Background: Successful communication with profoundly deaf children is heavily dependent on visual attention. Previous research has shown that mothers of deaf children – notably those who are deaf themselves – use a variety of strategies to gain their children’s attention. This study compares patterns of visual attention in deaf and hearing children to determine how they are affected by the absence of auditory cues, especially when looking to the mother’s face. Method: The visual attention of 18-month-old infants to their mothers was examined in two groups of deaf children (6 with deaf mothers and 6 with hearing mothers) and two of hearing children (6 with deaf mothers and 8 with hearing mothers). Dyads were observed in free play and 10 minutes of videorecorded interaction was analysed. All looks to the mother were classified as Spontaneous, Responsive (Child turns in response to something done by mother) or Elicited (Mother actively seeks to gain child’s attention by, e.g., tapping or waving). The kind of event that attracted the child’s attention in Responsive and Elicited episodes was also determined (e.g., object movement, speech, physical contact), as was the focus of the child’s attention (e.g., mother’s face, mother’s body). Results: Responsive looks to the mother were the most frequent for all groups but on only about 25% of occasions were they directed to her face. Elicited and spontaneous looks occurred less often but were frequently directed to the mother’s face. Spontaneous looking occurred in all groups but elicited looking very seldom occurred in Hearing–Hearing dyads. Overall, there were fewer looks to the mother in the two groups where mother and child had congruent hearing status, although the proportion of the looks to the mother’s face was similar. Conclusions: Both spontaneous and elicited looks are likely to involve attention to the mother’s face. However, while active elicitation of attention is an important part of successful communication with young deaf children, this does not appear necessary for typically developing hearing children who turn to look at their mother’s face on hearing her voice. The implications of these findings for differences in the dynamics of communication with young deaf and hearing children are discussed. Keywords: Deafness, visual attention, mother-infant interaction. Abbreviations: ASL: American Sign Language; BSL: British Sign Language.

In the United Kingdom, around 350 children every year experience severe/profound hearing loss either from birth or in the first year of life: the great majority of these children are born to hearing parents who have had little or no prior experience of deafness (Davis et al., 1997). Although there is considerable individual variation, a number of studies have found marked differences in the way that hearing and deaf mothers interact with deaf children in the first years of life (see Spencer & Harris, in press, for a detailed review.)

Many deaf mothers are fluent users of a sign language such as American Sign Language (ASL) or British Sign Language (BSL). They communicate with their children through sign, adopting a number of strategies that enable their signs – and gestures – to be seen. These strategies can be divided into two main types: displacing signs into the child’s line of sight and timing utterances so that the child is looking at the mother when she signs (Maestas y Moores, 1980; Harris, Clibbens, Chasin, & Tibbits, 1989; Waxman & Spencer, 1997). Both strategies increase sign visibility for the child.

Visibility is not, however, the only requirement of successful signing to young deaf children since, in order to acquire signs, they need to see both a sign and a contingent nonverbal context that will serve to elucidate its meaning. Mothers of deaf children – both deaf and hearing – produce signs that are embedded within a salient nonverbal context (Spencer & Lederberg, 1997; Harris 2001), just as hearing mothers of hearing children produce ‘contingent naming’ in spoken language (Barnes, Gutfreund, Satterly, & Wells, 1983; Tomasello & Todd, 1983; Harris, Jones, Brookes, & Grant, 1986; Baldwin & Markman, 1989; Barrett, Harris, & Chasin, 1991; Harris, 1992). There is, however, an important difference between the achievement of contingent naming when signing to deaf children and speaking to hearing children: signs have to be seen, whereas speech allows hearing children to have access to contingent naming by listening and looking. Deaf children have to observe both signs and context though the visual channel (except for a small number of cases where touch or taste can be used to provide the context for a sign).

