Comparison of various Psychoacoustic measures using two software: PSYCON and Maximum likelihood procedure in MATLAB

Sandeep Kumar, Banumathi , supriya mathew, KISHORE TANNIRU & Chandni Jain

Introduction:
Psyophysics has been described as "the scientific study of the relation between stimulus and sensation" [1]. Psychoacoustics is defined as a "branch of psychophysics involving the scientific study of sound perception" [2]. Psychoacoustics includes perceiving sound frequency, intensity, and temporal aspects, which are critical for speech perception [3,4]. The evaluation of these abilities has piqued the interests of audiologists, psychologists, and acoustics experts. Several studies assessing psychoacoustical skills in people with normal hearing have been conducted, and the results have been compared to aged people, people with a auditory processing disorder, hearing impairment and auditory neuropathy [5,6]. Assessment of psychoacoustic abilities has been done using various softwareâ€™s and procedures. Two common softwares which have been used in research to assess psychoacoustic abilities include Psycon and Maximum likelihood procedure (MLP) implemented in MATLAB [ 7,8,9,10,11].

Grassi and colleagues described a maximum-likelihood approach that adaptively changes the signal based on the responses received from previous trials. MLP hypothesises multiple psychometric functions, which are referred to as hypotheses. According to the subject's responses, the maximum likelihood algorithm determines which hypothesis has the most possibility of being comparable to the subject's real psychometric function. MLP can track any point on the psychometric function and can be done using NAF or yes/no tests [12].

PSYCON is Windows software to conduct psychoacoustic studies with varied presentation intervals. PSYCON makes use of the Auditory Syntax (AUX) scripting language, which is a programming syntax for describing and processing auditory data. Individuals who find programming in MATLAB intimidating or who have less programming skills will benefit the most from AUX. PSYCON supports methods in which the stimulus is delivered in a random order in numerous intervals, either "standard/reference" or "odd-ball/variable." The subject’s goal is to choose the odd-ball stimulus’s interval. Graphs are used to visualise the procedure's progress during the testing session [13].

Need for Study:
Psycon and MLP implemented in MATLAB have been widely used to assess psychoacoustic abilities [ 7,8,9,10,11]. Studies have used these applications independently and there is no literature regarding the comparison of results across these two softwares. If the two softwares give similar results, it will be easy for the researchers to generalize the data on psychoacoustics. Thus, the present study attempts to compare the results of various psychoacoustical abilities using Psycon and MLP.

Aim & Objectives:
The present study aimed to compare the frequency difference limen (FDL), intensity difference limen (IDL), duration discrimination threshold (DDT) and gap detection thresholds (GDT) using PSYCON and MLP software.

Method:
Materials and Method
A total of 39 adults (19 Female & 20 Male) in the age range of 18 to 26 years participated in the study. All the participants had normal audiological finding and there were no history of any middle ear pathology. A battery of psychophysical tests which assesses auditory discrimination and temporal resolution abilities were administered i.e. DLI, DLF, DLT and GDT test. These measures were assessed using Psycon application and MLP implemented in Matlab.

In Psycon (version 2.8), the psychoacoustic test stimuli were created using the AUX scripting language which consists of definitions of signals and arithmetic operations. Signals used in the present study were based on tonal components for DLI, DLF and DLT and noise components for GDT. Each test trial consisted of three blocks, two of which included the standard stimulus and the third block containing the variable stimulus, chosen randomly by Psycon. The participant was told to identify the block that contained the different stimuli.

Maximum likelihood procedure tool box was implemented in MATLAB (version 7.8.0, R2009a). All the tests were performed using a three-interval alternate forced choice adaptive technique to estimate a 79.4% response criterion. Each test trial consisted of three blocks, two of which included the standard stimulus and the third block containing the variable stimulus, chosen randomly by MLP. The participant was told to identify the block that contained the different stimuli.

All the stimuli related factors were kept similar in both Psycon and MLP. The audiometer was used to route all of the test stimuli given binaurally at 60 dB HL. The randomization of the test was also ensured. The psychophysical tests session lasted for approximately 45 minutes for each participant.

Results & Discussion:
Statistical Analysis
The current study's data was statistically analyzed with the Statistical Package for the Social Sciences (version 20). The mean and standard deviation of all parameters were calculated using descriptive statistics for the two softwares. To determine the significance of the differences between softwares paired t-test was used. And to determine the significance of the correlation between Psycon and MLP Karl Pearsonâ€™s correlation coefficient was employed.

Results
The purpose of this study was to compare the DLI, DLF, DLT and GDT results using Psycon and MLP. A paired t-test was performed, and the results revealed that there was no statistically significant difference in scores for DLI (t (38) = -1.391, p >0.05), DLF (t (38) = 0.95, p >0.05) and DLT (t (38) = -1.598, p >0.05) but there was statistically significant difference in gap detection threshold (t (38) = -3.091, p <0.05) between Psycon and MLP. Further, level of significance of correlation Karl Pearsonâ€™s coefficient performed, and the results revealed that there was statistically no significant correlation for DLI results (r=-0.144, p=0.38) and DLF results (r=0.292, p=0.072) between Psycon and MLP. But...
there was a statistically significant correlation for DLT (\(\rho=-0.509, p=0.001\)) and GDT (\(\rho=-0.462, p=0.003\)) between Psycon and MLP.

**Discussion**

This study measured several psychoacoustic measures namely DLI, DLF, DLT and GDT using Psycon and MLP application. This study is a preliminary attempt to establish the correlation of psychoacoustic measures between these two applications. The MLP toolbox in MATLAB is used by the majority of researchers and students for psychoacoustic testing [12]. However, MATLAB is a paid tool with a large platform that requires coding knowledge, whereas PSYCON is free software that is beneficial for beginners with no programming experience, but it can also be useful for experienced programmers [13]. However, the preliminary results of the present study shows not a good correlation (Ranging from no correlation to moderate correlation) between the two softwares and we should be cautious to generalize the data across Psycon and MLP.

**Summary & Conclusion:**

To conclude, the preliminary results of the present study shows that the correlation for the various psychoacoustic tests measured through Psycon and MLP ranges from no correlation to moderate correlation. Thus, the generalization of data from these two softwares is not advisable. However, further study with larger sample would strengthen the results of the present study.

**Reference:**