Self-Guided Parameter Fitting For Cochlear Implant Users

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Introduction

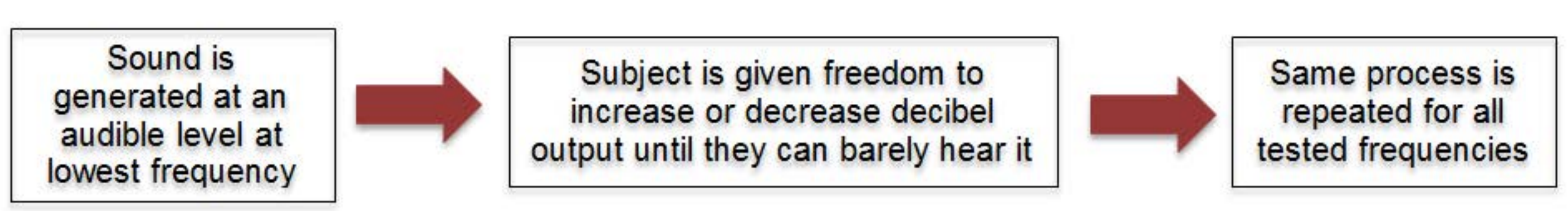
A cochlear implant is a surgically-implanted electronic device that converts sound into an electrical signal in the brain of a person who is hard-of-hearing. The complexity of the system as well as confounding factors such as brain plasticity and changing physiology require that the parameters associated with the cochlear implant be continually updated to maximize listening performance and user satisfaction. Updating the parameters of these devices currently requires visits to a clinician which limits the number and scope of updates possible within a fixed time frame. As a solution, design and development of a take-home fitting software system would enable implant users to interact with and control their personal device's parameters. CI users support the development of such a product and are comfortable adjusting their own device parameters; however, the ideal method by which to guide CI users to optimize their device parameters without clinician interaction is unknown.

Our project aims to develop a graphical user interface (GUI) that will guide CI users to adjust their device parameters so that their speech recognition and listening satisfaction are improved. In the current iteration of the project, the parameter that was measured was the minimum hearing threshold, which was tested using three different approaches. A GUI was programmed for each method, and each of these GUIs were subsequently tested on a group of ten normal hearing subjects in order to validate for one of the three proposed methods.

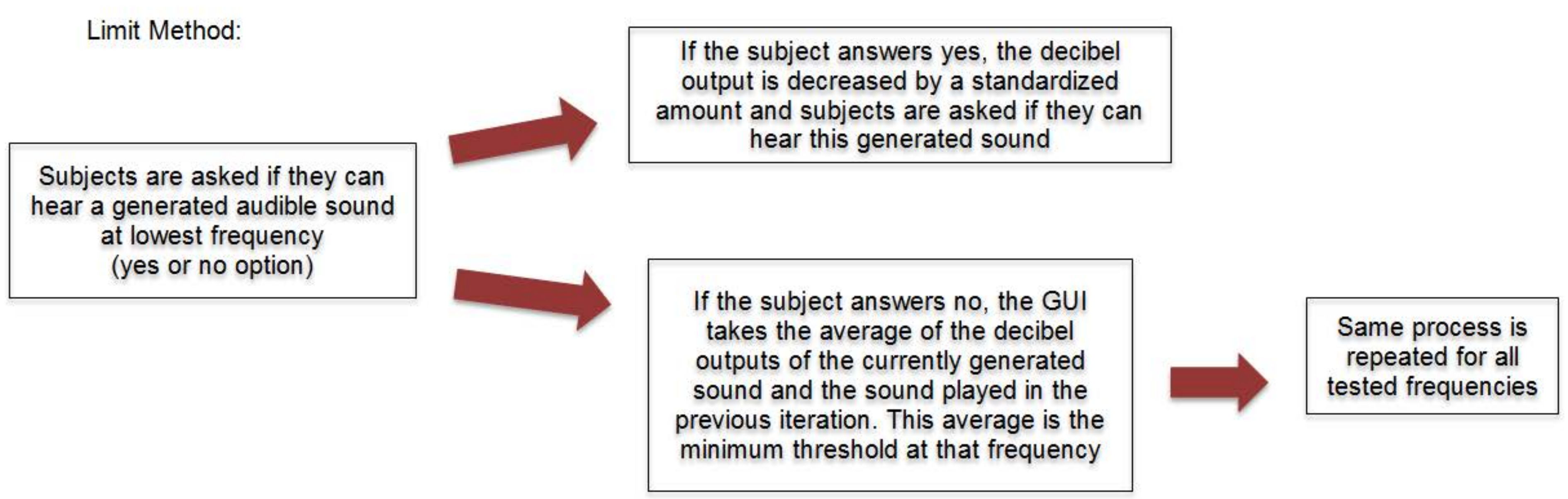
Threshold Detection

To measure the minimum hearing threshold, three methods were used, described below.

