Original Article

Directing and Maintaining Attention in Mother–Infant Interaction on Infants With and Without Autism Spectrum Disorder

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This study investigated how mothers, during face-to-face interaction with their infants, direct their infants’ attention. Mothers’ behaviors were measured by the frequency and type (e.g., directing vs. maintaining attention) as well as patterns of infant-directed speech (IDS) in two semi-structured conditions (e.g., eating vs. play), comparing the responses of seven infants with autism spectrum disorder (ASD) and eight infants with typical development (TD). Results showed that the mothers of infants with ASD showed ostensive cues more frequently, while the mothers of infants with TD maintained attention more frequently. Furthermore, the average tone pitch of mothers’ voices giving ostensive cue in both groups was higher in the play condition than that of the eating condition. The average tone pitch of mothers was not different between groups. The mothers’ behavior may have changed according to the characteristics of their infants and the context in which the interaction occurred.

Key Words: ostensive cue, maintaining attention, mother–infant interaction, autism spectrum disorder

Introduction

Adults’ behaviors toward infants, such as making eye contact or calling out the infant’s name, are known to be an important factor in mother–infant interactions across cultures (Csibra, 2010; Csibra & Gergely, 2009). Infant-directed speech (IDS; e.g., Fernald, 1985; Stern, Spieker, & MacKain, 1982) and infant-directed action (IDA; e.g., Brand, Baldwin, & Ashburn, 2002; Koterba & Iverson, 2009) have recently become a renewed focus as specialized cues that capture infants’ attention. These behaviors, collectively called “ostensive cues,” indicate the overt communicative intention to manifest new and relevant information, according to the theory of “Natural Pedagogy” (Csibra & Gergely, 2006, 2009) to which human infants are adapted in order to spontaneously and quickly transfer relevant cultural knowledge through a human social learning system.

Infants with autism spectrum disorder (ASD) are known to have difficulty in social interactions and communication, such as orienting to their name, looking at the faces of others, joint attention, and affect sharing (e.g., Baranek, 1999; Stone, Ousley, Yoder, Hogan, & Hepburn, 1997; Wetherby, Woods, Allen, Cleary, Dickinson, & Load, 2004). In order to examine the sensitivity to ostensive cues in ASD, Shizawa, Sanefuji, and Mohri (2012) first investigated the frequency and types of mothers’ cues in two semi-structured conditions (play vs. eating), using two stimuli (likes vs. dislikes) simultaneously; then, they compared an infant with ASD and an infant with typical development (TD). The results showed that ostensive cues were observed more frequently in the play condition and toward infants’ dislikes. Different types of mothers’ cues were chosen and used according to characteristics of ASD and TD infants, but replication of the findings using more samples is required because it was a case study.

During mother–infant interactions, IDS and IDA are used not only for highlighting new information and directing infants’ attention, that is, as ostensive cues (Csibra, 2010; Fisher & Tokura, 1995), but also for maintaining infants’ attention (Fernald & Simon, 1984; Masataka, 1992). Maternal references to objects
that the infant has already focused on could maintain and promote further attention (e.g., Bakeman & Adamson, 1984). In fact, it is suggested that maintaining attention is associated with social cognitive learning in infants (Tomasello & Farrar, 1986). Considering the difficulty in sharing attention in infants with ASD, their mothers may need to use ostensive cues more frequently, rather than for maintaining infants’ attention. However, how the mothers of infants with ASD use ostensive cues and/or maintain attention during interaction is not yet clear. Additionally, with regard to IDS, the pitch is affected by the meaning of the word and speech partner (Masataka, 1993). Thus, by using the pitch as an objective indicator, more detailed IDS could be explored, especially in changing the tone pitch of mothers’ utterances according to the situation and context.

Therefore, in the present study we have aimed to extend previous findings, specifically in two ways. First, we investigated whether or not mothers of infants with ASD use ostensive cues more frequently than they maintain their infants’ attention, compared to the mothers of infants with TD. Second, we assessed IDS patterns, especially pitch contour, comparing mothers of infants with ASD and infants with TD between both the eating and play condition.

Method

Participants

Seventeen infants, including eight infants with ASD and nine infants with TD, and their mothers participated in this study. Two infants (one with ASD and one with TD) were excluded from the analyses because they moved outside the observable area for the majority of the session. Thus, the final sample comprised of seven infants with ASD (Mean ages=22.6 months, SD=3.0 months; six males, one female) and eight infants with TD (Mean ages=20.3 months, SD=2.4 months; seven males, one female) and their mothers. Based on the Autism Diagnostic Observation Schedule (ADOS; Lord, Risi, Lambrecht, Cook, Jr., Leventhal, DiLavore, Pickles, & Rutter, 2000), among the seven infants with ASD, one infant was judged to have autism, and six infants were judged to have autism spectrum.

