

Phonetic Effects of Codeswitching on the Production of English Vowels in Hinglish*

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1 INTRODUCTION

1.1 Background

English was introduced to India in the second half of the 18th century, and Indian English has since become the country's lingua franca. Despite its 'distinctive national character' (Jenkins 2003: 7), Indian English is not homogeneous, describing a collection of varieties (Balasubramanian 2009). Certain phonological features, such as the lack of the voiced dental fricative /ð/, link these varieties, but it remains important to consider the social dimension of Indian English accents (Sailaja 2009).

The influence of English in India is evident in the recent rise of Hinglish as a communicative variety (Nema & Chawla 2018). Speakers of Hinglish frequently code-switch between Hindi and English, displaying the 'alternate use of two or more languages in the same utterance' (Grosjean 2019: 142). This separates Hinglish from Indian English, a variety of English with Indian vernacular patterns (Roy 2013).

Code-switching between Hindi and English can take place at virtually any point within the utterance, presenting exceptions to proposed constraints. For example, Muysken (1997) suggests that code-switching relies on congruent lexicalisation, where two languages share a grammatical structure which can be filled lexically with elements from either language. A mismatch in constituency order blocks switching. Switches would therefore not be expected around the prepositional phrase, as these are right-branching in English but left-branching in Hindi (Romaine 1989). However, the example in (1) below from Pandit (1990) shows a Hindi prepositional phrase inserted into an English sentence.

- (1) *John gave a book* एक लड़की को
ek ladki ko
one girl to

'John gave a book to a girl.'

Hindi uses compound verb constructions (Winford 2003). Whilst in English these compound verbs are formed of a verb plus a preposition, for example in *switch on*

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or *pass over*, in Hindi most compound verbs are formed of a verb stem followed by a second conjugated verb, usually one of देना *dena* ‘to give’ लेना *lena* ‘to take’, or जाना *jana* ‘to go’. These additional verbs lose their primary meaning and add a nuance to the compound verb. In (2), it implies that the object is moving away from the subject. In (3), the doer benefits from the verb, reflecting the difference between ‘giving’ and ‘taking’. Finally, (4) suggests an irreversible change of state.

- (2) हम गाड़ी बेच देते हैं
 ham gaadee bech dete hain
 we car sell give-PTCP are
 ‘We sell the car (to someone else).’

- (3) उसने पिछली गर्मियों में तैरना सीखा लिया
 usne pichhli garmiyon mein tairnaa sikhaa liyaa
 he last summer during swim-INF learn-STEM take-PST
 ‘He learnt how to swim (for himself) last summer.’

- (4) दुर्घटना के बाद, वह पूरी तरह से बदल गयी।
 durghatana ke-baad vah pooree tarah-se badal gayee
 accident after she whole way POST change-STEM go-PST
 ‘After the accident, she changed completely.’

Compound verbs play a crucial role in the bare forms strategy used in Hinglish code-switching (Picone 1994). Many switches involve the insertion of an English verb in a bare infinitive form, followed by a conjugated form of करना ‘to do’.

- (5) वो insist करते हैं
 voh karte
 they do-PRS
 ‘They insist.’

The range of English words used in Hinglish reflects the difficulty in distinguishing between code-switching and borrowings into the lexicon of a language (Winford 2003). There is little agreement over what should be included in intrasentential code-switching, specifically concerning the status of single-word insertional switches as in (5) (Winford 2003: 102). Poplack & Meechan (1995: 200) exclude single-word switches from intrasentential code-switching and refer to them as ‘nonce borrowings’, arguing that only entire constituents can be code-switched. On the other hand, Myers-Scotton (1993: 3) does include single-word switches in her Matrix Language Frame (MLF) model, suggesting that intrasentential code-switching occurs via the ‘selection [...] of forms from an embedded variety [...]

in utterances of a matrix variety'. This gives rise to mixed constituents, Matrix Language (ML) islands, and Embedded Language (EL) islands - which can consist of a single word. The MLF model implies that one language is dominant in code-switching, and its status as the chief model of insertional code-switching justifies the use of single-word switches in the present study (Winford 2003).

1.2 *Phonetic effects of code-switching*

There is a widespread assumption that, in contrast to borrowing, code-switched utterances represent a sudden shift between the phonological systems of each language. However, the existence of a code-switching-borrowing continuum means that code-switched utterances arguably show varying levels of convergence between the two languages. These phonetic effects of code-switching remain under-investigated (Bullock 2009).

In an early study, Caramazza, Yeni-komshian, Zurif & Carbone (1973) demonstrated that although Canadian French-English bilinguals maintain separate voice onset times (VOTs) in each of their languages, their productions were different from those of monolinguals in the two languages. This suggests that there are phonetic effects, while phonological categories remain distinct. Balukas & Koops (2015) conducted another study involving VOT, investigating productions of bilingual English-Spanish speakers from New Mexico. In English code-switches, the speakers shifted towards Spanish VOT, but the opposite effect did not occur. This asymmetry potentially reflects efforts to keep the languages distinct in an anglophone country.

For studies with languages such as Hindi which have a four-way stop contrast, comparing VOTs becomes extremely difficult. Hauser (2021) argues that a single VOT continuum cannot account for languages which distinguish aspirated and unaspirated voiced and voiceless stops. Therefore, more recent studies have focused on the production of vowels, allowing for a more robust comparison between crosslinguistic findings. Investigating English-Spanish bilinguals, Olson (2012) showed that f_0 and duration increased in a code-switched context. He links this to Lindblom's (1990) Hyper- and Hypoarticulation Theory, suggesting that code-switches exhibit hyperarticulation because they are less predictable in discourse. Muldner, Hoiting, Sanger, Blumenfeld & Toivonen (2019) also found that the duration increased in code-switched vowels for English-French bilinguals, with English vowels having a higher f_0 in a code-switched context. However, the opposite was true for French vowels. Olson (2012: 453) highlights the need to investigate different language pairings, as hyperarticulation may not occur where linguistic and social factors make code-switching highly predictable.

The formants of vowels did not shift significantly in English-French code-switching contexts, indicating that vowels behave like consonants and do not shift categorically (Muldner et al. 2019: 44). However, the phonetic effects of code-switching on vowel formants may not be uniform across speakers (Bullock & Toribio 2012). This is arguably an area where it is useful to look at the productions of individual participants before generalising across the population. Another study involving

English-Korean bilinguals found that code-switched English vowels shifted in the direction of Korean vowels in height and backness, with a greater degree of shift for intrasentential code-switching than intersentential code-switching (Seo & Olson 2024). Therefore, upon examination of F_1 and F_2 frequencies, f_0 , and duration of vowels, certain languages are linked to stronger phonetic effects of code-switching than others.