In part, deaf mothers rely on their children turning to look at them before they sign (Kyle & Ackerman, 1990; Mohay, Luttrell, & Milton, 1991; Spencer, Bodner-Johnson, & Gutfreund, 1992; Harris, 2001). This pattern of waiting for the child’s attention allows close contingency between a sign and an appropriate
nonverbal context since the child can break off, briefly, from an activity to look at the mother. However, deaf mothers do not always wait passively for their children to look at them. During the second year of life, they make an increasing number of attempts to attract their children’s attention, often using physical strategies such as tapping or waving (Maestas y Moores, 1980; Spencer & Lederberg, 1997; Harris & Mohay, 1997; Koester, Papousek, & Smith-Gray, 2000; Spencer, Swisher, & Waxman, 2004). Deaf mothers are more likely to use such strategies than hearing mothers of deaf children and they are generally more proactive and more successful in gaining their children’s attention (Spencer & Lederberg, 1997; Harris & Mohay, 1997).

Although the importance of visual attention for deaf children is most easily illustrated by an analysis of mothers’ signing strategies, it is clear that visual attention is equally important for oral communication since deaf children pick up essential information about speech from lip movements. The face of the communicative partner also provides additional cues about affect. Interestingly, deaf mothers often use exaggerated positive affect when communicating with young children so that their facial expression provides a strong cue to their reaction to an event (Erting, Prezioso, & O’Grady-Hines, 1990). Visual attention thus lies at the heart of successful communication for all deaf children and for the perception of sign, speech and affect: at this level there is a fundamental difference between the nature of successful communication with deaf and hearing infants.

The main aim of the present study was to compare the developing patterns of visual attention in deaf and hearing children in order to discover how audition affects visual attention. There is an extensive literature on the development of hearing children’s visual attention in mother–child dyads. Much of it focuses on joint visual attention, that is, ‘looking where someone else is looking’ (see Butterworth, 2001, for a review). Bakeman and Adamson (1984) charted the development of joint visual attention in hearing children, distinguishing between passive joint attention and coordinated joint attention. In the former, infant and adult are engaged with the same object but the infant is not engaged with the adult (although the adult is engaged with both the infant and the object). In the latter, the infant is engaged both with the object and the adult in a triadic relationship.

The Bakeman and Adamson framework has been used to compare the development of joint visual attention in deaf and hearing children. Using analysis of videotaped interaction in mother–child dyads, Prezbindowski, Adamson, and Lederberg (1988) found that hearing children (aged between 20 and 24 months) were engaged in coordinated joint attention for 63% of the time compared to 43% for deaf children of hearing parents. However, the amount of time spent in coordinated joint attention by deaf children of deaf parents has been shown to be similar to that found for hearing children at 18 months (Meadow-Orlans & Spencer, 1996), while hearing children of deaf mothers show a smaller amount (Spencer et al., 2004). This pattern of results suggests that coordinated joint attention is more frequent when child and mother are similar in hearing status.

The present study explored the pattern of visual attention in deaf and hearing children with deaf or hearing mothers. There were thus four comparison groups: Deaf–Deaf (Dd), Deaf–Hearing (DH), Hearing–Deaf (Hd) and Hearing–Hearing (Hh). The Hd group was included in order to find out how having a deaf parent influences the development of a hearing child. The study asked three main questions about the interactions within these dyads at 18 months. This particular age was chosen for analysis since, at this point in their children’s development, deaf mothers are no longer displacing their signs but are mainly relying on their children’s looking at them in order for their signing to be visible (Harris et al., 1989; Spencer & Harris, in press).

The first question concerned the pattern of attention within dyads. Given that deaf mothers of deaf children elicit their children’s attention more often than hearing mothers, we asked what is the pattern that occurs in hearing children of hearing parents and also those with deaf parents? Specifically we wanted to find out how much the parents of hearing children elicit attention. Elicitation of attention is a hallmark of successful interaction with deaf infants, but would hearing infants show a fundamentally different pattern? We also wanted to find out whether deaf and hearing children differed in the frequency of their spontaneous looking. We thought that deaf children might show more spontaneous looking to their mothers than hearing children because of their need to communicate visually, although Spencer et al.’s (2004) findings suggested that the similarity of hearing status within the dyad might be the most important factor.

The second question concerned children’s behaviour in responsive episodes. Harris and Mohay (1997) found that deaf children often responded to movement. However, it seemed highly likely that sound would play an important part in directing hearing children’s visual attention towards their mother. Our expectation arose from the finding that young infants have a very well-developed ability to orient to sound (see Fernald, 2001, for a review). It has been known for some time that neonates will turn their head towards a sound (Wertheimer, 1961; Muir & Field, 1979). Although this tendency declines over the first weeks of life, it reappears around 4 months of age and steadily becomes more accurate so that, by 11 months, infants can detect a change in sound location of only 9 degrees (Morrongiello, Fenwick, Hillier, & Chance, 1994). There is, therefore, a
substantial improvement in the spatial resolution of the auditory system over the first year of life that serves to make sound a very reliable cue to location. We therefore expected that hearing children would mainly turn towards their mother in response to sound.

