An independent analysis of the Phonological abilities of a Pahari speaking child with Delayed Language Development

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Abstract

This study reports the independent analysis data of a Pahari (an Indo-Aryan language) speaking child with delayed language development (DLD) at the age of 6;6. Data is elicited using a word list comprising of the Pahari consonant segments (established by Khan (2013)) at all possible word positions. The descriptive profile of the subject includes: percentage of consonant correct (PCC), consonant errors in terms of phonological processes, distribution of segments in phonological environments and word shapes. The study concludes that consequent to the age inappropriate phonological deficits, the subject employs preference and avoidance strategies which lead to the phonological processes. This work is restricted to Pahari consonants and also does not put the subject's performance in relational perspective in the absence of Pahari normative data.

Keywords: Delayed language development, phonological deficits, phonological processes, Pahari phonology, independent analysis, language milestones

1. Introduction

An in-depth understanding of phonological systems of children with speech disorders is key to the explorations in the area of atypical speech development. One way of doing so is to give a comprehensive descriptive profile of the underlying phonological systems. Such a description could employ two distinct procedures; i) an independent analysis that is specific to a particular child, and ii) a relational analysis that describes a child's system compared to the adult model (Ingram, 1981). An independent analysis minimally lists all the segments used by the child. These segments are categorized on the basis of place and manner of articulation along with the voicing parameter in order to profile the phonetic inventory. Additionally, the independent analysis may expand to account

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for the segment clusters and syllable shapes occurring in the subject's data. Alternatively, a relational analysis compares the child's production of sounds with the adult data. It takes care of the extent to which a particular phoneme, class or sequence of phonemes conform to, or depart from the adult norms of production. In the latter case, one talks in terms of the phonological processes or error patterns (Dyson, 1988). This paper hinges upon the former position, that is independent analysis as it works out the phonetic inventory, segment preference in phonological environments, phonological errors, segment clusters and syllable shapes of a 6;6 year old subject with delayed language development (DLD).

1.1 Pahari Genealogy

Pahari is an ancient language of the sub-Himalayan region with an estimated life-span of around three thousand years (Masoodi, 1985). Numerous, at times alternating and overlapping, attempts were made in the past couple of centuries to place Pahari in the genealogical classification system. Hoernle (1880) was the first one to attempt such a description of the Indo-Aryan languages of the Indian sub-continent wherein he presented a bipartite classification system. To him, the modern Indo-Aryan languages descended from the Magadhi and Sauraseni dialects of Old Indo-Aryan. He attributed the Southern and Eastern varieties (Marathi, Konkani, Bengali, Oriya and Bihari) to Magadhi while Northern and Western (Nepali, Garhwali, Kumauni, Gujarati, Sindhi, Punjabi and Western Hindi) to the Sauraseni origins. Building upon Hoernle (1880) but differing in essence, Grierson (1927) established two main sub-branches of the Indo-Aryan, namely Inner and Outer. Additionally, he introduced an intermediate off-shoot called Mediate that shared the features of both Inner and Outer branches. Placed under the Inner branch, the Pahari group accounted for the Indo-Aryan languages of the sub-Himalayan region extending from Nepal to the erstwhile state of Jammu and Kashmir (Kogan, 2016). Grierson's (1927) Inner-Outer model was scrutinized by Chatterji (1926), who abolished the Mediate branch and replaced Pahari group with North/Himalayan group. Later, Khan (2013) while citing Grierson (1918) reported that Pahari fell under the Lahnda sub-group of the Indo-Aryan family. Nigram (1972) placed 'Lahndi' (the feminine representation of Lahnda) under the 'Punjabi languages' sub-group of the Central-Northern branch of the Indo-Aryan family. Khan (2013) and Nigram (1972) reports further densify the already misty state of affairs. It was however, Masica (1991) who reproduced the Grierson (1916) classification in the form of a family tree and placed Pahari under the Inner sub-branch. He also added the following comments as caveats:

"It is plain from his (Grierson's) comments elsewhere, however, that he inclined to the view that the Outer represented the earlier and the Inner the later arrivals." (Masica, 1991, p. 448).

This elucidates the fact that (Grierson, 1916) Inner-Outer model does refer to the order of the two-wave Aryan migrations into the Indian subcontinent hypothesized by (Hoernle, 1880). Despite differences, the classification schemes cited above are still widely referred to in the contemporary scholarly contributions on Pahari, for instance, (Khan, 2013); (Khalique, 2018); (Lothers & Lothers, 2010); (Lothers & Lothers, 2012); (Karnahi, 2015); (Shakil, 2008) and (Shakil, n.d.).

Nevertheless, for our practical purpose, in figure (1.1) below we reconstruct the sub-classification of the Jammu and Kashmir Pahari as espoused by Karnahi (2007).

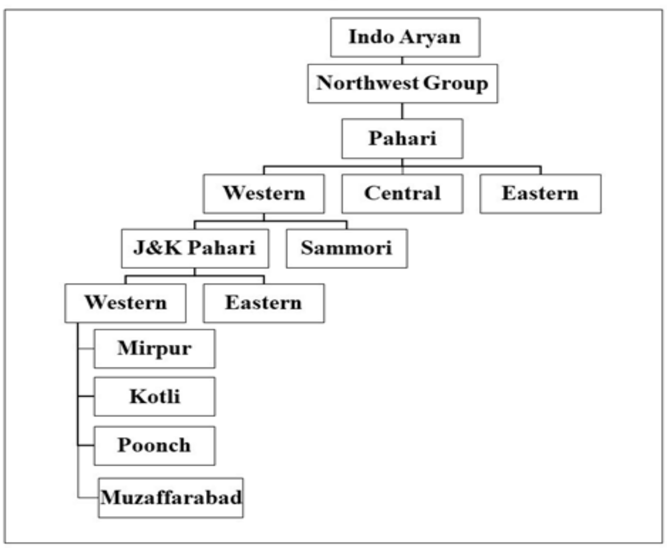


Fig. 1.1: Placement of Pahari in the Indo-Aryan group

Lying under the Western main branch of Pahari, Jammu and Kashmir Pahari (hereafter, J&K Pahari) further branches into the Eastern and Western sub-branches. The Western J&K Pahari sub-branch spoken mainly, but not exclusively, in the current State of Azad Jammu and Kashmir (also referred as Pakistani administered Kashmir, and hereafter referred as AJK in our work) is further classified into the Mirpur, Kotli, Poonch and Muzaffarabad dialects. The current study dwells on the Pooch dialect (hereafter Pahari) spoken in the administrative division Poonch of AJK.

1.2 Pahari Phonology

Since our work is concerned with the phonological abilities of a DLD subject, we restrict our discussion to the consonants alone. (Khan, 2013) established the phonemic inventory of Pahari and worked out 30 consonant phonemes as in table (1.1) below:

Table 1.1: **Pahari consonants established by Khan (2013)**

	Bilabial		Labiodental		Dental		Alveolar		Retroflex		Palatal		Velar		Glottal
Stops	p pʰ	b			t̪ t̪ʰ	d̪			ʈ ʈʰ	ɖ			k kʰ	g	
Nasals		m						n						ŋ	
Fricatives			f	v			s	z			ʃ		x	ɣ	ɦ
Lateral								l							
Trill								r							
Flap										ɽ					
Affricates											tʃ tʃʰ	dʒ			
Glides												j			

Khan (2013) describes twelve oral consonantal stops produced from four different places of articulation: bilabial /p/, /b/ and /pʰ/; dental /t̪/, /d̪/ and /t̪ʰ/; alveolar retroflex /ʈ/, /ɖ/ and /ʈʰ/; and velar /k/, /g/ and /kʰ/. The voicing and aspiration contrasts at all four places of articulation can be clearly seen in the table (1) above. Three voiced nasals /m/, /n/ and /ɳ/ were also identified. Eight fricatives articulated at five different places include: labiodental /f/ and /v/; alveolar /s/ and /z/; palatal /ʃ/; velar /x/ and /ɣ/; and glottal /ɦ/. With the exception of /ʃ/ and /ɦ/, all other Pahari fricatives present paired voicing contrast. Pahari has three affricates produced palataly; /tʃ/, /dʒ/ and /tʃʰ/ with the first two presenting voicing contrast and the first and the third presenting aspiration contrast respectively. Of the three voiced liquids, the lateral /l/ and trill /r/ are produced at the alveolar position while the flap /ɽ/ is produced as retroflex. The language has one voiced palatal glide /j/.

1.3 Delayed Language Development

Although "specific language impairment" (SLI) is the widely accepted term for children with language deficit not related to any other disability, many academics like Weiss and Paul (2010) prefer to use the term "delayed language development" (hereafter, DLD) to designate preschool children with delayed (slower than normal) development of speech and language skills not related to any other identifiable disability. These researchers reserve the term SLI to mean chronic established deficits in school-aged population while DLD as a transient condition (Weiss & Paul, 2010). The children with DLD manifest language impairments that cannot be attributed to any identifiable intellectual, organic and neurological abnormality, nor can they be linked to autism or parental/social neglect. Their language problem goes in relative isolation while other aspects of growth almost take a typical route. Arguing on the linguistic development of children with DLD, Leonard (1991) notes that their language development, though at par with that of the children at comparable ages, is asynchronous. This implies that some of their linguistic features are more delayed than the others. Weiss and Paul (2010) label the language of children with DLD as delayed rather than deviant, thereby meaning that the course of language development remains more-or-less the same, only lagging in chronology. It is, however, precautionary to mention that delayed language development (DLD) should not be confused with developmental language delay (also abbreviated as DLD), where the latter is of neurodevelopmental nature (McGregor, 2020).

