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An investigation into the voice of identical twins

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Abstract

The study aimed at perceptually and acoustically differentiating the voices of identical twins from each other. AX same-different perception test was done to find whether the voices of identical twins could be perceived as same or different voices. Ten monozygotic twin pairs, 5 males and 5 females between the ages of 10 to 15 year old served as speakers. The speakers phonation of \a\ was permuted which resulted in pairs of two different stimuli. The paired stimuli were part of one of the following speaker groups: same speaker (different repetitions) or monozygotic twins. For the AX perception test 5 native listeners (students of Speech Language Pathology) were asked to judge for each stimuli pair whether it belonged to the same speaker or different speakers. On average, the listener's correct identification of same speakers was 91.6% and the correct identification of monozygotic twin pair's voice as two different speakers was 80.27%. This shows that there was difficulty in perceptually distinguishing the voices of monozygotic twins as that of two different speakers but the listeners' sensitivity to twin differences was greater than chance . Acoustic analysis showed that shimmer values are more sensitive in discriminating twin voices among each other. This investigation can contribute to automatic speaker recognition as well as the field of forensic phonetics, especially forensic speaker identification.

Key words: voice parameters, voice , identical twins

Key message: Differentiating the voice of monozygotic twins while listening to their voice is difficult but can be done at greater than chance level. Acoustically also the voice parameters are more alike. Shimmer values were found to be different significantly among the twin pairs studied.

An investigation into the voice of identical twins

Introduction

Monozygotic twins / identical twins come from one fertilized egg (zygote) and thus their genetic makeup is expected to be identical. Identical twins cannot be distinguished from each other using DNA. Some authors recommend that biometric modalities, such as fingerprints, iris, palmprints, [1] face and voice [2, 3] can still be used to distinguish them.

According to Sataloff, [4] the physical characteristics of laryngeal mechanism such as vocal fold length and structure, size and shape of supraglottic vocal tract and phenotypic similarities elsewhere in vocal mechanism are genetically determined .Though voice is unique to individuals, studies show perceptive similarity in monozygotic twins [5] . Several studies showed that monozygotic (MZ) twins have very similar voice characteristics leading to perceived similarity [6.] Acoustic parameters were reported to be similar in monozygotic twins like F0 in phonation [7] , speaking F0 [5], formant [8]. Vocal quality measurement by Van Lierde, et al [9] in 45 monozygotic twins (19 male, 26 females) using Dysphonia severity index, showed that perceptual and objective voice characteristic were similar in Monozygotic twins. Jayakumar, and Savithri , found considerable similarity in voice source (aerodynamic measurements) in monozygotic twins using formant based inverse filter [10]

However there are also studies which show that voice of identical twins are sufficiently different to warrant their unique voice characteristics [11, 12]. Acoustic studies done using formant Centre frequency of identical twins show that despite the great similarity, differences could be found in most identical twins. [13, 14, 15]

We conducted perceptual and acoustic analysis of 10 identical twins. The similarities and differences between twins in the voice parameters are discussed.

Aim

The aim of our study was to find out whether it is possible to perceptually differentiate the voices of identical twins from each other and also to look more closely at acoustic parameters to determine the ways in which the twins' speech differed.

Method

Subjects and stimuli

Ten monozygotic Malayalam speaking twin pairs, 5 males and 5 females between the ages of 10 to 15 year old served as speakers. Voice samples were elicited by asking each participant to produce sustained phonations of the /a/ sound at his or her habitual levels of pitch and loudness .The voices of the subjects were recorded in a sound treated room with an ambient noise below 40 dB using PRAAT software (version 5.1.04). A Proton Boom -815 unidirectional condenser microphone was placed on a stand 8cm from the subject at an angle of 45^0 to the subject's mouth to decrease aerodynamic noise from the mouth. To investigate perceived speaker similarity an AX same-different perception test was conducted. The speakers phonation of \a\ was permuted which resulted in pairs of two different stimuli. The paired stimuli were part of one of the following speaker groups: same speaker (different repetitions) or monozygotic twins.For the AX perception test 5 native Malayalam speaking listeners (students of Speech Language Pathology) were asked to judge for each stimuli pair whether it belonged to the same speaker or different speakers. The perception test was run in PRAAT (version 5.1.04). Subjects listened to each presented stimulus pair once over Sennheiser HD 595 headphone in a randomized order. Directly after listening to each stimulus, they were asked to click on a button “same speaker” or “different speaker”. Each stimuli pair was presented in both possible orders (AX and XA) .

