

Phonetic and Phonological Description of Affricates in Pāli – Sanskrit

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Abstract

Affricates are the problematic sounds in phonetics and phonology to define whether they are single segments, bisegmentals, or clusters. This article aimed to study the phonetic and phonological description of affricates in Pali Sanskrit in three fields of study such as articulatory, acoustic, and auditory phonetics with the discussion of linguists to categorize the affricate class by phonological theories such as formal distinctive feature and autosegmental with the case study of Pāli – Sanskrit sound change. The main findings were affricates produced by constriction and release with two distinctive features: stop and fricative. According to SPE, it is classified as [+continuant] [+strident]. In Pāli – Sanskrit, it is frequently found the palatalization assimilation from the cluster of dental stops together with post-alveolar approximant [j] that leads to the feature of stop with the release sound of fricative.

Keywords: Phonetics; Phonology; Affricate; Pali; Sanskrit

Introduction

Sanskrit Phonetics was primarily described by ancient scholar of India called ‘Pāṇini’ (approximately 200 BCE). Thanks to the concept of restrictedly well-formed pronunciation of chanting to be able to connect to gods directly, it is required for Brahmin to produce sound correctly and orally preserved pronunciation so that we can rely on the phonetic and phonological

description from ancient documents. In this article, affricate sound is mainly focused because it is one of the arguable sound patterns in many languages, while in Sanskrit it is unclear to indicate the specific class of affricates from the ancient treatises together with the commentators.

In oral tradition of Sanskrit, there is a phoneme recitation ‘Akṣarasamāmnāya’ called ‘Māheśvara Sūtrāṇī’ or well-known as ‘Shiva Sutra’. This is the world oldest known of Phonetics. The recitation is composed of 14 verses that are the phonemes separated by their natural classes, each verse ended by single dummy letter or ‘anubandha’ the mark the end of the class. It is said in brief formula as ‘iKo yaN aCi’ (Aṣṭādhyāyī 6.1.77). That shows the way to change the sound by strengthening the sound or fortition when there is phonotactic with other letters; for example, ‘[i] > [j]’ | _aC’ that means /i/ will vary to /ja/ when it is placed before /a/ and may be followed by any consonant.

$$[i] > [j] \mid _aC$$

$$\text{adhi} + \text{āśraya} > \text{adhyāśraya} \text{ (Sk.)}$$

$$\text{adhi} + \text{āsaya} > \text{ajjhāsaya} \text{ (P.)}^2$$

According to the example above, we can see the difference of Pāli and Sanskrit words. In Sanskrit, the phonotactic compound changes the vowel to semivowel and becomes cluster. On the other hand, it is changed from voiced aspirated dental [dh] together with high front vowel [i] to another place of articulation of consonant called palatalization. There are plenty of compound words in Pāli and Sanskrit. But it is questionable whether the changed sound is a cluster or single consonant or gemination.

Affricates are the arguable consonant sounds which are defined variously whether they are clusters or single initials because they behave like stop. In Pāli–Sanskrit, it is treated as stop, but actually it plays the role of mergers from double articulation. As Pāṇini’s explanation of cluster लोऽनन्तराः संयोगः halo ‘nantarāḥ saṁyogaḥ’ ‘Consonants unseparated by a vowel are called conjunct consonants.’ (Sumitra M. Katre, 1987) is still unclear, and there are many

¹ According to the IPA script, it is normally transcribed as [y] in Sanskrit – Romanization system.

² ‘j’ is due to Romanized Pāli –Sanskrit that may represent [dʒ] (in this paper Sanskrit – Romanization pattern will be generally used) where *ajjhāsaya* = [atdʒa:saja].

Pāṇini terms to describe phonetic features of alphabet; for instance, the letters were categorized by the place of articulation (*sthāna*) and manner of articulation (*karaṇa*) including voice, aspiration, length, stress, intonation, and so on. The affricates were just described their place and manner; that is, *jihvā-madhyena* (middle tongue) and external effort features; openness (*vivṛta*) of glottis, breathed (*śvāsa*) emission, voiceness (*ghoṣa- aghoṣa*), and tone (*nāda*) (Bare, 1975).

This is problematic among many linguists because it is realized as two segments including stop or plosive and fricative. In 1952, Roman Jakobson, Fant, and Halle proposed the way to describe affricates by binary distinctive features of formal abstract manner such as [+consonant] or [-consonant], [+continuant] or [-continuant], and their proposal was that affricates are the single non-interrupted (stop) segments with [+strident] feature. However, this is still controversial as many linguists proposed different solutions especially when Lacharité (1992) and Kim (1997) had proved ‘non-strident’ feature of affricates is found in High Old German.

This paper aims to discuss about the phonetic findings and phonological analysis of affricates. To illustrate, Pāli-Sanskrit languages are raised to apply the analysis, so this paper is organized in 3 parts: namely, the articulatory and acoustic phonetic description, literature review on phonological analysis, and the affricates in Pāli-Sanskrit.

To begin with articulatory and acoustic phonetic description, affricate is defined as ‘a consonant sound that consists of a plosive and then a fricative made in the same place in the mouth: The “ch” sound at the beginning and end of “church” is an affricate.’ (Cambridge Dictionary³) As it is a combination of two distinctive features that are plosive and fricative, two distinctive manners of articulation are produced.

In general, every speech sound is described by the specific components of articulatory gestures; namely, airstream mechanism, state of the larynx, state of the velar port, combination of active and passive articulator or place of articulation, and manner of articulation. For consonant sound, it is produced by airstream mechanism. At first, the air flows from lung to vocal tract (pulmonic egression). When the air flows along the glottis, different gestures of articulation can cause the different phonation types such as voiced or unvoiced sounds due to the vibration of

³Cambridge University Press. (n.d.). affricate. In *Cambridge dictionary*. Retrieved November 10, 2023, from <https://dictionary.cambridge.org/dictionary/english/affricate>

vocal fold. If the vocal fold vibrates, it produces the voiced sound. In contrast, when the airflow is blocked, it makes the obstruent sound including plosives, fricatives, and affricates. Then, the difference between each obstruent sound is to describe as follows.

