A SYSTEMATIC REVIEW OF THE LITERATURE ON EARLY INTERVENTION FOR CHILDREN WITH A PERMANENT HEARING LOSS

Volume II

Report prepared for
Healthy Hearing Program
Queensland Health
Brisbane
Queensland

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References included in this volume 271
## Appendix One

### Critical appraisal form for quantitative studies
(modified McMaster instrument)

Note: ‘Yes’ or ‘NA’ (Not applicable) scores 1. ‘No’ or ‘Unable to determine’ scores 0.

**Publication:**

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>I Systematic review of RCTs</td>
<td>○</td>
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<tr>
<td>II RCT</td>
<td>○</td>
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</tr>
<tr>
<td>III-1 Pseudorandomised controlled trial</td>
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<td>III-2 Non-randomised experimental trial</td>
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<td>Prospective cohort</td>
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<td>Case-control with concurrent controls</td>
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<tr>
<td>III-3 Retrospective cohort</td>
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<td>Case-control with historical controls</td>
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<td></td>
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<tr>
<td>IV Case series with post-test outcomes</td>
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<tr>
<td>Case series with pre- and post-test outcomes</td>
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</table>

**Notes:**

- A single case report is a case series (n=1).
- Cohort studies must have a control or comparison group or comparative data of some kind. The comparisons can be *within* the sample/population.
- A case series is a single group of people exposed to the intervention (uncontrolled study).

**Level:** ______

<table>
<thead>
<tr>
<th>2. Study design:</th>
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<tbody>
<tr>
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<tr>
<td>○ Qualitative</td>
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<tr>
<td>○ Repeated measures</td>
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<tr>
<td>○ Mixed method</td>
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</table>

**Study purpose:**

3. Is the purpose of the study stated clearly? ○ Yes (1) ○ No (0) Score: ______

**Literature:**

4. Is relevant background literature reviewed? ○ Yes (1) ○ No (0) Score: ______

**Sample:**

5. Is the sample described in detail? ○ Yes (1) ○ No (0) Score: ______

- In cohort studies and case series, inclusion and/or exclusion criteria should be given.
- In case-control studies, a case-definition and the source for controls should be given.
- In surveys the sampling frame should be described.

6. Were the participants representative of the population under investigation? ○ Yes (1) ○ No (0) ○ Unable to determine (0) ○ NA (1) Score: ______

- The participation rate should be indicated. It should be shown that there are no important differences between participants and non-participants.

**Outcomes:**

7. Were the main outcome measures accurate (valid and reliable)? ○ Yes (1) ○ No (0) ○ Unable to determine (0) Score: ______

- The accuracy of ALL outcome measures must be demonstrated. References to other literature are sufficient provided it is clear that this literature demonstrates the accuracy of the measure(s).
### Intervention:

8. Is the intervention clearly described?
   - Yes (1)
   - No (0)
   - NA (1)
   For cochlear implant (CI) studies there must be some information about the implant (e.g. number of channels, model, year of surgery) – just ‘CI’ is not enough.

9. Are any co-interventions clearly described?
   - Yes (1)
   - No (0)
   - NA (1)
   For CI studies there must be some descriptive information about the type of adjunct communication program/method. Labels such as ‘oral’ and ‘total communication’ are not sufficient; there must be some additional information.

### Results:

10. Are the methods of analysis appropriate?
    - Yes (1)
    - No (0)

11. Are the results reported in terms of statistical significance?
    - Yes (1)
    - No (0)
    - NA (1)

12. Was the sample large enough to show an important difference should such a difference exist?
    - Yes (1)
    - No (0)
    - Unable to determine (0)
    - NA (1)
    The statistical power of the study should be reported.

13. Did the study identify possible confounding factors?
    - Yes (1)
    - No (0)
    - NA (1)

14. Did the study make some effort to deal with confounding variables?
    - Yes (1)
    - No (0)
    - NA (1)
    Ways to deal with confounders include randomisation, matching, sample design (e.g. excluding subjects with some confounding characteristic) and statistical correction (e.g. covariance, stratification).

15. Are the characteristics of participants lost to follow-up described?
    - Yes (1)
    - No (0)
    - NA (1)
    Answer Yes if there were no losses to follow-up or the characteristics of those lost to follow-up are described. Answer No where a study does not describe the number and characteristics of patients lost to follow-up or if it is not clear whether there were losses. Score cross-sectional study designs as NA (1).

### Conclusions:

16. Are the conclusions appropriate given the study methods and results?
    - Yes (1)
    - No (0)
    Score: _____
## Appendix Two

**Critical appraisal form for qualitative studies**  
*(modified McMaster instrument)*

Note: ‘Yes’ or scores 1. ‘No’ or ‘Unable to determine’ scores 0.

### Publication:

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<th>1. Qualitative research method:</th>
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<td><strong>What is the research method followed in the study?</strong></td>
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<td>Grounded Theory</td>
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<tr>
<td>Phenomenology</td>
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<tr>
<td>Ethnography</td>
<td>○</td>
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<tr>
<td>Participatory Action Research</td>
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<tr>
<td>Other</td>
<td>○</td>
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</tbody>
</table>

### Study purpose:

2. Is the purpose of the study stated clearly?  
   - Yes (1)  
   - No (0)  
   - Score: _____

### Literature:

3. Is relevant background literature reviewed and theoretical perspective identified?  
   - Yes (1)  
   - No (0)  
   - Score: _____

### 4. Methodology used:

- Interviews | ○ |
- Focus groups | ○ |
- Historical | ○ |
- Passive observation | ○ |
- Participant observation | ○ |
- Records or other documents | ○ |
- Multiple data sources | ○ |

### Sample:

5. Was the process of purposeful selection described?  
   - Yes (1)  
   - No (0)  
   - Score: _____

6. Was sampling done until redundancy in data was reached?  
   - Yes (1)  
   - No (0)  
   - Score: _____

7. Was ethics obtained and informed consent obtained?  
   - Yes (1)  
   - No (0)  
   - Score: _____

### Data collection:

8. Are the data collection methods (descriptions of the site and participants) described in sufficient detail?  
   - Yes (1)  
   - No (0)  
   - Score: _____

9. Were procedural rigour used in data collection?  
   - Yes (1)  
   - No (0)  
   - Score: _____

### Data analysis:

10. Is the process of transforming the data into themes/codes adequately described?  
    - Yes (1)  
    - No (0)  
    - Score: _____
11. Were sufficient and appropriate processes used to establish the trustworthiness of the findings?
   - Yes (1)
   - No (0)
   - Unable to determine (0)
   e.g. triangulation, member checking, independent coding or interpretation by other researchers
   Score: _____

**Results:**
12. Does the report include original evidence, such as quotes from study participants and/or documents, to illustrate specific points and support conclusions drawn from the data?
   - Yes (1)
   - No (0)
   Score: _____

13. Are the findings reported in sufficient detail so that the reader can evaluate the credibility of the conclusions?
   - Yes (1)
   - No (0)
   Score: _____

**Conclusions:**
14. Are the conclusions appropriate given the study methods and results?
   - Yes (1)
   - No (0)
   Score: _____

15. Are the conclusions presented within the context of other research and/or theory?
   - Yes (1)
   - No (0)
   Score: _____

16. Are the conclusions relevant to other settings?
   - Yes (1)
   - No (0)
   - Unable to determine (0)
   Score: _____
### Appendix Three

**Joanna Briggs Institute**  
**Systematic Review Critical Appraisal Tool**

Reviewer____________________________________________

Author ________________________________

Year _______________

<table>
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<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>Unclear</th>
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<tbody>
<tr>
<td>1. Is the review question clearly and explicitly stated?</td>
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<tr>
<td>2. Was the search strategy appropriate?</td>
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<td>3. Were the sources of studies adequate?</td>
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<td>4. Were the inclusion criteria appropriate for the review question?</td>
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<td>5. Were the criteria for appraising studies appropriate?</td>
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<tr>
<td>6. Was critical appraisal conducted by two or more reviewers independently?</td>
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<td>7. Were there methods used to minimise error in data extraction?</td>
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<td>8. Were the methods used to combine studies appropriate?</td>
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<tr>
<td>9. Were the recommendations supported by the reported data?</td>
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<tr>
<td>10. Were the specific directives for new research appropriate?</td>
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## Appendix Four

### Excluded publications prior to Critical Appraisal

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<td>Harris M, Mohay H: Learning to look in the right place: a comparison of attentional behavior in deaf children with deaf and hearing mothers. Journal of</td>
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<td>Compares deaf mothers with hearing mothers; does not</td>
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Removed: Age at onset / identification / intervention not stated.
Removed: Age at onset / identification / intervention not stated.
Removed: Age at onset / identification / intervention not stated.
Removed: Not appropriate – paper reports on psychometric validation of an assessment measure and the results are only incidental.
Removed: Data is a more detailed subset of data in other papers by the same author.
Removed: Age at onset / identification / intervention not stated.
Removed: Age at onset / identification / intervention not stated.
Appendix Five

Excluded quantitative publications

Scoring less than 7


Gantz, BJ, Rubinstein, JT, Tyler, RS, Teagle, HF, Cohen, NL, Waltzman, SB, Miyamoto, RT & Kirk, KI 2000 „Long-term results of cochlear implants in


Robinshaw, HM 1996 „The pattern of development from non-communicative behaviour to language by hearing impaired and hearing infants”, *British Journal of Audiology*, vol. 30, no. 3, pp. 177-198.


Robinshaw, HM & Evans, R 1996 „Assessing the acquisition of the auditory, communicative and linguistic skills of a congenitally deaf infant pre- and post-cochlear implantation”, *Early Child Development and Care*, vol. 117, pp. 77-98.


**Duplicated studies**


Appendix Six

Excluded qualitative publications scoring less than 7


## Critical appraisal scores for quantitative research studies

<table>
<thead>
<tr>
<th>Reference</th>
<th>Study design</th>
<th>NHMRC level of evidence</th>
<th>Type of data analysis</th>
<th>Cross-sectional or repeated measures</th>
<th>Study purpose</th>
<th>Literature</th>
<th>Sample: representativeness</th>
<th>Outcomes</th>
<th>Intervention</th>
<th>Co-interventions</th>
<th>Results: statistical significance</th>
<th>Confounders dealt with</th>
<th>Attrition (drop-outs)</th>
<th>Power</th>
<th>Results: methods</th>
<th>Confounding variables identified</th>
<th>Conclusions</th>
<th>Total</th>
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<tr>
<td>Allum, J. H., Greisiger, R., Straubhaar, S., &amp; Carpenter, M. G. (2000).</td>
<td>Prospective cohort</td>
<td>III-2</td>
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<td>Repeated measures</td>
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<td>Anderson, I., Weichbold, V., D’Haese, P. S. C., Szuchnik, J., Quevedo, M. S., Martin, J., et al. (2004). Cochlear implantation in children under the age of two--what do the outcomes show us? International Journal of Pediatric Otorhinolaryngology, 69(4), 426-431.</td>
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<td>Apuzzo, M. L., &amp; Yoshinaga-Itano, C. (1995). Early identification of infants with significant hearing loss and the Minnesota Child Development Inventory. Seminars in Hearing, 16(2), 124-139.</td>
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<td>Archbold, S., Nikolopoulos, T. P., O'Donoghue, G. M., &amp; Lutman, M. E. (1998). Educational placement of deaf children following cochlear implantation. British journal of audiology, 32(5), 295-300.</td>
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<td>Barker, B. A., &amp; Tomblin, J. B. (2004). Bimodal speech perception in infant hearing aid and cochlear implant users. Archives of Otolaryngology -- Head &amp; Neck Surgery, 130(5), 582-586.</td>
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<td>children after 10 to 14 years of cochlear implant use. Otology and Neurotology, 26(6), 1152-1160.</td>
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<td>Blamey, P., Barry, J., Bow, C., Sarant, J., Paatsch, L., &amp; Wales, R. (2001). The development of speech production following cochlear implantation. Clinical Linguistics &amp; Phonetics Vol 15(5) Jul-Aug 2001, 363-382.</td>
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<td>Robinshaw, H. M. (1996). Acquisition of speech, pre- and post-cochlear implantation: Longitudinal studies of a congenitally deaf infant. European Journal of Disorders of Communication, 31(2), 121-139.</td>
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  - Data analysis: 3 (2 cross-sectional, 1 repeated measures)
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  - Attrition (drop-outs): 1
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<td>Staller, S., Parkinson, A., Arcaroli, J., &amp; Arndt, P. (2002). Pediatric outcomes with the nucleus 24 contour: North American clinical trial. Annals of Otology, Rhinology, &amp; Laryngology - Supplement, 189, 56-61.</td>
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<td>Tobey, E. A., Geers, A. E., Brenner, C., Altuna, D., &amp; Gabbert, G. (2003). Factors associated with development of speech production skills in children implanted by age five. Ear and Hearing, 24(1 SUPPL.), 36S-45S.</td>
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<td>Co-interventions</td>
<td>Results: statistical significance</td>
<td>Confounding variables identified</td>
<td>Attrition (drop-outs)</td>
<td>Conclusions</td>
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<td>Study purpose</td>
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<td>Yoshinaga-Itano, C., Coulter, D., &amp; Thomson, V. (2001). Developmental outcomes of children with hearing loss born in Colorado hospitals with and without universal newborn hearing screening programs. Seminars in Neonatology, 6(6), 521-529.</td>
<td>Retrospective cohort</td>
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<td>Yoshinaga-Itano, C., Sedey, A. L., Coulter, D. K., &amp; Mehl, A. L. (1998). Language of early- and later-identified children with hearing loss. Pediatrics, 102(5), 1161-1171.</td>
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<td>Young, G. A., &amp; Killen, D. H. (2002). Receptive and expressive language skills of children with five years of experience using a cochlear implant. Annals of Otology, Rhinology &amp; Laryngology, 111(9), 802-810.</td>
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<td>Zimmerman-Phillips, S., Robbins, A. M., &amp; Osberger, M. J. (2000). Assessing cochlear implant benefit in very young children. Annals of Otolaryngology, Rhinology, &amp; Laryngology - Supplement, 185, 42-43.</td>
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<td>Zwolan, T. A., Ashbaugh, C. M., Alarfi, A., Kileny, P. R., Arts, H. A., El-Kashlan, H. K., et al. (2004). Pediatric cochlear implant patient performance as a function of age at implantation. Otology &amp; Neurotology, 25(2), 112-120. NOTE: PRINTED COPY ONLY</td>
<td>Retrospective cohort</td>
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<td>Zwolan, T. A., Zimmerman-Phillips, S., Ashbaugh, C. J., Hieber, S. J., Kileny, P. R., &amp; Telian, S. A. (1997). Cochlear implantation of children with minimal open-set speech recognition skills. Ear &amp; Hearing, 18(3), 240-251.</td>
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## Appendix Eight

### Critical appraisal scores for qualitative research studies

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<th>Reference</th>
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<th>Research method</th>
<th>Study purpose</th>
<th>Literature and theoretical background</th>
<th>Data collection methods</th>
<th>Sample: selection</th>
<th>Ethics and informed consent</th>
<th>Data collection detail</th>
<th>Procedural rigour</th>
<th>Coding of data</th>
<th>Trustworthiness of findings</th>
<th>Primary evidence of outcomes</th>
<th>Detail of findings</th>
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<td>Evans, J. F. (1995). <em>Conversation at home: a case study of a young deaf child’s communication experiences in a family in which all others can hear</em>. American Annals of the Deaf, 140(4), 324-332.</td>
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<td>Magnuson M: <em>Infants with congenital deafness: on the importance of early sign language acquisition</em>. American annals of the deaf 2000; 145(1):6-14.</td>
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<td>Preisler, G., Ahlstrom, M., &amp; Tvingstedt, A. L. (1997). The development of communication and language in deaf preschool children with cochlear implants. International Journal of Pediatric Otorhinolaryngology, 41(3), 263-272.</td>
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<td>Preisler, G., Tvingstedt, A. L., &amp; Ahlstrom, M. (2002). A psychosocial follow-up study of deaf preschool children using cochlear implants. Child: Care, Health and Development, 28(5), 403-418.</td>
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<td>Preisler, G., Tvingstedt, A. L., &amp; Ahlstrom, M. (2005). Interviews with deaf children about their experiences using cochlear implants. American Annals of the Deaf, 150(3), 260-267.</td>
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Appendix Nine

Critical appraisal scores for systematic reviews

Joanna Briggs Institute

Systematic Review Critical Appraisal Tool

Author: Helfand et al 2001 and Thompson et (Combined)

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<th>Question</th>
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<td>2. Was the search strategy appropriate?</td>
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<td>4. Were the inclusion criteria appropriate for the review question?</td>
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<td>5. Were the criteria for appraising studies appropriate?</td>
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<td>6. Was critical appraisal conducted by two or more reviewers independently?</td>
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<td>7. Were there methods used to minimise error in data extraction?</td>
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<td>8. Were the methods used to combine studies appropriate?</td>
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<td>9. Were the recommendations supported by the reported data?</td>
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<td>10. Were the specific directives for new research appropriate?</td>
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Score – 9/10
### Content experts

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<td>Marc Marschark</td>
<td>● Positive comments received indicating validation of the identified literature</td>
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<td>Johanna Grant Nicholas</td>
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<tr>
<td>Christine Yoshinaga-Itano</td>
<td>● Positive comments received indicating validation of the identified literature</td>
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Appendix Eleven

All included publications with information about their study design, sample size, participants, intervention/focus, dependent variables/outcomes, independent variables and measures.

