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JOINT ATTENTION AS A SYSTEM PROPERTY OF THE INFANT-CAREGIVER INTERACTION SYSTEM

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Abstract

The development of visual joint attention has been examined almost exclusively from the point of view of the infant's capacity. Researchers have focused on issues such as its developmental origins and timing, its implications for the development of social cognition, and the possible mechanisms for the changing patterns of joint attention. However, this approach does not reveal how this skill emerges from the infant's interaction with the caregiver. In this paper, joint attention is viewed as an interaction state achieved by the infant and the caregiver system. The development of this state is described first as led by the caregiver monitoring the attention of the infant and overcoming the spatial constraints. As the infant becomes able to control his posture and to respond to caregiver's attention getting bids, caregiver begins to introduce objects and their manipulations, thus extending the frame of joint attention. With the emergence of language and narratives, the 'window' of joint attention opens to include events beyond the here and now. The interaction system gradually overcomes the temporal constraints. The last stage of development sees the infant actively taking over the role of the caregiver by initiating attention getting. A full-fledge joint attention is characterized by the dyad's having overcome both the spatial and the temporal constraints.

Key Words : gaze following, joint attention, caregiver's role, spatial constraints, temporal constraints.

Introduction

At the end of the first year, an infant begins to be able to engage in an interaction involving the caregiver, an object and him(her)self. In this so-called 'triangular relationship', the infant's attention and behavior to the object have to be coordinated with the attention and behavior of the caregiver. It is considered an important step for the infant to be able to coordinate his(her) own gaze according to that of the caregiver. Although parents have long known about this, Scaife & Bruner first demonstrated the young infant's gaze following in 1975. This ability to follow the gaze of the other has been recognized as an important basic skill for many future developments, such as the development of deictic gestures (e.g., finger pointing), and acquisition of language, and theory of mind (Asao, 1992; Bakeman & Adamson, 1984; Baldwin, 1995; Bruner, 1983, Butterworth, 1995; Yamada, 1987; Muto, 1994). While in later researches, scholars have referred to gaze-following by using the term visual joint attention, later research has subsequently encouraged the demonstrations of other joint attention phenomena such as, social refer-

encing, early protocommunicative gestures, imitation, and early productive language (Bruner, 1995:1-14).

Current Emphasis on Individual Ability

For developmentalist, one of the first natural questions to ask about joint attention is the timing of its ontogenetic appearance and its developmental sequences. Indeed, researchers following Scaife & Bruner's paper asked these central questions. Butterworth, for example, conducted observations in the laboratory with infants from 6 to 18 months of age with their mothers in order to find out when young infants begin to look where the adult looks (Butterworth & Cochran, 1980). Other investigators such as Corkum & Moore, Baron-Cohen, and Tomasello continued this line of research, with little reference to the caregiver's role in the construction of joint attention (Corkum & Moore, 1995:64-65; Baron-Cohen, 1995a:43,1995b; Tomasello, 1995:124-125). One implication of this emphasis on the origins and the timing of development of individual skill is the neglect of how it emerges from dyadic interaction. Furthermore, because the appearance of gaze following, or visual joint attention behavior alone, does not guarantee the intersubjective mutual understanding of the dyad, the individual ability perspective does not help researchers asking questions which lead to understanding joint attention as a significant cultural activity.

In addition to examining the accuracy with which infants of different ages could localize the targets of another's attention, Butterworth and colleagues suggested three mechanisms, ecological mechanism, geometric mechanism, and representational mechanism, for accounting the developmental patterns of infants' joint attention behavior. According to Butterworth, while infants before 6 months are not able to look to the direction of the adult's orientation, at 6 months they look to the correct side of the room, although precise location specification was not achieved. The first stage is achieved by the change in the mother's gaze serving as an orienting signal specifying the direction for the infant to look while the interesting object completes the communicative link with the adult to specify the position at which to look (Butterworth, 1995:32). Then at 12 months, infants begin to be able to localize the target identified by the adult's gaze, even when there are more than one object along the infant's scan path. This second stage is achieved by the infants seemingly extrapolating an invisible line between the mother and the referent of her gaze, as plotted from the infant's position (Butterworth, 1995:32). At 18 months, with access of representational space, infants are able to follow the adults' gaze (Butterworth, 1995:32-33).