As affricates is combined with two segments such as plosives (stop) and fricative respectively but simultaneously pronounced, we can notice the cues of plosive segment followed by fricative. Plosive or oral stop sounds are produced by obstructing the airflow from mouth; in other words, closure of active and passive articulators such as [p] (lower and upper lips), [t] (tongue front to alveolar ridge), [k] (tongue body to velum). When we produce ‘affricates’ sound; for instance, ‘ch’ or [tʃ] sound, tongue front is firstly placed behind alveolar ridge then lower the tongue front to let the air exit from mouth. The latter articulation gesture is the feature of fricative which we can produce by not complete closure of articulators and leaving the narrow gap opened and forced air to flow through narrow channel. In addition, sibilant or dental fricative in Pāli (also alveolar and retroflex fricatives in Sanskrit) is called ‘usuma’ in Pāli, and ‘uṣman’ in Sanskrit to explain the way to produce the sound of letters श् [ɕ], ष् [ʂ], स् [s] and ह् [h]⁴ as it releases like the sound of steam from the boiled water pot on which the lid is put, and the hissing sound of steam out of the pot.

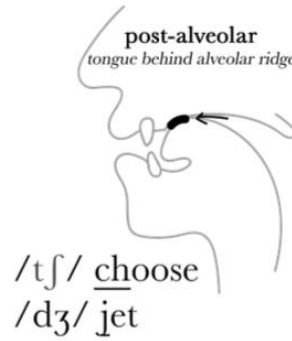


Figure 1. the articulation to produce affricates in English

⁴ (in gram.); see ऊष्मन्. ऊष्माणमिन्द्रियाण्याहुरन्तस्था बलमात्मनः Bhāg.3.12.47.

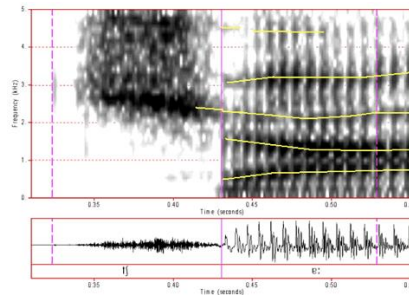


Figure 2. spectrogram of /t/

Thanks to the acoustic studies, it is evidentially seen by the spectrogram and waveform. Moreover, Ashby (2011) has indicated the ‘hold phase’ during the change of stop to fricative manner of articulation.

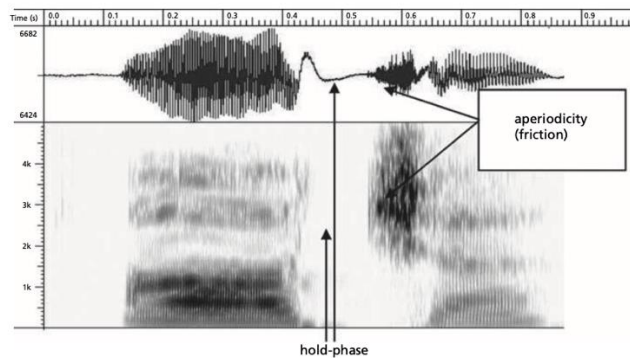


Figure 3. Speech waveform and spectrogram indicating the hold phase and aperiodicity (friction) due to the utterance of archer [a:tʃə] (Ashby, 2011)

In addition, Jovicic, Punisic, and Saric (2008) have detected the time – frequency in fricatives and affricates by time–frequency representation by FFT power spectra, time–frequency representation by AR–Burg power spectra, and power trajectory of signals in characteristic frequency bands.

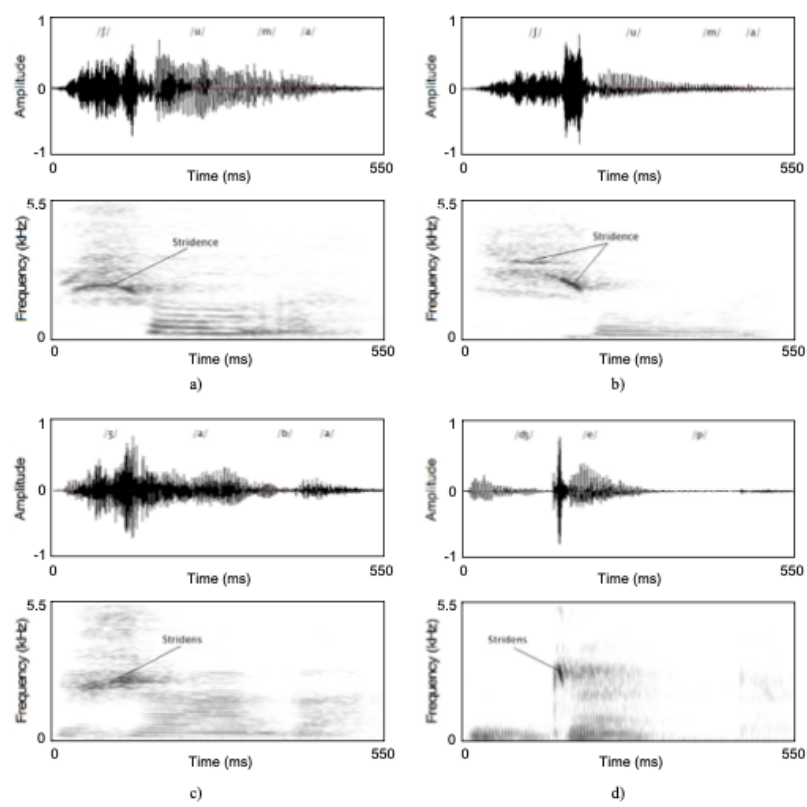


Figure 4. Examples of stridence: a) typical stridence, b) double stridence, c) harmonic stridence, and d) very short and strong stridence.

The example in the figure 4d shows that the sound *[dʒep]* in Serbian produced with very short and changeable time frequency. In Serbian languages, stridence frequently appears with the fricatives */ʃ/* and */ʒ/* within the frequency range of 2000 to 4000 Hz, with the fricatives */s/*, */z/* and */ts/* with the frequency range between 6000 – 9000 Hz, with the affricates */tʃ/* and */dʒ/* in the frequency range from 3000 to 8000 Hz, and affricates */tɕ/* and */dʑ/* with frequency range between 3000 to 8000 Hz. Furthermore, the resonant occurrence of stridence is with a spectral band between 26 to 250 Hz, and intensity approximately 20 dB above the envelope of the surround spectrum. Besides, the minimal duration is about 10ms and the maximum duration is up to $\frac{3}{4}$ of the duration of friction and affrication, strong correlation between spectral and amplitude manifestation exists. According to such characteristics of stridence, the researcher had conducted the experiment by TF–SD algorithm with 15 participants of stridence tests and 15 participants with non-stridence finding that there is the distribution of stridence across fricatives and affricates as follows: */ʃ/* – 8, */ʒ/* – 4, */tʃ/* – 2, and */dʒ/* – 1 and all stridents were strong. This study can be applied to diagnose and rehabilitate more precisely.

