Editorial: re-enacting sensorimotor experience for cognition

Health & Medicine

Editorial on the Research Topic

Re-Enacting Sensorimotor Experience for Cognition

Recent findings in cognitive science suggest that the human brain implements processes of simulation of sensorimotor activity (Pezzulo et al., 2013 ; Case et al., 2015 ; Wood et al., 2016). By re-enacting sensorimotor experience, the brain would be capable of anticipating the sensory consequences of intended motor actions. This would enable the individual to efficiently and fluidly interact with the environment.

This e-book puts forward the hypothesis that similar mechanisms underlie the development of basic cognitive capabilities. Therefore, sensorimotor simulation processes may represent one of the bridges between motor development and cognitive development in humans.

This collection comprises manuscripts published by Frontiers in *Robotics and Artificial Intelligence* , under the section Humanoid Robotics in the research topic “ Re-enacting sensorimotor experience for cognition.” The e-book aims at condensing the latest theoretical review and experimental studies that address new paradigms for learning and integrating multimodal sensorimotor information in artificial agents, re-use of the sensorimotor experience for cognitive development and further construction of more complex strategies and behaviors using these concepts.

1. Theoretical and Review Studies

In their review paper, Schillaci et al. introduce recent research on exploration as a drive for motor and cognitive development, and how this has been

applied to robotics. After focusing on the development of internal body representations, the authors review research that highlights the importance of sensorimotor simulations and their role in the grounding of higher cognitive capabilities in robots. Most of these works have been inspired by sensorimotor and enactive theories. Froese and Sierra , in their review of the volume edited by Bishop and Martin on Contemporary Sensorimotor Theory (2014), draw the attention of the reader to the similarities and the differences of the current sensorimotor and enactive theories. However, the authors point out the need of additional comparative studies, in particular in the context of Robotics and AI.

Nonetheless, several challenges have already been posed by these theories. How can we explain the phenomenological character of experience (Froese and Sierra)? Are body representation and internal simulation processes involved in coding a basic sense of self in artificial agents, and if so, how (Schillaci et al. ; Schillaci et al., 2016)? What should be built into an artificial agent “ so that it really feels the touch of a finger, the redness of red, or the hurt of a pain” (O’Regan, 2014)? Terekhov and O’Regan show mathematically and in simulation that naive artificial agents can build the abstract notion of space from their perceptual systems by learning sensorimotor invariants. Without making assumptions about the existence of space, such agents are able to learn the notion of rigid displacement. Their findings give a role to artificial intelligence in the quest of explaining the nature of space, prevalently addressed by philosophy and physics.

O’Regan, J. K. (2014). “ The explanatory status of the sensorimotor approach to phenomenal consciousness, and its appeal to cognition,” in *Contemporary Sensorimotor Theory* , eds J. M. Bishop, and A. O. Martin (Springer), 23–35.

Pezzulo, G., Candidi, M., Dindo, H., and Barca, L. (2013). Action simulation in the human brain: twelve questions. *New Ideas Psychol.* 31, 270–290. doi: 10. 1016/j. newideapsych. 2013. 01. 004

Schillaci, G., Ritter, C. N., Hafner, V. V., and Lara, B. (2016). “ Body representations for robot ego-noise modelling and prediction, towards the development of a sense of agency in artificial agents,” in *International Conference on the Simulation and Synthesis of Living Systems (ALife XV)* , (Cancún), 390–397.

Wood, A., Rychlowska, M., Korb, S., and Niedenthal, P. (2016). Fashioning the face: sensorimotor simulation contributes to facial expression recognition. *Trends Cogn. Sci.* 20, 227–240. doi: 10. 1016/j. tics. 2015. 12. 010