

Can young infants understand when another's attentional gaze is directed towards the same object that they were looking at?: Preliminary analyses

心理学科 Hiromi TSUJI

Abstract: This paper addresses the understanding that young infants have of another person's direction of gaze in the context of the development of joint attention. Twenty infants with a mean age of 10 months were studied using a preferential looking paradigm. This paradigm comprised two schematic faces, in which one of the faces looked at the infant and the other face looked either towards or away from the object to which the infants were initially introduced. The results indicated that infants preferred to look at the faces that either looked at them or looked at the object of common interest. The infants looked less at the face with eyes averted from both themselves and the object. This result suggests that these young infants have started to participate in joint attentional episodes.

Key words: joint attention, intentionality, social cognition

Acknowledgement: This study was funded by the Japan Society for the Promotion of Science as the Grants-in-Aid for Scientific Research for 2006 and 2007 (No. 18830086).

I would like to thank the parents and their children for their participation in this study.

1. Introduction

There is wealth of evidence suggesting that infants are very sensitive to eye gaze and that this basic aspect of human nature is observable from birth (Farroni, Csibra, Simon, & Johnson, 2002). Infants as young as 4 months-old are able to process facial information and differentiate between directions of gaze. They show a preference to look at a direct gaze towards themselves (Farroni, Johnson, &

Csibra, 2004). At the age of 5 months, as their sensitivity increases, infants are able to discriminate between subtle horizontal deviations of eye gaze (Symons, Hains, & Muir, 1998). A good understanding of eye gaze by young infants can be gained by studying their gaze following behaviors. This behaviour is also found in a neonate (Farroni, Massaccesi, Pividori, & Johnson, 2004). However, the extent to which such a gaze following behaviour represents their understanding of another's attentional

behaviour is not clear (Frischen, Bayliss, & Tipper, 2007).

Gaze following behaviour indicates an infant's ability to orient their attention to another person's gaze. Orientating one's attention to another's is very important because this is a foundation of joint attention, which begins to emerge in infants at the age of 9 months. Tomasello (1999; 1995) argues that joint attention is represented by the behaviour in which infants look at both the person and the object to which the person's line of gaze is directed. According to Tomasello, this behaviour indicates that infants have an understanding of another person as a psychological agent like themselves.

Joint attention is now recognized as one of the important developmental milestones achieved by young children. Moreover, this ability lays the foundation for a child's subsequent development of the "Theory of Mind", in other words, mind-reading skills (Baron-Cohen, 1991). Joint attentional skills also play a part in facilitating children's early language development (Akhter, Dunham, & Dunham, 1991; Baldwin, 1995; Carpenter, Nagell, & Tomasello, 1998; Tomasello & Farrar, 1986; Tomasello & Todd, 1983).

Despite a young infant's remarkable ability to discriminate between the directions of eye gaze, it is not until 9 months of age when infants explicitly show their understanding of another as a psychological being like themselves (Carpenter et al., 1998; Tomasello, Carpenter, Call, Behne, & Moll, 2005). How does the early precocious ability to understand the direction of gaze relate to the later development of joint attention? Although an attempt

was made to examine correlations between early attentional skills and later joint attentional skills, a clear longitudinal relationship was not found (Saxon, Frick, & Colombo, 1997).

If infants are interested in another person's orientation of gaze, even when a distractor object or another person is present, then they should show a behaviour of such an interest. When this hypothesis was tested by several studies, it was found that infants of 12- to 18-months of age showed an appreciation of an adult's gaze behaviour, by peeking over a barrier to try and see what the adult was looking at (Moll & Tomasello, 2004). As seen from this study, infants' appreciation of another's attentional gaze in such a complex context may not appear until after the first year. However, this does not mean to say that younger infants than those tested in Moll and Tomasello's study do not have an appreciation of another person's attentional gaze. Other studies (Flom & Pick, 2005; Striano & Bertin, 2005) suggest that infants as young as 5-months-old, can coordinate visual attention between a person and an object to form a triadic relationship. Despite an infants' early sensitivity to the direction of eye gaze, which is followed by their ability to coordinate their attention in a triadic manner, it is not clear how this transition happens. This is a critical ability to be acquired on the path to achieving joint attention.