Reference:

Study design:
Quantitative
Prospective cohort
Repeated measures over 2 years post-implantation

Sample size:
71

Participants:
Children with a cochlear implant divided into three groups: those above and those below the age of 7 years at the time of implantation, and children implanted at <3 years and deafened by meningitis

Intervention/focus:
Factors affecting outcome of cochlear implantation

Dependent variables/outcomes:
Auditory skills

Independent variables:
Age at implantation
Cause of hearing loss
Implant characteristics: implant model

Measures:
LiP, MAIS, MTP
Reference:

**Study design:**
Quantitative
Case series with post-test outcomes
Repeated measures over 2 years

**Sample size:**
7

**Participants:**
Children with hearing loss; aged 4–7 years at commencement of study

**Intervention/focus:**
Sign language
Bilingual-bicultural programs

**Dependent variables/outcomes:**
Auditory skills
Social-emotional development
Cognitive development
Receptive sign language: vocabulary
Expressive language
Academic achievement

**Independent variables:**

**Measures:**
BBCS, M-K, TAC, CPVT, GAEL-S, SAT
WJ
Reference:

**Study design:**
Quantitative
Retrospective cohort
Cross-sectional

**Sample size:**
69

**Participants:**
Children with hearing loss divided into 4 groups according to age at identification of hearing loss: birth – 2 months, 3–12 months, 13–24 months, 25+ months; age at testing = 25–60 months

**Intervention/focus:**
Factors affecting outcomes for children with hearing loss

**Dependent variables/outcomes:**
Receptive and expressive language
Motor development
Social-emotional development

**Independent variables:**
Age at identification of hearing loss

**Measures:**
Minnesota CDI
Reference:

**Study design:**
Quantitative
Prospective cohort
Repeated measures over 5 years

**Sample size:**
46

**Participants:**
Children with a cochlear implant; mean age at implantation = 53 months (30–82 months)

**Intervention/focus:**
Factors affecting outcomes of cochlear implantation

**Dependent variables/outcomes:**
Auditory skills
Speech production: intelligibility

**Independent variables:**
Communication mode (child’s preferred or usual): signed (includes use of spoken English with sign support) or oral (spoken language)

**Measures:**
IOWA Matrix Closed Set Sentence Test, CAP, SIR, CDT
Reference:

Study design:
Quantitative
Prospective cohort
Repeated measures: pre-implantation and two years post-implantation

Sample size:
48

Participants:
Children with a cochlear implant; mean age at implantation = 65.8 months

Intervention/focus:
Factors affecting outcome of cochlear implantation

Dependent variables/outcomes:
Educational placement

Independent variables:
Age at implantation
Duration of hearing loss prior to intervention

Measures:
Educational placement: pre-school, school for the deaf, unit or resource base within mainstream school or full-time mainstream provision
Reference:

Study design:
Quantitative
Prospective cohort
Repeated measures over 3 years post-implantation

Sample size:
85

Participants:
Children with a cochlear implant; mean age at implantation = 63.6 months (21–203)

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Cochlear implant use

Independent variables:
Age at implantation
Age at onset of hearing loss
Duration of hearing loss prior to intervention
Cause of hearing loss

Measures:
Parent- and teacher-rated device use – four-point scale ranging from none of the time to all of the time
Reference:

Study design:
Quantitative
Case series with pre- and post-test outcomes
Repeated measures over approximately 1 year

Sample size:
8

Participants:
Children with a cochlear implant; mean age at implantation = 15 months (11–20 months)

Intervention/focus:
Outcomes of cochlear implantation

Dependent variables/outcomes:
Speech perception

Independent variables:

Measures:
SPLP
Reference:

**Study design:**
Quantitative
Retrospective cohort
Repeated measures 7 years apart

**Sample size:**
41 children and their families

**Participants:**
29 children with a cochlear implant; mean age at implantation = 59 months
12 children with a hearing aid; age at amplification not stated
Mean age of entire sample at second data collection = 10 years

**Intervention/focus:**
Outcomes of cochlear implantation and amplification

**Dependent variables/outcomes:**
Communication skills
Daily living skills
Motor development
Social development
Receptive language
Expressive language

**Independent variables:**
Type of hearing technology used: cochlear implantation versus hearing aid
Age at implantation
Duration of hearing technology use
Degree of hearing loss

**Measures:**
VABS
Reference:

Study design:
Quantitative
Retrospective cohort
Repeated measures over 3 years post-implantation

Sample size:
33

Participants:
Children with a cochlear implant divided into two groups according to age at implantation: before and after 3 years; mean age at implantation = 4 years (9 months–9 years)

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Auditory skills

Independent variables:
Age at implantation

Measures:
EARS test battery
Reference:

Study design:
Quantitative
Case series with pre- and post-test outcomes
Repeated measures over approximately 10 years post-implantation

Sample size:
30

Participants:
Children with a cochlear implant; age at implantation = 2.5–11.1 years, age at final data collection = 14–23.9 years

Intervention/focus:
Outcomes of cochlear implantation

Dependent variables/outcomes:
- Cochlear implant use
- Speech perception
- Speech production: intelligibility
- Educational placement
- Vocational outcomes

Independent variables:

Measures:
CAP, SIR
Reference:

Study design:
Quantitative
Case series with pre- and post-test outcomes
Repeted measures over 6 years post-implantation

Sample size:
9

Participants:
Children with a cochlear implant; mean age at implantation = 45 months (30–62 months)

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Speech production
Speech perception

Independent variables:
Age at implantation

Measures:
Percentage of correctly used phonemes and words, MLU, PBK
Reference:

**Study design:**
Quantitative
Prospective cohort
Repeated measures over 3 years

**Sample size:**
87

**Participants:**
47 children with a cochlear implant; mean age at implantation = 3.5 years (1.2–8.2 years); mean age at data collection = 7.7 years (4.3–13.0)

40 children with a hearing aid; age at amplification unknown; mean age at data collection = 9.0 years (4.5–13.5)

**Intervention/focus:**
Outcomes of cochlear implantation and amplification

**Dependent variables/outcomes:**
Speech production
Receptive language: vocabulary

**Independent variables:**
Degree of hearing loss
Duration of hearing loss
Duration of device use

**Measures:**
PPVT, CELF, CNC, BKB, MLU, number of unintelligible words, percentage of correctly pronounced vowels and consonants
Reference:

Study design:
Quantitative
Case series with post-test outcomes
Repeated measures over approximately 7 years

Sample size:
3

Participants:
Children with hearing loss; age at commencement of study = 0;11, 0;11 and 1;6 years

Intervention/focus:
Bilingual (sign/spoken) language development in children with hearing loss

Dependent variables/outcomes:
Expressive language: language choice; vocabulary, syntax and morphology

Independent variables:
Maternal language input: content and accessibility

Measures:
Mother’s and child’s language choice: percentage of spoken, signed and combined signed/spoken input; percentage of mother’s words and signs seen by child; use of verbs by mother and child; child’s language - number of different word and sign types, MLU
Reference:

Study design:
Quantitative
Case series with pre- and post-test outcomes
Repeated measures over 18 months

Sample size:
10

Participants:
Children with a cochlear implant; mean age at implantation = 3.1 years (2.2–4.6 years)

Intervention/focus:
Outcomes of cochlear implantation

Dependent variables/outcomes:
Receptive and expressive language

Independent variables:

Measures:
RDLS, PPVT, MLU
Reference:

Study design:
Quantitative  
Prospective cohort  
Cross-sectional

Sample size:
89 mother-child dyads

Participants:
Children aged 17–30 months and their mothers divided into groups according to the hearing status of child and mother:

42 deaf children: 22 with a hearing mother (dc/HM), 20 with a deaf mother (dc/DM)

47 normally hearing children: 26 with a hearing mother (hc/HM), 21 with a deaf mother (hc/DM)

Intervention/focus:
Factors affecting outcomes for children with hearing loss

Dependent variables/outcomes:
Receptive and expressive language (signed and spoken)  
Symbolic play

Independent variables:
Parental hearing status

Measures:
ELI (NDW, word types), RDLS, coding of child play (amount of symbolic play)
Reference:
*Language and Cognitive Processes, 21*(5), 608-635.

**Study design:**
Quantitative
Prospective cohort
Cross-sectional

**Sample size:**
30

**Participants:**
Adults with hearing loss divided into groups according to age at first exposure to sign language: native learners (control group), early learners (first exposure at 5–7 years) and delayed learners (8–13 years)

There were no significant differences among the groups in mean length of sign language (ASL) use.

**Intervention/focus:**
Factors affecting outcomes for children with hearing loss

**Dependent variables/outcomes:**
Receptive language: sentence processing in American Sign Language

**Independent variables:**
Age at exposure to sign language

**Measures:**
Grammatical judgment task
Reference:

Study design:
Quantitative
Prospective cohort
Repeated measures over varying periods up to 3 years post-implantation

Sample size:
33

Participants:
Children with a cochlear implant divided into groups according to age in years at implantation: 2–3, 3–5

Intervention/focus:
Factors that affect outcomes of cochlear implantation

Dependent variables/outcomes:
Receptive language: vocabulary
Expressive language: vocabulary and syntax-morphology
Speech perception
Speech production

Independent variables:
Age at implantation

Measures:
PPVT, EOWPVT, rating of expressive language, ESP, AB Word Lists, CID Phonetic Inventory
Reference:

Study design:
Quantitative
Prospective cohort
Cross-sectional

Sample size:
73

Participants:
37 children 8- to 9-year old children with a cochlear implant; mean age at implantation = 3.0 years (1.7–5.0 years); total communication users (primary emphasis on manually coded English and lip-reading) and oral communication users (oral-only communication)

36 normally hearing children matched by age and gender to the cochlear implant children

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Speech timing
Cognitive ability and functioning: working memory

Independent variables:
Cochlear implant
Communication mode – child’s usual or preferred

Measures:
McGarr, WISC-III digit span test
Reference:

Study design:
Quantitative
Prospective cohort
Cross-sectional

Sample size:
28

Participants:
Children with hearing loss who had graduated from a total communication early intervention program; age at data collection = 45–88 months

Intervention/focus:
Factors affecting outcomes for children with hearing loss
Total communication

Dependent variables/outcomes:
Receptive and expressive language
Social-emotional development
Reading ability

Independent variables:
Parental involvement
Degree of hearing loss
Maternal communication skill

Measures:
Parent questionnaire on parental involvement, independent rating of parental involvement based on case notes, LPP-PV, PLS, TERA-D, SEAI, CBCL
Reference:

Study design:
Quantitative
Prospective cohort
Repeated measures 36 months apart

Sample size:
22

Participants:
Children with hearing loss who had graduated from a total communication early intervention program; mean age at final data collection = 62 months

Intervention/focus:
Factors affecting outcomes for children with hearing loss
Total communication

Dependent variables/outcomes:
Receptive and expressive language
Reading ability
Nonverbal cognitive ability
Social-emotional development

Independent variables:
Presence or absence of father

Measures:
LDS, PLS, WPPSI (geometric design subscale), LPP-PV, SEAI, CBCL, TERA-D
Reference:

**Study design:**
Quantitative
Prospective cohort
Cross-sectional

**Sample size:**
Study 1: 80
Study 2: 28

**Participants:**
Children with hearing loss who had graduated from a total communication early intervention program; age at data collection = 45–88 months

**Intervention/focus:**
Factors affecting outcomes for children with hearing loss
Total communication

**Dependent variables/outcomes:**
Receptive and expressive language
Auditory skills
Speech production
Social-emotional development
Reading ability

**Independent variables:**
Age at entry to early intervention program
Degree of hearing loss

**Measures:**
LDS, Auditory Training Checklist (unpublished measure of auditory skills), modified version of Ling, questionnaires on family perspectives regarding early intervention services and parental involvement in child’s education, LPP (modified version to assess maternal communication skill), PLS, TERA-D, SEAI
Reference:

Study design:
Quantitative
Retrospective cohort
Cross-sectional

Sample size:
98

Participants:
51 children with a cochlear implant; mean age at implantation = 3;2 years (1;5–5;10 years), chronological age = 2;11–10;8 years

47 normally hearing children; chronological age = 2;6–6;9 years

Intervention/focus:
Outcomes of cochlear implantation

Dependent variables/outcomes:
Speech intelligibility

Independent variables:
Duration of device use
Chronological age at testing

Measures:
BIT
Reference:

Study design:
Quantitative
Sample survey
Cross-sectional

Sample size:
62

Participants:
Parents of children with a cochlear implant

Intervention/focus:
Cochlear implantation

Dependent variables/outcomes:
Educational placement

Independent variables:

Measures:
Educational placement: mainstream, special unit, school for the deaf (day or residential)

Educational support services used (e.g. sign language interpreter, teacher’s aide)
Reference:

Study design:
Quantitative
Prospective cohort
Cross-sectional

Sample size:
90

Participants:
Experiment 1: 45 8- and 9-year old children with a Nucleus 22 cochlear implant; mean length of cochlear implant use = 5.5 years (4.3–6.9 years)
45 normally hearing children matched for age and gender with the cochlear implant group

Experiment 2: 27 of the original 45 normal hearing children

Experiment 3: New sample of 45 8- and 9-year old cochlear implant users

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Cognitive ability and functioning: working memory

Independent variables:

Measures:
Working memory task, WISC digit span, PPVT
Reference:

**Study design:**
Quantitative
Retrospective cohort
Cross-sectional

**Sample size:**
61

**Participants:**
61 children with a cochlear implant; mean age at testing = 9.2 years (5.3–16.5 years), mean age at implantation = 4.4 years (1.4–8.9); total communication users and „primarily oral” communicators

**Intervention/focus:**
Factors affecting outcomes of cochlear implantation

**Dependent variables/outcomes:**
Speech perception
Receptive language: vocabulary

**Independent variables:**
Communication mode – child’s usual or preferred

**Measures:**
PBK, LNT, PPVT, WISC digit span
Reference:

**Study design:**
Quantitative
Retrospective cohort
Repeated measures over 2 years post-implantation

**Sample size:**
10

**Participants:**
Children with a cochlear implant; age at implantation = 4–11 (mean 9.5) months
Comparison data is provided from two groups: children implanted at 12–23 and 24–36 months

**Intervention/focus:**
Early cochlear implantation

**Dependent variables/outcomes:**
Speech perception
Prelinguistic vocalisation

**Independent variables:**
Age at implantation

**Measures:**
CAP, age at onset of babbling and of babbling spurt
Reference:

Study design:
Mixed method (quantitative and qualitative)
Case series with pre- and post-test outcomes
Repeated measures over 14 years

Sample size:
1

Participants:
Child with a cochlear implant

Intervention/focus:
Cochlear implantation

Dependent variables/outcomes:
Speech intelligibility
Receptive language: vocabulary
Expressive language

Independent variables:

Measures:
McGarr, percentage of correctly pronounced consonants, PPVT, Woodcock-Johnson Picture Vocabulary and Passage Comprehension subtests, Woodcock Passage Comprehension subtest, MLU, NDW, thematic analysis of language samples
Reference:

Study design:
Quantitative
Retrospective cohort
Repeated measures over varying periods up to 4 years post-implantation

Sample size:
100

Participants:
100 children with a cochlear implant; four groups based on age at implantation (1–2.5 years, 2.6–3.5 years, 3.6–7 years, 7.1–10 years). All children were strictly oral communicators, i.e. speech with or without lip-reading, no sign language.

Intervention/focus:
Early cochlear implantation

Dependent variables/outcomes:
Receptive language: vocabulary
Speech production

Independent variables:
Age at implantation

Measures:
PPVT, consonant-production accuracy (SPEECH)
Reference:

**Study design:**
Quantitative
Prospective cohort
Repeated measures over 1 year

**Sample size:**
91

**Participants:**
Children with a cochlear implant; mean age at testing = 11 years (SD=2.7), mean age at implantation = 6.8 (3.1) years; 48 users of oral communication and 43 of total communication (speech plus manually coded English) programs.

Children were classified according to the type of program they were enrolled in, parental report and child communication at time of data collection.

