From syllables to words:
Language perception and language acquisition of young children with cochlear implants

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Background
The cochlear implant (CI) is a neuroprosthetic device that provides auditory sensation to otherwise deaf individuals. It does so by stimulating the auditory nerve directly thus bypassing any dysfunctional parts of the inner ear. Language acquisition is one key motivation for pediatric cochlear implantation, yet we still know little about the developing language network of young cochlear implanted children. The objective of the following studies was to assess which auditory features are available to deaf children in the first months following implantation and what effect a delayed auditory access to language has on the overall language development of young children.

Methods
Participants:
- Infants and children implanted bilaterally before the age of four years (9 – 50 months)

3 longitudinal studies:

I. Perception of word boundaries: basic markers of word boundaries that enable typically hearing children to segment the speech stream and identify single words

a) Vowel length /ba/ vs. /baa/
   Oddball paradigm with 1200 trials (standard trials: 83%, deviant trials: 17%). A Mismatch Response is elicited if and whenever a deviance is perceived.

b) Stress pattern /baa/ vs. /baaba/ (trochaic pattern baaba being the predominant stress pattern in German)
   Oddball paradigm with 1200 trials (standard trials: 83%, deviant trials: 17%). A Mismatch Response is elicited if and whenever a deviance is perceived.

II. Word acquisition: i.e. establishing fixed word-object relationships; picture-word-matching paradigm, visual stimulus: picture of simple object; auditory stimulus: spoken word; 88 trials per condition (congruent vs. incongruent).

III. Word acquisition: i.e. establishing fixed word-object relationships; picture-word-matching paradigm, visual stimulus: picture of simple object; auditory stimulus: spoken word; 88 trials per condition (congruent vs. incongruent).

- If word-object relationship is established, incongruent picture-word pairings (i.e. wrong label) will elicit an N400 effect.

Adaptation to the new sensory modality is relatively fast but not immediately present after activation of the CI. Some minimum time of sensory experience seems to be required.

Conclusion
- The perception of basic auditory features is developed in a comparable time frame as in typically hearing children (counting from hearing onset). Word segmentation cues are thus available faster if not immediately as some sensory experience is necessary.
- By contrast, word acquisition is influenced to a greater amount by cognitive maturation which can offset some of the disadvantages of late language exposure and the poorer input quality. Importantly, children with poor language outcomes mostly also had cognitive impairments and their EEG data differed already after 12 months of hearing experience for their implanted peers, i.e. one year before tested with formal language tests.

Discussion points for comparing music and language
We completed a study series on how deaf children perceive auditory features that are linguistically relevant and how this influences language acquisition. Similar features like stimulus length and stress/rythm are also present in music. In an ongoing study we look at how such features are processed by implanted children in a musical context (oddball paradigm with deviant changes of tones in intensity, length, rhythm, pitch and timbre). Which features are most easily accessible with the CI and do we see a relationship between performance with musical stimuli and performance with linguistic stimuli/later language performance?

References


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