1.4 Research Objectives

This study seeks to find:

i. the consonant inventory of the Pahari speaking subject with DLD at 6;6 years of age
ii. the extent to which the subject is able to produce Pahari consonants in meaningful words
iii. the phonological processes resulting from the difficulties in articulation
iv. the word level performance of the subject in the given word list

1.5 The Subject

The subject FW reported in this study is part of mini-ethnographic study on DLD. His language milestones are significantly delayed at the current age of 6:9 (as on July 25, 2022). His first word is reported to have emerged at the age of 3:5. The use of gestures emerged at an approximate age of 5 years. The child was referred for screening to the professional speech pathology services only after becoming part of the mentioned research project, that is, at the age of 5:3. The results for autism and psychological screening were negative. However, his speech difficulties were attributed to DLD. Yet, the parents did not agree to induct him for speech therapy and preferred to bank on wait and see strategy. The subject lives with his parents in a joint family setting where grandmother, two uncles, two aunts, and a 4-year-old cousin share the same household. All family members speak their native language, that is, the Poonch dialect of Pahari language. FW attends a local kindergarten school where Urdu is the medium of instruction and thus his second language.

2. Methodology

2.1 Stimulant Word List

A word list comprising of three words each at word initial, word medial and word final positions (where possible) for all Pahari consonants was prepared as a stimulus for data elicitation. The expected number of total words would be 270 (30 consonants x 3 positions x 3 words). The prepared word list was cross checked with the subject's family members in order to ascertain that our list contained the items commonly used in the household. The words reported to be less frequent in the day-today family repertoire were replaced with the common ones. Additionally, some unfamiliar words having the consonants /v/, /ɣ/, /ɽ/, /ɳ/, /pʰ/, /d̪/, /f/, /ɦ/, /tʰ/, /g/, /ɳ/ and /dʒ/ at different word positions were omitted from the word list. In this way, the stimulant word list was made up of 241 words in total. The word list was phonetically transcribed in IPA notations. This word list is hereafter referred as 'target word list' (TWL) and the words containing therein as 'target word(s)' (TW).

The target word list contained three (3) types of word shapes, that is, monosyllabic, bisyllabic and trisyllabic words. The word list comprised of 471 monosyllables, 243 bisyllables and 9 trisyllables. Overall, the target word list had twelve (12) different types of CV structures.

2.2 Data Elicitation

The subject was made to produce each word thrice either in imitation of the researcher, or, where possible, by naming the picture for the word. The responses were audio recorded in a silent room. The recorded responses were later transcribed phonetically by three linguists including the researcher. The responses are hereafter referred as ‘performance’ and the overall data comprising of these responses as ‘performance data’ (PD). Ideally, the performance count should have been seven hundred and twenty three (723) tokens. However, the subject produced 670 responses, thereby failing to produce 53 tokens. Each response was given a unique identifier number. For instance, WI.i-1p, where the first two alphabets (WI = word initial) identified the position of a particular phoneme in its corresponding word, roman numeric (i = example word number 1) identified the number of target word out of three words for each phoneme at a given position, the mathematical numbers (1= identified the phoneme out of the total 30 Pahari consonants) 1-30 were assigned to all consonants, and finally the phoneme was identified in its IPA form. So, when these identity markers are read in combination, our example WI.i-1p is read as: the first occurrence in the first target word for the phoneme /p/ at word initial position.

2.3 Data Analysis

Phonology Assistant Version 4.0.5 Copyright © 2008-2021 SIL International (hereafter, PA) was used for the analysis of data. The data were stored as database files with the extension (.db) to enable processing in the PA. The ambiguous sequences were defined. For example, PA treats the combination of two phonemes as an ambiguous sequence. Thus, to disambiguate the affricates /tʃ, /tʃʰ/ and /dʒ/, the base character was defined for each sequence, for instance, /t/ for /tʃ/, /ʃ/ for /tʃʰ/ (because PA did not accept the same base character for multiple sequences) and /d/ for /dʒ/. The box ‘treat as one unit’ in front of each sequence was checked. PA automatically assigns descriptive features to each segment based on IPA notation. Additional features were assigned where necessary. The phonetic inventory of the subject was established in the light of Khan (2013). Phonological processes were identified and listed in a separate column in front of each corresponding word. CV templates were also established using the software. The raw frequency scores were computed and tabulated separately for both TWL and PD. Measures of central tendency were also calculated for the two data sets. The scores on the percentage of consonants correct (PCC) scale propounded by (Shriberg & Kwiatkowski, 1982a) were calculated for the PD using the formula:

$$PCC = \frac{\text{number of correct occurrences of consonants}}{\text{number of correct plus incorrect occurrences of consonants}} \times 100$$

The severity scale for PCC values used to gauge the articulatory difficulties is as under:

PCC score	Severity
85–100%	Mild
65–85%	Mild-moderate
50–65%	Moderate-severe
<50%	Severe

Distribution charts for consonant environments were configured in PA by entering the consonant classes in the rows and phonological environments in the columns. The results were exported as the 'Word XML' files. The data corpus for both TWL and PD were sorted by CV patterns in order to tabulate the word shapes.

3. Results

3.1 Descriptive statistical comparison of TWL and PD

In order to compare the target word list and performance data, it is pertinent to start with the descriptive statistics such as frequency and measures of central tendency. The raw frequencies phonemes in the two data sets give us a good ground for further investigation.

Table 3.1: Raw frequencies of consonants in TWL and PD

Phoneme	TWL	PD	Phoneme	TWL	PD
p	75	76	f	24	19
pʰ	21	28	v	15	26
b	93	90	s	66	35
t̪	63	90	z	30	25
t̪ʰ	42	61	ʃ	30	74

d̪	42	71	x	39	18
ʈ	48	36	ɣ	24	7
ʈʰ	36	12	ɦ	26	26
ɖ	48	8	tʃ	45	37
k	81	108	tʃʰ	39	16
kʰ	72	70	dʒ	33	32
g	39	39	l	135	121
m	105	81	r	144	104
n	102	90	ɽ	39	22
ɳ	18	14	j	24	26

Table (3.1) gives the raw frequencies of the phonemes across TWL and PD. The target word list has /r/ as the most frequent consonant with the total count (*n* = 144). It is followed by /l/ (*n* = 135), /m/ (*n* = 105), /n/ (*n* = 102), and /b/ (*n* = 93), respectively. Among the least frequent consonants in TWL are /v/ (*n* = 15), /ɳ/ (*n* = 18), /pʰ/ (*n* = 21), and /j/, /ɣ/ and /f/ (*n* = 24 each) respectively.

On the other hand /l/ (*n* = 121) is the most frequent consonant in the performance data. Following in the frequency rank are /k/ (*n* = 108), /r/ (*n* = 104), and /b/, /t̪/, and /n/ (*n* = 90 each), respectively. Whereas, the least frequent consonants in PD are /tʃʰ/ (*n* = 16), /x/ (*n* = 18), /f/ (*n* = 19), /ɽ/ (*n* = 22), /z/ (*n* = 25), and /j/, /ɦ/ and /v/ (*n* = 26 each), respectively.

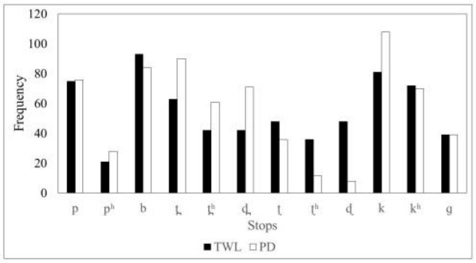
3.2 Frequencies of Consonants

As given in table (3.2), out of a total of 723 tokens, the child responded to 670 tokens (93%) leaving 53 (7%) of them unattended. 49% of these 670 responses were correct. However, a major portion of total responses in the performance data (that is, 341 tokens, 51%) involved articulatory errors.

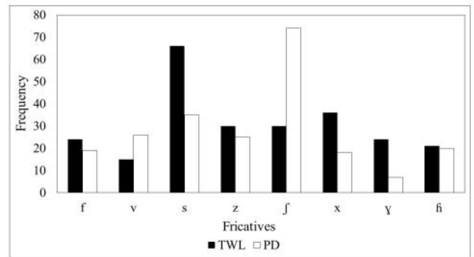
Table 3.2: Statistics of subject's performance

	Target tokens	Performance	Correct responses	No response	Errors
Frequency	723	670	329	53	341
Percentage		93%	49%	7%	51%

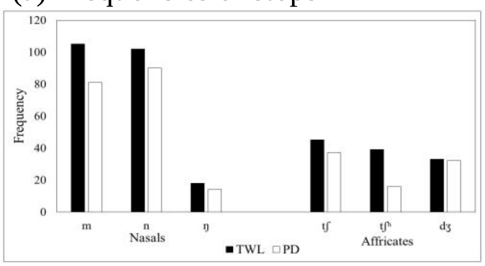
Now, we shall compare the frequencies of the consonants in TWL and PD by their specific categories. Figure (3.1) compares the frequencies of each consonant category across the two data sets.



