PICO Question:

Do children with bilateral implants perform better in word recognition in quiet and in noise tasks as compared to children with a unilateral implant plus a hearing aid in the non-implanted ear?

PRESENTED BY:
DANIELLE DEBIASE

Resources Searched:

Data Bases Searched:	Keyword Search Terms:	Number of Hits:
Pubmed – September 8, 2008	Bilateral Cochlear Implants	430
Pubmed – September 8, 2008	Pediatric Bilateral Cochlear Implants	26
USF library – September 8, 2008	Bilateral Cochlear Implants	2 books
USF library – MetaSearch – September 15, 2008	Bilateral Cochlear Implants	72
USF library – MetaSearch – September 15, 2008	Pediatric Bilateral Cochlear Implants	55
Google – September 15, 2008	Sound localization and speech intelligibility in noise in unilaterally and bilaterally implanted children	674

Search Strategies:

- *Inclusion Criteria:*
  - Population: Pediatrics
  - Intervention: Bilateral CI
  - Comparison: CI + HA
  - Outcomes: Word recognition in quiet and in noise tasks

- *Exclusion Criteria:*
  - Study involving only adult populations
  - Studies without word recognition in noise tasks
  - Studies published from cochlear implant companies (Cochlear) (included case study and information article)
  - Studies without a hearing aid plus cochlear implant group
  - Studies with less than four children

Articles Selected:

- *Thirteen articles were pertinent from searched resources.*
- *Three articles remained after applying the inclusion and exclusion criteria.*
- *All were Level III peer reviewed studies.*

- Litovsky, R. Y., Johnstone, P. M., & Godar, S. P. (2006). Benefits of bilateral cochlear implants and/or hearing aids in children. *International Journal of Audiology, 45*(Supplement 1), S78-S91.
- Peters, B. R., Litovsky, R., Parkinson, A., & Lake, J. (2007). Importance of age and post-implantation experience on speech perception measures in children with sequential bilateral cochlear implants. *Otolology and Neurotology, 28*(5), 649-657.
- Zeitler, D. M., Kessler, M. A., Terushkin, V., Roland, J. T., Svirsky, M. A., Lalwani, A. K., & Waltzman, S. B. (2008). Speech perception benefits of sequential bilateral cochlear implantation in children and adults: a retrospective analysis. *Otology and Neurotology, 29*(3), 314-325.

Description:

- Three comparative studies were found involving children that evaluated word recognition in quiet and noise tasks for bilateral cochlear implant users and subjects with unilateral implants + a hearing aid in the non-implanted ear.

First Author and Year of Publication	Location	Comparison	Control	Number of patients	Outcomes
Litovsky, 2006	USA	CI + CI and CI + HA	Concurrent	20	Speech intelligibility in quiet and noise (CRISP) and Minimum Audible Angle (MAA)
Peters, 2007	USA	CI + CI and CI + HA	Time-series	30	Speech intelligibility in quiet and noise
Zeitler, 2008	USA	CI + CI and CI + HA	Time-series	43	Speech intelligibility in quiet and noise

Background:

- Binaural hearing is associated with:
  - Improved speech understanding in quiet and in noise
  - Improved sound localization ability
- Even with cochlear implants, patients have difficulty localizing and understanding speech in everyday noisy situations.
- Normal hearing listeners use two ears to compensate for these difficulties, so bilateral cochlear implants are now being used to improve localization and speech understanding in noise.
- Bilateral CI users get this information from the head shadow effect, binaural squelch, and binaural summation.

Litovsky et al. (2006)

- Subjects:
  - CI-CI group
    - 10 children ages 3-14
    - First CI implanted at least one year prior to 2nd CI
    - All children had auditory verbal/speech therapy
    - All mainstreamed in an age appropriate grade level
    - Equalized loudness between implants
    - Variable histories
  - CI-HA group
    - 10 children ages 6-14
    - All identified by age 2 and implanted between 1.5-8.5 years
    - Attempted loudness balancing
    - Variable histories