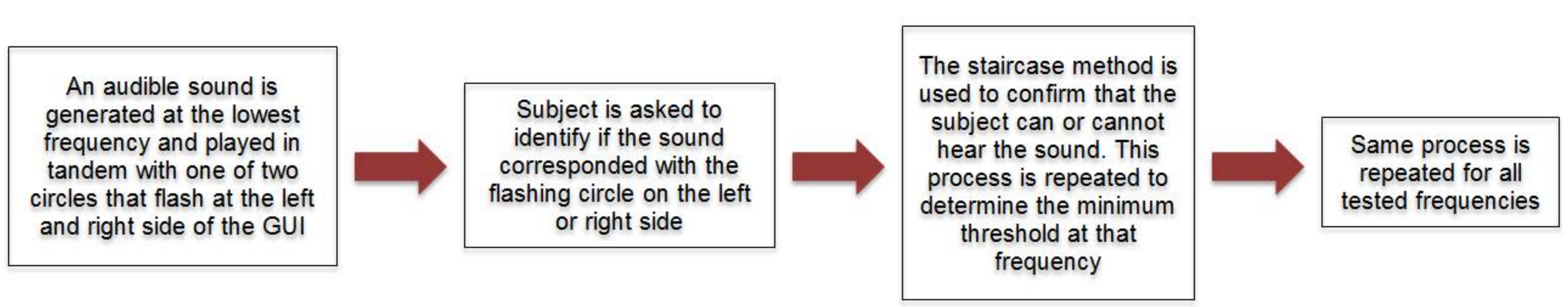
Manual Method:



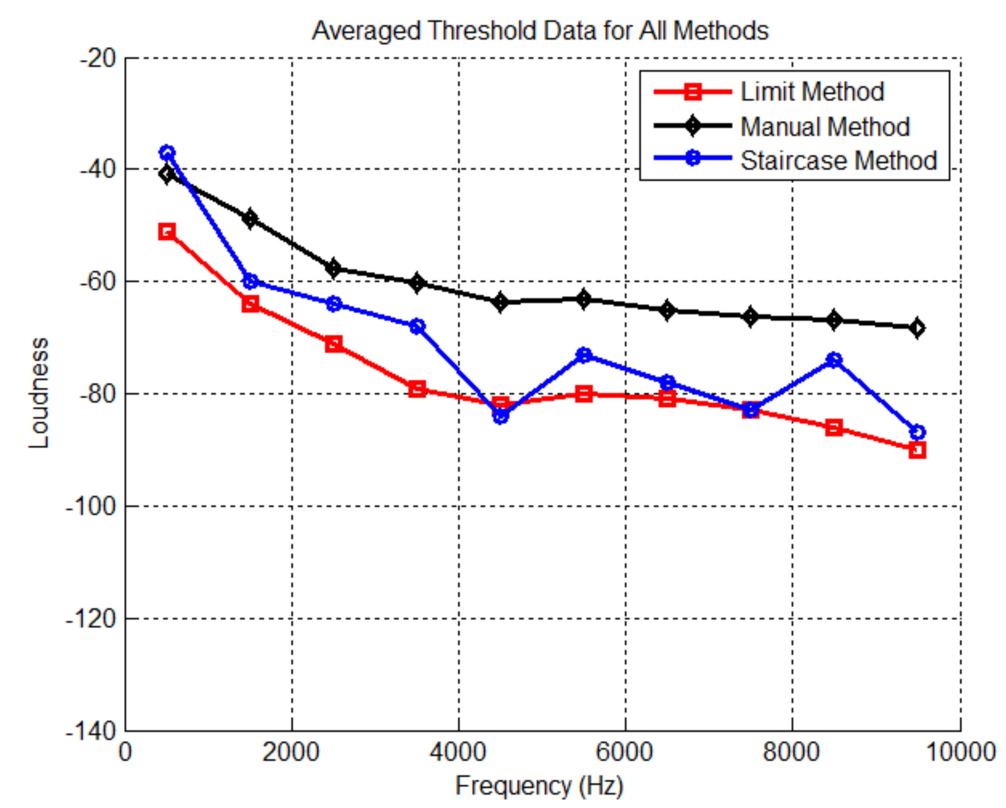
Limit Method:

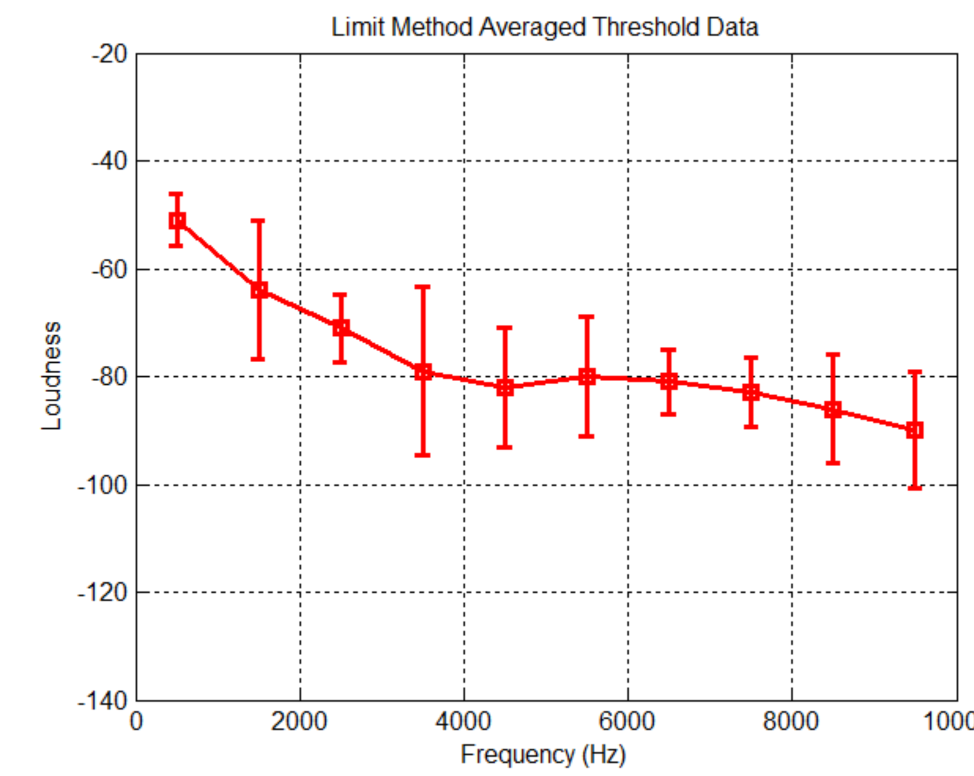


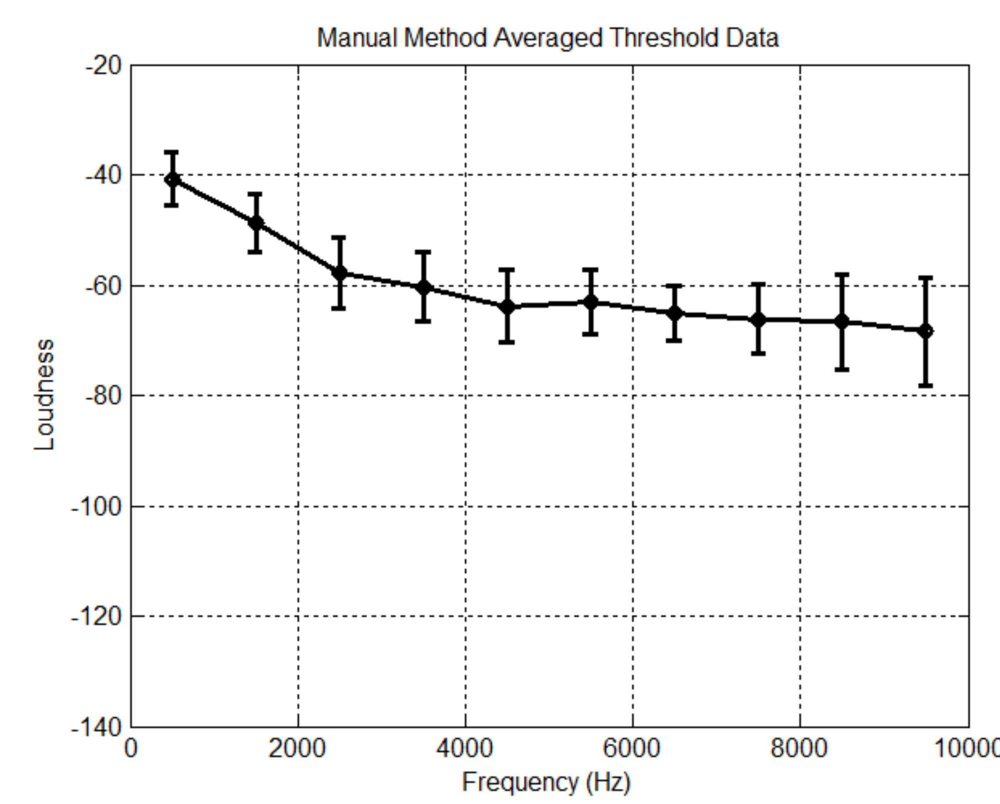
Staircase Method: [1]

