

Incidental language learning: impact of binaural hearing and executive functions



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Getting it right 0-5 years: London, 20 – 21 October 2017

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A lot of research showing the impact of bilateral/bimodal hearing:

- head shadow effect
- binaural summation effect
- squelch effect,
 - All this resulting in:
 - better localization
 - better understanding of softer speech
 - better speech understanding in noisy situations



But what is the impact on the children's language development ?

Preverbal skills of uni- and bilateral CI children using Tait Video Analysis

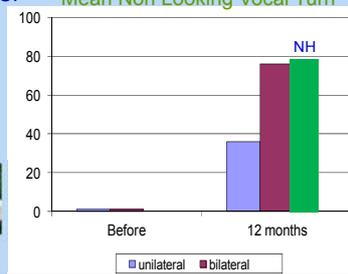
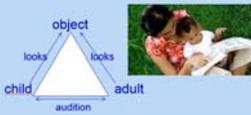
Tait M, Nikolopoulos T, De Raeve L, Johnson S, Datta G, Karltorp E, Gulpen P, Van Knegsel et al. 2010, International Journal of Pediatric Otorhinolaryngology, 74, 206-211.

Multicenter study

42 unilateral + 27 bilateral CI

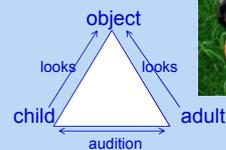
Mean Non Looking Vocal Turn

Non Looking Vocal Turn = Child takes initiative to communicate vocally without looking to the adult



Joint attention: an important milestone in language learning

joint attention (18-24 mths): adults talk about things the child is looking at



Most deaf children receiving cochlear implants early in life have the auditory skills to come to joint attention as typical hearing children

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Effect of Pediatric bilateral CI on Early Language Development

Boons, T., Brokx J., Frijns J., De Raeve L., Peeraer L., Philips B., Vermeulen A., Wouters J. & van Wieringen A., 2012, Arch. Pediatr. Adolesc. Med., 166, 28-34.

- Matched group of 25 bilateral and 25 unilateral implanted children (out of 288 unilaterals)
- Receptive and Expressive language of bilateral implanted children is performing significantly better than those undergoing unilateral implantation.
- A shorter interval between both implantations was related to higher standard scores.

Narrative spoken language skills in school-age children with cochlear implants

Boons, T., De Raeve L., Langereis M., Peeraer L., Wouters J. & van Wieringen A., 2013, Research in Developmental disabilities, 34, 3833-3846.

- Matched group of 66 CI children (27 bilateral, 18 bimodal, 21 unilateral) and 66 normal hearing peers
- Comparing narrative skills: more complex and later developing spoken language skills
- 20 high performers (as NH-children):
 - All bilateral CI users
 - No additional disabilities
 - Implanted < 24 months and both CI's before 30 months
 - Raised with one spoken language (no multilingual family)

Verbal Cognition in Deaf Children using Cochlear Implants: effect of unilateral and bilateral stimulation

De Raeve L., Vermeulen A., Snik A., *Audiology & Neurotology*, 2015, 20, 4: 261-266.

- Longitudinal study on 37 CI children (12 bilateral, 9 bimodal, 16 unilateral), all implanted < age 3 y
- Normal Nonverbal IQ (> 80) and no additional disabilities
- All rehab and education at KIDS-centre in Hasselt(B)

- 3 years post first CI: expressive vocabulary
receptive vocabulary
speech perception at 60 dB SPL
speech perception at 45 dB SPL
speech in noise threshold
verbal intelligence
- 5 years post first CI:

Comparing UNI and BI-group: No significant difference concerning: age first HA, age first CI, PV IQ

	Total group n= 37		UNI (n=16) & BI (n=21) groups	
	Mean	SD	Mean	SD
Age HA	7.1	6.2	UNI	6
			BI	5
Age CI	19.7	15	UNI	14.2
			BI	14.6
Non-Verbal IQ	104	14	UNI	103
			BI	105

Outcomes

Significant differences
between uni and bi-group:

• Speech perception at 45dB

• Signal to noise threshold

precursors for
incidental learning

• Verbal cognition

	Total group n=37		UNI (n=16) & BI (n=21) groups	
	Mean	SD	Mean	SD
SP 60 dB (% correct)	71	16	UNI	67
			BI	73
SP 45 dB (% correct)	26	19	UNI *	12
			BI	36
S/N (dB)	-0.5	2.6	UNI *	2.0
			BI	-1.6
Rec. Vocab. (percentile)	23	25	UNI	21
			BI	24
Expr. Vocab. (quotient scores)	87	26	UNI	85
			BI	89
Verbal IQ (quotient scores)	84	16	UNI *	74
			BI	92

Incidental learning = crucial milestones in language development:

Incidental language learning: > 90% of vocabulary of typical hearing children is learned outside classroom through incidental learning. From:

- what the parents say to each other
- what mama is telling to the other children
- from children at the playground
- from the radio, television,...