The present study addresses whether infants younger than one-year of age are able to show an appreciation of another person's eye gaze that is directed towards the same object that they are looking at. This

ability is examined by comparing the duration of an infants' gaze, as an indicator of their preference between a person who looks at the same object as themselves and another person who looks directly at them. It is hypothesized that if infants have an explicit understanding of another's line of gaze towards the same object as they are looking at, then they would prefer to look at that person rather than a person who has a simple direct gaze at them.

2. Method

2.1 Participants

A total of 20 full-term infants (9 boys and 11 girls) aged between 7 and 12 months ($M=308$ days, $SD=50$) participated in this study.

2.2 Apparatus and stimuli

The experiment was run on a PC (Apple Inc.) with a 20-inch colour monitor. One video-camera (Sony HDR-HC3 for NTSC) was used to record the infant's face and it was mounted on the top centre of the monitor. A chair for the parent was placed 70 cm away from the monitor. The parent held their infant on their lap during the experiment. Two room-partitioning screens (1.4m wide \times 1.5m tall) were placed on both sides to minimize distractions to the infant. In order to simultaneously record the stimuli and the infant's face, a full-length mirror was placed in a location, which enabled the screen image to be captured indirectly and the infants face to be captured directly by the camera.

Stimuli were created and presented using

the Apple Keynote software. The fixation target for the infant was a spinning circle with sound, which appeared on the screen for 2 seconds. This was followed by the presentation of the two schematic faces. Each face had a different direction of eye gaze and the faces appeared on both sides of the object (or fixation target). In order to create a situation in which the object that the infant is looking at was the same as that one that the schematic faces were looking at, the fixation target was presented as the object again. The stimuli have 4 different patterns of presentation; there are two patterns with a face looking at the infant on the left hand side of the object and the other face on the right hand side of the object either looking towards or away from the object. The other two patterns had the face looking at the infant on the right hand side of the object and the face on the left hand side of the object was either looking towards or away from the object. The experiment consisted of two conditions. One condition was of the schematic face looking away from the target object and the other schematic face looking at infant. The other condition comprised one schematic face looking at the target object and the other schematic face looking at infant. Each infant was presented with a block of two conditions. The face looking at the infant would appear on different sides of the object in different conditions. Each of the conditions was presented a similar number of times, by showing different blocks of two conditions to the individual infants. Figure 1 presents an example of a stimuli block.