Corkum & Moor, on the other hand, set out to find out what cues or behaviors are important for establishing joint visual attention for young infants. Especially, they proposed to examine the developmental changes in the social cues that infants rely on for establishing joint visual attention (Corkum & Moore, 1995:64-65). Adopting conditioned head turn paradigm, they concluded that the onset of joint visual attention is around 10-12 months, considerably later than what had been suggested earlier (Corkum & Moore, 1995:78). They also suggested that learning, in terms of contingent feedback of the adult, is a possible route of acquisition for the joint attention response (Corkum & Moore, 1995:81).

These researches, ranging from that of Scaife & Bruner to that of Corkum & Moore, have examined the origin of joint visual attention from the viewpoint of the development of individual ability, i.e., an ontogenetic viewpoint. Baron-Cohen, on the other hand, has approached it from a evolutionary psychology point of view (Baron-Cohen, 1995a:43,1995b). He hypothesized that during evolution, because of their considerable adaptive significance, three neurocognitive systems, the Eye Direction Detector (EDD), the Shared Attention Mechanism(SAM), and the Theory of Mind Mechanism (ToMM) emerged. Instead of trying to identify the origin of these mechanisms in individuals, he emphasized the evolutionary, and the neurophysiological foundations of these mechanisms. He emphasized that the lack of joint attention behaviors among children with autism could be attributed to the dissociation between EDD and SAM, the former mechanism appears to be intact while the latter mechanism is impaired (Baron-Cohen, 1995a:43; 1995b).

These previous researches share another commonality in their general view about the nature of joint (visual) attention, namely, that joint attention is an aspect of individual ability, capable of being investigated independent of the caregiver. Tomasello pointed out that if we take seriously the notion of joint attention, we must stipulate the existence of two persons attending to the same aspect of their common environment. He emphasized the need of both participants being monitoring the other's attention to the outside entity as a true criterion for joint attention (Tomasello, 1995:106). He argues that the above implies an understanding of the other participant not as an object or capturer of attention or potential punisher, but as a person who intentionally perceives a certain aspect of the environment that is the same as one's own, or could be made to be the same (Tomasello, 1995:107).

However, even Tomassello, who criticized all previous researches on joint attention for failing to recognize the underlying commonality among some of these skills, and for failing to recognize what he called the cognitive and social-cognitive bases of these behaviors has not gone beyond the individual infants, in the sense that he emphasizes the child's understanding of the adult's intention and not how the dyad as a system achieving the state of joint visual attention (Tomasello, 1995:124-125).

In this paper, we propose that the development of joint attention be examined from a dynamic systems point of view. We recognize the caregiver's intention to achieve joint attention even at the very beginning of her relationship with the infant. While a young infant has a very limited range of skills for interaction, the caregiver makes up a lot of the conditions necessary for achieving joint attention with the infant. She does different things according to the context of interaction and the developmental states of the infant. A full-blown joint attention only emerges from the dyad's overcoming first the spatial, then the temporal constraints, with the caregiver providing most of conditions first, and the infant taking over gradually. The purpose of this paper is to give an outline of the different phases of the development of joint attention, with an emphasis on the caregiver's scaffolding behaviors.

The Development of Joint Attention from Gaze Following to Conversation

Joint attention is a state of interaction which occurs frequently in everyday life.

Human social behaviors, particularly human communicative behaviors are basically based on the existence of joint attention among the participants. For example, when an object is handed to another person, or when an object is being referred to either by verbal expression or by fingerpointing, joint attention is a necessary condition for these acts to be meaningful. In these conditions, the target referred to does not have to be external physical object; it could be an idea or a concept. In conversation, when participants are commenting on the common topic(s), they are achieving a state of joint attention. The participants can achieve a state of joint attention even when one party has to be reminded of the existence or the relevance of an event, which was not in his/her mind up to that juncture. Indeed, as Bruner has pointed out recently, joint attentional episodes have a more general role in cultural poppsychology (Bruner, 1995; Tomasello, Kruger, & Ratner, 1993).

