Normative for Motor Speech Profile in Kannada-Speaking Adults

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Summary: Objective. The primary purpose of this study was to establish normative for 18 parameters of *Motor Speech Profile* (*MSP*; *Computerized Speech Lab*; KayPENTAX, Lincoln Park, NJ) in Indian population, specifically for Kannada-speaking adults across age and gender.

Study Design. Cross-sectional study.

Method. Native Kannada speakers (n = 300) were divided into three age groups (20–40, 41–50, and 51–60 years) with 50 males and 50 females in each group. The obtained data are reported across age and gender for the parameters of diadochokinetic rate, second formant transition, and voice and tremor characteristics of *MSP* software.

Results. Across *gender*, a statistically significant difference ($P < 0.05$) was seen for seven parameters; whereas across *age*, a statistically significant variation was seen for nine parameters in the age group of 51–60 years than other groups (20–40 and 41–50 years).

Conclusion. Establishment of the normative is essential for the effective use of acoustic analysis as an objective tool. The findings of the present study serve as a norm-based reference for *MSP* software in Indian population, aged between 20 and 60 years.

Key Words: Motor Speech Profile–Diadochokinetic rate–Second formant transition–Voice and tremor characteristics.

INTRODUCTION

Speech-language evaluation is carried out by speech-language pathologists (SLPs) to understand their client's problem and establish the beginning level of treatment.[1] The primary tool used by SLPs for the analysis of speech disorders remains perceptual analysis. However, because of its limitations, viz, reliability and poor understanding between perceptual attributes and underlying speech pathology, a need for more objective analysis has been emphasized.[2–4] The instrumental analysis, on the other hand, provides quantitative and objective data on a wide range of different speech parameters far beyond the scope of an auditory-based judgment.[5] Among the different types of instrumental analysis that could be used in speech disorders (eg, acoustic, aerodynamic, electromyographic), acoustic analysis is reported to be highly advantageous.[6]

Acoustic measurements are usually conducted by means of dedicated computer software. Some of these include *Computerized Speech Lab* (*CSL*; KayPENTAX, Lincoln Park, NJ),[7] time-frequency analysis software program for 32-bit windows 95/98/NT/2000/XP (*TF32*, formely known as CSpeech; CSL, Kay Elemetrics),[8] *Praat* (Institute of Phonetic Sciences, University of Amsterdam, The Netherlands),[9] *Dr Speech* (Tiger DRS, Inc., USA),[10] *Visi-Pitch* (KayPENTAX), and others. Effectiveness of *CSL* for analysis of various speech disorders and acoustic research purposes has been evaluated and reported,[11–13] with its perceptual and acoustical correlation[14,15] and in comparison with other instruments.[16,17] Literature reports indicate that *CSL* is found to be generally consistent on a number of acoustic features[11,12,18] and thus commonly preferred for speech analysis. To extract and analyze speech parameters relevant to speech disorders, *Motor Speech Profile* (*MSP*; KayPENTAX, Lincoln Park, NJ) software of the *CSL* program is being used.

MSP, a software program and a part of *CSL* program, was developed by Deliyski and Gress.[19] It evokes built-in protocols for different tasks (eg, running speech, sustained phonation, and diadochokinesis) and is developed to assess separate parameters, including diadochokinetic (DDK) rate, second formant transition, voice characteristics and tremor features, intonation patterns, and syllabic rate. Although *MSP* has been used for voice analysis among normal, hearing impaired, voice disordered, and dysarthrics, it was found to be effective in the analysis of speech in individuals with motor disorders.[20–22]

The past literature has revealed that significant variations prevail in the acoustical parameters of individuals who are regarded as healthy because of the influence of the differences that occur in the human body with respect to anatomy, physiology, and even vocal tract acoustics. Studies have indicated that these differences vary across age groups,[23,24] gender,[25–27] speakers of different language groups,[28,29] culture and social situations,[30] and for tasks, such as DDK rate,[31] maximum duration of vowel phonation, jitter, shimmer,[32] and so on.

Over the years, attempts have been made to standardize data for the laboratory equipment as speech and voice computerized analysis programs use different modes to calculate acoustic parameters.[33–35] Attempts to compare the main acoustic measures among the different analysis programs, to know whether they are in agreement or not, have been reported in the literature.[36,37] According to Titze,[38] standardization educates, simplifies, saves time, money, and effort, and assures certification.

Deliyski and Gress[19] in their development of the western norms of *MSP* have shown a significant difference between the genders in certain parameters of DDK, second formant transition, voice and tremor characteristics, standard syllabic rate, and intonation stimulability ($P < 0.05$). They derived the *MSP* normative within the age range of 18–61 years based on

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data obtained from 38 individuals. An Indian norm has been established only for the Multidimensional Voice Profile program of *CSL* (CSL, KayPENTAX).[39]

From the literature, it is evident that there is a paucity and need for establishing normative data for given equipment, specific to region, gender, and across age groups. Furthermore, with the increase in the number of SLP training institutions, speech clinics at various hospitals, and the incidence of neurologic communication disorders in India, the present study is justified and focused on developing norms for *MSP* software. This normative is developed for Kannada-speaking population (Udupi district), across the genders and age groups of 20–60 years for the three parameters of *MSP*, that is, DDK rate, second formant transition, and voice and tremor characteristics.