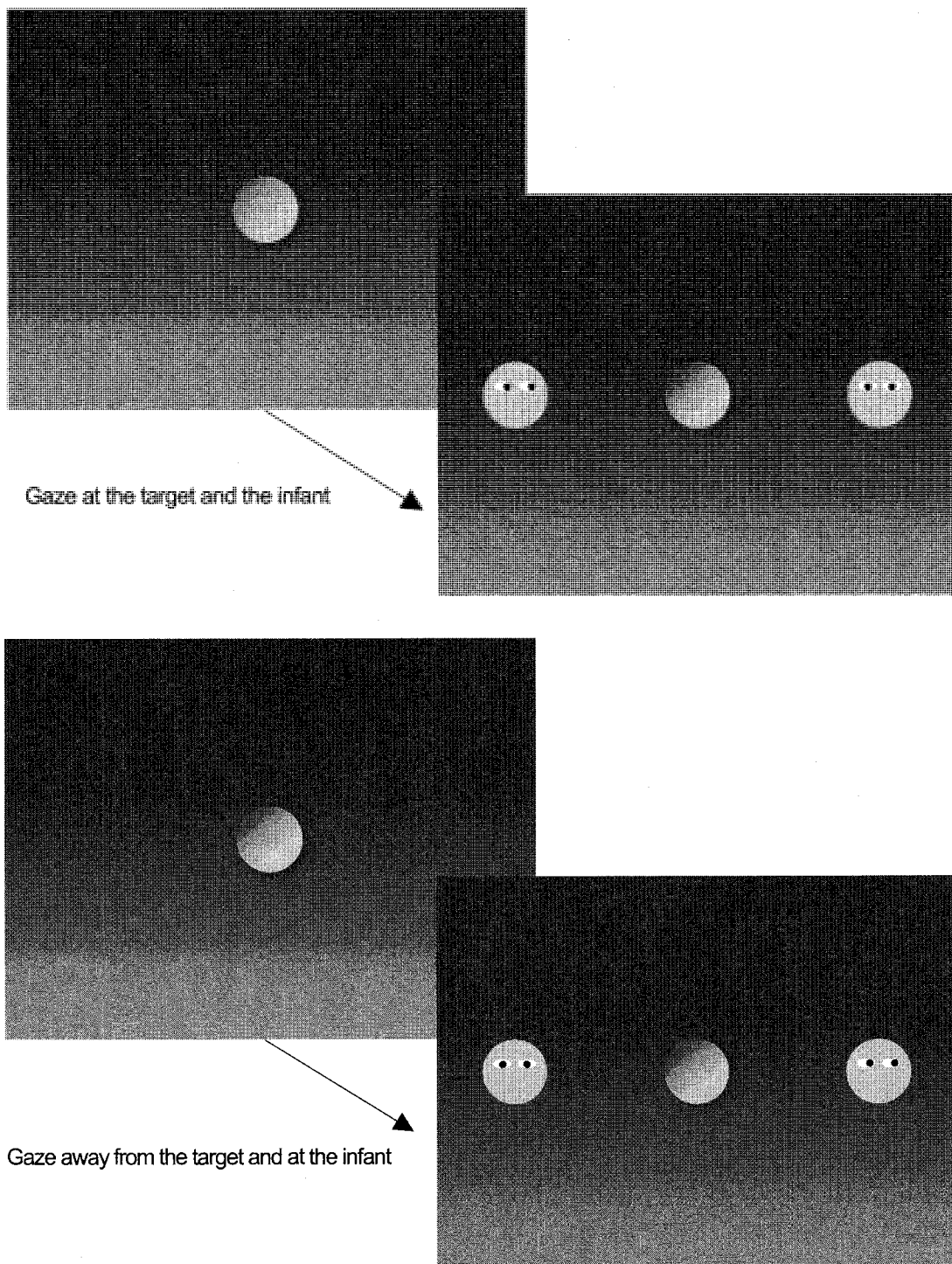


Figure 1 The stimuli used for the experiment

2.3 Procedure

The infant and their parent were invited into the experimental setting that was located in a quiet room. The infant sat on the parent's lap facing the monitor screen. One of the blocks was presented to the infant. In this way, all the infants had two conditions, one with a face looking at and the other with a face looking away from the target object.

2.4 Data analysis

The infant's gaze direction was assessed frame by frame. Total number of frames (a frame duration is 33.3 milliseconds) for which the infants looked at either of the two schematic faces was counted. In addition to looking at the two schematic faces, the infant also looked at the object in the centre, closed their eyes and turned their head away from the screen. These durations were also coded, but were not considered relevant for this study.

3. Results

The duration that the infants looked (number of frames) towards each of the two schematic faces were compared. Initially, the 4 youngest infants (age ≤ 7 months) were excluded from the analysis. However, as the results were similar when this group was included and excluded, it was decided to include them in the main group and carry out one set of analysis.

For each of the conditions, a paired sample t-test was carried out. The mean and standard errors for infants 'looking time', as a function of the direction of gaze of the schematic faces are presented in Figure 2 and 3.