If during conversation one feels that the other is not understanding what one is trying to convey, that is to say, when a sense of failure in achieving joint attention with the other is felt, we try to change the language we use, perhaps by using a different metaphor, or by adding hand gestures or facial expression, etc. in order to orient the other to what we have in mind. In this case, we make use of the context, the presupposition and/or knowledge that we have shared so far as Bruner also points out (Bruner, 1995:6). Joint attention, in its most sophisticated form, goes beyond gaze following to joint participation in a common culture. Through joint attention, we learn by imitating new behaviors from a more expert other, we deliberately teach the novice. Joint attention is an important base for cultural learning.

Thus, in order to achieve joint attention at a more sophisticated level, both participants have to monitor the attention of the other, and to judge if the other is orienting his/her attention toward the same target. However, because the target of joint attention is not limited to concrete external object, it is necessary to pay attention not only to where the other looks, but also the manner, the order and timing of verbal and nonverbal expressions of the other. With young infants who lack such subtle means of linguistic expressions, caregivers depend very much on their gaze, gestures, postures, and emotional expressions in monitoring and directing their attention.

Characteristics of Early Joint Attention

In the interaction between a young infant and his/her caregiver, a preliminary stage of joint attention is often achieved by calling the infant's name, or by bringing her own face into the infant's visual field. When the infant looks at the caregiver, then she may show a toy within the visual field. Because of the infant's limited capacity in controlling her own postures and her own attention, caregiver of young infants often make up these constraints for the infants in order to achieve joint attention with them. In this way, even with very young infants, far younger than what most researchers so far would acknowledge as being capable of joint attention, caregiver can achieve joint attention with them. As infants develop, the compensations a caregiver usually does in order to achieve joint attention also change.

When an infant can sit by himself and can control his attention by turning his head or body to whatever attracts him, the caregiver would use more distant modes of atten-

tion getting, such as speech voice or sounds produced by object. An older infant also begins to use pointing gesture or voice to object not visible by the caregiver to achieve joint attention. Thus, the caregiver compensate whatever elements are lacking in the interactional system in order to achieve joint attention with the infant. Viewed from this perspective, early joint attention is a property of the infant-caregiver interactional system, rather than the result of the development of the joint attention skills of the infant alone as implied by most previous researches.

Joint Attention From A Dynamic Systems Viewpoint

From the above discussion, it is clear that the development of joint attention can not be understood by merely describing the behavioral or cognitive changes of the infants. To understand the development of joint attention, it is necessary to understand how, owing partly to infant's developmental changes in action and perception, the infant and the caregiver change their behaviors and their roles in relation to the other, when monitoring and controlling the other's attention toward a common target.

According to the ecological view for development, 'the extraction of information that specifies the world is ever changing and that our understanding of this change demands attention to the structure of the organism doing the perceiving as well as the structure of the information to be perceived, with changes in either structure resulting in perceptual reorganizations' (Cooper, 1997:58). The same view can be applied to the development of joint attention. In the course of development, in order to achieve the state of joint attention, the caregiver and the infant constitute a dynamic system in which both the specification of the infant's body (length, weight, and flexibility of different parts, etc.), as well as the information perceived/perceivable change also, resulting in and causing changes and reorganization in both the caregiver and the infant's action and perception. Joint attention is not the result of the infant's skills, it is rather, a specific state of interaction of the dynamic system whose components include the infant and the caregiver in their various conditions. The following is an outline of a dynamic systems view of the development of joint attention in early infancy.

