



CHILDREN WITH INTELLECTUAL DEFICIT: VOICE QUALITY AND SPEECH INTELLIGIBILITY

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ABSTRACT:

Introduction: The relation between voice quality and its effect on the speech intelligibility of children with Intellectual Deficit (CID) is rarely studied. In this study we measured and compared voice characteristics of CID and normally developing children (NDC). We also compared speech intelligibility of CID with best voice characteristic (all voice parameter within normal range) and NDC. Part 1: Voice characteristics of CID vs NDC. **Methods:** 10 CID and 10 NDC aged between 7 and 12 years participated in this study. Dr Speech was used to measure the various characteristics of voice. Participants were asked to sit comfortably on chair and phonate /a/, /i/ and /u/ in front of a very sensitive microphone connected to the Dr Speech software. Fundamental frequency (Fo), jitter, shimmer and harmonic to noise ratio (HNR) values were recorded in all the participants. All the measurements were done in a sound treated room. **Results and Discussion:** Results indicated significant differences in the two groups in terms of Fo, jitter, shimmer and HNR for all the sound i.e. /a/, /i/ and /u/. CID group had higher Fo in comparison to NDC group. Jitter, shimmer and HNR values were lower in CID group when compared to NDC group. Part 2: Speech intelligibility of CID and NDC. **Methods:** Recording-20 monosyllabic words were recorded from 1 child with intellectual deficit (with all the voice parameter close to normal range) and 1 normal developing child. Standard recorder CENIX and speaker Philips SBC BP15 were used for recording. Participants-10 normal hearing adults aged between 18 and 30 years. Procedure-Speech Intelligibility Score (SIS) was measured in all the participants for the two recorded speech samples i.e. from child with intellectual deficit and normal developing child. The speech sample was presented to the participants through a laptop routed via an audiometer in order to keep the intensity level constant. The presentation level used was 50 dB HL. **Results and Discussion:** There was a significant difference in SIS obtained from the two speech samples. This point towards the poor speech intelligibility of speech recorded from children with intellectual deficit. **General Conclusion-**The results of the two studies highlight a significant relation between the voice characteristics and speech intelligibility.

KEYWORDS:

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I. INTRODUCTION

Previous studies have discussed the relationship between voice quality and speech perception.^[1, 2] Perceptually quality of voice can be estimated based on parameter such as fundamental frequency (Fo), jitter, shimmer and harmonic to noise ratio (HNR). Fundamental frequency refers to the number of times the vocal folds vibrate in one second, and measured in hertz (Hz). Jitter is the short-term changes that occur in Fo (pitch). Simply jitter is change of fundamental frequency from cycle to cycle. Shimmer describes the random cycle to cycle temporal change of the amplitude of the vocal fold vibration. Both jitter and shimmer are measured in %. Harmonic to noise ratio is a measure of additive unwanted noise in the voice and is measured in dB SNR (signal to noise ratio).

Perceptual voice analysis has shown abnormal

fundamental frequency (Fo), jitter, shimmer and harmonic to noise ratio (HNR) in children with intellectual deficit (CID).^[3, 4] But the effect of these abnormalities in the voice of CID on speech perception of normally developing children is rarely studied. This study was conducted in 2 parts. In part 1 voice characteristics of CID and normally developing children (NDC) was measured and compared. In part 2 we compared speech intelligibility of CID with best voice characteristic (all voice parameter within normal range) and NDC.

II. PART 1: VOICE CHARACTERISTICS OF CIDVS NDC

A. METHODS

Participants were 10 CID children with mild to moderate

level which were diagnosed by experienced psychologist team of Sweekaar Academy of Rehabilitation Sciences (Group 1) and 10 NDC children (Group 2). Children in Group 2 were attending normal school and performances were good as reported by school teachers and as well as parents. All the participants were male and had chronological age between 7 and 12 years.

Dr Speech was used to measure the various characteristics of voice in all the participants. Participants were asked to sit comfortably on chair in a sound treated room and phonate /a/, /i/ and /u/ for 5-10 seconds in front of a very sensitive microphone connected to the Dr Speech software.

Children with Intellectual deficit who were not able to follow the instructions and phonate for the required amount of time were given training prior to the recording.

B. RESULTS AND DISCUSSION

Mean and standard error of Fo, jitter, shimmer and HNR in the two groups for /a/, /i/ and /u/ are shown in figure 1, figure 2, figure 3 and figure 4, respectively.