METHOD

Before the initiation of the study, due approval was obtained from the institutional and research committees. Written consent was obtained from all the participants.

A cross-sectional study design was used with samples primarily drawn from Udupi district of Karnataka (one of the states of India). Based on the pilot study, only three age groups were considered, that is, 20–40, 41–50, and 51–60 years. Each group had 100 samples with equal representation of gender, thus resulting in a total sample size of 300. All the participants were native Kannada speakers with no history of speech or language deficits. Participants who are professional voice users (teachers/musicians) and those who did not consent were excluded from the study.

MSP (basic), a software program of *CSL* (KayPENTAX) was used for the study. Of the five parameters available in this program, only for three, that is, voice and tremor, DDK, and second formant transition, the normative value was established. A standard instruction for each recording was given to the participants and before actual measurement; two practice trials were given as a familiarity exercise.

For DDK, the participants were instructed to say "pa" repeatedly as fast as they could; for second formant transition, they were asked to produce /i–u/ as quickly as possible; for voice and tremor characteristics, they were instructed to produce /a/ as long as possible. All the tasks were recorded for 8 seconds only as the default time window is of 8 seconds. The total test duration for each participant was approximately 5–10 minutes.

The samples were recorded in the laboratory setting (sound-treated room) using Samsung (*SyncMaster 1100DF*) system and microphone (*SHURE SM-48*). For those participants who were not able to be present at the laboratory, samples were collected at their sites using the software for voice recording (*WaveSurfer*, Teledyne LeCroy) installed in a laptop (*TOSHIBA Satellite C650, intel CORE i3*) (Toshiba Corporation, Tokyo, Japan). A multimedia headphone with microphone was used for the recording (frequency, 50–16 000 Hz; maximum input power, 100 mW; microphone type, condenser; polar pattern, omnidirectional, and sensitivity, −62 dB). The participants were seated in front of the system, and the voice sample was collected through a microphone placed 6 cm away from the speaker.

The obtained data were analyzed by comparing the information across age and gender. A total of 18 parameters was measured and analyzed. *Descriptive statistics*, viz, mean ± standard deviation (SD), and range were calculated from the parameters. An independent *t* test was carried out to analyze the data across groups and gender with significance level set at $P < 0.05$. All statistical analysis was carried out using *Statistical Package for Social Sciences*, version 16.0, for windows (SPSS, Inc., Chicago, IL).

RESULTS

The three parameters of *MSP*, that is, DDK rate, second formant transition, voice and tremor characteristics, across age and gender are reported and discussed.

DDK rate

DDK rate is the ability to repeat consonant vowel combinations rapidly and rhythmically with brief pauses. The parameters analyzed under this measure were average DDK period (DDKavp), average DDK rate (DDKavr), coefficient of variation of DDK period (DDKcvp), perturbation of DDK period (DDKjit), and coefficient of variation of DDK peak intensity (DDKcvi).

When the parameters of DDK are compared across age groups (Table 1), it is seen that except DDKavr, all other measures of DDK (DDKavp, DDKcvp, DDKjit, and DDKcvi) are in ascending trend for both genders with the increasing age band. The decreasing trend for DDKavr can be attributed to its inverse relation to DDKavp. As inferred from the results, DDKavp is the longest for 51–60-year individuals (203.18 milliseconds for male speakers and 191.52 milliseconds for female speakers), whereas shortest for 20–40-year individuals (165 milliseconds for male speakers and 174.2 milliseconds for female speakers). DDKavr thus is fastest for young adults (6.33 seconds for male speakers and 5.58 seconds for female speakers) than individuals of 51–60 age bands (2.72 seconds for male speakers and 3.25 seconds for female speakers). Increasing trend in coefficient of variation in perturbation and intensity infers that the variations in voice increase with advanced age.

Across gender, statistically significant differences between male speakers and female speakers are noted for the parameter of DDKcvi for the age group of 20–40 years ($P = 0.01$), 41–50 years ($P < 0.001$), as well as for DDKcvi and DDKavp ($P < 0.001$) in 51–60 years. This indicated that male speakers are faster than female speakers in the task of diadochokinesis.

Second formant transition

This is the ability to accurately, quickly, and rhythmically make target second formant transition. The parameters analyzed under this measure are F_2magn (magnitude of second formant variation), F_2rate (rate of second formant variation), F_2reg (regularity of second formant variation), and F_2aver (average second formant value).

It is seen that second formant measures showed a different trend than DDK measures with respect to various age groups, as depicted in Table 2. Although second formant rate (F_2rate) and regularity (F_2reg) followed a decreasing trend, the variations