

## Acoustic Analysis of Post Alveolar Voiced Fricative Consonant /ʒ/ in Pakistani English

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### ABSTRACT

*This study analyzed the acoustic properties of post alveolar voiced fricative /ʒ/ consonant. It investigated how Pakistani English is a separate variety from BBC English on the basis of different pronunciation patterns of /ʒ/ consonant. Pakistani English had been considered as a distinct variety from standard English for the last two decades. This qualitative research depicted the inclusive picture of /ʒ/ consonant in BBC and Pakistani English by considering the recordings on PRAAT software. Acoustic parameters such as center of gravity (COG), harmonic to noise ratio (HNR), F2 transition of the following vowel and spectrogram were used to determine the voicing, place of articulation and manner of articulation of the consonant. COG and HNR in Pakistani English /ʒ/ consonant, showed that there was more voicing because of the vibration of vocal cords. F2 transition of the following vowel explained that the position of tongue is more back to post alveolar position and contact of the tongue is less with the palate. Spectral analysis indicated that there is no friction and air passes along the sides of the tongue which are the properties of approximants. The result of the acoustic analysis showed that Pakistani speakers pronounced /ʒ/ consonant like English /j/ consonant. So, this investigation assisted in proving that Pakistani English is a separate variety because Pakistani English speakers realized /ʒ/ consonant differently from BBC speakers.*

**Keywords:** /ʒ/ consonant, Pakistani English, PRAAT software, Acoustic parameters.

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### Introduction

Linguists, around the world, have coined a term 'World Englishes' to describe different varieties of English as

it is generally produced and perceived differently by the people of different countries. English is spoken as a second language in Pakistan with the taste of its local accent. Pakistani English has emerged as a different variety just like

Chinese English and Indian English since English in South Asia is 'nativized' and 'vernacularized' (Kachru, 1992). The existence of these varieties is the result of natural phenomenon. That's why, we speak in our own style and mostly people also prefer to speak English in their own accent.

In Pakistan, less than 8% people speak English as a first language but English is considered a prime source of language in education system. That's why, 49% of its population speaks English as a second language that makes Pakistan the 3<sup>rd</sup> country in Asia with respect to English speakers population (Brooks, 2017). Pakistan is a country where almost 74 languages including English are spoken (Rahman, 2011). So, even within Pakistani English, there are many varieties largely due to the speakers L1 (native language) as well as its usage according to the educational, social and regional background. The suggestion behind the concept of World Englishes supports the idea that each variety of English language has some marked features which makes it different from other varieties. So, the need is to prove these new varieties of World Englishes, as these nativized Englishes are easy to speak and even easy to comprehend for their natives.

Different researchers have presented their ideas regarding the indigenization of English language (Baumgardner, 1998; Kachru 1992). In Pakistan, Rahman and Mahboob put an

effort to prove that Pakistani English is a separate variety. English in Pakistan represents Pakistani-Muslim way of thinking which makes it a hybrid language (Mahboob & Ahmar, 2008). So, this study will also investigate that either Pakistani English is a separate variety or not by doing an acoustic analysis of Post alveolar voiced fricative /ʒ/ consonant. Out of all English consonants, only the production of /ʒ/ consonant at segmental level will be analyzed by using different acoustic parameters on PRAAT software.

The objectives of the study are:

- to investigate either Pakistani English is a separate variety or not.
- to analyze the acoustic characteristics of /ʒ/ consonant in words like measure and treasure.
- to describe properties of the consonant spoken by Pakistani speakers in the place of /ʒ/ consonant.

### **Literature Review**

Acoustic is a branch of physics which deals with sounds. Acoustic analysis of speech started in 1940s which involved the physical aspects of speech sounds (Naseer & Abolfazl, 2006). Spectrogram is one of the tools of analyzing sounds through which we analyze the physical aspects of sounds as the strength of sound waves is converted into a spectrogram. Many researchers have used spectrogram for the analysis of different acoustic properties of vowels

and consonants (Maniwa & Jongman, 2000; Ladefoged, 2012; Hamman & Sennema, 2005).

Consonants are usually classified into three main phonetic features: 1) Voicing, 2) Place of articulation, 3) Manner of articulation. These characteristics help in describing each consonant and distinguish them from each other (Roach, 2010). For analyzing the consonants, different parameters are used to describe these phonetic features.