1.3 The present study

The present study investigates the effect of code-switching on the frequency of F_1 and F_2 , f_0 , and duration of two monophthongs, /æ/ and /ɒ/, and two diphthongs, /əʊ/ and /eɪ/, in Hinglish. The four vowels selected are not phonemes in standard Hindi, but are in English. The contrast between /æ/ and /ɛ/ is allophonic in Hindi and can be neutralised (Chaturvedi 1973). Hindi /ɔ/ is both longer and higher than English /ɒ/ (Chaturvedi 1973). Hindi also possesses the nasalised /õ/, which is slightly lower, approaching English /ɒ/. Since English does not have phonemic nasal vowels, the contrast between /ɔ/ and /ɒ/ can be neutralised in Indian English. This suggests that when /æ/ and /ɒ/ are produced in a code-switched context, they shift towards /ɛ/ and /ɔ/ respectively.

This study differs from previous studies by including diphthongs in the vowels of interest. Southern Standard British English (SSBE) has 8 primary diphthongs (Sailaja 2009). Whilst standard Hindi does not have diphthongs, speakers of eastern varieties may use /eɪ/ and /oɪ/. Nevertheless, Hindi uses the Devanagari writing system, where it is impossible to juxtapose two vowel symbols without implying two syllables (Chaturvedi 1973). The two diphthongs /eɪ/ and /əʊ/ were selected since they are often monophthongised in Indian English to give /e:/ and /o:/, even for speakers who have acquired the other six diphthongs (Sailaja 2009). This suggests that under an ML influence, phonetic effects of code-switching would manifest via an increased monophthongisation in a code-switched context.

2 HYPOTHESES

The above discussion leads to the following hypotheses:

- i. Vowels will have a higher f_0 in code-switched contexts than monolingual contexts.
 - English vowels in a Hindi ML context will follow the pattern of the English vowels in a French ML context, as suggested by Muldner et al. (2019).
- ii. Vowels will have a longer duration in code-switched contexts than monolingual contexts, as their lower predictability in the linguistic context will lead to hyperarticulation.
- iii. Monophthongs will display significantly different F_1 and F_2 frequency values in code-switched contexts, compared to monolingual contexts.

- For /æ/, the frequency of F₂ will be higher in a code-switched context as the vowel will be fronted to approach Hindi /ɛ/. F₁ frequency may also be lowered due to the vowel being raised.
 - For /ɔ/, the frequency of F₁ will be lower in a code-switched context as the vowel will be raised to approach Hindi /ɔ/. A significant shift in F₂ frequency is not expected.
- iv. Diphthongs /əʊ/ and /eɪ/ will display significantly less change in F₁ and F₂ frequency values during the vowel in code-switched contexts, compared to monolingual contexts, indicating a greater degree of monophthongisation with the diphthongs approaching /o:/ and /e:/ respectively.

3 METHODS

The tokens for this study were taken from interviews conducted with two Bollywood actors: Shah Rukh Khan (hereafter SRK) and Kajol. These two actors were chosen because they are of a similar age and have both been in the film industry for a similar length of time. This means that they both have a similar amount of experience speaking English on an international stage, to the extent that they are both fully bilingual. For each actor, two interviews were analysed: one English interview where the target speaker was speaking to a native speaker of English, and one Hinglish interview where the target speaker was speaking to a native speaker of Hindi.

In the English interviews, SRK's interlocutor was David Letterman, an American TV host and presenter, and Kajol's interlocutor was Haroon Rashid, a Senior Entertainment Journalist at the BBC presenting with the BBC Asian Network. During these interviews, there was no sign that either interlocutor was adjusting their speech or mannerisms to accommodate for a non-native speaker of English. Both Hinglish interviews were conducted on the show *Aap ki Adalat* ('Your Court'), hosted by Indian journalist Rajat Sharma. All interviews were filmed between 2016 and 2019. The Hinglish interviews were approximately 50 minutes long, whilst the English interviews were between 25 and 35 minutes. A total of 313 vowel tokens were extracted, with [Table 1](#) showing their distribution.

Most vowels provided sufficient tokens in the Hinglish interviews to compare their production in a code-switched versus monolingual context. The exception was /əʊ/ for SRK, for which there were only 6 appropriate code-switched tokens available in the data. Although this small sample size limits the conclusions which can be drawn for this vowel for SRK, the results are included for completeness.

Some English words such as *helicopter* were used because there is no Hindi equivalent; these are borrowings into the lexicon rather than code-switches. Furthermore, many occupations such as *psychiatrist* are expressed in English because the Hindi term is rare and archaic (Sailaja 2011). Therefore, only code-switched tokens with a common Hindi equivalent were selected.

[Table 2](#) shows a sample of code-switched tokens used, with words assessed as code-switches rather than borrowings because there is a common Hindi equivalent.

Vowel	SRK		Kajol		Total
	English	Hinglish	English	Hinglish	
/æ/	23	31	26	23	103
/ʊ/	20	16	20	13	69
/əʊ/	16	6	20	19	61
/eɪ/	21	16	26	17	80
Total	80	69	92	72	313

Table 1 A summary of the number of tokens extracted from SRK and Kajol’s interviews, divided by linguistic context and vowel.

Monophthongs		Diphthongs	
/æ/	/ʊ/	/eɪ/	/əʊ/
<i>and</i>	<i>possible</i>	<i>fail</i>	<i>know</i>
<i>actually</i>	<i>wrong</i>	<i>player</i>	<i>hope</i>
<i>passion</i>	<i>shock</i>	<i>lazy</i>	<i>so</i>
<i>arrogant</i>	<i>job</i>	<i>day</i>	<i>only</i>
<i>family</i>	<i>pocket</i>	<i>neighbour</i>	<i>stove</i>

Table 2 A sample of the code-switched tokens used in the study for each of the four vowels investigated.

Praat was used to take measurements (Boersma & Weenink 2010). Figure 1 and Figure 2 show the data collection process. The formant ceiling was set to 5000Hz for SRK and 5500Hz for Kajol. Each vowel token’s f_0 value was measured at the midpoint and corroborated by finding the inverse of the wave’s time period. There were a range of neighbouring segmental contexts. To find the beginning and end of each vowel and measure duration, cues such as formant transitions, voicing pulses, and formant intensity were assessed; these were useful when there were adjacent voiced approximants or nasals.

For the monophthongs /æ/ and /ʊ/, the first two formant values were measured at the midpoint. For the diphthongs /eɪ/ and /əʊ/, changes in F_1 and F_2 frequencies during the diphthongs were found using *Praat*’s Formant Listing feature. Changes in F_1 and F_2 frequencies were used to compare the extent of diphthongisation in a monolingual versus code-switched context.

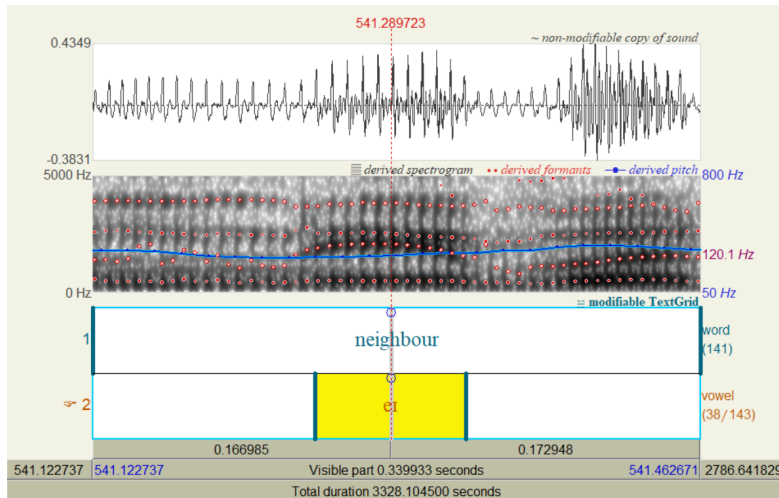


Figure 1 A screenshot of *Praat* showing the midpoint of /eɪ/ in the token ‘neighbour’.