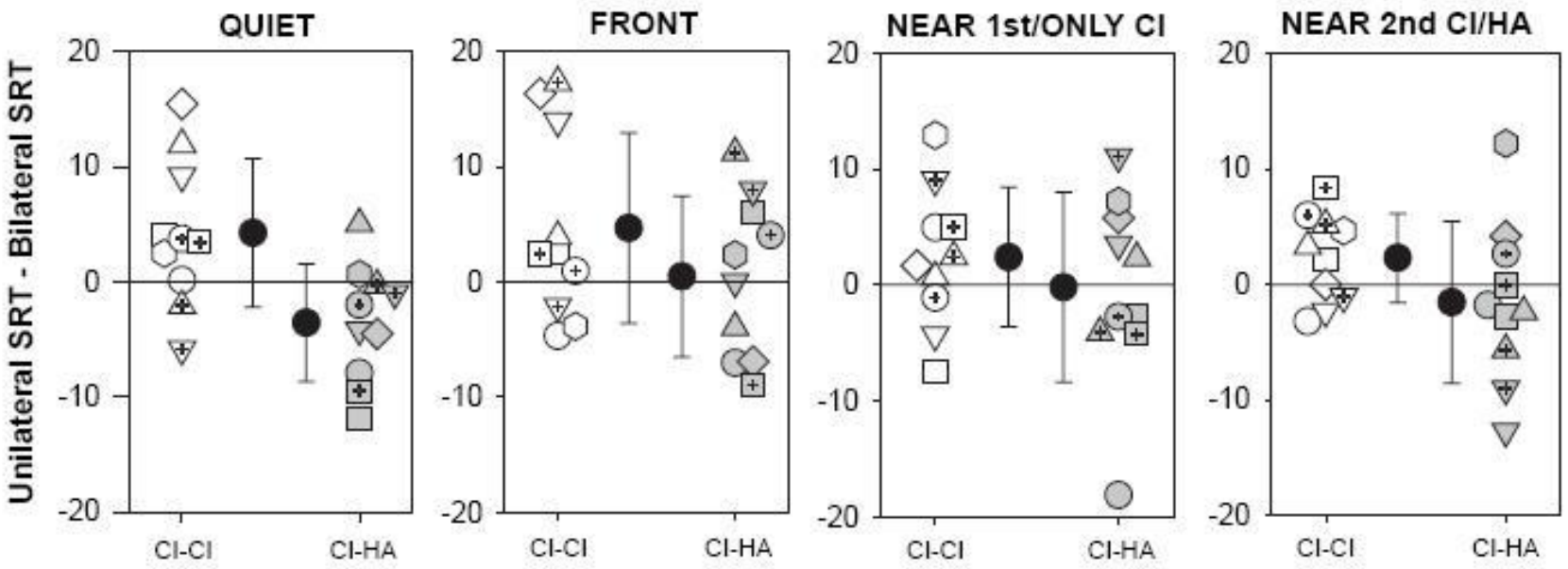
Litovsky et al. (2006)

- Experiments:
  - Speech intelligibility in quiet and noise
    - 25 picture spondees
    - 4 alternative forced choice to find SRTs (79.4%) on computer
  - MAA
- Results:
  - SRTs were lower in quiet than in all other conditions
  - Bilateral CIs and bimodal hearing resulted on average with similar SRTs
    - The level at which they are able to correctly identify spondaic words is not different

Litovsky et al. (2006)

- Results cont:
  - SRTs were higher when the competitors were in front than near the second CI or HA
    - Spatial release from masking
      - Difference between SRT with noise in front or at 90 deg on side
  - CI-CI group there was sig. correlations for SRM when noise was near the first CI side for bilateral and monaural mode
  - CI-CI s do better when noise is towards 2nd CI
  - Sig. effect of group for bilateral advantage for CI-CI group as compared to CI-HA group regardless of noise or quiet
    - 2 ear advantage was seen in CI-CI group: SRTs improved in bilateral mode
    - CI-HA: some did worst, had disruption, as seen by CRISP test

Litovsky et al. (2006)



Bilateral Advantage

Litovsky et al. (2006)

- Conclusions:
  - Children with two CIs perform significantly better than children with bimodal hearing on speech intelligibility tasks when using two devices compared with a single device

Peters et al. (2007)

