



RESEARCH PAPER

Acquisition of English Phonology: Spectro-Temporal Mapping of English Mid Vowels in Pakistan

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ABSTRACT

English phonology is the overwhelming challenge in successful acquisition of English as L2 as L1 phonological system can constraint the perception, categorization, and acquisition of L2 sound inventory. The current study is aimed at tracing the acquisition of English mid vowels /e/, /ə/, /ɜ:/, /ɔ:/ in Pakistani English learners. The acoustic-phonetic description of the mid vowels is based on the contours of the lowest two resonant frequencies i.e. F1 and F2 and their temporal frequencies. The sample of the study comprises of 30 female learners of English at middle level from a public school in Distt. Sheikhpura, Pakistan. The target mid vowels are embedded into / hvd / syllables in the carrier phrase 'say --- please' as a stimuli. The data set of 600 tokens elicited from participants at the same proficiency level is analysed at FormantPro (Xu, 2013). The analysis reveals some nonlinear features of English mid vowels which have, thus far, been either unidentified or deemed inconsequential in the specification of English mid vowels. Pakistani learners articulated English central vocalic sounds (/ə/, /ɜ:/) as peripheral sounds. Contrarily, the back vowel (/ɔ:/) is pronounced as central vowel in the data. However, the front mid vowel /e/ is pronounced analogous to the native speakers of English language as a front mid vowel. Parallel to spectral divergences, Duration of mid vowels is also deviant from the norm of English language. The findings of the study recommend that teaching of English phonology should not be limited just to orthographic representation or explicit rule presentation rather it should be supplemented with auditory aids.

Keywords: Acoustic Analysis, English Phonology, Mid Vowels

Introduction

The researchers agree upon the definition of 'second language' as a language other than the mother tongue of the speaker spoken inside or outside a classroom (Ellis, 1985; Fazel, 2014). The most commonly used second language of the world is English language that has a large community of one billion non-native speakers sufficient to outnumber its native speakers (Benecke, 1991). That's why it has got the status of lingua franca. Interestingly, different varieties of English such as British English, American English, Australian English, Canadian English, and African English etc. are distinct due to their phonological system. It is a matter of great concern that, in non-native speech community such as Pakistan English is taught through explicit presentation of rules of grammar to the learners. In this technique of teaching, communicative and phonological aspect of English language is heartlessly ignored. Moreover, orthographic form of English language is focused that is misleading and misguiding for acquisition of English phonology as there is no one-to-one relationship between orthographic system and phonological system of English language. That's why production of twenty vowel sounds just by five vowel letters aggravates the difficulties of acquisition of English phonology.

Vowels in English Phonology

In phonology of any language, the use of vowels rather than the use of consonants is the most remarkable (Ladefoged & Johnson, 2011). The vocalic sounds are produced with an open approximation in oral cavity. No obstruction in the airstream flowing from the larynx to the lips in varying geometry of the pharyngeal and oral cavities is involved in their production (Roach, 2009). The sounds are classified as voiced sounds (Fromkin et al., 1999) as their voicoid egressive pulmonic airflow is periodically interrupted by frequent closure and opening of the glottis in the larynx. Daniel Jones (1917) devised a chart of the cardinal vowels which serves as a reference point for the study of the vowels.

Spectral Aspect of Vowels

The most distinctive quality of vowels is their spectral feature which reflects the part of the tongue raised during production of vowels and to what extent relative to the roof of the mouth (Algeo, 2010). However, Heinz (2011) considers the opening and closure of jaw the second spectral aspect of vowel quality instead of tongue height. Lip-rounding is the third spectral aspect of vowel quality; however, this spectral feature is related with the spectral features of tongue fronting and jaw opening. All these spectral features along with pitch and loudness are clue for distinguishing one vowel from the other.

