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**Communicative interactions between visually impaired mothers and their sighted children:
analysis of gaze, facial expressions, voice and physical contacts**

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(Article begins on next page)

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Abstract

Background. Social and emotional development of infants and young children is largely based on the communicative interaction with their mother, or principal caretaker (Trevarthen 1984). The main modalities implied in this early communication are voice, facial expressions and gaze (Stern 1993). This study aims at analysing early mother-child interactions in the case of blind mothers, who do not have access to their children's gaze and facial expressions.

Methods. Spontaneous play interactions between seven blind mothers and their sighted children aged between 6 months and 3 years were filmed. These dyads were compared to a control group of sighted mothers and children analysing four modalities of communication and interaction regulation: gaze, physical contacts, verbal productions, facial expressions.

Results. The blind mothers' facial expressions differed from the ones of sighted mothers mainly with respect of forehead movements, leading to an impoverishment of conveyed meaning. Results regarding the other communicative modalities, suggest that blind mothers and their children use compensatory strategies to guaranty harmonic interaction despite the mother's handicap: whereas gaze results the main factor of interaction regulation in sighted dyads, physical contacts and verbal productions assume a prevalent role in dyads with blind mothers. Moreover, blind mother's children seem to be able to differentiate between their blind mother and sighted interaction partners, adapting differential modes of communication.

Conclusions. The results of this study appear to be encouraging for blind women who are, or desire to become mother, inasmuch as they show that, in spite of the obvious differences in the modes of communication, blindness does not prevent a harmonious interaction with the child.

Introduction

Trevarthen (1984) sustains that social and emotional development of infants and young children is largely based on the communicative interaction with their mother, or principal caretaker. The main modalities implied in this early communication are voice, facial expressions and gaze (Stern 1993). The present study aims at analysing early mother-child interactions in the case of blind mothers, who do not have access to their child's gaze and facial expressions.

Studies about early mother-child interaction where both partners are sighted show that children are motivated to communicate from birth (Trevarthen 1984), and display very early in life a considerable competence in the production and recognition of emotional expressions (Camras 1991; Walker-Andrews, Krogh-Jespersen, Mayhew & Coffield 2011). Mothers, for their part, are naturally prone to imitate positive expressions, and to comfort the child when he/she expresses negative feelings (Stern 1993). Moreover, being intuitively aware of the seductive power of their face, they frequently assume exaggerated expressions and tones of voice (Stern 1993). Normally, children respond positively to these maternal behaviours with smiles and vocalises. However, if the stimulation becomes too intense, they deviate gaze and, if the mother persists, show negative facial expressions or cry (Stern 1974). During the second half of the first year of life, the child and the caregiver begin to enact triadic exchanges which involve their mutual and coordinated focus of attention on a third object (Bakeman & Adamson 1984). For the establishment of these first episodes of joint attention, the caregiver's sensitivity and response-contingency are crucial (Mateus *et al.* 2013; Mendive *et al.* 2013); towards the end of the first year of life, the child begins to be able to start and coordinate him/herself episodes of joint attention, by using gaze, pointing gestures and facial expressions, to signal his/her intentions (Tomasello 1995, Liszkowski *et al.* 2007).

These findings highlight the fundamental role of the children's and caregivers' non-verbal behaviour in regulating early communicative interactions, thus it is pertinent to wonder what happens in the case of the interaction between a blind mother and her child? To our knowledge, there are only a few studies on this topic. Adamson *et al.* (1977), observing the interaction between

a blind mother and her sighted daughter during her first year of life, concluded that the mother, after initial difficulties, became able to use communicative modalities other than gaze, such as voice and touch, to interact with her child and guaranty reciprocity. Similar results were obtained by Collis and Bryant (1981), who observed the interactions between four blind parents (3 fathers, 1 mother) and their sighted children aged from 9 months to 2 years 9 months. A more recent study by Senju *et al.* (2013), showed that 5 children of blind mothers - aged from 6 months to 3 years 11 months - directed their gaze towards their mothers with a lower frequency and used vocal communication more frequently, than the children of the control group.

As far as we know, no quantitative comparative study assessed gaze, facial expressions, touch and vocal communication in early interactions between blind mothers and their sighted children. Based on this consideration, the present study aimed at addressing the following questions: 1) How the interaction between blind mothers and their sighted children is different from that of sighted dyads with respect to the following communication modalities: gaze, facial expression, vocal production, and touch? 2) Does the mother's blindness influence the child's expressive development?

To answer these questions, play interactions between blind mothers and their sighted children have been compared with play interactions of a control group.

Method

Participants

Seven blind or strongly visually impaired mothers and their first-born children aged between 6 months and 3 years participated in the study. They have been recruited by an announcement in the circular of the Italian Union of Blinds. These dyads were compared with a control group of seven couples of sighted mothers and children. The children of the two groups have been matched with respect to age and gender. All participating mother-child couples lived in the same household with the father of the child. None of the children frequented nursery school. Table 1 shows the main characteristics of the blind mothers and their children.