- Subjects:
  - 30 children (3-13 years)
    - First implant before 5 years
    - No speech or cognitive problems
    - Implants were Nucleus 22, 24, or 24 Contour in implanted ear and Nucleus 24 Contour or 24 Contour advanced in the second ear
    - Age Groups based on time of 2nd implant:
      - Group 1: 3-5 years
      - Group II: 5 years 1 month – 8 years
      - Group III: 8 years 1 month – 13 years

Peters et al. (2007)

- Experiments:
  - In quiet:
    - Bilateral/unilateral testing pre-op and 3, 6, and 12 months after 2nd device implanted
    - Tests: MLNT (group 1), LNT (group II and III), and HINT-C sentences in quiet (group III only)
  - In noise:
    - CRISP test
      - Compared monaural and bilateral performance at 3, 9 month post-op
      - Familiarized with a series of 25 picture/sound combinations
      - 4 test condition: In quiet, target front with noise front, right, and left) Tested bilaterally and with first ear alone

Peters et al. (2007)

Results In Quiet:	Group I	Group II	Group III
First ear did not significantly change	X	X	X
Second ear significantly changed with each time interval	X	X Except 6-12 month interval	X Only pre-op to 6 months
Second ear reached performance of the first ear	X		
Second ear was not sig. different than the first/bilateral condition at 12 months	X	X	
Bilateral score was not sig. different from the first ear	X	X	X
Bilateral 12 month score was sig. better than pre-op score with a CI+HA	X		X

Peters et al. (2007)

Results In Noise:	Group I	Group II	Group III
Subjects at 3 months:			
No significant difference between bilateral and first ear conditions	X	X	X
Subjects at 9 months:			
No significant difference between bilateral and first ear conditions	X		
Bilateral scores were sig. better than scores with first ear alone when noise is at front or at first CI			X
Difference between score for bilateral and first CI is largest when noise is directed at first CI	X	X	X
Performance in bilateral configuration was sig. better for all noise conditions especially when noise was directed toward the first implant	X	X	X
Bilateral score with noise at first implant had 13.2% improvement	X	X	X
Bilateral score with noise front and at second implant had 6.8% improvement	X	X	X
Increased advantage with bilateral over first ear with additional 6 months experience regardless of noise location	X	X	X

Peters et al. (2007)

- Conclusions:
  - Successful users of the first device are able to obtain open-set speech discrimination in their second ear even when receiving the second implant as late as 13 years of age
  - Speech perception scores in second ear improved:
    - During first 6 months of implant for all children
    - For 12 months in children under 8
  - Speech perception scores in second ear improved at faster rate and higher final level at 12 months in youngest children
  - In oldest group scores remained far less than first ear
  - Better speech perception scores in background noise in bilateral condition than with single implant
  - In quiet, did not reach significance due to small measured differences and small number of subjects