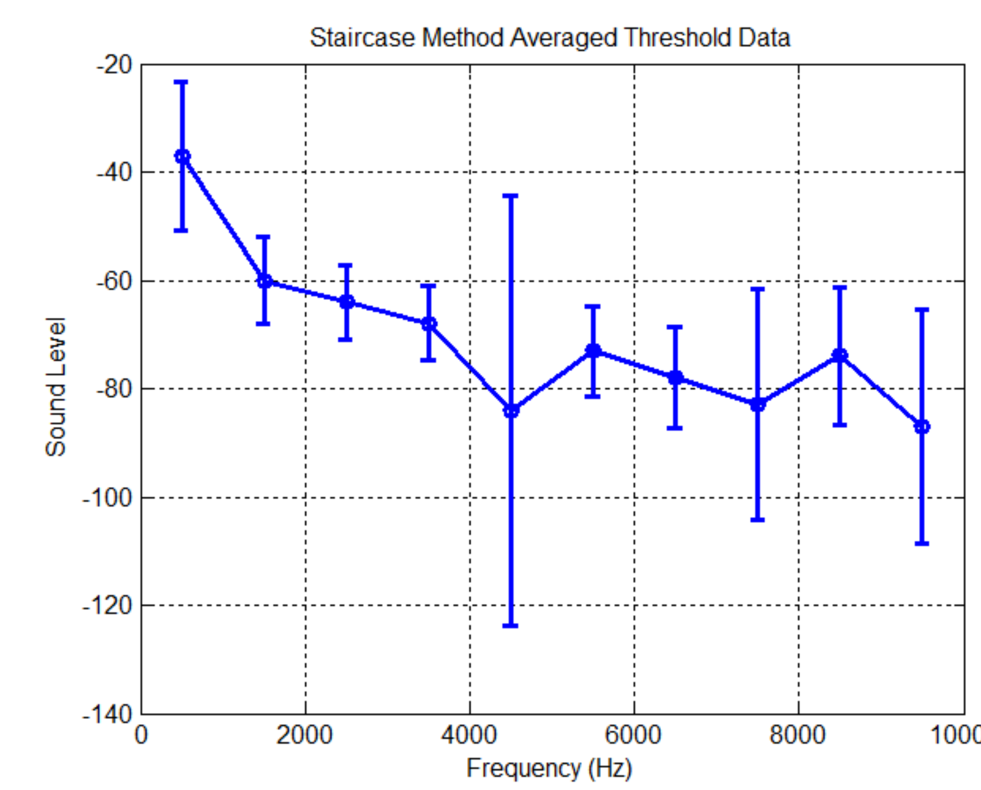


Threshold Data From Healthy Subjects









The above graphs show the accumulated data from 10 subjects, with error bars denoting standard deviation.
Ten frequencies, evenly spaced between 500 and 9500 Hz, were tested. The loudness levels were not calibrated but standardized for all experiments.

Discussion

Of the three methods, the data suggests that subjects tend to overestimate their hearing threshold with the manual method, and are of the opinion that it is the most accurate. The staircase method, while the most statistically accurate, has the largest variation and was the least rated method in terms of accuracy, preference and easiness. The limit method had the lowest values of the three data sets, and thus gives the most conservative estimate for the threshold values. It was also rated to be the easiest method and was the most preferred of all three. Taking these factors into account, the limit method appears to be the most suitable option. An alternate possibility would be to average the manual and limit method data to approximate the threshold values provided by the statistically superior staircase method, if the trend observed in comparing the data sets holds for larger sample sizes. These considerations will give direction to future programs designed to be of utility to cochlear implant users.

[1] Levitt, H. C. C. H. "Transformed up-down methods in psychoacoustics." *The Journal of the Acoustical society of America* 49.2B (1971): 467-477.