For the manner of articulation, shape of spectrogram is used through which spectral properties of consonants are observed. Post alveolar /ʒ/ consonant usually shows a mid-frequency spectral peak at around 2.5-3 KHz which is similar to F3 of the following vowel (Maniwa & Jongman, 2000). This consonant can also be distinguished on the basis of noise and friction. It often shows vertical strident lines and voice bar on spectrogram.

Voicing of the consonant can be measured by the 'centre of gravity' which is the mean of frequencies over the entire frequency domain. Centre of gravity tends to be lower for voiced fricative consonants (Hamann & Sennema, 2005). It means, those consonants whose centre of gravity is higher will be less voiced as compared to those consonants whose centre of gravity is lower. The standard centre of gravity value of /ʒ/ consonant starts from 2000 Hz to 3000 Hz as shown in the following figure:

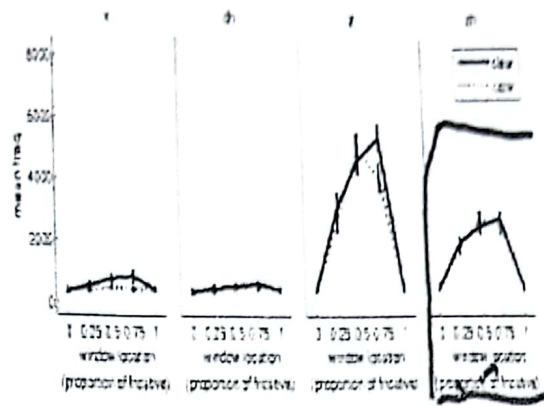


Figure 1. Mean moment 1 values (center of gravity) for fricatives (Maniwa & Jongman, 2000).

Harmonic to noise ratio (HNR) is an acoustic parameter to distinguish fricatives from approximants as this parameter will distinguish the voicing of vocal cords from the voicing of friction because voicing of fricatives consists of the vibration of vocal cords and noise of friction (Hamann & Sennema, 2005). If a mean of HNR is 0dB, it means that there is equal vibration in the vocal cords and in the noise of friction and a mean of 20 dB means that there is almost 100% of the vibration of the vocal cords (Boersma, 1993). The standard HNR value of /ʒ/ consonant is 3-5 dB as shown in the following figure:

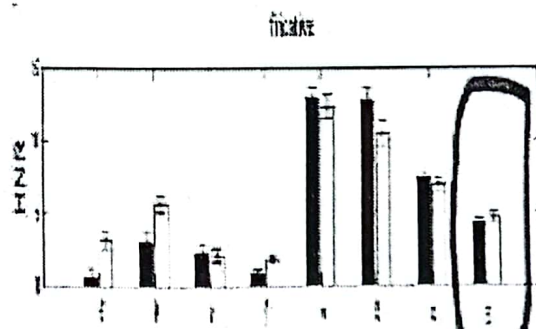


Figure 2. HNR value of the fricative (Maniwa & Jongman, 2000)

For the place of articulation, F2 transition of the following vowel is measured. F2 transition examines the use of tongue body in the production of consonants. Higher the use of tongue body means higher the frequency. Lower frequency shows less use of tongue body (Steven, 2000). In fricatives there is no complete closure between the articulators. The air passes through narrow oral cavity and in the result, noise is produced. Higher the F2 transition means more the tongue area is used and if less area of tongue is used then F2 transition will be lowered and position of tongue moves back. The standard F2 transition value of /ʒ/ is 1800 Hz to 2000 Hz as shown in the figure:

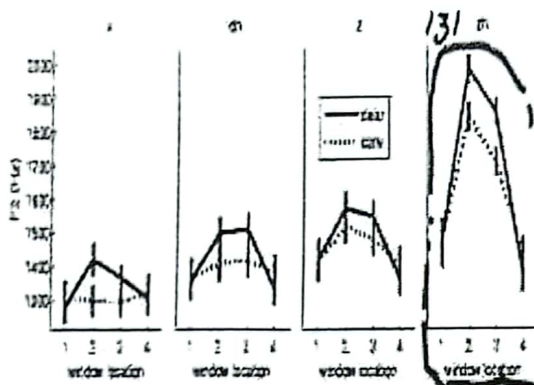


Figure 3. F2 values of fricatives (Maniwa & Jongman, 2000)

For the values of acoustic parameters, PRAAT software is used. PRAAT is a system for doing phonetics by computer. It is developed by Paul Boersma and David Weenink, in the institute of Phonetics sciences, University of Amsterdam (Boersma & Weenink, 2001).

## Research Methodology

Qualitative research is used to investigate the properties of consonant /ʒ/. The study was exploratory in nature and the data was analyzed through spectrogram and acoustic parameters.

