Speech Perception and Oral Language Development of Deaf Children in Mainstream schools

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Jockey Club Sign Bilingualism and Co-enrolment in Deaf Education Programme

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Acknowledgement

賽馬會手語雙語共融教育計劃
JOCKEY CLUB SIGN BILINGUALISM AND CO-ENROLMENT IN DEAF EDUCATION PROGRAMME

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The Hong Kong Jockey Club Charities Trust
The impact of hearing impairment

“deaf-mute” ?? 聾-啞 ??

HI has a negative impact on speech perception and oral language development!
The role of hearing technology

- High-gain HA
- Multichannel CI

Access to speech information

- Blamey (2003)
- Leigh (2008)

Develop oral language

- Geers and colleagues (2003)
The oral language ability of deaf children

• reports on the benefit of CI and neonatal hearing screening (Yoshinaga-Itano et al., 1998; Moog, 2002; Blamey & Sarant, 2002; Nikolopoulos et al., 2004; Svirsky et al., 2004; Hayes et al., 2009; Niparko et al., 2010; Meinzen-Derr et al., 2011)

• Oral language abilities of deaf children are still diverse and with large individual differences (Blamey, 1998; Svirsky et al., 2000; Geers, 2006; Fitzpatrick, 2011)

• The language growth rate of deaf children over the time is also questionable (Delage & Tuller, 2007; Geers et al., 2008; Hayes, 2009)
Contributing factors

• Demographic factors
  – Residual hearing prior to CI (Geers, 2006; Niparko, 2010)
  – Parent-child interactions (Niparko, 2010)
  – Socioeconomic status (Niparko, 2010)
  – Degree of HL (Sininger et al., 2010; Fitzpatrick, 2011)
  – Parent education (Fitzpatrick, 2011)
  – Age of receiving amplification / CI (Geers, 2006; Nicholas & Geers, 2007; Sininger et al., 2010)
  – Cochlear implant use (Sininger et al., 2010)
  – Rehabilitation focus (Geers, 2006)

• Outcome measurement
  – Speech perception (Blamey, 1998; Blamey et al., 2001; Pisoni, 2004; DesJardin, 2009)
Speech perception

Degree of Hearing Loss vs Speech Perception Ability

- a process by which the speech is heard, interpreted and understood
- critical for early linguistic development

Mild (25-40 dB)
Moderate (41-55 dB)
MS (56-70 dB)
Severe (71-90 dB)
Profound (>90 dB)
Assessing the speech perception ability

• Contemporary speech perception measures
  – Speech feature perception test (DesJardin, 2009)
  – Closed-set / open-set word perception test (Blamey, 1998; Lee & van Hasselt, 2004)
  – Sentence speech perception test (Bench et al., 1979)
  – Tone perception test (Lee et al., 2002)

• Beware of the tester’s lexical knowledge and speech production ability
The speech perception ability of deaf children

• Speech perception abilities of deaf children are delayed relative to normal hearing children (Lee et al., 2002)

• A high correlation of speech perception ability & language development (Blamey et al., 1998; Blamey et al., 2001; Pisoni, 2004) than any demographic variable (Blamey et al., 2001)

• Better speech perception ability $\Rightarrow$ better receptive language development $\Rightarrow$ better expressive language development? (DesJardin et al., 2009)
Research Questions

1. What is the speech perception and oral language abilities of deaf children in HK?

2. What factor(s) may better predict oral language outcome in deaf children?

3. What is the development of oral language ability of deaf children over the time?
Methodology
Participants

• 111 Cantonese-speaking children

• Hearing loss: PTA ≥ 25dB in the better ear

• Studying in mainstream primary schools
  – 97 in mainstreaming program
  – 14 in sign-bilingual education program

• Performance IQ ≥ 70, no other diagnosed disabilities
## Number of participants by groups

<table>
<thead>
<tr>
<th>Hearing Loss</th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
<th>P5</th>
<th>P6</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>mild</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<tr>
<td>moderate</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>Mod-sev</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>19</td>
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<tr>
<td>severe</td>
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<td>6</td>
<td>2</td>
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<td>13</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>33</td>
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<td><strong>Total</strong></td>
<td>27</td>
<td>24</td>
<td>14</td>
<td>16</td>
<td>9</td>
<td>21</td>
<td>111</td>
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</table>
## Demographics (time point 1)