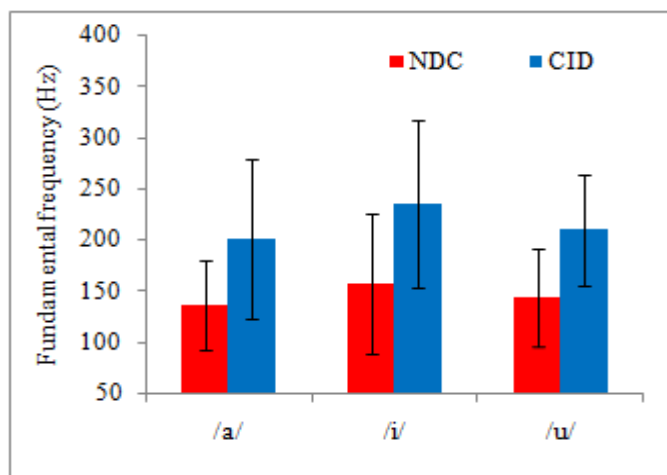


FIGURE 1: FUNDAMENTAL FREQUENCY (FO) FOR /A/, /I/ AND /U/ IN NDC AND CID

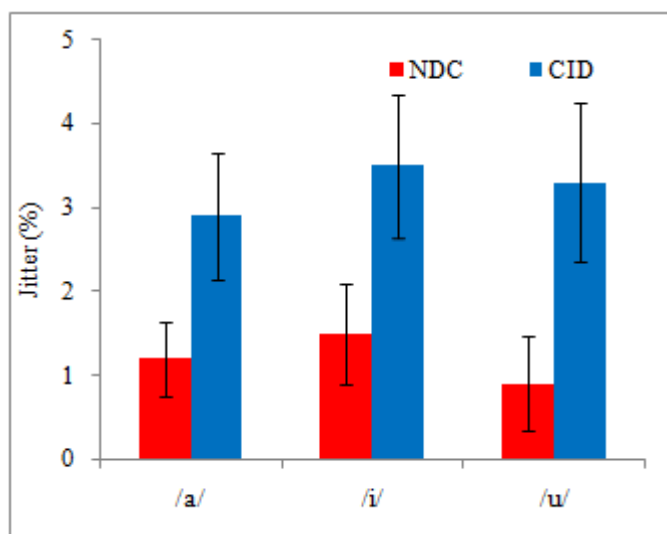


FIGURE 2: JITTER FOR /A/, /I/ AND /U/ IN NDC

AND CID

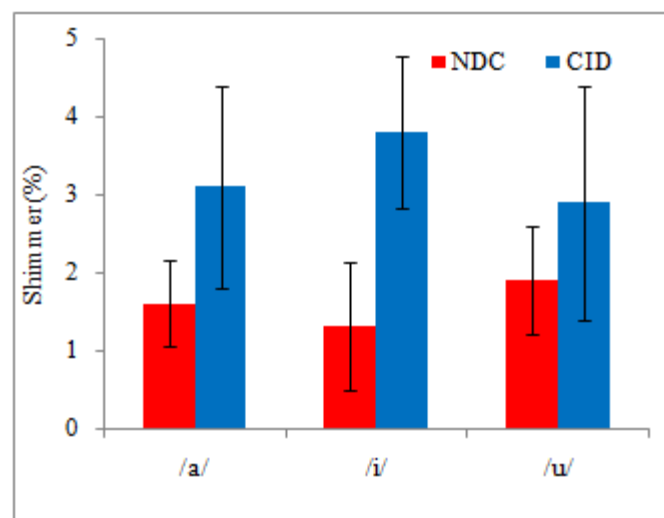


FIGURE 3: SHIMMER FOR /A/, /I/ AND /U/ IN NDC AND CID

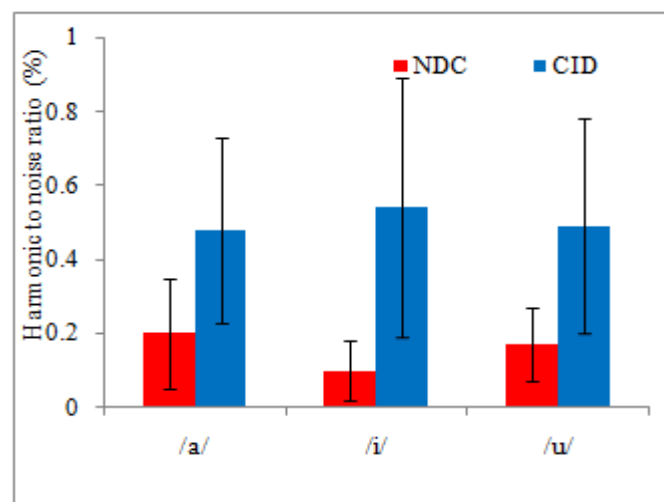


FIGURE 4: HNR (%) FOR /A/, /I/ AND /U/ IN NDC AND CID

T-Test was done to see the group effect on various parameters of voice for /a/, /i/ and /u/. Results indicated significant differences in the two groups in terms of fundamental frequency for all the sound; /a/ [$t(18) = 3.98$, $p < 0.001$], /i/ [$t(18) = 2.03$, $p < 0.001$] and /u/ [$t(18) = 4.16$, $p < 0.001$]. For Jitter, CID and NDC were significantly different; /a/ [$t(18) = 4.11$, $p < 0.001$], /i/ [$t(18) = 3.84$, $p < 0.001$] and /u/ [$t(18) = 2.62$, $p < 0.001$]. Shimmer was significantly different between the two groups; /a/ [$t(18) = 1.87$, $p < 0.001$], /i/ [$t(18) = 2.26$, $p < 0.001$] and /u/ [$t(18) = 2.59$, $p < 0.001$]. Results for HNR were also significantly different; /a/ [$t(18) = 2.38$, $p < 0.001$], /i/ [$t(18) = 3.12$, $p < 0.001$] and /u/ [$t(18) = 3.71$, $p < 0.001$].

CID group had higher Fo in comparison to NDC group (Figure 1). Jitter, shimmer and HNR values were lower in CID group when compared to NDC group (Figure 2, figure 3 and figure 4). These results showed higher frequency

and intensity fluctuations in CID than NDC. Intellectually normal individuals keeps modifying their voice according to the social needs and requirements which may be deficit in CID which may have resulted in poor voice quality in this population.

III. PART 2: SPEECH INTELLIGIBILITY OF CID AND NDC

A. METHODS

Prior to the experiment recording was from 1 Child with Intellectual Deficit (with all the voice parameter ie. Fo, jitter, shimmer and HNR close to normal range) and 1 normal developing child separately using a standard recorder CENIX and speaker Philips SBC BP15.