The study was implemented with the involvement of total 20 participants. Each participant pronounced the fixed stimulus three times. So,

Total participants = 20

Each participant pronounced = 3 (times)

Total stimuli =  $20 \times 3 = 60$

We had taken 10 native speakers of BBC English who pronounced the words *measure* and *treasure*, three times by same person at different places, in different shows. During the shows, we recorded them through j7 cell and then transferred the required data into PRAAT software.

To collect data from Pakistani speakers, a piece of paper with written stimulus was given to the participants. They were asked to produce a phrase three times in their natural way. The stimuli had the word carrying target sound. The phrase was "I can measure a cloth". But our main focus was on /ʒ/ consonant which was present in the word *measure*. This word has CVC structure and it helped us to identify the influence of vowels in the pronunciation of consonant. In the end recordings were

transferred to PRAAT software for analysis. After transferring data to PRAAT software, different values were calculated like F2 transition, Centre of gravity and mean Harmonic-to-noise ratio. Other differences were described by explaining the spectrogram. Screen shots of the spectrogram were taken and marked for certain acoustic features like turbulence through the option of editing. Then those pictures were transferred to MS word file for further analysis.

### Data Analysis

#### Manner of Articulation:

Several features are observed in the spectrogram of BBC English speakers and Pakistani English speakers. The spectrogram of word 'measure' of BBC speakers shows noise of friction clearer and darker. The spectrogram of voiced fricative /ʒ/ by BBC speakers is shown in figure 4.1(a). As you can see in the given spectrogram, the marked area shows friction noise which starts from around 2500 Hz. It is darker and shows turbulence of air with strident lines. These are the characteristics of /ʒ/ consonant of BBC speaker. The second spectrogram is spoken by the Pakistani speaker. Here marked area tells us that air passes along the sides of the tongue that is one of the most prominent feature of /j/ consonant.

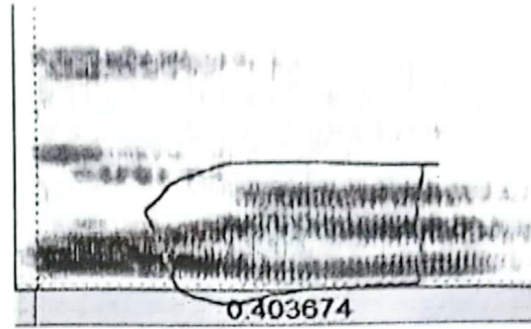


Figure 4 BBC speaker Figure 4.1(b)

#### Pakistani speaker

The presence of dark turbulent lines is a criterion to distinguish BBC /ʒ/ phoneme from Pakistani /ʒ/ phoneme. In figure (a), friction appears throughout the articulation of /ʒ/ phoneme but in figure (b) there is articulation without friction. Instead of frication, we can see different formants on the spectrogram because /j/ phoneme behaves like vowel which is usually analyzed by checking the formants.

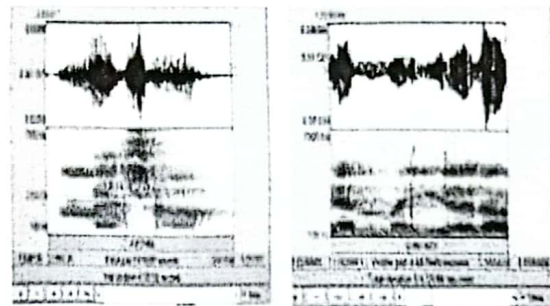


Figure 5 /j/, BBC speaker

#### Voicing

Voicing of the consonant can be measured by the 'centre of gravity' which is the mean of frequencies over the entire frequency domain. Centre of gravity

tends to be lower for voiced fricative consonants (Hamann & Sennema, 2005).

**Mean comparison of COG:**

There is an inverse relationship between the centre of gravity and the voicing. The total mean of Pakistani speakers is 472 Hz and the total mean of BBC speakers is 2088 Hz.

**Table 1** Participants' data:

No of Participants	Pakistani Speaker	BBC speaker
1	603	2729
2	444	2057
3	490	1148
4	403	1866
5	416	1417
6	411	2582
7	464	1923
8	699	2658
9	498	2788
10	292	1713
<b>Mean</b>	<b>472</b>	<b>2088</b>

So, the result shows that Pakistani pronunciation of /ʒ/ in word measure is more voiced than the BBC pronunciation of /ʒ/ in word measure. As the spectrogram shows that Pakistani speakers pronounce measure with /j/ consonant which behaves like a vowel. Vowels have more voicing than consonants. This result also shows that word measure spoken by Pakistani speakers has greater voicing. It means that they pronounce the word by using

their vocal cords which is a distinct feature of Pakistani English.

