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Joint attention in the first year: The coordination of gaze and affect between 7 and 10 months of age

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Abstract

We used a multilevel growth model to describe the developmental trajectories of infant's coordinated attention between people and objects between 7 and 10 months of age. Additionally, we assed whether the coordinated attention looks were accompanied by smiles as infants interacted social partners. These results confirm the emergence of visual joint attention skills before the end of the first year. These results will be useful in the construction of robotic systems that engage in joint attention.

1. Introduction

A fundamental component of social development in the first year is the infants' capability to coordinate attention between people and objects. This ability has been called "joint attention" or "triadic social skills". Joint attention is a necessary precursor for human cognitive skills such as social referencing, language acquisition and imitative learning. Prior studies (see Carpenter, Nagell, & Tomasello, 1998) argue that these skills do not emerge until 9 months of age. However, infants were not tested at ages younger than 9 months. Given the important role of joint attention in human cognition a precise understanding of the temporal development of this behaviour is important for the advancement of robotic constructions. In this study, we assessed the development of visual joint attention in sixteen infants between 7 and 10 months of age on a weekly basis.

2. Methods

2.1. Participants:

Sixteen infants participated in the study (3 males and 13 females). They were tested on a longitudinal basis, once a week, from 7 to 10 months of age (12 visits). During the testing sessions the infants were brought with their care-giver into the testing room. A female experimenter administering the tasks sat 0.8 m across them. The following task was performed with the infants:

2.2 Joint Attention Task

The purpose of this task was to assess whether infants spontaneously engaged in coordinated attention, namely, whether they alternated their visual attention from an outside entity (i.e., a toy) to the Experimenter (E) and immediately back to the same outside entity. E gave the infants several toys to play with. The toys served as the outside objects on which infants could establish coordinated attention with E. The free play episode lasted 6 minutes.

2.3 Coding:

Joint Engagement Looks

Infants gaze from a toy, to the E's face, and back to the same toy. To ensure that only spontaneous instances of coordinated attention were coded, any looks up infants made to E1 in response to her speaking or moving were not tallied.

Smiling

All Joint Engagement looks were coded for of smiling. Smiling was defined as infants' cheeks raise and at least one corner of the mouth turns up while looking at the E1's face.

2.4 Statistical analysis

We used a multilevel growth curve model to describe the relationship between age of the infants and the number of looks and smiles, respectively, per 6 min observation session. We tested both random intercept and a random slope models (Singer and Willett, 2003). In a random intercept model subjects only differ in their intercept only, which give rise to a set of parallel growth curves. A random slope model

varies in both intercept and slope which gives rise to a set of potential crossing growth curves. For both behavioral dependent variables we tested a linear and a quadratic trend model over time.

3. Results

Table 1a summarizes the results from the multilevel growth model for the number of coordinated attention looks over time. The number of looks was best described by a random intercept model with a quadratic term of age in weeks. For the observation period the model describes a nonlinear increase over age with a declining slope, reaching a plateau at the end of the observation period of 10 months. The differences in the intercept between the individuals and, therefore, the frequencies of looks were not significant

Table 1b summarizes the results from the multilevel growth model for the number of smiling over time. The number of smiles is best described by a random intercept model with a linear term of age in weeks. The model describes a linear increase for smiling during joint attention looks for the observation period. This pattern was not significantly different among individuals.

Task		Parameter estimates (SEE)	Test statistics	P
a) **Look**	**Fixed effects**			
	Intercept	- 1.28 (0.504)	F(1,177) = 6.468	.012
	Week	0.836 (0.176)	F(1,166) = 22.611	< .001
	$Week^2$	- 0.039 (0.013)	F(1,167) = 8.657	.004
	Random effect			
	Intercept (subjects)	0.156 (0.177)	Wald Z = 0.882	0.372
b) **Smile**	**Fixed effects**			
	Intercept	- 0.178 (.119)	F(1,129) = 2.258	.135
	Week	0.078 (0.016)	F(1,167) = 24.479	< .001
	Random effect			
	Intercept (subject)	0.01 (0.022)	Wald Z = 0.47	.638

Table 1: Multilevel growth curve models of number of a) looks and b) smiles per 6 minute experimental phase in dependency of age of infant in weeks from 7 to 10 months of age (SEE = standard error estimates).

4. Discussion

The results show that first joint attention skills begin to develop before 9 months of age. The successive appearances of a number of underlying cognitive skills are still unknown in robotics. These findings show that visual joint attention skills undergo a gradual development toward the end of the first year. The mechanisms that account for these transitions in human infancy are still unknown. However, these results show that joint attention skills (visual joint attention and the coordination of smiling) gradually unfold in early ontogeny. These results should help in the construction of robots that show sophisticated joint attention abilities and hence a qualitatively different kind of social awareness (Kaplan and Haffner, 2004).

5. Literature

Carpenter, M., Nagell, K., & Tomasello, M. (1998). Social cognition, joint attention, and communicative competence from 9 to 15 months of age. *Monographs of the Society of Research in Child Development, 63*(4, Serial No. 176).

Kaplan, F. and Hafner, V. (2004). The challenges of joint attention, Proceedings of the 4th International Workshop on Epigenetic Robotics, pp. 67-74, Lund University Cognitive Science Studies 117, Genoa, Italy.

Singer, J.D. and Willett, J. B. (2003). *Applied longitudinal Data Analysis: Modeling Change and Event Occurrence*. New York: Oxford University Press.