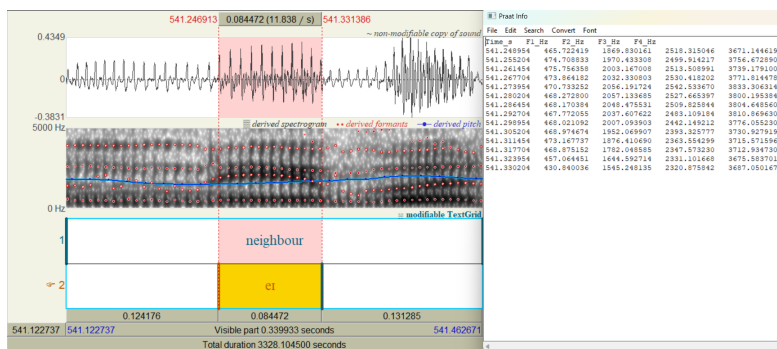


Figure 2 A screenshot of *Praat* showing the duration of the diphthong, as well as the formant listings used to find the differences in F_1 and F_2 . The start of the diphthong is marked by the darkening of the formants and raising of F_2 frequency, whilst the end is marked by the closure preceding the subsequent plosive.

Kajol often code-switched before a pause and stressed code-switched words, which is linked to increased f_0 and duration (Ladefoged 2014). These tokens were discounted, with every effort made to ensure code-switched tokens were taken from a fluent passage of speech. Tokens taken from larger embedded-language islands, where speakers had code-switched for a whole phrase or sentence, were also excluded. Kajol performed extended switches much more frequently than SRK. SRK sometimes used set expressions in Hinglish code-switching (Sailaja 2009) such as *I think* but generally used more Hindi than Kajol.

All statistical analyses were performed using *R* Statistical Software (R Core Team 2021). A total of 32 two-sample independent *t*-tests were used to compare the means of the monolingual and code-switched values for F_1 and F_2 frequencies, f_0 , and duration of the four vowels in the two speakers. Even though some hypotheses were predictions in a certain direction, these *t*-tests were two tailed by default. A

two-tailed test is more rigorous as it ensures that a result is only significant if it falls within the top or bottom 2.5% of the probability distribution, rather than the value of 5% for a one-tailed test.

4 RESULTS

4.1 Monophthongs

4.1.1 F_1 and F_2 frequency values

Figure 3 and Figure 4 show the distribution of F_1 and F_2 frequency values for /æ/ and /ɒ/ in a code-switched and monolingual context for the two actors, with means plotted for the four subsets of data.

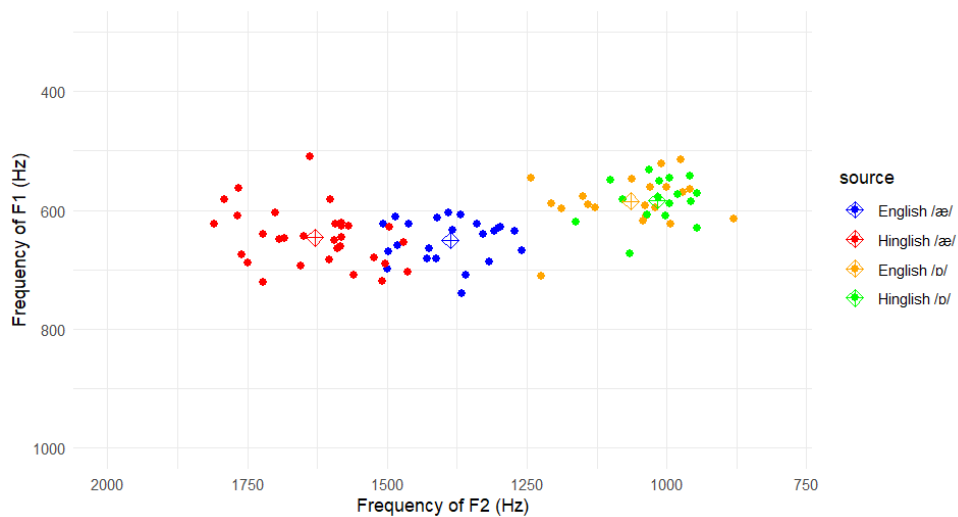


Figure 3 Scatterplot showing F_1 and F_2 frequency values for SRK for English /æ/, Hinglish /æ/, English /ɒ/ and Hinglish /ɒ/.

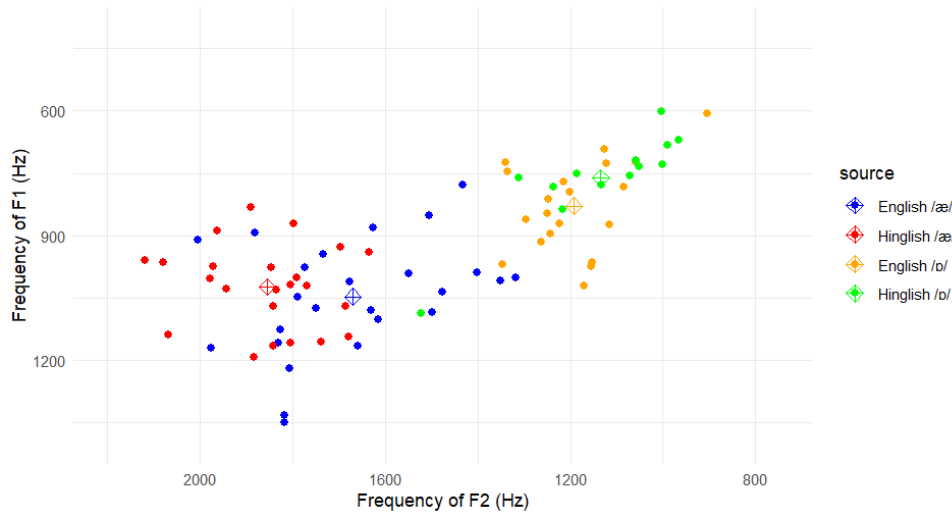


Figure 4 Scatterplot showing F_1 and F_2 frequency values for Kajol for English /æ/, Hinglish /æ/, English /ɒ/ and Hinglish /ɒ/.

Both [Figure 3](#) and [Figure 4](#) show the expected distribution of the monophthongs with respect to the vowel quadrilateral. In general, /æ/ is further forward than /ɒ/. Kajol's formants show greater spread.

Results of the t -tests conducted to compare the means of F_1 and F_2 frequency for /æ/ and /ɒ/ for SRK are shown in [Table 3](#). Significant p -values are shown in bold.