Recording participants were asked to sit comfortably on chair in sound treated room and made them to produce 20 monosyllabic

words ie. /p/, /b/, /t/, /d/, /k/, /g/, /f/, /v/, /s/, /z/, /l/, /r/, /j/, /m/, /n/ and /ŋ/.

10 normal hearing adults aged between 18 and 30 years participated in this part of the study. Speech Intelligibility Score (SIS) scores was measured in all the participants for both the speech sample; 1 from CID and 1 from NDC. Participants were made comfortable on chair in diagnostic lab and were instructed to repeat all sounds heard. The two samples were presented one by one which were already recorded. The speech sample was presented to the participants through a laptop routed via an audiometer in order to keep the intensity level constant. The presentation level used was 50 dB HL.

RESULTS AND DISCUSSION

T-Test showed significant [$t(9) = 2.42, p < 0.001$] difference in SIS obtained from the two speech samples (Figure 5). SIS for speech sample from normal developing child was higher when compared to the speech sample from intellectually deficit child just because voice quality were poor in IDC children compare to NDC children. SIS for speech recorded from normal developing children was more than 90% in all the participants. This point towards the poor speech intelligibility of speech recorded from children with intellectual deficit.

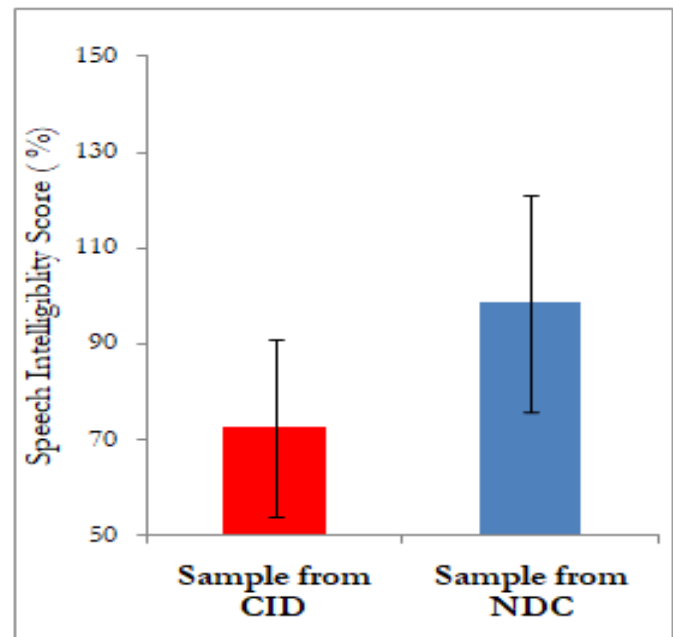


FIGURE 5: SPEECH INTELLIGIBILITY SCORES FOR SPEECH SAMPLE FROM CID AND NDC.

GENERAL CONCLUSION

The results of the two studies highlight a significant relation between the voice characteristics and speech intelligibility. Voice characteristics of CID were different from NDC which could have possibly resulted in poor speech intelligibility of speech sample of CID. The second study had some limitation in terms of not accounting for the misarticulations in CID which could also affect the speech intelligibility, though we tried to limit this variable by selecting the child (with intellectual deficit) who had negligible misarticulation problem for recoding.

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