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Performance ratings for children using bilateral cochlear implants obtained with the Speech, Spatial and Other Qualities of Hearing Scale for Parents

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Introduction

Researchers at The University of Melbourne are evaluating the broader outcomes of bilateral implantation in early-implanted school-age children, including effects on parent and child stress (Sarant and Garrard, 2013), language (Sarant et al., 2014), psychosocial functioning, academic achievement, and everyday listening. The Speech, Spatial and Other Qualities of Hearing Scale (SSQ) is a three-part adult questionnaire (http://www.ihr.mrc.ac.uk/products/display/ssq; Gatehouse and Noble, 2004). The SSQ focusses mainly on hearing functions requiring the binaural system and is therefore suitable for evaluating everyday listening performance with bilateral implants. The SSQ-P is an adapted version for use with parents of children with hearing impairment (Galvin and Noble, 2013). The first section of the SSQ focusses on speech perception in different listening scenarios, such as in group conversation in a noisy environment, or a single speaker in a reverberant environment. The second section focuses on spatial hearing, in this case the direction of movement and location of sound sources, including the speaker in a group conversation. The final section focusses on other qualities of hearing, including sound segregation, listening effort, and sound and object identification.

Methods

The participants were the parents of 78 children aged 5 to 9 years, who were simultaneously (n=9) or sequentially bilaterally implanted. The mean demographic values were 1.4 years (SD 0.75) for age at first implant, 2.8 years (SD 1.4) for age at second implant, 1.4 years (SD 1.2; range 0.0 to 5.0) for time between implants, and 4.1 years (SD 1.5) for bilateral experience. Each section of the SSQ-P was administered separately. For each section, the parent was provided with the listening scenarios relevant to that section, and asked to observe their child in those scenarios. In a followup phone call, the parent rated their child's performance in each scenario. Zero typically indicated *unable to perform at all* and 10 indicatied *performing perfectly*.

Results

For the speech perception section, children were generally rated as performing close to perfectly when conversing with a single speaker in a quiet environment (median rating 10; Figure 1). Performance ratings were also typically high for a single speaker with a constant noise or the TV in the background, and a group conversation in quiet (interquartile range 7 to 9). Ratings were lower for a single speaker in reverberation or with multiple speakers in the background (median 7), and there was a higher proportion of children rated more poorly (25^{th} percentile 5). The majority of children were not rated as performing well in group conversations in noisy environments, with an interquartile range of 4 to 6.74

when visual cues were available and 2 to 6 without visual cues. For the spatial hearing section, performance ratings were generally lower and also more variable across children, but were relatively similar across scenarios (Figure 2). Generally, median ratings were 6 to 7, the interquartile range was 3 to 4, and the range was 0 or 1 to 10. For the other qualities of hearing section, half to a majority of children were rated as performing at least reasonably, with the median rating being 6 to 9 across all scenarios (Figure 3). Outliers indicated some indivudals were rated as perfroming particularly poorly relative to the group in five scenarios. Performance ratings were highest for judging mood, awareness of a speaker with music playing, recognising voices, and distinguishing between musical pieces. Ratings were particularly variable across children for the effort required in conversation. The range was 0 (a great deal of effort) to 10 (no effort), the interquartile range 3 to 9.

Multiple linear regression analyses were used to examine the relationship between parent ratings and age at first implant, time between implants, and bilateral experience. Age at second implant was not included as it is a combination of the first two factors. Higher ratings for speech perception were associated with an earlier age at first implant ($p = 0.049$). Higher ratings for spatial hearing were associated with more bilateral experience ($p = 0.018$). Higher ratings for other qualities of hearing were associated with an earlier age at first implant ($p = 0.032$) and a shorter time between implants ($p = 0.026$)

Discussion

These children with bilateral implants were generally rated highly for their ability to follow a conversation with a single speaker or a group in quiet conditions, or a single speaker with the televsion on. Reverberant environments and a background of multiple speakers made it somewhat more difficult for the children to follow a single speaker. Despite their use of bilateral implants, the majority of children generally still struggled to follow a group conversation in background noise, particularly without visual cues. This is highly likely to impact on their functioning in a noisy mainstream classroom, in which group work also occurs. It is important to note that, for half of the scenarios, at least some children were rated at just 0 to 2, suggesting a very limited ability to perform the listening task. Across scenarios in the spatial hearing and other qualities of hearing sections, half of the children were rated as performing at least resonably well. Again, however, some children were rated as performing very poorly or not at all. The young age of the children may also impact negatively on their performance on the spatial hearing tasks.

The relationship between the earlier age at first implant and higher ratings was consistent with previous studies indicating greater advantage for earlier implanted children, at least when young; it was interesting to see that this advantage appeared to persist until 5 to 9 years. There was no relationship with the spatial hearing ratings; possibly because a first implant alone provides limited benefit for spatial hearing tasks. The strongest relationship was between higher ratings on the spatial hearing section and more bilateral experience. This is consistent with objective studies showing imporved localisation with bilateral experience, and some suggestions in the literature that spatial skills develop more slowly after bilateral implantation. The relationship between a shorter time between implants and better outcomes has been demonstrated previously; it is difficult to identify why this relationship was evident here only for the other qualities of hearing section.