Vowel and Formant	English Mean (SD)	Hinglish Mean (SD)	t -statistic	d.f.	p -value	
/æ/	F_1 (Hz)	650.8 (36.1)	645.8 (47.7)	0.44	52	0.663
	F_2 (Hz)	1386.9 (77.0)	1629.3 (98.8)	-10.13	52	<0.001
/ɒ/	F_1 (Hz)	585.1 (42.4)	583.8 (37.3)	0.09	34	0.925
	F_2 (Hz)	1064.7 (99.9)	1017.6 (60.3)	1.75	32	0.090

Table 3 Results of independent t -tests comparing SRK's mean F_1 and F_2 frequency values for /æ/ and /ɒ/, showing the mean and standard deviation of each group, followed by t -statistics, degrees of freedom, and p -values.

Results of the t -tests conducted to compare the means of F_1 and F_2 frequency values for /æ/ and /ɒ/ for Kajol are shown in [Table 4](#). Significant p -values are shown in bold.

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Vowel and Formant	English Mean (SD)	Hinglish Mean (SD)	<i>t</i> -statistic	d.f.	<i>p</i> -value	
/æ/	F ₁ (Hz)	1047.8 (139.2)	1023.7 (101.0)	0.69	44	0.493
	F ₂ (Hz)	1670.1 (190.3)	1855.3 (132.1)	-3.94	43	<0.001
/ɒ/	F ₁ (Hz)	828.6 (109.6)	760.9 (114.4)	1.69	25	0.104
	F ₂ (Hz)	1192.5 (108.4)	1134.5 (158.6)	1.15	19	0.262

Table 4 Results of independent *t*-tests comparing Kajol’s mean F₁ and F₂ frequency values for /æ/ and /ɒ/, showing the mean and standard deviation of each group, followed by *t*-statistics, degrees of freedom, and *p*-values.

Table 3 and Table 4 corroborate with the increased spread in Figure 4 compared to Figure 3, as standard deviations were consistently higher for Kajol than for SRK. The same trends were observed for both actors. The mean F₂ frequency for English /æ/ was significantly lower than for Hinglish /æ/. The mean F₁ frequency for English /æ/ was marginally greater than for Hinglish /æ/, shown by the similar height of each pair of means in Figure 3 and Figure 4. F₁ and F₂ frequencies for English /ɒ/ were higher than their Hinglish equivalents, although this difference was not significant.

4.1.2 *f*₀ and Duration

Figure 5 and Figure 6 show *f*₀ and duration of /æ/ and /ɒ/ for SRK in a monolingual and code-switched context, with the mean and outliers marked.

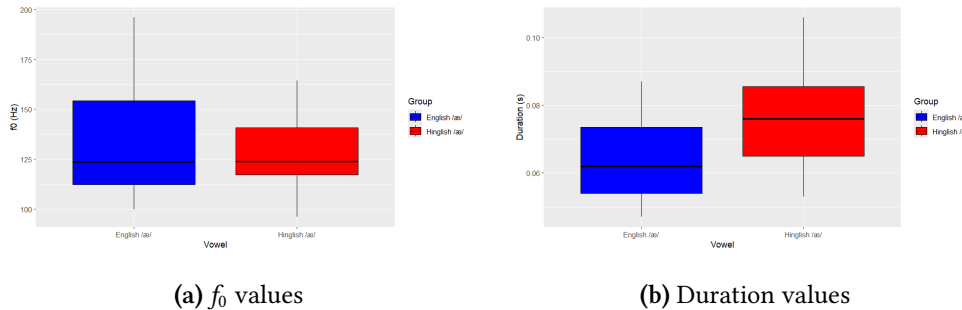


Figure 5 Boxplots showing the *f*₀ and duration values of /æ/ for SRK in monolingual and code-switched contexts.

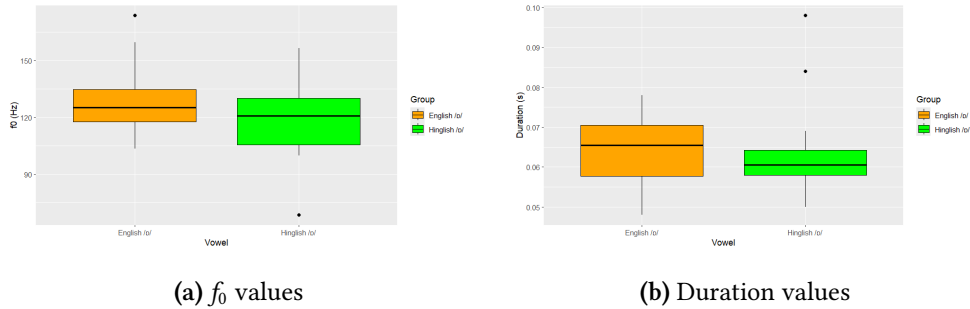


Figure 6 Boxplots showing the f_0 and duration values of /ɒ/ for SRK in monolingual and code-switched contexts.

For SRK, Hinglish /æ/ ($M = 76\text{ms}$) was significantly longer than English /æ/ ($M = 66\text{ms}$) ($p = 0.001$). There was no significant difference found between the f_0 of monolingual and code-switched /æ/ or /ɒ/. English /ɒ/ ($M = 66\text{ms}$) was slightly longer than Hinglish /ɒ/ ($M = 63\text{ms}$), though this difference was not significant ($p = 0.909$).

Figure 7 and Figure 8 show the f_0 and duration of /æ/ and /ɒ/ for Kajol in a monolingual and code-switched context, with the mean and outliers marked.

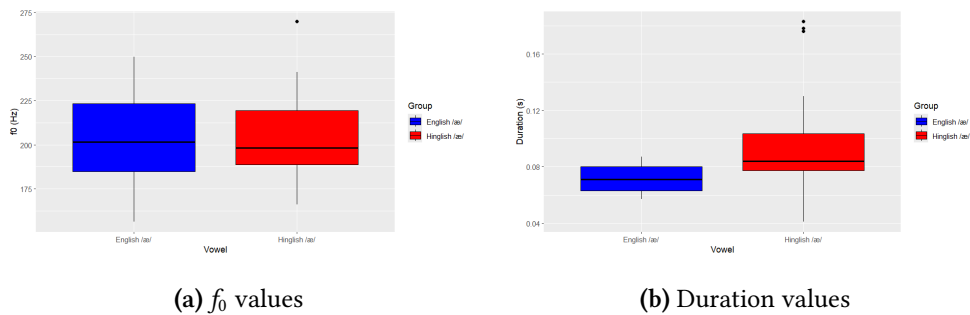


Figure 7 Boxplots showing the f_0 and duration values of /æ/ for Kajol in monolingual and code-switched contexts.

