Doctoral Dissertation
Doctoral Program in Bioengineering and Medical-Surgical Sciences (36th Cycle)

Assessment of speech and auditory performances in adult patients with hearing aids and cochlear implants: the role of ecological environments and challenging communication scenarios

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Summary

One of the main consequences of the evidence that population in western countries is aging is the progressive increase in diseases, such as the hearing loss, which are directly linked to aging. When comparing the 2020 EuroTrak results on self-reported hearing loss in Europe countries with the EuroStat data on the population 65 years or older, we observe indeed a very strong correlation. The higher the percentage of the population that is 65 years of age and older, the higher the percentage of the population that experiences hearing difficulties.
Hearing aids compensate, to a certain extent, for hearing impairment and, furthermore, ensure some individual rehabilitation: in 2018, 2 million Italian people owned hearing aids out of 7 million eligible people (29.5%). There is evidence that about 80% of adults who would benefit from hearing devices do not use them. Furthermore, more than 24% of hearing impaired given a hearing device do not really wear it in daily life, since they do not provide enough intelligibility improvement and comfort.
Differently, people with severe to profound deafness necessitate of hearing devices of greater power and complexity, such as the cochlear implants. A cochlear implant is a surgically implanted electronic medical device which can partially restore hearing in case of deafness.
All patients presenting hearing loss demonstrate outstanding auditory results in the use of hearing aids or cochlear implants in quite environments, but rather a significant performance deterioration and quite poor outcomes in the speech recognition for complex but typical everyday acoustic listening conditions.
In this context, there is also an important limitation of diagnostic tests that are currently performed in everyday clinical practice, namely a poor correspondence between audiometric measurements and the impairment reported by patients. A possible reason to explain the limitations of current audiometric tests is the use of simplistic diagnostic tools and sound systems that cannot adequately represent the spatial complexity of the real listening environments in which our patients live and work every day. Furthermore, although voice and phonation have been widely studied in the past with regards to prelingual deafness in childhood, very few studies in the literature report significant data regarding speech modifications in adults with hearing loss and consequent hearing remediation, by means of hearing aids or cochlear implants.
With this premise, the present doctoral thesis focuses on the increasing need to develop new diagnostic protocols to better assess speech and hearing loss to optimize hearing aid or cochlear implant fitting.
In clinical practice indeed, audiologists always face the critical phase to decide whether to recommend a hearing aid and, in the case of prescription, they do not have tools for a proper fitting on the different daily challenging listening conditions in the life environments (e.g., a noisy and reverberant office, day-care center, restaurant or public place). The same limitations are evident in subjects with cochlear implants.
Through a multidisciplinary approach, the thesis aims to develop a new diagnostic tool for hearing loss (the Simplified Italian Matrix Test - SiIMax, a simplified version of an adaptive audiometric test in noise), to conduct a comprehensive evaluation of the clinical consequences induced by the use of hearing aids or cochlear implants in adults (particularly regarding speech modifications), and finally, to assess the perceived quality and speech intelligibility in the use of modern flat-screen televisions and in complex acoustic scenarios such as daily environments with reverberant noise.