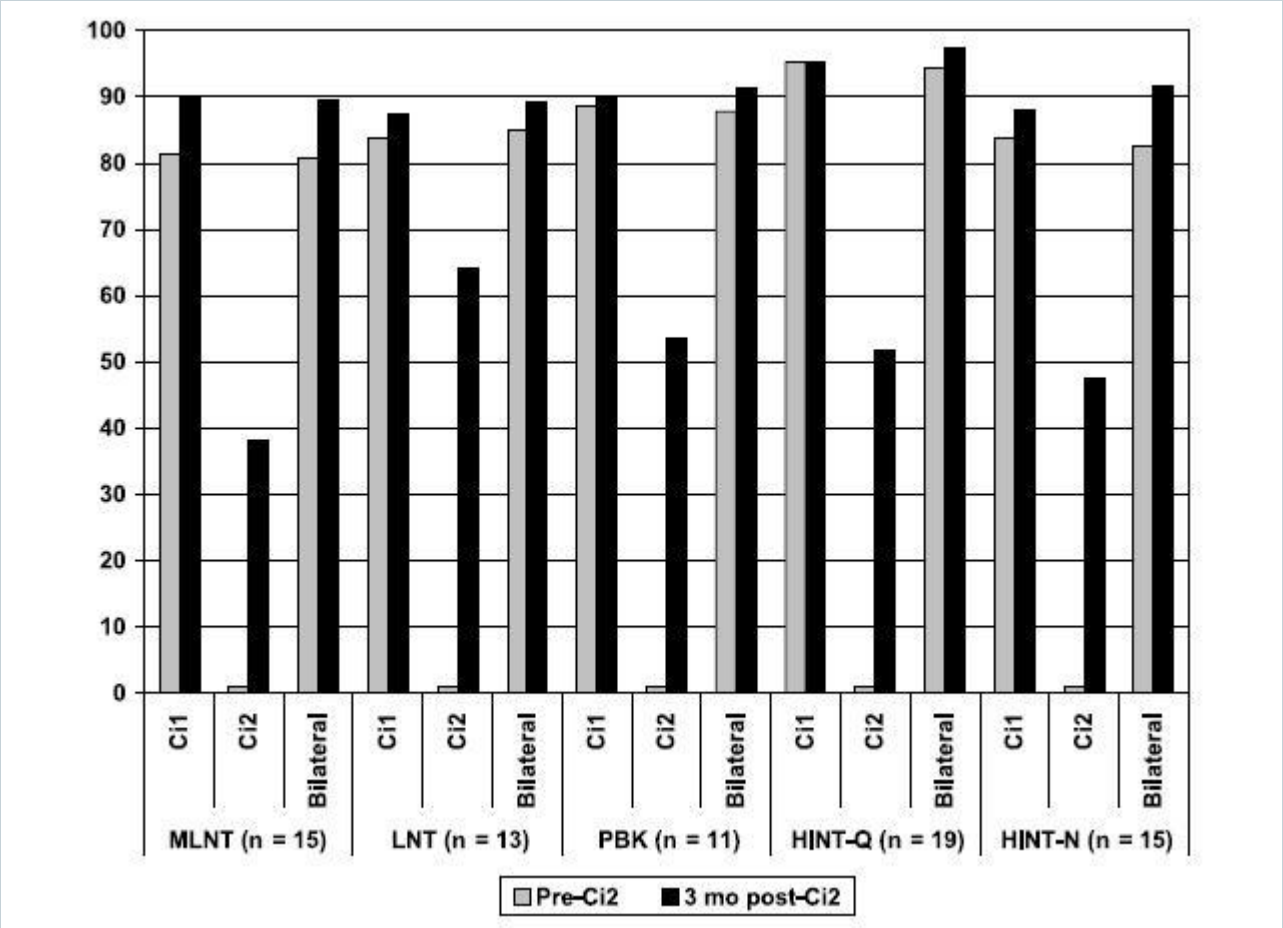
Zeitler et al. (2008)

- Subjects: (also included adults but not discussed here)
  - 43 pediatric patients
  - Bilateral severe-to-profound SNHL
  - English speaking
  - Minimum of 6 months between the first and second surgeries
  - First implants from under 12 months to over age 5
  - Mean time for amplification in second ear was 2.1
  - Different histories
  - Different processors

Zeitler et al. (2008)

- Experiments:
  - Tested in sound field
  - Tested pre-op and 3 months post-op for second CI
  - Tested in CI1 alone, ear to be implanted (HA/CI2), and bilaterally (CI+HA/CI+CI)
  - Children tested with the BKB-SIN in quiet and in noise
  - Speech presented in front and noise presented in front, or at either ear

Zeitler et al. (2008)



Zeitler et al. (2008)

- Results In Quiet:
  - No performance change in the first ear for words in quiet tests
  - Significant improvement in CI2 alone and bilateral performance after implant of second ear for words in quiet tests
  - For MLNT and HINT-Q; correlation indicates the shorter the length of deafness in CI1, the better the performance post CI2
  - Length of CI2 did not influence results
  - At 3 months post-op, in quiet situations, improvement was seen

Zeitler et al. (2008)