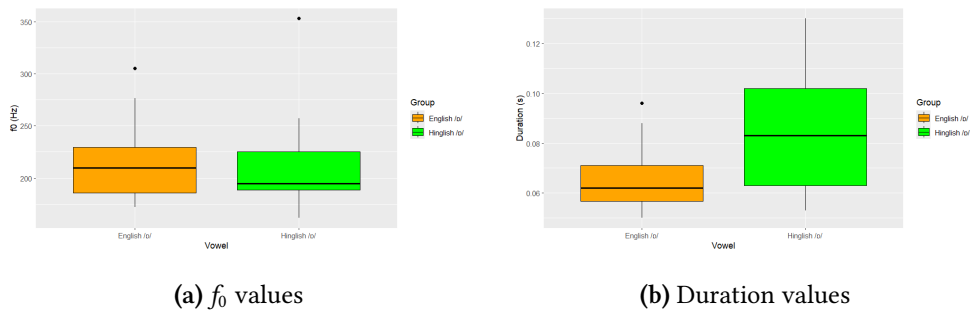


Figure 8 Boxplots showing the f_0 and duration values of /ɒ/ for Kajol in monolingual and code-switched contexts.

For Kajol, Hinglish /æ/ ($M = 97\text{ms}$) was significantly longer than English /æ/ ($M = 72\text{ms}$) ($p = 0.005$), and Hinglish /ɒ/ ($M = 83\text{ms}$) was significantly longer than

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English /ɒ/ ($M = 66\text{ms}$) ($p = 0.027$). There was no significant difference in f_0 of either vowel in a monolingual versus code-switched context.

To summarise, code-switched /æ/ shows a significant shift in F_2 and longer duration than monolingual /æ/. For Kajol, code-switched /ɒ/ was also longer than monolingual /ɒ/.

4.2 Diphthongs

4.2.1 Diphthongisation measure

Figure 9 and Figure 10 show the change in F_1 and F_2 frequencies during /əʊ/ and /eɪ/ for SRK.

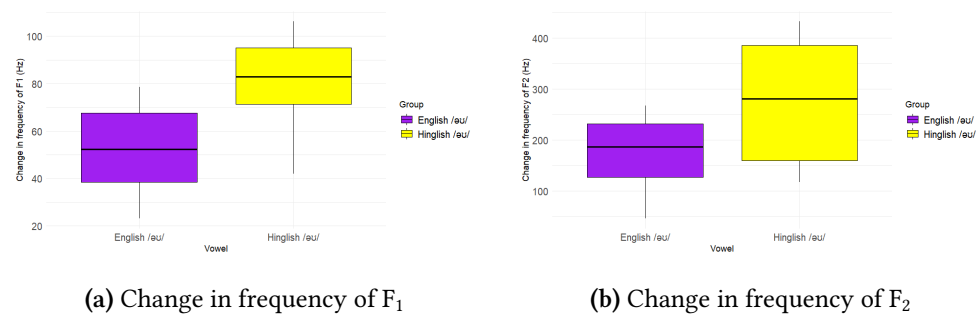


Figure 9 Boxplots showing change in F_1 and F_2 frequency during /əʊ/ for SRK in monolingual and code-switched contexts.

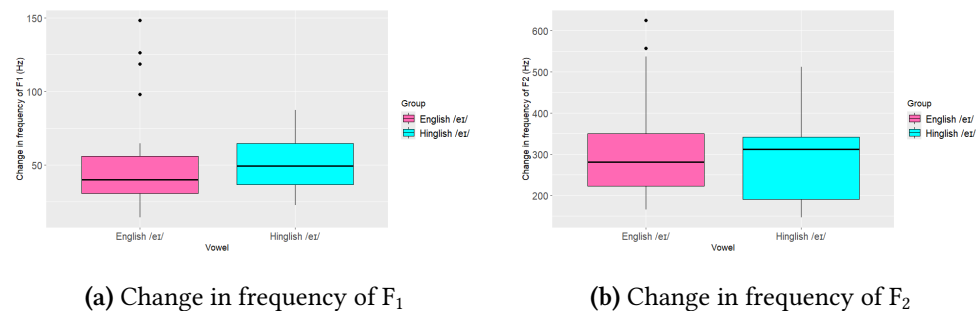


Figure 10 Boxplots showing change in F_1 and F_2 frequency during /eɪ/ for SRK in monolingual and code-switched contexts.

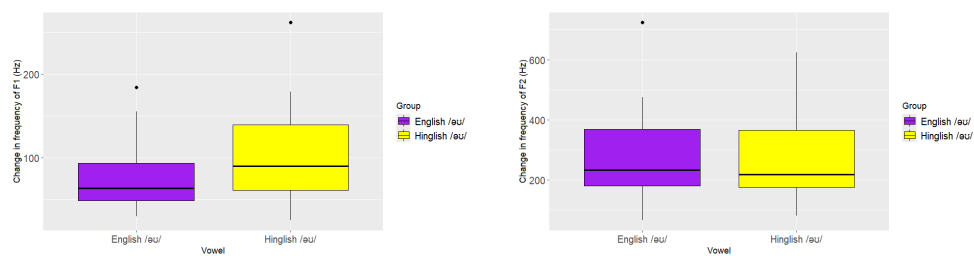
Results of t -tests conducted to compare the means of changes in F_1 and F_2 for /əʊ/ and /eɪ/ for SRK are shown in Table 5. Significant p -values are shown in bold.

Vowel and Formant	English Mean (SD)	Hinglish Mean (SD)	<i>t</i> -statistic	d.f.	<i>p</i> -value	
/əʊ/	Change in F ₁ (Hz)	52.6 (17.7)	80.1 (23.0)	-2.65	7	0.032
	Change in F ₂ (Hz)	173.9 (62.7)	275.2 (135.3)	-1.76	6	0.130
/eɪ/	Change in F ₁ (Hz)	53.6 (37.3)	50.8 (18.2)	0.29	30	0.771
	Change in F ₂ (Hz)	317.1 (130.3)	295.5 (102.3)	0.56	35	0.576

Table 5 Results of independent *t*-tests comparing SRK's mean differences in the change of F₁ and F₂ frequencies during /əʊ/ and /eɪ/, showing the mean and standard deviation of each group, followed by *t*-statistics, degrees of freedom, and *p*-values.

For SRK, the statistically significant result concerning the change of F₁ and the relatively low *p*-value for the change in F₂ for the diphthong /əʊ/ cannot be verified due to the very small sample of code-switched tokens obtained, which led to a low figure for the degrees of freedom in the *t*-test. Therefore, there were no significant differences in the mean differences in F₁ or F₂ frequencies for /əʊ/ and /eɪ/.

Figure 11 and Figure 12 show the change in F₁ and F₂ frequencies during /əʊ/ and /eɪ/ for Kajol.



(a) Boxplot of the change in frequency of F₁ during English /əʊ/ and Hinglish /əʊ/ for Kajol.

(b) Boxplot of the change in frequency of F₂ during English /əʊ/ and Hinglish /əʊ/ for Kajol.

Figure 11 Boxplots showing change in F₁ and F₂ frequency during /əʊ/ for Kajol in monolingual and code-switched contexts.

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(a) Boxplot of the change in frequency of F₁ during English /eɪ/ and Hinglish /eɪ/ for Kajol. (b) Boxplot of the change in frequency of F₂ during English /eɪ/ and Hinglish /eɪ/ for Kajol.

Figure 12 Boxplots showing change in F₁ and F₂ frequency during /eɪ/ for Kajol in monolingual and code-switched contexts.

Results of *t*-tests conducted to compare the means of changes in F₁ and F₂ for /əʊ/ and /eɪ/ for Kajol are shown in [Table 6](#).