Conclusions

Although there was significant variation in parent ratings of everyday performance for these 78 bilaterally implanted children, the median rating was 6 or more out of 10 across all items, with the exception of the lower ratings for group conversation in noise. The factors related to higher ratings on at least one SSQ section were a younger age at first implant, a shorter time between implants, and more bilateral experience. This data can help to inform clinical counselling. Recognising that there is a range of performance outcomes in everyday life for children using bilateral implants, and identifying the areas in which they perform well and those in which they may continue to have difficulty, is important for informed decision making and for establishing appropriate expectations of postoperative performance. The potential impact of time between implants is also relevant to decision making. Recognising the impact of bilateral experience, particularly on spatial hearing skills, will help parents and children to remain realistic and motivated postoperatively. Collection of data is ongoing, and future comparisons will be made with groups using unilateral implants and normal hearing.

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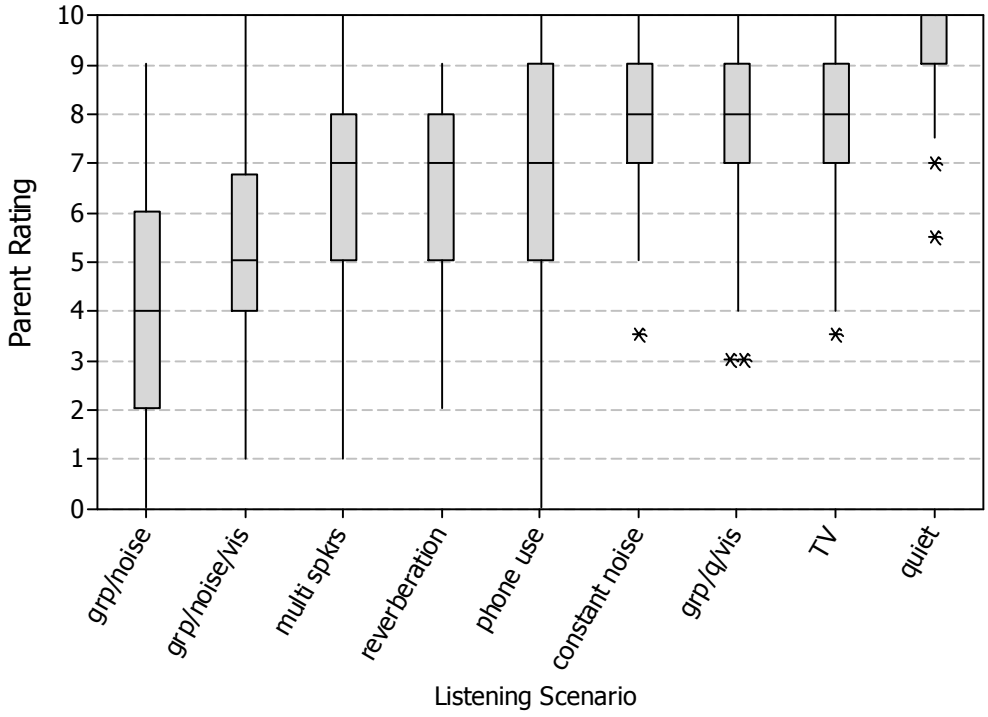
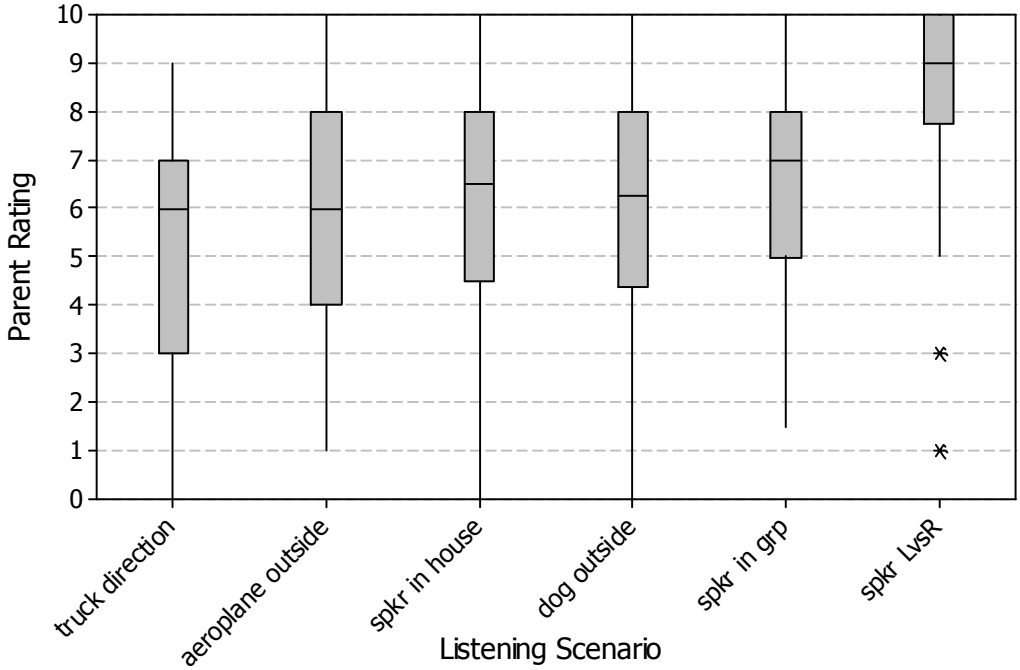
Figure legends

