

# **The effect of communication mode on outcomes for children with hearing loss: A review**

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## **1. Statement of intent**

From diagnosis, a primary goal for all children with hearing loss is the development of language, from which most other learning stems. It is of the utmost importance for parents of children with hearing loss to determine which communication approach will give their children the best possible chance of achieving age-appropriate competence in the language of their choice. In 95% of cases, parents with normal hearing have a strong desire to share their hearing culture and spoken language with their child.

It is suggested by some that all children with hearing loss should learn a sign language from diagnosis. Conversely, it is thought by others that learning a sign language may interfere with children's attention to the auditory signal, and may therefore impede their development of spoken language. In addition, it is also a concern that asking hearing parents to learn a new (sign) language is too onerous and will not provide a sufficient quality of language to be useful for the child.

These differing opinions raise questions about what the best course of practice is for children and their families. Parents are often confused when trying to decide the best options for their children, reporting that the advice they receive is often conflicting, and that these choices are often presented by advocates of different approaches in a way that makes it appear that there is no flexibility or compromise (Christiansen & Leigh, 2004). Most hearing parents have no knowledge or understanding of deafness before their child's diagnosis (Moores, 2001).

It is therefore incumbent on intervention services and clinicians to provide evidenced-based information about communication options to assist parents with their decision making, to ensure the best possible outcomes for all children and their families. To this end, a review of the available peer-reviewed evidence and literature has been conducted. It is important to note that statements of opinion cannot be rated or evaluated scientifically.

## 2. Background

### The importance of early language development

Hearing loss has well-reported and significant detrimental effects on the development of spoken language. Therefore, the importance of developing language as early as possible cannot be overestimated. Particularly for children with severe-profound loss, for whom auditory deprivation is most severe, exposure to language is not the same as that experienced by children with normal hearing.

Many human and animal studies of the neurosensory pathways of the auditory cortex in the brain show that the potential for development, or 'wiring' of the brain, is greatest during early development, and that there is a 'critical period' for development, during which auditory stimulation must occur in order for neural maturation to be completed (Kral, Hartmann, Tillein, Heid, & Klinke, 2001; A. Sharma, Dorman, & Spahr, 2002). Research in humans has shown that the auditory system can retain its plasticity for some years without auditory stimulation. When stimulated by hearing (for example, after cochlear implantation) maturation will commence at the same rate as for children with normal hearing, with the maturational sequence delayed by the period of sensory deprivation (Ponton et al., 1996).

Physiological studies suggest that there is a period of about 3.5 years of auditory deprivation during which the central auditory system retains its maximum plasticity, and after this plasticity is greatly reduced (Gordon, Wong, & Papsin, 2010; Anu Sharma, Dorman, & Kral, 2005). It is therefore critical for the development of spoken language that auditory stimulation occurs as soon as possible. The same applies to the development of sign language, where it has been found that when access to the sign language is delayed there are processing deficiencies and delayed later development (Mayberry, Chen, Witcher, & Klein, 2011).

It has also been shown that learning spoken and sign language involve the left lateralized part of the brain (Hickok, Love-Geffen, & Klima, 2002), and that the processing of signs and spoken words in the brain is identical (MacSweeney, Capek, Campbell, & Woll, 2008).

## **The importance of a common language for parents and children**

The literature on bilingualism for normal-hearing populations reports on the importance of parents using their native language to communicate with their children. Similarly, the social and emotional benefits of sharing the same language for deaf children of deaf parents are also stressed in the literature. Deaf children of deaf parents have been consistently rated more highly on various social and emotional scales compared with deaf children of hearing parents, the explanation given for this being that deaf children have a common language with their parents (Nicholas & Geers, 2003). However, there have been several recent reports of children with cochlear implants showing no significant differences in psychosocial development when compared with their peers with normal hearing in terms of quality of life (Huber, 2005; Loy, Warner-Czyz, Tong, Tobey, & Roland, 2010b), self-esteem (Loy et al., 2010b; D. Martin, Bat-Chava, Lalwani, & Waltzman, 2010; Sahli & Belgin, 2006), or the incidence of loneliness and psychosocial difficulties (Percy-Smith, Caye´-Thomasen, Gudman, Hedegaard Jensen, & Thomsen, 2008; Schorr, 2006).