<table>
<thead>
<tr>
<th>Age of Diagnosis</th>
<th>N</th>
<th>Mode of amplification</th>
<th>Deaf parents</th>
<th>program</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>nil</td>
<td>HA</td>
<td>CI</td>
</tr>
<tr>
<td>mild</td>
<td>20</td>
<td>3;02</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>moderate</td>
<td>20</td>
<td>2;08</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>ms</td>
<td>19</td>
<td>2;09</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>severe</td>
<td>19</td>
<td>2;00</td>
<td>18</td>
<td>1</td>
</tr>
<tr>
<td>profound</td>
<td>33</td>
<td>1;01</td>
<td>9</td>
<td>24</td>
</tr>
<tr>
<td>Total</td>
<td>111</td>
<td></td>
<td></td>
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</tbody>
</table>
Measurements

1. Cantonese Lexical Neighborhood Test (CLNT)

2. Cantonese tone identification test (CANTIT)

3. Hong Kong Cantonese Oral Language Assessment Scale (HKCOLAS)
Measurements

1. Cantonese Lexical Neighborhood Test (CLNT)
   (Yuen, K. C. P., Ng, I. H. Y., Luk, B. P. K., Chan, S. K. W., Chan, S. C. S.,
   Kwok, I. C. L. et al., 2008)

   - 25 disyllabic words
   - Live voice presentation
   - correct recognition >> ✓
Measurements

2. Cantonese tone identification test (CANTIT)
   (Lee, K. Y. S., 2012)

- Research version
- 75 monosyllabic words
- Stimuli were presented through computer speaker
- Scores from aided condition
Measurements

3. Hong Kong Cantonese Oral Language Assessment Scale (HKCOLAS)

- Cantonese Grammar (CG)
- Textual Comprehension (TC)
- Word Definition (WD)
- Lexical-Semantic Relationship (LS)
- Story Retell (SR)
- Expressive Nominal Vocabulary (EV)
HKCOLAS testing procedure

• Changing the presentation mode
  Audio >> Visual (to simulate the daily circumstance)
• Test instructions and test items are the same as in the original format

Adapted by Centre for Sign Linguistics and Deaf Studies (CSLDS)
Results
Research Question 1

What is the speech perception and oral language ability of deaf children in HK?
Presentation of scores in HKCOLAS

• Norm-referenced test
• Standard score was used
Performance in each subtest

<table>
<thead>
<tr>
<th></th>
<th>CG (Can. Grammar)</th>
<th>TC (Textual Comp.)</th>
<th>WD (Word Definition)</th>
<th>LS (Lexical-semantic)</th>
<th>SR (Story Retell)</th>
<th>EV (Exp. Vocab.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>mild</td>
<td>-0.59</td>
<td>0.03</td>
<td>0.02</td>
<td>-0.65</td>
<td>-1.04</td>
<td>0.02</td>
</tr>
<tr>
<td>moderate</td>
<td>-0.98</td>
<td>-0.61</td>
<td>-0.36</td>
<td>-0.83</td>
<td>-0.82</td>
<td>-1.21</td>
</tr>
<tr>
<td>ms</td>
<td>-1.94</td>
<td>-0.99</td>
<td>-0.31</td>
<td>-1.54</td>
<td>-1.47</td>
<td>-2.05</td>
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<tr>
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<td>-2.45</td>
<td>-1.70</td>
<td>-1.21</td>
<td>-1.85</td>
<td>-2.16</td>
<td>-2.28</td>
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<tr>
<td>profound</td>
<td>-2.90</td>
<td>-2.24</td>
<td>-1.30</td>
<td>-2.10</td>
<td>-2.96</td>
<td>-2.29</td>
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<tr>
<td>average</td>
<td>-1.90</td>
<td>-1.23</td>
<td>-0.71</td>
<td>-1.47</td>
<td>-1.84</td>
<td>-1.64</td>
</tr>
</tbody>
</table>

*The mean is displayed in standard scores*
# Performance in each subtest

<table>
<thead>
<tr>
<th></th>
<th>CG</th>
<th>TC</th>
<th>WD</th>
<th>LS</th>
<th>SR</th>
<th>EV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Can. Grammar)</td>
<td>(Textual Comp.)</td>
<td>(Word Definition)</td>
<td>(Lexical-semantic)</td>
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<td>(Exp. Vocab.)</td>
</tr>
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</tr>
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</tr>
<tr>
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<td>-1.54</td>
<td>-1.47</td>
<td>-2.05</td>
</tr>
<tr>
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<td>-1.70</td>
<td>-1.21</td>
<td>-1.85</td>
<td>-2.16</td>
<td>-2.28</td>
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<td>-2.96</td>
<td>-2.29</td>
</tr>
<tr>
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<td><strong>-1.84</strong></td>
<td><strong>-1.64</strong></td>
</tr>
</tbody>
</table>