Vowel and Formant		English Mean (SD)	Hinglish Mean (SD)	<i>t</i> -statistic	d.f.	<i>p</i> -value
/əʊ/	Change in F ₁ (Hz)	74.4 (30.9)	101.5 (60.4)	-1.57	27	0.127
	Change in F ₂ (Hz)	275.6 (158.9)	262.1 (144.3)	0.27	34	0.788
/eɪ/	Change in F ₁ (Hz)	69.9 (43.1)	74.8 (42.9)	0.36	34	0.717
	Change in F ₂ (Hz)	300.4 (150.1)	359.0 (133.1)	-1.34	37	0.187

Table 6 Results of independent *t*-tests comparing Kajol’s mean differences in the change of F₁ and F₂ frequencies during /əʊ/ and /eɪ/, showing the mean and standard deviation of each group, followed by *t*-statistics, degrees of freedom, and *p*-values.

For Kajol, although the change in F₁ frequency during /əʊ/ and the change in F₂ frequency during /eɪ/ were higher in a code-switched than in a monolingual context, these differences were not significant. Therefore, there were no significant differences in the mean differences in F₁ or F₂ frequencies for /əʊ/ and /eɪ/.

4.2.2 *f*₀ and Duration

[Figure 13](#) and [Figure 14](#) show the *f*₀ and duration of /əʊ/ and /eɪ/ for SRK in a monolingual and code-switched context, with the mean and outliers marked.

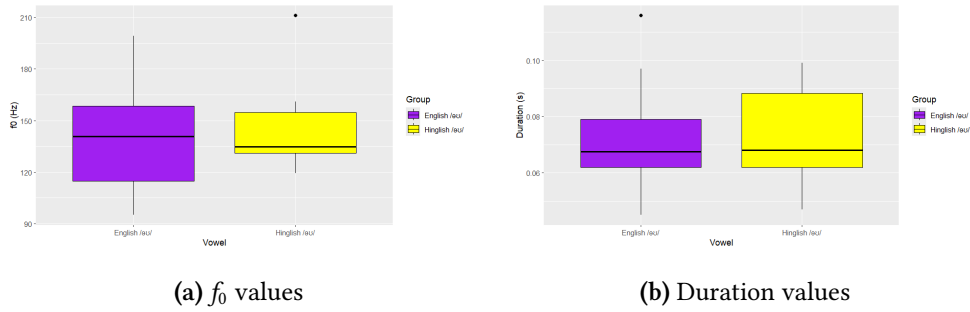


Figure 13 Boxplots showing f_0 and duration values of /əʊ/ for SRK in monolingual and code-switched contexts.

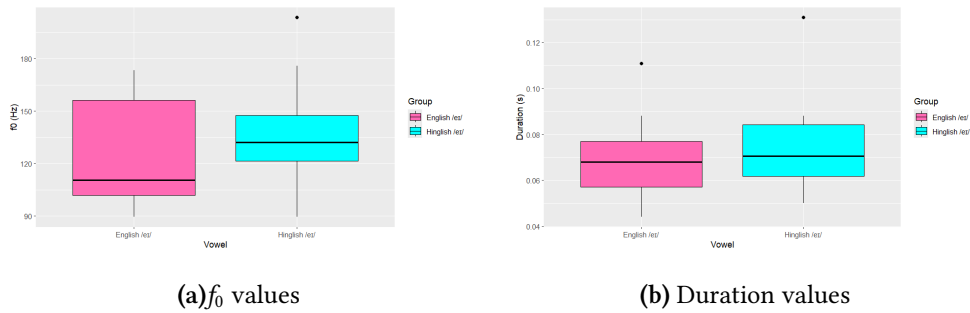


Figure 14 Boxplots showing f_0 and duration values of /eɪ/ for SRK in monolingual and code-switched contexts.

Results of t -tests conducted to compare the means of f_0 and duration for /əʊ/ and /eɪ/ for SRK are shown in [Table 7](#).

	Vowel	English Mean (SD)	Hinglish Mean (SD)	t -statistic	d.f.	p -value
/əʊ/	f_0 (Hz)	140.1 (32.1)	148.6 (38.6)	-0.53	9	0.609
	Duration (ms)	71 (19)	73 (20)	-0.17	9	0.870
/eɪ/	f_0 (Hz)	123.6 (28.1)	137.2 (27.4)	-1.48	33	0.148
	Duration (ms)	68 (15)	74 (20)	-1.06	27	0.297

Table 7 Results of independent t -tests comparing SRK's mean f_0 and duration values for /əʊ/ and /eɪ/, showing the mean and standard deviation of each group, followed by t -statistics, degrees of freedom, and p -values.

For SRK, f_0 and duration for both diphthongs were higher in a code-switched context than in a monolingual context. However, these differences were not significant.

[Figure 15](#) and [Figure 16](#) show the f_0 and duration of /əʊ/ and /eɪ/ for Kajol in a monolingual and code-switched context, with the mean and outliers marked.

Phonetic Effects of Codeswitching on the Production of English Vowels in Hinglish

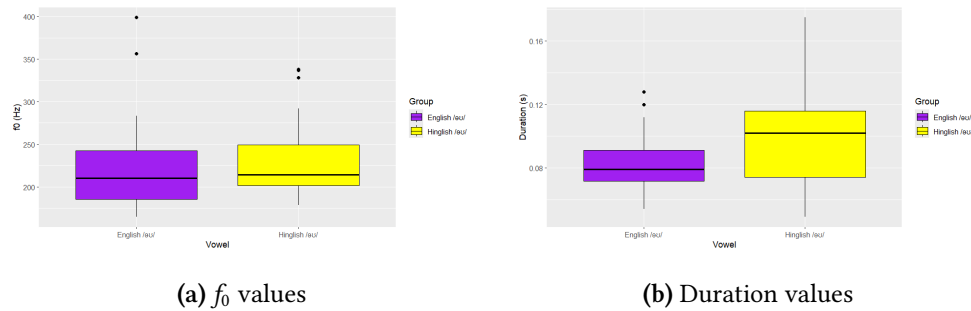


Figure 15 Boxplots showing f_0 and duration values of /əʊ/ for Kajol in monolingual and code-switched contexts.

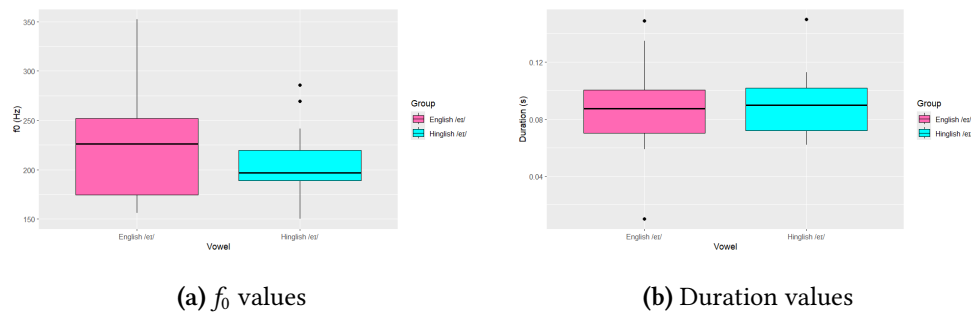


Figure 16 Boxplots showing f_0 and duration values of /eɪ/ for Kajol in monolingual and code-switched contexts.