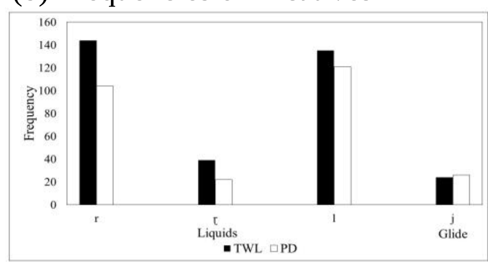
(a) Frequencies of stops



(b) Frequencies of fricatives



(c) Frequencies of nasals and affricates



(d) Frequencies of liquids and glides

Fig. 3.1: Frequencies of consonants across TWL and PD

3.2.1 Occurrences of stop consonants

The frequencies of stop consonants are compared across the target word list and the performance data in sub-figure (3.1a). Before reporting the frequencies, it is pertinent to place the caveat on record that a normal frequency value for a consonant in PD does not necessarily mean it has been correctly realized at the target word position. The frequency of voiceless unaspirated bilabial /p/ in PD matches the one in TWL. Same is the case with the voiced bilabial /b/, the voiceless aspirated velar /k^{h}/ and the voiced velar /g/. However, some drastic discrepancies in frequencies have been observed for some stops wherein the PD frequencies either fall short of TWL as in the voiceless retroflex /ʈ/, voiceless aspirated retroflex /ʈ^{h}/ and the voiced retroflex /ɖ/, or surpass them such as those in the voiceless aspirated bilabial /p^{h}/, voiceless unaspirated dental /t̪/, voiceless aspirated dental /t̪^{h}/, voiced dental /d̪/ and the voiceless unaspirated velar /k/.

3.2.2 Occurrences of fricatives

Sub-figure (3.1b) gives the comparison of frequencies of fricatives across the target word list and the performance data. The frequencies of the voiced glottal /ɦ/, voiced alveolar /z/ and voiceless labiodental /f/ in the PD, although slightly less, closely match the ones in the TWL. Instead, the frequency of the voiced labiodental /v/ is moderately less in the PD. On the other hand, the frequencies of the voiceless velar /x/, voiced velar /ɣ/ and the voiceless alveolar /s/ in the PD are radically low, while that of the voiceless palatal /ʃ/ is radically high in comparison to TWL.

3.2.3 Occurrences of nasals and affricates

Sub-figure (3.1c) compares the frequencies of nasals and affricates in the PD with the TWL. Among the nasals, the frequencies of alveolar /n/ and velar /ɳ/ are slightly lower in PD than those in TWL, whereas that of the bilabial /m/ is quite radically low.

Among the affricates, the frequency of the voiced palatal /dʒ/ in PD matches the one in TWL, while those of the voiceless unaspirated palatal /tʃ/ and the voiceless aspirated palatal /tʃʰ/ in PD are quite low in comparison to the TWL.

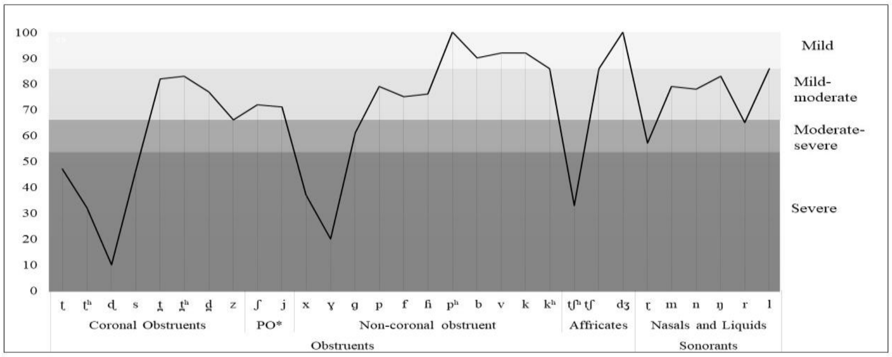
3.2.4 Occurrences of liquids and glide

Sub-figure (3.1d) gives a comparative view of the frequencies of liquids (trill, flap and lateral) and glide across the PD and TWL. We observe that the frequency of the alveolar trill /r/ is radically low in PD. The frequency of the retroflex flap /ɽ/ is also quite low in PD. On the other hand the frequencies of the alveolar lateral /l/ and the palatal glide /j/ in PD are quite close to those in TWL.

3.3 Percentage of Consonants Correct

In order to gauge the degrees of difficulty (the writer prefers the term '*difficulty'* to *'disorder'* as the work is not clinical in nature) in the performance of target word list, the percent consonant correct values for individual consonants are worked out.

Figure (3.2) summarizes the severity of articulatory difficulties faced by the subject on the PCC index. On the continuum of severity, the four levels of severity are represented in the increasing order of background darkness; the darker the background, the severer is the difficulty and the other way around. The consonants are categorized in terms of the manner and place features.



* Palatal Obstruents

Figure 3.2: Severity of articulatory difficulties on the PCC scale

On the PCC scale, the subject is comfortable with the obstruents /p^{h}/, /b/, /v/, /k/, /k^{h}/, /tʃ/ and /dʒ/, and the sonorant /l/. Of these, /p^{h}/ and /dʒ/ have PCC values of 100%, meaning they are correctly realized on all instances, while rest of the segments exhibit mild difficulty. The feature [+labial] is common among /p^{h}/, /b/ and /v/, /k/ and /k^{h}/ share the feature [+dorsal], while /tʃ/, /dʒ/ and /l/ share the feature [+coronal].

The mild-moderate category has the highest number of segments. It includes the obstruents /t̪/, /t̪^{h}/, /d̪/, /z/, /ʃ/, /p/, /f/ and /ɦ/; and the sonorants /j/, /m/, /n/, /ɳ/ and /r/.The mild moderate category includes a variety of segments articulated from various tongue positions as well as through lip-involvement. The feature [+coronal] is common among /t̪/, /t̪^{h}/, /d̪/, /z/, /ʃ/, /n/and /r/; [+dorsal] is common among /j/ and /ɳ/; while [+labial] is common among /p/, /f/ and /m/.
The moderate-severe category only contains the [+dorsal] obstruent /g/ and the [+coronal] sonorant /ɽ/.

The severe category of PCC index contains /ʈ/, /ʈ^{h}/, /ɖ/, /s/, /x/, /ɣ/ and /ʈʃ^{h}/. All of these segments are obstruents /ʈ/, /ʈ^{h}/, /ɖ/ and /s/ are [+coronal], while /x/ and /ɣ/ are [+dorsal], and /ʈʃ^{h}/ is [+distributed].

Overall, the PCC scores suggest that the subject is quite comfortable with all the sonorants except the retroflex /ɽ/. For that matter, all Pahari retroflex consonants exhibit difficulty on the severe side of the PCC index. The PCC scores for the non-coronal obstruents are also encouraging. With the exception of /x/, /ɣ/, /g/ and the distributed /ʈʃ^{h}/, all non-coronal obstruents have the PCC scores on the mild side of the index. The palatal obstruents /ʃ/ and /j/ are mild-moderately difficult for subject.

With the exception of retroflex /ʈ/, /ʈʰ/, /ɖ/ and the continuant /s/, all other coronal obstruents have PCC scores on the mild side of the index.

3.4 Errors in the Articulation of Consonants

The difficulties in the articulation of certain consonants examined in the preceding sub-section are manifested in the form of errors or, as viewed by Bernthal, Banksoz, and Jr. (2017), "mismatches". This sub-section provides a description of the errors observed in the subject's performance data. Appendix (A) presents the patterns of these errors in the form of phonological processes for the consonants across all possible word positions, which is further elaborated in terms of phonological processes below.

3.4.1 Fronting

Fronting is a common phonological process observed in the child language. Many studies such as that of Ingram (1981); Grunwell (1981, 1987); Lowe, Knutson, and Monson (1985); and Dodd, Holm, Hua, and Crosbie (2003) report fronting process in various languages. It involves production of a segment further anterior to its normal place of articulation (Bernthal et al., 2017). In the current study, the consonants /ʈ/, /ɖ/, /r/, /f/, /x/, /ɣ/, /ʃ/ and /ɽ/ undergo fronting of the places of articulation. The process of fronting in the current study is illustrated as:

- [ʈ] → [t̪] [ʈʊr] → [t̪ʊr] 'walk'

$$\begin{bmatrix} +alveolar & +retroflex & \begin{matrix} -voiced \\ \\ -aspirated \end{matrix} & +stop \end{bmatrix} \rightarrow \begin{bmatrix} +dental & \begin{matrix} -voiced \\ \\ -aspirated \end{matrix} & +stop \end{bmatrix} \#\_\ ,\ \_\#\_$$

The voiceless unaspirated alveolar retroflex stop /ʈ/ is replaced with the voiceless unaspirated dental stop at the word initial and medial position.

- [ʈʰ] → [t̪ʰ] [əʈʰʈʰaː] → [ɦət̪ʰt̪ʰaː] 'waist belt'
  [pəʈʰ] →[pət̪ʰ] 'young goat'

$$\begin{bmatrix} +alveolar & +retroflex & \begin{matrix} -voiced \\ \\ +aspirated \end{matrix} & +stop \end{bmatrix}_{\_\#\_} \rightarrow \begin{bmatrix} +dental & \begin{matrix} -voiced \\ \\ +aspirated \end{matrix} & +stop \end{bmatrix} \#\_\ ,$$

The voiceless aspirated alveolar retroflex stop /ʈʰ/ is replaced with the voiceless aspirated dental stop /tʰ/ at the word initial and medial positions.

- [ɖ]→ [d̪] [ɖəb] → [d̪əb] 'house'

$$\begin{bmatrix} & & +voiced & \\ +alveolar & +retroflex & & +stop \\ & & -aspirated & \end{bmatrix} \rightarrow \begin{bmatrix} & +voiced & \\ +dental & & +stop \\ & -aspirated & \end{bmatrix} \#\_ \,, \_\#\_$$

- [ɖ]→ [t̪] [laːɖ] → [laːt̪] ‘caress’

$$\begin{bmatrix} & & +voiced & \\ +alveolar & +retroflex & & +stop \\ & & -aspirated & \end{bmatrix} \rightarrow \begin{bmatrix} & -voiced & \\ +dental & & +stop \\ & -aspirated & \end{bmatrix} \_\#$$

The voiced unaspirated alveolar stop /ɖ/ is replaced with the voiced unaspirated dental stop /d̪/ at the word initial and medial positions, while at the word final position it is replaced with the voiceless unaspirated dental stop /t̪/.