**Intervention/focus:**
Factors affecting outcomes of cochlear implantation

**Dependent variables/outcomes:**
Reading ability
Expressive and receptive vocabulary

**Independent variables:**
Pre-implantation language: vocabulary
Pre-implantation mode of communication
Pre-implantation audition
Duration of device use
Age of onset of hearing loss
Socioeconomic status
Gender
Race/ethnicity

**Measures:**
Woodcock Passage Comprehension subtest, Woodcock-Johnson Picture Vocabulary subtest, EOWPVT
Reference:

Study design:
Quantitative
Prospective cohort
Cross-sectional

Sample size:
69

Participants:
32 children with a cochlear implant; mean age at time of study = 9.0 years (4.5–13 years); mean age at implantation = 3.7 years (1.0–9.7 years)

37 normally hearing classmates of the children with a cochlear implant

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Functioning in mainstream education

Independent variables:
Duration of hearing loss
Duration of device use
Age at implantation
Age at onset of hearing loss

Measures:
AMP, SIFTER, Bosman and Gestel-Nijmegen Dutch language tests of phoneme and word identification
Reference:

Study design:
Quantitative
Retrospective cohort
Cross-sectional

Sample size:
49

Participants:
Children with a cochlear implant, divided into three groups on the basis of cognitive performance: normal/average or above (n=27), mild/low-average/borderline normal (14), moderate or significant delay/intellectually disabled (8); group means for age at testing = 60.1–79.2 months, group means for age at implantation = 25.1–27.7 months

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Speech perception

Independent variables:
Presence or absence of other disabilities (cognitive/developmental delay)

Measures:
Clinical rating of open- and closed-set speech perception using a wide range of tests and measures including PLOTT and PBK
Reference:

**Study design:**
Quantitative
Prospective cohort
Cross-sectional

**Sample size:**
76

**Participants:**
Children with a cochlear implant; mean age at implantation = 3.3 years (SD=1.0); total communication (use of sign, usually signed English, and lip-reading) and oral-only communicators

**Intervention/focus:**
Factors affecting outcomes of cochlear implantation

**Dependent variables/outcomes:**
Nonword repetition task (involving speech perception, speech production and working memory)

**Independent variables:**
Age at onset of hearing loss
Communication mode: child's usual or preferred
Duration of hearing loss prior to implantation
Chronological age at testing

**Measures:**
CNRep, WIPI, WISC digit span, McGarr
Reference:

Study design:
Quantitative
Prospective cohort
Repeated measures over four testing sessions

Sample size:
30

Participants:
Children with hearing loss; age at data collection = 30–57 months

Intervention/focus:
Factors affecting outcomes for children with hearing loss

Dependent variables/outcomes:
Cognitive development
Receptive and expressive language
Speech production: phonology
Pragmatic language development

Independent variables:
Lip reading skills

Measures:
VMI, ITPA, RDLS, TACL, PPVT, EOWPVT, MLU, TTR, phoneme repertoire, percent consonants correct, speech error patterns
Reference:

Study design:
Quantitative
Prospective cohort
Repeated measures over 21 months

Sample size:
54

Participants:
25 children with hearing loss enrolled in an auditory-verbal program; mean age = 5.5 years

29 children with normal hearing matched by language age to the children with hearing loss; mean chronological age = 3 years

Intervention/focus:
Auditory-verbal programs

Dependent variables/outcomes:
Receptive and expressive language
Speech production

Independent variables:

Measures:
PLS, PPVT, CELF, parent survey on children’s language development
Reference:

**Study design:**
Quantitative  
Prospective cohort  
Repeated measures over 9 months

**Sample size:**
58

**Participants:**
29 children with hearing loss enrolled in an auditory-verbal program; mean age = 5.5 years  
29 children with normal hearing matched by language age to the children with hearing loss; mean chronological age = 3 years

**Intervention/focus:**
Auditory-verbal programs

**Dependent variables/outcomes:**
Receptive and expressive language  
Speech production

**Independent variables:**

**Measures:**
PLS, PPVT, CELF
Reference:

Study design:
Quantitative
Prospective cohort
Repeated measures over varying periods post-implantation ranging from 3 months to 10 years

Sample size:
102

Participants:
Children with a cochlear implant; age = > 4 years, mean age at implantation = 5.9 years (1.5–17.6 years); users of exclusively oral communication and users of speech plus some level of „manual supplement”

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Speech perception

Independent variables:
Age at implantation
Age at onset of hearing loss
Duration of hearing loss prior to implantation
Duration of device use
Cause and nature of hearing loss (meningitis/non-meningitis, progressive/non-progressive)
Communication mode: child’s usual or preferred
Presence or absence of other disabilities
Implant characteristics: processing strategy

Measures:
PBK, BKB
**Reference:**

**Study design:**
Quantitative
Prospective cohort
Cross-sectional

**Sample size:**
22

**Participants:**
11 children with hearing loss attending an oral integrated preschool; age = 3.8–5.2 years

11 normally hearing children attending the same preschool; age = 3.7–5.3 years

**Intervention/focus:**
Outcomes of integrated programs for children with hearing loss
Outcomes of oral rehabilitation approaches

**Dependent variables/outcomes:**
Pragmatic language development: conversational skills

**Independent variables:**

**Measures:**
Social Organization of Discourse Checklist/Conversational Skills (unpublished measure)
Reference:

**Study design:**
Quantitative
Prospective cohort
Cross-sectional

**Sample size:**
40

**Participants:**
40 children aged less than 10.5 years with hearing loss who had attended auditory-verbal programs and their families

**Intervention/focus:**
Auditory-verbal programs

**Dependent variables/outcomes:**
Outcomes of auditory-verbal therapy: successful graduation versus leaving because of dissatisfaction

**Independent variables:**
Gender
Presence or absence of additional disabilities
Having a cochlear implant
Maternal employment status
Parental involvement
Social-emotional development
Educational placement: mainstream versus special setting
Presence or absence of other disabilities: having a delay in reading/language development of >1 year

**Measures:**
Reference:

**Study design:**
Quantitative
Prospective cohort
Cross-sectional

**Sample size:**
70

**Participants:**
40 children with hearing loss who had attended auditory-verbal programs and their families

**Intervention/focus:**
Auditory-verbal programs

**Dependent variables/outcomes:**
Social-emotional development
Reading/language delay
Educational placement: mainstream versus special setting

**Independent variables:**
Gender

**Measures:**
LIPS, parent interview and questionnaire data on attitudes to auditory-verbal therapy and children’s language progress
Reference:

**Study design:**
Quantitative
Prospective cohort
Repeated measures over approximately 2 years

**Sample size:**
32

**Participants:**
Children with a cochlear implant; mean age at testing = 1.9 years (1.2–2.8 years);
mean age at implantation (switch-on) = 2.4 years (1.5–3.4 years)

**Intervention/focus:**
Factors affecting outcomes of cochlear implantation

**Dependent variables/outcomes:**
Speech perception
Speech production: intelligibility

**Independent variables:**
Presence or absence of other disabilities (cognitive/developmental delay)

**Measures:**
SGS II, IT-MAIS, SIR, E2L
Reference:

**Study design:**
Quantitative
Case series with pre-and post-test outcomes
Repeated measures over 14 months

**Sample size:**
1

**Participants:**
Child with a cochlear implant; age at commencement of study = 17 months, age at implantation = 19 months

**Intervention/focus:**
Outcomes of cochlear implantation

**Dependent variables/outcomes:**
Speech production

**Independent variables:**

**Measures:**
SAEVD


Reference:

**Study design:**
Quantitative
Case series with pre- and post-test outcomes
Repeated measures over 14 months

**Sample size:**
2

**Participants:**
Children with a cochlear implant; age at commencement of study = 8 and 26 months, age at implantation = 10 and 28 months respectively

**Intervention/focus:**
Outcomes of cochlear implantation

**Dependent variables/outcomes:**
Speech production

**Independent variables:**

**Measures:**
Classification of vocalisations – precanonical, canonical or postcanonical
Reference:

**Study design:**
Quantitative
Case series with pre- and post-test outcomes
Repeated measures over 20 months (child 1) and approximately 10 months (child 2)

**Sample size:**
2

**Participants:**
Children with a cochlear implant; age at commencement of data collection = 7;6 and 4;2 years, age at implantation = 7;6 and 3;0 years (children 1 and 2 respectively)

**Intervention/focus:**
Speech-language therapy following cochlear implantation

**Dependent variables/outcomes:**
Speech perception and other auditory skills

**Independent variables:**

**Measures:**
Wide range of receptive and expressive language measures including Ling 6, PPVT, RDLS
Reference:

Study design:
Quantitative
Case series with pre- and post-test outcomes
Repeated measures over 14 months

Sample size:
1

Participants:
Child with a cochlear implant; age at commencement of study = 17 months, age at implantation = 19 months

Intervention/focus:
Outcomes of cochlear implantation

Dependent variables/outcomes:
Speech production
Expressive and receptive vocabulary

Independent variables:

Measures:
SAEVD; MCDI: Words and Gestures; precanonical, canonical and postcanonical vocalisation, consonant production
Reference:

**Study design:**
Quantitative
Case series with pre- and post-test outcomes
Repeated measures over 14 months

**Sample size:**
1

**Participants:**
Child with a cochlear implant; age at commencement of study = 17 months, age at implantation = 19 months

**Intervention/focus:**
Outcomes of cochlear implantation

**Dependent variables/outcomes:**
Receptive language: vocabulary and comprehension
Speech intelligibility and other aspects of speech production
Expressive speech: lexical diversity and pragmatics

**Independent variables:**

**Measures:**
PPVT, ACLC, BIT, Expressive Vocabulary Test, classification of utterances by phonological type and communicative intent, TTRs, MLU
Reference:

**Study design:**
Quantitative
Prospective cohort
Cross-sectional

**Sample size:**
30

**Participants:**
Three groups of adults: 10 deaf native signers, 10 hearing subjects with deaf parents and 10 hearing subjects who had had no contact with deaf people or sign language

**Intervention/focus:**
Sign language: influence of sign language on written language ability

**Dependent variables/outcomes:**
Written language ability

**Independent variables:**

**Measures:**
Series of writing tasks: NDW; use of non-standard forms
Reference:

**Study design:**
Quantitative
Prospective cohort
Repeated measures over varying periods ranging from 12 to 21 months post-implantation

**Sample size:**
6

**Participants:**
Children with a cochlear implant; mean age at commencement of study = 5;0±0;10 years, mean age at implantation = 2;4±0;6 years

**Intervention/focus:**
Factors affecting outcomes of cochlear implantation

**Dependent variables/outcomes:**
Speech production: intelligibility

**Independent variables:**
Chronological age at testing
Duration of device use

**Measures:**
II
Reference:

Study design:
Quantitative
Retrospective cohort
Cross-sectional

Sample size:
2858

Participants:
468 children with a cochlear implant
2390 children with a hearing loss without a cochlear implanted

Intervention/focus:
Demographic and other background characteristics of children with a cochlear implant

Variables examined:
Degree of hearing loss
Gender
Socioeconomic status
Cause of hearing loss
Presence or absence of other disabilities: number of additional disabilities
Parental hearing status
Communication mode: child’s usual or preferred
Reference:

**Study design:**
Quantitative
Retrospective cohort
Repeated measures over 5 years post-implantation

**Sample size:**
34

**Participants:**
Children with a cochlear implant; age at implantation = 2/6–15;4 years. All participants were total communication users, with varying degrees of use of signing.

**Intervention/focus:**
Factors affecting outcomes of cochlear implantation

**Dependent variables/outcomes:**
Speech perception

**Independent variables:**
Age at implantation

**Measures:**
MTS, ESP, WIPI, Vowel Perception Test, PBK
Reference:

**Study design:**
Quantitative
Prospective cohort
Cross-section

**Sample size:**
181

**Participants:**
8- and 9-year old children with a cochlear implant; mean age at implantation = 3;4 years (1;8–5;4 years)

**Intervention/focus:**
Factors affecting outcomes of cochlear implantation

**Dependent variables/outcomes:**
Speech perception

**Independent variables:**
Child and family characteristics:
- Age at testing
- Age at implantation
- Age at onset of hearing loss
- Nonverbal cognitive ability
- Family structure: family size
- Socioeconomic background
- Gender

Educational characteristics:
- Intensity of intervention: number of hours of therapy
- Therapist experience
- Parental involvement
- Educational placement: private versus public school, mainstream versus special education
- Communication mode of program attended by child (rated on a scale from 1 to 6: 1 – sign-only; 2 – almost always simultaneous communication; 3 – speech only part of the time ; 4 – cued speech; 5 – auditory-oral; 6 – auditory-verbal)

Implant characteristics:
- Processing strategy
- Number of inserted electrodes
- Dynamic range
- Loudness growth

**Measures:**
ESP, VIDSPAC, WIPI, LNT, CAVET
Reference:

Study design:
Quantitative
Prospective cohort
Cross-sectional

Sample size:
27

Participants:
8- and 9- year old children with a cochlear implant; mean age at implantation = 3.7 years (2.5–4.9 years); all enrolled in total communication programs (sign language plus speech)

Intervention/focus:
Outcomes of cochlear implantation for children in total communication programs

Dependent variables/outcomes:
Speech perception
Speech production: intelligibility
Receptive language
Expressive language (both spoken and signed): syntactic complexity, lexical diversity

Independent variables:
Mode of communication: child’s usual or preferred

Measures:
WIPI, McGarr, BIT, TACL-R, NDW, number of words and morphemes per utterance, percentages of words signed and spoken
Reference:

Study design:
Quantitative
Prospective cohort
Cross-sectional

Sample size:
181

Participants:
8- and 9-year old children with a cochlear implant; mean age at implantation = 3;4 years (1;8–5;4 years)

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Reading ability

Independent variables:
Child and family characteristics:
  Age at testing
  Age at implantation
  Age at onset of hearing loss
  Nonverbal cognitive ability
  Family structure: family size
  Socioeconomic background
  Gender

Educational characteristics:
  Intensity of intervention: number of hours of therapy
  Therapist experience
  Parental involvement
  Educational placement: private versus public school, mainstream versus special education
  Communication mode of program attended by child (rated on a scale from 1 to 6: 1 – sign-only; 2 – almost always simultaneous communication; 3 – speech only part of the time; 4 – cued speech; 5 – auditory-oral; 6 – auditory-verbal)

Implant characteristics:
  Processing strategy
  Number of inserted electrodes
  Dynamic range
  Loudness growth

Phonological processing
Speech perception and production, language (using results reported in earlier publications from the same data set)

Measures:
WRMT, PIAT, WISC-III digit span, lexical decision task, rhyming task
Reference:

Study design:
Quantitative
Prospective cohort
Cross-sectional

Sample size:
172

Participants:
133 congenitally deaf 8- and 9-year old children with a cochlear implant; mean age at implantation = 3;6 years (2;0–5;2 years)

39 8- and 9-year old children with deafness acquired by age 3 years and a cochlear implant; implanted by aged 5

Intervention/ focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Speech perception
Speech intelligibility and other aspects of speech production
Receptive and expressive language
Reading ability

Independent variables:
Age at implantation
Duration of device use
Duration of deafness

Measures:
Large battery of speech, language and achievement measures including LNT, CAVET, BKB, ESP, WIPI, VIDSPAC, ARQ, McGarr, fricative and plosive production, parent report of speech intelligibility, MLU, IPSyn, NDW, TACL, PIAT, WRMT
Reference:

**Study design:**
Quantitative
Prospective cohort
Cross-sectional

**Sample size:**
181

**Participants:**
8- and 9-year old children with a cochlear implant; mean age at implantation = 3;4 years (1;8–5;4 years)

**Intervention/focus:**
Demographic and other background characteristics of children with a cochlear implant

**Variables examined:**
Child and family characteristics:
- Age at testing
- Age at implantation
- Nonverbal cognitive ability
- Family structure: family size
- Socioeconomic background
- Gender

Educational characteristics:
- Intensity of intervention: number of hours of therapy
- Parental involvement
- Educational placement: private versus public school, mainstream versus special education
- Communication mode of program attended by child (rated on a scale from 1 to 6: 1 – sign-only; 2 – almost always simultaneous communication; 3 – speech only part of the time; 4 – cued speech; 5 – auditory-oral; 6 – auditory-verbal)

Implant characteristics:
- Processing strategy
- Number of inserted electrodes
- Dynamic range
- Loudness growth

Reference:
Study design:
Quantitative
Prospective cohort
Cross-sectional

Sample size:
181

Participants:
8- and 9-year old children with a cochlear implant; mean age at implantation = 3;4 years (1;8–5;4 years)

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Receptive and expressive language

Independent variables:
Child and family characteristics:
  Age at testing
  Age at implantation
  Age at onset of hearing loss
  Nonverbal cognitive ability
  Family structure: family size
  Socioeconomic background
  Gender

Educational characteristics:
  Intensity of intervention: number of hours of therapy
  Therapist experience
  Parental involvement
  Educational placement: private versus public school, mainstream versus special education
  Communication mode of program attended by child (rated on a scale from 1 to 6: 1 – sign-only; 2 – almost always simultaneous communication; 3 – speech only part of the time ; 4 – cued speech; 5 – auditory-oral; 6 – auditory-verbal)

Measures:
TACL-R, IPSyn, MLU, NDW, use of bound morphemes, narrative task, speech/sign interview

Reference:

Study design:
Quantitative
Retrospective cohort
Repeated measures over 9 years

Sample size:
37

Participants:
Children with a cochlear implant; mean age at implantation = 5.7 years. The children were divided into two groups based on their hearing threshold: <95 dB (n=37) and ≥95 dB (n=96).

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Speech perception

Independent variables:
Degree of hearing loss

Measures:
WIPI, PBK
Reference:

**Study design:**
Quantitative
Prospective cohort
Repeated measures over 8 years (study 1) or 5 years (study 2) post-implantation

**Sample size:**
82

**Participants:**
Study 1: 82 children with a cochlear implant; mean age at implantation = 5.4 years (2.0–13.3 years). The children were allocated to subgroups based on age at implantation (2, 3, 4, 5, 6, 7, 8, 9 and 10–13 years).

Study 2: 82 children with a cochlear implant; mean age at implantation = 6.3 years (1.9–5.4 years). Binary partitioning was used to analyse the effect of age at implantation.

**Intervention/focus:**
Factors affecting outcomes of cochlear implantation

**Dependent variables/outcomes:**
Speech perception

**Independent variables:**
Age at implantation

**Measures:**
TAC, GASP, PBK
Reference:

**Study design:**
Quantitative
Prospective cohort
Repeated measures over 2 years post-implantation

**Sample size:**
119

**Participants:**
Children with a cochlear implant; mean age at implantation = 7;1 years (1;6–16;3 years). The participants were allocated to six groups based on age in years at implantation: 0–3, 4–5, 6–7, 8–9, 10–11 and 12.

**Intervention/focus:**
Factors affecting outcomes of cochlear implantation

**Dependent variables/outcomes:**
Speech perception

**Independent variables:**
Age at implantation

**Measures:**
Persian measure of speech perception
Reference:

Study design:
Quantitative
Prospective cohort
Repeated measures over 2 years post-implantation

Sample size:
12

Participants:
Children with a cochlear implant; mean age at implantation = 20.5 months (17–23 months)

The results were compared with data obtained from a group of children who received an implant between the ages of 2 and 5 years.

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Auditory skills

Independent variables:
Age at implantation

Measures:
LiP, CAP
Reference:
Rockville, MD: Agency for Healthcare Quality and Research.