Informed consent was written by all caretakers, and this study was approved by the Institutional Review Board for Clinical Research at Osaka University Hospital.

Setting

The study was conducted in either a quiet, plain-looking room in university or community centers in areas where participants lived. Inside the room were a rectangular table, a chair for the infant, two video cameras (Sony HDR-CX700V) and Linear PCM recorder (Sony PCM-D50) with an electret condenser microphone (Sony ECM-MS957). One video camera was focused on the mother and the other on the infant. In addition, a microphone was placed on the floor approximately 30 cm from the mother.

Procedure

Each pair of participants was observed individually, and each pair sat facing each other diagonally at corners of the table. The infant was seated on the chair while the mother was seated on the floor.

The observation procedure consisted of two semi-structured conditions (play and eating). Each condition had two sessions (likes and dislikes). This was done to investigate more thoroughly the differences in behaviors toward likes or dislikes. Each session lasted a total of 3 min, the observational time when infants were within the observation area and recorded. The order of conditions and sessions was counterbalanced across participants. Mothers were instructed to interact with their infants as naturally as possible. Moreover, we told mothers that if they feel challenged to continue the session, they could ask to terminate the session at any time. Actually, all participants completed the session without interrupting, and all mothers found no problem when we asked how they feel after the session. Details for each condition were as follows.

In the play condition, two toys were brought from home by the mother. One was a toy the infant liked, and the other was a toy that the infant disliked, based on the judgment of the mother. Either one of the two toys was placed in front of the infant on the table. If her infant did not want to play with the toy, the mother would encourage her infant to become interested in it, but she would not force the infant to play with it. After approximately 3 min, the toy was replaced, and then the mother played with her infant in the same way.

In the eating condition, two types of food were prepared and brought by the infant’s mother. Just as
in the play condition, one was food that the infant liked, and the other was food that the infant disliked, based on the judgment of the mother. Either one of the two foods was placed on the table in the same way as toys were placed in the play condition. If the infant did not want to eat, the mother would attempt to feed her infant, but she would not force the infant to swallow the food. After approximately 3 min, the food was replaced, and then the mother began feeding her infant in the same way. In reality, all mothers behaved calmly to their infants when they attempted to direct their infants’ attention in both conditions.

Sampling and Analysis

All mothers’ behaviors and infants’ responses to cues during each session were coded from the audio and video data. If infants moved outside the observable area, those times were excluded from the analysis. However, if infants moved around in the observable area, those times were included in the analysis. Analysis time was almost the same length across the participants (see the details in Results). Because infants played and ate by themselves for the majority of the time in “like” sessions during both conditions, the number of mothers’ behaviors was 0, or rare. This was why only “dislike” sessions were analyzed. The coding categories were described as follows.

Mothers’ behaviors: Cues and maintaining attention

Mothers’ cues and maintaining attention in each condition were coded in six categories: IDS, call name, call object name, IDA, pointing, and eyebrow raise. Each category is defined as follows.

IDS is defined as the mother’s speech to her infant, characterized by a higher and broader pitch and amplitude variation (Fernald, 1985). For pitch contour classification of each mother’s utterances, average, range, and duration of the fundamental frequency (F0) were measured using interactive sound analysis software (the Cornell Bioacoustics Research Program, Raven Pro 1.3) with the low pass filtered 400 Hz (Fernald, 1985). Then, we coded IDS when the pitch was higher than the average F0 of mother’s voices when talking to the experimenter. In the case of continuous utterances, where it was difficult to determine the split-off point, the utterance was divided if there were pauses longer than one second and/or a complete sentence was formed (Reissland, Shepherd, & Stephenson, 1999). Call name refers to the behavior where the mother calls her infant by name. Call object name refers to the behavior where the mother calls the name of the object to which she would like to direct or maintain her infant’s attention. IDA is defined as the mother’s general actions in the context of using objects as demonstrations, especially considering the following six components: closer proximity to the partner, higher interactivity, more enthusiasm, simplified sequences, more repetition, and increased amplitude of movement (Brand, Baldwin, & Ashburn, 2002). Pointing is defined as the behavior where the mother points to an object with her index finger. Eyebrow raise refers to the behavior where the mother raises her eyebrows.