*The mean is displayed in standard scores*
Statistical operation

Principal Component Analysis (PCA)

variable-reduction technique

\[ \text{a larger set of variables into a smaller set of ‘artificial’ variables} \]
Statistical operation

Principal Component Analysis (PCA)

variable-reduction technique

↘ a larger set of variables into a smaller set of ‘artificial’ variables
## Principal Component Analysis (PCA)

**variable-reduction technique**: a larger set of variables into a smaller set of ‘artificial’ variables

### Total Variance Explained

<table>
<thead>
<tr>
<th>Component</th>
<th>Initial Eigenvalues</th>
<th>Extraction Sums of Squared Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>% of Variance</td>
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<tr>
<td>CG</td>
<td>4.912</td>
<td>81.871</td>
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<tr>
<td>TC</td>
<td>0.411</td>
<td>6.851</td>
</tr>
<tr>
<td>WD</td>
<td>0.223</td>
<td>3.710</td>
</tr>
<tr>
<td>LS</td>
<td>0.204</td>
<td>3.404</td>
</tr>
<tr>
<td>SR</td>
<td>0.149</td>
<td>2.488</td>
</tr>
<tr>
<td>EV</td>
<td>0.101</td>
<td>1.676</td>
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</table>
**Statistical operation - PCA**

<table>
<thead>
<tr>
<th>Component</th>
<th>1</th>
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</thead>
<tbody>
<tr>
<td>CG</td>
<td>.947</td>
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<td>TC</td>
<td>.910</td>
</tr>
<tr>
<td>WD</td>
<td>.805</td>
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<td>.920</td>
</tr>
<tr>
<td>SR</td>
<td>.920</td>
</tr>
<tr>
<td>EV</td>
<td>.920</td>
</tr>
</tbody>
</table>

![Table with data](image)
Defining Language Ability

1. Standard diagnostic criterion of HKCOLAS

- Standard score less than -1.25 in two or more subtests
- Language delay: 72 (65%)
- Age appropriate: 39 (35%)
2. Cluster analysis

Two step cluster using Schwarz’s Bayesian Criterion (BIC) and Euclidean estimation
Defining Language Ability

2. Cluster Analysis

- Language delay: 72 (65%)
- Age appropriate: 39 (35%)

Lower language ability group

Higher language ability group
Defining Language Ability

2. Cluster Analysis

- Language delay & low ability: 52 (47%)
- Language delay but high ability: 20 (18%)
- Age appropriate & high ability: 39 (35%)
OL performance in 3 Language Ability Groups

Age appropriate   Mild-moderate LD   Severe LD

CG  TC  WD  LS  SR  EV
Speech perception performance in 3 language ability groups

- Age appropriate
- Mild-moderate LD
- Severe LD

CLNT
CANTIT
Research Question 2

What factor(s) may better predict oral language outcome in deaf children?
Correlation

• Dependent variable
  – composite score

• Independent variable
  – Degree of HL
  – With or without deaf parents
  – Type of hearing devices
  – Program type
  – Month of hearing diagnosis
  – CLNT scores
  – CANTIT scores
Correlation

- Spearman rank-order correlation
- Dependent variable: composite score

<table>
<thead>
<tr>
<th>Correlation Coefficient</th>
<th>Degree of HL</th>
<th>Deaf parents</th>
<th>Type of aid (HA)</th>
<th>Type of aid (CI)</th>
<th>Program type</th>
<th>Month of HL dx</th>
<th>CLNT</th>
<th>CANTIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation Coefficient</td>
<td><strong>-.470</strong></td>
<td>.087</td>
<td><strong>.273</strong></td>
<td><strong>-.335</strong></td>
<td><strong>.307</strong></td>
<td>.131</td>
<td><strong>.571</strong></td>
<td><strong>.735</strong></td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.364</td>
<td>.004</td>
<td>.000</td>
<td>.001</td>
<td>.171</td>
<td>.000</td>
<td>.000</td>
</tr>
</tbody>
</table>