**Study design:**
Systematic review of observational studies

**Participants:**
Children with hearing loss

**Intervention/focus:**
Factors affecting outcomes for children with hearing loss

**Dependent variables/outcomes:**
Varies across studies reviewed

**Independent variables:**
Age at identification
Reference:

Study design:
Quantitative
Prospective cohort
Cross-sectional

Sample size:
416

Participants:
213 mothers and 213 fathers of children with hearing loss

Intervention/focus:
Factors affecting outcomes for children with hearing loss

Dependent variables/outcomes:
Social-emotional development
Communicative competence

Independent variables:
Parental coping/stress
Communication mode of family
Parental educational level
Gender
Degree of hearing loss
Age at data collection
Having a cochlear implant
Presence or absence of other disabilities
Age at identification of hearing loss
Cause of hearing loss

Measures:
PSI, SDQ-D, SOC, SSQ, self developed scale

Reference:
Study design:
Quantitative
Prospective cohort
Cross-sectional

Sample size:
58

Participants:
Children with a cochlear implant; mean age at implantation = 6 years (2–14 years); age at data collection = 2–17 years

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Speech perception

Independent variables:
Duration of device use
Age at implantation
Socioeconomic status
Bilingual home
Participation in private therapy
Educational placement: private versus public school
Communication mode: child’s usual or preferred

Measures:
ESP, NU-CHIPS, Minimal Pairs Test, PBK, Hollingshead Four Factor Index of Social Status
Reference:

Study design:
Quantitative
Retrospective cohort
Repeated measures over 2–3 years

Sample size:
69

Participants:
19 children with a cochlear implant with cognitive delay; mean age at implantation = 38 months (SD=14)

50 children with a cochlear implant without cognitive delay or any other disability; mean age at implantation = 29 months

Within these groups (delayed, not delayed) a comparison was made between oral communicators (no use of sign) and total communicators (speech plus manually coded English).

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Auditory skills
Receptive and expressive language

Independent variables:
Presence or absence of other disabilities
Mode of communication: child’s usual or preferred

Measures:
IT-MAIS, GAEL-P (adapted to measure speech perception), Mr Potato Head Task, PSI, PPVT, RDLS
Reference:

Study design:
Quantitative
Retrospective cohort
Repeated measures over varying periods ranging from 1 to 6 years post-implant

Sample size:
47

Participants:
Children with a cochlear implant; mean age at implantation = 4.4±1.4 years

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Variables examined:
Cognitive development: response delay (behavioural inhibition)

The first part of the study examines the effect of various variables on response delay:
Age at onset of hearing loss
Cognitive ability (nonverbal IQ)
Degree of hearing loss
Gender
Cause of hearing loss
Communication mode: child’s usual or preferred
Duration of device use

The second part of the study examines response delay as a predictor of speech perception, speech intelligibility, and receptive and expressive language.

Measures:
Preschool Delay Task (Gordon Diagnostic System), PBK, PPVT, RDLS, BIT
Reference:

Study design:
Quantitative
Retrospective cohort
Repeated measures over

Sample size:
23

Participants:
Children with a cochlear implant; mean age at implant (activation) = 28.2±13.8 months

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Speech perception
Receptive and expressive language

Independent variables:
Pre-implantation motor skills: gross and fine

Measures:
VABS, GAEL-P (used as a measure of speech perception), RDLS, PPVT
Reference:

Study design:
Quantitative
Prospective cohort
Cross-sectional

Sample size:
48

Participants:
24 children with a cochlear implant; 12 ‘young’ CI (mean age at implantation and testing = 21 and 38 months respectively), 12 ‘old’ CI (mean age at implantation and testing = 37 and 60 months respectively); age at testing = 28–68 months

24 children with normal hearing age-matched with the children with a cochlear implant

Intervention/focus:
Outcomes of cochlear implantation
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Receptive and expressive language: vocabulary

Independent variables:
Age at implantation
Chronological age at testing
Duration of device use

Measures:
Novel word-learning task
Reference:

Study design:
Quantitative
Prospective cohort
Repeated measures over varying periods from approximately 3 to 8 months

Sample size:
64

Participants:
16 children with a cochlear implant; age at implantation < 2 years
24 normally hearing 6-month olds and 24 normally hearing 9-month-olds

Intervention/focus:
Outcomes of cochlear implantation

Dependent variables/outcomes:
Auditory skills: discrimination of speech contrasts, attention to speech

Independent variables:

Measures:
Visual habitation procedure
Reference:

**Study design:**
Quantitative
Prospective cohort
Repeated measures over varying periods ranging from 1 day to 18 months post-implantation

**Sample size:**
105

**Participants:**
Children with a cochlear implant: „earlier implanted” (mean age at activation = 11.9 months) and „later implanted” (mean age at activation = 19.4 months)

Comparison group of normally hearing children aged 6 months (n=25), 9 months (26), 18 months (24) or 30 months (12)

**Intervention/focus:**
Factors affecting outcomes of cochlear implantation

**Dependent variables/outcomes:**
Auditory skills: audiovisual integration

**Independent variables:**
Age at implantation

**Measures:**
SPLP
Reference:

**Study design:**
Quantitative
Prospective cohort
Repeated measures over 1 year

**Sample size:**
40

**Participants:**
19 children with a cochlear implant aged 6-10 years at commencement of study; mean duration of implant use = 44 months (SD=3.5)

21 children with a hearing aid

**Intervention/focus:**
Outcomes of cochlear implantation

**Dependent variables/outcomes:**
Speech perception: phonological awareness

**Independent variables:**

**Measures:**
Author-devised tasks of syllables (syllable number), rhyme, and phoneme awareness
Reference:

Study design:
Quantitative
Prospective cohort
Repeated measures over varying periods averaging 20 months

Sample size:
18

Participants:
Children with a cochlear implant; mean age at implantation = 14.2 months

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Receptive and expressive language

Independent variables:
Pre-implantation language

Measures:
CSBS, RDLS
Reference:

Study design:
Quantitative
Prospective cohort
Cross-sectional

Sample size:
183

Participants:
120 children with hearing loss divided into two groups according to age in months at identification of hearing loss: ≤9, >9

63 normally hearing children matched by age to the children with hearing loss

Intervention/focus:
Factors affecting outcomes for children with hearing loss

Dependent variables/outcomes:
Receptive and expressive language

Independent variables:
Age at identification of hearing loss

Measures:
CCC, TROG, BPVS, Renfrew Language Scales: Bus Story Test, Raven’s Progressive Matrices
Reference:

**Study design:**
Quantitative
Prospective cohort
Repeated measures over approximately 18 months

**Sample size:**
27

**Participants:**
Children with hearing loss followed post-diagnosis; mean age at identification of hearing loss = 31 months (14–52)

**Intervention/focus:**
Factors affecting outcomes for children with hearing loss

**Dependent variables/outcomes:**
Expressive language: vocabulary

**Independent variables:**
Degree of hearing loss
Age at onset of hearing loss
Age at identification of hearing loss
Duration of device use
Age at fitting of hearing aids

**Measures:**
German picture-naming tests, KABC (German version, vocabulary subtest), CMMS, Raven’s Progressive Matrices
Reference:

**Study design:**
Quantitative
Prospective cohort
Cross-sectional

**Sample size:**
41

**Participants:**
Consecutive series of children with hearing loss diagnosed in an audiology clinic over 1 year; median age at identification of hearing loss = 32 months

**Intervention/focus:**
Factors affecting outcomes for children with hearing loss

**Dependent variables/outcomes:**
Receptive and expressive language: vocabulary
Use of device

**Independent variables:**
Degree of hearing loss

**Measures:**
German language development test (MFED)
Reference:

**Study design:**
Quantitative
Retrospective cohort
Repeated measures over varying periods up to 3 years post-implantation

**Sample size:**
106

**Participants:**
Children with a cochlear implant divided into groups according to age at implantation (< 2;0, 2;0–4;11 and ≥5;0 years) and communication method (oral or total communication)

**Intervention/focus:**
Factors affecting outcomes of cochlear implantation

**Dependent variables/outcomes:**
Speech perception
Receptive and expressive language

**Independent variables:**
Age at implantation
Communication mode: child’s usual or preferred

**Measures:**
GAEL-P (used as a measure of speech perception), Mr Potato Head Task, PPVT, RDLS
Reference:

**Study design:**
Quantitative
Prospective cohort
Repeated measures over varying periods averaging 19 months

**Sample size:**
187

**Participants:**
24 children with a cochlear implant; mean age at commencement of study = 15 months (8–23), mean age at implantation = 19 months (11–29)

163 normally hearing children, mean age at commencement of study = 9 months (0.5–20)

**Intervention/focus:**
Outcomes of cochlear implantation
Factors affecting outcomes of cochlear implantation

**Dependent variables/outcomes:**
Prelexical vocalisation

**Independent variables:**
Auditory skills

**Measures:**
IT-MAIS, PRISE
Reference:

Study design:
Quantitative
Prospective cohort
Repeated measures over 8 months

Sample size:
40 mother-child dyads

Participants:
20 children with hearing loss and their hearing mothers; age at first data collection = 22 months
20 children with normal hearing and their hearing mothers; matched with the children with hearing loss by sex and maternal employment, education and marital status

Intervention/focus:
Factors affecting outcomes for children with hearing loss
Outcomes of childhood hearing loss

Dependent variables/outcomes:
Expressive language

Independent variables:

Measures:
Number of utterances by type (speech, sign); language rated on a five-level scale from non-linguistic (production of no linguistic utterances) to highest (production of multi-word utterances with an average length of more than 2)
Reference:

**Study design:**
Quantitative
Prospective cohort
Repeated measures over 8 months

**Sample size:**
40 mother-child dyads

**Participants:**
20 children with hearing loss and their hearing mothers; age at first data collection = 22 months

20 children with normal hearing and their hearing mothers; matched with the children with hearing loss by sex and maternal employment, education and marital status

**Intervention/focus:**
Factors affecting outcomes for children with hearing loss
Outcomes of childhood hearing loss

**Dependent variables/outcomes:**
Pragmatic language development

**Independent variables:**

**Measures:**
Coding of mother-child conversation by topic, attentional focus and pragmatic function
Reference:

**Study design:**
Quantitative
Prospective cohort
Cross-sectional

**Sample size:**
99

**Participants:**
67 children with hearing loss grouped by age (8 or 11 years), current communication mode (cued speech or sign language) and age of exposure to current communication mode

32 children with normal hearing grouped by age (8 or 11 years)

**Intervention/focus:**
Factors affecting outcomes for children with hearing loss

**Dependent variables/outcomes:**
Spelling

**Independent variables:**
Communication mode of family
Age at exposure to language: early at home versus late at school

**Measures:**
Lexical decision task
Reference:

Study design:
Quantitative
Prospective cohort
Cross-sectional

Sample size:
86

Participants:
College students with hearing loss from varying educational backgrounds

Intervention/focus:
Factors affecting outcomes for children with hearing loss

Dependent variables/outcomes:
Cognitive ability and functioning: working memory
Reading and written language ability, including morphology, syntax and vocabulary

Independent variables:
Cognitive factors: use of speech, sign and visual recoding strategies in memory tasks, reading, writing, and related English processing tasks
Current communication mode: percent speech, sign, ASL and manually coded English
Communication mode used in prior education: years of oral and TC education
Speech discrimination
Age at exposure to sign language
Speech intelligibility

Measures:
Working memory task; DAT, Abstract Reasoning subtest; CAT, Reading Comprehension subtest; NTID Writing Test indices of the extent to which individuals depended on speech, sign and vision in memory; reported use of speech, sign and finger-spelling; scores for working memory derived from experimental data; tests of syntax, morphology, semantics and spelling
Reference:

**Study design:**
Quantitative
Prospective cohort
Cross-sectional

**Sample size:**
16

**Participants:**
18–24 month old children with hearing loss and their parents (n=31) grouped by parental hearing status and communication mode: hearing parents, oral communication; hearing parents, total communication; deaf parents, sign language

**Intervention/focus:**
Factors affecting outcomes for children with hearing loss

**Dependent variables/outcomes:**
Quality of parent-child interaction: intersubjectivity (interaction involving shared involvement in a reciprocal exchange)

**Independent variables:**
Communication mode of family: oral, total communication (signed Dutch), Flemish Sign Language (a natural sign language)

**Measures:**
Intersubjectivity Index (number of observed moments of intersubjectivity times mean length of moments)
Reference:

Study design:
Qualitative
Multiple sources of data
Repeated measures over approximately 3 years

Sample size:
2

Participants:
Children with hearing loss; age at completion of study = 3;5 and 4;6 years, age at identification of hearing loss = birth and 2 years

Intervention/focus:
Factors affecting outcomes for children with hearing loss
Sign language
Bilingual language development of children with hearing loss

Dependent variables/outcomes:
Language development
Social-emotional development

Independent variables:
Age at identification of hearing loss

Measures:
Interviews with the parents, teachers and audiological pedagogists, analysis of observations
Reference:

**Study design:**
Quantitative
Prospective cohort
Repeated measures over varying periods up to 8 years post-implantation

**Sample size:**
182

**Participants:**
Children with a cochlear implant divided into groups according to age in years at implantation: 0–3, 4–6, 7–10 and 11–14

**Intervention/focus:**
Factors affecting outcomes of cochlear implantation

**Dependent variables/outcomes:**
Speech perception
Receptive language: vocabulary
Expressive language

**Independent variables:**
Age at implantation

**Measures:**
Vowel confusion test, series of daily words test, bisyllabic words, CID, PPVT, RDLS
Reference:

**Study design:**
Quantitative
Prospective cohort
Cross-sectional

**Sample size:**
16

**Participants:**
Parents of children attending an early intervention program for children with hearing loss

**Intervention/focus:**
Factors affecting outcomes for children with hearing loss

**Dependent variables/outcomes:**
Social development
Receptive and expressive language

**Independent variables:**
Parental coping strategies

**Measures:**
CSA, Social Competence Questionnaire, LDS
Reference:

Study design:
Quantitative
Retrospective cohort
Cross-sectional

Sample size:
112

Participants:
Children with hearing loss aged 6–12 years

Intervention/focus:
Factors affecting outcomes for children with hearing loss

Dependent variables/outcomes:
Academic achievement

Independent variables:
Intensity of intervention: hours per week provided to child and parents; hours per week provided to child by a speech therapist, audiologist and psychologist and number of hours per week in a special nursery or day care centre for hearing impaired children
Target of intervention: family-centred versus child-centred services
Age at first intervention
Service setting: home- versus centre-based
Parental compliance: hours per week on home exercises recommended by professionals
Degree of hearing loss
Socioeconomic status: family income
Parental level of education
Family structure: number of children in family and birth rank of child with hearing loss
Communication mode of program attended by child

Measures:
School grades in reading/writing and mathematics; presence or absence of an academic delay
Reference:

Study design:
Quantitative
Retrospective cohort
Cross-sectional

Sample size:
328

Participants:
Children and adolescents with hearing loss aged 1–18 years grouped by mode of hearing aid use: bilateral, alternating unilaterally, unilateral right ear, unilateral left ear, and not in use

Intervention/focus:
Factors affecting outcomes for children with hearing loss

Dependent variables/outcomes:
Use of hearing aid
Use of bilateral versus unilateral amplification

Independent variables:
Age at fitting of hearing aids
Degree of hearing loss
Gender
Age at data collection

Measures:
Use of hearing aids as determined from case notes and professional report
Reference:

**Study design:**
Quantitative
Prospective cohort
Cross-sectional

**Sample size:**
54

**Participants:**
Adults (age = 16–70 years) with different early language experiences:
14 participants with hearing loss who acquired sign language early in life
13 participants with hearing loss who had no accessible language until age 6 or older
13 participants with normal hearing who acquired English as a second language at school
14 participants with normal hearing who had English as their native language

**Intervention/focus:**
Factors affecting outcomes for children with hearing loss

**Dependent variables/outcomes:**
Receptive language: grammar

**Independent variables:**
Age at exposure to sign language

**Measures:**
Grammatical judgment and comprehension tasks
Reference:

**Study design:**
Quantitative
Retrospective cohort
Cross-sectional

**Sample size:**
168

**Participants:**
Children with hearing loss; age = 8–22 months

**Intervention/focus:**
Factors affecting outcomes for children with hearing loss

**Dependent variables/outcomes:**
Receptive language: vocabulary

**Independent variables:**
Age at identification of hearing loss
Presence or absence of additional disabilities
Race/ethnicity
Degree of hearing loss
Socioeconomic status: maternal level of education
Family communication mode: use of signs versus no use of signs

**Measures:**
Macarthur CDI
Reference:

**Study design:**
Quantitative
Retrospective cohort
Cross-sectional

**Sample size:**
113

**Participants:**
Children with hearing loss; mean age = 31 months (24–37)

**Intervention/focus:**
Factors affecting outcomes for children with hearing loss

**Dependent variables/outcomes:**
Expressive language: vocabulary

**Independent variables:**
Age at identification of hearing loss
Nonverbal cognitive ability
Presence or absence of additional disabilities
Race/ethnicity
Degree of hearing loss
Parental/caregiver level of education
Family communication mode: use of signs versus no use of signs

**Measures:**
Macarthur CDI
Reference:


Study design:
Quantitative
Case series with pre-and post-test outcomes
Repeated measures over 14 months

Sample size:
1

Participants:
Child with a cochlear implant, age at commencement of study = 23 months, age at implantation = 24 months

Intervention/focus:
Outcomes of cochlear implantation

Dependent variables/outcomes:
Speech production
Receptive and expressive language

Independent variables:

Measures:
Frequency counts and percentages for segmental features of speech e.g. vowel and consonant segments, syllable number; phonetic inventory; word accuracy; RITLS
Reference:

Study design:
Quantitative
Prospective cohort
Repeated measures over 6 months

Sample size:
80 mother-child dyads

Participants:
80 children and their mothers divided into groups according to hearing status of mother and child;

40 deaf children: 20 with a hearing mother (Dh), 20 with a deaf mother (Dd)

40 normally hearing children: 19 with a hearing mother (Hh), 21 with a deaf mother (Hd)

Age at data collection = 12 and 18 months

Intervention/focus:
Factors affecting outcomes for children with hearing loss

Dependent variables/outcomes:
Quality of parent-child interaction

Independent variables:
Parental hearing status

Measures:
Observational rating scale for maternal behaviours (e.g. sensitivity), child behaviours (e.g. participation) and interaction of mother-child dyads (e.g. reciprocal turn-taking)
Reference:

Study design:
Quantitative
Retrospective cohort
Repeated measures over varying periods up to 8 years post-implantation

Sample size:
132

Participants:
74 children with a cochlear implant divided into two groups based on the communication method of the program attended by the child: oral (mean age at implantation = 5.7 years) or total communication (mean age at implantation = 4.8 years)

58 children with a hearing aid divided by program communication method (oral or TC) and degree of hearing loss (90–100 dB or 101–110 dB). Hearing aid fitting occurred on average at or before 18 months in all groups.