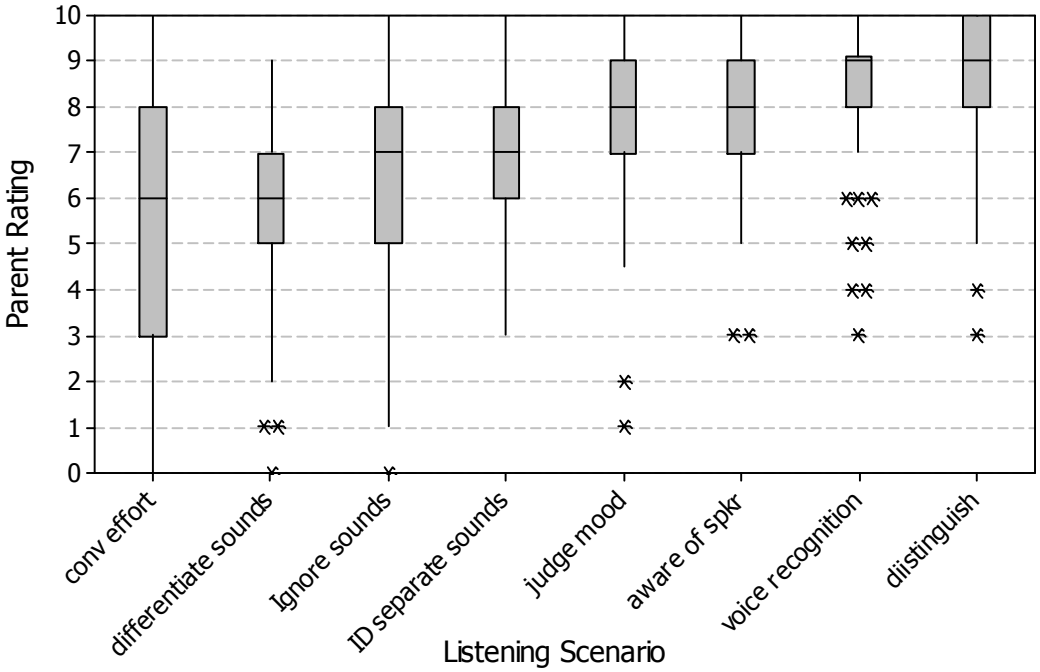
Figure 1: Parent ratings (n=78) for the speech perception scenarios of the SSQ-P. Black bar: median; grey box: interquartile range; whiskers: minimum and maximum; asterisks: outliers. The first, second and seventh scenarios from the left involvd following a group conversation in noise or quiet (q) without or with (vis) visual cues. The remining scenarios involve understanding a single speaker in different environments.

Figure 2: Parent ratings (n=78) for the spatial hearing scenarios of the SSQ-P. Black bar: median; grey box: interquartile range; whiskers: minimum and maximum; asterisks: outliers. The first scenario involved identifying the direction of an approaching truck; the remaining scenarios involved identifying sound source locations.

Figure 3: Parent ratings (n=78) for the other qualities of hearing scenarios of the SSQ-P. Black bar: median; grey box: interquartile range; whiskers: minimum and maximum; asterisks: outliers. From the left, the scenarios involved effort required in conversation, differentiating somewhat similar sounds, ignoring other sounds when trying to listen to something, identifying two sounds as separate, judging mood, being aware of somone speaking when music is playing, recognising voices, and distinguishing between musical pieces.


Parent Rating
10
9
8
7
6
5
4
3
2
1
0
grp/noise
grp/noise/vis
multi spkrs
reverberation
phone use
constant noise
grp/q/vis
TV
quiet
Listening Scenario


Parent Rating
10
9
8
7
6
5
4
3
2
1
0
truck direction
aeroplane outside
spkr in house
dog outside
spkr in grp
spkr LvsR
Listening Scenario


Parent Rating
10
9
8
7
6
5
4
3
2
1
0
conv effort
differentiate sounds
Ignore sounds
ID separate sounds
judge mood
aware of spkr
voice recognition
diistinguish
Listening Scenario