In addition, Pycha (2009) also studied about the duration of affricates produced by 14 Hungarian speakers finding lengthening of affricates where the affected portion is near to the edge or boundaries, and it also lengthening after the geminating suffix.

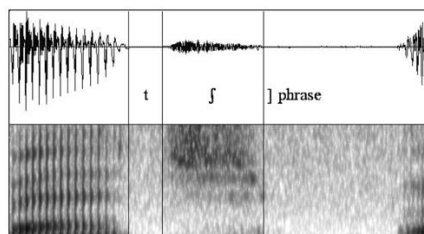


Figure 5. Segmentation of the alveolar affricate [tʃ] in *becs* 'honor' in phrase-final position (Pycha, 2009)

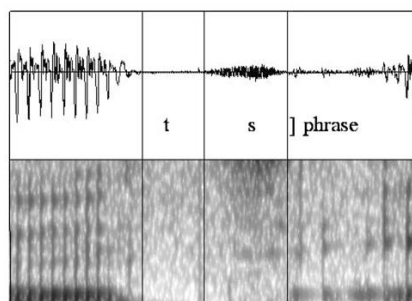


Figure 6. Segmentation of the alveolar affricate [ts] in *tekno* "tortoise" in phrase-final position. (Pycha, 2009)

According to the articulation gestures explanation above, we can see how different to produce obstruent sounds that leads us to discuss the empirical criteria to determine the characteristics of affricates acoustically. In English, Gimson, and Cruttenden (2001) suggest that there are two phonemes of affricate sounds such as [tʃ] and [dʒ] as in 'cheese' (voiceless palato-alveolar affricate) or 'joke' (voiced palato-alveolar affricate). Dorman, Raphael, and Isenberg (1979) conducted the experiment to identify acoustic cues between fricative and affricate contrast in word-final position (as in 'dish' and 'ditch'). They prepared the computer-edited natural speech tokens of 'dish' and 'ditch' to test the perception of the audience. It was found that the variables to identify fricatives or affricates were temporal and/or spectral characteristics of the vocalic interval; duration of a silent interval; presence or absence of a release burst; rise-time of the fricative noise and the duration of the fricative noise. The results show neither a single acoustic property detector nor a single natural category can satisfactorily account for the perception of fricatives and affricates. In the following figure, we can see the aspiration phase of /tʃ/ after 0.1

seconds that the duration is similar to voiceless stops even when comparing with the spectrogram of *tʃ*.

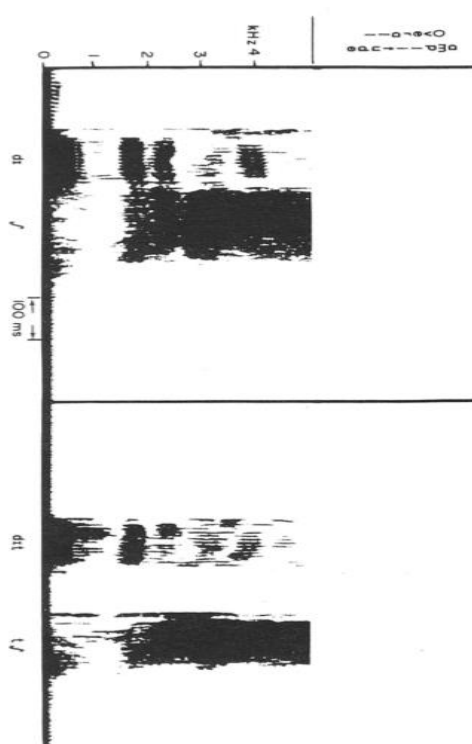


Figure 7. Spectrograms of a male speaker's productions of "dish" (left) and "ditch" (right) showing contrastive acoustic features which may be relevant in perception of the fricative–affricate distinction

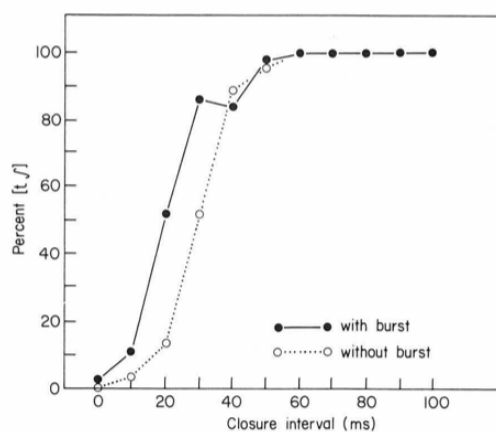


Figure 8. Effect of closure duration and presence or absence of a release burst on listeners' identifications of stimuli as "dish" or "ditch".

Due to the figures above, Dorman et al. (1979) had designed the experiments by Pattern Playback speech synthesizer to investigate the perception of utterances and acoustic cues as follows; the release burst, the rise-time of the fricative noise and the duration of the fricative noise. (Bailey & Summerfield, 1978) The experiment 1 was conducted to find whether two aspects of fricative noise onset- the release burst and the rise-time of the fricative noise have perceptual salience in the contrast between fricative and affricate in word-final position. The result in figure 7, we see that the vocalic portions of the two utterances differ in duration (Isenberg, 1978) as well as in the degree of formant movement preceding the closure.

The following experiments were designed to determine the effects of each of the acoustic described above on the perception of the fricative-affricate contrast. In summary, these variables are: (a) the vocalic portion of the utterance, (b) the duration of the closure interval, (c) the presence of a release burst, (d) the rise-time of the fricative noise amplitude envelope and (e) the duration of the fricative noise.