Temporal Aspect of Vowels

Temporal aspect of vowels deals with the time during which the vowel signal remains passive in terms of other precepts (Algeo, 2010). This dimension of 'duration' distinguishes short vowels from long vowels in vowel quality. In various languages i.e. English, duration differentiates between pairs of words such as 'kneel' and 'nil'. The 'extrinsic' duration of vowels is affected by contextual factors, contrary to their 'intrinsic' duration, and 'temporal pattern of formant movements' (Lehiste, 1976) such as phonemic vowel length, Vowel height, Syllable structure, Polysyllabic words, Lexical stress, Following consonant, Domain position, Tone, and Speech rate (Ali, 2013).

Mid Vowels

There two extreme positions of the mouth for the production of vowel sounds are open and close in English phonological system. An open vowel is produced when the mandible is depressed with the low position of the tongue (Ladefoged & Johnson, 2011). Open vowels are also called low vowels. On the other hand, a closed vowel is produced when the mandible is in relative closed position than the open vowels (Algeo, 2010). There are three other categories of vowels based on the intermediate position of the mandible: open-mid vowels, mid vowels, and close-mid vowels. All these three categories of mid vowels are the focus point of this study.

Literature Review

Learning L2 phonology is emphatically studied in literature. Many scholars explored that direct instruction may help students' pronunciation (Derwing, Munro & Wiebe, 1997; 1998; Lord, 2005; Saalfeld, 2011). However, many other researchers (Carlet & Kivisto, 2018; Charles, 2014) held up that exposure to the target language community is also necessary for successful acquisition of L2 phonology. Among the first set of findings, Lord's (2005) study is noteworthy here. His investigation was about the advanced Spanish learners of English phonology after attending a course of phonetics. He observed that students' pronunciation was enhanced over the course of a semester. However, the findings of the study were not quite reliable as the study lacked in a control group for comparison of the experimental group. That's why it is uncertain whether the phonetic course had anything to do with the improvement or some other factor was responsible for the improvement. Saalfeld (2011)

conducted an experimental study with an experimental group of learners registered in a Spanish phonetic course (n = 11) and a control group of learners attending advanced Spanish courses (n = 17). All the participants were placed in the third and fourth year of Spanish courses. Their reading was recorded during the first four weeks of semester, and the final four weeks of the semester. The results reveal that the learners taking the phonetics course statistically significantly performed better than the learners in the control group, supporting the hypothesis that phonetic input affects acquisition of Spanish vowels.

Carlet and Kivistö (2018) investigated how input affected English vowels in their perception and production as L2. The learners of the target language received input of vowels in formal setting clearly instructed how to pronounce the vowels. Pre-test and post-test were administered before and after the treatment of 8 weeks. It was observed that the learners' skill to perceive vowel sounds was greatly improved. However, instructional input did not affect the learners' pronunciation of vowels significantly. This study came to conclusion that for L2 phonology acquisition to be successful, studying outside the classroom setting and instruction on phonology both are necessary.

Charles (2014) took a sample comprising of English speakers learning Spanish as L2. He divided sample into two groups: those who had spent a significant amount of time in a Spanish-speaking nation (RM) and those who had only visited a Spanish speaking nation for a brief length of time (AH). Spanish native speakers were taken as a control group to compare how the first two groups pronounced and centralised the Spanish letter /a/. Different formal and informal activities such as a short tale, a word list, and an interview were employed to examine how these groups differ in pronouncing the Spanish /a/. The study revealed that the participants who stayed in a Spanish-speaking nation (RM) for long time showed a significant difference ($p < 0.05$) between their production of the stressed /á/ and the unstressed /a/ in Spanish in informal and formal tasks. But the at-home (AH) group showed a significant difference ($p < 0.05$) between the two tokens in informal activities. The study concluded that a longer period of exposure in the target language community is beneficial for learning the target vowels. The focus of the aforementioned empirical investigations, as well as similar ones, has been on the provision of input, whether in the form of explicit phonological instructions or exposure to the target language community. The element of input consistency has never been investigated before in the context of learning L2 phonology.