Mothers’ behaviors were recorded by the onset and offset times for all the categories in each condition according to the method of sampling all occurrences of behaviors (Altmann, 1974). Next, the number of times each behavior occurred was counted. If the mothers’ behaviors included multiple elements occurring simultaneously, all the overlapped elements were counted separately. For example, when a mother called the name of her infant in a high-pitched voice and emphasized intonation, it was coded as both call name and IDS. Additionally, these overlapped cues used in combination were redefined as segments of cues and were counted additionally. Finally, each mother’s behavior was separately coded by the occurrence of the infants’ behavior; the behaviors of the mother were coded as cues when directing her infant’s attention, whereas her behaviors after the infant directed attention once, or for maintaining her infant’s attention were coded as maintaining attention.

Infants’ responses to their mothers’ cues

Infants’ responses to each segment of cue from their mothers were divided into two categories: positive response and no response. The detailed procedure for coding each infant’s response is described as follows.

First, what the infant looked at (an object or his/her mother) and what the infant touched or ate in each condition were recorded by the onset and offset times. Next, on the basis of the infant’s behavior that was contiguous and contingent upon the mother’s cue, responses from each infant were categorized as either positive response or no response. Positive response is defined as a positive change in the infant’s behavior, which is determined by comparing the be-
behaviors before and after the mother’s cue. Conversely, no response is defined as a lack of change in the infant’s behavior. For example, while the infant did not play with a toy and did not ever look at it, the mother demonstrated how to play with a toy. If the infant then came to look at or play with a toy, the response was coded as positive response. On the other hand, if the infant still did not look at the toy after the mother’s actions, the response was coded as no response.

To ensure reliability, another coder independently coded 25% of the data. Inter-rater reliability was sufficient (kappa coefficients for all behaviors ranged from = 0.78 to 1.0).

Results

Analysis times
The median (interquartile range: IQR) of total analysis time in each session was 180.0 (180.0 to 197.3) s in infants with ASD and 180 (180.0 to 180.0) s in infants with TD; there was no significant difference in Mann–Whitney U test, exact test, U (n₁=7, n₂=8)=15.0, ns (two-tailed). Of those, the median (IQR) of time when infants were inside the observable area but moved around were 97.0 (18.8 to 153.3) s in infants with ASD and 0 (0 to 2.5) s in infants with TD; there was significant difference in Mann–Whitney U test, exact test, U (n₁=7, n₂=8)=5.5, p<.05 (two-tailed).

Mothers’ behavior: ASD versus TD
The number of segments of ostensive cues and mothers’ maintaining attention of infants with ASD was compared to that of the mothers of infants with TD in each condition. The mothers of infants with ASD used ostensive cues more frequently than the mothers of infants with TD, in both conditions (Table 1), eating: χ² (1, n=15)=43.7; play: χ² (1, n=15)=17.4, respectively, ps<.01. In other words, the mothers of infants with TD used maintaining attention more frequently in both conditions than the mothers of infants with ASD, and the difference in eating condition was more noticeable.

Specifically, each mother’s behavior in each condition was counted between mothers of infants with ASD and TD (Table 2, 3). Mothers of both groups used IDA and IDS frequently, whereas pointing and eyebrow raise was rarely observed. Comparing each mother’s behavior between groups, two-tailed Mann–Whitney U tests (exact test) showed significant differences in the frequency of IDS, U (n₁=7, n₂=8)=8.0, p<.05, and call name, U (n₁=7, n₂=8)=8.5, p<.05 as ostensive cue in the play condition. In the eating conditions, IDS as maintaining attention was significantly different, U (n₁=7, n₂=8)=6.0, p<.01. In contrast, in both conditions, there were no significant differences in frequency of IDA, call object name, pointing, and eyebrow raise between groups.

Pitch of Mothers’ Speech
Table 4 shows the median values of average F₀ of the mothers’ speech for each group in two conditions. There was no significant difference between the mothers of infants with ASD and TD in both conditions, Mann–Whitney U tests, exact test, U (n₁=7, n₂=8)=25; play=25, respectively, ns (two-tailed). As for the ostensive cue, comparing the conditions, median (IQR) values of average F₀ in the play condition (292.7 (281.8 to 321.0) Hz) was higher than in the eating condition (275.0 (267.9 to 293.9) Hz); Wilcoxon Signed-Rank Test, Matched Pairs, exact test, p<.05 (two-tailed).

