Problems in acquisition of allophones of an L2

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ABSTRACT: The study is based on an experiment with two groups of participants. One group comprised of Pakistanis who speak Punjabi and the other comprised of Indian who speak Hindi as the L1. Both groups were living in and around London at the time of experiment. They had started getting input from native speakers of English after puberty. The participants read a list of English words carrying stops on onset position. VOT of stops was calculated to know if the participants could maintain aspiration contrast in their speech. To find out effect of adjacent vowel on VOT of stops was also one of the objectives of the study. The results show that there was no significant difference in the performance of Pakistan and Indian learners. Both had produced English voiced stops with pre-voicing and both could not maintain aspiration contrast on labial and coronal stops. In velar stops, they had acquired aspiration contrast. The effect of vowel was partially significant on VOT of the preceding voiceless stops. The results confirm that for speakers of voicing language acquisition of voiced stops are very significant. The findings also demonstrate that acquisition of a new language is acquisition of the whole grammar not only that of phonemes of the target language.

Key words: *consonant, perception, pre-voicing, production, VOT*

1. Introduction and background literature

English is a legacy of British colonialism in Pakistan and India. Both countries got independence from the British rule at the same time. Most of the indigenous languages of Pakistan and India also belong to the same families. After independence, English developed in Pakistan and India without any native speaker model. In these circumstances it is hypothesized that speakers of similar Pakistani and Indian languages may experience similar kind of learning difficulties in acquisition of English. The current study is an attempt to test this hypothesis.

After independence, native speakers of English left the Sub-continent. But English remained an official language of this area. In the absence of native speakers, learners of English in Pakistan developed a variety of English which is called Pakistani English (Rahman, 1990). Pakistani English has linguistic characteristics which are the same as those described about Indian English (Gargesh, 2004). In the same line, it is expected that Pakistani and Indian learners who speak similar languages face similar perception and production difficulties in learning English.

Previous studies show that Pakistani learners face difficulty in discrimination of [v w] consonants of English (Rahman, 1991). They also cannot accurately perceive and produce English dental fricatives [θ ð] (Syed, 2013c). Another difficulty that Pakistani learners face is in

perception and production of alveo-palatal fricative of English [ʒ] (Syed, 2013b). Pakistani learners also produce English voiced stops with pre-voicing (Syed, 2013a, 2014b). An interesting phenomenon in Pakistani English is that Pakistani learners normally do not maintain aspiration contrast in English plosives (Syed, 2014a). This is not a result of L1 influence because most of Pakistani languages maintain aspiration contrast in plosives (Cardona & Jain, 2007). The aim of this study is to see if Indian languages also undergo similar difficulties and problem acquisition of English. For this purpose, a group of 8 adult Indian learners of English who speak Hindi as L1 and 8 adult Pakistani learners of English who speak Punjabi as L1 were selected for a production experiment. The target sounds in this study are English plosives. The detail of participants and data collection techniques are given in the following section.

The literature on second language acquisition demonstrates that L1 interferes in L2 acquisition (Best, 1994, 1995; Eckman, 1977, 1991; Lado, 1957). There is also a vast literature available on innate human ability to acquire a language during a specific period of life called critical period for language acquisition, the time period after which the same innate ability to acquire a language declines, diminishes or thoroughly terminates. The idea is called critical period hypothesis (CPH) (Patkowski, 1990; Scovel, 1988). Feature model (FM) addresses the question whether problems in adult L2 acquisition are due to inaccessibility of learners to Universal Grammar or it is because of interference of L1? The feature model was developed by Brown (2000). The model explains with empirical evidence the way L1 feature geometry influences L2.

Children are born with innate ability to acquire language. For the FM, UG is actually the innate ability of learners to perceive and acquire a language. A major difference between L1 and L2 acquisition is that L1 is acquired when the ability of learners to perceive phonetic material is at its peak whereas with the passage of initial some months that natural ability to perceive sounds universally, diminishes because learners have acquired phonology of L1 by this time. Thus, after the age of approximately nine months, the universal ability of babies to perceive phonetic nature of sounds diminishes but at the same time, their ability to perceive sounds phonologically increases. Thus, after acquisition of L1, all linguistic material is filtered through the funnel of L1. For Brown (2000), it is the L1 feature geometry which filters new L2 sounds.