The third focus of the study was where children look when they turn towards their mother. There are various possibilities. Children might look at their mother’s face, her hands, her body or something that she was holding. We were interested in the possibility that children would look at the mother’s face more often in some kinds of episode than in others. We expected that looking to the face would be highest in spontaneous episodes since they could be regarded as social referencing (Campos & Stenberg, 1981) in which the infant seeks information from the mother’s face. We also expected that looking at the mother’s face would be relatively low in responsive episodes since, in these, children were likely to be responding to movement, especially the movement of an object.

Method

Participants

The participants in this study were recruited as part of three longitudinal investigations into the development of communication and language in deaf and hearing children. In all there were 26 mother–child dyads and, at the time of the observations reported here, the children were aged around 18 months (mean = 79 weeks, range 75 weeks to 87 weeks). There were 6 dyads in the Deaf child–Deaf mother (Dd), Deaf child–Hearing mother (Dh) and Hearing child–Deaf mother (Hd) groups and 8 dyads in the Hearing child–Hearing mother (Hh) group. There was no difference in the age of the children across groups ($F_{3,22} = 1.48, p > .05$). All groups comprised both boys and girls.

All the deaf children had a prelingual hearing loss, diagnosed before the end of the first year of life, of at least 90 dB in the better ear. Deaf mothers were native users of BSL, and BSL was used as the main language at home. Two hearing mothers with deaf children were able to sign before their child was born and, of these, one was a fluent user of BSL. The other mothers did not know how to sign before the birth of their child but all used some signing after they discovered that their child was deaf.

Observation and analysis

During observation, each mother was asked to play with her child as she would do normally. A standard set of toys was provided but mothers were not restricted to playing with these. All sessions were filmed for between 15 and 40 minutes and filming was continuous unless the mother or child left the room. All deaf mothers were filmed by a deaf researcher and hearing mothers by a hearing researcher. Most recordings were made in the child’s home but some were made in a video laboratory.

Previous studies have established that comparable patterns of mother–child interaction emerge in these two settings when children are in the first two years of life (Harris, 1992).

Ten continuous minutes of the video recording made at the 18-month session were analysed. The analysed segment usually began five minutes after the start of the session, allowing time for the mother and child to settle down and become used to the recording procedure. In some cases, where it was not possible to see both child and mother in the early part of the recording, a later 10-minute segment was analysed.

There were three main analyses. The first followed the procedure outlined in Harris and Mohay (1997). Initially, all cases where the child turned to look at the mother were identified. Then each look was classified as Spontaneous (Child turned towards mother spontaneously), Responsive (Child turns in response to something done by mother) or Elicited (Mother actively seeks to gain child’s attention by, e.g., tapping or waving). In this coding, as in all other codings described in this paper, two independent coders were used and all inconsistencies between them were resolved by reinspection of the videotape. Next, all responsive and elicited episodes were classified according to the event that had brought about the child’s attention to the mother. The analysis was virtually identical to the one used by Harris and Mohay (1997), except that the noisy toy category was expanded to sound + other. The categories were: physical contact (between mother and child), mother’s movement, object movement, sound, sound + other. Table 1 gives examples of the events that fell into each of these categories.

The final analysis was concerned with where children looked. Each look to the mother was coded as a look to her face, her hands, her body or to an object that she was holding.

Results

The first column of Table 2 shows the total number of looks to the mother made by the children in each of the four groups. Children in the Hh group turned to look at their mother least often, while those in the Dh and Hd groups looked most frequently. These differences were confirmed in a one-way ANOVA where there was a significant effect of group ($F_{3,22} = 7.51, p = .001$). Post hoc Bonferroni tests revealed that there was no significant difference between the Hh and Dd dyads ($p = .960$) but there was a significant difference between the Hh dyads and both the Dh ($p = .006$) and Hd groups ($p = .003$). These two groups did not differ from each other or from the Dd dyads. Overall, there were fewer looks for dyads with congruent hearing status than incongruent status ($t_{24} = 4.37, p < .001$).