Development of Joint Attention in A Dyadic Interaction System

(1) Overcoming the Spatial Constraints

As a perceiver and an interactor, a young infant undergoes a variety of developmental changes, such as in his/her visual function, memory, understanding of causal relationship, and posture control (Tsuneda & Chen, 2001). Particularly in the early months, infant's posture imposes great constraint on the interaction with the caregiver (Rochat, 1992). In order to interact with an infant too young to maintain a sitting posture, for an example, the caregiver tends either to backup the infant with her hand(s), put the infant in a reclining chair for baby, or lay the infant on its side. In other words, the caregiver has to adjust her posture in order to be en face with the infant. At around two months after birth, an infant can visually focus at the caregiver in front of him, or at an object shown to him by the caregiver. However, it is not yet possible for him to shift his look from the one to the other flexibly. This is partly due to the immaturity of the infant's nervous system (e.g., Matsuzawa & Shimojo, 1997). Nevertheless, the caregiver makes an

effort to achieve joint attention with the infant by doing various things to ‘make up for the infant’. The following is an episode from an observation carried out at the infant’s home, which illustrates this point.

Episode 1: Ah, you’re looking (2:14).

The infant was laid on a floor cushion (zabuton) supine, with his head turning to his left. The mother sat near his feet. She leaned over to look into his face.

Mother : “ Morning, H. ” She tried to make him look her way by calling his name. He moved his head several times, but was not looking at the mother.

Mother : “ Here, this side! ” She clicked her tongue. “ Where are you looking? ” The infant maintained looking to his left.

Mother : “ H. Are you there? Look this side! ” She tickled the right side of his cheek. “ Mr. H.! ” She called again. The infant made a small voice : “ Ah-e. ” She sat up and moved his feet from side to side.

Mother : “ Time for exercise. One, Two, Three. ” The infant remained looking toward his left. Mother stopped moving his feet.

Mother : “ H. What are you looking at? What are there so attractive? ” She peeked into his face, and extended her hand to reach for a rattle from a basket which was within his view. He looked at her arm which came into his sight.

Mother : “ Here! ” She shaked the rattle to attract him. He glanced at the rattle briefly, but turned his look back to the left side.

Mother : “ H! It’s here! ” Touching the right side of his cheek with the rattle, she said sigingly. He now looked at the mother. She immediately leaned herself toward him and move her face and upper body toward the infant’s right, as if trying to pull the infant to look at her.

Mother : “ This side! This side! ” He turned his head toward the right, and gazed at the mother. She shaked the rattle and he looked at the rattle briefly before looking at the mother’s face.

Mother : “ Ah, you’re looking, aren’t you? ” She shaked the rattle. He Looked away from her, returning to looking to his left.

Mother : “ Alah! ” She uttered a voice disappointingly.

(2) Balancing the Sitting Posture and Manipulating a Toy

Around 4 months after birth, infants become able to hold their head steady and are frequently made to assume sitting posture when awake. This is because the sitting posture allows the infants a much wider visual field than was possible when lying supine, and this helps to keep the infants in good mood for a more extended period of time, and to facilitate play interaction with the caregivers. This is the beginning of the so called triangle relationship (i.e., infant, mother, and the object). Owing to being gradually liberated from the grip of the visual target in previous period, infants become able to choose the object of looking, and to manipulate what is in sight and within reach. In addition, the infants also enlarge their field of peripheral attention. However, they still need help to maintain in sitting position, especially when they are manipulating object.

To make up conditions for achieving joint attention with infant in this developmen-

tal state, the caregiver makes use of a variety of methods for attention getting, such as adjusting the infant's postures, touching the infant's cheek, lightly stroking one side of the body, calling the infant in melodious tone of voice, bringing her face up into the infant's visual field, using attractive toys or objects, and so on. Once the infant looks at the caregiver, she also tries to maintain and to extend this "window" available for interaction by continuing the attention getting acts and by introducing an object.

Episode 2 : It's hard to grab (4:29)

The infant was made to sit, with floor cushions around him to keep him from collapsing. He needed constant readjustment to maintain sitting. His mother was sitting on her heels on the floor in front of him. She was trying to get a toy with a string out from the basket on her side. The infant watched intently at her mother's movement, while holding a rattle in his left hand.