Results of t -tests conducted to compare the means of f_0 and duration for /əʊ/ and /eɪ/ for Kajol are shown in [Table 8](#).

	Vowel	English Mean (SD)	Hinglish Mean (SD)	t -statistic	d.f.	p -value
/əʊ/	f_0 (Hz)	228.4 (60.2)	235.8 (53.7)	-0.39	35	0.695
	Duration (ms)	84 (20)	103 (36)	-2.01	24	0.056
/eɪ/	f_0 (Hz)	223.2 (51.0)	207.8 (33.6)	1.20	41	0.237
	Duration (ms)	89 (29)	89 (22)	-0.09	45	0.931

Table 8 Results of independent t -tests comparing Kajol's mean f_0 and duration values for /əʊ/ and /eɪ/, showing the mean and standard deviation of each group, followed by t -statistics, degrees of freedom, and p -values.

For Kajol, f_0 and duration of /əʊ/ was greater in a code-switched context than in a monolingual context, although these differences were not significant. f_0 of /eɪ/ was slightly higher in English than in Hinglish, whilst duration values were nearly identical.

To summarise, for the diphthongs, there were no statistically significant differences in the changes in F_1 and F_2 frequencies, f_0 , or duration between a monolingual and code-switched context for either actor.

5 DISCUSSION

5.1 Monophthongs

Figure 3 and Figure 4 show that /ɒ/ is generally produced higher in the mouth than for British English speakers, in line with expectations from a comparison of Hindi and English phonology (Chaturvedi 1973). The higher standard deviations for Kajol along with the higher spread in Figure 4 support the findings of Kwon (2010), who demonstrated that female speakers tend to have a greater spread in F_1 and F_2 than male speakers.

Furthermore, both speakers showed the expected shift in F_2 frequency for /æ/, indicating that they produce a vowel closer to /ɛ/ in a code-switched context. This shows strong support for Hypothesis 3 concerning shifts in formant frequencies of code-switched vowels and is a significant finding compared to previous studies, of which only Seo & Olson (2024) observed a difference in vowel quality due to code-switching. Neither actor displayed significant shift of F_1 or F_2 frequency in /ɒ/, perhaps indicating that the presence of /ĩ/ in Hindi inhibits the acquisition of /ɒ/ in Indian English compared to /æ/. Hindi's nasal vowels could be linked to the near identical means of F_1 frequency of English /æ/ and Hinglish /æ/ in both actors; since nasal vowels are generally lower than oral vowels, /ĩ/ is closer to /æ/ than /ɛ/ (Chaturvedi 1973). Speakers may therefore maintain a difference between /æ/ and /ĩ/ by not adjusting the height of /æ/ in a code-switched context.

Both SRK and Kajol produced longer /æ/ in a code-switched context. This provides strong support for Hypothesis 2 concerning the increased length of code-switched vowels, and suggests that /æ/ in particular exhibits stronger phonetic effects from code-switching compared to vowels examined in previous studies. For /ɒ/, Kajol displayed the expected increase in duration in a code-switched context, but SRK did not, with his monolingual /ɒ/ being slightly longer, albeit with increased spread in values. There were no significant findings regarding f_0 , suggesting that the premise in Hypothesis 1 can be rejected. Olson (2012) observes that measuring the midpoint of the vowel in the embedded word might obscure the influence of the ML on the intonation contour, and that it may be better to examine the embedded word in the context of the entire phrase instead of in isolation to better see the effect of code-switching on f_0 .

5.2 Diphthongs

Hypothesis 4 suggests that diphthongs pronounced in a code-switched context will exhibit less diphthongisation. However, Figure 9 to Figure 12 show that, conversely to the prediction of Hypothesis 4, there was slightly more diphthongisation in Hinglish diphthongs than in English diphthongs. The results of the t -tests in Table 5 and Table 6 confirm that these differences were not significant. The premise in Hypothesis 4 can therefore be rejected. The general trend observed suggests that there is scope for future studies to examine whether there is an EL influence on the production of diphthongs.

There were no other statistically significant findings for f_0 or duration for the diphthongs in either actor, suggesting that code-switching was more predictable in these contexts, preventing hyperarticulation (Olson 2012). Nevertheless, for Kajol, the duration of /əʊ/ was longer in a code-switched context, approaching significant status with a p -value of 0.056. Obtaining more tokens for this vowel in future studies would allow for a more complete comparison between participants.

6 LIMITATIONS

The primary limitation of this study was the use of secondary data; similar studies examining phonetic effects of code-switching in different language pairs collected primary data from participants. In particular, there was little control over tokens extracted from the Hinglish interviews. As previously stated, SRK only produced 6 suitable code-switched tokens containing /əʊ/; despite obtaining statistically significant results for the change in F_1 , firm conclusions could not be drawn for this vowel.

Furthermore, tokens were not controlled for the consonants surrounding the vowels. There was little consistency regarding the presence of consonants in the onset and coda. In particular, liquids and nasals affect vowel formants more than stops. Taking initial F_1 and F_2 values for diphthongs slightly after the start of the vowel, and ending values slightly before the end of the vowel, ensuring that only stops were permitted in onsets or codas of syllables of interest, would help mitigate this effect.

The crosslinguistic lengthening of vowels before voiced consonants compared to voiceless consonants is another motivation to better control tokens in future studies (Chen 1970). This phenomenon was observed in English by House & Fairbanks (1953) and Peterson & Lehiste (1960). In English, pre-fortis clipping (the shortening of vowels before a voiceless consonant) is an important perceptual cue to consonant voicing, as final consonants are widely devoiced. Hindi has a four-way stop contrast, leading to three increments of vowel length (Maddieson & Gandour 1975). Vowels are shortest before plain voiceless stops, /p t k/. Vowels before plain voiced /b d g/ and aspirated voiceless stops /p^h t^h k^h/ are longer. Vowels before murmured stops /b^h d^h g^h/ are longest of all, as both voicing and aspiration add one increment of length. In future studies, the interaction between code-switched vowel duration and the following consonant could be explored, particularly to see how the three-tier vowel length variation in Hindi maps onto the two tiers in English and vice versa.

Moreover, in this study, only one direction of code-switching (with Hindi as the ML) was explored. A future primary study could involve devising a corpus with Hindi words inserted into English ML sentences, investigating whether Hindi vowels also shift towards English vowels in a code-switched context, or whether the effect is asymmetric similar to the Balukas & Koops (2015) study.