**Mean comparison of HNR:**

To measure the ratio of the number of vibrations of vocal cords and noise from friction while pronouncing the word 'measure', we will compare the values of 'Harmonic to noise ratio'.

**Table 2.** Participants' data:

No of Participants	Pakistani Speaker	BBC Speaker
1	10	4
2	14	3
3	12	4
4	10	3
5	12	2
6	9	2
7	19	3
8	13	3
9	19	4
10	20	2
<b>Mean</b>	<b>14</b>	<b>3</b>

There is a direct relationship between Harmonic to noise ratio and voicing with vocal cord. Here data shows that mean of Harmonic to noise ratio of Pakistani speakers is 14 dB which means, there is 70% of the involvement of the

vocal cord while pronouncing /ʒ/ in the word measure. Mean of Harmonic to noise ratio of BBC speakers is 3 dB which means that there is 15% of the involvement of the vocal cord while pronouncing /ʒ/ in the word measure. More involvement of vocal cord means behaving more like a vowel. Both speakers pronounced /ʒ/ with voicing but the difference is that /ʒ/ spoken by BBC speakers is more voiced because of the friction of the noise while /ʒ/ spoken by Pakistani speakers is voiced because of the vibration of vocal cords. As we can see in spectrogram of BBC speaker, there are weak voice bars below the spectrogram while in spectrogram of Pakistani speaker, there are strong and dark voice bars which is one of the indications of vocal cord vibration.

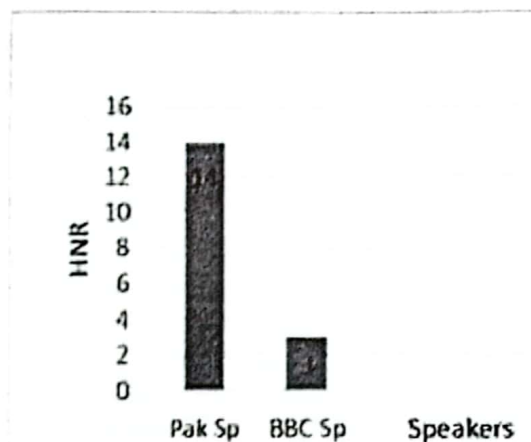


Figure 6 **BBC Speaker /ʒ/**

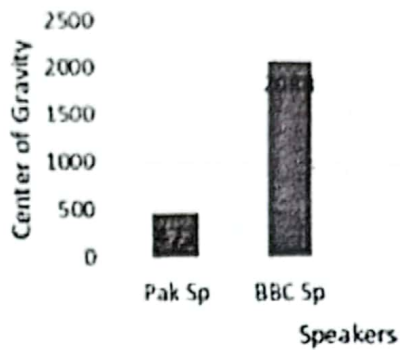


Figure 7 **Pakistani Speaker /ʒ/**

### Place of articulation

F2 transition examines the use of tongue body in the production of consonants. Higher the use of tongue body means higher the frequency. Lower frequency shows less use of tongue body (Steven, 2000).

### Mean comparison of F2 transition:

There is a direct relationship between the F2 transition and area of tongue.

Table 3 Participants' data

No of participants	Pakistani speaker	BBC speaker
1	2168	1965
2	1807	1913
3	1425	1584
4	1418	1980
5	1871	1856
6	1741	1742
7	2234	1714
8	1096	1770
9	1159	2126
10	890	1834
Mean	1587	1848

Here data shows that the mean of F2 transition of Pakistani speakers is 1587 Hz and the mean of F2 transition of BBC speakers is 1848 Hz which is higher than the Pakistani speakers.