\(a\) dummy variable indicating which hearing aid method the deaf child was using (none, HA, CI)

\(b\) measured on 5 levels of hearing loss (mild, moderate, MS, severe and profound)

* p < 0.05  ** p < 0.01
## Multiple Regression Analysis

<table>
<thead>
<tr>
<th>Variables</th>
<th>B</th>
<th>Std. Error</th>
<th>β</th>
<th>R² change</th>
<th>F(6,104)</th>
<th>Collinearity statistics (VIF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program</td>
<td>-.051</td>
<td>.221</td>
<td>-.018</td>
<td><strong>.486</strong>*</td>
<td>16.421***</td>
<td>1.278</td>
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<tr>
<td>HL</td>
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<td>.066</td>
<td>-.082</td>
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<td></td>
<td>2.262</td>
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<tr>
<td>HA&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-.090</td>
<td>.415</td>
<td>-.042</td>
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<td></td>
<td>7.723</td>
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<tr>
<td>CI&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-.034</td>
<td>.481</td>
<td>-.015</td>
<td></td>
<td></td>
<td>9.604</td>
</tr>
<tr>
<td>CANTIT</td>
<td>.046</td>
<td>.008</td>
<td><strong>.688</strong>*</td>
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<td>2.946</td>
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<tr>
<td>CLNT</td>
<td>-.007</td>
<td>.019</td>
<td>-.036</td>
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<td>2.099</td>
</tr>
</tbody>
</table>

Note. Effect was measured by VIF = variance inflation factors (VIF with values less than 10 showed that the model did not suffer from multicollinearity problems)

<sup>a</sup> dummy variable indicating which hearing aid method the deaf child was using (none, HA, CI)

*** p< 0.001
Research Question 3

What is the development of oral language ability of deaf children over the time?
Participants in time point 2

Initial Ax (TP1) N=111

Around 3 years later – re-assessed N=83

25% dropout

Still studying in primary school (TP2) N=55
Demographics (55 participants)

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Age of dx</th>
<th>Mode of amplification</th>
<th>Deaf parents</th>
<th>program</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>nil  HA  CI</td>
<td></td>
<td>sign bilingual Main-streaming</td>
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<tr>
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<td>20</td>
<td>8 3;02 3;03</td>
<td>3 17 8</td>
<td>1 1</td>
<td>19 7</td>
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<tr>
<td>moderate</td>
<td>20</td>
<td>9 2;08 2;04</td>
<td>20 9 19 9</td>
<td>20 9</td>
<td>20 9</td>
</tr>
<tr>
<td>ms</td>
<td>19</td>
<td>7 2;09 3;01</td>
<td>19 7 19 6</td>
<td>1 1</td>
<td>18 6</td>
</tr>
<tr>
<td>severe</td>
<td>19</td>
<td>11 2;00 1;03</td>
<td>18 11 1 3 2 3 3 16 8</td>
<td>3 2 3 3 16 8</td>
<td></td>
</tr>
<tr>
<td>profound</td>
<td>33</td>
<td>20 1;01 1;01</td>
<td>9 4 24 16 3 1 9 9 24 11</td>
<td>9 9 24 11</td>
<td></td>
</tr>
</tbody>
</table>
3 Language Ability Groups

- With reference to their composite scores at TP2, participants were categorized into respective language ability groups

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Time Point 1 (N=55)</th>
<th>Time Point 2 (N=55)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age appropriate</td>
<td>17</td>
<td>22</td>
</tr>
<tr>
<td>Mild-moderate LD</td>
<td>11</td>
<td>13</td>
</tr>
<tr>
<td>Severe LD</td>
<td>27</td>
<td>20</td>
</tr>
</tbody>
</table>
### 3 Language Ability Groups

- Individual change across language ability groups

<table>
<thead>
<tr>
<th>Time Point 1 (N=55)</th>
<th>Regress (5%)</th>
<th>keep up (71%)</th>
<th>Progress (24%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age Appropriate (17)</td>
<td>1</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Mild-moderate LD (11)</td>
<td>2</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Severe LD (27)</td>
<td>18</td>
<td></td>
<td>9</td>
</tr>
</tbody>
</table>
## Change of scores from TP1 to TP2