Although the actors will have partially prepared their answers, the interview data used in this study was more spontaneous than lab-elicited speech. Documented differences between spontaneous and lab speech include a tendency for

hyperarticulation in the latter (Van Summers, Pisoni, Bernacki, Pedlow & Stokes 1988) and (Harnsberger, Wright & Pisoni 2008). Furthermore, in a study looking at F_1 and F_2 in Yoloxóchitl Mixtec, an endangered language spoken in Mexico, Di-Canio, Nam, Amith, García & Whalen (2015) found that there was more variability in spontaneous than elicited speech. Therefore, whilst most primary studies use lab data, this may understate the extent of the phonetic effect (Bullock 2009). Conversely, the use of elicited speech in studies may overstate the extent to which code-switched segments are hyperarticulated. A challenge for future studies in this area is how best to navigate the balance between spontaneous and lab data. It is extremely difficult to devise a study using spontaneous primary data, particularly when aiming to gather insertional code-switched tokens. A prepared corpus also ensures that each vowel of interest appears in the same number of tokens, preventing the disparity seen in this study.

7 CONCLUSION

This study explored the phonetic effects of code-switching in the speech of two Hindi-English bilingual Bollywood actors. The first two formant frequencies, f_0 , and duration values of /æ/, /ɒ/, /əʊ/, and /eɪ/ in a monolingual English versus Hinglish code-switching context were examined. Findings showed that code-switched /æ/ both shifted towards the Hindi phonological system under a matrix language influence and was lengthened, supporting the hypothesis of code-switching leading to hyperarticulation. The other vowels did not show this effect. The present study provides insights which future primary studies exploring this phenomenon can build upon, particularly when devising a dataset for participants.

REFERENCES

- Balasubramanian, C. 2009. *Register Variation in Indian English*, vol. 37. Netherlands: John Benjamins Publishing Company 1st edn.
- Balukas, C. & C. Koops. 2015. Spanish-English bilingual voice onset time in spontaneous code-switching. *The International Journal of Bilingualism: Cross-Disciplinary, Cross-Linguistic Studies of Language Behavior* 19(4). 423–443.
- Boersma, P. & D. Weenink. 2010. Praat: Doing phonetics by computer. Type: Miscellaneous. <http://www.praat.org/>.
- Bullock, B. E. 2009. Phonetic reflexes of code-switching. In *The Cambridge handbook of linguistic code-switching*, 163–181. Cambridge University Press.
- Bullock, B. E. & A. J. Toribio (eds.). 2012. *The Cambridge handbook of linguistic code-switching*. Cambridge University Press.
- Caramazza, A., G. H. Yeni-komshian, E. B. Zurif & E. Carbone. 1973. The acquisition of a new phonological contrast: The case of stop consonants in French-English bilinguals. *The Journal of the Acoustical Society of America* 54(2). 421–428.
- Chaturvedi, M. 1973. *A contrastive study of Hindi-English phonology*. Delhi: National Pub. House.

- Chen, M. 1970. Vowel length variation as a function of the voicing of the consonant environment. *Phonetica* 22(3). 129–159.
- DiCanio, C., H. Nam, J. D. Amith, R. C. García & D. Whalen. 2015. Vowel variability in elicited versus spontaneous speech: Evidence from Mixtec. *Journal of Phonetics* 48. 45–59.
- Grosjean, F. 2019. Life with two languages. In *A journey in languages and cultures*, Oxford: Oxford University Press.
- Harnsberger, J. D., R. Wright & D. B. Pisoni. 2008. A new method for eliciting three speaking styles in the laboratory. *Speech Communication* 50(4). 323–336.
- Hauser, I. 2021. Contrast implementation affects phonetic variability: A case study of Hindi and English stops. *Laboratory Phonology* 12(1).
- House, A. S. & G. Fairbanks. 1953. The influence of consonant environment upon the secondary acoustical characteristics of vowels. *The Journal of the Acoustical Society of America* 25(1). 105–113.
- Jenkins, J. 2003. *World Englishes: a resource book for students*. London: Routledge.
- Kwon, H.-B. 2010. Gender difference in speech intelligibility using speech intelligibility tests and acoustic analyses. *The Journal of Advanced Prosthodontics* 2. 71–76.
- Ladefoged, P. 2014. *A course in phonetics*. Cengage Learning 7th edn.
- Lindblom, B. 1990. Explaining phonetic variation: A sketch of the H&H Theory. In W. J. Hardcastle & A. Marchal (eds.), *Speech Production and Speech Modelling*, 403–439. Dordrecht: Springer Netherlands.
- Maddieson, I. & J. Gandour. 1975. Vowel length before stops of contrasting series. *The Journal of the Acoustical Society of America* 58(S1). S61–S61.
- Muldner, K., L. Hoiting, L. Sanger, L. Blumenfeld & I. Toivonen. 2019. The phonetics of code-switched vowels. *The International Journal of Bilingualism: Cross-Disciplinary, Cross-Linguistic Studies of Language Behavior* 23. 37–52.
- Muysken, P. 1997. Code-Switching Processes: Alternation, Insertion, Congruent Lexicalization. In M. Putz (ed.), *Language choices: Conditions, constraints, and consequences*, 361–380. Amsterdam: John Benjamins.
- Myers-Scotton, C. 1993. *Duelling languages : grammatical structure in codeswitching*. Oxford: Clarendon.
- Nema, N. & J. K. Chawla. 2018. The dialectics of Hinglish: A perspective. *Applied Linguistics Papers* (25/2). 37–51.
- Olson, D. 2012. The phonetics of insertional code-switching: Suprasegmental analysis and a case for hyper-articulation. *Linguistic Approaches to Bilingualism* 2(4). 439–457.
- Pandit, I. 1990. Grammaticality in code switching. *Codeswitching as a worldwide phenomenon* 11. 33–70. Publisher: New York: Lang.
- Peterson, G. E. & I. Lehiste. 1960. Duration of syllable nuclei in English. *The Journal of the Acoustical Society of America* 32(6). 693–703.
- Picone, M. D. 1994. Code-intermediate phenomena in Louisiana French. *CLS* 30. 320–334.
- Poplack, S. & M. Meechan. 1995. Patterns of language mixture: nominal structure in Wolof-French and Fongbe-French bilingual discourse. In L. Milroy &

- P. Muysken (eds.), *One speaker, two languages: Cross-disciplinary perspectives on code-switching*, 199–232. Cambridge, England: Cambridge University Press.
- R Core Team. 2021. *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing. <https://www.R-project.org/>.
- Romaine, S. 1989. *Bilingualism*. Oxford: Basil Blackwell.
- Roy, A. G. 2013. The politics of Hinglish. *The politics of English: South Asia, Southeast Asia, and the Asia Pacific* 21–36.
- Sailaja, P. 2009. *Indian English*. Edinburgh: Edinburgh University Press 1st edn.
- Sailaja, P. 2011. Hinglish: code-switching in Indian English. *ELT Journal* 65(4). 473–480.
- Seo, Y. & D. J. Olson. 2024. Phonetic shifts in bilingual vowels: Evidence from intersentential and intrasentential code-switching. *The International Journal of Bilingualism: Cross-Disciplinary, Cross-Linguistic Studies of Language Behavior*.
- Van Summers, W., D. B. Pisoni, R. H. Bernacki, R. I. Pedlow & M. A. Stokes. 1988. Effects of noise on speech production: Acoustic and perceptual analyses. *The Journal of the Acoustical Society of America* 84(3). 917–928.
- Winford, D. 2003. *An Introduction to contact linguistics*. Blackwell Publishing Ltd.

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