially did not think as "central" in our models: synchrony, rhythms and the overall dynamics of the

[1] IEEE Autonomous Mental Development Newsletter, Volume 6, Number 1, page 4--5 - 2009

[2] CWA : Children With Autism

interactions composed of two agents (robot, adult or child) . It also brings us to study more the role of emotions in development.

In our Lab, we are far away from using robots for therapeutic applications. Recently, a lot of roboticists have started to develop robots intended to help CWA and other disorders. Yet, as stated by Kerstin Dautenhahn, we should be very careful not to try to sell a tool before understanding what could be its real effect on children. Robotic toys can be very useful for psychologists (to facilitate the interaction) , but if the robot is unable to adapt and progress with the child it will tend to result in isolating more the child in a new routine (after the first positive interactions). Hence, pluri-disciplinary researches are crucial both for a better understanding of the processes involved in the child development and the design of new robotic architectures allowing to take into account the social environment.