2. Role of allophony, contrast and complimentary distribution in acquisition

Zampini studied acquisition of allophonic variance in voiced stops of Spanish by English learners. In Spanish /b d g/ are spirantized to [β ð ɣ] when they occur between two vowels. However, they are produced as stops when they occur in word-initial position or after [n] in a phrase. Thus the words *Vamos* 'let us go', *Damel*' 'give it to me' and the second word of the phrase *un gato* are produced with [b], [d] and [g] word-initially but the words like *aldea (village) and algo (something)*are produced with [ð] and [ɣ] respectively, in the word-medial positions. On the other hand, English does not have such allophonic variance. Normally, in Standard English pronunciation, voiced stops are not spirantized to fricatives. However, coronal fricative [ð] exists in English as a separate phoneme. In this way, [d ð] contrast is phonemic in English but the same is allophonic in Spanish. The fricatives [β ɣ] are new consonants for English learners. Zampini attempted to study interference L1 phonemic contrast of English in acquisition of allophonic variance of Spanish obstruents.

A group of 32 student learners of Spanish who speak English as L1, were asked to participate in this experiment. 17 of them were students of second semester and 15 of fourth semester in an intensive Spanish course. They were asked to participate in a formal reading and an informal question-answer session. To determine the effect of formal and informal learning context on acquisition was also one of the objectives of this study. The productions of the participants included voiced stops in different variants.

The results show there is no significant difference in the performance of two groups of learners which means the difference of level on learning of these sounds is not significant. This also indicates learning difficulty for all English students at all levels in acquisition of Spanish variants of voiced stops. The results show that the learners have an excellent performance in production of voiced stops in the context where they occur as stops in Spanish. But in the context where they occur as fricatives in Spanish, the performance of the participants was poor. The difference in the performance of the participants for [β ð ɣ] was also significant. They produced [β ð ɣ] sounds accurately in 21.02%, 5.78% and 22.03% of the trials. These results show that allophonic variance of voiced stops of Spanish is difficult for English learners. It also shows that if the sounds which are phonemes in the L1 but allophones in the L2 are more difficult to acquire than those allophones of L2 which do not exist in the L1. This is because, in the words of Zampini, in English substitution of [d] with [ð] implies a change in meaning of words. English learners

transfer this phenomenon in L2 Spanish from the L1 English; therefore they avoid such a substitution. On the other hand, the new allophones [β ɣ] though overall difficult are relatively easier.

Goad (2008) attempt to know how English and French speakers perceive Thai aspirated, plain and voiced plosives. The feature [spread glottis] is not active in English because aspirated and unaspirated sounds are at complimentary distribution in English and aspiration split is allophonic, not phonemic in English. Similarly, French also does not have phonemic aspiration. Thus the study aimed to investigate how adult speakers perceive a non-contrastive non-native feature. According to the author, listeners mostly posit L1 abstract phonemic contrast in perception of L2 sounds in adult L2 acquisition, but at some stage gradient phonetic cues also have a very significant contribution in L2 perception. The results of the study by show that although the feature [spread glottis] is not active in English and French but rather feature [voice] is a major phonemic factor which is expected to determine perception of VOT stops by English and French listeners, aspiration also seems to have a very effective role in perception of Thai stops which has three-way distinction. In the opinion of at some stage of development of an L2, learners start exploiting phonetic perceptual cues which are not active in their L1 grammar. While saying this, Goad (2008, p.336) disagrees with it or rather extends the idea of given in feature model (Brown, 1997, 1998, 2000) that only those L1 features may be exploited by learners which are active in their L1. On the contrary, claims that those features which are not active or contrastive in the L1 of listeners may also be exploited if the acoustic cues of the relevant sounds are very prominent as is the case of aspiration in stops. The findings of experiments by Curtin, Goad, and Pater (1998) and Pater (2003) also substantiate this idea.