Furthermore, Ferrero, Pelamatti, and Vaggies (1982) had studied continuous and categorical perception of a fricative-affricate continuum. They designed the experiments by synthetic speech stimuli /sa-tsa/ and /f_a-t f_a/ which are systematically different by duration of frication with the hypothesis that a continuous noise of fricatives in case they were rendered prominently for the discrimination task by additional stimuli of shortened duration in the continuum, would be perceived. The findings were suggested the availability of acoustic information in auditory memory is immaterial for producing continuous perception in a discrimination task. However, the particular continuum could not be drawn. The results obtained in both experiments for the stimuli having the shortest frication showed a significant difference between obtained and predicted discrimination functions. The ratio between the duration of the frication noise and the duration of the entire stimulus are suggested by the result.

Aforementioned study can contribute to the discrimination between fricative and affricate sounds. On the other hand, it can be described phonologically as the systematical occurrence of affricates whether not cluster but monosegmental phonemes according to Clements (1999) conclusion as following criteria; namely, phonotactics, tautosyllabicity, noncompositionality, noncommutivity, inalterability, inseparability, and contrastivity.

For phonotactics, in case of bisegmental stop + fricative sequences are not allowed, affricates occur as the single stops. Moreover, affricates pose as onsets whereas the stop + fricative are posed as coda + onset sequences for their tautosyllabicity. Besides, affricates are two

independently occurring phonemes, while the cluster of stop and fricative sequence cannot be decomposed. Furthermore, affricates can be commuted with another phoneme, and affricates cannot be applied with the rules of cluster. In addition, the stop + fricative sequences are inseparable by mechanic of sound change such as epenthesis, reduplication etc. Lastly, there is contrastive corresponding sounds between affricates and stop + fricative sequences in some languages e.g. Czech, Polish. According to the criteria to determine the cluster and affricates as monosegmental phonemes, this paper is to analyze the case in Sanskrit and Pali sound changes in the following session.

Research Objective

To investigate the linguistic feature of affricate in Pali and Sanskrit according to ancient and modern linguists' explanation.

Research Results

Regarding the palatal plosives, the pronunciation is a matter of debate. In contemporary attestation, the palatal plosives are a regular series of palatal stops, supported by most Sanskrit sandhi rules. However, the reflexes in descendant languages, as well as a few of the sandhi rules regarding *ch*, could suggest an affricate pronunciation *jh* was a marginal phoneme in Sanskrit, hence its phonology is more difficult to reconstruct; it was more commonly employed in the Middle Indo-Aryan languages as a result of phonological processes resulting in the phoneme.

Affricates in Pāli – Sanskrit

Due to the previous studies, the production and perception of affricates were described by their contrast and conjunction among fricatives as well as stops. To be more focused on Pāli-Sanskrit aspect, firstly we may insist that oral tradition of Pāli-Sanskrit transmission was significant and systematically described. In Hindu, it has been required that every Hinduist must follow the *Āśram* principles according to ved *āṅga* to begin with *śikṣā*. In *śikṣā*, there are explanation of Sanskrit alphabets more than two thousand years ago. As aforementioned about Pāṇini's description of Sanskrit alphabets, they are vertically and horizontally discriminated.

In **Śikṣā**, it can be called as subject of Phonetics including 6 lessons such as phonetics, phonology,

ॐ शिक्षां व्याख्यास्यामः ।

वर्णः स्वरः । मात्रा बलम् ।

साम सन्तानः । इत्युक्तः शिक्षाध्यायः ॥ १ ॥

Om! We will explain the Shiksha.

Sounds and accentuation, Quantity (of vowels) and the expression (of consonants),

Balancing (Saman) and connection (of sounds), So much about the study of Shiksha. ॥ 1 ॥

— Taittiriya Upanishad 1.2, Shikshavalli, Translated by Paul Deussen

The organization of Sanskrit alphabets is called '**varṇamālā**' (*vəɽṇma:la:*), 'the garland of phonemes'. It is divided into two parts: the open sounds, or vowels, called svar (*svəɽ*) and closed sounds, or consonants, called 'vyañjana' (*vjəndʒən*). There are classes of alphabets by place of articulation called '**sthāna**' (Skt.) or '**ṭhāna**' (Pāli) and active articulators such as effort to produce sounds called '*prayatana*' '**karaṇa**'. effort required to produce them (prayatana – *prəjəɽn*); the duration (kaal – *ka:l*) of sound; and whether it is reflected, attenuated or amplified (**karaṇa** – *kəɽəṇə*). The consonants are classified in five symmetrical vargas (*vərgə*), or classes, plus glides, sibilants and an aspirate. The five vargas are called sparsh '**spṛṣṭa**' (*spəɽf*) or '**samphuṭṭha**', touch consonants, meaning they need contact of the tongue and roof, thereby becoming stops or affricatives.

However, it is conceived in Indian linguistic tradition, there are five passive places of articulation: Ko**ṇṭ**hya: Velar, Tā**ḍ**hya: Palatal, Mū**ṛ**dhyā: Retroflex, Dantya: Dental, Ō**ṣṭ**hya: Labial. Besides, there are double articulation of such places as; Dant'o**ṣṭ**hya: Labio-dental (e.g.:

v), Kantat^āavya: e.g.: Diphthong e, Ka^{ṇṭōṣṭ}hya: labial–velar (E.g.: Diphthong o). In addition, there are three active places of articulation: Jihv^ām^ūla: tongue root, for velar, Jihv^āmadhya: tongue body, for palatal, Jihv^āgra: tip of tongue, for cerebral and dental, Adh^{ōṣṭ}ha: lower lip, for labial. Finally, the effort (or manner) of articulation (Ucc^āra^ṇa Prayatna) is of two types for consonants, B^āhya Prayatna: External effort, Sp^{rṣṭ}a: Plosive, ^īshat Sp^{rṣṭ}a: Approximant, ^īshat ^{sa}m^{vṛ}ta: Fricative, Abhyantara Prayatna: Internal effort, Alpapr^āṇa: Unaspirated, Mah^āpr^āṇa: Aspirated, ^śv^āsa: Unvoiced, N^āda: Voiced. Due to the description, it can be compared to IPA system as follows.