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Speech perception

Independent variables:
Degree of hearing loss
Type of device used: cochlear implantation versus hearing aid

Measures:
Minimal Pairs Test, Common Phrases Test
Reference:

**Study design:**
Quantitative
Retrospective cohort
Cross-sectional

**Sample size:**
112

**Participants:**
Children with hearing loss aged 5–7 years; mean age at identification of hearing loss = 1.6 years (birth–4.5)

**Intervention/focus:**
Factors affecting outcomes for children with hearing loss

**Dependent variables/outcomes:**
Receptive language: vocabulary
Cognitive ability and functioning: verbal reasoning

**Independent variables:**
Age at identification of hearing loss
Age at entry to early intervention program
Degree of hearing loss
Nonverbal cognitive ability
Mode of communication of program attended by child: oral versus total communication
Parental involvement

**Measures:**
PPVT, PLAI, rating of parental involvement by service providers
Reference:

**Study design:**
Quantitative
Pseudorandomised controlled trial
Repeated measures over 2 years

**Sample size:**
10

**Participants:**
Children with hearing loss randomly allocated to two equal groups: use of hearing aids only or use of an FM system in the home setting in addition to amplification

**Intervention/focus:**
FM systems

**Dependent variables/outcomes:**
Expressive language
Use of device
Auditory skills: listening

**Independent variables:**

**Measures:**
Grammatical development: mean sentence length, complexity of sentences, use of bound morphemes, pronoun errors; parent report measure of child’s auditory responsiveness in routine listening environments
Reference:

**Study design:**
Quantitative
Prospective cohort
Cross-sectional

**Sample size:**
48 dyads

**Participants:**
22 children with hearing loss and their mothers; age of children = 6.9 years (4.3–9.9)

26 normally hearing children and their mothers; mean age of children = 5.0 years (4.3–5.9)

**Intervention/focus:**
Factors affecting outcomes for children with hearing loss

**Dependent variables/outcomes:**
Cognitive development: theory of mind (reasoning about false beliefs)

**Independent variables:**
Type of device used: cochlear implant versus hearing aid
Maternal sign language skills
Sibling sign use

**Measures:**
IPSyn, false beliefs task, coding of maternal talk
Reference:

**Study design:**
Mixed methods
Retrospective cohort
Repeated measures over 4 years

**Sample size:**
20

**Participants:**
Children with hearing loss selected from a larger data set of 103 children: the 10 children whose spoken language was most above expectation (‘high speech’ group) and the 10 children whose spoken language was most below (‘low speech’ group); mean age = 7 years in both groups

**Intervention/focus:**
Factors affecting outcomes for children with hearing loss

**Dependent variables/outcomes:**
Expressive language
Speech production

**Independent variables:**
Degree of hearing loss
Age at fitting of hearing aids
Use of unilateral versus bilateral hearing aids
Gender
Family structure: number of siblings
Parental educational level
Socioeconomic status
Maternal employment
Age at intervention
Mode of communication of program attended by child
Educational placement: integrated versus segregated
Extent of parent training

**Measures:**
Variety of measures based on Ling’s phonological level analysis, WISC, LIPS, parent interview
Reference:

**Study design:**
Quantitative
Prospective cohort
Repeated measures over 18 months

**Sample size:**
36

**Participants:**
18 orally-educated children with hearing loss and 18 normally hearing children; age at commencement of study = 36 months

**Intervention/focus:**
Outcomes of oral habilitation methods
Outcomes of childhood hearing loss

**Dependent variables/outcomes:**
Expressive language

**Independent variables:**
Pragmatic language development: rate and type of communicative acts
Mode of communication: gesture or sign alone, vocalisation, intelligible speech

**Measures:**
Coding scheme for children’s speech, vocalisations, gestures and signs
Reference:

**Study design:**
Quantitative
Prospective cohort
Cross-sectional

**Sample size:**
160

**Participants:**
Children with hearing loss:
38 children enrolled in total communication (simultaneous communication) programs
38 children in programs emphasising oral communication
84 normally hearing children

Age at data collection = 18–54 months

**Intervention/focus:**
Factors affecting outcomes for children with hearing loss

**Dependent variables/outcomes:**
Pragmatic language development: rate and type of communicative acts
Mode of communication: gesture or sign alone, vocalisation, intelligible speech
Receptive and expressive language: vocabulary

**Independent variables:**
Parental sign language competence
Mode of communication of program attended by child

**Measures:**
Coding scheme for children’s speech, vocalisations, gestures and signs; MLU; NDW
Reference:

Study design:
Quantitative
Prospective cohort
Cross-section

Sample size:
181

Participants:
8- and 9-year old children with a cochlear implant; mean age at implantation = 3;4 years (1;8–5;4 years)

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Social-emotional development: adjustment

Independent variables:
Child and family characteristics:
  Age at testing
  Age at implantation
  Age at onset of hearing loss
  Nonverbal cognitive ability
  Family structure: family size
  Socioeconomic background
  Gender
Educational characteristics:
  Intensity of intervention: number of hours of therapy
  Therapist experience
  Parental involvement
  Educational placement: private versus public school, mainstream versus special education
  Communication mode of program attended by child (rated on a scale from 1 to 6: 1 – sign-only; 2 – almost always simultaneous communication; 3 – speech only part of the time ; 4 – cued speech; 5 – auditory-oral; 6 – auditory-verbal)
Implant characteristics:
  Processing strategy
  Number of inserted electrodes
  Dynamic range
  Loudness growth

Measures:
Pictorial Scale of Perceived Competence and Social Acceptance for Young Children (modified version), M-K, parent rating of satisfaction with cochlear implantation
Reference:

Study design:
Quantitative
Prospective cohort
Cross-sectional

Sample size:
76

Participants:
8- and 9-year old children with a cochlear implant; mean age at implantation = 3;6 years (12–38 months). All of the participants were in intervention programs using exclusively spoken language.

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Expressive language

Independent variables:
Degree of hearing loss
Aided hearing threshold: hearing aid
Age at fitting of hearing aids
Duration of device use: hearing aid
Age at implantation
Aided hearing threshold: cochlear implant
Duration of device use: cochlear implant

Measures:
MLU, NDW, number of bound morphemes, CDI: Word and Sentences, SECS
Reference:

**Study design:**
Quantitative
Prospective cohort
Repeated measures over varying periods up to 4 years

**Sample size:**
126

**Participants:**
Children with a cochlear implant; mean age at implantation = 4;2 years (1;9–6;10)

**Intervention/focus:**
Factors affecting outcomes of cochlear implantation

**Dependent variables/outcomes:**
Speech perception and other auditory skills
Speech intelligibility

**Independent variables:**
Age at implantation

**Measures:**
Iowa Matrix Closed Set Sentence Test, CDT: number of words per minute correctly identified, CAP, SIR
Reference:

Study design:
Quantitative
Prospective cohort
Repeated measures over varying periods up to 2 years

Sample size:
19

Participants:
Children with hearing loss divided into 4 groups according to their speech skills at 36 months

Intervention/focus:
Factors affecting outcomes for children with hearing loss

Dependent variables/outcomes:
Speech production: prosody and articulation
Expressive language: syntax

Independent variables:
Degree of hearing loss
Presence or absence of additional disabilities: motor difficulties, cognitive development
Speech production
Expressive language

Measures:
Coding of speech samples
Reference:

Study design:
Quantitative
Prospective cohort
Repeated measures over 5 years post-implantation

Sample size:
40

Participants:
Children with a cochlear implant; mean age at implantation = 4;4 years (2;6–7;10); 14 exclusively oral communicators and 26 total communicators (use of sign to any degree)

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Speech perception

Independent variables:
Age at implantation
Cause/nature of hearing loss (congenital versus meningitis)
Mode of communication: child’s usual or preferred
Socioeconomic status
Implant characteristics: number of inserted electrodes

Measures:
CDT: number of words per minute correctly identified
Reference:

Study design:
Quantitative
Retrospective cohort
Repeated measures over varying periods up to 4 years

Sample size:
29 prelingually deaf children
17 postlingually deaf adults

Participants:
Children with a cochlear implant; mean age at implantation = 6;0 years (2;3–11;4)

Intervention/focus:
Factors affecting outcomes in cochlear implantation

Dependent variables/outcomes:
Speech perception

Independent variables:
Age at implantation

Measures:
CID (Korean version)
Reference:

Study design:
Quantitative
Retrospective cohort
Repeated measures over 6 months post-implantation

Sample size:
116

Participants:
Children with a cochlear implant divided into groups according to age in months at implantation (12–23, 24–36 and >36) and the mode of communication used in the program attended by the participants (oral or total communication)

Intervention/focus:
Factors affecting outcomes in cochlear implantation

Dependent variables/outcomes:
Auditory skills

Independent variables:
Age at implantation
Communication mode of program attended by child

Measures:
IT-MAIS, ESP, PBK, LNT, MLNT
Reference:

Study design:
Quantitative
Prospective cohort
Cross-sectional

Sample size:
Study 1: 135
Study 2: 31
Study 3, concerning modes of reading instruction, is not relevant to this review.

Participants:
School-aged children with hearing loss

Intervention/focus:
Sign language
Factors affecting outcomes for children with hearing loss

Dependent variables/outcomes:
Reading ability

Independent variables:
Parental hearing status
Age at identification of hearing loss
Presence or absence of other disabilities
Sign language skills

Measures:
SAT-HI: reading achievement; ASL test battery: verb agreement production, sentence order comprehension tests developed by the authors: ASL sentence imitation task, finger-spelling task, test assessing ability to write the English counterparts of signs
Reference:

**Study design:**
Quantitative
Retrospective cohort
Cross-sectional

**Sample size:**
24

**Participants:**
Children with a cochlear implant; mean age at implantation = 5;1 years (2;7–11;0), mean age at test = 12;4 years (8;4–18;3). All but one of the participants were total communication users.

**Intervention/focus:**
Outcomes of cochlear implantation
Factors affecting outcomes of cochlear implantation

**Dependent variables/outcomes:**
Speech intelligibility

**Independent variables:**
Age at implantation

**Measures:**
Short-Long Sentence Test
Reference:

Study design:
Quantitative
Prospective cohort
Cross-sectional

Sample size:
30

Participants:
Children with a cochlear implant; mean age at implantation = 5;8 years (2;3–10;3); age at data collection = 6–12 years

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Speech production
Receptive and expressive language

Independent variables:
Age at implantation
Duration of device use

Measures:
Author-devised test of consonant production in Mandarin, PPVT (Mandarin version), Chinese test assessing preschool language disorders
Reference:

**Study design:**
Quantitative
Retrospective cohort
Cross-sectional

**Sample size:**
200

**Participants:**
Children with hearing loss; age = 6–72 months, age at intervention = birth–72 months

**Intervention/focus:**
Factors affecting outcomes for children with hearing loss

**Dependent variables/outcomes:**
Expressive language
Social-emotional development: mastery motivation (persistence at moderately difficult or difficult tasks)

**Independent variables:**
Degree of hearing loss
Age at entry to early intervention
Maternal educational level
Race/ethnicity
Socioeconomic status: family income
Gender
Communication mode of family

**Measures:**
Minnesota CDI: Expressive language, DMQ
Reference:

Study design:
Quantitative
Retrospective cohort
Cross-sectional

Sample size:
184

Participants:
Hearing mothers of young children who were deaf or hard of hearing; age = birth -72 months, age at interventions – birth -72 months

Intervention/focus:
Predictors of Parental Stress in Mothers

Dependent variables/outcomes:
Expressive language
Amount of support
Hassles
Parental stress

Independent variables:
Additional disabilities
Age
Age at identification
Race/ethnicity
Gender
Degree of hearing loss
Family income
Mode of communication
Months between identification of hearing loss and observations

Measures:
Parental Stress Index/short form, Parenting Daily Hassles Scale, Family Support Scale: Parental Stress
Minnesota CDI: Expressive language
Reference:

Study design:
Quantitative
Prospective cohort
Cross-sectional

Sample size:
176

Participants:
8- and 9-year old children with a cochlear implant; age at implant = <5 years. The participants were part of the sample described in Geers & Brenner (2003).

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Speech intelligibility
Speech production

Independent variables:
Cognitive ability and functioning: working memory

Measures:
WISC-III digit span, WIPI, LNT, BKB, McGarr
Reference:

Study design:
Quantitative
Retrospective cohort

Sample size:
50

Participants:
Children with a cochlear implant divided into children who scored in the top 20% of a speech perception test (‘Stars’) and children who scored in the bottom 20% (‘Controls’). The groups were matched on length of implant use (approximately 2 years).

The second part of this paper reports on a study that is more extensively reported in Pisoni & Cleary (2003).

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Variables examined:
Speech perception
Receptive and expressive language

Measures:
PBK, Minimal Pairs Test, Common Phrases Test, LNT, MLNT, PPVT-R, RDLS, BIT
Reference:

Study design:
Quantitative
Prospective cohort
Cross-sectional

Sample size:
97

Participants:
37 children with hearing loss; age = 5–14 years
60 normally hearing children; age = 5–13 years

Intervention/focus:
Factors affecting outcomes for children with hearing loss

Dependent variables/outcomes:
Rapid word learning
Receptive language: vocabulary

Independent variables:
Age at identification of hearing loss
Age at fitting of hearing aids
Duration of device use

Measures:
Rapid word learning task, PPVT
Reference:

Study design:
Quantitative
Prospective cohort
Cross-sectional

Sample size:
11

Participants:
Children with hearing loss; age = 3;11–5;10 years

Intervention/focus:
Factors affecting outcomes for children with hearing loss

Dependent variables/outcomes:
Cognitive ability and functioning: working memory
Speech production: articulatory and phonological development, intelligibility

Independent variables:
Parental hearing status
Educational placement

Measures:
VMI, LIPS, PPVT, Italian test of grammatical comprehension
Reference:

Study design:
Quantitative
Sample survey and educational achievement data collected in two consecutive years

Sample size:
Sample survey and achievement data were available from approximately 400 students in each year

Participants:
16-year old students with hearing loss in mainstream schools

Intervention/focus:
Factors affecting outcomes for children with hearing loss

Dependent variables/outcomes:
Academic achievement: examination results
Communication competence
Social acceptance

Independent variables:
Socioeconomic status
Presence or absence of other disabilities
Degree of hearing loss
Age at identification of hearing loss
Gender
Socioeconomic status
Parental hearing status
Educational placement
Race/ethnicity
Age at onset of hearing loss
Family structure: family size

Measures:
Secondary school examination results (GCSE, UK), teaching rating of communication competence and social acceptance
Reference:

**Study design:**
Qualitative
Multiple sources of data
Repeated measures over 2 years

**Sample size:**
22

**Participants:**
Children with a cochlear implant; age at implantation = 1;11–4;10 years

**Intervention/focus:**

**Dependent variables/outcomes:**
Speech perception and production
Expressive language
Play: level of participation in play and content of play

**Independent variables:**
Communicative style of adults with whom the child interacts
Opportunity to participate in age-appropriate play

**Measures:**
Analysis of direct observations and videorecordings of the children in natural interaction with their parents and siblings and with their teachers and peers in the preschool setting, interviews with parents and teachers
Reference:

Study design:
Qualitative
Interviews
Cross-sectional

Sample size:
11

Participants:
Children with a cochlear implant; age = 8.5–10.5 years and length of use of implant = 5.0–7.5 years

Intervention/focus:
Cochlear implantation

Dependent variables/outcomes:
Auditory skills
Communication skills
Social-emotional development
Language development
Family life
Quality of life

Independent variables:
Reference:

Study design:
Qualitative
Observational: repeated observations over 2 years

Sample size:
27

Participants:
Children attending sign bilingual preschool programs; age = 2–7 years

Intervention/focus:
Factors affecting outcomes for children with hearing loss
Sign language
Bilingual programs

Dependent variables/outcomes:
Communication skills
Social-emotional development

Independent variables:
Measures:
Coding of children’s natural interactions at their preschool centre
Reference:
Reference 1:

Reference 2:

These papers present overlapping and substantially similar data.

**Study design:**  
Quantitative  
Prospective cohort  
Repeated measures over 1 year

**Sample size:**  
Reference 1: 24 dyads  
Reference 2: 42 dyads

**Participants:**  
Children with hearing loss and their mothers; age at commencement of study = 21–30 (20-27) months

**Intervention/focus:**  
Factors affecting outcomes for children with hearing loss

**Dependent variables/outcomes:**  
Expressive language

**Independent variables:**  
Maternal characteristics: sensitivity and structuring/intrusiveness  
Parent-child interaction: child responsiveness and involvement in interaction with parents  
Degree of hearing loss

**Measures:**  
Minnesota CDI infant and toddler versions
Reference:

Study design:
Quantitative
Prospective cohort
Cross-sectional

Sample size:
19

Participants:
Adolescents with hearing loss aged 13-16 years divided into two groups based on assessed language ability: typical and delayed

Intervention/focus:
Factors affecting outcomes for children with hearing loss

Dependent variables/outcomes:
Receptive and expressive language

Independent variables:
Nonverbal cognitive ability
Other cognitive factors: executive function

Measures:
WISC, D-KEFS, Tower Test (NEPSY), CELF
Reference:

Study design:
Quantitative
Case series with post-test outcomes
Repeated measures over 2 years

Sample size:
4

Participants:
2 monolingual (American Sign Language) twins with hearing loss and 2 bilingual (ASL/English) twins with normal hearing; age at commencement of study = 2 years

Intervention/focus:
Bilingual (sign/spoken) language development in children with normal hearing.

Dependent variables/outcomes:
Expressive language
Gaze during utterances

Independent variables:

Measures:
Language type (signed or speech), MLU, coding of gaze as to the timing and maintenance of gaze in language interactions between children and others
Reference:

**Study design:**
Quantitative
Case series with post-test outcomes
Repeated measures over 1 year

**Sample size:**
12

**Participants:**
Children with a cochlear implant; mean age at implantation = 20 months (6–35); age at test = 17 months–12 years. All of the participants were exclusively oral communicators and all were exposed to a second language, to varying degrees.