Boomershine, Hall, and Hume (2008) studied the impact of allophony versus contrast on speech perception. In English the sounds [d] and [ɾ] are allophones of /d/ as used in the words 'dell' [del] and 'better' [beɾr]. But the sounds [d] and [ð] are two different phonemes which are used contrastively. On the other hand, in Spanish, [d] and [ð] are allophones of the same phoneme /d/ but [ð] and [ɾ] are two different phonemes. Boomershine et al. (2008) conducted four experiments to test discrimination of [d ɾ], [d ð] and [ð ɾ] pairs by Spanish and English speakers. According to their findings, [d ɾ] pair which is based on non-contrastive sounds in English and [d ð] pair which is non-contrastive in Spanish is more similar by English and Spanish listeners

respectively. In the same line [ð ɾ] was perceived as different sounds by speakers of both languages because these consonants are contrastive in L1 of both groups. The authors conclude that those L2 sounds which are contrastive in L1 are perceived as different with ease and those sounds which are non-contrastive in L1 are perceived as different by listeners. The current study looks at a mirror image situation of how adult learners will react to a pair of sounds which are non-contrastive in L2 but contrastive in L1. English aspirated and non-aspirated stops are at complimentary distribution with each other but the same sounds are contrastive in Punjabi and Hindi. The current study aims to test acquisition of English plosives by adult Punjabi and Hindi learners.

3. Research Methodology

Two groups of 16 participants living in and around London were selected for this study. Half of them were from Pakistan and half were from India (Delhi). Pakistan-based learners speak Punjabi as their L1. Indian learners speak Hindi as their mother tongue. In this study, Pakistani group is called group A and Indian group is called Group B. The details of the participants are given in the following table.

Table 1: Participants' details

Factors	Group A	Group B
Age of Arrival in UK (years)	31.50 (3.51)	22.50 (1.41)
Age (years)	34.25 (4.43)	23.75 (1.49)
Length of Residence in UK (months)	27.75 (9.74)	11.62 (9.84)
Speaking English hours/day	04.63 (2.97)	06.13 (0.99)
Listening English hours/day	05.63 (3.076)	06.88 (1.36)

For stimuli, a list of written words carrying 'peak, speak, teach, steal, key, ski, pool, spoon, tool, stool, cool, school, park, spark, tall, stall, call, scarf, beak, bark, boot, deal, do, dark, geese, gall, goose' was given to the participants. They were asked to produce these words in accurate English. Each word was written six times on the list. Thus, we got three recordings for each of the target English plosives spoken by each of the sixteen participants. VOTs of the plosives were taken using Praat software (Boersma & Weenink, 2012).

3. Presentation and discussion

In this section, results are presented. Voice onset time was considered relevant acoustic correlate for analysis. The details of VOTs of English voiced stops produced by the participants are given in section 3.1 and those of voiceless English plosives are described in section 3.2.

3.1. Pre-Voicing of voiced stops

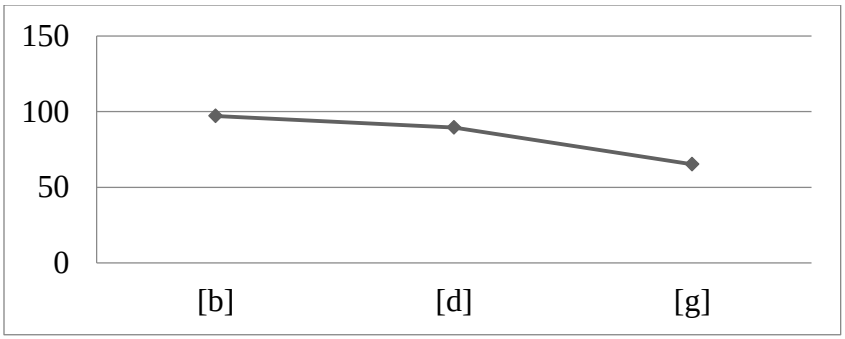
A repeated measures ANOVA were applied on the VOTs with place of articulation and adjacent vowels as repeated measures and group variance with between group factor which confirm that there is no significant difference between the VOTs of voiced stops produced by both groups of participants (F=0.053, p=.821). The overall effect of vowel was also non-significant (F=1.487, p=0.243) on VOTs of the adjacent plosives. However, the effect of place of articulation is significant (F=9.824, p=.007) on VOTs. A quadratic three-way interaction was significant (F=16.911, p=.001) but no two-way interaction was found significant (p>.1). This shows that significant three-way interaction is only because of place of articulation effect. Since the effect of vowels on the VOTs of adjacent stops and group variance are not significantly different, the VOTs of six repetitions by all participants were averaged. Table 3 shows the mean VOTs of all participants regardless of grouping. It is based on averaged VOTs of 144 (3 repetitions*3 vowels*16 participants) tokens.