<table>
<thead>
<tr>
<th></th>
<th>CG (Cantonese Grammar)</th>
<th>TC (Textual Comp.)</th>
<th>WD (Word Definition)</th>
<th>LS (Lexical-semantic)</th>
<th>SR (Story Retell)</th>
<th>EV (Expressive Vocab.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age Appropriate (17)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP1</td>
<td>0.03</td>
<td>0.23</td>
<td>0.31</td>
<td>-0.49</td>
<td>-0.10</td>
<td>0.12</td>
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<tr>
<td>TP2</td>
<td>0.21</td>
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<td>0.37</td>
<td>0.15</td>
<td>0.05</td>
<td>0.24</td>
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<tr>
<td><strong>Mild-moderate LD (11)</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP1</td>
<td>-1.59</td>
<td>-1.06</td>
<td>-0.44</td>
<td>-1.24</td>
<td>-1.47</td>
<td>-1.01</td>
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<tr>
<td>TP2</td>
<td>-1.21</td>
<td>-0.10</td>
<td>0.06</td>
<td>-1.32</td>
<td>-1.35</td>
<td>-0.50</td>
</tr>
<tr>
<td><strong>Severe LD (27)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP1</td>
<td>-3.62</td>
<td>-2.68</td>
<td>-1.77</td>
<td>-2.48</td>
<td>-3.63</td>
<td>-3.10</td>
</tr>
<tr>
<td>TP2</td>
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<td>-2.26</td>
<td>-3.45</td>
<td>-3.01</td>
</tr>
</tbody>
</table>
# Change of scores from TP1 to TP2
(Repeate Measure ANOVA)

<table>
<thead>
<tr>
<th></th>
<th>CG * (Cantonese Grammar)</th>
<th>TC ** (Textual Comp.)</th>
<th>WD (Word Definition)</th>
<th>LS (Lexical-semantic)</th>
<th>SR (Story Retell)</th>
<th>EV (Expressive Vocab.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age Appropriate (17)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP1</td>
<td>0.03</td>
<td>0.23</td>
<td>0.31</td>
<td>-0.49</td>
<td>-0.10</td>
<td>0.12</td>
</tr>
<tr>
<td>TP2</td>
<td>0.21</td>
<td>0.44</td>
<td>0.37</td>
<td>0.15</td>
<td>0.05</td>
<td>0.24</td>
</tr>
<tr>
<td><strong>Mild-moderate LD (11)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP1</td>
<td>-1.59</td>
<td>-1.06</td>
<td>-0.44</td>
<td>-1.24</td>
<td>-1.47</td>
<td>-1.01</td>
</tr>
<tr>
<td>TP2</td>
<td>-1.21</td>
<td>-0.10</td>
<td>0.06</td>
<td>-1.32</td>
<td>-1.35</td>
<td>-0.50</td>
</tr>
<tr>
<td><strong>Severe LD (27)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP1</td>
<td>-3.62</td>
<td>-2.68</td>
<td>-1.77</td>
<td>-2.48</td>
<td>-3.63</td>
<td>-3.10</td>
</tr>
<tr>
<td>TP2</td>
<td>-3.02</td>
<td>-1.93</td>
<td>-1.42</td>
<td>-2.26</td>
<td>-3.45</td>
<td>-3.01</td>
</tr>
</tbody>
</table>

* p< 0.05  ** p< 0.01
Conclusions

• Align with some previous findings, the performance of deaf children is behind the level of children with normal hearing in general (Blamey et al., 1998; Wake et al., 2004; Fitzpatric et al., 2011)

• Performed poorer in:
  – CG > SR > EV > LS > TC > WD

• Three language groups:
  – Age appropriate: 35%
  – Mild-moderate LD: 18%
  – Severe LD: 47%
Conclusions

• Among the various predictors, tone perception was significantly correlated with oral language outcome (48.6% of variance)
  
  – Degree of HL
  – With or without deaf parents
  – Type of hearing devices
  – Program type
  – Month of hearing diagnosis
  – CLNT scores
  – CANTIT scores
Conclusions

• Oral Language performance after 3 years time:
  – Age appropriate (40%)
  – Mild-moderate language delay (24%)
  – Severe language delay (36%) \[= 60\%\]

• Significant improvement was seen in Cantonese Grammar and Textual Comprehension.

• What factors contribute to the improvement is left to be answered.
References


• Lee, K. Y. S. (2012). Cantonese Tone Identification Test
References

Thank You!

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