Until the advent of early diagnosis, cochlear implants and technologically advanced hearing aids, it was very difficult for children with hearing loss to acquire the native language of their hearing parents through audition, therefore sign language was often the only method of communicating with children with severe-profound hearing loss. However, hearing parents who use sign support or sign language are communicating in both a foreign mode and a foreign language, and it has been shown that learning sign language as an adult is difficult. Even with early detection, children of hearing parents are rarely exposed to fluent sign language, as this is not their parents' native language. Although children of deaf signing parents achieve early fluency in sign language and this can lead to age-appropriate word and sentence level milestones, the evidence shows that children of hearing parents are often delayed in both their sign language development and in language comprehension, and in early pragmatic and narrative competence (Becker, 2009; Herman & Roy, 2006). In addition to the difficulty of learning sign language as an adult with a busy life, part of this may be due to the fact that most hearing parents expect that their children will not need to use sign after cochlear implantation (Hyde, Punch, & Komesaroff, 2010).

It is now also possible for many children with a significant hearing loss and early diagnosis

to develop age-appropriate spoken language solely through their audition if supported through oral intervention and educational programs (Duchesne, Sutton, & Bergeron, 2009; Sarant, Harris, Bennet, & Bant, 2014; Spencer, 2004). In today's society, the majority of children with hearing loss are educated in this way, rather than in segregated settings. This practice has been shown to facilitate development commensurate with normal-hearing peers in terms of academic development (Sarant, Harris, & Bennet, 2015) and normal psychosocial development for many children (Loy, Warner-Czyz, Tong, Tobey, & Roland, 2010a; D Martin, Bat-Chava, & Waltzman, 2010; Percy-Smith et al., 2008). However, not all children will achieve this, and those who do not would benefit from learning sign language from diagnosis. After cochlear implantation or receiving hearing aids, when there is a means of learning through audition, the use of sign language for most children wanes as spoken language develops (Watson, Archbold, & Nikolopoulos, 2006). However, for children with additional disabilities, or those for whom the predicted benefits of cochlear implantation are slow to occur or are not as expected, the use of sign language may continue (Hyde & Punch, 2011).

For hearing parents of children with hearing loss who wish for their children to develop spoken language, early use of sign language may support both the development of the parent-child bond and aspects of communication such as joint attention that develop communicative intent, and that form the basis for language learning. Sign language may also provide a 'back up' method of communication in case outcomes with oral communication are not as expected. Some recent research has shown that earlier exposure to sign language structure may also facilitate later development of spoken English when auditory information becomes available (Davidson, Lillo-Martin, & Chen Pichler, 2014).

There are two forms of educational approach involving signing. The first, oral communication plus sign, is a multisensory approach to communication aimed at providing oral and visual codes. The signing used in this mode is based on Signed English (or other language), which was originally designed to be used simultaneously with spoken language. This form of sign language is not one that has evolved within a Deaf community, such as NZSL.

More recently, some educational/intervention centres have begun to support teaching children the natural sign language of their country from birth and spoken/written language

as the second language (bimodal bilingualism). This approach gives deaf children an opportunity to learn both a sign language and spoken/written languages. However, there is no globally agreed definition of what this method involves (Swanwick, 2016).

With earlier diagnosis and intervention resulting from universal newborn hearing screening, and advances in both hearing aid and cochlear implant technology, alternative methods of enabling children with hearing loss to be bilingual/bicultural have also emerged. In some cases, children acquire spoken language through audition first and then acquire a sign language as their second language, while others learn both simultaneously. In the latter cases children may learn a sign language as a result of parental choice, or as an outcome of having difficulty progressing in an oral program (Mayer & Leigh, 2010). However, there is no evidence to suggest that students in bilingual programs are achieving the age-appropriate language and literacy levels that were predicted when these were first implemented (Mayer & Leigh, 2010).