Material and Methods

The current study is quantitative. A class group of 30 female learners (middle level) from a public school in District Sheikhpura, Pakistan, were taken as a sample of the study. The researchers kept some variables constant i.e gender, age, and language proficiency level to maintain some internal validity and external validity of the research. The researchers applied the structure of CVC syllable /h-v-d/ to embed the target front vowels because its phonetic context is called 'null environment' (Stevens & House, 1963). The [h] has the quality of the vowel it precedes because the configuration of the vocal tract in producing [h] is determined by adjacent sounds supplying a neutral phonetic context (Cox, 2006; Perry, Ohde, & Ashmead, 2001) to examine the effects of articulation of the sounds preceding or following [h]. Similarly, [d] is appreciated for having least anticipatory co-articulatory effect on the vowel followed by [d] except the effect of the pre-boundary voicedness on the length of the preceding vowel (Pickett, 1999). Moreover, the combination of the phonemes [h] and [d] in /hvd/ syllable assures more standardization of the syllable shape and minimizes intonational as well as co-articulatory influences (DeJoy & Barnes, 2011). In the current study, the /hvd/ syllables are head, herd, ha, hawed. These /hvd/ syllables are put in the carrier phrase 'say hvd please' to control the intonational influences, to provide the required number of tokens of each vowel, and to get the prominent acoustic properties of speech sounds (Ali, 2013; Cox, 2006).

Data Collection

The researchers collected average performance of the participants rather than tentative one by instructing them to read each carrier phrase five times in pre-test and five times in post-test. The 'hvd' syllable was preceded and followed with gaps to make the acoustic properties of the target vowel sounds prominent in clear speech. The researchers digitized the carrier phrases at 44100 Hz in PRAAT (Boersma, 2001). The average reading speed of the participants' phrases was examined as two syllables per second that was categorized as slow speech rate by Pickett (1999). A sound attenuated place was used to make recordings in the school. Distance of 20 cm was maintained between microphone and mouth. Each phrase was read 5 times for four vowels adding up six hundred tokens of English vowels ($05 \times 04 = 20 \times 30 = 600$).

Research Validity

The researchers tried to maintain external validity as well as internal validity of the study. They took an authentic class group and did not tightly control the educational environment that may result in the artificial framework in laboratory conditions affecting the external validity of the study (Clarke & Kitzinger, 2004). Moreover, they kept certain variables such as locality, age, gender constant to ensure internal validity of the research.

Data Analysis

Segmentation and Labeling

Acoustic analysis of the vowels was initiated with segmentation of hvd syllable from the carrier phrase. This lexical segmentation was guided by visual cues from the intensity curves of waveform and formant contours of spectrogram on FormantPro (Xu, 2015). The boundary of hvd syllable was marked from the fricative turbulence of /h/ and after the release of the burst of /d/ preceded and followed by pauses. When acoustic cues were not available, the auditory and visual cues from waveforms and spectrograms were relied to identify the most likely location of the approximant beginning of fricative [h] and closure and burst of [d] in the hvd syllable (Figueroa & Evans, 2015). For phonemic segmentation, the interval from the approximate onset and offset of the vowel was marked (Ali, 2013; Di Canio, 2015; Hillenbrand et al., 2001). The release of the preceding consonant /h/ accompanied by the commencement of vocal folds vibration was taken as the onset of the vowel. This clue was further supported by wave amplitude and its complexity. To mark the offset boundary of the vowels, the researchers excluded the closure of [d] phoneme focusing on three co-occurring events: a sudden decline in amplitude and complexity in waveform; variation of energy in higher formants (F2, F3, F4) in spectrogram; the onset of aperiodicity. During process of phonemic segmentation, the segmented vowel phonemes were labeled according to the categories assigned to them.