**Intervention/focus:**
Outcomes of cochlear implantation

**Dependent variables/outcomes:**
Receptive and expressive language

**Independent variables:**

**Measures:**
RDLS, OWLS, SOLOM
Reference:

**Study design:**
Quantitative
Prospective cohort
Repeated measures over approximately 1 year

**Sample size:**
216

**Participants:**
107 children with a cochlear implant divided into groups according to age in months at implantation: 12-17, 19–23 and 24–36

109 normally hearing children aged less than 3 years

**Intervention/focus:**
Factors affecting outcomes of cochlear implantation

**Dependent variables/outcomes:**
Auditory skills

**Independent variables:**
Age at implantation
Duration of device use

**Measures:**
IT-MAIS
Reference:

Study design:
Quantitative
Retrospective cohort
Repeated measures over 2 years

Sample size:
105

Participants:
Children with a cochlear implant divided into equal groups according to age in years at implantation: < 3.0, 3.1–6.0, 6.1–10.0

Intervention/focus:
Factors affecting outcomes in cochlear implantation

Dependent variables/outcomes:
Auditory skills

Independent variables:
Age at implantation

Measures:
LiP, MTP
Reference:

Study design:
Quantitative
Retrospective cohort
Cross-sectional

Sample size:
167 in total; not all participants provided results on each measure

Participants:
Children with a cochlear implant divided into two groups according to the type of speech perception results they provided: words (mean age at implantation = 5.3 years) or sentences (mean age at implantation = 5.6 years).

Age at implantation for the two groups combined ranged from 1.2 to 15.5 years.

Within the groups, participants were classified according to their mode of communication: oral, simultaneous sign and speech, or sign only.

The participants were also grouped by the location of the clinic at which they were treated, Sydney or Melbourne.

Mean age at data collection = 5 years

Intervention/focus:
Factors affecting outcomes in cochlear implantation

Dependent variables/outcomes:
Speech perception

Independent variables:
Duration of hearing loss prior to implantation
Duration of device use
Communication mode: child’s usual or preferred
Cochlear implant centre attended (Sydney versus Melbourne)
Implant characteristics: number of inserted electrodes
Implant characteristics: processing strategy

Measures:
BKB, PBK, CNC

Reference:
Study design:
Quantitative
Prospective cohort
Repeated measures over approximately 1 year post-implantation

Sample size:
20

Participants:
10 children with a cochlear implant; age at implantation = 5–19 months
10 children with normal hearing aged 6–11 months

Intervention/focus:
Outcomes of cochlear implantation
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Prelexical vocalisation
Auditory skills

Independent variables:
Age at implantation

Measures:
Age at onset of babbling and babbling spurt, CBR, CAP, APE
Reference:

**Study design:**
Quantitative
Prospective cohort
Cross-sectional

**Sample size:**
94

**Participants:**
29 children with hearing loss; all fitted with hearing aids soon after diagnosis (<2 years)

25 children with a cochlear implant; mean age at implantation = 2;2 years (1;0–3;3)

40 children with normal hearing

All of the participants were aged 5 to 9 years at the time of the study

**Intervention/focus:**
Outcomes of cochlear implantation

**Dependent variables/outcomes:**
Non-verbal development e.g. spatial integration, motor control and attention

**Independent variables:**

**Measures:**
Variety of motor tasks; protocol consisting of 11 measures of neurological and neuropsychological capacities
Reference:

Study design:
Quantitative
Case series with pre- and post-test outcomes
Repeated measures over 21 months

Sample size:
2

Participants:
Twin sisters, one with a cochlear implant (age at implantation = 20 months) and the other with normal hearing

Intervention/focus:
Outcomes of cochlear implantation

Dependent variables/outcomes:
Receptive and expressive language
Early communication skills e.g. gestures and pointing

Independent variables:

Measures:
Macarthur CID infant and toddler versions, PPVT, CSBS DP
Reference:

**Study design:**
Quantitative
Prospective cohort
Cross-sectional

**Sample size:**
180

**Participants:**
Children with hearing loss divided into four age groups: 8–11, 14–17, 20–23 and 26–30 months

**Intervention/focus:**
Factors affecting outcomes for children with hearing loss

**Dependent variables/outcomes:**
Development of play
Receptive and expressive language

**Independent variables:**
Gender
Age at identification of hearing loss
Presence or absence of other disabilities
Degree of hearing loss
Play behaviour

**Measures:**
PAQ, CDI
Reference:

Study design:
Quantitative
Prospective cohort
Repeated measures over 9 months

Sample size:
43 mother-child dyads

Participants:
43 children and their mothers divided into groups according to hearing status of mother and child;

28 deaf children: 15 with a hearing mother (Dh), 13 with a deaf mother (Dd)

15 children with normal hearing with a hearing mother (Hh)

Age at commencement of study = 9 months

Intervention/focus:
Factors affecting outcomes for children with hearing loss

Dependent variables/outcomes:
Play
Expressive Language

Independent variables:
Parental hearing status
Maternal characteristics: responsiveness

Measures:
Coding of the type, frequency and duration of observed play: manipulative, relational, representational; coding of language: frequency, length (number of signs/words), content; rating scale assessing mother-child interaction
Reference:

Study design:
Mixed method
Prospective cohort
Cross-sectional

Sample size:
13

Participants:
Children with a cochlear implant; mean age at implantation = 1;11 years (1;1–3;2), age at data collection = 3;11 -7;11 years

Intervention/focus:
Outcomes of cochlear implantation
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Speech perception
Receptive and expressive language
Pragmatic language skills: conversational cohesion

Independent variables:
Nonverbal cognitive ability
Duration of device use
Age at implantation
Presence of other disabilities
Parent involvement

Measures:
LIPS, CNC, LPP, BKB, PPVT, CELF, parent interview

**Study design:**
Quantitative
Retrospective cohort
Cross-sectional

**Sample size:**
27

**Participants:**
Children with a cochlear implant aged at least 16 years: mean age at implantation = 6.4 years (2.4–12.7)

**Intervention/focus:**
Outcomes of cochlear implantation
Factors affecting outcomes of cochlear implantation

**Dependent variables/outcomes:**
Speech perception
Speech production
Academic achievement
Vocational outcomes
Use of device (as an outcome)

**Independent variables:**
Use of device

**Measures:**
PBK, WIPI, HINT, Short-Long Sentences Test, WRMT, WJ ACH, vocational data, questionnaire on consistency of device use
Reference:

**Study design:**
Quantitative
Prospective cohort
Cross-sectional

**Sample size:**
2858

**Participants:**
468 children with a cochlear implant
2390 children with a hearing loss without a cochlear implant

The participants were grouped by mode of communication used in teaching: spoken language only, British Sign Language alone or in conjunction with another mode, Sign Supported English alone or in conjunction with another mode, Makaton alone or in conjunction with another mode, or other methods.

Mean age at data collection = 11.6 years (3.3–20.6)

The children with a cochlear implant were also grouped according to age in years at implantation (<5 and ≥5) and duration of use in years of the implant (<2, ≥2 to <4, and ≥4).

**Intervention/focus:**
Factors affecting outcomes of cochlear implantation

**Dependent variables/outcomes:**
Speech perception and other auditory skills
Use and production of speech
Academic ability and achievement
Vocational outcomes
Use of device
Educational participation and engagement
Quality of life

**Independent variables:**
Age at data collection
Degree of hearing loss
Age at onset of hearing loss
Gender
Presence or absence of additional disabilities
Socioeconomic status (represented by parental occupational skill level)
Race/ethnicity
Parental hearing status
Age at implantation
Duration of device use
Communication mode of program attended by child

**Measures:**
CAP; SIR; parent and teacher ratings of use and production of speech and of academic ability; school attainment levels (key stage attainments); teacher rating of reading age and participation and engagement in education; parent report of quality of life, social development, and ability to independently perform tasks such as shopping and use of a telephone
Reference:

**Study design:**
Quantitative
Prospective cohort
Repeated measures over varying periods up to 7 years

**Sample size:**
75

**Participants:**

**Intervention/focus:**
Factors affecting outcomes of cochlear implantation

**Dependent variables/outcomes:**
Expressive language
Speech perception

**Independent variables:**
Age at implantation

**Measures:**
RDLS, Macarthur CDI, Mr Potato Head Task
Reference:

Study design:
Quantitative
Case series with post-test outcomes
Repeated measures over 18 months

Sample size:
10

Participants:
Children with a cochlear implant; mean age at implantation = 2;3 years (1;2–3;10). All came from monolingual spoken language environments.

Intervention/focus:
Outcomes of cochlear implantation

Dependent variables/outcomes:
Expressive language: syntax, morphology, vocabulary

Independent variables:

Measures:
MLU, acquisition of grammatical morphemes, TTRs
Reference:

Study design:
Quantitative
Prospective cohort
Repeated measures over varying periods ranging from 27 to 36 months

Sample size:
44

Participants:
22 children with a cochlear implant; mean age at implantation = 2;5 years (1;2–3;8), age at start of data collection = 1;8–4.4 years. All came from monolingual spoken language environments.

22 normally hearing children matched by initial language level to the cochlear implant children; age = 16 months at the start of data collection

Intervention/focus:
Outcomes of cochlear implantation
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Expressive language: grammar and vocabulary

Independent variables:
Age at implantation
Degree of hearing loss

Measures:
MLU, NDW (parent report)
Reference:

**Study design:**
Quantitative
Prospective cohort
Repeated measures over 28 or 36 months

**Sample size:**
15

**Participants:**
9 children with a cochlear implant; mean age at implantation = 2;3 years (1;2–3;10), age at start of data collection = 1;8–4;4 years. All came from monolingual spoken language environments.
6 children with a normal hearing matched by initial language level to the cochlear implant children; age = 16 months at the start of data collection

**Intervention/focus:**
Outcomes of cochlear implantation

**Dependent variables/outcomes:**
Expressive language: morphology, syntax

**Independent variables:**

**Measures:**
Frequency of use of correct article forms, frequency of errors of case and gender
Reference:

Study design:
Quantitative
Prospective cohort
Cross-sectional

Sample size:
181

Participants:
8- and 9-year old children with a cochlear implant; mean age at implantation = 3;4 years (1;8–5;4 years)

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Speech intelligibility and other aspects of speech production

Independent variables:
Child and family characteristics:
  Age at testing
  Age at implantation
  Age at onset of hearing loss
  Nonverbal cognitive ability
  Family structure: family size
  Socioeconomic background
  Gender
Educational characteristics:
  Intensity of intervention: number of hours of therapy
  Therapist experience
  Parental involvement
  Educational placement: private versus public school, mainstream versus special education
  Communication mode of program attended by child (rated on a scale from 1 to 6: 1 – sign-only; 2 – almost always simultaneous communication; 3 – speech only part of the time ; 4 – cued speech; 5 – auditory-oral; 6 – auditory-verbal)
Implant characteristics:
  Processing strategy
  Number of inserted electrodes
  Dynamic range
  Loudness growth

Measures:
Percentage correct consonants and vowels, McGarr, parent rating of speech intelligibility, time devoted to repairing communicational breakdown
Reference:
effect of age at cochlear implant initial stimulation on expressive language growth in
853-867.

Study design:
Quantitative
Retrospective cohort
Repeated measures over varying periods up to 50 months

Sample size:
29

Participants:
Children with a cochlear implant; mean age at implantation = 21 months (11–40)

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Expressive language

Independent variables:
Age at implantation

Measures:
Minnesota CDI, PLS
Reference:

Study design:
Quantitative
Prospective cohort
Repeated measures over varying periods up to 5 years

Sample size:
26

Participants:
13 children with a cochlear implant; age at implantation = 1;10-6;6

13 children with normal hearing matched by chronological age, follow-up duration and intelligence (development quotient) to the cochlear implant children

Intervention/focus:
Outcomes of cochlear implantation

Dependent variables/outcomes:
Receptive language

Independent variables:

Measures:
French tests of receptive language, ITPA
Reference:

**Study design:**
Quantitative

**Sample size:**
28

**Participants:**
Children with a cochlear implant divided into groups according to their age in years at implantation: 2–5, 5–8 and 8–15. All participants used total communication (simultaneous communication) at the time of implantation.

**Intervention/focus:**
Factors affecting outcomes of cochlear implantation

**Dependent variables/outcomes:**
Speech intelligibility and other aspects of speech production
Expressive language

**Independent variables:**
Chronological age at testing
Speech perception

**Measures:**
Short-Long Sentence Test, story-retell task, Audiovisual Feature Test, parent rating of communication skills, WIP1, Children’s Vowel Test
Reference:

Study design:
Quantitative
Prospective cohort
Repeated measures over 18 months

Sample size:
22

Participants:
10 children with a cochlear implant; age at implantation = < 3 years, age at commencement of study = 1;3–5;0 years

12 children with a hearing aid; age at commencement of study = 2;4–5;9 years

Intervention/focus:
Outcomes of cochlear implantation
Outcomes of amplification

Dependent variables/outcomes:
Receptive language

Independent variables:

Measures:
RDLS
Reference:

**Study design:**
Quantitative
Prospective cohort
Repeated measures over approximately 3 years post-implantation

**Sample size:**
12

**Participants:**
Children with a cochlear implant; mean age at implantation = 7.2 years, mean age at first assessment = 7.1 years. The children were divided into groups according to their mode of communication: auditory-oral, cued speech and sign language.

**Intervention/focus:**
Factors affecting outcomes of cochlear implantation

**Dependent variables/outcomes:**
Expressive speech: syntax

**Independent variables:**

**Measures:**
Percentage correct words by type, overall rating of language level
Reference:

Study design:
Quantitative
Prospective cohort

Sample size:
15

Participants:
Fifteen infants with PTAs ranging from 25 dB HL to 120 dB HL in the better hearing ear participated.

The infants were grouped according to the PTA in the better hearing ear: normal (PTA=25dB); mild-to-moderately-severe (PTA = 26-70 dB HL); and severe-to-profound (PTA>71 dB HL).

All infants with a hearing loss attended oral-aural habilitation sessions at least once a week.

Intervention/focus:
Relationship between auditory sensitivity and prelinguistic vocalisation patterns in infants during the babbling stage.

Dependent variables/outcomes:
Prelinguistic vocalisation

Independent variables:
Degree of hearing loss (PTA)

Measures:
CBR and percentage of utterances containing canonical syllables; vocalisation types within utterance strings, glottal syllables and canonical syllables; syllable shapes; number of consecutive canonical syllable sequences in an utterance; consonant onset within canonical syllables of CV shape; and consonant place in canonical syllables.
Reference:

**Study design:**
Quantitative
Prospective cohort
Cross-sectional

**Sample size:**
87

**Participants:**
7- and 8-year old children with hearing loss

**Intervention/focus:**
Outcomes of childhood hearing loss

**Dependent variables/outcomes:**
Receptive and expressive language
Speech production
Social-emotional development: adaptive behaviour; emotional, conduct and other behaviour problems
Cognitive development
General physical and psychosocial health
School functioning

**Independent variables:**

**Measures:**
CELF, PPVT, GFTA, VABS, WISC, CHQ, Rutter, PEDS, questionnaire assessing school functioning
Reference:

Study design:
Quantitative
Prospective cohort
Cross-sectional

Sample size:
87

Participants:
7- and 8-year old children with hearing loss

Intervention/focus:
Factors affecting outcomes for children with hearing loss

Dependent variables/outcomes:
Receptive and expressive language
Speech intelligibility and other aspects of speech production
Reading ability

Independent variables:
Degree of hearing loss
Age at identification of hearing loss
Age at fitting of hearing aids
Maternal education
Socioeconomic status: paternal occupational prestige
Family functioning

Measures:
CELF, PPVT, WISC (Perceptual Organisation Index), GFTA, RPT1, McMaster Family Assessment Device (General Functioning Scale), teacher rated speech intelligibility
Reference:

Study design:
Quantitative
Retrospective cohort
Repeated measures over varying periods up to 9 years

Sample size:
20

Participants:
Children with hearing loss divided into two groups according to their speech abilities at final test: talking and not talking; age at first data collection = ≤13 months

Intervention/focus:
Factors affecting outcomes for children with hearing loss

Dependent variables/outcomes:
Receptive and expressive language
Motor development
Social-emotional development

Independent variables:
Prelexical vocalisation
Degree of hearing loss

Measures:
Mean babble level, consonant inventory, PAQ, MCDI
Reference:

**Study design:**
Quantitative
Retrospective cohort
Cross-sectional

**Sample size:**
57

**Participants:**
Adolescents with hearing loss and hearing parents. The participants were divided into 3 groups according to the communication history of child and mother: auditory/oral (use of English by both mother and child since the child’s early years), sign match (use of sign by both mother and child since the child’s early years), and sign mismatch (children who used sign in adolescence but not early childhood, or who signed in early childhood but whose mother did not)

**Intervention/focus:**
Factors affecting outcomes for children with hearing loss

**Dependent variables/outcomes:**
Social-emotional development: mental health

**Independent variables:**
Communication mode: child and mother

**Measures:**
YSR
Reference:

Study design:
Quantitative
Case series with pre-and post-test outcomes
Repeated measures over varying periods ranging from 5 to 13 years

Sample size:
81

Participants:
Children with a cochlear implant; mean age at implantation = 4.2 years (1;1–15)

Intervention/focus:
Outcomes of cochlear implantation

Dependent variables/outcomes:
Speech perception
Educational placement
Communication mode: child’s usual or preferred

Independent variables:

Measures:
ESP, NU-CHIPS, GASP, PBK, Common Phrases Test, BKB,
Reference:

**Study design:**
Quantitative
Case series with pre- and post-test outcomes
Repeated measures over approximately 6 or 12 months

