The Comparison of Vowel Space in Normal children and Children with Down syndrome

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Down syndrome (hereafter DS) is a chromosomal condition caused by the presence of all or part of a third copy of chromosome 21. People with DS may have a variety of intellectual disabilities, a characteristic facial appearance and weak muscle tone. In addition, a global delay that affects their motor development, cognition, communication and language is often reported. This study aims to investigate and compare vowel spaces of healthy and DS children. This research is quantitative and to investigate vowel spaces of participants, twelve subjects (6 healthy children with the average age of 8 and 6 DS children with the average age of 10) attended the research project. The data were 36 monosyllabic (CVC) words and for each of them, the codas and onsets were occupied by similar voiced and voiceless Persian stops. The acoustic data were recorded in a soundproof chamber and the subjects' production was recorded using SHURE® microphone (SM81 Condenser) placed at the mouth level. Each speech sample was segmented and analyzed acoustically using Praat® speech analysis software (Version 5.2.24). Making a text grid, it was possible to analyze both sound waves and spectrograms simultaneously, securing reliable analyses. Therefore, using PRAAT script, first formant frequency (F1) and second formant frequency (F2) of all the Persian vowels were measured for all the participants. In the next step, repeated measure ANOVA and SPSS (version 17) were performed to investigate differences between vowels of all subjects. The level of significance was α: 0.05. Thus, the confidence interval would be 95%. If the p-value of the repeated measure ANOVA was less than 0.05, post-hoc Bonferroni test would be employed to analyze the dependent variables. Statistical information on mean F1 of vowels shows that F1 of [ɑ, æ, o] in healthy children is more than that in children with DS. This result indicates that these vowels are articulated in a higher position in subjects with DS. From the other hand, mean F1 of [u, i, e] in healthy children is more than that of children with DS. It can be concluded that in children with DS, these vowels are articulated in a lower position. Analyzing statistical information on mean F2 of vowels in subjects with DS indicates that F2 of [æ, i, e] is less than those in healthy children. In other words, these vowels are

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articulated in a more back position in these participants. Also, analyzing F2 of [ɑ, u, o] in DS children shows that these vowels are articulated in a more front position. Another part of this research is dedicated to analytic statistics of vowels. It was hypothesized that the effect of DS on F1 and F2 of vowels is significant. This hypothesis is partially supported by the findings. The results indicate that there is no significant difference between F1 of all Persian vowels [æ, e, o, ɑ, u, i] in the two groups of subjects. Nevertheless, it is worth noting that the difference between F2 of all Persian vowels except [ɑ] is significant between healthy and DS children. All in all, these results support the fact that formant values are more centralized for children with DS, which means a reduced vowel space area. Consequently, it can be concluded that, in DS children, structural features of oral cavity, like smaller oral orifice, narrower but not higher palatal curve and shorter vocal cords have an effect on formant structure of vowels.

Keywords: Down syndrome, First Formant Frequency, Second Formant Frequency, Vowel Space.