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Early imitation and the emergence of a sense of agency

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In this paper, I would like to emphasize the developmental role of imitation as a foundation for the emergence of a sense of agency (i.e. a sense of being the owner of one's own action). There is a large body of psychological and neuroimaging experiments that have demonstrated that perception of action share some common neural and cognitive mechanisms with action generation, action simulation, action recognition and action imitation. How the concept of shared motor representations relate to neonatal imitation is of major interest. Indeed, primary wired perceptual-motor coupling may be viewed as primitives of imitation which could play a main constitutive role in the establishment of a distinction between action originating from self and action originating from others. We will show that 2-month-olds do not imitate a self-propelled robotic mouth protruding its tongue, while they do imitate a human tongue protrusion. This suggests that imitation is already selective of human action. Young infants select biological movements among all moving stimuli that are similar in speed, colour and morphology.

Similarly, be imitated may be viewed as an action-perception coupling which may strongly contribute to distinguish between self-agency and other's agency. In her first developmental steps, the very young infant may take the behaviour seen as being hers, which could result in reciprocal imitation if the movement seen does not match exactly the movement done. Through imitation, this will lead the infant to distinguish between two classes of perception that Russell proposes to be at the origin of the sense of agency: those perceptions that are a by-product of one's own action and intention, and perceptions coming from the external world, that you cannot modify at will. Comparing 2-month-olds' behavior with a device allowing to present with a seamless shift contingent image and voice of the mother or delayed image and/or voice of the mother, we found 10 times more imitation in the contingent episode, where infant and mother can reciprocate imitation rounds. In addition, a high positive correlation between number of mother's imitation and number of infant's imitation was found. This suggests that imitation begets imitation early after birth.

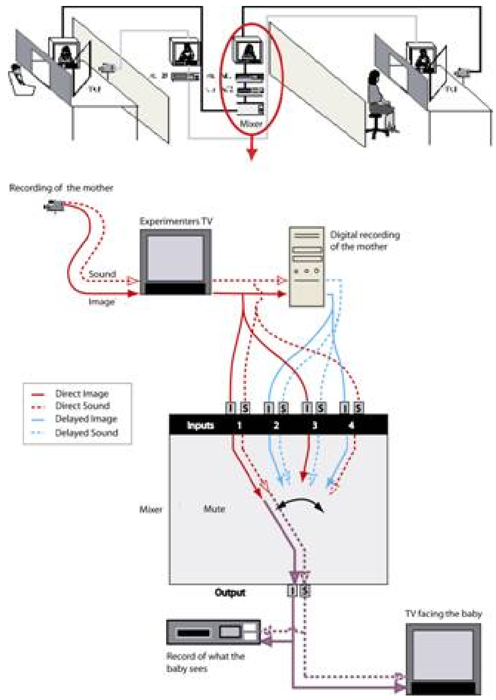

Figure 1: The teleprompter device used to delay image and/or voice of the mother (Nadel, Prepin & Canet, 2004)

In the past we have shown that synchronic imitation and imitation recognition allow preverbal infants to find common topics based on similar actions, and to take conversational turns by alternating the roles of imitator and model. Therefore the gap between recognizing actions and coding messages with communicative intent is not as enormous as it looks at first glance: Understanding the other's intentional actions is prepared by the use of the imitative system, via the action recognition mechanism

Our experiments led in socially embedded situations have shown that nonverbal children with autism - even very low-functioning children - mostly produce spontaneous imitations when meeting a non autistic child or a playful adult. The imitations pro-

Figure 2: Two 30 month-olds interacting via imitation

duced are simple gestural matching or imitations of familiar or novel actions that are goal-directed and involve affordant or non-affordant objects. They are a good predictor of social capacities. They enhance attention to persons and expectancies for social contingencies. Repeated imitative sessions improve imitation, recognition of being imitated, and non verbal communication (see Figure 3).

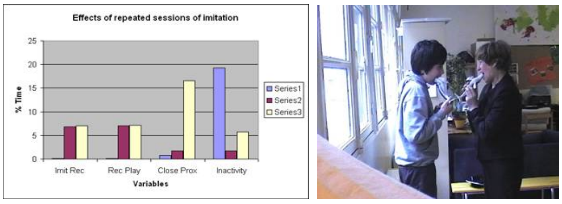

Figure 3:

We suggest that the stimulation of perception-action coupling can be used as a remediation to enhance autonomous actions that the autistic children will learn and then may possibly be able to encode as such.

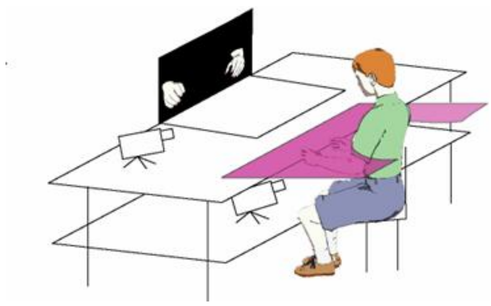

Figure 4: Children with autism have to distinguish whether they see on the screen their hand movement or another's hand movement

The enhancement of such experiences may be based on new technologies, providing parameterised environments such as robotic or virtual experimenters.

Figure 5: Robota, designed by Aude Billard (EPSL) allows the child to understand that the doll's movement originates from his own movement (sense of agency) and is limited to a restricted category of movement (enhances intentional action)

Robotic or virtual experimenters possibly meet more closely what children with autism can accept as a social environment, gently push toward acceptance of human presence and lead to further social use of imitation. For synchronous imitation generates a unique phenomenon with multiple outcomes: seeing ones' intentions acted through the behaviour of the other.

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