Measurement Reliability

The reliability of the measurement of data was estimated by intra-judge measurement reliability (Cox, 2006; Robb & Chen, 2009). The researchers took ten percent of the total data set (60 token of vowels) and reanalyzed them. Afterwards, the researchers calculated the mean values of the F1, F2, and Duration of the 1st and the 2nd measurement. This process led to computation of Mean Absolute Deviation of the F1, F2, and Duration values of the second measurement. The analysis show that the Mean Absolute Deviation of the F1 and F2 of vowels ranges from 0 to 15.15 Hz from the mean values. This little deviation shows the reliability of measurement of current data is within the accepted range of reliability of measurement i.e. ± 60 Hz (Monsen & Engebretson, 1983). In case of measurement reliability of duration, its MAD values range from 0 to 15.02 ms that is within acceptable boundaries of reliability of data.

Analysis of Data

The segmented sounds were imported to the Formant Pro software (Xu, 2013) that calculated average values of F1, F2, and Duration of five tokens of a vowel of thirty participants.

Results and Discussion

Table 4.1
Spectral and Temporal Values of Mid Vowels of the Pakistani Learners of English

Vowel	F1 (Hz)	F2 (Hz)	Duration (ms)
/e/	639	1716	122
/ə/	833	1391	165
/ɜ:/	682	1657	157
/ɔ:/	771	1475	168

Spectral Analysis

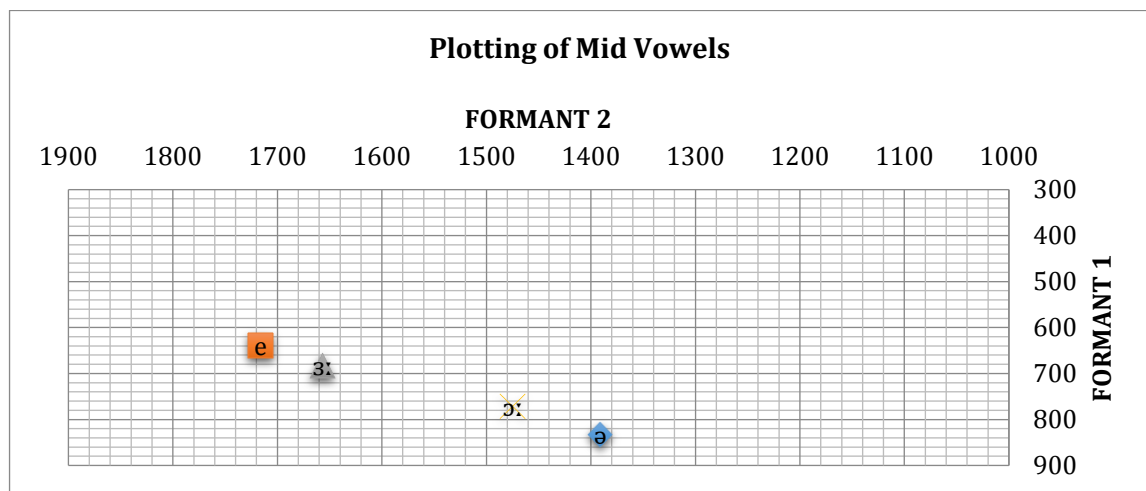


Figure 1 Graphic Representations of Spectral Values of Vowels

The analysis of the data shows that mid vowels of the Pakistani female learners of English are distinct and have their own particular patterns of articulation. The speakers articulated English vocalic sound /ə/ categorized as mid vowels (Roach, 2004) as open vowel sound. It is produced somewhat at the position of the vowel sound /a:/ on Y axis. Similarly, the vowel (/ɔ:/) categorized as back vowel in IPA is pronounced as central vowel in the data with 771 values of F1 on Y axis and 1475 values of F2 on X axis. The next vocalic sound /ɜ:/ is also observed deviant from the category assigned to it i.e. central vowel in English phonology in IPA. This central vowel is produced as a front vowel by the Pakistani learners of English. However, the front mid vowel /e/ is pronounced analogous to the native speakers of English language as a front mid vowel.