### **3. Detailed critical review of the evidence**

A detailed critical review of the evidence of outcomes for children using either oral communication (OC) or a combination of oral and signed communication has been conducted in order to address some of the issues raised above.

#### **Study selection**

Study methodologies in the review included controlled clinical trials, prospective and retrospective cohort studies. Studies that addressed the use of oral communication with sign versus oral communication only (either auditory-verbal and/or auditory oral methods; OC) were included. Outcomes examined are shown in Table 1. Evidence has not been restricted to high quality evidence only, as this would exclude all of the published evidence.

Studies prior to 1995 were excluded from this review, as generations of children prior to this time were unlikely to have received similar standards of intervention and technology. It is also important to note that most of the studies involved only children with severe-profound deafness and used cochlear implants. This is likely due to the fact that many of these children with more severe hearing loss received intervention that included sign in addition to spoken language, particularly in previous decades, when cochlear implants were a recent and comparatively unknown option, with unknown longer term outcomes and more limited perceptual benefits. There is therefore a lack of evidence for children who have a less than a severe-profound hearing loss, with only 5/39 studies reviewed including children with hearing loss using hearing aids. This also relates to the fact that most children with lesser losses function well with hearing aids and there is no perceived need to use sign language.

The quality of the evidence collected was graded using the criteria set out by the U.S. Preventative Services Task Force (USPSTF) guidelines (Harris et al., 2001), where a good study met all of the criteria for study design, a fair study did not meet all criteria but was judged to have no fatal flaw that invalidated its results, and a poor study was fatally flawed. See Table 2 for Criteria for grading the internal validity of individual studies used by the USPSTF.

## **Considerations**

The results of research in this field to date show a range of findings and are not straightforward to interpret, for a number of reasons.

Firstly, there are issues regarding the form of data collection in order to determine what the outcomes are. For example, there are inherent difficulties with the interpretation of formal assessment results for children with hearing loss, as most standardized tests are normed on samples of children with normal hearing tested using a strict protocol, and sometimes the test administration procedures are deviated from in order to ensure children with hearing loss understand the assessment task or can respond appropriately (for example, by using an interpreter). Additionally, when using informal assessment measures, children may fail to exhibit a particular language skill during the assessment, which means that the question of whether or not the child has mastered that skill remains unanswered.

A further complication with obtaining valid data occurs when children with hearing loss are part of a family whose first language differs from that of the majority of the community in which they live, for example, and proficiency in this language may be variable. This raises challenges for the professionals working with these families where there isn't a shared language, or where language proficiency varies, in addition to those of assessment.

Further, many studies investigating developmental outcomes for children with hearing loss have limited methodology. For ethical reasons, it is not possible to conduct a randomized controlled trial of either treatments (cochlear implants vs hearing aids) or communication modes. Therefore, many studies of outcomes are either retrospective or fail to consider or control for many factors that could influence outcomes (for example, intelligence, parental involvement, age at implant or hearing aid fitting). This has resulted in findings that are applicable only to small samples and not generalizable to the wider population, and which often leave many questions unanswered.

## 4. Conclusions

The following conclusions are based on the available evidence in the literature. Overall, there are a greater proportion of studies showing evidence of superior results across a range of developmental outcomes for children using an oral method of communication. However, because of limitations in the design of most studies, (usually small numbers of participants and failure to control for other possible confounding factors) there are not one or two easy and definitive conclusions to be drawn.