Mother : " Fancy it? This. " She dangle the toy in front of him. He looked at the dangling toy and, from time to time, shaked and licked the rattle alternatively. The mother tried to attracting his attention by keeping the toy dangling. He banged the floor with his hands, with a tense expression and a frown, as if he was angry.

Mother : " Eh! " She uttered a sound, imitating the infant's expression, while she kept dangling the toy in front of him. He waved his arm with effort, unable to reach the toy. His upper body tilted.

Mother : " Eh? Are you all right? Not comfy? " She helped him sit up. she showed the toy again. He waved his arm with effort. Failing to reach the toy he threw the rattle on the floor. The mother moved the toy to him and touched his hand. Now he caught the toy and put it to his mouth and licked it.

Mother : " You gobbled it. " She pulled the toy up away from his mouth and dangled it in front of him. He caught it again and put it into his mouth again.

When the infant begins to follow the caregiver's movement actively and to focus on the object she is showing him, the first form of joint attention can be said to be achieved. With this, the caregiver's role in achieving this interactive state also changes. The caregiver is not only getting the infant's attention to the object she is showing, she also tries to monitor and direct his attention to how the object is to be manipulated, all at the same time. As was shown in the above episode, the mother sat the infant in a sitting position, maintained his posture by floor cushions, dangled the toy, vocalized, pulled the toy from his mouth, and touched his hand with the toy. In doing all these, two things are being achieved: (1) the caregiver extends the time frame of joint attention from a brief one of the infant looking either at the caregiver or the object, to a longer frame in which the attention of the infant shifts from the one to the other, often alternatively, (2) the caregiver conveys the structure of joint attention as being framed within the triangle relationship. The latter is usually achieved by the caregiver's differential expressions of looking; the 'attention getting' looking at the beginning, and the 'semi-intersubjective' looking after she makes sure that the infant seems to understand what she means and that she knows this. Nevertheless, infants around 6 months of age are still in a stage where they can only look at either the caregiver or the object, one at a time. The caregivers also tend

more frequently to elicit from their infants what Tomasello called “gaze alternation” (Tomasello, 1995). In addition, owing to infants’ development in memory retrieval, infants at this age are beginning to be seen shifting their gaze suddenly to a different direction, as if they are being reminded of something else than what they are engaged in. Caregivers tend to interpret this behavior as infants’ intention to express something, as illustrated in the following episode.

Episode 3: You want to say something? (5:13)

The infant was sat on an air cushion for children, while his mother sat in front of him, en face. The observer was video-recording their interaction in profile view.

The mother tried to wipe the infant’s mouth with a towel, but the infant avoided her by turning away and hitting the air cushion as if in protest.

While his face was being wiped, he looked at the camera and the mother from time to time. When she stopped wiping his face, the infant looked intently at the camera, with no movement nor vocalization. As the look was very intense, the observer chuckled. The infant looked at the observer and turned toward her with a smile, hitting the air cushion several times, as if he was happy about the observer’s chuckling comment on his hitting.

Mother : “ That bothers you most, doesn’t it. The camera. ” She was talking to him.

Then he looked at her, not smiling. She looked at him and said “ Ah! ” He then also uttered “ Ah! ” and hitting the cushion with his left hand, as if he is responding to the mother’s vocalization.

Mother : “ Ah! You understood, eh? ” She looked into his face. He looked away and vocalized “ Ahn! ” The mother imitated him. He looked at her and repeated the vocalization “ Ahn! ”

Mother : “ Ahn, ahn, ahn. ” Repeating the voice and nodding, she took his hands in hers and brought her face near him.

Mother: “ You want to say something? Tell me! What’s in your mind? ” She talked to him softly. He then turned his face toward the observer, smiling, and said “ Eh, eh. ” The mother imitated the infant’s vocalization while making another attempt to wipe his face with a towel.

In this episode, the infant first showed an interest (concern) in the camera and the observer by looking intently at them, and at the mother from time to time. The caregiver was watching at all this. A state of joint attention can be said to have been achieved by the caregiver and the infant. Furthermore, the joint attention then led to the caregiver’s interpreting the infant’s behavior as showing an intention for expression.

