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The Role of Movement in the Development of Joint Attention: A Robotic Approach

Yukie Nagai

National Institute of Information and Communications Technology, Kyoto, Japan

Although researchers in cognitive science and developmental psychology have revealed the ontogenic and phylogenic processes of joint attention, the mechanism of its development remains unclear. Constructivist approaches, on the other hand, enable the researchers to gain a new understanding of the mechanism by modeling and evaluating their hypotheses using robots.

I present a robotic approach to understanding the role of movement in the development of joint attention. Moore et al. (1997) found that human infants could be trained to follow another person's gaze only when they watched the head turning movement of the person whereas they failed without watching the movement. The static head orientation was not enough to encourage infants to follow the person's gaze. Why does movement help infants to follow the person's gaze? By what mechanisms do infants detect movement and learn the relationship with their own movement to achieve joint attention? A model I developed enables a robot to learn to establish joint attention by acquiring the sensorimotor relationship between motion vectors in the vision and in the somatic sense. The movement of head turning of another person is detected as motion vectors in the robot's vision, i.e. optical flows, while the movement of the robot's head turning is detected as motion vectors in its somatic sense. In other words, the self's and other's movement detected in different modalities can be represented as equivalent forms of motion vectors. This equivalence enables the robot to easily find the sensorimotor relationship to achieve joint attention.

Experimental results showed that movement helped the robot to acquire the ability of joint attention as in infants. The speed of learning was accelerated in the early stage of learning compared to the speed when the robot learned using only static visual information, i.e. edge images of another person's head. The edge images played the role to improve the accuracy of joint attention in the latter stage. The reason why the optical flows and edge images had complementary effects on learning is that the former yielded rough but easily understandable information to estimate the direction of another person's gaze while the latter provided complicated but exact information. Similar effects found in infant development suggest that these results can help us to understand the mechanism of infant development.

Reference:

Chris Moore, Maria Angelopoulos, and Paula Bennett. The role of movement in the development of joint visual attention. Infant Behavior and Development, 20(1):83-92, 1997.