Table 3: Voice onset time for voiced plosives

Sound	N	Minimum	Maximum	Mean	Std. Deviation
[b]	16	-147.00	-41.00	-97.17	36.35
[d]	16	-173.67	-18.67	-89.52	45.42
[g]	16	-134.00	47.00	-65.27	57.21

Table 3 shows that the participants have maximum pre-voicing duration for voiced labial stop and minimum pre-voicing duration for voiced velar stop of English. Table 3 shows that the direction of decrease of pre-voicing duration is from labial to velar position. The following figure reflects a trend of decreasing pre-voicing duration from labial to velar place of articulation in the L2 phonemic inventory of participants.

Figure 1: Pre-voicing time



It is already established that distance between vocal fold and place of articulation of a plosive is in inverse proportion of VOT of the plosive (Lisker & Abramson, 1964, 1967). Thus, velar stops being closest to the vocal folds have been found to have the biggest VOTs and labial stops being the remotest in place from vocal folds have been found to have the shortest VOTs (Cho & Ladefoged, 1999; Docherty, 1992; Foulkes, Docherty, & Jones, 2010). The current study confirms that the distance between place of articulation and vocal folds is in proportion to pre-voicing duration. The decrease in distance between place of articulation and vocal fold causes decrease in pre-voicing duration of voiced stops in the speech of Pakistani and Indian learners. That is why voiced velar stops have shortest pre-voicing duration and voiced labial stops being most distant from vocal folds have the biggest pre-voicing duration. The reason for this is, as pointed out by Xu (personal communication), a shorter distance between point of articulation and vocal folds develops higher pressure which cannot be sustained for a longer time but a longer distance between point of articulation and vocal folds creates a longer tube which develops relatively lower pressure which can be sustained for a longer time. That is why [b] which is produced at the longest distance from vocal folds has a longer time for pre-voicing but [g] which is produced very closer to vocal folds has the shortest pre-voicing duration.

3.2.2. VOTs of voiceless stops

A repeated measures analysis of variance confirmed that there is no significant difference between Hindi and Punjabi speakers ($F=1.837$, $p=0.197$). There was a linear increase in the VOTs of plosives produced at different place of articulations ($F=61.79$, $p<.0001$). The linear effect of the adjacent vowels is also strongly significant ($F=23.624$, $p<.0001$). All three-way and two-way interactions are non-significant. The following table shows the average results. A

separate test applied on the groups of sounds separately shows the following effect of vowels on adjacent sounds.

Table 4: Effect of vowel on VOT of voiceless plosives

Sound	F	P
[p^h]	2.132	0.165
[t^h]	.186	0.673
[k^h]	**12.492**	**0.003**
[p]	**11.817**	**0.004**
[t]	.023	0.882
[k]	1.485	0.242

The results show that although overall effect of adjacent vowels on VOTs of stops was significant but in individual analysis it was significant only for aspirated dorsal and unaspirated labial stop. The following table shows the VOTs of these sounds.