(3) Extending the Interaction Window

When mutual gazing becomes available more frequently, the the caregiver begins to extend the window for interaction by immediately changing her behavior from attention getting to object manipulating. This is often carried out within a zone very near her face, with constant monitoring of the infant’s attention, as seen in the next episode.

Episode 4: Ahoy! Here It Goes! (12:26)

Mother sat on her heels at the center of the room, and the infant stood by her.

The observer was about 2m away from them, facing the mother. The infant looked at the observer, with concern. The mother put a piece of building block into a cylinder and shaked it, producing a rattling sound to attract the infant. Upon hearing the sound, the infant turned back and looked at the cylinder. The mother tilted the cylinder and let the block piece slide down the cylinder toward the infant. The infant looked at the block piece, picked it up and put it back into the cylinder, and looked at the observer. The mother repeated the tilting act, uttering something. The infant looked back toward his mother and stared at the building block. He took it out of the cylinder and then put it back.

Mother : " Ahoy! Here it goes! " She tilted the cylinder and let the block piece slide toward the infant again.

Mother: " There it goes again! " When this was repeated once more, the infant cried out " Ah! " and looked to the observer. The building block fell on the floor.

Mother : " It dropped! " The infant looked at the block piece on the floor and picked it up. She asked the infant to put it back, and he diso.

Mother : " Look! " She tilted the cylinder toward herself. The infant looked at her, expectingly. Mother " It came this way. This way. " She then tilted it toward the infant and said " There! " They repeated this sequence four more times.

(4). Overcoming Temporal Constraints: Attending to Past Event

Most infants older than 12 months are self-locomotors, their ability in posture control allows them to orient to stimulus of interest actively. They are also able to monitor their caregivers' attention during interaction. While for the infants, gaze has been a means of looking (gaze as perception), now it assumes the new meaning of expression (gaze as communication).

Episode 5: Bidding farewell (14:21)

The mother sat on her heels at the center of the room. The child stood by her. They had been reading a picture book together. The child walked away from his mother with the book toward one corner of the room where he put the book into a handbag on the floor which belonged to the observer.

Mother : " Want to put it away? You do. Then, there! " The child looked at her.

Mother : " Right?! " They gazed at each other. The child began to take the book out of the handbag.

Mother : " Don't get the other thing out. " She was monitoring what he did.

Mother : " Have you got it? Have you? " He was not being able to get the book out. She moved near the child to help. " There you are! " He received the book and thrust- ed it back to the handbag. He tried to get the book out again, while gazing at the mother.

Mother : " Have you got it? " She took the book out of the handbag and gave it to him saying " Here you are. " He took it and again put it back.

Mother : " You did it again. Oh, no! Let me get you a different bag. " She left for the

next room. He touched and groped about the handbag.

Mother : " There you are! Your bag. Put it in here. " He gazed at the new bag.

Mother : " In it goes. The tramcar (book) in here. " She pointed at the book. The child looked at the book and took it. She opened the bag and made it easy for him to put the book in. He looked at the bag but no action. Instead, he took a pockbook out of the bag.

Mother : " There it goes. I did it. " She put the book into the bag. He looked at all this and then put the pockbook into the bag.

Mother : " Want to put the phone? The mobile phone? " She put the toy phone in. He looked at the mother's hand movements.

Mother : " There! Want me to put it on your shoulder? There! " She put the strap across his chest. He smiled and began to walk about.

Mother : " Itterasshai! " She pretended the farewell-bidding ritual playfully. The child walked about the room and found a toy car at one corner and began to play with it.

Mother : " Do you go with your car? " He put down the toy car and walked about.

Mother : " Itterasshai! " She waved her hand to him. He looked at her and then walked toward the entrance. He tried to open the door leading to the entrance. Mother : " You really want to go out, eh? " He tried hard at opening the door. Mother : " Want to open it? O.K. " She moved near to the door and opened it for him. He passed the door and walked toward the entrance and gazed at the shoes. He then turned around slowly and walked back to the room saying " Damma, (I am home) " raising his hand, smiling. He looked at the observer and the mother much pleased. Mother : " Welcome home! " She gazed at the child and smiled.