Place of Articulation	Voiceless		Voice		Voice	Voiceless	
Aspiration	Unaspirated	Aspirated	Unaspirated	Aspirated	nasal	Glide/Rhotic/ Lateral	Sibilants
gutturals	क <i>k</i> [k]	ख <i>kh</i> [k ^h]	ग <i>g</i> [g]	घ <i>gh</i> [g ^h]	ङ <i>ṇ</i> [ɳ]	ह <i>h</i> [h]	ः <i>ḥ</i> [ɬ]
Palatals (Alveolo– Palatal)	च <i>c</i> [t͡ʃ]	छ <i>ch</i> [t͡ʃ ^h]	ज <i>j</i> [d͡ʒ], [j]	झ <i>jh</i> [d͡ʒ ^h], [j ^h]	ञ <i>ṇ</i> [ɲ]	य <i>y</i> [j]	श <i>ś</i> [ɕ]
Cerebral	ट <i>ṭ</i> [ɽ]	ठ <i>ṭh</i> [ɽ ^h]	ड <i>ḍ</i> [ɖ]	ढ <i>ḍh</i> [ɖ ^h]	ण <i>ṇ</i> [ɳ]	र <i>r</i> [r]	ष <i>ṣ</i> [ʂ]
Dental/Alveolar	त <i>t</i> [t̪]	थ <i>th</i> [t̪ ^h]	द <i>d</i> [d̪]	ध <i>dh</i> [d̪ ^h]	न <i>n</i> [n]	ल <i>l</i> [l]	स <i>s</i> [s̪] [s]
Labials	प <i>p</i> [p]	फ <i>ph</i> [p ^h]	ब <i>b</i> [b]	भ <i>bh</i> [b ^h]	म <i>m</i> [m]	व <i>v</i> [v] [ʋ]	

Figure 9. Classification of Sanskrit consonants, with IPA 1993 equivalents (adapted from Kalpesh, 2007)

Thus, we can see that Sanskrit alphabets are well arranged in all the three categories of consonant classifications – namely, voicing state, manner of articulation and place of articulation. In the first 25 sparsh (*spərʃ*) consonants, the first two vertical columns of /k/, /tʃ/, /t/, /t̪/, /p/ and their aspirates /kʰ/, /tʃʰ/, /tʰ/, /t̪ʰ/, /pʰ/ are voiceless; and the last three columns /g/, /dʒ/, /d̪/, /d̪/, /b/ and their aspirates /gʰ/, /dʒʰ/, /d̪ʰ/, /d̪ʰ/, /bʰ/ and nasals /ŋ/, /ɲ/, /ɳ/, /n/, /m/ are voiced.

Furthermore, they are classified as non-aspirate alp-praan (*əlpəpraŋ*) or aspirate *mahāprāṇa* (*məha:praŋ*) to define whether the breath is held back or thrown out. In addition, Kalpesh (2007) noted that the first and third columns are stops, while the second and fourth columns are corresponding stops with aspirates, regardless those in the second row of /tʃ/ which are all affricatives. Besides, the second and fourth columns also contain sounds that can be fricatives – for example, /θ/, /ð/, /f/ etc. Kalpesh also noted that each class or varga of five consonants is arranged from back to front – starting with velars, palatals, retroflex, alveolar, bilabials and labiodentals. Even glides /j/, /r/, /l/, /w/ and sibilants /ʃ/, /ʒ/, /s/ are arranged back to front.

Sounds are also arranged regarding the force or the effort required. The effort of sound production has been decreasing from left to right. There are also explanations of hard or soft sounds such as kathor (*kəṭʰor*), or hard sounds like /k/, /tʃ/, /t/, /t̪/, /p/; and mridu (*mṛ̥ḍu*), or soft sounds like /g/, /dʒ/, /d̪/, /d̪/, /b/. In addition, there is also description of glides as they are called ‘ishat sparsh’ (*ʃəṭ sparʃ*), or very light touch, thereby called semivowels. Further, /j/ is semivowel of /l/, /r/ of /å/ and /l/ of /lå/ and /w/ of /u/. Lastly, sibilants are explained as ushmaan (*uʃman*), or warm sounds, as they produce warmth at the point of production, indicative of fricative nature.

Seeing that there is well-organized description of the sound system in Sanskrit. However, there is no clear explanation of affricates, and they treat affricates as one of stop while there are not only the sound of /tʃ/ or /dʒ/ that are included in stop class, but also the cluster sound such as kʃ that is always occurred together and finally the Devanagari script has mixed it up as one of cluster alphabets with different form as क्ष. Thus, this paper is to discuss about how they conceive the stop, affricates, or cluster by phonological rules.

It is sure that /tʃ/, /tʃʰ/, /dʒ/, /dʒʰ/ behave as stops, they can be both onset and coda, but not for the aspirated ones because of the ease of articulation to produce aspirated sound

before unaspirated sounds. When they become geminates, the sound can be metathesis such as /itʃʰ/ > /ittʃʰə/ ‘need’ where the underlying form of /itʃʰ/ is aspirated affricates but when it is naturally produced, it becomes /t/ as stops final.

To study Pāli and Sanskrit is not a synchronic study; of course, it is diachronic one. Thus, the way to study sound production is to study sound changes from the evidence of language variation distribution in Indian languages or other language influenced by Pāli – Sanskrit sound system. The importance of studying affrication is applied to investigate the sound changes that separate the Indian languages and Iranian languages; that is, depalatalization, and deaffricatization as Zoller, C. P. (2016). Furthermore, another importance to study affricates is to study sound changes interlingually from Sanskrit to Pāli or other Prakrit scripts.

The studies of affricates sound change were primarily studied by many scholars. The early one is that of Bloomfield, L. (1911) One of interesting earlier studies is of Turner, R. L. (1936). He composed the article noticing about ‘ā-kṣeti’ (Skt.) that becomes ‘acchati’ (Pāli or Prakrit) in many modern Indo-Aryan languages. Normally the sound /kṣ/ in Sanskrit as the initial can become /kh/ in Pāli or other Prakrit, while in this case it is posed as the geminates (the final and initial of another syllables). It is rare case where /kṣ/ can be /cch/ in lexicography of Sanskrit, but this word is widely distributed in many Prakrit dialects.



Figure 10. Map illustrating the distribution of *ā-kseti* (Skt.) to *acchati* in Modern Indo-Aryan languages.

Due to such case, we can assume that /kṣ/ with the intervocalic environment can become two consonants such /c/ as final and /ch/ as initial of another syllable. Thus, this case the sound of /kṣ/ may be included in cluster while the sound of /ch/ is not as it is individually separable. Furthermore, in more recent studies, Levman, (2016) stated that the affricate/cluster **ṣ** becomes a simple voiced fricative [z]. In most Prakrits the affricate kṣ > ch or kh (Pischel §317); In G it was pronounced as a retroflex fricative [ṣ̣] (Bailey, 1946) which is corroborated by Chinese transliterations (Levman, 2014).