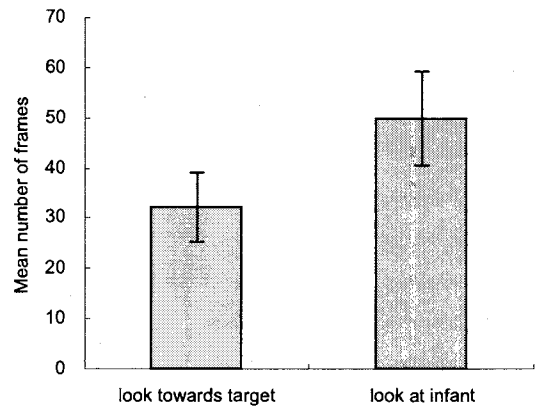


Figure 2 The mean and standard errors for the infant's looking time at the schematic faces that were either looking at the target or at the infant

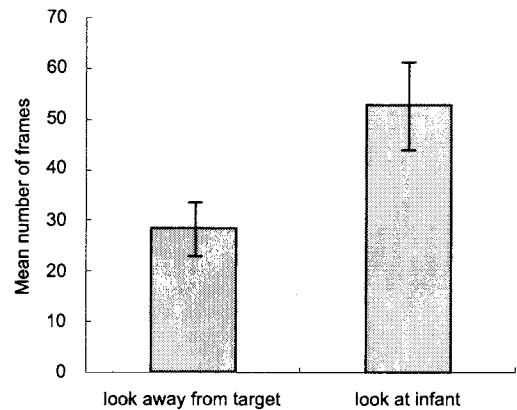


Figure 3 The mean and standard errors for the infant's looking time at the schematic faces that were either looking away from the target or at the infant

For the condition in which one schematic face was looking at the same object that the infant was looking at and the other schematic face was looking at the infant, no significant difference was found between the duration for which the infant looked at either face, (Fig. 2).

Although the duration for which the infant looked at the face looking at them was longer than for the face looking at the object, no

significant preference was found for this sample size: $t(19)=1.24$, ns.

For the condition in which one schematic face was looking away from the object that infant was looking at and the other face was looking at the infant, there was a significant difference between the durations for which the infant looked at each face (Fig.3). Infants looked longer at the schematic face that is looking at them: $t(19)=2.13$, $p<.05$. This result suggests that infants prefer to look at a face that is looking at them, rather than at the face looking away from the object.

4. Discussion

This study examined young infants' understanding of another's attentional gaze, as a precursor to early joint attention. In order to form full-fledged joint attention, infants need to have an understanding of others as psychological agents like themselves (Tomasello, 1999; M. Tomasello, 1995). This ability was assessed in an experimental setting by comparing two different directions of a gaze. The hypothesis of this study was that for an infant to have an explicit understanding of others as psychological agents, they must realize and show an interest in the face that is looking at the same agent or object that they are looking at. In other words, if infants have this social-cognitive understanding, then they would look at the face that is looking at the same object as them for a longer period of time than another face. Infants' preference to this particular situational gaze was compared with a gaze directed towards the infant and a gaze directed away from the object and the infant.

No significant difference was found between the infants' looking time between the faces with a gaze at the target object and a gaze at the infant. Although the mean duration of time spent looking at the face gazing at the infant was longer than for the other face, for this sample it is possible to say that, statistically the infants made no preference. This finding is very interesting with reference to previous findings. Previous studies (Farroni et al., 2002; Farroni, Johnson et al., 2004; Farroni, Menon, & Johnson, 2006) examined infants' preference for direction of gaze by comparing faces with a gaze directed to or averted from the infants and found that infants preferred to look at the face which gazed at them. This study compared two faces that were likely to be preferred by the infants. Therefore, as there is no statistical difference in looking time between these stimuli, this indicates that infants are interested in both the face that looks at the target and the face looking at them.

This argument could be supported by the second condition in which the duration of time for which the infants looked and a face gazing at them was compared to a face looking away from the object and away for them. In this condition, the infants preferred to spend a significantly longer time looking at the face that gazed at them. Therefore, the infants in this study can discriminate between the faces with a different direction of gaze. Taken together, it is possible to say that infants are sensitive to the direction of gaze and that this understanding extends to the case where another is looking at the same object as them. This could be a reflection of an understanding of others

as intentional agents like themselves.

