

Elementary Developmental Process of Intentional Agency: Artificial Construction of Infant's Gaze Alternation in Communicative Eye Gaze

Developmental Construction of Infant's Gaze Alternation with Intentional Agency

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Index Terms—Infants' Developmental Process, Communicative Eye Gaze, Gaze Alternation, Understanding Others' Intention, Intentional Agency, Goal and Means, Constructive Approach

We focus on behavior of communicative eye gaze which is infants' gaze alternation. The gaze alternation is to gaze at a caregiver and at particular objects alternately. It is pointed out that the gaze alternation, which is a basis of social communication, is related to a developmental process of an intentional agency. The intentional agency is defined as an act composed of a desired goal and a means. It is mentioned that the infants understand others' intentions based on the intentional agency. In this viewpoint, the gaze alternation is not mere behavior to bring back the infant's gaze point to the caregiver after looking at the particular objects, but intentional behavior to gaze at the caregiver according to the infant's desire. This intentional behavior may be able to develop into more communicative use of the eye gaze, that is, social referencing and utilizing of the gaze alternation.

In our research, in order to study an elementary developmental process of the intentional agency, we constructed a computational model which acquires (1)visual orientation as a means by the reinforcement learning and (2)gaze alternation between the caregiver and the objects as a goal through memorizing sensory states. (1)The visual orientation function that is an ability to gaze at the caregiver and at the objects on the center of the visual field consists of three modules: selector, evaluator, and motion learner. (2)In order to acquire the gaze alternation with the intentional agency as the internal states, we add a module: associator, to the visual orientation system.

We conducted experiments to investigate how the agent model acquires the gaze alternation based on the intentional agency. As the result, we confirmed that the constructed agent model can acquire the gaze alternation outside the visual field, even though a few objects are displayed in the visual field. In the behavior, the agent can modify the moving direction of the gaze point according to an associated goal when the agent finds the visual stimulus in the different direction from the moving direction of the gaze point.

By taking the present construction of the infant agent, the agent is endowed with abilities of selection and disambiguation of objects. The selection means that the agent can keep the object at which the agent wants to gaze when the different object appears in the agent's visual field. If two objects are placed in the caregiver's eye direction, the agent can look at the object at which the agent wants to gaze, using the selection ability. We consider that the agent can resolve ambiguous situations according to the associated goals.

In the developmental construction of the model, we confirmed that two functions, discrimination and association, play an important role. The former discriminates between the caregiver and the objects in stimuli. The latter associates the caregiver with the objects by storing the relations between sensory states. We suggest that acquiring the two functions, which consists of the associator, is important in the developmental process of the intentional agency. Comparing infants' intentional agency with our constructed model, we argue that a nested structure, in which the gaze alternation composed of a goal and a means is utilized as a means to achieve another goal, is an important feature in the developmental process of the intentional agency.