Table 5: Effect of adjacent vowels on VOTs[1]

Consonant	N	Minimum	Maximum	Mean	Std. Deviation
[pi]	16	13.00	106.00	26.50	23.00
[pu]	16	.00	105.00	33.19	32.27
[pa]	16	.00	89.00	15.75	21.67
[k^hi]	16	42.00	102.00	66.25	21.81
[k^hu]	16	22.00	97.00	60.50	22.65
[k^ha]	16	22.00	117.00	50.19	26.76

The above results show that the effect of [a] is stronger than other vowels on these sounds. Individual pair-wise comparisons show that only the VOT of unaspirated stops followed [a] and [u] are significantly different from each other (t=2.435, p=0.028). The difference between the VOTs of dorsal stops after [a] and [u] are marginally non-significant (t=1.805, p=0.091). These analyses confirm that only the effect of [a] and [u] on labial stops are effective in that [u]

[1] Since the effect of adjacent vowel on VOT of coronal stops is non-significant, they are not included in the table.

increases the VOTs of [p] and [a] decreases that of [p] and [k^h]. The effect of vowels on other sounds is non-significant. Since the effect of adjacent vowel in most of the cases is non-significant, therefore, the VOTs obtained in the context of different vowels were all averaged for ease of further analysis. The following table shows the averaged VOTs.

Table 6: Averaged VOTs of stops

Sounds	N	Minimum	Maximum	Mean	Std. Deviation
[p^h]	16	4.67	57.00	27.25	14.03
[p]	16	6.33	91.33	25.15	21.04
[t^h]	16	16.00	80.33	36.81	20.05
[t]	16	18.00	67.67	33.06	12.03
[k^h]	16	35.00	103.00	58.98	20.80
[k]	16	30.33	72.00	44.83	14.49

In the repeated measures analysis of variance, overall aspiration contrast was found significant. However, individual pair-wise comparisons show that the aspiration contrast is significant only on dorsal place ($t=3.665$, $p=.002$) but non-significant for other two places ($p>.1$). An individual comparison shows that the aspiration contrast for only velars is significant in the VOTs of both groups. For other sounds, aspiration contrast is non-significant in the VOTs of both groups of participants ($p>.1$).

4. Analysis and discussion

Starting from VOT of voiced stops, the results show that all voiced stops of English were produced with pre-voicing by all participants. It is already known that most of the languages of Indo-Aryan family are voicing languages. Voicing languages are those languages which have truly voiced stops produced with pre-voicing (Harris, 1994). On the other hand, English is an aspiration language (Honeybone, 2005). The major difference between aspiration and voicing languages is that the former differentiate between stops on the basis of the feature [spread glottis] whereas the latter uses feature [voice] to differentiate between stops on the basis of laryngeal specification. It is already observed that acquisition of aspiration contrast is very difficult for speakers of voicing languages (Syed, 2012, 2014b). The speakers of Punjabi and Hindi have pre-voiced stops in their L1. For English they also transfer the same negative VOT values. It is a kind of equivalence classification between L1 and L2 voiced stops that these participants have developed for these sounds; and in the words of Flege (1995), establishment of a new phonetic category for new L2 sounds is not possible if adult learners develop an equivalence classification

between the new L2 and the corresponding L1 sounds. The results of the current study are quite in accordance with the predictions of Flege (1995).

A possible difficulty in acquisition of English voiced stops with positive VOT is that if these learners produce English voiced stops with post-burst short-lag VOT like native speakers of English, they will confuse voiced stops with voiceless unaspirated stops of English because Pak-Indian speakers produce English unaspirated stops with short-lag post-burst VOT. To maintain the difference between these two groups of plosives, Pak-Indian learners produce voice stops with pre-voicing and voiceless unaspirated stops with positive VOT. English native speakers produce both these stops with positive VOT but they have a complimentary distribution between voiced and unaspirated stops on onset position because of which they can maintain the difference between these two types of stops. Since there is a no such complimentary distribution for voiced and unaspirated stops in Hindi and Punjabi languages, the participants cannot develop native-like VOT ranges for these stops. These findings demonstrate that acquisition a second language is not only acquisition of phonemic inventory of that language only. We cannot concatenate phonemes of an L2 and produce words of the L2 without acquiring phonotactics involved in the grammar of that language.