Figure 1 shows the mean number of episodes that were classified as spontaneous, elicited or responsive for each group. It can be seen that responsive episodes occurred more frequently than spontaneous or elicited episodes for all groups, whereas the frequency of elicited and spontaneous looks varied. The
The next set of comparisons was concerned with what attracted children’s attention. In the original coding, looking was categorised as a response to physical contact, mother’s movement, object movement, sound and sound + other. In order to simplify the analysis, and in view of the fact the some categories occurred rather infrequently, the second two categories (both involving movement) were combined into a single movement category. As in Harris and Mohay (1997), detailed analysis of what attracted the children’s attention was restricted to responsive episodes since these were the most common type of episode; and, as the total number of responsive episodes differed across the groups, analysis was conducted on proportions.

Figure 2 shows that movement was a significant factor in looking for all children. However, its relative importance varied across groups, as evidenced by a highly significant effect of group in a one-way ANOVA ($F_{3,22} = 31.3$, $p < .001$). Scheffé tests revealed the presence of three significantly different groups at $p < .05$. As might be expected, for the two groups of deaf children, a very large proportion of responses were to movement. The deaf children differed from the two groups of hearing children who, in turn, differed from each other, with the Hh group showing the smallest percentage of movement responses and the Hd group an intermediate percentage.

The pattern of responses to sound was essentially a mirror image of responses to movement, with a highly significant effect of group ($F_{3,22} = 20.7$, $p < .001$) and significant differences between children in Hh dyads and both groups of deaf children ($p < .001$ for both comparisons on a Scheffé test). Again, there was also a difference between children in the Hh and Hd groups ($p = .002$).

The final analysis was concerned with where children looked. Again, proportions rather than raw scores were analysed. Table 3 shows the location of looking in spontaneous and responsive episodes. The proportion of looking to the mother’s face was compared across these two types of episode and the four groups. Neither group nor the group × episode interaction was significant. However, there was a
highly significant effect of episode type ($F_{1,22} = 112.31, p < .001$), reflecting the fact that looking to the mother's face was considerably more frequent in spontaneous than responsive episodes for all groups of children.

Since elicited episodes were relatively infrequent across the sample as a whole (see Figure 1), these data were not subject to analysis with inferential statistics. Overall, children looked to their mother's face in 68% of elicited episodes (see Table 3). Overall looking to the face was compared in a final analysis. The second column of Table 2 shows the total number of looks to the face and, in the final column, this figure is expressed as a percentage of total looks. These two measures give a somewhat different picture of the looking pattern. For total number of looks, congruence of hearing status proved to have a significant effect, with the congruent dyads producing a mean of 23.7 looks ($SD = 12.3$) to the mother's face in 10 minutes and the incongruent dyads a significantly larger mean of 34.7 ($SD = 12.8$) ($t_{22} = 2.21, p = .04$). However, when the percentage of looks to the face was considered, this effect of congruence of hearing status disappeared and there was no significant difference among groups.

**Discussion**

The most striking finding to emerge from this study was that there is a fundamental difference in the dynamics of successful interaction between deaf and hearing infants and their mothers. Previous studies have shown that deaf mothers with deaf children regularly elicit their attention through a variety of strategies; and this seems to be an essential aspect of successful communication with young deaf children (Spencer & Harris, in press). In this study, as in previous studies, deaf mothers of deaf children showed most elicitation but there was also evidence of elicitation in both the Dh and Hd groups. The pattern within the Hh dyads was notably different: as Figure 1 shows very clearly, hearing mothers of hearing children almost never elicited attention.

The reason for the contrasting patterns of Dd and Hh children becomes clear when looking at what attracted their attention. For hearing children, sound played a very important role in attracting attention to the mother (see Figure 2) and 70% of responsive looks involved sound, either on its own or in conjunction with some action of the mother's. Much of this sound was, of course, speech. The sound of the mother's voice had a powerful effect on the hearing children's attention, as extracts from one of the Hh dyads illustrates (see Table 4). In the first two episodes, the mother's speech produces an immediate look to her face (C is the child and M the mother). The powerful effect of sound on hearing children suggests why it was that hearing mothers of hearing children did not need to elicit attention since, as soon as a hearing mother began talking, her child typically turned to look at her face. This explains why 50% of the looks to the mother in the Hh groups were to her face even though mothers almost never elicited their child's attention.