The evidence indicates the following:

1. The brain is wired to learn language through both visual and auditory modes, with the left hemisphere being dominant for the processing of both spoken and signed languages.
2. When access to either spoken or sign language is delayed, there is a subsequent negative impact on language/literacy development.
3. Hearing parents find learning sign language very difficult as adults, and the majority do not provide fluent sign language for their children.
4. In most cases, children who initially signed but went on to develop spoken language dropped the use of sign gradually over time.
5. There is little evidence to suggest that use of sign language causes negative effects in terms of developing spoken language, as long as the use of audition and spoken language is emphasized.
6. There is limited evidence that early use of sign language may assist with the development of spoken language.
7. There is no evidence to show that bilingual education improves educational outcomes over oral education.
8. It is often difficult to predict which children will successfully develop spoken language through audition and which will not, unless they have additional disabilities (these are often difficult to diagnose at a young age). Learning sign language could provide a means of communication prior to cochlear implantation, and 'insurance' in cases where spoken language does not develop quickly or at all. This is a complex issue, however:



- a) This group of children is very small relative to the wider population of children with hearing loss
  - b) Some children cannot sign due to motor difficulties (eg. Cystic Fibrosis)
  - c) Some children who perceive spoken language well cannot speak due to motor difficulties. In order to be a part of the larger hearing world they need to use assistive devices for expressive communication rather than sign.
9. There is evidence to suggest that children in oral communication education settings (vs oral plus sign settings) develop significantly better spoken language.
10. There is evidence that children using oral communication achieve significantly better speech perception and speech production outcomes than do children using oral plus sign communication.
11. There is evidence that children with early cochlear implants who use oral communication can achieve language, social and academic outcomes comparable with those of their peers with normal hearing.

**Table 1. Outcomes examined in studies included in the literature review.**

| <b>Measured outcome</b>       | <b>Sub-area</b>  |
|-------------------------------|--|
| <b>Speech perception</b>      |  |
| <b>Speech production</b>      | Intelligibility<br>Articulation proficiency<br>Consonant production accuracy<br>Communication breakdowns |
| <b>Vocabulary development</b> | Expressive vocabulary<br>Receptive vocabulary  |
| <b>Language development</b>   | Spoken language<br>Written language  |
| <b>Reading/literacy</b>       |  |
| <b>Academic development</b>   |  |
| <b>Social development</b>     | Peer interactions<br>Social well-being   |

**Table 2. Criteria for grading the internal validity of individual studies used by the USPSTF**

| <b>Study design</b>   | <b>Criteria</b>   |
|---|---|
| <b>Systematic reviews</b>                                     | <ul style="list-style-type: none"> <li>• Comprehensiveness of sources/search strategy used</li> <li>• Standard appraisal of included studies</li> <li>• Validity of conclusions</li> <li>• Recency and relevance</li> </ul>   |
| <b>Case-control studies</b>                                   | <ul style="list-style-type: none"> <li>• Accurate ascertainment of cases</li> <li>• Nonbiased selection of cases/controls with exclusion criteria applied equally to both</li> <li>• Response rate</li> <li>• Diagnostic testing procedures applied equally to each group</li> <li>• Appropriate attention to potential confounding variables</li> </ul>  |
| <b>Randomized controlled trials (RCTs) and cohort studies</b> | <ul style="list-style-type: none"> <li>• Initial assembly of comparable groups: For RCTs: adequate randomization, including concealment and whether potential confounders were distributed equally among groups<br/>For cohort studies: consideration of potential confounders with either restriction or measurement for adjustment in the analysis; consideration of inception cohorts</li> </ul>   |
| <b>Diagnostic accuracy studies</b>                            | <ul style="list-style-type: none"> <li>• Screening test relevant, available for primary care, adequately described</li> <li>• Study uses a credible reference standard, performed regardless of test results</li> <li>• Reference standard interpreted independently of screening test</li> <li>• Handles indeterminate results in a reasonable manner</li> <li>• Spectrum of patients included in study</li> <li>• Sample size</li> <li>• Administration of reliable screening test</li> </ul> |

**Table 3. Summary of all reviewed evidence.**

Note that some studies measured multiple outcomes. Caution must be taken when interpreting these findings, as the quality of studies varied, therefore the findings cannot be weighted equally. Some studies reported no significant results.