**Sample size:**
18

**Participants:**
Children with a cochlear implant; mean age at implantation = 10 months (6–11)

**Intervention/focus:**
Outcomes of cochlear implantation

**Dependent variables/outcomes:**
Auditory skills
Speech perception

**Independent variables:**

**Measures:**
IT-MAIS, GASP, Common Phrases Test, LNT, MLNT
Reference:

**Study design:**
Quantitative

**Sample size:**
68

**Participants:**
34 children with hearing loss divided into two groups according to age of acquisition of sign language: native signers and later signers; age = 50–95 months

34 normally hearing children; age = 52–94 months

**Intervention/focus:**
Factors affecting outcomes for children with hearing loss

**Dependent variables/outcomes:**
Cognitive development: theory of mind (ability to interpret others’ actions in goal-directed terms)

**Independent variables:**
Age at exposure to sign language

**Measures:**
Imitation task, Raven’s Progressive Matrices
Reference:

Study design:
Quantitative
Prospective cohort
Repeated measures over approximately 2 years

Sample size:
36

Participants:
18 children with hearing loss taking part in a deaf mentor project for deaf children and their families; mean age at start of project = 27 months

18 children with hearing loss attending oral or total communication (manually coded English) programs matched by hearing loss, age, amount of SKI*HI services received prior to the project and pretest language development to the children taking part in the deaf mentor project

Intervention/focus:
Bilingual-bicultural programs

Dependent variables/outcomes:
Receptive and expressive language
Parental attitudes to deafness

Independent variables:

Measures:
GAEL-P, PEST, LDS, questionnaire assessing parents’ attitudes to deafness, Deaf culture and their deaf child
Reference:

**Study design:**
Quantitative
Retrospective cohort
Repeated measures over varying periods up to 5 years

**Sample size:**
176

**Participants:**
Children with a cochlear implant divided into groups according to age in years at implantation (≤3, 3–5 and >5) and mode of communication (oral or sign, with sign defined as use of sign (BSL or sign supported English) to any degree)

**Intervention/focus:**
Factors affecting outcomes of cochlear implantation

**Dependent variables/outcomes:**
Communication mode: child’s usual or preferred

**Independent variables:**
Age at implantation

**Measures:**
Reference:

Study design:
Quantitative
Prospective cohort
Cross-sectional

Sample size:
15

Participants:
Children with a cochlear implant; mean age at implantation = 3;11 years (2;0–6;1), age at testing = 2;2–7;10

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Speech perception
Receptive and expressive language: grammar
Speech production: phonemes

Independent variables:
Age at implantation
Duration of device use
Chronological age at testing
Cognitive ability and functioning: working memory

Measures:
A variety of Swedish language tests of speech perception and language, sentence-completion task assessing complex working memory, non-word repetition task assessing phonological working memory
Reference:

Study design:
Quantitative

Sample size:
3

Participants:
Children with a cochlear implant; mean age at implantation = 13.7 months

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Communication skills
Receptive and expressive language
Motor development

Independent variables:

Measures:
CII, DVA, RDLS, VABS
Reference:

Study design:
Quantitative

Sample size:
40

Participants:
Parents and teachers of children participating in auditory-verbal programs; mean age of children = 55 months (29–110)

Intervention/focus:
Outcomes of auditory-verbal programs

Dependent variables/outcomes:
Receptive and expressive language

Independent variables:
Age at data collection
Age of first device fitting
Age at identification of hearing loss
Age at entry to early intervention
Intensity of intervention: duration of early intervention
Parental involvement
Parental expectations
Teacher expectations

Measures:
Checklist derived from the REEL, measure assessing parents’ and teachers’ expectations of auditory-verbal therapy
Reference:

Study design:
Quantitative

Sample size:
28

Participants:
Children with a cochlear implant divided into groups based on age in years at implantation: <3 (mean age at implant = 2.2) and >3 (mean age at implant = 5.5 years)

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Speech perception

Independent variables:
Age at implantation

Measures:
MLNT (Mandarin version)
Reference:

**Study design:**
Quantitative
Prospective cohort
Cross-sectional

**Sample size:**
147

**Participants:**
Children with hearing loss; age = 14–60 months

**Intervention/focus:**
Factors affecting outcomes for children with hearing loss

**Dependent variables/outcomes:**
Speech intelligibility and other aspects of speech production
Expressive language

**Independent variables:**
Gender
Presence or absence of other disabilities
Degree of hearing loss
Maternal educational level
Race/ethnicity
Age at identification of hearing loss
Communication mode of child/family/program attended by child

**Measures:**
Number of different consonants, vowels, initial blends and final blends; rating of overall speech intelligibility; Minnesota CDI
Reference:

Study design:
Quantitative

Sample size:
3

Participants:
Children with a cochlear implant; age at implantation = 20, 21 and 30 months

Intervention/focus:
Outcomes of cochlear implantation

Dependent variables/outcomes:
Speech intelligibility and other aspects of speech production
Receptive and expressive language

Independent variables:

Measures:
Macarthur CDI, MCDI, NDW, number of utterances and phonemes, rating of speech intelligibility
Reference:

**Study design:**
Quantitative
Retrospective cohort
Cross-sectional

**Sample size:**
82

**Participants:**
Children with hearing loss divided into two groups according to age of identification of hearing loss: before 6 months, or between 7 and 18 months; mean age at testing = 26 months (19–36)

**Intervention/focus:**
Factors affecting outcomes for children with hearing loss

**Dependent variables/outcomes:**
Receptive and expressive language
Motor development
Social development
Communicative development (gestures)
Speech production: phonemic repertoire

**Independent variables:**
Age at identification of hearing loss
Degree of hearing loss

**Measures:**
Minnesota CDI, Macarthur CDI: Words and Sentences, PAQ, number of different vowels and consonants
Reference:

Study design:
Quantitative
Retrospective cohort
Cross-sectional

Sample size:
40

Participants:
Children with hearing loss divided into two groups according to age of identification of hearing loss: before 6 months or after 18 months

Intervention/focus:
Factors affecting outcomes for children with hearing loss

Dependent variables/outcomes:
Receptive and expressive language
Motor development
Social development

Independent variables:
Age at identification of hearing loss

Measures:
Minnesota CDI
Reference:

Study design:
Quantitative
Retrospective cohort
Cross-sectional

Sample size:
50

Participants:
25 children born in hospitals with newborn hearing screening programs („Screen”)  
25 children born in hospitals without newborn hearing screening programs („No screen”), matched to the „Screen” group by age, degree of hearing loss and cognitive quotient

Significantly higher numbers of „No screen” children had their hearing loss identified after age 6 months compared to the „Screen” group.

Intervention/focus:
Factors affecting outcomes for children with hearing loss

Dependent variables/outcomes:
Receptive and expressive language
Cognitive development
Speech intelligibility and other aspects of speech production

Independent variables:
Age at identification of hearing loss

Measures:
Minnesota CDI; Macarthur CDI; number of consonants, vowels and initial blends; rating of overall speech intelligibility
Reference:

**Study design:**
Quantitative
Retrospective cohort
Cross-sectional

**Sample size:**
150

**Participants:**
Children with hearing loss aged 13–36 months divided into two groups according to age of identification of hearing loss: before 6 months or after 6 months

**Intervention/focus:**
Factors affecting outcomes for children with hearing loss

**Dependent variables/outcomes:**
Receptive and expressive language

**Independent variables:**
Age at identification of hearing loss
Cognitive ability

**Measures:**
Macarthur CDI
Reference:

Study design:
Quantitative

Sample size:
7

Participants:
Children with a cochlear implant; age at implantation = 2;3–6;10 years

Intervention/focus:
Factors affecting outcomes of cochlear implantation

Dependent variables/outcomes:
Speech perception
Receptive and expressive language

Independent variables:

Measures:
CELF, BKB, AB Word Lists, PPVT, TOWK
Reference:

**Study design:**
Quantitative

**Sample size:**
295

**Participants:**
Children with a cochlear implant divided into groups according to age in years at implantation: 1–3, 3–5, 5–7, 7–9, 9–11

**Intervention/focus:**
Factors affecting outcomes of cochlear implantation

**Dependent variables/outcomes:**
Speech perception

**Independent variables:**
Age at implantation

**Measures:**
ESP, NU-CHIPS, Minimal Pairs Tests, GASP
Reference:

**Study design:**
Quantitative

**Sample size:**
24

**Participants:**
Children with a cochlear implant; age at implantation = 2;7–12;3 years. Twelve children demonstrated no open-set speech perception prior to receive their implant, and 12 demonstrated some open-set speech perception prior to implantation.

**Intervention/focus:**
Factors affecting outcomes of cochlear implantation

**Dependent variables/outcomes:**
Speech perception

**Independent variables:**

**Measures:**
MTS, WIPI, GASP, NU-CHIPS
Appendix Twelve

Complete list of all outcome measures identified in this review

There are multiple versions of many of the measures listed below; no attempt is made to list all of these.