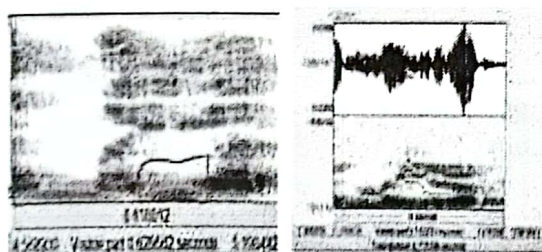
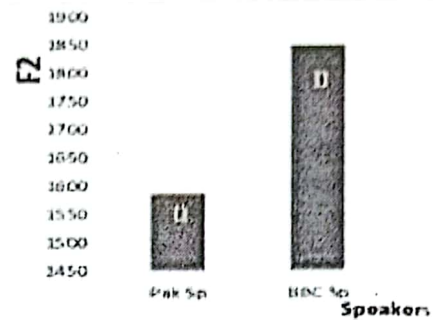


Figure 8



So, BBC speakers pronounce /ʒ/ phoneme while using more area of the tongue at the post-alveolar position. This makes it a fricative. On the other hand, Pakistani speakers use less area of tongue to pronounce /ʒ/. As a result the position of tongue is more back and the gap between the tongue is greater which is the cause of continuous flow of air and less friction that makes it an approximant. Because of such characteristics of /ʒ/ phoneme in word 'measure' spoken by Pakistani speakers, we perceive it as a /j/ phoneme that is closer to BBC /j/ phoneme.

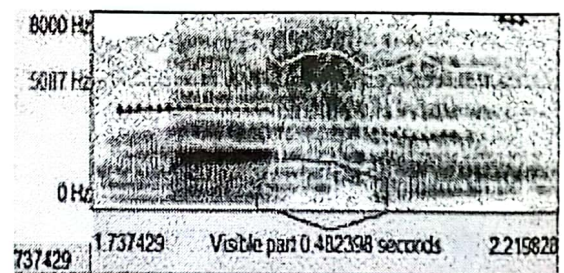


Figure 9

Moreover, we can see Formants in red lines, in the spectrogram of Pakistani speakers which is also one of



the characteristics of approximant /j/ consonant.

### Findings

The findings of the acoustic analysis of post alveolar voiced fricative /ʒ/ consonant, to state whether Pakistani English is a separate variety or not, are following:

- 1) The result, BBC consonant in words like measure and treasure is realized differently by Pakistani speakers, contributes in proving Pakistani English as a separate variety.
- 2) Spectral shape of /ʒ/ consonant spoken by Pakistani speaker has resemblance with the spectrogram of approximant /j/ as;
  - Air passes along the sides of tongue.
  - Formation of dark voicing bars
  - Formation of formants like vowels.
- 3) Pakistani speakers do not produce friction during the pronunciation of /ʒ/ consonant.
- 4) The vibration of vocal cords, in /ʒ/ consonant spoken by Pakistani speaker, is greater than BBC speaker.
- 5) Pakistani speakers use less area of tongue while pronouncing /ʒ/ consonant in word 'measure'. Therefore, /ʒ/ consonant spoken by Pakistani speakers is realized closer to BBC /j/ consonant.

### Discussion

According to Ledefoged (2012), approximants lie between fricatives and vowels, means there is an articulation like fricatives, continuation of air through the oral cavity, articulators come in contact like fricatives but the gap between them is not enough to create the turbulence of air. As a result, the noise of air is not enough to be realized as friction. Moreover, approximants behave like vowels. That's why, we can see different formants on the spectrogram which are the quality of vowels.

Mahboob and Ahmar (2004) has stated in their article of Pakistani English phonology that Pakistani Punjabi speakers pronounce the word 'measure' as /mejər/ or /medʒər/. But they did not give us enough evidence. Pakistani speakers pronounce /j/ consonant in place of /ʒ/ consonant which is a semi vowel. That's why, when they pronounce the word "measure", their vocal cords vibrate more because /j/ is semi vowel (Syed & Ansari, 2017). This is what the present study examined to state Pakistani English as a separate variety from BBC English through the pronunciation of /ʒ/ consonant.

This research is focused on only /ʒ/ consonant's pronunciation by using PRAAT software. This research investigates Pakistani speakers' pronunciation and the research approach is qualitative. The analysis of these spectrograms has been made through

PRAAT software. Finally, the researchers have compared both speakers' spectrogram by keeping in mind the mean of COG, HNR and F2 transition.

Hence, it is proved that Pakistani English has a variety of its own. It possesses different sort of pronunciation than BBC speakers. No one can call pronunciation a fallacious one.

This study shows that, in the pronunciation of /ʒ/ consonant, there is a clear difference between Pakistani English and BBC English. It presents how pronunciation in Pakistani English deviates from BBC English in words like measure, treasure and pleasure.

### Conclusion

All these findings lead us towards the conclusion that Pakistani speakers pronounce /ʒ/ phoneme in words like measure, leisure and treasure differently from BBC speakers. Most of its characteristics have resemblance with the approximant /j/. So, it is proved through investigation that /ʒ/ phoneme is pronounced differently that is a distinct feature of Pakistani English variety.

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