Moreover, the sound perception can also be found in transcription; for instance, Kumārājīva transliterated the sound of /ks./ in word ‘aks.aye’ found in the dhāran.ī as 惡叉邏 è chā luó (PB: ʔak-t͡ɕʰai /t͡ɕʰɛ-lə= aks.ara). This indicates that he conceived -ks.- as conjunct, for -k- is an allowed final in EMC. For ks.aye and aks.aye, he transcribed with a retroflex affricate sound

tṣhai- and with *aks.in.e* he uses a velar stop with a glide *-gji-*. In addition, Levman added that in Gandhari symbolized the sound *-ks.-* in Sanskrit by **𑖦** that actually represented a retroflex unaspirated fricative (*t.s.* or aspirate *t.s.ʰ*) which Kumārājīva transcribed as *-(c)ch-* sound in Middle Indic (as in *chudam*, Gir, Rock Edict 9 < S *ks.udra*, ‘small, trifling;’ or in Pali which has both *khaṇa* and *chaṇa* as derived forms of S *ks.aṇa* “moment”). Furthermore, Kumārājīva uses **𑖦𑖩** = **tṣhai/ tṣhɛ** in his arapacana syllabary to represent *-ks.-* in Sanskrit. It can be assumed that the source of his translation might be from Gandhari. On the other hand, the Sanskrit word ‘*aks.in.e*’ was not transcribed as a retroflex fricative but as a voiced aspirated stop, pronounced and/or written *aghin.e* in the source document. To be more illustrated, there are examples of this in Pali where *-ks.-* > *-(c)ch-*, *-(j)jh-* as well as *-(g)gh-*; for example, *ks.āyati* (Skt.) > *jhāyati* and *ghāyati* (‘it is consumed’) in Pali.

According to the discussion above, it is about the transcription from the source which varied the pronunciation. It was because in other Prakrit dialects there might not be the sound of *ks.* originally; in other words, they may be perceived with the single sound of palatal or velar stops. Žygis, (2008) proposed the argument on typological tendency of voiced sibilant affricates avoidance cross-linguistically due to the phonetic properties and aerodynamic characteristics; especially, it is too high pressure of air released from stop to produce voicing sound. In contrast, many Indo – Aryan languages tended to change many sounds to palatal affricates or post-alveolar affricates due to the complex sound with the suffix *[-j]* as Arsenault in the following paragraph.

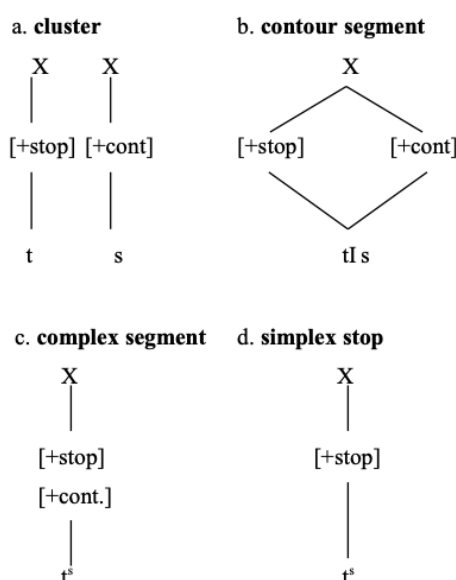
One way to describe the authentic sounds in Sanskrit can be studied from the current Indo-Aryan languages. One of acknowledged studies is of Arsenault (2012). Although his study mainly focused on retroflex sounds, we can see some distribution of affricates sound from his paper. Arsenault explained about palatal stops class is widely realized as laminal post-alveolar affricates in many South Asian languages. Similarly, Kenstowicz, and Kisseberth, (1979) illustrated that many Indian languages retroflex sounds are produced as apical alveopalatals or laminal sounds */tʃ/* and */dʃ/*. In my opinion, such sounds may be included to determine the sound of affricates. Additionally, Arsenault had explained about how to define and symbolize the affricates sound in South Asian languages as follows.

Most South Asian languages have a series of so-called ‘palatal’ stops that are realized as laminal post-alveolar affricates. These are typically transcribed as c, č or ć, in the case of voiceless phonemes, and j or ĵ, in the case of their voiced counterparts. I have modified these to IPA palato-alveolar affricates, tʃ and dʒ, throughout. Similarly, ‘palatal’ post-alveolar fricatives, which are typically transcribed as š or s’ and ž in the literature, have been modified to IPA ʃ and ʒ. The IPA alveolo-palatals, tʃ, dʒ, ɟ and ɟ̟, are also possible equivalents for palatal affricates and fricatives in many South Asian languages. For the sake of consistency, I have only used the palato-alveolars, tʃ, dʒ, ʃ and ʒ. Within the literature, ċ and ġ are sometimes used for dental or alveolar affricates. These have been modified to IPA ts and dz. The use of j throughout this dissertation corresponds to a palatal approximant (typically y in the source materials), not a voiced palatal stop/affricate, as in the South Asian tradition.

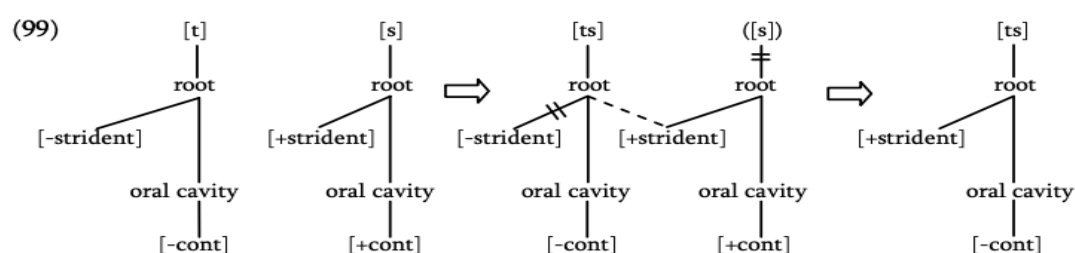
However, from the explanation above, it is still perplexed between the cluster /ts/ and /ch/ and other sounds whether they can be included in affricates class or not. We may compare to the sound of Greek to trace back the similar perception of such cluster or affricates sound in Sanskrit as the study of Syrika et al. (2011). The study was designed to determine the sequences between the affricates acquired before clusters in the position of initial of s- before or after other stops sounds by experiment with 60 Greek children. The findings were greater accurate on for /s/-stop and stop - /s/ sequences. However, the sound of affricates /ts/ in Greek were substituted by the stop sounds as well as the cluster /ps/ and /ks/ substituted by fricative sounds. The results were similarly both in children and adults. Thus, this is one of the perceptual evidences to produce and realize the affricates and cluster sounds that may be comparable to Pali and Sanskrit transmission.