- [r] → [v] [roʈʈɪ]→[voʈʈɪ] ‘bread’

$$\begin{bmatrix} & +voiced & \\ +alveolar & & +trill \\ & +liquid & \end{bmatrix} \rightarrow$$

$$\begin{bmatrix} +labiodental & +voiced & +fricative \end{bmatrix} \#\_$$

The voiced alveolar liquid /r/ is replaced with the voiced labiodental fricative /v/ at the word initial position.

- [f] → [p] [sa:f]→[sa:p] ‘neat’

$$\begin{bmatrix} +labiodental & -voiced & +fricative \end{bmatrix} \rightarrow$$

$$\begin{bmatrix} & -voiced & \\ +bilabial & & +stop \\ & -aspirated & \end{bmatrix} \_\#$$

The voiceless labiodental fricative /f/ is replaced with the voiceless unaspirated bilabial stop /p/ at the word final position.

- [x]→[ʃ] [xʊʃ]→[ʃʊʃ] ‘happy’

$$\begin{bmatrix} +velar & -voiced & +fricative \end{bmatrix} \rightarrow \begin{bmatrix} +palatal & -voiced & +fricative \end{bmatrix}$$

$$\#\_$$

The voiceless velar fricative /x/ is replaced with the voiceless palatal fricative /ʃ/ at the word initial position.

- [ɣ]→[v] [ɣossa]→[vʊʃʃa] ‘anger’
  [tʃẽ:ɣʊn] →[tʃɪ:vən] ‘tomato’

$$\begin{bmatrix} +velar & +voiced & +fricative \end{bmatrix} \rightarrow$$

$$\begin{bmatrix} +labiodental & +voiced & +fricative \end{bmatrix} \#\_\,,\ \_\#\_$$

The voiced velar fricative /ɣ/ is replaced with the voiced labiodental fricative /v/ at the word initial and medial positions.

- [ɽ]→[r] [ɽu:t̪]→[ru:t̪] 'blockhead'
  [poɽ]→[por] 'catch'

$$\begin{bmatrix} +alveolar & +retroflex & +flap \end{bmatrix} \rightarrow$$

$$\begin{bmatrix} +alveolar & +liquid & +trill \end{bmatrix} \#\_\,,\_\#$$

The retroflex flap /ɽ/ is fronted to the alveolar trill /r/ at the word initial and final positions.

- [ɽ]→[l] [so:ɽɪ]→[ʃo:lɪ] 'tight/narrow'

$$\begin{bmatrix} +alveolar & +retroflex & +flap \end{bmatrix} \rightarrow \begin{bmatrix} +alveolar & +liquid & +lateral \end{bmatrix}$$

$$\_\#\_$$

The retroflex flap /ɽ/ is fronted to the alveolar lateral /l/ at the word medial position.

- [ʃ]→[s] [re:ʃa:]→[re:sa:] 'phlegm'

$$\begin{bmatrix} +palatal & -voiced & +fricative \end{bmatrix} \rightarrow$$

$$\begin{bmatrix} +alveolar & -voiced & +fricative \end{bmatrix} \_\#\_$$

The voiceless palatal fricative /ʃ/ is fronted to the voiceless alveolar fricative /s/ at the word medial position.

3.4.2 Backing

Contrary to fronting, backing involves producing a consonant further back in oral cavity for a forward target. Bernthal et al. (2017) while citing Parker (2005) views the backing processes as nondevelopmental and uncommon to typically developing young children. In our data /p/, /m/,

/d̪/, /ʈʰ/, /s/, /z/, /r/ and /x/ are produced further backwards in the oral cavity. Following are the examples from our data.

- [p]→[ʈʰ] [pʊʈʰʈʰa:]→[ʈʰʊʈʰʈʰa:] 'wrong'

$$\begin{bmatrix} +bilabial & \begin{matrix} -voiced \\ \\ -aspirated \end{matrix} & +stop \end{bmatrix} \rightarrow \begin{bmatrix} +alveolar & +retroflex & \begin{matrix} -voiced \\ \\ +aspirated \end{matrix} & +stop \end{bmatrix} \_\#\_$$

The voiceless unaspirated bilabial stop /p/ is produced further backwards as the voiceless aspirated alveolar retroflex stop /ʈʰ/ at the word medial position. This can also be termed as the assimilation process where the target consonant /p/ assimilates into the nearby /ʈʰ/ in the target word.

- [m]→[v] [məkʰkʰʊn]→[vəkʰkʰʊn] 'butter'

$$\begin{bmatrix} +bilabial & +nasal & +stop \end{bmatrix} \rightarrow \begin{bmatrix} +labiodental & +voiced & +fricative \end{bmatrix} \#\_$$

The bilabial nasal stop /m/ is replaced with the voiced labiodental fricative /v/ at the word initial position.

- [d̪]→[ɖ] [d̪a:l]→[ɖa:l] 'pulses'

$$\begin{bmatrix} +dental & \begin{matrix} +voiced \\ \\ -aspirated \end{matrix} & +stop \end{bmatrix} \rightarrow \begin{bmatrix} +alveolar & +retroflex & \begin{matrix} +voiced \\ \\ -aspirated \end{matrix} & +stop \end{bmatrix} \#\_$$

The voiced unaspirated dental stop /d̪/ is replaced with the voiced unaspirated alveolar retroflex stop at the word initial position.

- [s]→[ʃ] [sep]→[ʃep] 'snake'
  [ləssI]→ [ləʃʃI] 'yougart milk'

$$\begin{bmatrix} +alveolar & -voiced & +fricative \end{bmatrix} \rightarrow$$

$$\begin{bmatrix} +palatal & -voiced & +fricative \end{bmatrix} \#\_, \_\#\_$$

- [z]→[j] [zær]→[jær] 'poison'

$$\begin{bmatrix} +alveolar & +voiced & +fricative \end{bmatrix} \rightarrow \begin{bmatrix} +palatal & +glide \end{bmatrix} \#\_$$

The voiced alveolar fricative /z/ is produced further backwards as the palatal glide /j/ at the word initial position.

- [r]→[ɽ] [kʰəppʊr]→[kʰəppʊɽ] 'a bird'

$$\begin{bmatrix}+alveolar & +trill\end{bmatrix} \rightarrow \begin{bmatrix}+retroflex & +flap\end{bmatrix} \_\#$$

The alveolar trill /r/ is replaced with the retroflex flap /ɽ/ at the word final position.

- [x]→[ɦ] [xʊʃ]→ [ɦʊʃ] ‘happy’

$$\begin{bmatrix}+velar & -voiced & +fricative\end{bmatrix} \rightarrow \begin{bmatrix}+glottal & +voiced & +fricative\end{bmatrix} \#\_$$

The voiceless velar fricative /x/ is replaced with the voiced glottal fricative /ɦ/ at the word initial position.

3.4.3 Stopping

Stopping involves the change of the manner of articulation. Generally, it refers to the substitution of a stop consonant for a non-stop consonant. It is a general consensus that the fricatives and affricates undergo stopping, see for example (Miccio and Scarpino (2008); Adnyani and Pastika (2016) and Bernthal et al. (2017)). However, we found that the liquids (trill and lateral) also undergo the stopping process. The consonants /z/, /x/, /ɣ/, /r/ and /l/ undergo the change of manner to stops in the current study as below:

- [z]→[k] [ra:z]→ [a:k] ‘secret’

$$\begin{bmatrix}+alveolar & +voiced & +fricative\end{bmatrix} \rightarrow \begin{bmatrix}+velar & \begin{matrix}-voiced \\ \\ -aspirated\end{matrix} & +stop\end{bmatrix} \_\#$$

The voiced alveolar fricative /z/ undergoes change in manner to the voiceless unaspirated velar stop /k/ at the word final position.

- [x]→[k^h] [xɑ:b]→ [k^hɑ:b] ‘dream’
  [li:x]→ [li:k^h] ‘lice’

$$\begin{bmatrix}+velar & -voiced & +fricative\end{bmatrix} \rightarrow \begin{bmatrix}+velar & \begin{matrix}-voiced \\ \\ +aspirated\end{matrix} & +stop\end{bmatrix} \#\_, \_\#$$

The voiceless velar fricative /x/ is replaced with the voiceless aspirated velar stop /k^h/ at the word initial and final positions.

- [x]→[k] [me:x]→ [me:k] ‘nail’

$$\begin{bmatrix}+velar & -voiced & +fricative\end{bmatrix} \rightarrow \begin{bmatrix}+velar & \begin{matrix}-voiced \\ \\ -aspirated\end{matrix} & +stop\end{bmatrix} \_\#$$

At the word final position, the voiceless velar fricative /x/ is replaced with the voiceless unaspirated velar stop /k/.

- [ɣ]→[g] [bẽ:ɣʊn]→ [begʊn] 'bringal'

$$\begin{bmatrix} +velar & +voiced & +fricative \end{bmatrix} \rightarrow \begin{bmatrix} +velar & +voiced & +stop \end{bmatrix} \_\#\_$$

The voiced velar fricative /ɣ/ is replaced with the voiced unaspirated velar stop /ɡ/ at the word medial position.

- [ɣ]→[k] [ra:ɣ]→ [la:k] 'melody'

$$\begin{bmatrix} +velar & +voiced & +fricative \end{bmatrix} \rightarrow \begin{bmatrix} & -voiced & \\ +velar & & +stop \\ & -aspirated & \end{bmatrix} \_\#$$

The word final voiced velar fricative /ɣ/ is replaced with the voiceless unaspirated velar stop /k/

- [r]→[k^h] [rʊk^{h}k^{h}a:]→ [k^{h}ʊk^{h}k^{h}a:] 'dry'

$$\begin{bmatrix} +alveolar & +trill \end{bmatrix} \rightarrow \begin{bmatrix} & -voiced & \\ +velar & & +stop \\ & +aspirated & \end{bmatrix} \#\_$$

The alveolar trill /r/ is replaced with the voiceless aspirated velar stop /k^h/ at the word initial position.

