**Teleological reasoning in infancy**

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The aim of my talk is to discuss the amazing capacity of understanding goal-oriented actions shown very early by infants. More precisely the focus is about the innate principle of efficiency that would make infants able to comprehend the agents’ goal in structured actions.

From the end of the 90s, Amanda Woodward and her colleagues have argued that by 5-6 months of ages infants understand goal-directed actions.

“Children develop immersed in sea of human action […]. Becoming a functional member of our species depends on being able to represent these actions not as purely physical motions through space, but rather as the manifestation of a person’s psychological life” (Woodward, 2005).

According to Woodward paradigm, when 6-month-old infants see an agent’s hand repeatedly grasping one of two objects, they anticipate that the same object would be grasped again even when the spatial location of the objects are rearranged. This result shows that infants are more likely to associate a grasping hand with the grasped object than with its location, which is useful for interpreting the grasping action as directed to the goal of acquiring a specific object. When infants are unable to link the action to the goal, they do not have any expectations concerning how the agent should behave in a changed environment. In additional experiments, the actor was replaced with a flat occluder shaped like an arm and hand, a rod tipped with a sponge, or a mechanical claw. The infants did not look reliably longer at the new-goal event, and Woodward concluded that 5- to 6-month-olds attribute goals to human but not to non-human agents. Therefore, according to Woodward infants’ ability to reason about goals develops as a result of their experiences with human agents (humans-first view).

Luo and Baillargeon (2005) showed that also 5 month-old infants attribute goals to any entity they identify as an agent. Indeed, another possible interpretation to Woodward’s tasksis that the infants tested did not attribute goals to the occluder, rod, and claw simply because the available information did not clearly mark them as agents. Luo and Baillargeon proposed to infants similar tasks without the presence of human agents and the results were surprising.

The underlying core question is the following: *Do infants read actions’ or minds’ agents?* And in particular, *what is it really necessary to infants in order to understand the action’s goal, independently whether the agent is human or not?*

Csibra and Gergely (2003) have proposed that goal attribution is rooted in a specialized system of reasoning that is activated whenever infants encounter individuals they identify as agents. According to this view infants attribute goals to both human and non-human agents (all-agents view). In particular, Gergely and Csibra provided “the naïve theory of rational choice”, according to which infants apply a *non-mentalistic interpretational system*, the ‘teleological stance’ to represent actions by relating relevant aspects of reality (action, goal-state and situational constraints) through the principle of rational action, which assumes that actions function to realize goal-states by the most efficient means available.

According to their theory, in order to interpret an action as goal-directed, one has to take into account the relevant constraints of the situation in which the action is performed. The outcome (the effect) of an action may, or may not, be seen as the goal, depending on whether the outcome is judged to justify the action in the given situation. Such normative evaluation of actions is based on the principle of rational action which allows for the assessment of the relative efficiency of the action performed to achieve the goal within the situational constraints given.

The efficiency principle of goal attribution requires that agents expend the least possible amount of energy within their motor constraints to achieve a certain end. The role of the efficiency principle is the same in goal attribution as the role of the principle of rationality in mental state attribution, but it is applied to states of the world rather than to mental state contents. Therefore, infants apply the principle of rational action to the interpretation of behaviours of people, hands, puppets, robots, geometric shapes. Insufficient knowledge about the constraints of the agent or the situation may produce wrong predictions or goal attribution by teleological reasoning.

It’s a basic assumption: agents achieve their goals efficiently. The assumption of efficiency also helps to verify hypotheses about possible future goal states. *Evaluating efficiency is impossible without some basic knowledge of physical potentials of objects and agents, and can even lead to insights into new and relevant physical or biological constraints.* Teleological action interpretation involve two kinds of inferences, which require different types of computations. Indeed, predicting a future goal state from interpreting an ongoing action represents an ‘action-to-goal’ inference (‘What is the function of this action?’), while during action anticipation the inference goes in the opposite direction from ‘goal-to-action’ (‘What action would achieve that goal?’). (Csibra&Gergely, 2007).

Interpreting novel actions in terms of goals can allow infants to learn useful new means by observing how agents use them successfully to achieve their goals. In other words, social learning of new means allows infants to figure out what action is to be performed (or what tool is to be used) to achieve a certain goal.

 During the talk, we will see several experimental evidences in favor of the principle of efficiency, among others the Victoria Southgate et al. experiment proposed in 2008 and focused on the understanding of biomechanically impossible actions. I will underline the need to revisit the theoretical relation between teleological and mindreading system under the light of more recent experiments on theory-of-mind abilities in infants. In conclusion, I will emphasize the significant relevance of the teleological stance, and in particular its dissociation with mindreading skills, in developmental pathologies as autism, through experimental examples.

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