Some Theoretical Hypotheses

(1) *The Primacy of Looking.*

Joint attention begins as an unconscious act of the caregiver in seeking eye contact with the infant. A caregiver constantly monitors the state of the infant. When the infant is awake and quiet, she either leaves him alone, or she interacts with him, by talking to or looking at him. When the infant is awake but fussing or crying, she tries to alter his behavioral state by holding him up or getting his attention by calling his name or showing her face. The first stage of joint attention is achieved by the caregiver getting the visual attention of the infant. She is satisfied by the infant's looking at her, no matter how fleeting the mutual gaze is. Although the gaze of the caregiver does not seem to generate much emotional excitement in the infants during the first weeks, at two months, it elicits social smile from the infants. This smiling response of the infant further encourages the caregiver to keep eliciting the response from the infant in later months. Although looking remains important for mutual understanding for the rest of one's life, a sophisticated form of joint attention goes beyond the visual mode. The primacy of looking in joint attention can better be appreciated by examining the development of joint attention behaviors in dyads with deficits in visual function.

(2) *Spatial and Temporal Constraints.*

There are spatial and temporal constraints the infant-caregiver interaction system

has to overcome in order to achieve joint attention. The spatial constraints arise from the infant's limitation in controlling his posture and in maintaining attention on a target. During the early months, visual attention can only be achieved within a relatively narrow cone-shaped zone, projecting from the infant's upper body. The caregiver plays an important role in making sure that the target of attention is posited within this zone. This zone enlarges as infant develops. The caregiver varies what she does as this zone changes. The caregiver sometimes has to fall back to an earlier strategy, if the system's conditions are being compromised by the infant's emotional states, such as fussiness or drowsiness.

The temporal constraints arises from the limitedness in infant's memory and knowledge. However, as infant develops, the 'here-and-now' mode extends to include the past and the future (Donaldson, 1985). The extension of the infant's mode of operation benefits from engagement in narrative activities with the caregiver (Siegel, 1999:60-64). How the caregiver first cope with, then extend, the infant's limitedness in the mode of operation need to be uncovered before the achievement of joint attention can be more fully understood.

The details of the caregiver's strategies in first overcoming the spatial, and then the temporal constraints in achieving a more sophisticated form of joint attention will reveal the processes of the system in constructing a fuller mutual understanding. The behavioral sequences of interaction between the caregiver and the infant should provide clues for designing better programs in helping dyads with special needs.

(3) *Beyond Gaze Following.*

In research literature, the term 'joint attention' has been used in a loose way, ranging from meaning the gaze following behavior(gazing as perception) to a more sophisticated form of joint attention with intersubjectivity.

The same gaze following behavior can sometimes have the meaning of mutual understanding (gazing as expression/communication), especially when the gaze to the target is further followed by a look back to the directing face, and with a smile of understanding. Although children with autism are said to be able to follow the direction of other's gaze, it is rarely that they further look back to the directing face, let alone doing so with a smile (Beppu, 2001).

Conclusion

Joint attention, considered from a process (developmental) point of view, consists of behaviors of both the caregiver and the infant. It first appears as the caregiver's intention to obtain visual attention from the infant. In the early months, caregiver has to do most of the monitoring, positioning, attention getting, extending the window of attention, manipulating, and distancing the object from herself. In other words, the first task for the caregiver is to overcome the spatial constraints of the interaction system. In subsequent months, when joint attention begins to take place away from the 'here and now', with invisible target becoming the focus of attention, the dyadic interaction system is said to have overcome the temporal constraints, entering the realm of a more sophisticated joint attention, which is the hallmark of genuine human mutual understanding, as celebrated in many literary works.

By approaching joint attention from a dynamic systems perspective, not only important concrete research questions can be formulated, theoretical hypotheses can also be generated, thus leading to a bettering understanding of the process of its development.

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