- [r]→[d̪] [rəb]→ [d̪əb] 'God'

$$\begin{bmatrix} +alveolar & +trill \end{bmatrix} \rightarrow \begin{bmatrix} +dental & +voiced & +stop \end{bmatrix} \#\_$$

The alveolar trill /r/ has also been found changing its manner to the voiced dental stop /d̪/ at the word initial position.

- [l]→[d̪] [lət̪]→ [dət̪] 'leg'
  [k^{h}o:l]→ [k^{h}o:d̪] 'open'

$$\begin{bmatrix} +alveolar & +lateral \end{bmatrix} \rightarrow \begin{bmatrix} +dental & +voiced & +stop \end{bmatrix} \#\_\ ,\ \_\#$$

The alveolar lateral /l/ is replaced with the voiced dental stop /d/ at the word initial and final positions.

3.4.4 (De)Aspiration

Aspiration is an important feature in Pahari stops. Khan (2013) reports that all voiceless stops in Pahari bear the contrast of aspiration. In our study /p/ undergoes aspiration while /t̪^{h}/ and /k^{h}/ undergo deaspiration as:

- [p]→[p^{h}] [pət̪^{h}t̪^{h}ʊr]→ [p^{h}ət̪^{h}t̪^{h}ʊr] 'stone'
- [t̪^{h}]→[t̪] [t̪^{h}ʊk]→ [t̪ʊk] 'spit'
  [ɦət̪^{h}]→ [ɦət̪] 'hand'
- [k^{h}]→ [k] [k^{h}ən]→ [kən] 'dig'
  [mək^{h}]→ [mek] 'fly'

$$\begin{bmatrix} +bilabial & & -aspirated & \\ +dental & -voiced & +aspirated & +stop \\ +velar & & +aspirated & \end{bmatrix} \rightarrow$$

$$\begin{bmatrix} +bilabial & & +aspirated & \\ +dental & -voiced & -aspirated & +stop \\ +velar & & -aspirated & \end{bmatrix} \begin{matrix} \#\_ \\ \#\_,\_\# \\ \#\_,\_\# \end{matrix}$$

The voiceless unaspirated bilabial stop /p/ undergoes aspiration word initially while retaining the voicing feature and the place of articulation. On the other hand the voiceless aspirated dental stop /t̪^{h}/ and the voiceless aspirated velar stop /k^{h}/ lose their aspiration feature word initially as well as word finally.

3.4.5 De(Voicing)

The phonological process where a voiced segment loses its voicing feature is termed as devoicing, while the other way around is voicing. Usually, final consonant devoicing receives most of the attention in literature, however Velleman (1998) also reported initial consonant devoicing. In our data, /d̪/, /ɖ/, /v/ and /g/ undergo devoicing at various word positions as under:

- [d̪]→ [t̪] [zɪd̪]→ [zɪt̪] 'insistence'

$$\begin{bmatrix} +dental & +voiced & +stop \end{bmatrix} \rightarrow \begin{bmatrix} & -voiced & \\ +dental & & +stop \\ & -aspirated & \end{bmatrix} \_\#$$

The voiced dental stop /d̪/ is replaced with the voiceless unaspirated dental stop /t̪/ at the word final position.

- [ɖ]→ [ʈ] [bəɖ]→ [bəʈ] 'wheat straw'

$$\begin{bmatrix} +alveolar & +retroflex & +voiced & +stop \end{bmatrix} \rightarrow$$

$$\begin{bmatrix} & & -voiced & \\ +alveolar & +retroflex & & +stop \\ & & -aspirated & \end{bmatrix} \_\#$$

The voiced alveolar stop /ɖ/ is replaced with the voiceless unaspirated alveolar stop /ʈ/ at the word final position.

- [v] → [f] [vɪtʃ] → [fɪtʃ] 'within'

$$\begin{bmatrix}+labiodental & +voiced & +fricative\end{bmatrix} \rightarrow \begin{bmatrix}+labiodental & -voiced & +fricative\end{bmatrix} \#\_$$

The voiced labiodental fricative /v/ undergoes devoicing and results into the voiceless labiodental fricative /f/ at the word initial position.

- [g] → [k] [əg] →[a:k] 'fire'

$$\begin{bmatrix}+velar & +voiced & +fricative\end{bmatrix} \rightarrow \begin{bmatrix}+velar & -voiced & +fricative\end{bmatrix} \_\#$$

The voiced velar fricative /g/ is replaced with the voiceless velar fricative /k/ at the word final position.

- [p] → [b] [pəg] → [bək] 'turban'

$$\begin{bmatrix}+bilabial & \begin{matrix}-voiced \\ -aspirated\end{matrix} & +stop\end{bmatrix} \rightarrow \begin{bmatrix}+bilabial & \begin{matrix}+voiced \\ -aspirated\end{matrix} & +stop\end{bmatrix} \_\#$$

The voiceless unaspirated bilabial stop /p/ is replaced with the voiced counterpart /b/ at the word initial position.

- [s] → [z] [ma:s]→ [ma:z] 'flesh'

$$\begin{bmatrix}+alveolar & -voiced & +fricative\end{bmatrix} \rightarrow \begin{bmatrix}+alveolar & +voiced & +fricative\end{bmatrix} \_\#$$

The voiceless alveolar fricative /s/ is undergoes voicing as the voiced alveolar fricative /z/ at the word final position.

- [k] → [g] [kədʒ]→[gədʒ] 'cover (it)'

$$\begin{bmatrix}+velar & \begin{matrix}-voiced \\ -aspirated\end{matrix} & +stop\end{bmatrix} \rightarrow \begin{bmatrix}+velar & +voiced & +stop\end{bmatrix} \#\_$$

The word initial voiceless unaspirated velar stop /k/ undergoes voicing and results into the voiced velar stop /ɡ/.

- $[k^h] \rightarrow [ɡ]$ $[k^h$əbbʊl] →[ɡəbbʊl] 'grass'

$$\begin{bmatrix} +velar & \begin{matrix} -voiced \\ \\ -aspirated \end{matrix} & +stop \end{bmatrix} \rightarrow \begin{bmatrix} +velar & +voiced & +stop \end{bmatrix} \#\_$$

The voiceless aspirated velar stop $/k^h/$ receives voicing resulting into the voiced velar stop /ɡ/ at the word initial position.

In the examples above, most of the instances of devoicing take place at the word final position. The voiced labiodental fricative /v/ is the only exception which undergoes devoicing at the word initial position.

3.4.6 Denasalization

When a nasal consonant is substituted with a non-nasal consonant, the process is called Denasalization. In our study, nasal stops /m/, /n/ and /ɳ/ are substituted with the oral stops at the same or nearest possible position as:

- [m] → [p] $[mət̪^ht̪^h$a:] → $[pət̪^ht̪^h$a:] 'forehead'

$$\begin{bmatrix} +bilabial & +nasal & +stop \end{bmatrix} \rightarrow$$

$$\begin{bmatrix} +bilabial & \begin{matrix} -voiced \\ -aspirated \\ +oral \end{matrix} & +stop \end{bmatrix} \#\_$$

The word initial bilabial nasal stop /m/ undergoes denasalization and the resulting phoneme is the voiceless unaspirated bilabial oral stop /p/.

- [m]→ [b] [məgga:] → [bəgga:] 'cup'

$$\begin{bmatrix} +bilabial & +nasal & +stop \end{bmatrix} \rightarrow \begin{bmatrix} +bilabial & \begin{matrix} +voiced \\ \\ +oral \end{matrix} & +stop \end{bmatrix} \#\_$$

The bilabial nasal stop /m/ is also replaced with the voiced bilabial oral stop /b/ word initially in some instances.

- [n] → [d̪] [nəkka:] →[d̪əkka:] 'ridge'

$$\begin{bmatrix} +alveolar & +nasal & +stop \end{bmatrix} \rightarrow \begin{bmatrix} +dental & \begin{matrix} +voiced \\ \\ +oral \end{matrix} & +stop \end{bmatrix} \#\_$$

The alveolar nasal stop /n/ undergoes denasalization and results into the voiced dental oral stop /d̪/ at the word initial position.

- [ɳ] → [k] [təɳnã:] →[təkənã:] 'to lift'

$$\begin{bmatrix} +velar & +nasal & +stop \end{bmatrix} \rightarrow \begin{bmatrix} & -voiced & \\ +velar & -aspirated & +stop \\ & +oral & \end{bmatrix} \_\#\_$$

The velar nasal stop /ɳ/ is replaced with the voiceless unaspirated velar oral stop /k/ at the word medial position.

All instances of denasalization take place at the word initial position except for the velar nasal stop /ɳ/, which undergoes denasalization word medially for the obvious reason that this nasal stop does not occur word initially in Pahari.

3.4.7 (De)Affrication

When a fricative or a plosives is realized as an affricate, the process is called affrication and the other way around (i.e., when an affricate is realized as a fricatives) is called deaffrication (Bernthal et al., 2017). We find the instances of both affrication and deaffrication in the data. /ʃ/ undergoes affrication while /tʃ/ and /tʃʰ/ undergo deaffrication in the following manner:

- [ʃ] → [tʃ] [xʊʃ] → [ʃʊtʃ] 'happy'

$$\begin{bmatrix} +palatal & -voiced & +fricative \end{bmatrix} \rightarrow$$

$$\begin{bmatrix} & -voiced & \\ +palatal & & +affricate \\ & -aspirated & \end{bmatrix} \_\#$$

The voiceless palatal fricative /ʃ/ is replaced with the voiceless unaspirated palatal affricate /tʃ/ at the word final position.