Responding to movement did not automatically bring attention to the face as it did in the case of speech. Much of the mother's movement in responsive episodes involved play objects, as in episodes 9 and 10 above. Typically, as in this example, the children's attention remained on the source of the movement but this did not present a problem for hearing children who could hear what their mother was saying. However, mothers of deaf children had to find alternative ways of getting children's attention onto their face so that they could communicate. The extract in the second part of Table 4 shows how one deaf mother achieved this. In episode 5 she uses three different physical strategies, illustrating how much persistence is often required to gain a young deaf child's attention. In episode 7 she signs and the child turns towards her, having presumably detected her hand movements in peripheral vision. By contrast, in episodes 6 and 8, both of which involved response to movement, the child does not look at the mother's face.

As in previous studies, we found that deaf mothers were good at eliciting attention because they had developed successful strategies. The more successful hearing mothers of deaf children – notably the two who could sign before their children were born – used similar strategies but, overall, there was less elicitation than in the Dd dyads (although this difference did not reach significance).

The pattern that emerged in the Hd dyads (where mothers were deaf but the children were hearing) is of particular interest. These children responded more to movement than hearing children with hearing parents but, not surprisingly, they also responded to sound more than deaf children. Deaf mothers with hearing children typically make use of sound and often speak...
Table 4 Examples of contexts in which the child’s attention turned to the mother

<table>
<thead>
<tr>
<th>Episode number</th>
<th>Event (location of looking in italics)</th>
<th>Ensuing interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hearing-Hearing Dyad</td>
<td>M and C trace outline of wheel with M’s finger. M says ‘wheel’. C looks to mother’s face and says ‘car’.</td>
<td>M shakes head, laughs and says, ‘It’s not a car, it’s a train.’</td>
</tr>
<tr>
<td>Deaf-Deaf Dyad (Mother is pretending to feed toy animals with the spoon)</td>
<td>M taps C on arm then touches him under chin. M says C’s name and turns his face slightly towards her. C looks up at mother’s face.</td>
<td>M then looks briefly towards spoon that M is holding.</td>
</tr>
<tr>
<td>Deaf-Deaf Dyad (Mother is pretending to feed toy animals with the spoon)</td>
<td>M moves hand that is holding toy spoon. C looks towards mother’s hand.</td>
<td>M signs and says ‘Rabbit and doggy full – now sleep’.</td>
</tr>
<tr>
<td>Deaf-Deaf Dyad (Mother is pretending to feed toy animals with the spoon)</td>
<td>M vocalises and signs. C looks up at mother’s face.</td>
<td>C watches M as she vocalises and signs.</td>
</tr>
<tr>
<td>Deaf-Deaf Dyad (Mother is pretending to feed toy animals with the spoon)</td>
<td>M moves spoon down to toy plate. C looks down at spoon and plate.</td>
<td>M pushes plate along floor and then place spoon on it.</td>
</tr>
</tbody>
</table>
time, for young deaf children to acquire signs or spoken vocabulary, it is important that the demands of visual attention do not preclude opportunities to relate language to its immediate context.

On the whole, deaf mothers are better than hearing mothers at managing the complex demands of visual attention. However, some hearing mothers develop very effective communicative strategies with deaf children and a number of recent intervention programmes have shown that the most effective strategies – such as careful timing of utterances – can be taught (see Spencer & Harris, in press). Across both deaf and hearing mothers, a number of factors have been found to predict deaf children’s language production at 18 months (Spencer, Meadow-Orlans, Koester, & Ludwig, 2004). These are: children’s visual behaviours (including social referencing and coordinated joint visual attention), the overall quality of children’s behaviour during interaction, frequency of mother’s signing and their rate of responding to their child’s focus of attention. Interestingly, the hearing status of the mother did not account for additional variance. These findings clearly illustrate that the pattern of visual attention within the mother–child dyad and the mapping of the mothers’ language to the child’s focus of attention are the most important factors for promoting young deaf children’s language development.

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