Another study to determine the cluster and single was also conducted by Tzakosta, and Vis (2009) resulted that the preservation of affricates over stop+/s/ over /s/+stop clusters and all other clusters were more preferred. The participants tended to insert vowel between the cluster but not for affricates. The behavior of the consonants was due to the place of articulation identity of each sound and the degree of satisfaction of consonant’s strength scale. It is limited degree of decomposition for Affricates, while /s/ + stop + clusters show the higher degree of decomposition

but stop+ /s/ cluster is relative, and other cluster types are significantly decomposed. The researchers assumed the degrees of decomposition are different due to (a) different phonological representations, (b) the co-occurrence of clusters with other clusters in the word and (c) their position in the word. From the study, the tree diagram expressing the different phonological features is exhibited as follows.



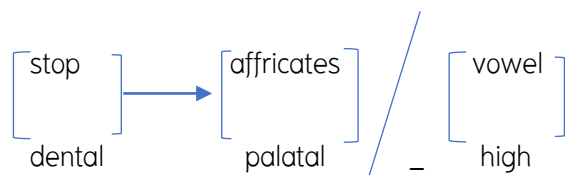
On the other hand, we may apply the phonological theory; namely, autosegmental or feature geometry to see the process of sound production abstractly and determine cluster or monosegmental.



Berns (2013) had cited many works to capture the process of affricates by the above. This feature trees show the feature of stops [t] together with fricatives [s], then it is delinked from stops sound to another feature of fricatives; that is, [+strident]. Strident is a crucial feature which many scholars have concerned and propose to ways to describe affricates originally in Clements (1985)

with the consonant coalescence process. Furthermore, affricates show the contour segment with the feature [strident] spreading together with [+continuant] at the same time.

Apart from *Pāṇiniyā Śikṣā*, *Pāṇiniyā Pratisākhya* the applied Phonetics describing the assimilation of dental explosives to palatal affricates; for instance, ‘*tad ca*’ becomes ‘*tacca*’ according to the phonotactic. There are plenty of examples in *Pāli* and Sanskrit assimilation that expresses the sound of affricates, especially palatalization. Typologically, in many languages such as Zoque and Papago (Saxton & Saxton, 1969 cited in Kenstowicz & Kisseberth, 1979) the stops sounds will become affricates in case they are in front of the high vowels; for instance, *čūagia* ‘net bag’ *čučul* ‘chicken’ *čukma* ‘dark’ *čiposid* ‘to brand’ *čilwin* ‘to rub’ *čigitog* ‘to think’ *činig* ‘to move the lips’ *čikpan* ‘work’ etc. Consequently, it can be noted as the generative rule of phonology as follows.



Universally, many languages change the sound from stops to affricates; in case, they are before the high vowels. Ohala, and Solé (2008) had insisted the controversy even in Sanskrit. They summarized that ‘*stops engender friction on adjacent glides, high vowels and sonorants*’ is moderated by voicing effects, with ‘*voiceless stops tending to be affricated more often than voiced stops*’ such as in English as nation [naʹtsjo:n] etc.

To illustrate the assimilation from [stop dental] + [glide] or [high front vowel] in Sanskrit can become [palato-alveolar affricates] in other Pali, the following examples are listed.

	Skt.	Pali	Gloss
a)	satya	sacca	‘truth’
b)	prati + eka > pratyeka >	pacceka	‘individual’
c)	matsya	maccha	‘fish’
d)	nṛtya	nacca	‘dance’

According to the examples above, in a) is the example abided by the rule of [dental stop] + [glide] > [affricates]; in other words, [t] + [j] becomes [c] called palatalization. For b) example, it shows the phonotactic or sandhi between two different vowel [i] becomes [j] or written ‘y’ in Sanskrit–Romanization system when contacting with other vowels; so that, it changes to ‘cc’ in Pali⁵. In c), it is the example of three segments cluster [tsj] where becomes [cch] in Pali. This indicates the sound compensation of the [s] sound together with [j] sound as the aspirated stop [–h] (or actually affricates). Lastly, in d) it is the example of retroflex sound [ɭ] or [ɮ] assimilated with the sound [j] can be changed to [–cc] as well.

To study sound change of affricates is not only leading us to the old–time languages, but also the comparative languages to complement the gap of word transmission in other related languages; for instance, Parpola, A. (2017) studied Finnish *vatsa* ~ Sanskrit *vatśa-* and the formation of Indo–Iranian and Uralic languages. Findings were that there are two words in Finnish similarly derived from Proto–Indo–Aryan word such as *vatsa* ‘stomach’ and *vasa* ‘calf’. These show the sound change process from the Proto–Indo–Aryan and trace back to Proto–Indo–European as follows; PIE **vet-(e)ś-o-* ‘yearling’ > Proto–Indo–Aryan **vatśa-* ‘calf’ > PFU **vaćća* > Finnish *vatsa* ‘stomach’, in contrast to Finnish *vasa-* ‘calf’ that maybe from the reconstructed form of Proto–Iranian as **vasa-* ‘calf’. The sound –ts– in Indo–Aryan –ts– and –s– Iranian can reflect the divergent development of PIE **-tst-* in the Iranian branch (> **-st-*, with Greek and Balto–Slavic) and in the Indo–Aryan branch (> **-tt-*, probably due to Uralic substratum). According to the split of such sounds, it can be traced Indo–Iranian in Yamnaya, North Pontic, and Volga during 3,000 BCE because the different sources of metal use; that is, Iranian branch relying on the North Caucasus, but Indo–Aryan branch faced to the Urals. Seeing that we can learn history by the language information and sound change. Though /ts/ sound in this case cannot be included to affricates, it turned to /ćć/ in some language’s divergence.