Several points can be addressed by further investigations. As indicated earlier, the results are still preliminarily. In a study with more careful control of ages, it could be possible to study different age groups to identify the point at which infants start to understand another's intentionality. A study with more participants could also show other statistically significant aspects of young children's understanding of another's gaze. The stimuli could also be amended. The infants may find it difficult to interpret the salient features of the schematic faces. It may be more effective to create the stimuli from photo based human faces with different directions of eye gaze. Nevertheless, the infants were able to show some understanding of mutual interest between others and themselves.

References

- Akhter, N., Dunham, F., & Dunham, P. J. (1991). Directive interactions and early vocabulary development: the role of joint attentional focus. *Journal of Child Language*, *18*, 41-49.
- Baldwin, D. A. (1995). Understanding the link between joint attention and Language. In K. M. Moore & P. J. Dunham (Eds.), *Joint attention* (pp. 131-158). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Baron-Cohen, S. (1991). Precursors to a theory of mind: Understanding attention in others. In A. Whiten (Ed.), *Natural theories of mind: The evolution, development and simulation of everyday mindreading* (pp. 233-251). Oxford: Basil Blackwell.
- 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*(255).
- Farroni, T., Csibra, G., Simon, F., & Johnson, M. H. (2002). Eye contact detection in human from birth. *Proceedings of the National Academy of Sciences*, *99*, 9602-9605.
- Farroni, T., Johnson, M. H., & Csibra, G. (2004). Mechanisms of eye gaze perception during infancy. *Journal of Cognitive Neuroscience*, *16*, 1320-1326.
- Farroni, T., Massaccesi, S., Pividori, D., & Johnson, M. H. (2004). Gaze Following in Newborns. *Infancy*, *5*(1), 39-60.
- Farroni, T., Menon, E., & Johnson, M. H. (2006). Factors influencing newborns' preference for faces with eye contact. *Journal of Experimental Child Psychology*, *95*(4), 298-308.
- Flom, R., & Pick, A. D. (2005). Experimenter affective expression and gaze following in 7-month-olds. *Infancy*, *7*, 207-218.
- Frischen, A., Bayliss, A. P., & Tipper, S. P. (2007). Gaze Cueing of Attention: Visual Attention, Social Cognition, and Individual Differences. *Psychological Bulletin*, *133*(4), 694-724.
- Moll, H., & Tomasello, M. (2004). 12- and 18-month-old infants follow gaze to spaces behind barriers. *Developmental Science*, *7*, F1-F9.
- Saxon, T. F., Frick, J. E., & Colombo, J. (1997). A Longitudinal Study of Maternal Interaction Styles and Infant Visual Attention. *Merrill-Palmer Quarterly*, *43*(1), 48-66.
- Striano, T., & Bertin, E. (2005). Relations among joint attentional skills in 5- to 10- months-old infants. *British Journal of Developmental Psychology*, *23*, 1-11.
- Symons, L. A., Hains, S. M. J., & Muir, D. W. (1998). Look at me: five-month-old infants' sensitivity to very small deviations in eye-gaze during social interactions. *Infant Behavior and Development*, *21*, 531-536.
- Tomasello, M. (1999). *The Cultural Origins of Human Cognition*. London: Harvard University Press.
- Tomasello, M. (1995). Joint attention as social cognition. In K. M. Moore & P. J. Dunham (Eds.), *Joint Attention* (pp. 103-130). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Tomasello, M., Carpenter, M., Call, J., Behne, T., &

- Moll, H. (2005). Understanding and sharing intentions: the origins of cultural cognition. *Behavioral and brain sciences*, 28, 675-735.
- Tomasello, M., & Farrar, M. J. (1986). Joint attention and early language. *Child Development*, 57, 1454-1463.
- Tomasello, M., & Todd, M. (1983). Joint attention and lexical acquisition style. *First Language*, 4, 169-176.