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Number (%) of Segments of Mothers’ Behavior in Two Conditions</th>
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<tbody>
<tr>
<td></td>
<td>ASD Infant</td>
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<tr>
<td></td>
<td>Number (%)</td>
</tr>
<tr>
<td>Play condition</td>
<td></td>
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<tr>
<td>Ostensive cue</td>
<td>88 (39.5)</td>
</tr>
<tr>
<td>Maintaining attention</td>
<td>135 (60.5)</td>
</tr>
<tr>
<td>Eating condition</td>
<td></td>
</tr>
<tr>
<td>Ostensive cue</td>
<td>105 (61.4)</td>
</tr>
<tr>
<td>Maintaining attention</td>
<td>66 (38.6)</td>
</tr>
</tbody>
</table>

Note. ASD=Autism spectrum disorder; TD=Typical development.
Infants’ Responses to Mothers’ Cues

The responses of infants to their mothers’ cues were significantly different between infants with ASD and TD in the play condition (Table 5), \( \chi^2 (1, n=15)=4.5, p<.05; \) infants with ASD showed more no responses while infants with TD showed more positive responses. In the eating condition, however, there was no significance, \( \chi^2 (1, n=15)=3.2, ns. \)
The present study demonstrates that mothers showed differed frequencies of behavior in each group and condition in mother–infant interactions. Regarding the frequency of each mother’s behavior, IDS and IDA were used most frequently for directing infants’ attention, which corresponds with the previous study (Shizawa et al., 2012). In the present study, our results showed a similarity, as well as differences, between groups. Regarding similarity, IDA was not significantly different between infants with ASD and TD in both conditions. It is suggested that IDA is a useful cue for mothers of this age group regardless of the characteristics of infants. The following two differences were found: mother’s behaviors and responses of infants. The mothers of infants with ASD called names more frequently than mothers of infants with TD, which may be because infants with ASD moved around during observation longer than infants with TD. Infants with ASD in the play condition showed more no responses to mothers’ cues, as compared to infants with TD. This result is in line with the previous findings in which calling an infant’s name yielded fewer responses for infants with ASD (Stone et al., 1997). According to the characteristics of infants, mothers directing infants’ attention did not always establish a positive relationship to infants’ social behavior (Legerstee, Varghese, & van Beek, 2002).

The mothers of infants with ASD used ostensive cues more frequently, while the mothers of infants with TD maintained attention more frequently, especially in eating condition. It indicates that mothers of infants with ASD needed to encourage their infants to focus on objects and events, as compared to mothers of infants with TD, who needed to try to continue interaction. Because infants with ASD lack the skill of sharing attention (Mundy, Sigman, & Kasari, 1990; Stone et al., 1997), mothers may have to try repeatedly to direct infants’ attention. These results suggested that mothers selected and used either cues or maintaining attention, depending on the circumstances as interaction is established bi-directionally.

The average $F_0$ of mothers’ voices was not signifi-
significantly different between infants with ASD and TD. The average $F_0$ of mothers’ utterances as ostensive cue for both groups in the play condition was higher than that of the eating condition. In the play condition, mothers attempted to direct infants’ attention to the toy and to the mother herself, for triad communication. On the other hand, because the eating condition had a specific focus on feeding rather than on interaction, mothers might not need a higher tone of speech. This is why the mothers’ pitch may have increased naturally, as they strongly attempted to direct their infants’ attention toward objects in the play condition. IDS might have been used during these interactive strategies.

In short, our study demonstrated that the mothers’ behavior for directing infants’ attention may be selected and used according to the characteristics of their infants and the context of the interaction. In addition, we indicated that IDS as an ostensive cue was used as these mothers’ interactive strategies along with a degree of pitch that is adjusted accordingly. But it is still unclear how the qualitative differences such as the emphasis or pattern in IDS, IDA and other mother’s behaviors are affected on the infant’s responses. Future research may reveal more details of the effects of mother’s behaviors by adding more samples and analyses. In the present study, our participants were preverbal infants. As the features of mothers’ behaviors involved mostly nonverbal communication, mothers’ strategies during interactions with young children who can communicate using a language may be different. However, the impact of the development (including language) on the mothers’ behaviors during interaction is still unclear. Further research should focus on older children in order to investigate the effects of language acquisition or social cognitive development. Such studies will contribute to the better understanding of interaction with children. They would be helpful to mothers and therapists who need information about effective ways of directing and/or maintaining attention of children.

References