⁵ Well–known example of this is found in Sanskrit coalescence. In **Sanskrit** vowel coalescence, a low vowel coalesces with a following **high** vowel to create a mid vowel (Whitney 1960 cited in Causley, 1999)

Discussions

Despite the advanced instruments to illustrate how the affricate sound is produced, many traditional schools of Pali and Sanskrit still classify affricate sounds as ‘stop’. This perhaps the behavior of affricates can be the final and becomes cluster, in other words, geminate. For gemination, there are several sound changes from Sanskrit to Pali; for instance, the dental stop [t] followed by glide [j] becomes [cc], the geminate that can preserve two main features of the consonants (both striction and release sound), and it can sometimes even preserve the feature of the segment with aspiration such as [dh] + [j] becomes [jjha] as the rule of compensation. However, the affricate consonant derived from Pali is pronounced variedly due to their linguistic area as well as the sound system in their mother tongue; for example, affricates from Pali pronounced as fricative [s] in Myanmar. (Ankura, 2021), so it may lead to confusion among the audience.

Knowledge from Research

This article describes about affricates in Pali and Sanskrit in order to help improve the comprehension in language learning such as the pronunciation of affricates that had been classified as palatal stop, but actually with the evidence of the acoustic description it should be alveolopalatal affricate. In addition, according to the spectrogram, we can see the boundary of two main segments such as the area of striction and release. Consequently, affricates also behave as the cluster of stop and fricative derived from the assimilation between dental stop together and glide [j] (palatal approximant) which it still preserves the feature of bisegmental geminate.

Conclusion

In summary, the study of Phonetic and Phonological Description of Affricates in Pāli – Sanskrit according to the approaches of acoustic phonetics, phonological description, and articulatory phonetics found that in the ancient traditional grammatical scholars classified the affricate sounds as one of stops because they can behave as the initial, medial, or final, and the geminate according to the sound change from assimilation of dental stop together with palatal approximant [j].

This study can lead to more precise pronunciation of Pali, Sanskrit words especially for the religious purpose and avoid misunderstanding of the similar sounds.

Suggestions

As the oral transmission tradition of Pali and Sanskrit; especially in Sanskrit, pronunciation is crucial to recite the correct sound to connect to the gods. This paper will be beneficial to help improve the mispronounced sound. Moreover, the result from this study can also be applied to language learning to avoid misunderstanding from the affricate sounds pronounced variedly due to the influence of the speaker's mother tongue's sound system.

References

- Ashby, P. (2011). *Understanding Phonetics*. Routledge. <https://doi.org/10.4324/9780203776780>
- Bare, J., S. (1975). *Phonetics and Phonology in Pāṇini: The System of Features Implicit in the Aṣṭādhyāyī* (Doctor of Philosophy, Language and Literature, Linguistics). University of Michigan.
- Bloomfield, L. (1911). The Indo-European Palatals in Sanskrit. *The American Journal of Philology*, 32(1), 36–57. <https://doi.org/10.2307/288802>
- Bod, R. (2013). Antiquity: The Dawn of the 'Humanities'. In R. Bod (Ed.), *A New History of the Humanities: The Search for Principles and Patterns from Antiquity to the Present*. Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780199665211.003.0002>
- Cooper, L., Cooper, B., & Lew, S. (2012). *A phonetic description of Burmese Obstruents*. In Conference: 45th International Conference on Sino-Tibetan Languages and Linguistics. Nanyang Technological University, Singapore.
- Dorman, M. F., Raphael, L. J., & Isenberg, D. (1980). Acoustic Cues for a Fricative-Affricate Contrast in Word-Final Position. *Journal of Phonetics*, 8(4), 397–405. [https://doi.org/https://doi.org/10.1016/S0095-4470\(19\)31496-2](https://doi.org/https://doi.org/10.1016/S0095-4470(19)31496-2)
- Dunin-Borkowski, J. (2022). "OCP Effects and the Representation of Affricates in Basque". *Glossa: a Journal of General linguistics*, 7(1). DOI: <https://doi.org/10.16995/glossa.5859>
- Fujimura, O., Joseph, B. D., & Palek, B. eds. (1999). Proceedings of LP '98: Item Order in Language and Speech. Prague: The Karolinum Press. pp. 271–299.
- Jovicic, S., Punisic S., & Saric, Z. (2008). *Time-frequency Detection of Stridence in Fricatives and Affricates*. In *Proceeding Acoustic08 Paris*. Retrieved November 10, 2023, from <http://webistem.com/acoustics2008/acoustics2008/cd1/data/articles/002486.pdf>

- Levman, B. G. (2014). *Linguistic Ambiguities, the Transmissional Process, and the Earliest Recoverable Language of Buddhism*(Doctor of Philosophy. Department for the Study of Religion). University of Toronto.
- Panini P., & Katre S. M. (1987). *Astadhyayi of Panini*. Motilal Banarsidass.
- Turner, R. (1936). Sanskrit –kṣeti and Pali acchati in Modern Indo–Aryan. *Bulletin of the School of Oriental and African Studies*, 8(2–3), 795–812. DOI:10.1017/S0041977X0014145X
- Tzakosta, M., & Vis, J. (2009). *Phonological Representations of Consonant Sequences: The Case of Affricates vs. ‘True’ Clusters*. In M. Baltazani, G. K. Giannakis, T. Tsangalidis, & G. J. Xydopoulos (Eds.), In 8th International Conference of Greek Linguistics: Ioannina, Greece, Augustus 30th–September 2nd 2007 (pp. 558–573). Department of Linguistics, School of Philology, University of Ioannina.
http://www.linguist-uoι.gr/cd_web/docs/english/042_tzakosta&Vis8ICGL_OK.pdf
- Zgusta, L. (1990). *Aṣṭādhyāyī of Pāṇini*: Sumitra M. Katre, Texas Linguistic Series, University of Texas Press, Austin, 1987. *Lingua*, 82(2), 247–253.
[https://doi.org/10.1016/0024-3841\(90\)90063-Q](https://doi.org/10.1016/0024-3841(90)90063-Q)
- Žygis, M., Pape, D., & Jesus, L. M. T. (2012). (Non-)retroflex Slavic Affricates and their Motivation: Evidence from Czech and Polish. *Journal of the International Phonetic Association*, 42, 281329. DOI:10.1017/S0025100312000205