- [tʃ]→ [ʃ] [sætʃ] → [sæʃ] 'truth'

$$\begin{bmatrix} & -voiced & \\ +palatal & & +affricate \\ & -aspirated & \end{bmatrix} \rightarrow$$

$$\begin{bmatrix} +palatal & -voiced & +fricative \end{bmatrix} \_\#$$

The voiceless unaspirated palatal affricate /tʃ/ is replaced with the voiceless palatal fricative /ʃ/ at the word final position.

- [tʃʰ] → [ʃ] [tʃʰa:p]→ [ʃa:p] 'ring'
  [pɪtʃʰæ:] →[pɪʃʃæ:] 'behind'

$$\begin{bmatrix} +palatal & \begin{matrix} -voiced \\ \\ +aspirated \end{matrix} & +affricate \end{bmatrix} \rightarrow \begin{bmatrix} +palatal & -voiced & +fricative \end{bmatrix} \#\_\ ,\ \_\#\_$$

The voiceless aspirated palatal affricate /tʃʰ/ is replaced with the voiceless palatal fricative /ʃ/ at the word medial and final positions.

3.4.8 Lingual maneuvers (lateralization / retraction / trilling)

We coin the term lingual maneuvers to denote the phonological processes resulting from various movements of tongue. For the present purpose it is used as a cover term for the three processes namely, lateralization, retraction and trilling. Each of these is discussed below with their instances following the definitions.

When air is emitted laterally (sideways) instead of forward during the articulation of a sound, the phenomenon is termed as lateralization (Bernthal et al., 2017). Retraction refers to the backward/inward movement or bending of tongue during the articulatory process (Pandey, n.d). The process wherein the tongue tip makes several quick contacts with the alveolar ridge is termed as trilling (Pandey, n.d). We have the instances of lateralization, retraction and trilling in our data as under:

Lateralization

- [n]→ [l] [bʊn]→ [bʊl] ‘down’

$$\begin{bmatrix} +alveolar & +nasal \end{bmatrix} \rightarrow \begin{bmatrix} +alveolar & +lateral \end{bmatrix} \_\#$$

The alveolar nasal /n/ is replaced with the alveolar lateral /l/ at the word final position.

- [r]→ [l] [rəkʰ] →[ləkʰ] ‘keep (it)’

$$\begin{bmatrix} +alveolar & +trill \end{bmatrix} \rightarrow \begin{bmatrix} +alveolar & +lateral \end{bmatrix} \#\_$$

The alveolar trill /r/ is replaced with the alveolar lateral /l/ at the word initial position.

Retraction

- [r] → [ɽ] [kʰəppʊr] [kʰəppʊɽ] ‘a bird’

$$\begin{bmatrix} +alveolar & +trill \end{bmatrix} \rightarrow \begin{bmatrix} +alveolar & +retroflex & +flap \end{bmatrix} \_\#$$

The alveolar trill /r/ is replaced with the retroflex flap /ɽ/ at the word final position.

Trilling

- [l] → [r]   [ʈʰel] → [ʈʰer] 'dismantle'

The alveolar lateral /l/ is replaced with the alveolar trill /r/ at the word final position.

3.4.9 Cluster reduction

Adnyani and Pastika (2016) define cluster reduction as the reduction of a consonant cluster to a single consonant. In our data both initial and final clusters are reduced as under:

Initial cluster reduction:

- [mr] → [m]   [mro:ɽ] → [mo:ɽ] 'abdominal cramp'

$$C_1C_2 \text{ (word initial)} \begin{bmatrix} C1 & C2 \\ +nasal & +alveolar \\ +bilabial & +trill \end{bmatrix} \rightarrow \begin{bmatrix} C \\ +nasal \\ +bilabial \end{bmatrix}$$

The word initial consonant cluster made up of a bilabial nasal /m/ as C_1 and an alveolar trill /r/ as C_2 retains the nasal and drops the trill.

Final cluster reduction:

- [rf] → [f]   [bərf]→ [bəf] 'snow'

$$C_1C_2 \text{ (word final)} \begin{bmatrix} C1 & C2 \\ +alveolar & +fricative \\ +trill & +labiodental \\ & -voiced \end{bmatrix} \rightarrow \begin{bmatrix} C \\ +fricative \\ +labiodental \\ -voiced \end{bmatrix}$$

The word final cluster made up of an alveolar trill /r/ as C_1 and a voiceless labiodental fricative /f/ as C_2 retains the fricative by dropping the trill.

- [xt̪] → [t̪]   [sext̪] → [ʃet̪] 'hard'

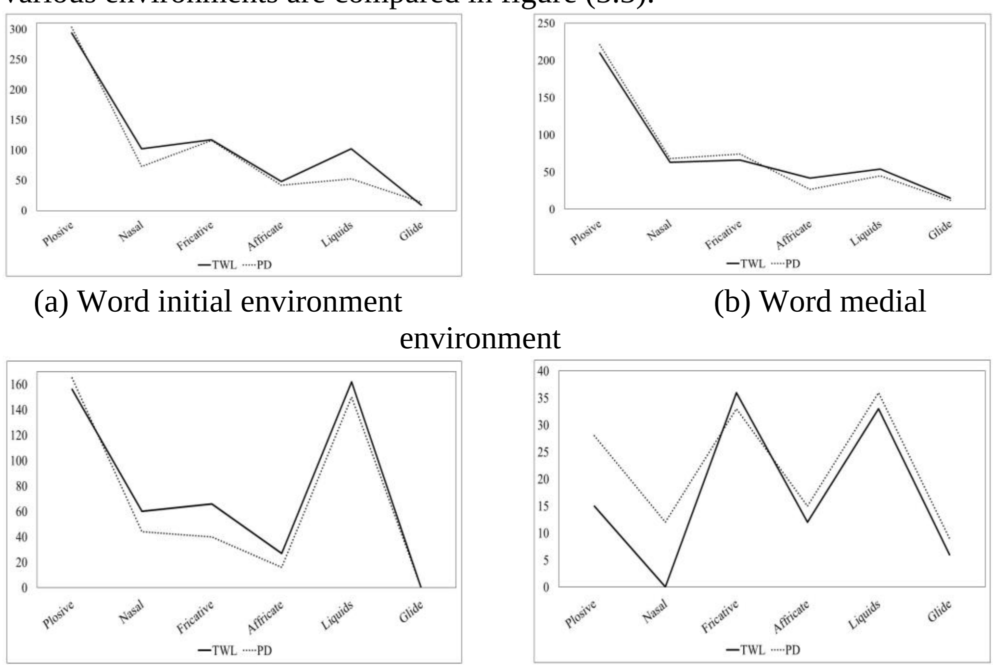
$$C_1C_2 \text{ (word final)} \begin{bmatrix} C1 & C2 \\ +fricative & +stop \\ +velar & +dental \\ -voiced & -aspirated \\ & -voiced \end{bmatrix} \rightarrow \begin{bmatrix} C \\ +stop \\ +dental \\ -voiced \end{bmatrix}$$

The word final cluster made up of a voiceless velar fricative /x/ as C_1 and a voiceless unaspirated dental stop /t̪/ as C_2 undergoes cluster reduction by retaining the latter consonant C_2.

The general tendency of preferences for retention of a cluster constituent in the descending order is stop, fricative and nasal respectively in conformity with Adnyani and Pastika (2016) and Ingram (1973).

3.5 Distribution of consonants in various environments

This section compares the occurrences of various consonant categories in four environments across the target word list and the performance data. Appendix (B) gives the overall picture of the frequencies across the two data sets. Here, we discuss each environment separately and represent the comparison of frequencies across the two data sets in the form of line graphs. The horizontal axis plots the consonant categories while the vertical axis plots the frequencies. The solid line represents the frequencies of consonant categories in TWL while the dotted line represents their frequencies in PD. The frequencies of consonants in various environments are compared in figure (3.3).



(a) Word initial environment (b) Word medial environment

(c) Word final environment (d) Intervocalic environment

Fig. 3.3: Distribution of consonants in various phonetic environments

3.5.1 Distribution of consonants in word initial environment

The line graph of distribution of consonants in the word initial environment is given in sub-figure (3.3a). The two lines start quite closely for plosives implying that their frequencies are almost same in the two data sets, that is, target word list and performance data. Contrarily, a remarkable gap is observed in the frequencies of nasals, wherein their frequencies in PD fall short of those in TWL. However, the two lines once again come closer in the categories fricatives and affricates. The lines for the frequencies of liquids exhibit a radical divide, while meeting once again at the glide. Overall, the frequencies of plosives, fricatives, affricates and glide in TWL and PD match closely, while a remarkable discrepancy is observed for those of the liquids and nasals, respectively. This mismatch owes to the phonological processes of elision (e.g. [nək] → [ək]), backing (e.g. [mət̪] → [vət̪]), stopping (e.g. [rʊk^{h}k^{h}a:] → [k^{h}ʊk^{h}k^{h}a:]), oral stopping (e.g. [mək^{h}k^{h}ʊn] → [pək^{h}k^{h}ʊn]), fronting (e.g. [mək^{h}k^{h}ʊn] → [vək^{h}k^{h}ʊn]; [rottɪ] → [vottɪ]) and lateralization ([ra:ɣ]→[la:k]). A part of this mismatch also owes to the fact that the subject did not respond to certain words (for instance, [mæɽi:], [rɪtʃ^{h}]).