Precursor = good auditory skills to pick up language from distance and in background noise.

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DEAFNESS & EDUCATION INTERNATIONAL, Vol. 15 No. 1, March, 2013, 52-68

Maximizing the Benefits from Bilateral Implantation, in Therapy, at Home and at School

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Why are some binaural device users performing well and others don't?

• Because of good auditory skills:

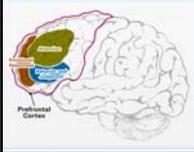
- *Speech perception of soft speech
- *Speech perception in noise
- *Localisation

But also

• Because of good cognitive skills (executive functions= higher controlling functions of the brain)

Executive Functioning

an umbrella term for cognitive process that regulate, control, and manage other cognitive processes, such as planning, problem solving, organization, and prioritizing. Executive functioning is regulated in the interior frontal lobe.



Cognition	Behaviour
Working Memory	Inhibition
Planning	Flexibility
Organisation	Attention Span
Time management	Task Initiation
Metacognition	Emotion regulation
	Goal-directed persistence

Executive function in everyday life: implications for young cochlear implant users,

Beer, Kronenberger, Pisoni, Cochlear Implants International. 2011 May ; 12(Suppl 1): S89–S91

“Weak working memory is influencing the executive function in CI children. We also found that problems related to working memory predicted children’s performance on tests of general language (CELF-4) and speech perception in noise (HINT-C in noise).

Executive Functions of Adolescents Who Use Cochlear Implants,

Beer, Pisoni, Kronenberger, Geers, *The ASHA Leader*, December 2010, Vol. 15, 12-14.

“Relationship between working memory capacity and verbal rehearsal speed at age 8 and performance on measures of speech perception, production, language, vocabulary, and reading at age 16”.

Executive Function and social emotional development

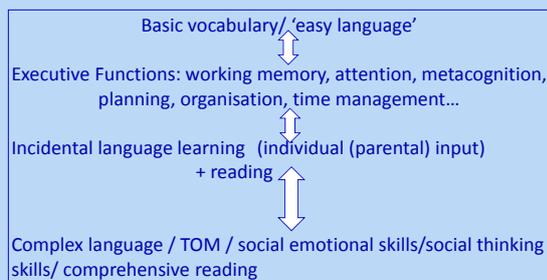
- Hintermair M, Korneffel D., *Z Kinder Jugend-psychiatr Psychother.* 2013 Sep;41(5):347-59.

“Relationship between executive functioning and social-emotional problems of deaf and hard-of-hearing students at general schools”.

- Hintermair, *Executive Functions and Behavioral Problems in Deaf and Hard-of-Hearing Students at General and Special Schools, J Deaf Stud Deaf Educ* (2013) 18 (3): 344-359.

“Relationship between executive functioning and behavior problems of deaf and hard-of-hearing students”

Collaboration between Vocabulary/Language and Executive Functions to achieve complex language/TOM/social-emotional functioning/reading



Why are some binaural device users performing well and others don't?

•Audiological skills:

- *Speech perception of soft speech
- *Speech perception in noise
- *Localisation

•Cognitive skills (executive functions= higher controlling functions of the brain)

- *Verbal working memory
- *Inhibition – emotion regulation
- *Flexibility (to switch from one situation/person to another)
- *Time management/planning
- *Attention span,...

So, we have to focus on these topics in therapy and education to maximize outcomes

Conclusion

- Binaural hearing creates the possibility to understand soft speech and speech in noisy situations, which are precursors to come to incidental learning and to develop good verbal cognition skills.
- Children need also the cognitive skills to come to (incidental) learning: executive functions
- So we have to monitor the auditory and cognitive skills to come to complex language learning regularly
- Results are still heterogeneous and we need individualized auditory and cognitive training (support) to meet the students' specific needs

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Thank you for your attention:



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