Furthermore, an acoustic analysis was made to look for the parameters that would determine the uniqueness of the voice among the identical twins.

Acoustic analysis

All acoustic analyses were conducted using PRAAT. (version 5.1.04).

Mean and standard deviation of the following parameters were found

1. Fundamental frequency (F0) - is the rate of vibration of the vocal folds

2. Jitter - is an acoustic measurement of how much a given period differs from the period that immediately follows it.

3. Shimmer or amplitude perturbation quantifies the short-term instability of the vocal signal.

4. Formants are defined as 'the spectral peaks of the sound spectrum or an acoustic resonance of the human vocal tract . The formant with the lowest frequency is called f1,and the second formant is f2.

Statistics

Paired individual –t test was done using The Statistical Product and Service Solution Ver. 15.0 (SPSS Inc., Chicago, IL,USA; 2006)to find the difference between twin pairs for quantitative measures.

RESULTS

In the AX same-different perception test (Table I), on an average, the listener’s correct identification of same speakers was 91.6% and the correct identification of monozygotic co -twin pair’s voice as two different speakers was 80.27%.

Statistical analysis of the acoustic parameters of the co twins (Table II) using Paired individual –t test revealed that fundamental frequency, Jitter (cycle to cycle variation in fundamental frequency), first formant frequency and second formant frequency were not statistically significant. The acoustic parameter of shimmer (cycle to cycle variation in intensity) differed between the co twins.

Table I. Perceptual analysis scores

	Percentage
correct identification of same speakers	**91.6%**
correct identification of different speakers	**80.27%**

Acoustic Analysis

Table.II. Showing the results of paired individual –t test to find the difference between twin pairs for the different acoustic parameters

Parameters	Group	Mean	Standard deviation	P
F0	twin1	234.45	34.05	.827
	twin2	239.45	42.42	
Jitter	twin1	.8683	.4767	.411
	twin2	.6889	.4229	
Shimmer	twin1	10.3944	2.4832	.099
	twin2	7.7856	3.7108	
F1	twin1	859.7400	128.3596	.572
	twin2	899.3567	161.4003	
F2	twin1	1395.3389	139.9680	.938
	twin2	1399.9556	107.0397	

DISCUSSION

For the perceptual analysis task, on an average, the listener's correct identification of same speakers was 91.6%. For the monozygotic twin groups the percentage of correct identification scores were 80.27% which showed that there was difficulty in perceptually distinguishing the voices of monozygotic twins as that of two different speakers but the listeners' sensitivity to twin differences was greater than chance.

The acoustic parameters of fundamental frequency, Jitter (cycle to cycle variation in fundamental frequency), first formant frequency and second formant frequency were found to be more similar in the monozygotic twins.(Table II.) The study is in support of earlier work done in this area which shows F0 to be the crucial acoustic parameter which determines perceived speaker similarity [2]. Our study reveals that shimmer is more sensitive in discriminating twin voices among each other. Further research is needed with larger samples as well as with other acoustic parameters to help in differentiating identical twins.

Conclusion

Several studies have shown that monozygotic (MZ) twins have very similar voice characteristics leading to perceived similarity. However there are also studies which shows that voice of identical twins are sufficiently different to warrant their unique voice characteristics .According to our study there was difficulty in perceptually distinguishing the voices of monozygotic twins as that of two different speakers but the listeners' sensitivity to twin differences was greater than chance (80.27%) .The acoustic parameters of fundamental frequency, Jitter (cycle to cycle variation in fundamental frequency), first formant frequency and second formant frequency were found to be more similar in the monozygotic twins. Shimmer values were more sensitive in discriminating twin voices among each other. This investigation can contribute to automatic speaker recognition as well as to the field of forensic phonetics, especially forensic speaker identification. To what extent other aspects of acoustic parameters might play a role in the uniqueness of individual voices is a subject of further research.

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