---- Insert Table 1 about here ----

Procedure

The observations took place at the participants' home according to the present general procedure. In a first time, the mothers were interviewed following a semi-standardized protocol of questions. The aim of this interview was twofold: collect biographical information and establish an atmosphere of confidence between the mother and the observer. After this interview, mothers were asked to sit in front of a table and to place their child on a high-chair or a normal chair in a right angle position with respect to herself. Then she was asked to play with her child as she would do in an everyday play interaction. In addition, some toys were at their disposal: rattles for the babies (6 months old), nesting cups and construction blocks for the older children. The play interactions lasted from 22 to 35 minutes.

Materials

To film the mother-child interactions, two cameras have been installed on tripods placed approximately 2 m away from the table where the mother and the child were playing. One camera framed the child's face and upper body, the other the mother's face and upper body. Synchronization of the two records was obtained by relying upon a flash, shot with a photo camera, before the interaction began. This flash was clearly visible and permitted to identify with precision one specific frame recorded at the same moment on the two video sequences.

Measures and coding procedure

The obtained video sequences have been analysed by coding the following modalities of verbal and non-verbal behaviour of the mothers and their children:

- Gaze: Duration and frequency of gazes were coded during the first 10 minutes of interaction distinguishing four categories: gaze directed towards the partner's the face, an object, the observer's face, or elsewhere.

- Facial expressions: The mothers' and children's facial expressions occurring during the first 3 minutes of interaction were coded by using FACS (Facial Action Coding System, Ekman &

Friesen, 1978a). By means of this coding system it is possible to attribute a numerical code to each single muscular movement of the face, the so-called Action Unit (AU). For example, AU4 describes the contraction of the *corrugator* resulting in a brow lower.

- Verbal and vocal productions: Duration and frequency of each speech act, including vocalizes and babblings of the babies have been coded during the first 5 minutes of interactions. Single speech acts were defined by audible pauses between vocalizations or verbalizations.

- Physical contacts: Duration and frequency of each contact between body parts of the two interaction partners were coded, including contacts mediated by an object (contact between hands when reaching for an object) during the first 10 minutes of interaction.

Coding of the facial expressions was done by a trained FACS user (last author), who had passed the final test as administered by the developers of FACS (Ekman & Friesen, 1978a). Gaze, verbal productions and physical contacts of each participant were analysed by one coder for the whole coding time for each modality, and by a second coder for 15 % of the time analysed for each communication modality. Intercoder agreements are reported in Table 2.

---- Insert Table 2 about here ----

Results

We first will present the results relative to each communication modality and then a particularly interesting single case will be described more in detail.

Gaze

As shown in Table 3, regarding the cumulative duration of the different categories of gaze direction, blind mothers showed a significantly higher duration of 'gaze directed towards the observer's face' and a tendency of higher duration of 'gaze directed elsewhere', compared to the sighted mothers. For the children, only one difference tended to be significant: blind mothers' children directed their gaze towards the observer's face for a longer time than sighted mothers' children did. More generally, results of cumulative gaze duration indicate that the mothers of both

groups mostly directed their gaze towards their child's face, whereas the children were principally centred on the object.

Regarding the frequency of gaze directions, sighted mothers directed their gaze significantly more frequently towards their child's face or an object, than blind mothers' did. The same phenomenon has been observed in the two groups of children: sighted mothers' children looked more frequently at both their mother's face and the object, than blind mothers' children did. These results indicate that in the dyads with sighted mothers, gaze direction changed much more often, switching between partner and object, than in the dyads with blind mothers. Mean duration of gaze directions was indeed longer in the dyads with blind mothers, compared to the dyads of the control group. Linked to these results, the mean frequency of reciprocal gazes, was significantly higher in the dyads with sighted mothers ($M = 69.7$, $SD = 26.9$), than in the dyads with blind mothers ($M = 33.3$, $SD = 27.7$, $t(12) = 2.49$, $p < .05$).

---- Insert Table 3 about here ----

Physical contacts

The interaction between blind mothers and their children was characterized by significantly more physical contacts ($M = 84.3$, $SD = 45.7$) than the one between sighted mothers and their children ($M = 44.6$, $SD = 14.71$, $t(12) = 2.19$, $p < .05$). Also cumulative durations of physical contacts tended to be higher in the dyads with blind mothers ($M = 148.4$ s, $SD = 98.3$ s) than in the control group ($M = 63.5$ s, $SD = 68.8$ s, $t(12) = 1.87$, $p = .086$).

Verbal productions

There was no difference with respect to the frequency of verbal productions neither between the two groups of mothers, nor between the two groups of children. On the contrary, regarding the duration of verbal productions, there was a tendency of the blind mothers' children to speak more: during the 5 minutes analysed, the mean duration of vocal productions of the blind mothers' children was 56 s ($SD = 40.5$ s), whereas the sighted mothers' children talked or vocalised during 30 s ($SD = 19.1$ s, $t(12) = 1.75$, $p = .10$). In particular, there were two rather extreme cases: the boy

of dyad 4, aged 2 years and 2 months talked during 2 minutes, and the boy of dyad 6, aged 2 years 11 months, talked during 1 minute 48 seconds, whereas the maximum for the sighted mothers' children was 59 seconds.