Temporal Analysis

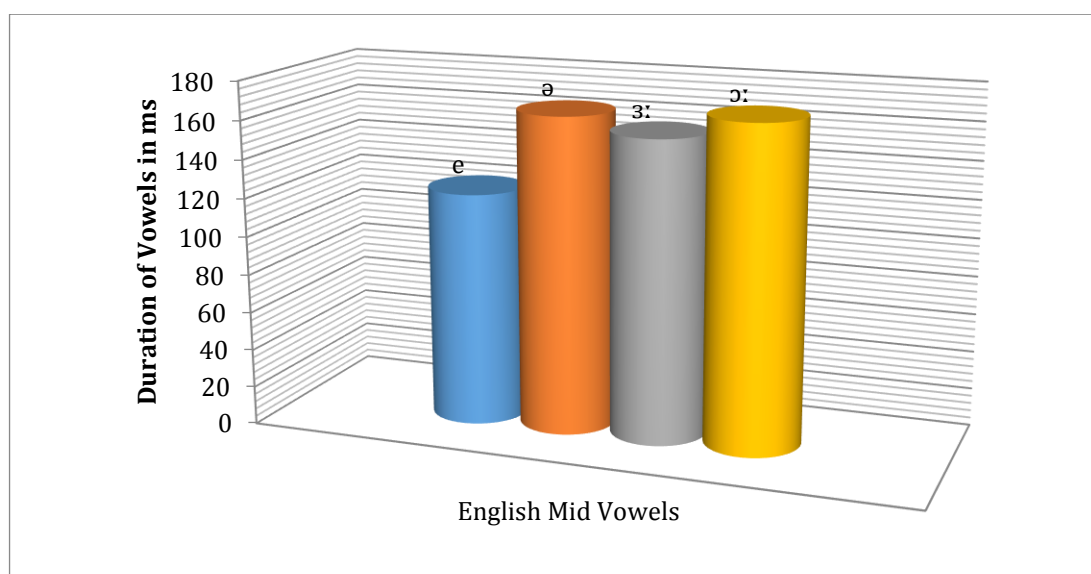


Figure 2 Graphic Representation of Temporal Values of Vowels

Parallel to spectral divergences, Duration of mid vowels is also deviant from the norm of British English. In the current pre-voiced phonetic context, the effect of the spectral values is also found on the temporal values of the vowels. The vowel sounds close in their spectral positions are also analogous in their temporal values. The vocalic sounds produced as open vowels (/ə/, /ɔ:/) have equal vowel length i.e 165 ms and 168 ms respectively. Similarly, the sounds produced as front vowels (/e/, /ɜ:/) vowel length 122 ms and 157 ms respectively.

Conclusion

The analysis of the data shows some nonlinear features of English mid vowels which have, thus far, been either unidentified or deemed inconsequential in the specification of English mid vowels. In case of English phonology as L2, the Pakistani learners of English have difficulty in pronouncing the back vowels and central vowels. Their L1 (Urdu and Punjabi) have put constraints on the acquisition of English mid vowel and central vowel phonemes inventory. The vowel sound in the data set which is articulated aligned with IPA chart is front vowel /e/. It is acquired with ease because its articulation is proverbial for them in their L1 as well. The place of articulation affected the vowel length also. The duration of the mid vowels of Pakistani speakers ranges from 122 ms to 168 ms. But Chen (1970) put his claim that vowels in pre-voiced stops phonetic context have average vowel length of 203 ms. Therefore, the vowel sounds of Pakistani speakers have shorter length than the norm.

Recommendations

The findings of the study recommend that the teaching of English should be based on phonological aspect rather than orthographic representation of language. The teaching of English as L2 should be supplemented with the auditory aids so that the learners may have access to the exact and accurate input of the English phonology. Moreover, during teaching of English phonology, the teachers should focus on the weak areas of the learners i.e. English back vowels and central vowels by highlighting dissimilarity between phonological system of their L1 and L2.

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