3.5.2 Distribution of consonants in word medial environment

As given in sub-figure (3.3b) for the word mJedial environment, the frequencies of plosives, nasals, friJcatiJves, liquids and glide are roughly similar across the TWL and PD. On the other hand the frequencies of affricates across the two data sJets are quite apart. The phonological process of deaffrication (e.g. [pɪtʃ^{h}tʃ^{h}æ:] → [pɪʃʃæ:]) is responsible for this mismatch.

3.5.3 Distribution of consonants in word final environment

The frequencies of consonants in the word final environment are given in sub-figure (3.3c). The frequencies of plosives, liquids and glide fall quite close in both data sets. Contrarily, the word final frequencies of nasals, fricatives and affricates exhibit varying discrepancies across the TWL and PD. These discrepancies owe to the phonological processes stopping (e.g. [sɪŋ]→[sɪŋk]; [sa:f]→ [sa:p]) and deaffrication (e.g. [sətʃ]→[sæʃ]). Some target words were also no responded to in the PD (e.g. [betʃ]).

3.5.4 Distribution of consonants in the intervocalic environment

In the sub-figure (3.3d) for the intervocalic environment, the frequencies of plosives and nasals exhibit a remarkable gap, while for the categories fricatives, affricates, liquids and glide, the frequencies fall comparatively closer across TWL and PD. The mismatch in the frequencies of plosives and nasals owe to the phonological processes of oral stopping of nasals (e.g.[təŋnã:] → [təkənã:]), stopping of fricatives (e.g. [bẽɣʊ:n]→[begʊn] and epenthesis (e.g. [lədnæ̃:]→[lədenæ̃:]).

Given the unequal frequencies of various consonant categories in the target word list across various environments, these comparisons are simply descriptive in nature and no claims are intended on the basis of such comparisons. Still, they serve to give us ideas about the occurrences of these consonants.

3.6 Word Shapes

Different word shapes and their frequencies in target word list and the subject's performance are compared in table (3.3). When the frequencies of word shapes are compared in TWL and PD, a drastic decrease in monosyllables from 471 to 411; a minute decrease in bisyllables from 243 to 239; and a notable increase in trisyllables from 9 to 18 are observed. However, a greater variety of CV structures is observed in the subject's performance data in comparison to the target word list. Within the three types of word shapes, the number of CV structures increases to 17 compared to the target 12. The performance data has all the CV structures of target word list except CCVC. Further 6 new structures have been added by the subject in his performance, that is, bisyllables (CV.V), (VC.CVC) and (V.CVC); and trisyllables (CV.CV.V), (V.CV.CV) and (VC.CV.CV).

Table 3.3: Comparison of word shapes in target word list and subject's performance

Target Word List		Subject's Performance	
CV Template	**Frequency**	**CV Template**	**Frequency**
Monosyllabic	**471**	**Monosyllabic**	**411**
CV	15	CV	18
CVC	420	CVC	352
CVCC	12	CVCC	16
CCVC	6		
VC	6	VC	12
VCV	12	VCV	13
Bisyllabic	**243**	**Bisyllabic**	**239**
		CV.V	3
CVC.CV	117	CVC.CV	93
CVC.CVC	15	CVC.CVC	15

CV.CV	81	CV.CV	78
CV.CVC	6	CV.CVC	9
VC.CV	24	VC.CV	32
		VC.CVC	6
		V.CVC	3
Trisyllabic	**9**	**Trisyllabic**	**18**
CV.CV.CV	9	CV.CV.CV	3
		CV.CV.V	3
		V.CV.CV	1
		VC.CV.CV	11

The syllable patterns identified in the data are: the minimal syllable V; the open syllable CV; and the closed syllables VC, CVC, CCVC and CVCC. The following table (3.4) compares the frequencies of these syllable patterns across the target word list and the performance data. An increase in the frequencies of V, CV, VC and CVCC is observed in the data. On the other hand, the frequencies of CVC and CCVC manifest a remarkable decline. The increase in V syllables owes to the process of epenthesis whereby a vowel is added to the word (e.g. /rʊs/ CVC → /u:rʊs/ V.CVC), and initial consonant deletion whereby a word initial consonant is dropped (e.g. /ro:za/ CV.CV → /o:za/ V.CV). The increase in CV syllables also owes to epenthesis (e.g. /lədn̪æ̃:/ CVC.CV → /lədenæ̃:/ CV.CV.CV). Initial consonant deletion is also responsible for increase in VC syllables (e.g. /ro:z/ CVC → /o:z/ VC). Where the processes of epenthesis and initial consonant deletion serve to increase the frequencies of the aforesaid syllable patterns, they are detrimental to CVC syllables.

Epenthesis deprives the CVC syllable of its coda and attaches it to the onset of the following syllable with the inserted vowel serving as the nucleus. Same is the case with the initial consonant deletion as it deprives the CVC syllable of its onset. The phonological process of initial cluster reduction (that reduces the syllable initial consonant cluster to a single consonant) tends to reduce the frequency of CCVC syllables (e.g. /mroɽ: / CCVC → /mo:ɽ / CVC). The frequency of CVCC is enhanced by the addition of a plosive following a word final nasal consonant (e.g. /sɪŋ/ CVC → /sɪŋk/ CVCC).

Table 3.4: Comparison of syllable patterns in the target word list and subject's performance

Syllable	TWL*	PD**
V	2	0
CV	342	370
VC	39	56
CVC	579	495
CCVC	6	0
CVCC	12	16

* TWL= target word list
** PD= performance data

4. Discussion

The goal of this study was to profile the phonological abilities of a 6;6 year old Pahari speaking DLD subject. These abilities were gauged using a word list comprising of the consonant segments in all possible positions. The measures of phonological abilities used in this study were frequencies, percentage of consonants correct, phonological processes, consonant distribution in phonological environments and word shapes. We report that the subject was unable to realize all 30 Pahari consonantal segments established by Khan (2013) in the required positions. When he was asked to imitate a word list targeting these segments in various environments, he presented a striking amount of limitations atypical of his chronological age, testifying difficulty in phonological processing. The frequencies of consonants were compared across the target word list and the performance data. Percent consonant correct (PCC), the traditional measure of severity of SSD, was also taken into account. The errors in the performance data were analyzed in terms of the phonological processes. We proceeded to consider the phonological environments by taking into account the distribution of consonants in various phonological environments. Finally, we compared the word shapes across the two data sets, that is, TWL and PD. It was found that the child extended the range of CV templates in order to accommodate his difficulties of phonological processing.

The comparison of frequencies across the two data sets revealed remarkable discrepancies in the frequencies of certain consonants. These include retroflex stops and flap; dental stops; alveolar fricatives and liquids; velar fricatives; bilabial nasal; and voiceless affricates. One problem with the frequency count was that it did not account for the correctness of a given consonant. Due to the processes of substitution, a normal frequency count for a consonant did not necessarily mean that it was correctly realized on all instances. Therefore, it was wiser to apply more robust measure of performance accuracy, that is, percent of consonant correct. To report the PCC scores, the consonants were classified as obstruents (coronal, palatal and non-coronal) and sonorants. The subject scored high for sonorants, a majority of coronal obstruents, palatal obstruents and a number of non-coronal obstruents. There was the evidence of severe difficulty with the alveolar retroflex /ʈ/, /ʈ^{h}/, /ɖ/, /ɽ/; alveolar strident /s/; dorsal obstruents /x/, /ɣ/ and /g/ and the distributed /tʃ^{h}/.

These difficulties or errors in the articulation of consonants in various phonological environments were described in terms of eight (8) phonological processes, namely; fronting, backing, stopping, (de)aspiration, (de)voicing, (de)affrication, lingual maneuvers and cluster reduction. The processes were illustrated with the help of examples from the data. We found that the stops, liquids, fricatives and retroflex consonants were fronted to the adjacent anterior place of articulation, for instance, alveolar to labiodental and dental; labiodental to bilabial; and velar to palatal. One may reword it as they followed the principle of proximity. However, exceptional to this principle were the fricatives where the quantum of fronting was distal, that is, the change of place from extreme back of the oral cavity to the extreme front. The process of backing was observed in stops, nasal, fricatives and liquids. All other consonant categories obeyed the principle of proximity except the fricative again, which involved backing from alveolar to palatal places of articulation. The phonological process of stopping was found in fricatives and liquids. In our analysis, the processes of reversal of aspiration in stop consonants was also found, where the aspirated consonants were changed into unaspirated ones and vice versa. Similarly, the reversal of voicing feature of stops was also found in the data. Nasal stops were substituted with the oral stop in the process of denasalization. In the same vein, the change of fricatives into affricates and the other way around was also observed during the course of analysis. We introduced the term lingual maneuvers for the phonological processes occurring in consequence to various movements of the tongue affecting the airflow in the oral cavity. Interestingly, all of these maneuvers took place at the alveolar place of articulation. A possible explanation for this behavior is the closeness of the tip of tongue and the alveolar ridge where it appears easier for the tongue to manipulate its shapes and movements. Finally, we found the reduction of both word initial and final consonant clusters. In our data the consonants favored for retention were stops, fricatives and nasals respectively, which is in line with the previous studies. Owing to these phonological processes, the mismatches of varying degrees were noted in the distribution of certain consonants in various environments.

Our target word list was made up of three types of word shapes namely, monosyllables, bisyllables and trisyllables, and 12 different CV structures. In the subject's performance of the word list, a remarkable decrease in the frequency of monosyllables, slight decrease in bisyllables and a noteworthy increase in trisyllables was observed. Despite an overall decrease in word shapes, a remarkable increase from 12 to 17 in the CV structures was found in our data. CCVC was the only structure in the target word list that we did not find in the performance data. On the contrary, 6 new CV structures were added namely, bisyllables (CV.V), (CV.CV.V), (VC.CVC), and (V.CVC); and trisyllables (V.CV.CV) and (VC.CV.CV). These new templates owed to difficulties in the production of certain target words and certain phonological processes (e.g. [pjɑːr] CCVC [pɪ.ɑː] CV.V and /lədֽ.næ̃ː/ CVC.CV /lə.dֽe.næ̃ː/ CV.CV.CV).