- Results In Noise: HINT-N Test
  - Significant improvement in mean scores for CI2 and bilateral conditions with no significant change in CI1
  - Age at time of CI2 and length of deafness in CI1 and CI2 were negatively correlated with performance
  - Greater the time between implants, the lower the absolute score, absolute difference, and % change when CI2 was tested
  - Older age at 2nd implant impacted adversely on bilateral score, performance in CI2 and absolute improvement, and % change in score in CI2 at 3 months
  - Longer the length of deafness in first ear, poorer outcomes in bilateral conditions at 3 months after 2nd implant
  - Length of deafness in 2nd ear to be implanted increased, scores for bilateral condition and CI2 alone were poorer at 3 months after second implant
  - Time between implant and length of deafness negatively influenced performance
  - 12 month data found improvement in speech understanding in noise over time

Zeitler et al. (2008)

- Conclusion:
  - Sequential bilateral implants can provide improved open set speech understanding that increases over time
  - Improvement may take longer in children

Methods:

- All 3 studies:
  - Not randomized
  - Included information about inclusion criteria
- Litovsky et al. (2006)
  - Subjects:
    - Various etiologies
    - All had CI mappings and HA fittings performed by own clinicians prior to study
    - Vary in age, device, amount of 1st CI experience, and amount of CI-CI experience
- Peters et al. (2007)
  - All implanted with same brand of CI (Cochlear)
  - Divided into three age groups
- Zeitler et al. (2008)
  - Retrospective study
  - Subjects:
    - Various etiologies
    - Various devices and strategies used

Conclusions:

- Overall, studies showed more improvement in speech understanding with bilateral implants than just a cochlear implant and hearing aid in the opposite ear.
  - However, have to consider the characteristics of each patient separately such as:
    - Age
    - Time between implants
    - Length of deafness

Articles Not Critically Appraised:

- **Study involving only adult populations:**
- Noble, W., Tyler, R., Dunn, C., & Bhullar, N. (2008). Unilateral and bilateral cochlear implants and the implant-plus-hearing-aid profile: Comparing self- assessed and measured abilities. *International Journal of Audiology, 47*(8), 505-514.
- **Studies without word recognition in noise tasks:**
- Bauer, P. W., Sharma, A., Martin, K., & Dorman, M. (2006). Central auditory development in children with bilateral cochlear implants. *Arch Otolaryngology Head Neck Surgery,* 132, 1133-6.
- Beijen, J-W., Snik, A., & Mylanus, E. (2007). Sound localization ability of young children with bilateral cochlear implants. *Otology & Neurotology, 28,* 479-485.
- Litovsky, R., Johnstone, P., Godar, S., et al. (2006). Bilateral cochlear implants in children: localization acuity measured with minimum audible angle. *Ear & Hearing, 27,* 43-59.

Articles Not Critically Appraised:

- **Studies without a hearing aid plus cochlear implant group:**
- Galvin, K., Mok, M., & Dowell, R. (2007). Perceptual benefit and functional outcomes for children using sequential bilateral cochlear implants. *Ear & Hearing, 28,* 470-482.
- Kuhn-Inacker, H., Shehata-Dieler, W., Müller, J., & Helms, J. (2004). Bilateral cochlear implants: a way to optimize auditory perception abilities in deaf children? *Intl J Pediatric Otorhinolaryngology , 68,* 1257-1266.
- Litovsky, R., Johnstone, P., Parkinson, A., Peters, R., & Lake, J. (2004). Bilateral cochlear implants in children. *International Congress Series, 1273,* 451-454.
- Litovsky, R., Parkinson, A, Arcaroli, J., Peters, R., Lake, J., Johnstone, P., & Gonqiang, Y. (2004). Bilateral cochlear implants in adults and children. *Arch Otolaryngology Head Neck Surgery, 130,* 648-655.
- Scherf, F., van Deun, L., van Wieringen, A., et al. (2007). Hearing benefits of second-side cochlear implantation in two groups of children. *Int J Pediatric Otorhinolaryngology, 71,* 1855-63.
- Wolfe, J., Baker, S., Caraway, T., et al. (2007). 1-year postactivation results for sequentially implanted bilateral cochlear implant users. *Otol Neurotol ogy, 28,* 589-596.

Additional Resource:

- If interested in more bilateral cochlear implantation peer reviewed journal articles as of February 2008, check out…
  - http://www.bionicear.com/UserFiles/File/Bilateral%20Reference%20List-February%202008.pdf