An acoustic analysis of productions of voiceless stops show that the participants have developed two significant ranges of VOTs for aspirated and unaspirated velar stops. But they could not develop two separate VOT ranges for labial and coronal stops. According to Brown (2000), if a feature which differentiates between two sounds of L2 is active in the L1 of a group of learners, the learners will acquire such a contrast. From this point of view these participants should acquire aspiration contrast on all three places. However, they could only acquire this contrast on velar place. Thus the prediction of the feature model is partially verified. There may be a possible objection against this conclusion may be that according to Brown (2000), acquisition of an allophonic variance may be equal to acquisition of phonemic contrast or phonological feature. However, Archibald (personal communication) considers that acquisition of allophonic variance also implies acquisition of the relevant feature because a) acquisition of allophonic variance is more difficult than that of a phonemic contrast; thus acquisition of allophonic contrast implies acquisition of phonemic contrast and b) acquisition of allophones also means development of two different categories of sounds although at a different level of representation. However, the participants' ability to acquire English aspiration contrast on velar position but their failure to

acquire the same contrast on labial and coronal position indicates that there are some other factors also involved in acquisition of new contrast. In the current context, there are some aerodynamic factors which are involved in proper acquisition. Place of contact between active and passive articulator and distance between vocal folds and point of contact in production of a sound has direct relation with VOT. A bigger place of contact between active and passive articulator gives a bigger VOT and vice versa. Similarly, a shorter distance between point of articulation of a stop and vocal folds yields bigger VOT. From both angles velar stops are more amenable for a bigger VOT (Docherty, 1992; Foulkes et al., 2010; Lisker & Abramson, 1964, 1967). It is already known that both Pakistani and Indian learners produce both aspirated and unaspirated allophones of English plosives with shorter VOT. In other words, they have to learn how to produce a stop with bigger VOT for which velar stops are by default amenable. Thus, the participants could acquire aspiration contrast in English velar stops. These findings demonstrate that it is not only relevant phonological feature which matters in adult L2 acquisition. Other phonetic factors also have equally significant role in adult language acquisition.

Finally, acquisition of new allophones of English velar stops at least partially rejects the critical period hypothesis. The information given in table 1 shows that all participants started learning British English at adult age which indicates that they acquired aspiration contrast on velar place of articulation. It means, contrary to the CPH claim, a new sound contrast can be acquired in adult age.

Lastly, we shall have a comment on influence of adjacent vowel on L2 acquisition. The results of statistical tests show that the effect of vowel on /k/ and /p/ is significant. This indicates that because of flexibility of tongue, coronal /t/ does not get influence of the adjacent vowel. Detailed results in table 5 show that [p] adjacent to [u] has bigger VOT values because both have similar place of articulation. On the other hand, velar aspirated was produced with strong aspiration when it occurred before [i]. [u] and [a] caused a decrease in VOT of aspirated velar stops. It means that the same place of articulation though helpful for labial was an impediment in production of aspiration after /k/ which is closer to the vocal folds. In other words, closer to the vocal folds, a common place of articulation of a plosive and the adjacent vowel is an impediment in VOT but as the distance between place of articulation and vocal folds increases, the common place of articulation causes increase of VOT. This interaction of VOT, place of articulation and nature of adjacent vowel requires further research. Apparently, [u] caused a decrease in VOT

because of lip rounding. But the issue needs further investigation and is a topic of future research.

5. Conclusion

The current study was based on an acoustic analysis of production of voiced and voiceless stops of English by adult Pakistani and Indian learners. VOT was taken as acoustic cue for phonetic analysis. The results show that the Pak-Indian learners cannot produce English voiced stops with positive VOT in native-like manner. This implies that speakers of voicing languages cannot acquire voiced stops of aspiration languages. The participants also could not acquire aspiration contrast on labial and coronal place. However, they could acquire the same contrast on velar contrast which challenges the predictions of the CPH. However, these findings also indicate that acquisition of a second language is actually acquisition of a whole system along with its phonotactics. The findings of this study also indicate that besides phonological factors, phonetic factors also play a vitally important role in L2 acquisition. The role of adjacent vowel on acquisition of VOT of plosives in adult L2 could not be thoroughly explained. It will be a question for future investigation.

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