Review articles were not rated for quality (N/A), but conclusions were noted.

| <b>Outcome measures</b>  | <b>No. studies</b> | <b>Study ratings</b> | <b>No. studies</b> | <b>Study conclusions</b>               | <b>No. studies</b> |
|--------------------------|--------------------|----------------------|--------------------|--|--------------------|
| <b>Speech perception</b> | <b>14</b>          | N/A                  | 1                  | Not enough evidence                    | 1                  |
|                          |                    | Good                 | 0                  | OC significantly better than OC + sign | 10                 |
|                          |                    | Fair                 | 11                 | No negative effect of sign             | 0                  |
|                          |                    | Poor                 | 2                  | No difference between groups           | 0                  |
|                          |                    |                      |                    | Negative effect of sign use            | 1                  |
|                          |                    |                      |                    | OC + sign significantly better than OC | 0                  |
| <b>Speech production</b> | <b>16</b>          | N/A                  | 1                  | Not enough evidence                    | 1                  |
|                          |                    | Good                 | 0                  | OC significantly better than OC + sign | 10                 |
|                          |                    | Fair                 | 13                 | No negative effect of sign             | 1                  |
|                          |                    | Poor                 | 2                  | No difference between groups           | 0                  |
|                          |                    |                      |                    | Negative effect of sign use            | 1                  |
|                          |                    |                      |                    | OC + sign significantly better than OC | 0                  |
| <b>Vocabulary</b>        | <b>9</b>           | N/A                  | 0                  | Not enough evidence                    | 0                  |
|                          |                    | Good                 | 0                  | OC significantly better than OC + sign | 4                  |
|                          |                    | Fair                 | 5                  | No negative effect of sign             | 0                  |
|                          |                    | Poor                 | 4                  | No difference between groups           | 3                  |
|                          |                    |                      |                    | Negative effect of sign use            | 0                  |
|                          |                    |                      |                    | OC + sign significantly better than OC | 1                  |

| <b>Outcome measures</b>   | <b>No. studies</b> | <b>Study ratings</b> | <b>No. studies</b> | <b>Study conclusions</b>               | <b>No. studies</b> |
|---------------------------|--------------------|----------------------|--------------------|--|--------------------|
| <b>Language</b>           | <b>16</b>          | N/A                  | 1                  | Not enough evidence                    | 1                  |
|                           |                    | Good                 | 1                  | OC significantly better than OC + sign | 6                  |
|                           |                    | Fair                 | 6                  | No negative effect of sign             | 2                  |
|                           |                    | Poor                 | 8                  | No difference between groups           | 4                  |
|                           |                    |                      |                    | Negative effect of sign use            | 2                  |
|                           |                    |                      |                    | OC + sign significantly better than OC | 1                  |
| <b>Reading/ literacy</b>  | <b>4</b>           | N/A                  | 0                  | Not enough evidence                    | 0                  |
|                           |                    | Good                 | 0                  | OC significantly better than OC + sign | 1                  |
|                           |                    | Fair                 | 2                  | No negative effect of sign             | 0                  |
|                           |                    | Poor                 | 2                  | No difference between groups           | 3                  |
|                           |                    |                      |                    | Negative effect of sign use            | 0                  |
|                           |                    |                      |                    | OC + sign significantly better than OC | 0                  |
| <b>Social development</b> | <b>3</b>           | N/A                  | 0                  | Not enough evidence                    | 0                  |
|                           |                    | Good                 | 0                  | OC significantly better than OC + sign | 1                  |
|                           |                    | Fair                 | 2                  | No negative effect of sign             | 0                  |
|                           |                    | Poor                 | 1                  | No difference between groups           | 1                  |
|                           |                    |                      |                    | Negative effect of sign use            | 0                  |
|                           |                    |                      |                    | OC + sign significantly better than OC | 0                  |

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