Facial expressions

The facial expressions of the blind mother of dyad 3 could not be analysed because her forehead was covered by fringes. Therefore, with respect to facial expressions, the results of six dyads with blind mothers and the corresponding control dyads will be presented.

Between the two groups of mothers, some differences emerged with respect to upper face movements, whereas lower face movements were very similar. As shown by the standard deviations, blind mothers produced either much less, or much more eyebrow raises (Sighted: $M = 9.8$, $SD = 1.1$; Blind: $M = 11.6$, $SD = 15.8$) and frowns (Sighted: $M = 2.0$, $SD = 2.0$; Blind: $M = 7.0$, $SD = 13.0$), than sighted mothers did. More specifically, two blind mothers raised very frequently their eyebrows (cf. Figure 1, blind mothers 4 and 5), whereas the other four blind mothers produced this movement never or only a few times. On the contrary, sighted mothers raised their eyebrows with a very similar frequency among them, ranging between 9 and 13 times during the 3 minutes analysed. The same occurred for the brow lower, which has been produced very often by the blind mothers of dyads 4 ($n = 33$) and 5 ($n = 9$), but never or almost never by the other blind mothers (from 0 to 2 times).

---- Insert Figure 1 about here ----

Regarding the children's expressions, blind mothers' children showed a tendency to imitate the rather extreme (very low or very high) frequencies of forehead movements produced by their mothers. Ordering mothers and children by the frequencies of these movements and computing Spearman rang correlations, a significant result for brow raise ($t(10) = 1.86$, $p < .05$), and a tendency for brow lower ($t(10) = 1.57$, $p = .087$), was observed.

Qualitative analysis of dyad 4

As anticipated, a particularly interesting single case will be described more in detail. Among the blind mothers, there is only one who is completely blind from birth. It's the mother of dyad 4 who produced the highest amount of eyebrow movements. As shown in Table 4, qualitative analysis of these movements suggests that they are mostly 'blindisms' (repetitive facial movements with no emotional or communicative meaning, Brambring & Tröster 1992), whereas only 1 of the 14 brow raises of the corresponding sighted mother could not be interpreted in terms of conversational or emotional meaning.

--- Insert Table 4 about here ---

The behaviour of the blind mother's son, who is a little older than 2 years, suggests that his mother's facial expressions convey little information for him. In fact, he practically never looked at his mother's face: only 4 times for a total duration of 5.2 s during the 10 minutes analysed. In comparison, the minimum cumulative gaze duration directed towards the mother in sighted mothers' children was 49 seconds, and in the blind mother' children, excluding this case, 23 seconds. Qualitative analysis of the mother's facial expressions showed that her face often conveyed contradictory information. For example, she frequently produced strong brow lowers simultaneously with smiles or positive verbal messages.

Yet, the interaction of this dyad seems not compromised and the analysis of the other communicative modalities can explain why. As mentioned above, the boy of this dyad talked more than all other children, continuously describing to his mother what he was doing. Furthermore, 161 physical contacts of a cumulative duration of 4 minutes and 36 s were observed for this dyad. In other words, during quasi half of the observational time, the partners of this dyad were in touch. This suggests that interaction regulation through gaze has been substituted by language and physical contacts, which beat the rhythm of interaction and probably are also used to transmit affective messages.

Discussion

Despite the small number of participants, some general tendencies emerged from this study. The upper face components of the facial expressions of blind mothers were only loosely related to the communicative context in which they were generated. The children tended to match both the high and low frequencies with which these components appeared in their mothers' face. However, unlike their mothers, their expressions were generally congruent with the associated communicative intentions. This suggests that children of blind mothers have the possibility to learn from sighted persons how to effectively use facial expressions with emotional as well as conversational functions. This possibility combined with the children's innate expressive competences (Galati, Sini, Schmidt & Tinti, 2003; Izard & Malatesta 1991), seems to permit an expressive development which is not negatively affected by the mother's blindness.

The analysis of the other communicative modalities showed that blind mothers and their children overcome the disability by adopting compensatory strategies in which physical contacts and verbal productions assume a more important, and qualitatively different, role. In particular, children are prompted to learn how to rely on other modalities of communication when they realize implicitly that the interaction with their mother cannot be regulated by gaze, and that her face not always conveys meaningful information. Moreover, they seem to be able to differentiate between their blind mother and sighted interaction partners, adapting differential modes of communication. One particular observation illustrates this point. The child of dyad 4 constructed a very high tower with the construction blocks. To show this achievement to his mother, he guided her hand on the top of the tower by saying "Look, how it is high". At the same time he faced the observer with a triumphant smile as children do when begging for compliments. Indeed, the observer could not prevent herself from exclaiming "Bravo!"

In conclusion, the results of this study appear to be encouraging for blind women who are, or desire to become mother, inasmuch as they suggest that, in spite of the obvious differences in the modes of communication, blindness does not prevent a harmonious interaction with the child, nor his/her normal expressive development.

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