Cochlear Implants (CIs) and Plasticity of the Auditory System

Short Communication

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Introduction

Auditory plasticity is part of general neuroplasticity of the human central nervous system which has the ability to accommodate intrinsic insults and extrinsic new environmental influence. Plasticity allows the brain to reorganize its structure, function and connections and is reflected in behavior [1]. From such point of view, when plasticity is associated with function improvement, it can be called adaptive plasticity. However, if plasticity is associated with impaired or functional loss, it is called maladaptive plasticity. Also there is developmental plasticity related to maturation of the central auditory pathway, learning related plasticity induced by environmental stimulation and compensatory plasticity induced by central or peripheral auditory pathway insults [2,3].

Impairment of the peripheral auditory sensory input to the brain is followed by subsequent circuit alterations as a result of partial or total loss of receptor function. The situation is worse in cases with a severe or profound sensorineural hearing loss that constitute about 11-13.5% of the hearing-impaired population. Cochlear implants (CIs) represent important choice in such cases. This surgical intervention has many benefits including improved speech and language skills as well as higher academic achievement [5].

The time of cochlear implantation is very critical as the development of the auditory cortex is largely dependent on sufficient and appropriate auditory input. The term of sensitive periods have been well described [6] which is charatarized by the increased ability of the cortex to be altered as a result of either auditory stimulation or deprivation. In turn, this will affect the development of cortical infrastructure and associated behavioral abilities. Deprivation of auditory input during sensitive periods has adverse effects on many aspects of cortical maturation with subsequent poor behavioral performance. So, the central auditory pathway maturation should be considered in the management of children with hearing loss [7]. Among these clinical methods, are cochlear implants (CIs). Cochlear implant speech-processing attempts to replace the function of the cochlea that is relevant for speech understanding. Acoustic signals are analyzed into different frequency bands and the speech information from each band is presented to an electrode along the scala tympani that represents the corresponding frequency region [8].

Cortical auditory evoked potentials particularly P1 can be used as a biomarker for assessing different stages of childhood developmental plasticity of the central auditory system. Other befavioral speech and language tests can be use also to assess speech and language outcome in children with cochlear implants. Children implanted before the age of 3-4 years tend to show superior speech and language outcomes in relation to children implanted after age 6-7 years [9,10]. Moreover, Positron emission tomography (PET). Results showed decreased spontaneous glucose metabolism in the auditory cortices and good post-implantation behavioral outcomes in children who had undergone shorter durations of hearing loss [11].

However, there is a great variability speech perception outcome in those populations. These variability's is related to several factors such as age at onset of hearing loss (before or after language acquisition) (Galey, 1984), duration of hearing loss, status of survival neurons, duration of CI use and speech processing strategies in the device itself. Moreover, temporal and spectral processing capabilities of the patients should be also considered [12,13].

Conclusion

In conclusion, cortical development is dependent on extrinsic stimulation and sensory deprivation can dramatically alter functional connectivity and growth in the auditory system. Cochlear implants help to reduce the deprivation-induced delays in maturation through direct stimulating the central auditory system, and thereby restoring auditory input.

References

1. Feldman DE (2009) Synaptic mechanisms for plasticity in neocortex. Annu Rev Neurosci 32: 33-55.
2. Cohen LG, Celnik P, Pascual-Leone A, Corwell B, Falz L, et al. (1997) Functional relevance of cross-modal plasticity in blind humans. Nature 389(6647): 180-183.
3. Nudo RJ (2006) Plasticity. NeuroRx 3(4): 420-427.
4. Ries PW (1991) The demography of hearing loss. In: Orlans H (Ed). Adjustment to Adult Hearing Loss. Singular, San Diego, USA.
5. Svirsky MA, Robbins AM, Kirk KI, Pisoni DB, Miyamoto RT (2000) Language development in profoundly deaf children with cochlear

implants. Psychol Sci 11(2): 153-158.

6. Knudsen EI (2004) Sensitive Periods in the Development of the Brain and Behavior. J Cogn Neurosci 16(8): 1412-1425.
7. Sharma A, Campbell J, Cardon G (2015) Developmental and cross-modal plasticity in deafness: Evidence from the P1 and N1 event related potentials in cochlear implanted children. Int J Psychophysiology 95(2): 135-144.
8. Shannon RV, Fu QJ, Galvin J, Friesen L (2003) Speech Perception with Cochlear Implants. In: Zeng FG, et al. (Eds,). Auditory Prostheses. Springer Handbook of Auditory Research, Volume X, Los Angeles, CA, USA.
9. Wang NY, Eisenberg LS, Johnson KC, Fink NE, Tobey EA, et al. (2008) Tracking development of speech recognition: longitudinal data from hierarchical assessments in the childhood development after Cochlear Implantation Study. Otol Neurotol 29(2): 240-245.
10. Dunn CC, Walker EA, Oleson J, Kenworthy M, Van Voorst T, et al. (2014) Longitudinal speech perception and language performance in pediatric cochlear implant users: the effect of age at implantation. Ear Hear 35(2): 148-160.
11. Lee HJ, Giraud AL, Kang E, Oh SH, Kang H, et al. (2007) Cortical activity at rest predicts cochlear implantation outcome. Cereb Cortex 17(4): 909-917.
12. Clark JH, Yeagle J, Arbaje AI, Lin FR, Niparko JK, et al. (2012) Cochlear implant rehabilitation in older adults: literature review and proposal of a conceptual framework. J Am Geriatr Soc 60(10): 1936-1945.
13. Friesen LM, Shannon RV, Baskent D, Wang X (2001) Speech recognition in noise as a function of the number of spectral channels: Comparison of acoustic hearing and cochlear implants. J Acoust Soc Am 110(2): 1150-1163.

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