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Abbreviation</th>
<th>What it measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>APE</td>
<td>APE</td>
<td>Speech perception: phoneme discrimination</td>
</tr>
<tr>
<td>Arthur Boothroyd Word Lists</td>
<td>AB Word Lists</td>
<td>Open-set speech perception: word recognition</td>
</tr>
<tr>
<td>Assessment of Children's Language Comprehension</td>
<td>ACLC</td>
<td>Receptive language (comprehension of different word classes)</td>
</tr>
<tr>
<td>Assessment of Mainstream Performance</td>
<td>AMP-E, AMP-K</td>
<td>Child’s ability to participate in a range of classroom activities and behaviours that are age- and content-appropriate The AMP-E is for elementary and high school students and the AMP-K is for preschool and kindergarten children.</td>
</tr>
<tr>
<td>Audiovisual Feature Test</td>
<td></td>
<td>Closed-set speech perception: nonsense syllables</td>
</tr>
<tr>
<td>Auditory Responsiveness Questionnaire</td>
<td>ARQ</td>
<td>Various auditory behaviours e.g. ability to identify sex of speaker, responding to name, speaking on the telephone Parent report measure</td>
</tr>
<tr>
<td>Beginner’s Intelligibility Test</td>
<td>BIT</td>
<td>Speech intelligibility</td>
</tr>
<tr>
<td>Bench-Kowal-Bamford sentence test</td>
<td>BKB</td>
<td>Open-set speech perception: sentences</td>
</tr>
<tr>
<td>Bracken Test of Basic Concepts</td>
<td>BBCS</td>
<td>Concept development and receptive language in 11 categories e.g. colours, letters, shapes, self/social awareness</td>
</tr>
<tr>
<td>British Picture Vocabulary Scale</td>
<td>BPVS</td>
<td>Receptive language: vocabulary</td>
</tr>
<tr>
<td>Instrument</td>
<td>Abbreviation</td>
<td>What it measures</td>
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</tr>
<tr>
<td>California Achievement Tests</td>
<td>CAT</td>
<td>Academic competency in a variety of areas including reading/language, mathematics, science and social science</td>
</tr>
<tr>
<td>Canonical Babbling Ratio</td>
<td>CBR</td>
<td>Onset of Babbling (Pre-linguistic vocalisation)</td>
</tr>
<tr>
<td>Carolina Picture Vocabulary Test</td>
<td>CPVT</td>
<td>Receptive sign language: vocabulary</td>
</tr>
<tr>
<td>Categories of Auditory Performance</td>
<td>CAP</td>
<td>Speech perception, identification and use of everyday sound</td>
</tr>
<tr>
<td>Child Behavior Checklist</td>
<td>CBCL</td>
<td>Behavioural problems, internalising and externalising behaviours Parent/teacher report measure</td>
</tr>
<tr>
<td>Child Health Questionnaire</td>
<td>CHQ</td>
<td>Physical and psychosocial health Parent report measure</td>
</tr>
<tr>
<td>Children’s Audio-Visual Enhancement Test</td>
<td>CAVET</td>
<td>Speech perception: the increase in speech perception that results when auditory information is added to lip-reading</td>
</tr>
<tr>
<td>Children’s Communication Checklist</td>
<td>CCC</td>
<td>Expressive language (speech, syntax, semantics and coherence) and pragmatics (initiation, scripted language, context and nonverbal communication)</td>
</tr>
<tr>
<td>Children’s Test of Nonword Repetition</td>
<td>CNRep</td>
<td>Phonological working memory</td>
</tr>
<tr>
<td>Children’s Vowel Test</td>
<td></td>
<td>Speech perception: vowels</td>
</tr>
<tr>
<td>CID (Central Institute of the Deaf) everyday sentences test</td>
<td>CID</td>
<td>Open-set speech perception: understanding of everyday sentences</td>
</tr>
<tr>
<td>CID Phonetic Inventory</td>
<td></td>
<td>Speech production: provides a profile of phonetic skills</td>
</tr>
<tr>
<td>Instrument</td>
<td>Abbreviation</td>
<td>What it measures</td>
</tr>
<tr>
<td>------------------------------------------------</td>
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</tr>
<tr>
<td>Clinical Evaluation of Language Fundamentals</td>
<td>CELF</td>
<td>Receptive and expressive language (composite scores for each). Additional scores cover language structure, language content, language content and memory, and working memory.</td>
</tr>
<tr>
<td>Columbia Mental Maturity Scale</td>
<td>CMMS</td>
<td>Cognitive ability: general reasoning level</td>
</tr>
<tr>
<td>Common Phrases Test</td>
<td></td>
<td>Open-set speech perception: sentence comprehension</td>
</tr>
<tr>
<td>Communication and Symbolic Behavior Scales</td>
<td>CSBS</td>
<td>Communication, social-affective and symbolic abilities of children whose functional communication age is 8 months–2 years</td>
</tr>
<tr>
<td>Communication and Symbolic Behavior Scales: Developmental Profile</td>
<td>CSBS DP</td>
<td>Communicative competence (use of eye gaze, gestures, sounds, words, understanding, and play)</td>
</tr>
<tr>
<td>Communicative Intention Inventory</td>
<td>CII</td>
<td>Early intentional communication</td>
</tr>
<tr>
<td>Connected discourse tracking</td>
<td>CDT</td>
<td>Speech perception: understanding of connected speech CDT can be used to test either open- or closed-set speech perception.</td>
</tr>
<tr>
<td>Consonant-Nucleus-Consonant monosyllabic word test</td>
<td>CNC</td>
<td>Open-set speech perception</td>
</tr>
<tr>
<td>Consonant-production accuracy</td>
<td>SPEECH</td>
<td>Percentage of consonant phonemes produced correctly in response to picture stimuli.</td>
</tr>
<tr>
<td>Conversational Act Categories</td>
<td></td>
<td>Pragmatic language development</td>
</tr>
<tr>
<td>Coping Scale for Adults</td>
<td>CSA</td>
<td>Self-report measure of coping behaviour</td>
</tr>
<tr>
<td>Delis-Kaplan Executive Function System</td>
<td>D-KEFS</td>
<td>Higher level cognitive functions (e.g. problem solving, concept formation, creativity)</td>
</tr>
<tr>
<td>Instrument</td>
<td>Abbreviation</td>
<td>What it measures</td>
</tr>
<tr>
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</tr>
<tr>
<td>Developmental Test of Visual Motor Integration</td>
<td>VMI</td>
<td>Integration of visual perception and motor behaviour. The test is non-verbal.</td>
</tr>
<tr>
<td>Developmental Vocal Assessment</td>
<td>DVA</td>
<td>Prelexical vocalisation</td>
</tr>
<tr>
<td>Differential Aptitude Tests</td>
<td>DAT</td>
<td>Ability to learn or succeed in a wide range of areas: verbal reasoning, numerical ability, abstract reasoning, mechanical reasoning, space relations, language usage</td>
</tr>
<tr>
<td>Dimensions of Mastery Motivation Questionnaire</td>
<td>DMQ</td>
<td>Maternal perception of a child’s persistence and general competence</td>
</tr>
<tr>
<td>E2L toy test</td>
<td>E2L</td>
<td>Closed-set speech perception</td>
</tr>
<tr>
<td>Early Language Inventory</td>
<td>ELI</td>
<td>Expressive language: vocabulary</td>
</tr>
<tr>
<td>Early Speech Perception Test for Profoundly Hearing-Impaired Children</td>
<td>ESP</td>
<td>Speech perception: pattern perception and word identification</td>
</tr>
<tr>
<td>Evaluation of Auditory Responses to Speech</td>
<td>EARS</td>
<td>Open- and closed-set speech perception: test battery consisting of the LiP, MPT, MUSS, GASP, LS, a word test and a sentence test</td>
</tr>
<tr>
<td>Expressive One-Word Picture Vocabulary Test</td>
<td>EOWPVT</td>
<td>Expressive language: vocabulary</td>
</tr>
<tr>
<td>Expressive Vocabulary Test</td>
<td></td>
<td>Expressive vocabulary</td>
</tr>
<tr>
<td>Fisher-Logeman Test of Articulatory Competence</td>
<td>Fisher-Logeman</td>
<td>Speech production: systematically examines all English phonemes according to syllabic function</td>
</tr>
<tr>
<td>German language development test</td>
<td>MFED</td>
<td>Receptive and expressive oral language skills developmental age</td>
</tr>
<tr>
<td>Glendonald Auditory Screening Procedure</td>
<td>GASP</td>
<td>Open-set speech perception: ability to understand simple sentences</td>
</tr>
<tr>
<td>Goldman-Fristoe Test of Articulation</td>
<td>GFTA</td>
<td>Speech production: articulation of common speech sounds, misarticulation</td>
</tr>
<tr>
<td>Instrument</td>
<td>Abbreviation</td>
<td>What it measures</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Grammatical Analysis of Elicited Language - Pre-Sentence Level</td>
<td>GAEL-P</td>
<td>Expressive language: elicits simple and complex sentences through an imitative sentence task and prompted language sample. Developed for children with hearing loss</td>
</tr>
<tr>
<td>Grammatical Analysis of Elicited Language – Simple Sentence Level</td>
<td>GAEL-S</td>
<td>Speech perception: ability to repeat sentences in a quiet environment and with competing noise</td>
</tr>
<tr>
<td>Hearing in Noise Test</td>
<td>HINT</td>
<td>Speech perception: ability to repeat sentences in a quiet environment and with competing noise</td>
</tr>
<tr>
<td>Hollingshead Four Factor Index of Social Status</td>
<td></td>
<td>Social status</td>
</tr>
<tr>
<td>Illinois Test of Psycholinguistic Abilities</td>
<td>ITPA</td>
<td>Auditory and visual reception, receptive and expressive language including speech, writing, reading and spelling</td>
</tr>
<tr>
<td>Index of Productive Syntax</td>
<td>IPSyn</td>
<td>Expressive language: syntactic complexity</td>
</tr>
<tr>
<td>Intersubjectivity Index</td>
<td></td>
<td>Number of observed moments of intersubjectivity times mean length of moments</td>
</tr>
<tr>
<td>Intelligibility Index</td>
<td>II</td>
<td>Speech intelligibility</td>
</tr>
<tr>
<td>Iowa Matrix Closed Set Sentence Test</td>
<td></td>
<td>Closed-set speech perception</td>
</tr>
<tr>
<td>Kaufman Assessment Battery for Children</td>
<td>KABC</td>
<td>Cognitive ability (processing, planning, learning and knowledge)</td>
</tr>
<tr>
<td>Language Assessment, Remediation, and Screening Procedure</td>
<td>LARSP</td>
<td>Syntactic and discourse development</td>
</tr>
<tr>
<td>Language Proficiency Profile</td>
<td>LPP</td>
<td>Expressive language and communicative skills of children with hearing loss (rating by parent or teacher). The measure is not specific to any modality or language system. The emphasis in several of the subscales is pragmatics (such as conversational turn-taking). The LPP-PV assesses parental communication skills.</td>
</tr>
<tr>
<td></td>
<td>LPP-PV</td>
<td></td>
</tr>
<tr>
<td>Instrument</td>
<td>Abbreviation</td>
<td>What it measures</td>
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</tr>
<tr>
<td>Language-Specific Sentence Test</td>
<td>LS</td>
<td>Open-set speech perception</td>
</tr>
<tr>
<td>Leiter International Performance Scale</td>
<td>LIPS</td>
<td>General intelligence, primarily abstract concepts The test is non-verbal.</td>
</tr>
<tr>
<td>Lexical Neighborhood Test Multi-syllabic Lexical Neighborhood Test</td>
<td>LNT MLNT</td>
<td>Open-set speech perception: word recognition The LNT contains monosyllabic words and the MLNT contains longer polysyllabic words.</td>
</tr>
<tr>
<td>Ling 6 Sound Test</td>
<td>Ling 6</td>
<td>Speech perception: phoneme detection, discrimination and identification</td>
</tr>
<tr>
<td>Lipreading Assessment for Children with Hearing Impairment</td>
<td>LACHI</td>
<td>Lip reading ability</td>
</tr>
<tr>
<td>Listening Progress Profile</td>
<td>LiP</td>
<td>Auditory discrimination and identification: voices, phonemes, environmental sounds and rhythmic features</td>
</tr>
<tr>
<td>MacArthur Communicative Development Inventory</td>
<td>Macarthur CDI: Words and Gestures Macarthur CDI: Words and Sentences</td>
<td>Receptive and expressive language The Words and Gestures version is for infants and measures comprehension, word production, and symbolic and communicative gesture. The Words and Sentences version is for toddlers and measures word production and early grammar. Parent report measure</td>
</tr>
<tr>
<td>McGarr Sentence Intelligibility Test</td>
<td>McGarr</td>
<td>Speech intelligibility and articulation</td>
</tr>
<tr>
<td>McMaster Family Assessment Device</td>
<td>FAD</td>
<td>Self-report measure of emotional relationships and functioning within the family</td>
</tr>
<tr>
<td>Meadow-Kendall Social-Emotional Assessment Inventory for Deaf and Hearing Impaired Students</td>
<td>M-K</td>
<td>Social adjustment, self-image, and emotional adjustment</td>
</tr>
<tr>
<td>Mean length of utterance</td>
<td>MLU</td>
<td>Mean number of morphemes per</td>
</tr>
<tr>
<td>Instrument</td>
<td>Abbreviation</td>
<td>What it measures</td>
</tr>
<tr>
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</tr>
<tr>
<td>Meaningful Auditory Integration Scale</td>
<td>MAIS</td>
<td>Observable auditory behaviour in everyday situations The IT-MAIS is an adaptation of the MAIS for use with very young children (birth onwards). Parent report measure</td>
</tr>
<tr>
<td>Meaningful Use of Speech Scale</td>
<td>MUSS</td>
<td>Use of language in everyday situations: voice control, speech production and communication strategy Parent/teacher report measure</td>
</tr>
<tr>
<td>Minimal Pairs Test</td>
<td>MTP</td>
<td>Closed-set speech perception: discrimination of consonants and vowels</td>
</tr>
<tr>
<td>Minnesota Child Development Inventory</td>
<td>Minnesota CDI</td>
<td>Measure of children’s development in 8 areas: expressive language, comprehension - conceptual development, situation comprehension, self help, personal social, gross motor, fine motor, general development</td>
</tr>
<tr>
<td>Monosyllabic-Trochee-Polysyllabic Test (subscale of the PLOTT Test)</td>
<td>MTS</td>
<td>Closed-set speech perception: identification of words and numbers of syllables</td>
</tr>
<tr>
<td>Monosyllable, Trochee, Spondee test (subscale of the PLOTT Test)</td>
<td>NTID Writing Test</td>
<td>Closed-set speech perception: word recognition</td>
</tr>
<tr>
<td>Mr Potato Head Task</td>
<td>National Technical Institute for the Deaf Writing Test</td>
<td>Open-set speech perception: comprehension of words and sentences</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Written language: organisation, content, grammar and vocabulary</td>
</tr>
<tr>
<td>Instrument</td>
<td>Abbreviation</td>
<td>What it measures</td>
</tr>
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</tr>
<tr>
<td>Northwestern University Children's Perception of Speech</td>
<td>NU-CHIPS</td>
<td>Closed-set speech perception: word recognition</td>
</tr>
<tr>
<td>Number of different words</td>
<td>NDW</td>
<td>Number of different words used</td>
</tr>
<tr>
<td>Oral and Written Language Scales</td>
<td>OWLS</td>
<td>Receptive and expressive language, including semantic, syntactic, pragmatic and supralinguistic (higher order thinking) skills</td>
</tr>
<tr>
<td>Parenting Stress Index</td>
<td>PSI</td>
<td>Stress in the parent-child system as measured by child characteristics (e.g. demandingness) and parent personality and situation (e.g. competence, isolation)</td>
</tr>
<tr>
<td>Parents’ Evaluation of Developmental Status</td>
<td>PEDS</td>
<td>Developmental and behavioural problems in children aged 0 to 8 years</td>
</tr>
<tr>
<td>Pattern Elicitation Syntax Test</td>
<td>PEST</td>
<td>Assess the child’s ability to use 44 basic grammatical structures of English</td>
</tr>
<tr>
<td>Peabody Individual Achievement Test</td>
<td>PIAT</td>
<td>Academic achievement: reading, written expression, spelling, mathematics</td>
</tr>
<tr>
<td>Peabody Picture Vocabulary Test (various versions)</td>
<td>PPVT</td>
<td>Receptive single-word vocabulary</td>
</tr>
<tr>
<td>Pediatric Speech Intelligibility Test</td>
<td>PSI</td>
<td>Speech perception: recognition of words and sentences</td>
</tr>
<tr>
<td>Phonetic Level Speech Evaluation and Phonologic Level Speech Evaluation</td>
<td>PSI</td>
<td>Speech production: phonetic and phonologic skill level in children with hearing loss</td>
</tr>
<tr>
<td>Phonetically Balanced Kindergarten Words test</td>
<td>PBK</td>
<td>Open-set speech perception: word and phoneme recognition</td>
</tr>
<tr>
<td>Instrument</td>
<td>Abbreviation</td>
<td>What it measures</td>
</tr>
<tr>
<td>-----------------------------------------------------------</td>
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<td>-------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Pictorial Scale of Perceived Competence and Social Acceptance for Young Children (modified version)</td>
<td></td>
<td>This instrument is comprised of 24 items that prompt children to reveal feelings about their own competence in the domains of cognitive competence, physical competence, socio-emotional competence, school adjustment, and communicative competence.</td>
</tr>
<tr>
<td>Play Assessment Questionnaire</td>
<td>PAQ</td>
<td>Development of play Parent report measure</td>
</tr>
<tr>
<td>PLOTT Test</td>
<td>PLOTT</td>
<td>Closed-set speech perception</td>
</tr>
<tr>
<td>Preschool Delay Task (Gordon Diagnostic System)</td>
<td></td>
<td>Response delay, a cognitive skill important for the accomplishment of goal-oriented behaviours. Response delay requires inhibition of action and prevention of distraction from extraneous stimuli.</td>
</tr>
<tr>
<td>Preschool Language Assessment Instrument</td>
<td>PLAI</td>
<td>Receptive and expressive language, pragmatics</td>
</tr>
<tr>
<td>Preschool Language Scale</td>
<td>PLS</td>
<td>Broad spectrum of speech and language skills, including receptive and expressive language, articulation, connected speech, voice, fluency and pragmatics</td>
</tr>
<tr>
<td>Production of Infants Scale Evaluation questionnaire</td>
<td>PRISE</td>
<td>Prelexical vocalisation Parent report measure</td>
</tr>
<tr>
<td>Raven’s Progressive Matrices</td>
<td></td>
<td>Nonverbal cognitive ability: ability to form perceptual relations and to reason by analogy, independent of language and formal schooling</td>
</tr>
<tr>
<td>Reading Progress Test 1</td>
<td>RPT1</td>
<td>Reading ability: reading comprehension</td>
</tr>
<tr>
<td>Receptive-Expressive Emergent Language Scale</td>
<td>REEL</td>
<td>Receptive and expressive language Parent report measure</td>
</tr>
<tr>
<td>Renfrew Language Scales: Bus Story Test</td>
<td></td>
<td>Expressive language: story-retelling task</td>
</tr>
<tr>
<td>Instrument</td>
<td>Abbreviation</td>
<td>What it measures</td>
</tr>
<tr>
<td>------------------------------------------------------</td>
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<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Revised Rutter Parent Scale for School-Age Children &amp; Revised Rutter Teacher Scale for School-Age Children</td>
<td>Rutter</td>
<td>Emotional, conduct and other behavioural difficulties</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Parent/teacher report measures</td>
</tr>
<tr>
<td>Reynell Developmental Language Scales</td>
<td>RDLS</td>
<td>Verbal comprehension and expressive language</td>
</tr>
<tr>
<td>Rossetti Infant-Toddler Language Scale</td>
<td>RITLS</td>
<td>Infant and toddler preverbal and verbal development: interaction-attachment, pragmatics, gesture, play, receptive and expressive language</td>
</tr>
<tr>
<td>Scales of Early Communication Skills for Hearing-Impaired Children</td>
<td>SECS</td>
<td>Receptive and expressive language</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Teacher report measure</td>
</tr>
<tr>
<td>Schedule of Growing Skills II</td>
<td>SGS II</td>
<td>Skills in 10 areas, including hearing, speech, language, motor, visual, social, and self-care</td>
</tr>
<tr>
<td>Screening Instrument for Targeting Educational Risk</td>
<td>SIFTER</td>
<td>Several areas of classroom performance, including academics, attention, communication and participation</td>
</tr>
<tr>
<td>Sense of Coherence questionnaire</td>
<td>SOC</td>
<td>Response to stressful situations</td>
</tr>
<tr>
<td>Short-Long Sentence Test</td>
<td></td>
<td>Speech production: ability to correctly pronounce a series of short and long sentences</td>
</tr>
<tr>
<td>SKI*HI Language Development Scale</td>
<td>LDS</td>
<td>Receptive and expressive language</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Parent report measure</td>
</tr>
<tr>
<td>Social Competence Questionnaire</td>
<td></td>
<td>Social development: degree of competence in seven areas of social behaviour e.g. egocentrism, unresponsiveness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Teacher report measure</td>
</tr>
<tr>
<td>Social Support Questionnaire</td>
<td>SSQ</td>
<td>Social support</td>
</tr>
<tr>
<td>Instrument</td>
<td>Abbreviation</td>
<td>What it measures</td>
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</tr>
<tr>
<td>Social-Emotional Assessment Inventory</td>
<td>SEAI</td>
<td>Social-emotional development of children with hearing loss: sociable, communicative behaviours; dominating behaviours; anxious, compulsive behaviours; developmental lags</td>
</tr>
<tr>
<td>Speech Intelligibility Rating</td>
<td>SIR</td>
<td>Speech intelligibility</td>
</tr>
<tr>
<td>Split-Screen Preferential Looking Procedure</td>
<td>SPLP</td>
<td>Bimodal (audiovisual) speech perception</td>
</tr>
<tr>
<td>Stanford Achievement Test</td>
<td>SAT</td>
<td>Academic knowledge of primary and secondary school students in 8 areas: word study skills, reading skills/comprehension, vocabulary, mathematics, language, spelling, social studies/science, listening The SAT-HI is specifically for children with hearing loss.</td>
</tr>
<tr>
<td>Stanford Achievement Test-Hearing Impaired</td>
<td>SAT-HI</td>
<td></td>
</tr>
<tr>
<td>Stark Assessment of Early Vocal Development</td>
<td>SAEVD</td>
<td>Speech production – 6 levels of vocalisations e.g. control of articulation, canonical syllables</td>
</tr>
<tr>
<td>Story-retell tasks</td>
<td></td>
<td>Speech production and/or expressive language</td>
</tr>
<tr>
<td>Strengths and Difficulties Questionnaire</td>
<td>SDQ</td>
<td>Behaviour: emotional symptoms; problems of conduct, hyperactivity/inattention and peer relationships; prosocial behaviour</td>
</tr>
<tr>
<td>Student Oral Language Observation Matrix</td>
<td>SOLOM</td>
<td>Receptive and expressive language skills in a second language: comprehension, vocabulary, fluency, grammar and pronunciation</td>
</tr>
<tr>
<td>Test Battery for American Sign Language Morphology and Syntax</td>
<td>ASL test battery</td>
<td>Knowledge and use of specific morphological and syntactic structures in ASL The test battery consists of 12 comprehension and production measures e.g. narrative production, noun-verb comprehension.</td>
</tr>
<tr>
<td>Instrument</td>
<td>Abbreviation</td>
<td>What it measures</td>
</tr>
<tr>
<td>------------------------------------------------</td>
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</tr>
<tr>
<td>Test for Reception of Grammar</td>
<td>TROG</td>
<td>Receptive language: grammar</td>
</tr>
<tr>
<td>Test of Auditory Comprehension</td>
<td>TAC</td>
<td>Speech perception: ranging from simple auditory discrimination to comprehension of complex stories</td>
</tr>
<tr>
<td>Test of Auditory Comprehension of Language-Revised</td>
<td>TACL-R</td>
<td>Receptive language: word classes and relations, grammatical morphemes, elaborated sentences (complex sentence constructions)</td>
</tr>
<tr>
<td>Test of Early Reading Ability – Deaf/Hard of Hearing</td>
<td>TERA-D</td>
<td>Reading ability: ability to attribute meaning to printed symbols, knowledge of the alphabet, understanding of the conventions of print</td>
</tr>
<tr>
<td>Test of Word Knowledge</td>
<td>TOWK</td>
<td>Receptive and expressive vocabulary</td>
</tr>
<tr>
<td>Tower Test (NEPSY)</td>
<td></td>
<td>Executive functions of planning, monitoring, self-regulation, and problem solving</td>
</tr>
<tr>
<td>Type-token ratios</td>
<td>TTRs</td>
<td>Expressive language: lexical diversity – ratio of the number of different words produced to the total number of words produced</td>
</tr>
<tr>
<td>Video Game Test of Speech Pattern Contrast Perception</td>
<td>VIDSPAC</td>
<td>Closed-set speech perception: discrimination of specific phoneme contrasts</td>
</tr>
<tr>
<td>Vineland Adaptive Behavior Scales</td>
<td>VABS</td>
<td>Personal and social sufficiency in four domains: communication, daily living skills, socialisation, motor skills</td>
</tr>
<tr>
<td>Vowel Perception Test</td>
<td></td>
<td>Speech perception</td>
</tr>
<tr>
<td>Wechsler Intelligence Scale for Children</td>
<td>WISC</td>
<td>Intelligence (verbal and performance IQ)</td>
</tr>
<tr>
<td>Wechsler Preschool and Primary Scale of Intelligence</td>
<td>WPPSI-R</td>
<td>Intelligence of children aged 3;0 to 7;3</td>
</tr>
<tr>
<td>Instrument</td>
<td>Abbreviation</td>
<td>What it measures</td>
</tr>
<tr>
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</tr>
<tr>
<td>Woodcock Reading Mastery Tests-Revised</td>
<td>WRMT</td>
<td>Reading ability</td>
</tr>
<tr>
<td>Woodcock-Johnson Psycho-Educational Battery</td>
<td>WJ</td>
<td>Cognitive ability, scholastic aptitude and academic achievement</td>
</tr>
<tr>
<td>Woodcock-Johnson Tests of Achievement</td>
<td>WJ ACH</td>
<td>Academic achievement; part of the Woodcock-Johnson Psycho-Educational Battery</td>
</tr>
<tr>
<td>Word Intelligibility by Picture Identification</td>
<td>WIPÍ</td>
<td>Closed-set speech perception</td>
</tr>
<tr>
<td>Youth Self Report</td>
<td>YSR</td>
<td>Child and adolescent psychopathology</td>
</tr>
</tbody>
</table>


Connor, CM, Craig, HK, Raudenbush, SW, Heavner, K & Zwolan, TA 2006, „The age at which young deaf children receive cochlear implants and their vocabulary and speech-production growth: is there an added value for early implantation?”, *Ear & Hearing*, vol. 27, no. 6, pp. 628-644.


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