The target word list was made up of six different types of syllable patterns namely, CVC, CV, VC, V, CVCC and CCVC in the descending order of frequencies. Overall, the subject preserved the comparative frequency of the syllable patterns except for CCVC. The comparison of performance data with the target word list revealed that the differences were more conspicuous at the phonemic level than at the structural level, that is, syllable. Our findings for the irregularities at the level of syllables are consistent with that of Bankson and Bernthal (1990b) and Bernthal et al. (2017) who identified syllable structure processes such as final consonant deletion, cluster simplification / reduction and weak syllable deletion. We also reported that the syllable-level difficulties of the subject owed to these phonological processes, however, the process of initial consonant deletion was more remarkable than the final consonant deletion.

Research has suggested that the children employ selection (preference) of sounds types and syllables as well as avoidance of others to overcome language learning difficulties (Edwards & Shriberg, 1983; Ferguson, 1978; Weiner, 1981a). Our findings are consistent with these studies in such that the subject demonstrates preference as well avoidance of certain consonants in various phonological environments.

5. Summary

To summarize this independent analysis of the phonological abilities of a DLD subject, we conclude that the remarkable irregularities were found in the subject's performance of a word list made up of Pahari segments. These irregularities were explored from various vantage points as recapitulated in the following lines.

First, some remarkable disparities in the frequencies of certain consonants set the ground for further robust analysis of the phonological data. Consequently, the conventional "percentage of consonant correct" (PCC) was employed to gauge the severity of articulatory difficulties. The subject scored high for most of the sonorants, and coronal and palatal obstruents as well as a few non-coronal obstruents, respectively. All Pahari retroflex consonants /ʈ/, /ʈ^{h}/, /ɖ/, /ɽ/; alveolar strident /s/; dorsal obstruents /x/, /ɣ/ and /ɡ/ and the distributed /tʃ^{h}/ evidenced severe difficulty on the PCC index.

Second, in the illustration of errors of consonants in terms of the phonological processes we found that the place changing processes such as fronting and backing obeyed the principle of proximity except for the fricatives. Fricatives apart, all other consonant categories either fronted or backed to the nearest possible place of articulation. Along with the processes of stopping, (de)aspiration, (de)voicing, denasalization and (de)affrication; we also discovered the processes involving lingual maneuvers (term coined herein). Used as a cover term for the processes of lateralization, trilling and retraction, all instances of lingual maneuvers took place at the alveolar place of articulation, possibly on the account of close contact between the tongue tip and the alveolar ridge in the resting position.

Third, the distribution of certain consonants in various environments also reflected discord between TWL and PD. The difficulties in the production of certain words and the ensuing phonological processes resulted in the expansion of word shapes where 6 new shapes were added as; bisyllables (CV.V), (CV.CV.V), (VC.CVC), and (V.CVC); and trisyllables (V.CV.CV) and (VC.CV.CV). The syllable structure phonological processes such as final consonant deletion, cluster reduction and weak syllable deletion were also found in the data.

Finally, we acknowledge that the findings from this study of a single child are unworthy of generalizations. Similarly, we failed to capture the phenomenon of bilingualism at the child's household and its consequences to the present study as Urdu was the second language of the child. In the absence of normative data on Pahari phonology, we did not measure the child's performance on the touchstone of language learning milestones. Future studies might look into the cross-phonological influences on the acquisition of Pahari language. We also suggest cohort studies of both typically developing and speech delayed children to establish normative guidelines and enable relational studies. One might also consider the acquisition of Pahari vowels.

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Appendix A: Errors in the articulation of consonant

	Replacement			Word Initial			Word Medial			Word Final		
	WI	**WM**	**WF**	**TW**	**PD**	**ENG**	**TW**	**PD**	**ENG**	**TW**	**PD**	**ENG**
Fronting												
ʈ →	t̪	t̪		/ʈʊr/	/t̪ʊr/	walk	/kəʈʈa:/	/kət̪t̪a:/	calf			
ʈʰ →		t̪ʰ	t̪ʰ				/əʈʰʈʰa:/	/ɦət̪ʰt̪ʰa:/	waist belt	/pəʈʰ/	/pət̪ʰ/	goat
d →	d̪	d̪	t̪	/dəb/	/d̪əb/	house	/ədda:/	/əd̪d̪a/	bus station	/lɑ:d/	/lɑ:t̪/	caress
r →	v			/roʈʈI/	/voʈʈI/	bread						
f →			p							/sa:f/	/sa:p/	neat
x →	ʃ			/xʊʃ/	/ʃʊʃ/	happy						
ɣ →	v	v		/ɣossa:/	/vʊʃʃə/	anger	/tʃẽ:ɣʊn/	/tʃi:vən/	tomato			
ɽ →	r	l	r	/ɽu:t̪/	/ru:t̪/	blockhead	/so:ɽɪ/	/ʃo:lɪ/	narrow	/po:ɽ/	/po:r/	catch
ʃ →		s					/re:ʃa:/	/re:sa:/	phlegm			
Backing												
p →		ʈʰ					/pʊʈʰʈʰa:/	tʰʊt̪ʰt̪ʰa:	wrong			
m →	v			/məkʰkʰʊn/	/vəkʰkʰʊn/	butter						
d̪ →	d			/d̪a:l /	/da:l/	pulses						
s →	ʃ	ʃ		/sep/	/ʃep/	snake	/ləssI/	/ləʃʃI/	yougart milk			
z →	j			/zær/	/jær/	poison						
r →			ɽ							/kʰəppʊr/	/kʰəppʊɽ/	a bird
x →	ɦ			/xʊʃ/	/ɦʊʃ/	happy						
Stopping												
z →			k							/ra:z/	/a:k/	secret
x →	kʰ		kʰ	/xɑ:b/	/kʰɑ:b/	dream				/li:x/	/li:kʰ/	lice
			k							/me:x/	/me:k/	nail
ɣ →		g					/bẽ:ɣʊn/	/begʊn/	bringal			
			k							/ra:ɣ/	/la:k/	melody
r →	kʰ			/rʊkʰkʰa:/	/kʰʊkʰkʰa:/							
	d̪			/rəb/	/d̪əb/	God						
l →	d̪		d̪	/lət̪/	/d̪ət̪/	leg				/kʰo:l/	/kʰo:d̪/	open
(De)Aspiration												
p →	pʰ			/pət̪ʰt̪ʰʊr/	/pʰət̪ʰt̪ʰʊr/	stone						
t̪ʰ →	t̪		t̪	/t̪ʰʊk/	/t̪ʊk/	spit				/ɦət̪ʰ/	/ɦət̪/	hand
kʰ →	k		k	/kʰən/	/kən/	dig				/məkʰ/	/mək/	fly
(De)Voicing												
p →	b			/pəg/	/bək/	turban						
d̪ →			t̪							/zId̪/	/zIt̪/	insistence
d →			ʈ							/bəd/	/bəʈ/	wheat straw
s →			z							/ma:s/	/ma:z/	flesh
v →	f			/vItʃ/	/fItʃ/	within						
k →	g			/kədʒ/	/gədʒ/	cover (it)						
kʰ →	g			/kʰəbbʊl/	/gəbbʊl/	grass						
g →			k							/əg/	/a:k/	fire
Denasalization												
m →	p			/mət̪ʰt̪ʰa: /	/pət̪ʰt̪ʰa:/	forehead						
→	b			/məgga:/	/bəgga:/	cup						
n →	d̪			/nəkka:/	/d̪əkka:/	ridge						
ŋ →		k					/t̪əŋnã:/	/t̪əkənã:/	to lift			
(De)Affrication												

	Replacement			Word Initial			Word Medial			Word Final		
	WI	**WM**	**WF**	**TW**	**PD**	**ENG**	**TW**	**PD**	**ENG**	**TW**	**PD**	**ENG**
ʃ →			tʃ							/xʊʃ/	/ʃʊtʃ/	happy
tʃ →			ʃ							/sætʃ/	/sæʃ/	truth
tʃʰ →	ʃ	ʃ		/tʃʰa:p /	/ʃa:p/	ring	/pɪtʃʰæ:/	/pɪʃʃæ:/	behind			
Lingual maneuvers												
Lateralization												
n →			l	/bʊn/	/bʊl /	down				/bʊn/	/bʊl /	down
r →	l			/rəkʰ/	/ləkʰ/	keep (it)						
Retraction												
r →			ɽ							/kʰəppʊr/	/kʰəppʊɽ/	a bird
Trilling												
l →			r							/ʈʰel/	/ʈʰer/	dismantle
Cluster Reduction												
rf →			f							/bərf/	/bəf/	snow
mr →	m			/mro:ɽ /	/mo:ɽ/	cramp						
xt̪ →			t̪							/sext̪/	/ʃət̪ /	hard

WI = word initial WM = word medial WF = word final TW= target word
PD = performance data ENG = English meaning

Appendix B: Distribution of consonant categories across different

	Word initial		Word medial		Word final		Intervocalic	
	TWL	**PD**	**TWL**	**PD**	**TWL**	**PD**	**TWL**	**PD**
Plosive	294	303	210	221	156	165	15	28
Nasal	102	73	63	68	60	44	0	12
Fricative	117	116	66	74	66	40	36	33
Affricate	48	42	42	27	27	16	12	15
Liquids	102	52	54	45	162	150	33	36
Glide	9	14	15	12	0	0	6	9